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## SUMMARY OF BANK ANGLE RELATING TO $V_{MC}$ SPEED AND DRAG

| Bank Angle | $V_{MC}$ Speed | Drag |
|---|---|---|
| 5° bank towards inoperative engine | High | Moderate |
| 0° bank | Moderate | Moderate |
| **2°-3° bank toward operating engine (Zero Sideslip)** | **Low** | **Minimum** |
| 8° bank towards operating engine | Lower | High |

Chart of Factors Affecting Vmc

## CHART OF FACTORS AFFECTING $V_{MC}$

| Effect on | $V_{MC}$ | Performance |
|---|---|---|
| Power Increase | Up – more yaw. | Up – more power. |
| Temp Increase | Down – less dense, less power, less yaw. | Down - less dense, less power. |
| Pressure Decrease | Down - less dense, less power, less yaw. | Down - less dense, less power. |
| Density Altitude Increase | Down – less dense, less power, less yaw. | Down – less dense, less power. |
| Bank Angle – 0° bank – no turn | Up – sideslip plane – less AOA on rudder because of sideslip airflow – less rudder effectiveness - more rudder needed. | Down – more drag – slipping. |
| Zero Sideslip – 2-3° bank – no turn | Middle – Use horizontal lift to stop turn – not slipping – more rudder effectiveness. | Up – less drag – zero slip. |
| Bank Angle – 5° bank – no turn | Down – plane turning toward good engine + rudder used to stop turn = slip toward good engine – high AOA on rudder. | Down – more drag – slipping. |
| Windmilling Propeller | Up – more drag, more yaw. | Down - more drag. |
| Feathered Propeller | Down – less drag, less yaw. | Up – less drag. |
| Aft C.G. | Up – less distance between rudder and C.G. - less rudder effectiveness. | Up- less tail down force required less induced drag Down - smaller arm on controls, less control effectiveness. |
| Heavier Weight | Down – more lift needed in level flight – more horizontal lift available during turn – helps prevent turn. | Down – more weight, more power required. |
| Flaps Down | Down - more induced drag from good engine side prevents yaw towards dead engine. | Down - more airflow over flap causes greater drag, causing increased yaw, causing increased roll, requiring more aileron to stop roll, creating more adverse yaw = more induced drag. |
| Gear Down | ??? – depends on location of C.G. to gear & direction of travel – moves C.G. ($V_{MC}$ Down – Keel Effect). | Down - more parasite drag. |
| Critical Engine Fails | Up – P-factor, Accelerated Slipstream, Torque make yaw worse. | Down – larger control inputs – more drag. |
| In Ground Effect | Up – less drag – more thrust available – more yaw. | Up – less drag. |

$V_{MC}$ down (slower) = good = more rudder available, or rudder more effective.
$V_{MC}$ up (faster)= bad = less rudder available, or rudder less effective.

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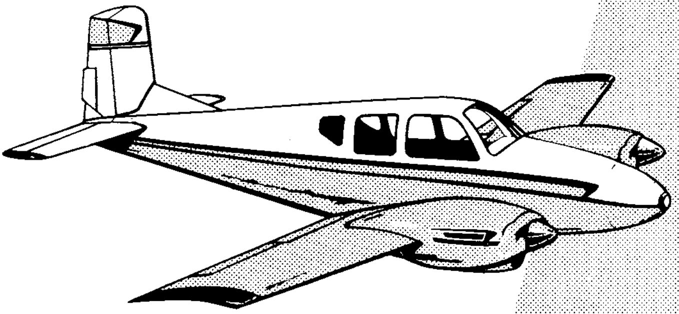

# Beechcraft 95 Travel Air

# OWNER'S MANUAL

Published by
Parts and Service Operations
Beech Aircraft Corporation
Wichita, Kansas 67201

Founded in 1932 by Walter H. Beech

95-590014-1
November 15, 1957

95-590014-1A4
Revised March 15, 1968

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## IMPORTANT

(Please attach this Owner's Manual Supplement to the inside cover of the Owner's Manual or other suitable location which is readily available to the pilot.)

# OWNER'S MANUAL

# SUPPLEMENT

## for

55, A55, B55, B55A, B55B, C55, C55A, D55, D55A, E55, E55A, 95, B95, B95A, D95A, E95.

The following information supersedes the information contained in the Owner's Manuals for the above listed airplanes.

1. Maximum usable fuel of each 25 gallon main tank is 22 gallons.

2. Maximum usable fuel of each 39 or 40 gallon main tank is 37 gallons.

3. Approximate reduction in range with full fuel due to change in usable fuel is:

   a. 6% with the 142 gal. fuel system (all 55).

   b. 7% with the 112 gal. fuel system (all 55's, and 95's).

   c. 10% with the 78, 80 or 84 gal. fuel systems (all 95's).

4. On Models 95 and B95 Owners Manuals, reduce range by an additional 135 statute miles to account for climb and 45 minutes reserve at 45% maximum continuous power.

P/N 96-590011-9

Issued: February 11, 1972

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## THANK YOU . . .

for displaying confidence in us by selecting a BEECHCRAFT airplane. Our design engineers, assemblers, and inspectors have utilized their skills and years of experience to ensure that the BEECHCRAFT meets the high standards of quality and performance for which BEECHCRAFT airplanes have become famous throughout the world.

## IMPORTANT NOTICE

This manual should be read carefully in order to become familiar with the operation of the airplane. Suggestions and recommendations have been made within it to aid in obtaining maximum performance without sacrificing economy. Be familiar with and operate the airplane in accordance with the Owner's Manual and FAA Approved Airplane Flight Manual and/or placards which are located in the airplane.

As a further reminder, the owner and operator should also be familiar with the Federal Aviation Regulations applicable to the operation and maintenance of the airplane, and FAR Part 91, General Operating and Flight Rules. Further, the airplane must be operated and maintained in accordance with FAA Airworthiness Directives which may be issued against it.

The Federal Aviation Regulations place the responsibility for the maintenance of this airplane on the owner and the operator, who should make certain that all maintenance is done by qualified mechanics in conformity with all airworthiness requirements established for this airplane.

All limits, procedures, safety practices, time limits, servicing, and maintenance requirements contained in this manual are considered mandatory for continued airworthiness to maintain the airplane in a condition equal to that of its original manufacture.

BEECHCRAFT Authorized Outlets will have recommended modification, service, and operating procedures issued by both the FAA and Beech Aircraft Corporation, which are designed to get maximum utility and safety from the airplane.

NOTE

Beech Aircraft Corporation expressly reserves the right to supersede, cancel, and/or declare obsolete, without prior notice, any part, part number, kit, or publication that may be referenced in this handbook.

It shall be the responsibility of the owner/operator to ensure that the latest revisions of publications referenced in this handbook are utilized during operation, servicing, and maintenance of the airplane.

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## WARNING

Use only genuine BEECHCRAFT or BEECHCRAFT approved parts obtained from BEECHCRAFT approved sources, in connection with the maintenance and repair of Beech airplanes.

Genuine BEECHCRAFT parts are produced and inspected under rigorous procedures to insure airworthiness and suitability for use in Beech airplane applications. Parts purchased from sources other than BEECHCRAFT, even though outwardly identical in appearance, may not have had the required tests and inspections performed, may be different in fabrication techniques and materials, and may be dangerous when installed in an airplane.

Salvaged airplane parts, reworked parts obtained from non-BEECHCRAFT approved sources, or parts, components, or structural assemblies, the service history of which is unknown or cannot be authenticated, may have been subjected to unacceptable stresses or temperatures or have other hidden damage, not discernible through routine visual or usual nondestructive testing techniques. This may render the part, component or structural assembly, even though originally manufactured by BEECHCRAFT, unsuitable and unsafe for airplane use.

BEECHCRAFT expressly disclaims any responsibility for malfunctions, failures, damage or injury caused by use of non-BEECHCRAFT approved parts.

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## *Performance Graphs*

# General Specifications

## ENGINES

Two Lycoming, 4 cylinder, O-360-A1A, rated at 180 hp @ 2700 rpm for all operations.

## PERFORMANCE — TRUE AIRSPEED, STANDARD ALTITUDE

MAXIMUM CRUISING SPEED:
(a) at 75% power (2450 rpm) ........................ 200 mph at 7500 ft.
(b) at 65% power (2300 rpm) ........................ 195 mph at 10,500 ft.

HIGH SPEED AT SEA LEVEL
(2700 rpm, full throttle) ............................ 210 mph

RATE OF CLIMB AT SEA LEVEL (rated power)
Two engines .......................................... 1360 fpm
One engine ........................................... 225 fpm

SERVICE CEILING (rated power) @ 4000 pounds
Two engines (100 fpm) ................................ 19,300 ft.
One engine (50 fpm) .................................. 6200 ft.

ABSOLUTE CEILING @ 4000 POUNDS
Two engines .......................................... 20,900 ft.
Single engine (descending to level out at) ........... 8,000 ft.

STALLING SPEED (Power Off), Flaps 33°, Gear Down ...... 70 mph

MAXIMUM RANGE @ 165 mph ........................... 1410 miles on 112 gal.

ENDURANCE ............................................ 8.75 hours

TAKE-OFF DISTANCE — (20° flap) Ground Run ............ 850 ft.*
Total Distance over 50 ft. ........................... 1025 ft.*

LANDING DISTANCE — (33° flap) Ground Run ............. 590 ft.*
Total Distance over 50 ft. ........................... 950 ft.*

*Take-off and landing performance based on Sea Level Standard Conditions.

## TYPE

Four-place, high performance, all-metal, low-wing, twin-engine cantilever monoplane, with fully retractable tricycle landing gear, solid cabin top, and full complement of engine and flight instruments standard.

## BAGGAGE

Maximum 270 pounds — rear
270 pounds less equipment — front

## WEIGHTS

Gross Weight ......................................... 4000 pounds
Empty Weight ......................................... 2570 pounds
(Empty weight includes complete set of flight instruments; cabin heating and venti-

lating system, with windshield deicers; sound proofing; navigation, cabin, instrument and landing lights; unusable fuel and oil.)

Useful Load ........................................ 1430 pounds

Available weight for people and baggage with full tanks, (standard fuel) ............................ 917 pounds

## WING AREA AND LOADINGS

Wing Area ........................................ 193.8 sq. ft.
Wing Loading, at gross weight ........................ 20.6 lbs./sq. ft.
Power Loading, at gross weight ........................ 11.1 lbs./hp

## DIMENSIONS

Wing Span ........................................ 37 ft. 10 in.
Length ........................................ 25 ft. 4 in.
Height ........................................ 9 ft. 6 in.

## CABIN DIMENSIONS

Cabin Length ........................................ 6 ft. 11 in.
Cabin Width ........................................ 3 ft. 6 in.
Cabin Height ........................................ 4 ft. 2 in.
Passenger Door, size ................................ 36 in. x 37 in.
Baggage Door, size ................................ 24 in. x 22 in.
Baggage Compartments, size rear ........................ 16.5 cubic ft.
Baggage Compartment, size front........................ 13 cubic ft.

## PROPELLER AND EQUIPMENT

Propeller — Hartzell, hydraulically controlled continuously variable pitch, diameter 72″, with Woodard hydraulic governor, full feathering.

## ENGINE EQUIPMENT (Per Engine)

Starter
Generator
Voltage Regulator
Engine Primer
Fuel Booster Pump
Carburetor Air Filter
Mufflers and Carburetor Heaters (stainless steel)
Exhaust Manifolds (stainless steel)
Vacuum Pump

## FUEL AND OIL CAPACITY

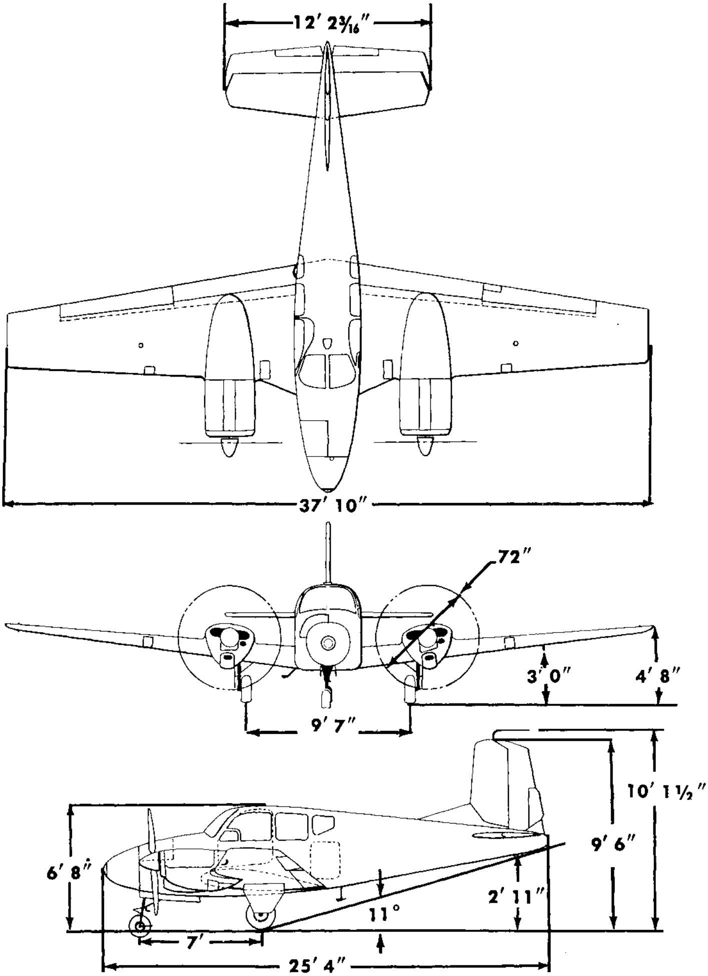
Fuel Capacity in standard wing tanks .................... 86 gal. (84 usable)
Fuel Capacity with optional auxiliary wing tanks ........... 113 gal. (112 usable)
Oil Capacity ........................................ 16 quarts

## LANDING GEAR

Tricycle type with swiveling steerable nose wheel equipped with shimmy dampener. Beech air-oil struts on all wheels designed for smooth taxiing and to withstand the shock created by landing with a vertical descent component of over 600 feet per minute. Main tires 6.50″ x 8″ size; nose wheel tire 5.00″ x 5″ size. Wheels — Goodyear with single disc hydraulic brakes.

## ELECTRICAL EQUIPMENT (24 Volt System)

Battery — 17 ampere-hour or 24 ampere-hour
Electric motors for operating flaps and landing gear
Electrically Operated Cowl Flaps
Two 15-Amp. Generators or two 25-Amp. Generators



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# *This Is Your Travel Air*

THE Model 95 TRAVEL AIR is a four-place, low wing monoplane with a maximum gross weight of 4,000 pounds. The all-metal, semi-monocoque airframe structure is of aluminum, magnesium and alloy steel, riveted and spotwelded for maximum strength. Careful workmanship and inspection make certain that structure strength will withstand flight loads in excess of the CAA requirements for a "Normal" category, under which the Model 95 is licensed.

Power is furnished by two Lycoming O-360-A1A engines, each rated 180 horsepower at 2700 rpm for both take-off and maximum continuous operation. Each engine drives a Hartzell two-blade, constant speed, full feathering propeller.

Under normal gross load configurations the Model 95 has a cruising speed of 200 miles per hour at 75% power (2450 rpm), and a maximum speed of 210 miles per hour (2700 rpm) in level flight.

The TRAVEL AIR has fully-retractable tricycle-type landing gear. When retracted, the wheels and struts are completely enclosed by fairing doors to reduce drag to the minimum.

Space for electronic equipment and the electrical system's 24-volt battery is provided in the upper portion of the nose compartment; in addition, the compartment may be used for baggage within the placarded weight limitations. The aft baggage compartment is accessible both through the door on the right side of the fuselage and from inside the cabin by reaching over the rear seat back.

Coat hangers secured overhead behind the rear seat may be used to hang clothing in the baggage compartment, without folding. Clothing hung here is completely clear of the passenger area, yet readily accessible in flight. The compartment door has a key type lock for security of items stored in the baggage compartment when the aircraft is parked.



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The baggage compartment floor is fitted with tiedown lugs for lashing cargo, and pockets on the back of the rear seat may be used to stow small, loose items.

The ventilating system and combustion heater, with windshield defrosters and a blower for heater operation on the ground, provide an adequate supply of both cold and heated air under thermostatic control.

Flight control surfaces are of the conventional three-control type and have controllable trim tabs; all controls and tabs are manually operated from the cockpit and the trim tabs have cockpit position indicators.

## CABIN ARRANGEMENT

The conventional side-by-side interior arrangement of the TRAVEL AIR cabin offers all the advantages of executive transport comfort with "safety engineered" appointments. Pilot and passenger fatigue factors have been taken into consideration wherever they are pertinent in designing the airplane. These primary design considerations assure relaxed, comfortable, speedy travel.

All occupants of the aircraft have excellent visibility through the large tinted, ultra-violet-proof windshield and side windows. Both rear windows open for ground ventilation and have positive locks to prevent opening in flight. Release pins permit the windows to be used as emergency exits. Attractive upholstery and "wall to wall" carpeting add distinctive styling and finish to the remainder of the cabin furnishings and complement the basic color scheme of the aircraft. These travel-designed interiors also include cabin loudspeaker, front seat sun shades, shoulder harness, adjustable seats, collapsible armrests, detachable headrests and other comforts of truly "hushed" air travel.

## ASSIST STEP

To make entering the Travel Air cabin easier an assist step is located behind and below the trailing edge of the right wing and there is hand grip on the fuselage above and ahead of the step. To reduce drag, the step is retracted and extended with the landing gear.



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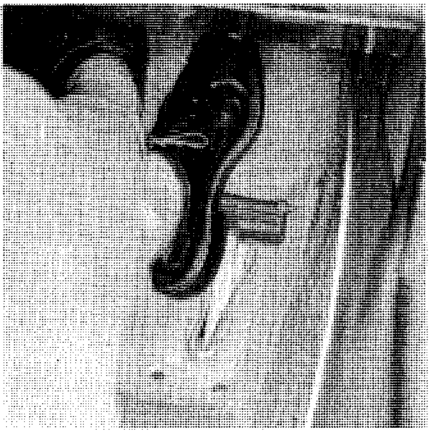

## SEAT ADJUSTMENTS

Since people come in different shapes and sizes, the Travel Air's seats may be adjusted to fit the individual comfort requirements of their occupants. Both front seats are adjustable fore-and-aft by pulling up on the small lever just to the right of each seat cushion and pulling or pushing on the seat. The front seat backs are also adjustable to three positions off vertical. Except when the aircraft is to be operated from the right side, the right hand set of rudder pedals may be laid forward against the floorboards, for maximum leg room.




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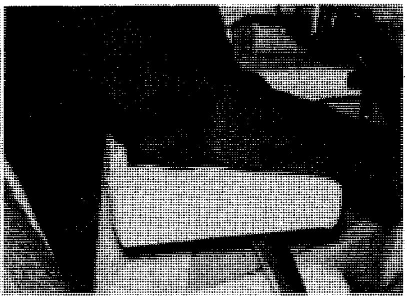
The rear seat back also may be adjusted to three positions off vertical by pulling forward on the seat back to raise it or pulling forward until the catch releases, then pushing back again, to lower it. On aircraft TD-174 and after the rear seat backs may be individually reclined. Levers at the outboard edge of each rear seat control the reclining mechanism.

In addition to the four seats described above, an optional fifth seat is available for installation in the baggage compartment. The seat folds back out of the way when not in use. Optional structure added to the fuselage supports the seat. To provide the necessary room for the fifth passenger, rear seats with shorter backs are installed on which head rests of the type used on the front seats may be installed.

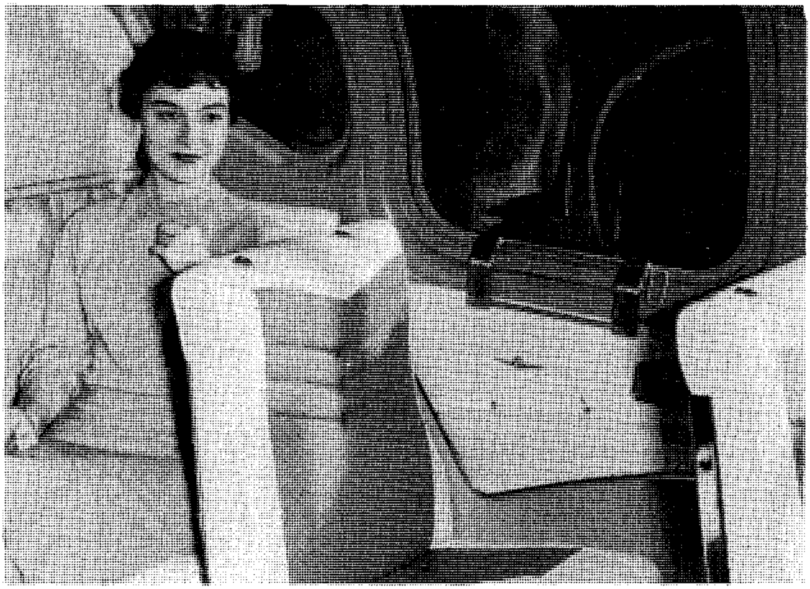
## ARMRESTS AND HEADRESTS

Armrests for both front and rear seat passengers are built into the cabin sidewalls and the door; a cup in the door armrest forms a convenient handle for pulling the door closed. A center armrest in the rear seat back may be swung down or folded up into the seat back, and a generously-proportioned armrest between the two



front seats may be raised into position on a pedestal, or lowered flush with the seat cushions. On TD-174 and after, the center arm rest slips out of sockets in the seat frame and may be stowed in the pocket under the seat.

All four passenger seats have sockets for attaching large, pillow style headrests, two of which are provided as standard equipment. On TD-174 and after, when the optional fifth seat is not installed, only the two front seats have sockets for headrests, one of which is provided as standard equipment. The pillows may be used comfortably in connection with the shoulder harness and will lessen fatigue during a long flight or rough air operation.



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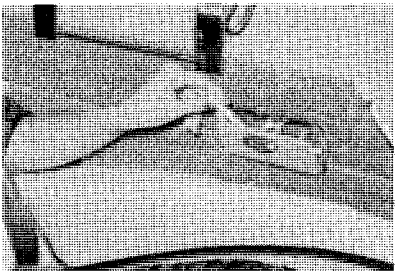
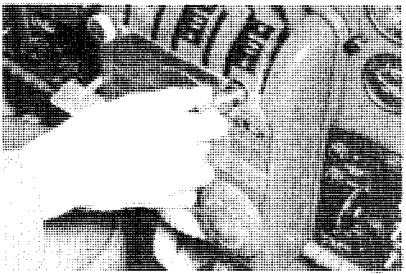
## SHOULDER HARNESS AND SAFETY BELTS

The Beech designed high-strength shoulder harness and safety belts on your Travel Air, if properly worn, will keep its occupants snugly in their seats in rough air or under rapid deceleration. Tests show that shoulder harness will protect its wearer in sudden straight ahead decelerations approaching 20 Gs. The harness is mechanically simple and comfortable and wearing it you have sufficient freedom of movement to easily operate all the controls. The nylon strap material, in colors complementing the upholstery, is soil resistant and easily cleaned. The airline-type harness buckles may be fastened or released quickly and are easily adjusted.

## ASH TRAYS AND LIGHTERS

For the convenience of passengers who smoke, there is an electric cigarette lighter in the control console. Pull-out ash trays are incorporated in the cabin door and in each side panel for both front and rear seat passengers. To remove an ash tray for emptying, depress the snuffer bar and pull the tray out of its mounting.







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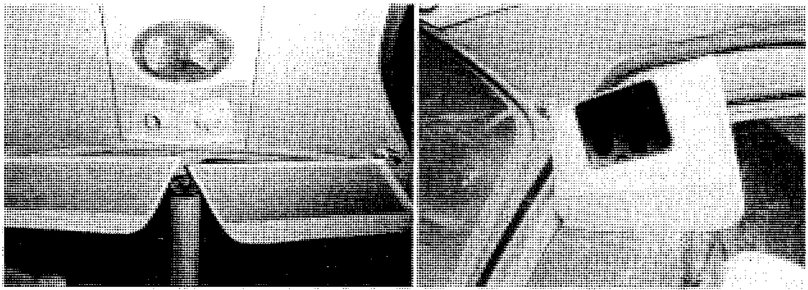


## SUN VISORS

Individual front seat sun visors, as standard equipment, may be adjusted to shield either the pilot's or front seat passenger's eyes as desired. For maximum forward and upward visibility, the visors may be laid back completely clear of the windshields.

## SPECIAL FEATURES

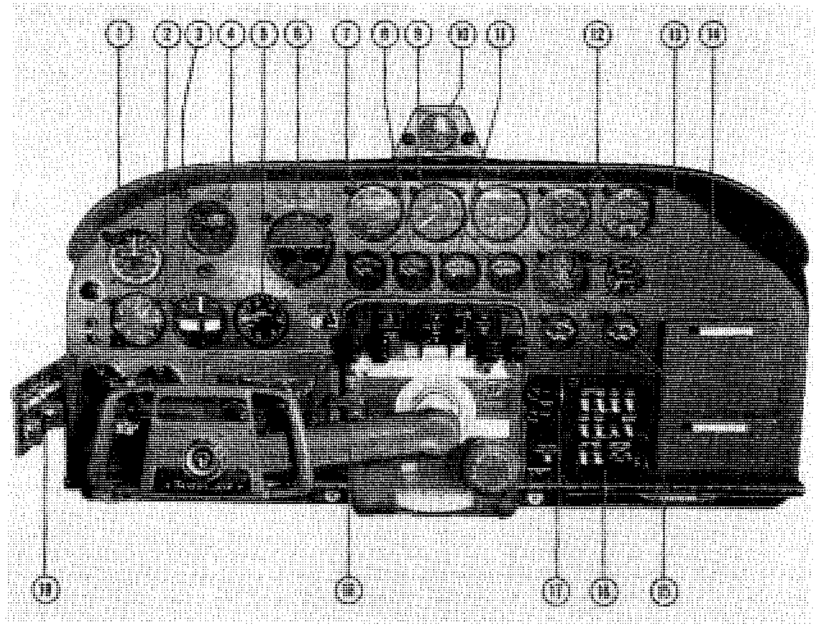
Among the special new design features and advantages incorporated in the Model 95 are the dynafocal type engine mounting which reduces engine vibration to an absolute minimum. Acoustically engineered and soundproofed, the cabin has the lowest noise level of any light twin in the TRAVEL AIR's class. For control of engine cooling, electrically-operated, gill-type cowl flaps are adjustable at the touch of a switch.

The fuel system uses a cross-feed arrangement which makes available the entire fuel supply of both wings to be used by either engine. This safety feature makes possible continued flight on one engine, if necessary, until the entire fuel supply for the aircraft is exhausted.

Landing gear and wing flap switches are designed to be pulled back out of a detent before they can be repositioned, to help avoid accidental tripping.

The extra-large floating instrument panel, designed for a more flexible instrumentation including several combinations of optional radio navigational equipment, features the SAE type of accepted indicator arrangement and optional individual instrument lighting. As an extra BEECHCRAFT safety feature the airspeed indicator, calibrated in both miles per hour and knots, is marked with a blue line range for single-engine operation.

The greater wing area and aspect ratio attained with the addition of the new wing tip to the basic wing design increases the over-all take-off, climb and service ceiling performance of the aircraft, especially during single-engine operation.



1. Airspeed Indicator
2. Altimeter
3. Turn-and-Bank Indicator
4. Directional Gyro
5. Rate-of-Climb Indicator
6. Attitude Gyro
7. Dual Manifold Pressure Gage
8. Fuel Gages
9. Dual Tachometer
10. Clock
11. Ammeters
12. Engine Gage Units
13. Dual Cylinder Head Temperature Gage
14. Suction Gage
15. Carburetor Air Temperature Gages
16. Lighting Switch Panel
17. Landing Gear Position Switch
18. Flap Position Switch
19. Engine Switch Panel

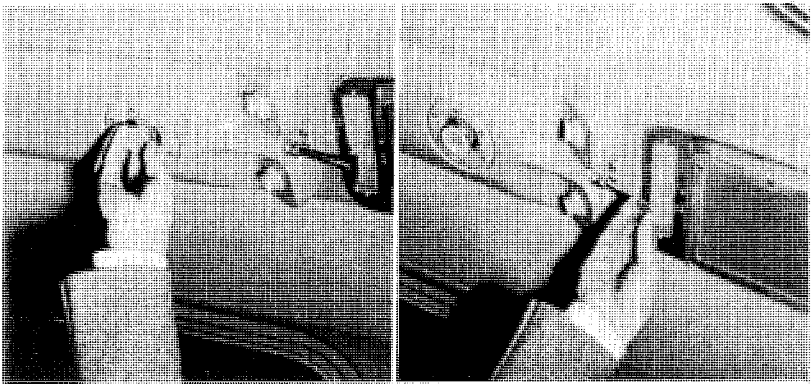
## OPTIONAL EQUIPMENT

Due to the variation in aircraft requirements to fit the needs of individual operators, your Travel Air has been designed with the features most needed for average use as standard equipment. Other equipment items are considered as optional equipment. The extra items offered may be installed in your Travel Air at the factory when the aircraft is assembled or by your BEECHCRAFT distributor or dealer. Some items, such as auxiliary wing tanks and super soundproofing, are suitable only for factory installation due to the impracticability of installing them on a completed aircraft.

The following pages describe the majority of optional equipment items available on your Travel Air, either to be specified when ordering the aircraft or installed at a later date by your BEECHCRAFT distributor or dealer.

## EVAPORATIVE COOLER

An abundant supply of cooled and filtered fresh air is supplied by the evaporative cooler on the cabin overhead. Without moving parts, the cooler passes air picked up from a scoop in the cabin top over mineral wicks resting in a pan of water. The wicks pick up pollen, and dust from the air and the evaporating moisture reduces its temperature. As with any evaporative cooler, the temperature drop and water consumption depend on the relative humidity of the incoming air; in average summer weather, the water supply will last up to four hours.





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The cooled, washed air is distributed by individually-adjustable outlets in the overhead duct. The hinged airscoop is opened, closed or set in any desired intermediate position to regulate the intake airflow, with a push-pull control placed overhead, just aft of the cabin loudspeaker. Pushing the control in closes the scoop; turning the handle counterclockwise locks it in the desired position. The cooler requires only refilling with demineralized water and a seasonal draining and cleaning to keep it in good working order.

## AUXILIARY FUEL CELLS (Factory Installation Only)

For additional fuel capacity, 31-gallon auxiliary cells in the outer wing panels replace the 17-gallon cells; they provide a usable capacity of 112 gallons, while the standard cell arrangement provides 84 gallons of usable fuel.

The large auxiliary cells may be installed only at the time the aircraft is assembled at the factory, due to the extensive rework necessary to install them after the wing skins are riveted in place.

## LOOSE TOOLS

In addition to the standard loose tools and accessories, an optional kit with hoisting slings, adapters, and special wrenches for wing and propeller adjustments is available. This equipment is the same type as used by the factory in the assembly of your aircraft and by BEECHCRAFT dealers, distributors, and Certified Service Stations.

## PROPELLER ACCUMULATOR

Installed as optional equipment, a 60 cubic-inch air-oil type accumulator unit for each engine assists the propeller unfeathering process.

The accumulator unit is charged with 135 psi of nitrogen or dry compressed air. Oil under pressure obtained from the propeller governor at approximately 300 psi is forced into the accumulator whenever the engine is operated. Through mechanical linkage between the propeller control, propeller governor and accumulator shutoff valve, the accumulator pressure is retained when the propeller control is moved to the full aft or feather position.

When the control for the feathered propeller is moved full forward to the governing range, the governor pilot valve is set to the increase rpm position and simultaneously the accumulator shutoff valve is opened, permitting the oil under pressure in the accumulator to flow through the high rpm passage of the governor and out to the propeller piston, returning the blades to low pitch.

## EXTERNAL POWER RECEPTACLE

To extend battery life an external power receptacle may be installed in the upper, outboard side of the left engine nacelle. The power receptacle, which will accept a standard auxiliary power unit's AN plug is connected to the starter relays and when a power unit or battery cart is connected, the electrical system is energized.

External power is of particular value in making radio and electrical equipment checks without starting the engines and, in cold weather, for operating the heater and blower before starting. External power will aid materially in cold-weather starts, also, overcoming the dual disadvantage of high starter loads from cold oil, and lowered battery output.

## DUAL CONTROLS

For pilot instruction, familiarization and demonstration purposes, your Travel Air may be equipped with a dual control column having two wheels, instead of the standard throwover control arm. Dual brakes, with master cylinders on the right hand rudder pedals as well as the left hand, plus the deluxe panel with dual flight group provide a complete dual control installation.

## TAXI LIGHT AND ROTATING BEACON

Of particular value for night operation are the taxi light and rotating beacon or anti-collision light. The sealed-beam taxi light, which may be used continuously if desired, replaces a chrome plated plug in the center of the nose air intake and is controlled by a toggle switch on the right sub-panel.

For night flying or while under conditions of low visibility, especially in high-density air traffic areas, the anti-collision beacon is almost an essential. It produces two rotating beams of high-intensity red light, 180 degrees apart, which are visible for several miles. The beacon is mounted on the cabin top aft of the baggage compartment and is controlled by a toggle switch on the right sub-panel.

Available as optional equipment on TD-174 and after, a rotating beacon is mounted on the underside of the cabin for additional anti-collision protection.

## GENERATORS AND BATTERIES

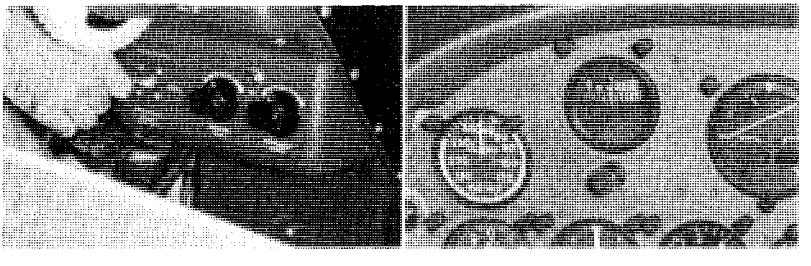
For operations requiring an electrical system of larger capacity, 25-ampere generators may be substituted for the standard 15-ampere generators. Also available as a replacement for the standard 17-ampere-hour, 24-volt battery are two 24-ampere-hour, 12-volt batteries connected in series to provide the normal 24 volts.

## SUPER SOUNDPROOFING (Factory Installation Only)

The acoustics of super-soundproofing achieve a maximum in low cabin noise and vibration levels, a major factor in pilot and passenger comfort. This soundproofing consists of completely encasing the cabin area with an extra heavy fiberglass blanket and an additional coat of asphalt sound-deadener on the inside surface of the fuselage skin. Extra-heavy windshields and a thick foam rubber mat beneath the carpeting further deaden external noises.

## INSTRUMENT LIGHTS

Individual eyebrow-type red instrument lights make night flying easier and safer. Individual lighting assures evenly-distributed, illumination without glare or reflections of all the panel instruments. A rheostat switch under the control console controls the lights and adjusts them to the desired intensity. On aircraft TD-174 and after a light mounted on the lower part of the console illuminates the light rheostats and fuel selector panel.



## KOLLSMAN DIRECTION INDICATOR

The Kollsman direction indicator is a novel direct-reading magnetic compass which may be mounted on the windshield divider in place of the standard installation. The completely dry, vertical dial corresponding to a compass rose, brings the simplicity of indication to the board compass which has been previously associated only with horizontal reading compasses. Other advantages over the average magnetic instrument include freedom from oscillation, stability in rough air, no operation impairment due to severe temperature changes and the rapidity with which new headings are recorded. Both the period and the overswing are less than half that of the average magnetic indicator.

## CARBURETOR AIR TEMPERATURE INDICATORS

For safer and more efficient engine operation, carburetor air temperature indicators may be installed. Individual gages, calibrated in degrees of Fahrenheit, are mounted in the instrument panel and a resistance-type temperature bulb is located in each carburetor air intake plenum. The electrical circuit for the indicators is protected by a 5-ampere circuit breaker. Wiring for the indicators, from the firewalls to the instrument panel, is installed in all aircraft, to simplify later installation of the instruments if desired.

A comparison in flight of the outside air temperature indicator and the carburetor air temperature indicators will show a slight difference, due to heat picked up in the filters and ducts. Carburetor air temperature should not be used to establish a power setting with your horsepower calculator, since it is based on outside air temperature and the temperature rise in the ducts was allowed for in making the calculator.

## SINGLE TACHOMETER GAGE

A single tachometer with dual indicator hands and using the original mechanical drive cables may be installed in place of the two standard tachometers, thus leaving an opening in the panel for the installation of other equipment if desired.

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# Systems and Their Controls

TO develop a good flying technique, you must first have a general working knowledge of the several systems and accessories of your aircraft. Although they are closely interdependent in fact, these systems have been broken down arbitrarily in this section as follows: Flight controls, power plants and controls, fuel system, electrical system and components, vacuum system, heating and ventilation system and pitot and static system. In addition to these systems, this section describes the more important items of optional equipment.

## FLIGHT CONTROLS

The primary movable control surfaces of the Travel Air are operated through push-pull rods and conventional closed-circuit cable systems terminating in bell cranks. The pre-formed, extra-flexible steel cables run over phenolic pulleys with sealed ball bearings which ordinarily require no lubrication and insure smooth, free action and long cable life. Standard equipment provides a throw-over type control-wheel arm for elevator and aileron control which may be locked in two positions on either the pilot or co-pilot side and dual rudder pedals adjustable fore and aft to fit individual pilot requirements. The right hand rudder pedals may be laid flat against the floorboards when not in use. Trim tabs on all flight control surfaces are adjustable from the control console through closed-circuit cable systems which drive jackscrew type actuators. Position indicators for each of the trim tabs are located near their respective controls. The left aileron tab incorporates servo action, in addition to its trimming function. As the aileron deflects from neutral, its tab moves in the opposite direction. This action is independent of the tab's trim function and occurs without disturbing the trim setting.

The single, slot-type wing flaps extend from the fuselage to the aileron on each wing and are electrically operated through a system of flexible shafts and jackscrew actuators driven by a split field, series, reversible electric motor located under the front seat. The flap position lights on the left side of the control console show



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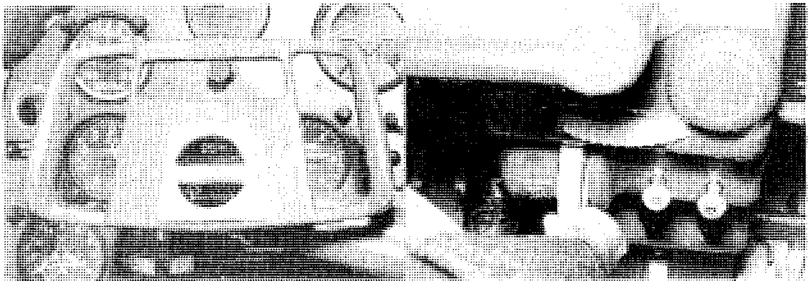
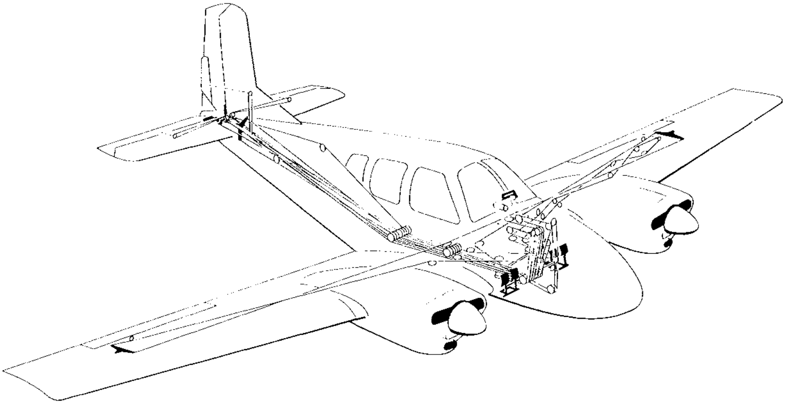


green for the up position and red for the full down (33°) landing position. Intermediate flap positions of 10° and 20°, as marked on the leading edge of the left flap, may be selected by moving the three position control switch, on the left side of the console, to "OFF" when the desired flap setting mark lines up with the wing trailing edge. Limit switches automatically shut off the flap motor when the full up or down position is reached.



## STALL WARNING INDICATOR

As an impending stall is approached a stall warning indicator sounds a warning horn and flashes a red light on the instrument panel while there is still ample time for the pilot to correct his attitude. The stall warning indicator, triggered by a sensing vane on the leading edge of the left wing, is equally effective in all flight attitudes and at all weights and airspeeds. Irregular and intermittent at first, the warning signal will become steady as the aircraft approaches a complete stall.

## POWER PLANTS

The Model 95 is powered by two Lycoming O-360-A1A engines rated at 180 horsepower each, at 2700 rpm, for both take-off and maximum continuous operation. They are four-cylinder opposed, air cooled engines with direct propeller drives and have a compression ratio of 8.5:1. They are fitted with a pressure-type cowling; cooling is controlled by opening and closing electrically-operated gill-type flaps on the trailing edge of the cowling. Float-type carburetors are used, with the carburetor air intake through a filtered airscoop at the lower front of each engine. Alternate air is heated to prevent carburetor ice, by heater muffs around the exhaust stacks; spring-loaded doors in the carburetor intake open automatically if the airscoops or filters are blocked by impact ice or dirt. Full dual ignition systems are used, with an impulse-coupling on the left magneto of each engine for easier starting. The electrical system uses Delco-Remy starters, generators and voltage regulators. Diaphragm fuel pump, vacuum pump and constant-speed propeller governor are standard equipment. Other engine features include sodium-cooled rotator-type valves, chrome piston rings and a nitrided crankshaft.

## PROPELLERS

The Hartzell constant-speed, two bladed, hydraulic, full feathering propellers on the Model 95 use pressure from a feathering spring and centrifugal force from the blade shank counter-weights to increase pitch, and engine oil under governor-boosted pressure to decrease pitch.

Above 800 rpm, when the propeller control lever is moved toward the high rpm position (forward) and the propeller is in an under-speed condition, the governor directs oil to a piston on the forward end of the propeller hub. As the piston moves away from the hub, pitch change linkage connected between the piston and the blades twists the blades toward low pitch. When the propeller control lever is moved toward the low rpm position (aft) and the propeller is in an over-speed condition, oil pressure from the governor to the propeller is relieved and the feathering spring pressure plus centrifugal force from the counter-weights pulls the piston toward the hub and twists the blades toward high pitch.

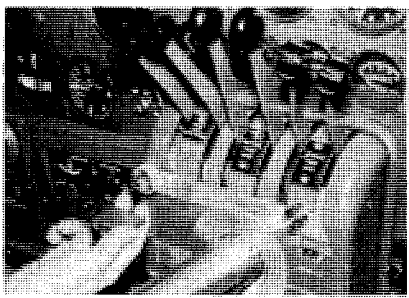
The propeller is feathered by pulling back on the propeller control past the detent to the limit of travel. Oil from the governor is shut off and a by-pass valve is opened allowing the feathering spring plus the counter-weights to force the oil out of the propeller piston and increase pitch to the feathered position. Automatic, centrifugally-actuated high-pitch stop pins engage the propeller hubs below 800 rpm, to prevent feathering action when the engine is not operating on the ground.

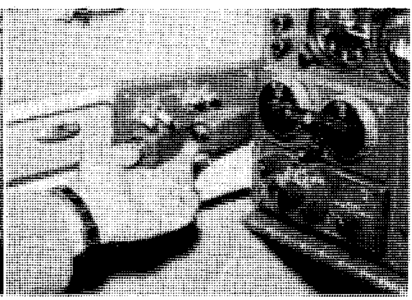
To unfeather, return the propeller control to the governing range (full forward) and start the engine with the starter. On airplanes with the optional unfeathering accumulator, start the engine by moving the propeller control full forward and engaging the starter as the blades begin to unfeather. With the engine operating, governor oil pressure returns the propeller pitch to the cruise setting.

## POWER PLANT CONTROLS

The throttle, propeller and mixture control levers, grouped along the upper face of the control console, are within easy reach of the pilot. Their knobs are shaped to military standard configuration so they may be identified by feel.

The levers are connected to their respective units by flexible control cables routed through the leading edge of each wing stub. A controllable friction lock on their support shaft may be tightened







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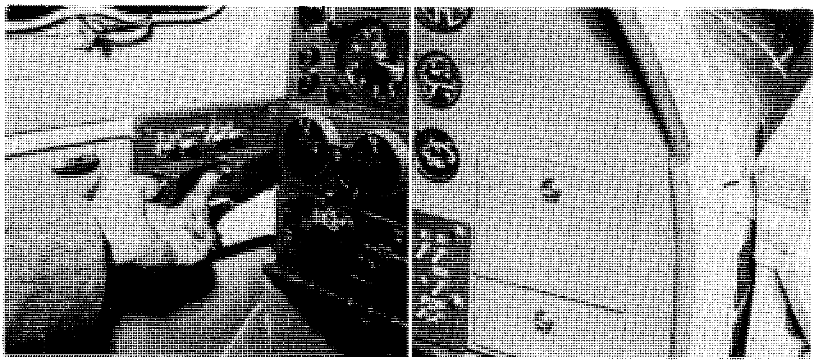
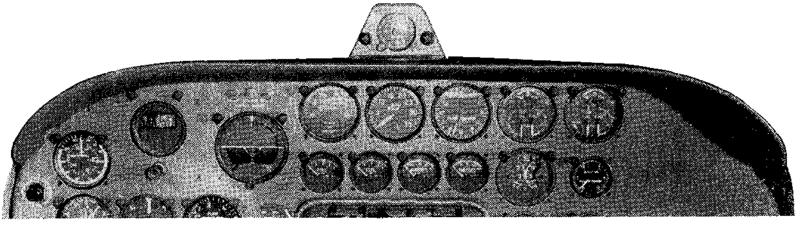
once power settings are established to prevent creeping. Controls for the carburetor heat are push-pull type with center button locks, and are mounted on the lower face of the control console.

The direct-cranking electric starters are relay-controlled and have a single toggle-type starter switch located on the left instrument sub-panel with the individual magneto switches. The three-position (center-OFF) toggle-type switches for the electrically-operated cowl flaps are mounted to the right of the control console on the instrument sub-panel. Intermediate settings for the cowl flaps may be used to maintain the desired cylinder head temperatures.

## INSTRUMENT PANEL AND INDICATOR MARKINGS

All the flight and engine instruments are mounted on the floating instrument panel in such a manner that the more important instruments are seen first. Instrument markings have a fluorescent coating for night operation and where practicable the normal operating limits are indicated. The airspeed indicator is marked with a special blue line range for single-engine operation and is calibrated in both miles per hour and knots. The standard panel instrumentation arrangement allots sufficient space for the various combinations of optional instruments and radio-navigational equipment currently available. A map case and glove compartment are conveniently set into the right side of the instrument panel. The map case is of correct size to hold folded aeronautical charts while the glove compartment may be used for the stowage of the surface control lock, pitot head cover and other small articles. The entire instrument panel, sub-panel and console are finished in colors selected to minimize glare and provide maximum legibility.





The attractive instrument cowl pad, made of foam rubber encased in dull-finish leather, is shaped to cover the contour above and between the instrument panel and the windshield. This pad, extending aft over the instrument panel in an eyebrow effect, and properly worn shoulder harness give the front seat occupants maximum protection during sudden stop or rapid deceleration.

## FLIGHT INSTRUMENTS

Standard flight instrumentation includes attitude and directional gyros, airspeed, altimeter, rate-of-climb, electric turn and bank and a clock. These instruments are appropriately grouped at the left side of the panel for easy reference by the pilot. An outside air temperature thermometer and magnetic compass are mounted in the windshield divider.

## ENGINE INSTRUMENTS

The engine instruments, except for the cylinder head temperature, suction and optional carburetor air temperature indicators, are grouped at the top center of the panel. The engine gage units, mounted to the right of the tachometers, indicate fuel and oil pressure and oil temperature for their respective engines. The recording tachometers, driven by flexible shafts from the engine accessory cases automatically total each engine's operating time. The pressure reading for the manifold pressure gage, located to the left of the tachometer installation, is obtained from each engine at the #3 cylinder. The fuel quantity indication is shown by two separate gages, each gage serving both fuel tanks in each wing. The gages are mounted with the ammeters just above the control console.



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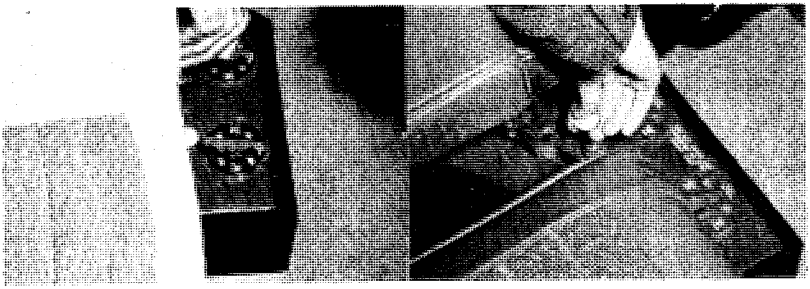


## FUEL SYSTEM

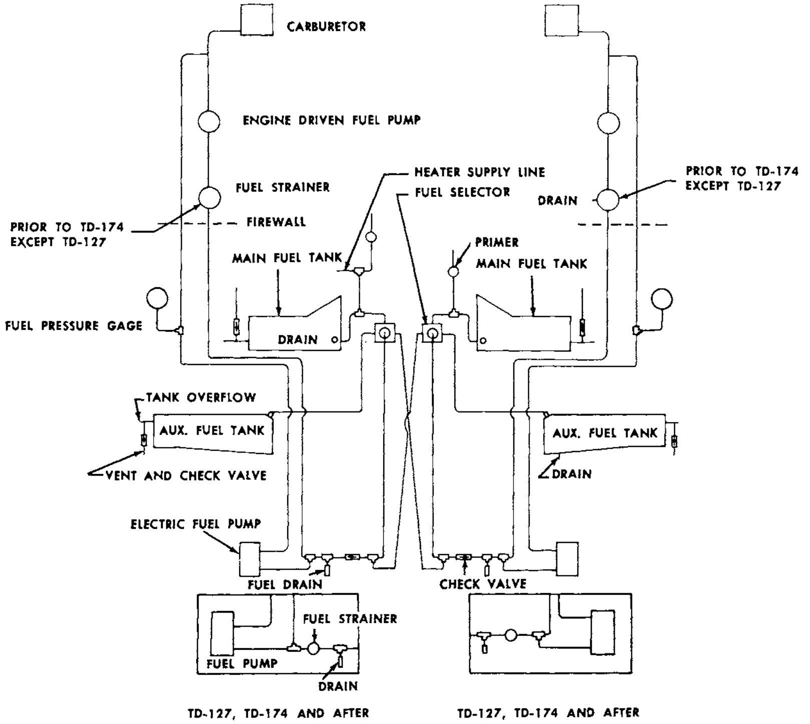
The Travel Air's fuel system consists of a separate, identical supply for each engine, interconnected by crossfeed lines for emergency use. During normal operation each engine uses its own fuel pumps to draw fuel from its respective fuel cell arrangement. However, on crossfeed operations the entire fuel supply of any or all cells may be consumed by either engine. A fuel selector valve for each engine controls the cell from which fuel is used.

The standard fuel cell installation uses two 25-gallon main cells in each wing stub and two 17-gallon auxiliary cells in the wing panels outboard of each nacelle. Total capacity for the system, with auxiliary cells, is 84 gallons of usable fuel. With the optional 31-gallon auxiliary wing cells the total capacity is raised to 112 gallons of usable fuel. Fuel cannot transfer from one cell to another during flight.

Fuel quantity is measured by a float-type transmitter unit in each cell, which transmits a signal to the fuel gages on the instrument panel. A two-position selector switch, controlled by the pilot, determines the cell, main or auxiliary, to which each gage is connected. Each cell is filled through its own filler neck with openings in the upper wing surface which are covered by flush-type filler caps.

Individual electric boost pumps for each engine furnish fuel pressure for starting and provide adequate fuel for full-throttle operation should the engine-driven pump fail. Due to the in-line location of the boost pumps, between the cells and the carburetor, fuel may be drawn from any cell within the system by the boost pump for the operating engine. A manually-operated primer for each engine, mounted on the fuel selector panel, supplies fuel taken from the main cell supply line directly to cylinders 1, 2 and 4. The fuel

# FUEL SYSTEM


CARBURETOR
ENGINE DRIVEN FUEL PUMP
HEATER SUPPLY LINE
FUEL STRAINER
FUEL SELECTOR
DRAIN
PRIOR TO TD-174
EXCEPT TD-127
FIREWALL
PRIOR TO TD-174
EXCEPT TD-127
PRIMER
MAIN FUEL TANK
MAIN FUEL TANK
FUEL PRESSURE GAGE
DRAIN
TANK OVERFLOW
AUX. FUEL TANK
AUX. FUEL TANK
VENT AND CHECK VALVE
DRAIN
ELECTRIC FUEL PUMP
FUEL DRAIN
CHECK VALVE
FUEL STRAINER
FUEL PUMP
DRAIN
TD-127, TD-174 AND AFTER
TD-127, TD-174 AND AFTER

system is drained at eight different locations: four snap-action valves on the underside of the wings drain the cell sumps which are fitted with finger screens; two snap-action valves fitted with extension tubes and located at the system low-spots, extend through the underside of the fuselage and drain the interconnecting lines and selector valves; a quick-drain valve, on the outside of each engine lower inboard cowling, drains the remainder of the system through a fuel strainer and sediment bowl. A check valve is installed in each cell over-flow and vent line to break any tank siphoning action due to temperature changes and fuel expansion or to over-filling.

For single-engine operation, using the crossfeed system, a series of check valves are installed between the crossfeed lines and the carburetors. These check valves prevent the suction of the operating engine's fuel pumps from pulling air into the system through the inoperative engine.

The heater fuel supply is taken from the left main cell. Due to the small amount of fuel burned by the heater, its consumption may be ignored in calculating fuel requirements. The fuel pressure for normal operation, indicated by the engine gage in the instrument panel, is 3 psi desired; 6 psi maximum and .5 psi minimum. The instrument always reads the electric boost pump pressure when it is in use. *Engine-driven fuel pump pressure is indicated only with the boost pump off and the engine operating.*

At least 91/96 octane aviation grade fuel must be used; no lower octane fuel is recommended. *If 91/96 octane fuel is not available, use the next higher grade* as an emergency measure until you can obtain the correct grade.

## OIL SYSTEM

The engine oil system is of the full-pressure, wet-sump type and has an 8 quart capacity. For safe engine operation, the absolute minimum amount of oil required in the sump is 2 quarts. Oil operating temperatures are controlled by an automatic thermostat bypass control incorporated in the engine oil passage of each system. The automatic by-pass control will prevent oil flow through the cooler when operating temperatures are below normal, as during the initial engine warm-up period. It also will bypass if the radiator is blocked. System servicing and draining points are shown on the servicing diagram. The determining factor for choosing the correct grade of oil is the oil inlet temperature which is observed during flight; inlet temperatures consistently near the maximum allowable would indicate a heavier oil is needed. Only straight petroleum base, aviation grade, non-detergent oil of the lightest weight that will give adequate cooling should be used. Avoid any additive to the basic lubricant.

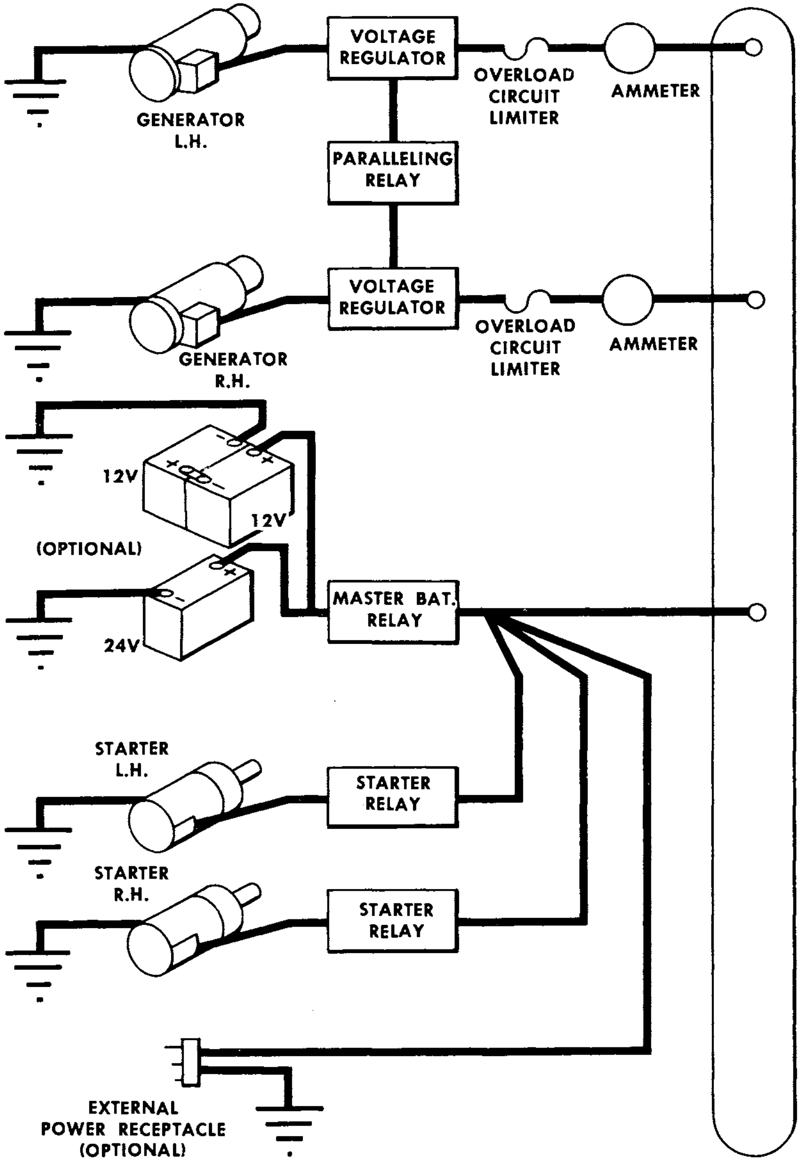
Moisture that may have condensed and settled in the oil sump may be drained by occasionally removing the oil drain plug and allowing a small amount of oil to escape; ideally, this draining should be done when the engines have been stopped overnight or approximately 12 hours. This procedure should be followed more closely during cold weather or when a series of short flights of less than 30 minutes duration have been made and the engines allowed to cool completely between such flights. For engine operating temperatures to reach and maintain a sufficient heat to evaporate this moisture will take approximately 90 minutes of normal operating time. This moisture content is always present and only under a continuation of abnormal circumstances would it reach harmful proportions.

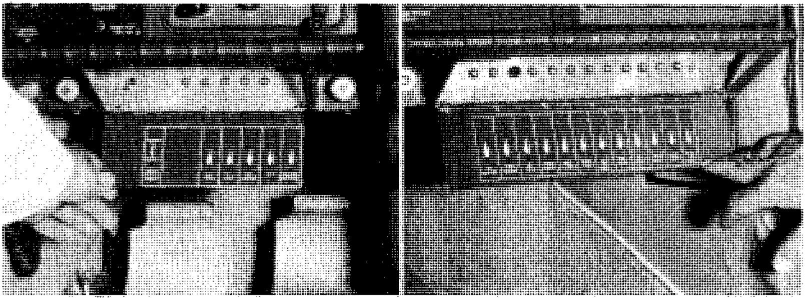
## ELECTRICAL SYSTEM

The TRAVEL AIR's direct-current 24-volt electrical system consists of one 17-ampere-hour, 24-volt battery mounted in the upper portion of the nose section, and two 15-ampere, 24-volt, belt-driven generators connected in parallel. Optional equipment consists of two 24-ampere-hour, 12-volt batteries connected in series to provide 24 volts, and two 25-ampere, 24-volt generators. The generator-to-bus connections are through the voltage regulators and ammeters. Each generator's output is automatically controlled by its voltage regulator and the system paralleling relay which adjusts the generator output so both are equal.

The ammeters in the Travel Air, although of the conventional charge-discharge type, are connected only to the generator output leads and function as loadmeters. With the system working properly, the ammeters will give a positive indication, increasing or decreasing directly with the load applied. Since the generator load also includes battery charging, battery condition may be estimated from the ammeter reading when the battery is momentarily switched off. Normally, the ammeters should show a negative reading only for a moment before the reverse-current relay opens, when an engine slows below generator cut-in speed. Each generator is controlled by

# ELECTRICAL POWER DISTRIBUTION





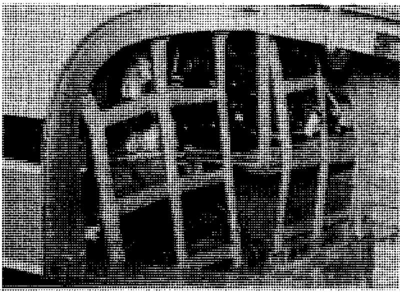
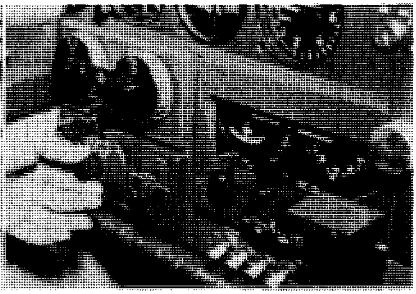
a separate toggle switch on the left instrument sub-panel which opens the generator field circuit when in the "OFF" position. The battery is connected to the main bus system through a master battery relay which is actuated by a master switch on the left instrument subpanel. On aircraft TD-174 and after a single master switch replaces the separate generator and battery toggle switches. Most of the primary circuits in the aircraft are protected by circuit breakers and are fed through the main bus system, using the aircraft structure as a common ground return. Individual circuit breakers, located along the bottom of the right instrument subpanel, are placarded with their particular circuit functions and are either the push-to-reset, push-pull or toggle type. Extra space is provided for circuit breakers to protect additional equipment which may be installed later.

The automotive-type starters are relay-controlled which minimizes the length of heavy cable required to carry the high amperage of the starter circuit. A drive unit actuated by centrifugal force from the operating starter motor engages and rotates the external ring-gear at the front of the engine crankcase. When the starter motor is de-energized the drive disengages from the ring gear pinion.

An optional external power receptacle on the left engine nacelle will accept a standard auxiliary power unit's AN plug for ground checks and starting. External power should be used particularly in cold weather when the starting load is greatest and the batteries output is reduced.

## RADIO EQUIPMENT

The combinations of optional radio packages available include VHF communications and navigation equipment, marker beacon, ADF and standard broadcast reception in addition to low, medium and high-frequency transmitters and receivers. Since selection of

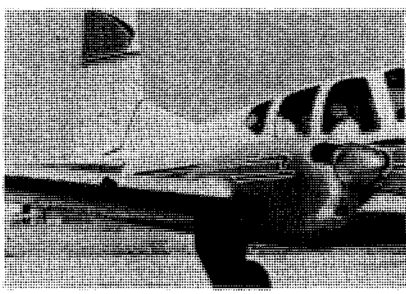
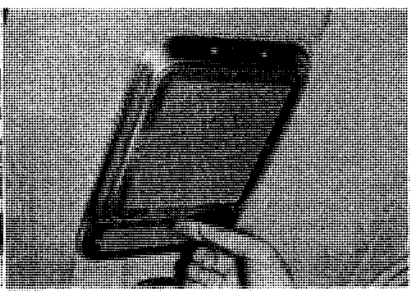
the radio equipment is determined by the needs and preferences of individual operators, detailed discussion of radio equipment has been omitted from this handbook.

All radio equipment is installed in the upper portion of the nose compartment and controlled from the instrument panel. The glass fiber nose section is suitable for ILS and flush-type omni antennas. The completely enclosed glass fiber tail cone may be used to house an ADF loop.

## LIGHTING

Cabin and instrument illumination are provided by a lighting system in the cabin overhead panel. The cabin light is controlled by an "ON-OFF" switch beside the light and a rheostat switch beneath the control console adjusts the intensity of the instrument lights.

Sealed-beam landing lights in the leading edge of each outboard wing panel are shielded by clear plastic lenses with a specially-designed shaded area to produce maximum effectiveness. Either light is operated independently by separate switches; operation



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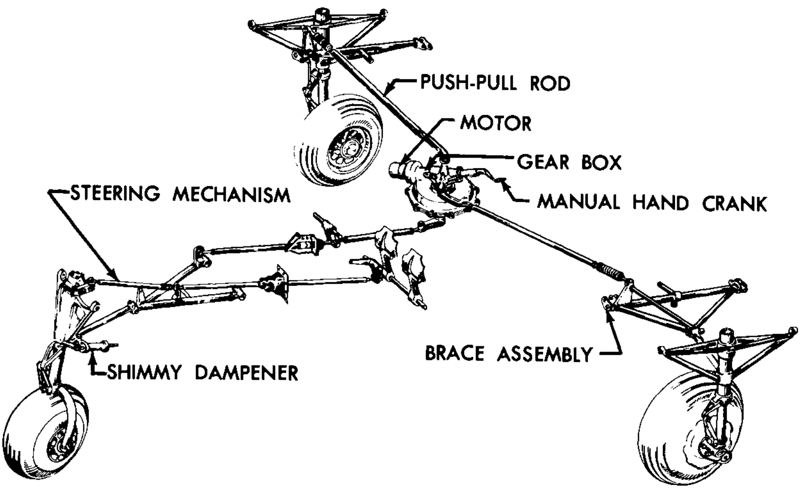
during ground maneuvering or prolonged operation in the air should be avoided. Conventional position lights on the wing tips and tail cone are operated through a flasher unit, designed to give steady lights if a malfunction occurs, and are controlled by a two position switch on the right sub-panel.

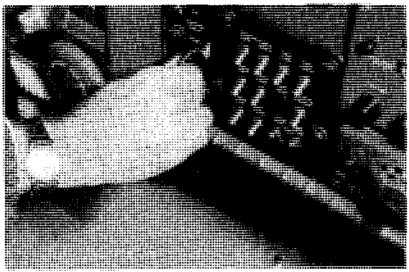
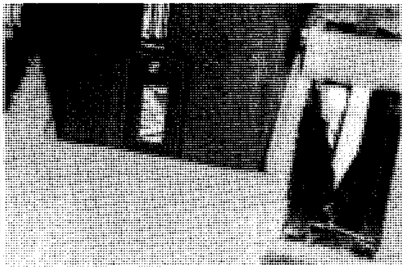
Lighting for the trim tab and mechanical landing gear position indicators is controlled by a rheostat switch slightly below the control console.

## LANDING GEAR, BRAKES AND STEERING

The TRAVEL AIR's extra-strong, electrically-operated landing gear incorporates the advantages obtainable only with tricycle type gear. The ease of ground operation is assisted by the increased visibility, more positive directional control for parking or operation under high surface wind conditions; decreased stopping distance and longer brake and tire life; these are but a few of the advantages.

The gear is operated through push-pull tubes by a reversible electric motor and actuator gear box under the front seat. The motor is controlled by a two-position landing gear switch located on the



instrument panel. Limit switches and a dynamic braking system automatically stop the retract mechanism when the gear reaches its full up or full down position.

With the landing gear in the up position, the wheels are completely enclosed by fairing doors which are operated mechanically by the retraction and extension of the gear. After the gear is lowered, the main gear inboard fairing doors automatically close, producing extra lift and reduced drag for take-off and landing. Individual up-locks actuated by the retraction system lock the main gear positively in the up position. No down locks are necessary since the over-center pivot of the linkage forms a geometric positive lock when the gear is fully extended. The linkage is also spring loaded to the over-center position.

The landing gear position lights, located beside the landing gear switch, indicate the position of the gear, either up or down; coming on only when the gear reaches its fully extended or retracted position. In addition a mechanical indicator beneath the control console shows the position of the gear at all times.

To prevent accidental gear retraction on the ground a safety switch, on the left main strut, breaks the control circuit whenever the strut is compressed by the weight of the airplane and completes it, so the gear may be retracted, when the strut extends. NEVER RELY ON THE SAFETY SWITCH TO KEEP THE GEAR DOWN WHILE TAXIING OR ON TAKE-OFF OR LANDING ROLL. ALWAYS CHECK THE POSITION OF THE SWITCH HANDLE.

When either, or both throttles are retarded below an engine setting sufficient to sustain flight, with the gear retracted, a warning horn will sound an intermittent note. During single engine operation



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the horn may be silenced by advancing the throttle of the inoperative engine enough to actuate the warning horn's throttle switch.

The steerable nose wheel, connected to the rudder pedals by a spring loaded linkage, is designed to absorb shocks and automatically caster to the correct alignment upon touch-down, when operating under cross-wind conditions. The retraction of the gear relieves the rudder pedals of their nose steering load and centers the wheel, by a roller and slot arrangement, to insure proper retraction into the wheel-well. A hydraulic dampener on the nose wheel strut compensates for the inherent shimmy tendency of a pivoted nose wheel.

The landing gear wheels are carried by heat-treated tubular steel trusses and use Beech air-oil type shock struts. Since the shock struts are filled with both compressed air and hydraulic fluid their correct inflation should be checked prior to each flight. Even brief taxiing with a deflated strut can cause severe damage.

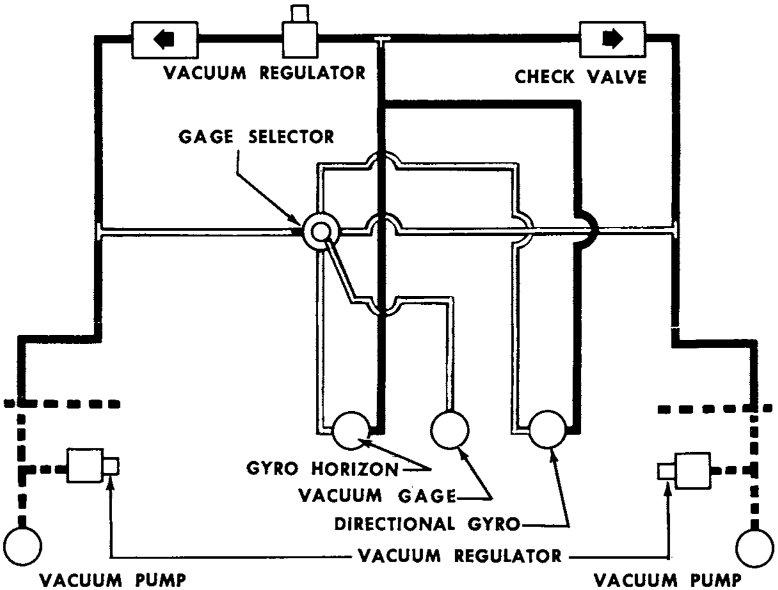
For manual EMERGENCY operation of the landing gear (lowering only) a hand-crank is located behind the front seat. The crank, when engaged, drives the normal gear actuation system.

The main landing gear wheels are equipped with Goodyear single-disc, self-adjusting hydraulic brakes actuated by individual master cylinders connected to the rudder pedals and operated as toe brakes. The hydraulic brake fluid reservoir is accessible from the forward baggage compartment and should be checked occasionally for specified fluid level. The parking brake is set by a push-pull control with a center-button lock and is located just to the right of and slightly below the control console. Setting the control does not pressurize the brake system, but simply closes a valve in the lines so that pressure built up by pumping the toe pedals is retained and the brakes remain set. Pushing the control in opens the valve and releases the brakes.

## VACUUM SYSTEM

Suction for the vacuum-operated gyroscopic flight instruments is supplied by two engine-driven vacuum pumps, interconnected to form a single system. For single-engine operation an automatic check valve for the inoperative engine closes thus forming a complete vacuum system sustained by the engine in use. Either vacuum

# VACUUM SYSTEM




pump has sufficient capacity to maintain the complete aircraft gyro instrumentation.

A vacuum gage selector valve, on the lower control pedestal, permits a check of the vacuum at four points in the system. The valve has four positions: directional gyro, gyro horizon, left pump and right pump. The suction in inches of mercury at any of the points selected is indicated on the instrument panel suction gage. During normal operation the valve should be positioned in either "Directional Gyro" or "Gyro Horizon." Air entering the system is taken in through the using instruments themselves. To eliminate dust and grit, which might injure the instruments, each of the instrument air intakes is fitted with a filter. Sluggish or erratic operation of one or more of the vacuum driven instruments, with a normal suction gage reading, indicates that clogged filter is reducing the volume of intake air to less than the instruments require. Suction in the system is controlled by adjustable, spring-loaded valves. One in the instrument line just ahead of the instrument panel acts as a system regulation valve and one in each engines nacelle acts as a relief valve. All three valves are set to bleed air into the system as required to maintain the correct suction supply.



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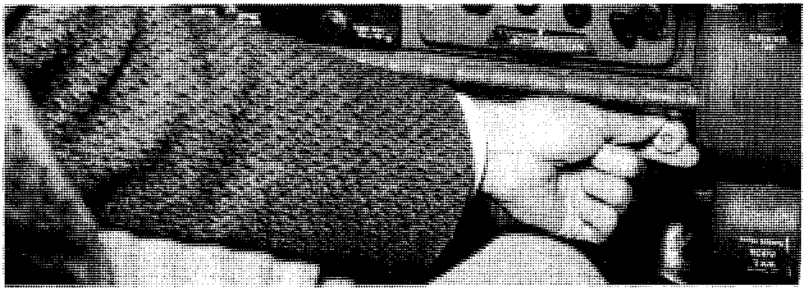


## HEATING AND VENTILATING SYSTEM

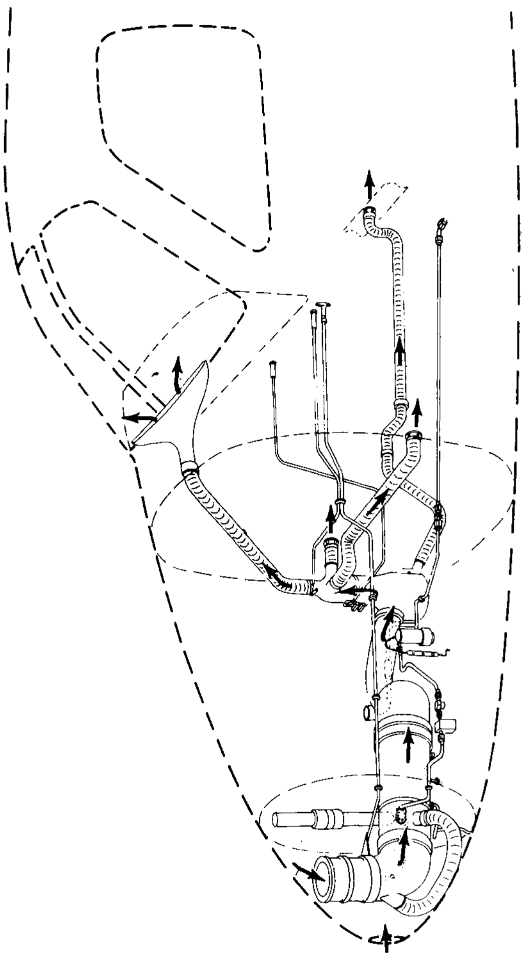
The fresh air heating and ventilation system in the nose of the Travel Air provides an ample supply of heated or cold air to the cabin both in flight and on the ground. Manually-operated cockpit controls regulate the heater and the air supply for individual preferences. The system consists of a Janitrol 35,000 BTU combustion heater, a ventilation air blower, fuel pump, fuel filter, shut-off valves and temperature-limiting thermostats. An iris-type air valve controlled from the cabin admits ram air taken in around the nose taxi light into the blower and the combustion heater plenum. All ventilation air passes through the heater before it is distributed to the cabin and windshield defroster outlets.

For flight operation, ram pressure alone forces fresh air through the system; on the ground, when ram pressure would be insufficient, a ventilation blower maintains air flow through the system for either hot or cold air. The blower is controlled by a switch connected to the landing gear actuation linkage in the fuselage center section, so that the blower operates when the landing gear is down, the "Cabin Heat" switch "ON" and the "Cabin Air" control in. The blower is shut off automatically when the gear is retracted, and may be shut off manually through the instrument panel switches or by pulling the "Cabin Air" valve control out approximately half way, partially closing the iris valve in the intake and opening a blower switch in the control linkage. This switch also turns off the heater since with the iris valve only slightly open the intake air will be insufficient for proper heater functioning.

To obtain more cabin heat during flight in low outside air temperatures, pull the "Cabin Air" valve control out as far as possible without shutting off the heater. This reduces the volume of air passing through the heater thus enabling the heater to raise the temperature of the air to a comfortable level.

Heater operation is controlled by a ductstat in the distribution plenum, which acts as a cycling thermostat to maintain within close tolerances the temperature selected with the mechanical thermostat control, by starting and stopping the heater. The "Cabin Temperature" control, on the left sub-panel, adjusts the opening

## HEATING AND VENTILATION





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temperature of the ductstat. When less heat is required, the opening temperature is lowered, and when more heat is required, the opening temperature is raised. The ductstat upper limit is set at 180°F, to prevent uncomfortably-hot air from entering the cabin. The windshield defroster duct serves a dual purpose; in addition to its normal function, cabin ventilation may be more evenly distributed by using it as a variable cold air outlet.

A normally-open thermostat in the heater discharge plenum acts as a safety device, to render the heater system completely inoperative if a malfunction should occur which would result in dangerously-high temperatures. This thermostat is set to close at 300°F, grounding a circuit through a fuse in the heater power supply. Grounding the circuit will blow the fuse, disconnecting all power to the heater circuits. It does not affect the blower circuit, however. The fuse is located on the upper right-hand segment of the bulkhead behind the instrument panel, in a place chosen deliberately for inaccessibility in flight. Since any condition causing this fuse to blow will be hazardous, its location is intended to prevent replacement before the malfunction has been investigated and corrected. Such an arrangement is required by Civil Aeronautics Board regulations, for combustion-type heaters.

Fuel for the heater is drawn from the left main wing tank, by a separate, electric fuel pump. The heater fuel line is equipped with a strainer. A spring-loaded solenoid valve, which closes whenever the heater is off, prevents any seepage of fuel from the line into the inoperative heater.

If a heater malfunction should occur resulting in the overheat fuse blowing, the system should be thoroughly checked and the malfunction corrected before the heater is operated again.

The heater ignition unit, mounted in the nose cap, uses a vibrator to provide interrupted current for its high-voltage coil. The unit is equipped with two sets of points; a toggle type switch, located beneath the left sub-panel, will place the alternate set in service. When the alternate points are used, the points should be replaced as soon as practicable.

## PITOT AND STATIC PRESSURE SYSTEMS

Impact air pressure and atmospheric air pressure for the airspeed indicator, altimeter and vertical speed indicator are supplied by



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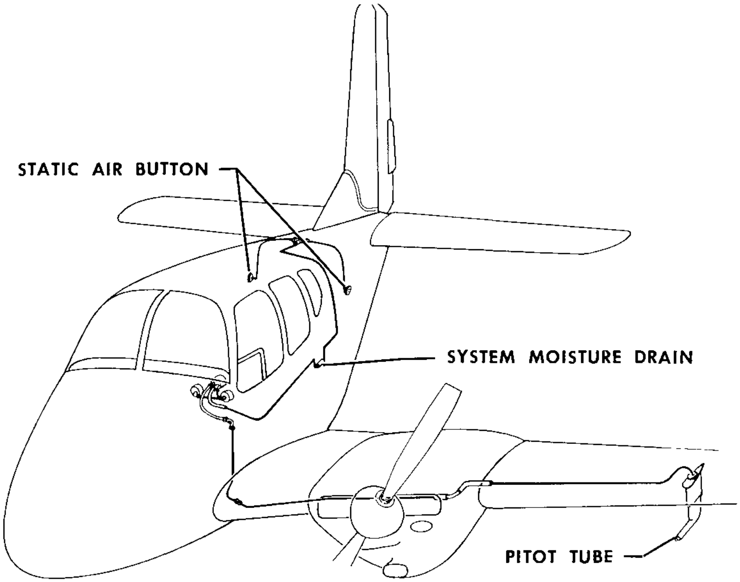
# PITOT AND STATIC AIR SYSTEM




the pitot and static air systems. Since the accuracy of these instruments depends on accurate pickup of the two pressures, the systems have been developed carefully and tested in flight with highly-accurate special equipment.

The static air system picks up atmospheric pressure from buttons on each side of the fuselage just aft of the last cabin bulkhead, where they are least affected in flight by impact pressure and turbulence. Lines from the buttons are connected to a single line which runs forward to the instrument panel, where it is connected to the airpseed, altimeter and vertical speed instruments. A short length of rubber tubing in the static pressure line, accessible through an opening in the left side of the baggage compartment, may be disconnected to drain moisture from the system.

Operated by the differential between impact air pressure and atmospheric air pressure, the airspeed indicator is connected to both the static system and the pitot system. Impact pressure is picked up by the pitot head, mounted on a mast under the left wing, and conducted inboard to the instrument panel. Since the pitot head is subject to impact ice accumulations, it is equipped with an electric heating element, controlled by a switch on the right sub-panel.

Proper operation of the pitot and static systems may be vital to your safety, and their proper care merits your personal attention. Both the pitot and static port openings must be kept free of foreign matter. Always install the pitot cover whenever the aircraft is parked, and make a check of the openings a part of every preflight inspection. Sluggish or obviously-low indications from all three instruments will result from even a partial restriction in the static system, while similar response from the airspeed indicator only may indicate a restriction in the pitot system. Limit ground operation of the pitot heater to brief periods for functional checks.

# *Flying the Travel Air*

TO the pilot with many hours of multi-engine experience, much of the material in this section, and in the section on emergencies, will be familiar. He can scan whole pages, make mental notes of a few points and go on, for the Travel Air is quite a normal twin-engine airplane. This section is aimed primarily at the pilot, however experienced, to whom steering with the throttles may be a novelty; if to the experienced multi-engine pilot this section seems over-large, his indulgence is asked.

The specific information of this section as to operational limitations, necessary precautions and procedures, have been determined through engineering computations and flight testing of the aircraft. The general handling technique presented is based on the recommendations and data compiled by Beech Aircraft Corporation pilots who have test flown and demonstrated the aircraft, and may be followed with confidence in forming your own procedures. The tables and diagrams give a working basis for figuring the aircraft's performance under many combinations of the variable factors connected with flying. However except for the limitations and precautions mentioned, both the procedures and the graphs are intended primarily as guides and are no substitute for good judgment.

In general the aircraft is characterized by excellent stability, handling ease and high maneuverability; the controls are effective throughout the speed range from stall to maximum dive velocity. You will find the Travel Air has no unconventional traits or peculiarities to master; it behaves exactly as an airplane should.

## EXTERIOR INSPECTION

To a pilot, the general airworthiness of his aircraft is both a legal obligation and a direct responsibility to his passengers and himself. Personal attention to the preflight procedures is the mark of a safe pilot and will repay you not only in safety but in lower maintenance costs as well.

In addition to the checks listed below, the "walk-around" portion of your preflight inspection should include checking the rig and freedom of control surfaces, visually checking the condition of the windshield and side windows, antenna rigging and dents and scratches in the skin or other minor damage which should be noted and evaluated.

The following items require specific checking during the "walk around" phase of the preflight inspection:

1. Cabin for desired arrangement; battery and magneto switches "OFF." Adjust all trim tab controls to indicate a "O" reading. Remove and stow the control lock.

**CAUTION**

Under circumstances where propeller blast or windy conditions are likely to be encountered when opening the cabin door, retain the door forcibly by hand and position it against the open stop, thus preventing the possibility of damage to the door or its hinges.

2. Static pressure buttons for foreign material; trim tabs streamlined with the control surfaces.

3. All access doors and inspection openings covered and their fastenings secure.

4. Wing tips and position lights for damage; remove pitot cover and tie-down lines.

5. Fuel level in all cells: check visually then replace and secure the filler caps.

6. Drain the fuel sediment bowls and strainers (2 places); the fuel selector valves (2 places) and the fuel cell sumps (4 places).

7. Engine oil level, open cowling and read from the graduated dip-stick in the oil filler cap; replace and tighten the filler caps.

8. Inside each nacelle for evidence of oil, fuel or exhaust leakage; secure cowling.

9. Propeller blades for freedom from nicks and scratches.

10. Tires and shock struts for specified inflation and cleanliness. Landing gear safety switch for security and obvious damage. Main gear tire pressure 36 psi; nose gear tire pressure 28 psi. All shock struts extended 2 inches (under normal fuel and oil load only).

11. Baggage compartments for cargo security; doors closed and latched.

12. Aircraft loading within the specified weight and balance limitations.

## BEFORE STARTING ENGINES

1. Lock the cabin door and windows. Fasten your safety belt and be sure your passengers do the same; use shoulder harness as desired.

2. Set parking brake; adjust seat and rudder pedals.

3. Check all controls for full travel and freedom of movement.

4. Set the altimeter and clock; uncage the gyro instruments.

5. Check circuit breaker panel.

6. Landing gear switch DOWN. Mechanical indicator under the control pedestal full DOWN.

7. Carburetor heat controls full forward (cold).

8. Fuel selector valves on the main fuel tanks.

9. Radio switches "OFF."

10. Battery and generator master switches "ON." If an auxiliary power unit is to be used, leave the master switches "OFF."

11. Check the fuel level indication for all cells.

12. Check the landing gear and flap position lights, both green, and test the stall warning light, red.

13. Cowl flaps "OPEN." (On aircraft TD-174 and after, check the cowl flap position light, amber.)

14. Position the propeller controls full forward (low pitch, high rpm).

15. Position the throttles about ¼ inch open.

16. Set trim tabs – 0 to 3 points nose up, depending on your loading.

## STARTING

Look over the area around the aircraft to be sure of sufficient taxi clearance with respect to other aircraft, buildings or other structures. Make sure your propeller blast is in the clear before running up the engines.

The use of prime for engine starting is largely a matter of individual preference and the operational temperatures concerned, both atmospheric and mechanical. With atmospheric temperatures above 30°F priming normally is unnecessary while below 30°F it is usually beneficial.

1. Left magneto switch "ON" for engine to be started.

2. Cold engine starting: mixture controls full forward (rich mixture). Apply 2 or 3 full strokes with the hand primer on the engine to be started.

   Hot engine starting: mixture controls full aft (idle-cut-off). Advance mixture control after the starter is actually cranking the engine; do not prime.

3. Fuel boost pump "ON" only for engine to be started. Check fuel pressure indication.

4. Propeller clear.

5. Actuate the starter switch. Limit each cranking period to a 10 or 12 second operation. A 5 minute cooling and rest interval, between cranking periods, will extend starter life.

**NOTE**

Should the engine stop firing completely due to an excessively rich mixture or flooded condition, move the mixture control full aft (idle-cut-off), turn "OFF" the magneto switch and move the throttle control full forward. Engage the starter and turn the engine through approximately ten revolutions. Following the check list procedure, attempt a restart. *Do not pump the throttle; to do so will only increase the possibility of flooding.*

# SMOKE AND FLAME IDENTIFICATION

| POSSIBLE INSTRUMENT INDICATION | DANGER | CAUSE AND REMEDY | SMOKE AND FLAME PATTERN |
|---|---|---|---|
| High CHT and CAT fluctuating MP, rpm. | Loss of power, engine failure. | CAUSE: Detonation, afterfire or backfire from lean mixture and/or carburetor failure. REMEDY: Enrich mixture, reduce power and temperature. Watch engine instruments. | Puffs of black smoke from exhaust. Rough engine. |
| Drop in oil pressure. | Slight possibility of fire. | CAUSE: Slight oil leak.<br>REMEDY: Shut down and check. Be alert for fire. | Thin wisps of bluish-grey smoke from cowl flaps and exhaust areas. |
| High CHT; fluctuating MP, rpm, and low oil pressure. | Engine failure and fire. | CAUSE: Cylinder head or exhaust stack failure.<br>REMEDY: Shut down and check. Be alert for fire. | Variable grey smoke and possible light flame from cowl flaps and exhaust areas. |
| Sudden drop in MP and rpm with high CHT. | Uncontrolled fire. | CAUSE: Initial induction fire from burning fuel.<br>REMEDY: Increase rpm, try to draw fire thru engine. | Heavy black smoke from exhaust. |
| Variable oil pressure. High CAT. | Uncontrolled fire. | CAUSE: Oil leak and oil fire.<br>REMEDY: Shut down, fight fire. | Black smoke from accessory section. |
| Variable fuel pressure, high CAT. | Uncontrolled fire. | CAUSE: Fuel leak and fire.<br>REMEDY: Shut down, fight fire. | Black smoke and orange flame from accessory section. |
| Drop in MP, RPM, low CHT. | Slight possibility of fire. | CAUSE: excessively-rich mixture, carburetor failure.<br>REMEDY: Lean mixture, shut down and check carburetor. | Black smoke, perhaps orange flame from exhaust. |

6. After the engine is running evenly, turn on the right magneto switch and open the throttle to an indicated engine speed of 800 rpm; check the engine gage for oil pressure indication. If no pressure is shown within 30 seconds, stop the engine.

7. When engine temperatures have begun to rise, advance the throttle to an indicated engine speed of approximately 1300 rpm for warm-up.

8. Switch the fuel boost pump "OFF" and check the engine driven fuel pump pressure and operation.

9. Start the remaining engine using the same procedure.

10. Disconnect external power, if used, then turn on battery switch.

## EXTERNAL POWER

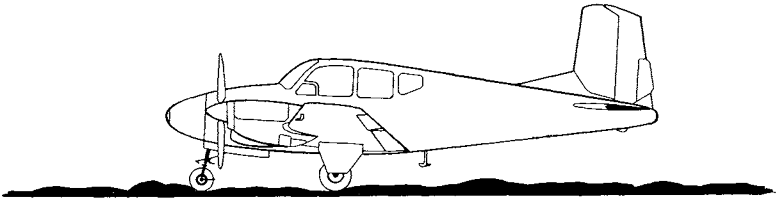
Before connecting an auxiliary power unit, turn "OFF" the battery and generator switches and all other electrically-operated equipment. If the auxiliary power unit does not have a standard AN type plug, check the polarity of the unit and connect its positive lead to the center post and the negative lead to the front post of the aircraft's external power receptacle. The aircraft, being negative-ground, requires a negative-ground auxiliary power unit; reversing the polarity of the unit can produce a battery fire or serious damage to other electrical equipment. *Make sure of polarity before the unit is connected.*

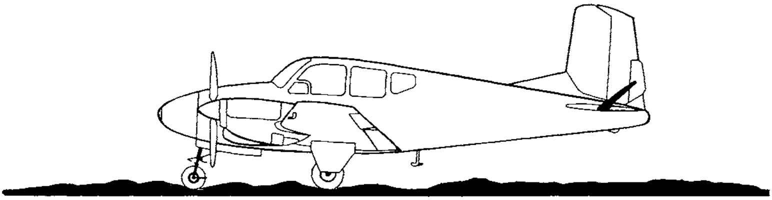
## TAXIING

### NEVER TAXI WITH A FLAT SHOCK STRUT

Ground operation under its own power is quite easy in the Travel Air, with its excellent visibility, short turning radius and maneuverability. Normally, warm-up rpm will supply sufficient power for ground operations except when taxiing over rough areas or under extremely windy conditions.

To taxi, simply release the parking brake control and allow the aircraft to start rolling forward, check the brakes by applying them several times lightly, thus assuring that the brakes are functioning properly and are ready for use. Unless sudden stoppage is probable, do not "ride" the brakes. Govern your taxi speed with throttle coordination. Most turns may be made with the steerable nose





wheel and the throttles. Tight turns may be accomplished by applying a combination of inside brake and outside power.

When taxiing over rough surfaces use minimum power settings and allow the aircraft to coast over obstructions. Do not apply brakes suddenly unless absolutely necessary. Hold the control column full back to reduce weight and relieve loads on the nose gear assembly. Although the nose wheel is unusually strong, always be conscious of its location and the fact that the airplane is pushing it along the ground.

## WARM-UP AND PREFLIGHT CHECKS

After you have reached the designated or pre-determined point on the airport for engine run-up, which should be at least 100 feet from the active runway, head the aircraft into the wind, straighten the nose wheel and set the parking brake. If necessary allow the engines to complete their warm-up at 1300 rpm. Limit ground running as near as possible to 4 minutes in cold weather and 2 minutes at temperatures above 70°F.

To attain maximum engine cooling, the rpm settings given are those to be used with the propellers in full low pitch (high rpm)



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and when the aircraft is warmed-up and checked on a clean hard-surfaced area. Reduce the rpm accordingly for other types of surfaces to prevent damage to the propellers and underside of the fuselage from small stones, sand etc. picked up and thrown by the propellers.

When normal engine operating temperatures are reached, set either throttle at 2200 rpm and complete the following checks:

1. Visually check for both engines – oil temperature, 140°F minimum for run-up. Oil pressure – 85 psi maximum, 60 psi minimum and 25 psi idling. Fuel pressure – 5.0 psi maximum, 0.5 psi minimum and 3.0 psi desired.

2. Re-check the fuel gages for correct reading with the electrical system now in operation.

3. Check the ammeter gages for correct generator output. Generator cut-in speed should be approximately 1250 engine rpm.

4. Mixture controls full forward (rich mixture).

5. Pull the carburetor heat control out. Correct operation will be indicated by a drop in manifold pressure and engine rpm. If equipped with carburetor mixture temperature indicators, a heat rise will be noted.

6. Turn the vacuum selector valve to the engine being checked. The suction gage should indicate about 5.4 inches Hg. Position the valve in either "Directional Gyro" or "Gyro Horizon" after the check.

7. Pull the propeller control lever aft to the high pitch detent and reposition it full forward again after the propeller has changed to high pitch (low rpm) and the engine speed has stabilized. Exercise the propeller through this cycle 2 or 3 times to assure correct governing action.

**NOTE**

When exercising the propellers within their governing range, do not move the control lever aft past the detent. To do so will allow the propeller to change rapidly to the full feathered position.

8. Advance the throttle to full open, 2550 to 2600 static rpm and switch "OFF" each magneto separately for approximately 3 seconds. Maximum drop should not exceed 75 rpm.

9. Reduce the engine speed to idle rpm and switch "OFF" both magnetos just long enough to determine if the engine stops firing. To avoid spark plug fouling, do not idle the engines at low speeds for prolonged periods.

10. Adjust engine speed to approximately 1300 rpm and repeat steps 5 through 10 for the other engine.

11. Set the gyro instruments.

12. Check pitot heat, by observing the ammeters when the switch is turned "ON," then "OFF."

13. With the propeller controls full forward, in the low pitch (high rpm) position, open both throttles simultaneously with a smooth, steady motion and observe if power is developed equally in both engines. Retard the throttles to approximately 1300 rpm. On an average day, with full throttle, the static rpm should be approximately 2600. Bear in mind, however, that atmospheric conditions affect both the manifold pressure and rpm obtainable and that on a cold day with high barometric pressure it is possible to exceed the manifold pressure limit.

14. Adjust the friction lock on the control console tight enough to prevent the engine controls from creeping.

15. Turn the fuel boost pumps "ON" and check the indicated pressure.

16. Visually check the control console from top to bottom and the instrument panel from right to left. Special attention should be given to fuel and oil pressures, oil temperature and cylinder head temperature.

**NOTE**

Since the propellers are feathered by a spring which exerts a constant pressure, and will do so whenever the governor boosted oil pressure to the propeller hub is relieved, it is not necessary to check the feathering cycle with each preflight inspection. The heavy loads imposed on the engine offset the advantages of the check.

## NORMAL TAKE-OFF

When you are ready for the take-off run and have moved into position on the active runway, release the brakes and open both throttles smoothly and evenly, maintaining positive directional control with the rudder pedals. Do not exceed 28.5 inches Hg. or 2700 rpm.

### CAUTION

If you are taking-off or landing behind a large multi-engine or jet aircraft, allow sufficient spacing so that the air turbulence in the wake of the other airplane will dissipate and settle before you encounter it. This turbulence may remain for several minutes, depending upon the wind direction and velocity, and is severe enough to cause even large aircraft to become uncontrollable.

As an airspeed of approximately *70 mph* is attained, apply a gentle but steady back pressure, sufficient to bring the wings to a slightly positive angle of attack. As lift-off speed is reached, approximately *85 mph,* normal back pressure should cause the aircraft to fly off the ground.

Once you have broken ground, hold some forward pressure to avoid excessive angle of climb until normal climb speed, *105 mph,* is attained. Retract the landing gear as soon as you are firmly airborne with no danger of settling back to the runway. If 10 degrees or more of wing flap are used, delay your retraction until a safe airspeed is attained. Turn the fuel boost pumps "OFF" individually and check the fuel pressure indication.

Remember, on a hot day, a longer run will be required for take-off than under average temperatures. The same rule is true as field elevation increases since lift is attained only through actual density altitude. Though your airspeed indications will be the same, almost twice the runway length will be required to attain lift-off airspeed at an airport elevation of 6000 feet than under the same conditions at sea level and your ground speed will be appreciably higher also. Watch the airspeed needle, rather than the runway markers, and be sure you have sufficient *airspeed* before applying back pressure for the lift-off. Other conditions to be considered at all field elevations and during every take-off, are runway surface condition, runway gradient, aircraft gross weight and surface winds. A good take-off depends on the correct allowances for all these factors. Do not forget them.

Section IV on Cruise Control discusses the effect of temperature and barometric pressure on your aircraft's performance. These factors influence all performance, all the time, and you should understand them thoroughly.

## SOFT OR ROUGH FIELD AND MINIMUM RUN TAKE-OFF

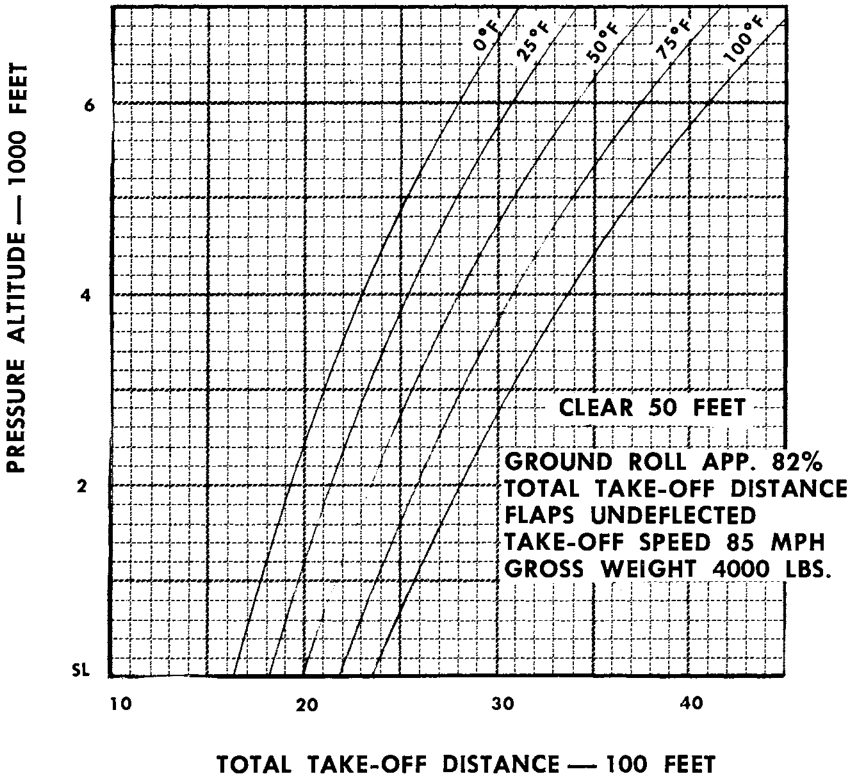
To get the aircraft airborne in the shortest forward distance traveled, under less than ideal surface conditions, use 20 degrees of wing flap and adjust the elevator trim from "O" to 3 points "nose up," depending on the loading; apply full power and release the brakes. The control wheel should be held well back during the beginning of the take-off run, to establish the maximum possible angle of attack. As the take-off run progresses and landing gear drag decreases, the angle of attack should be gradually reduced for better acceleration to flying speed. Lift-off should occur at approximately *70 mph;* however, this speed will vary with your loading and atmospheric conditions. As you become fully airborne, relax back pressure to permit the aircraft to accelerate, and retract the landing gear. Retract the wing flaps as normal climb speed is attained.

## OBSTACLE TAKE-OFF

Where an obstacle must be cleared on take-off or under conditions where you must attain a maximum of altitude in a minimum of forward distance, use 20 degrees of wing flap and set the elevator trim, between "O" and 3 points "nose up," as required; apply full power available and release the brakes. Hold the wings in a near

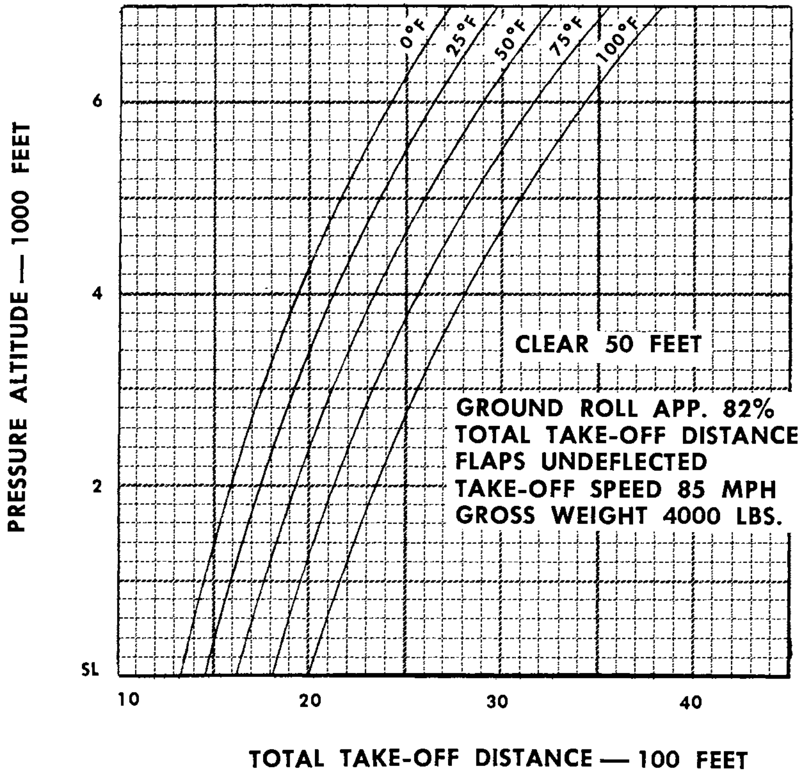
# NORMAL TAKE-OFF

## 0 WIND



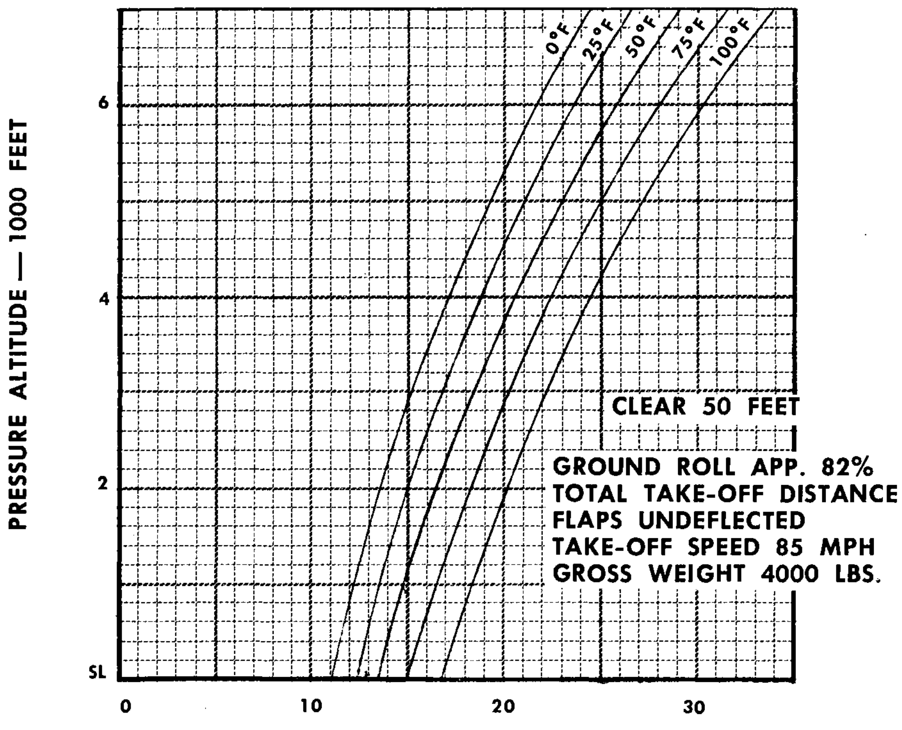
# NORMAL TAKE-OFF

## 10 MPH WIND



# NORMAL TAKE-OFF

## 20 MPH WIND



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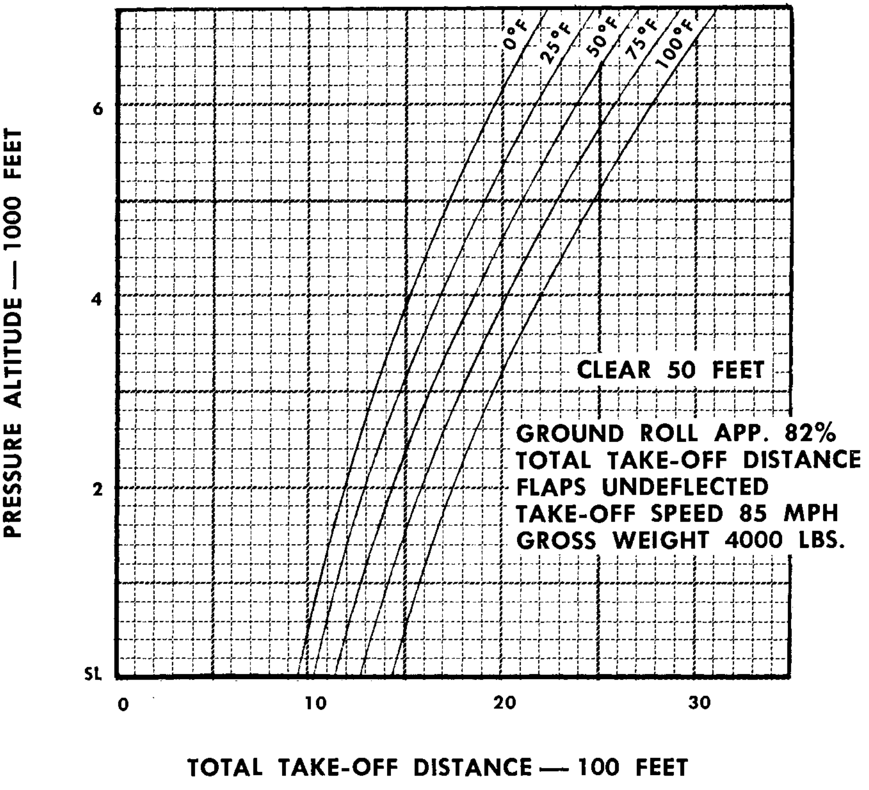
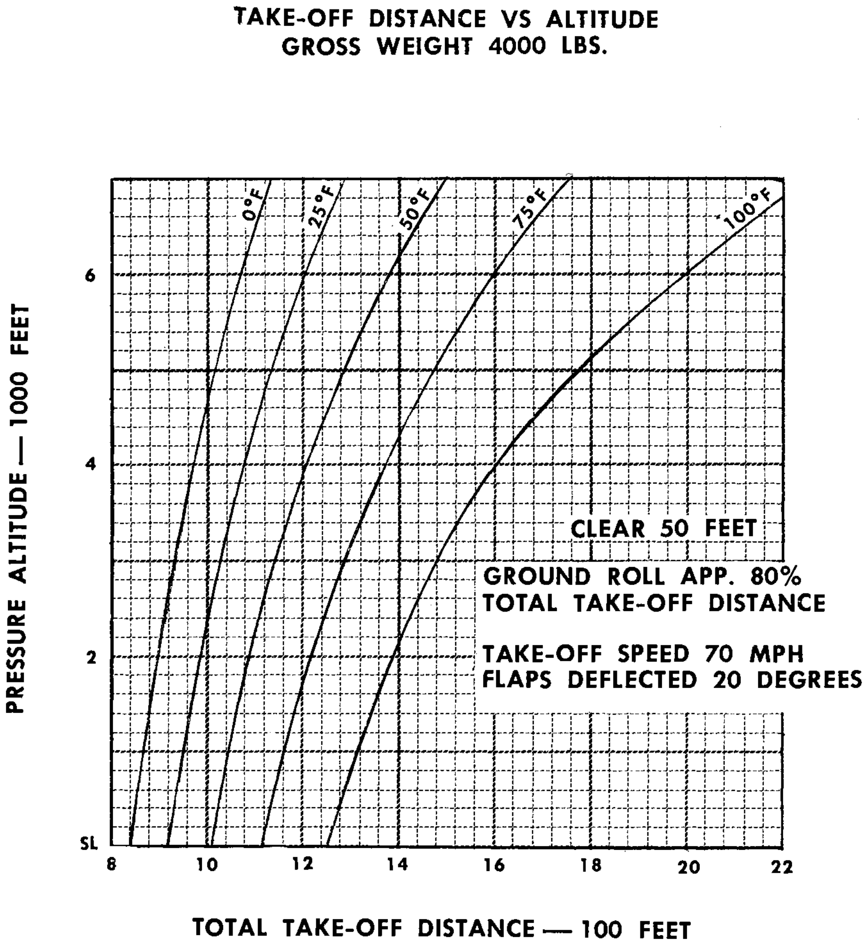
# NORMAL TAKE-OFF

## 30 MPH WIND



# MINIMUM RUN TAKE-OFF

## NO WIND



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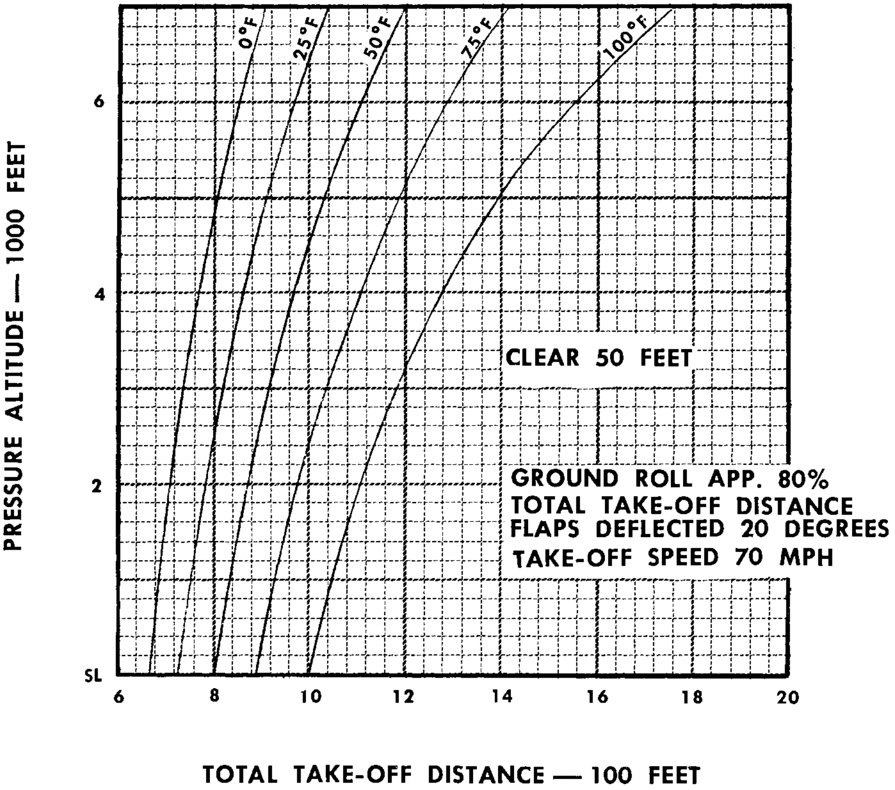
# MINIMUM RUN TAKE-OFF

## 10 MPH WIND

TAKE-OFF DISTANCE VS ALTITUDE
GROSS WEIGHT — 4000 LBS.



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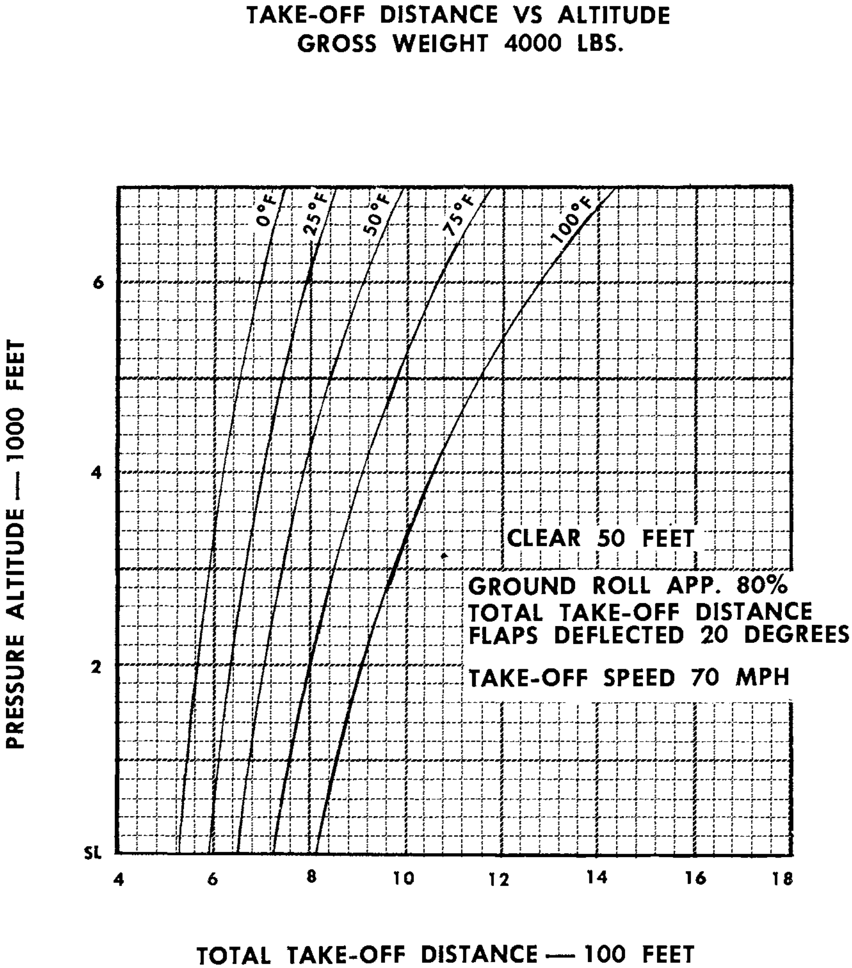
# MINIMUM RUN TAKE-OFF

## 20 MPH WIND



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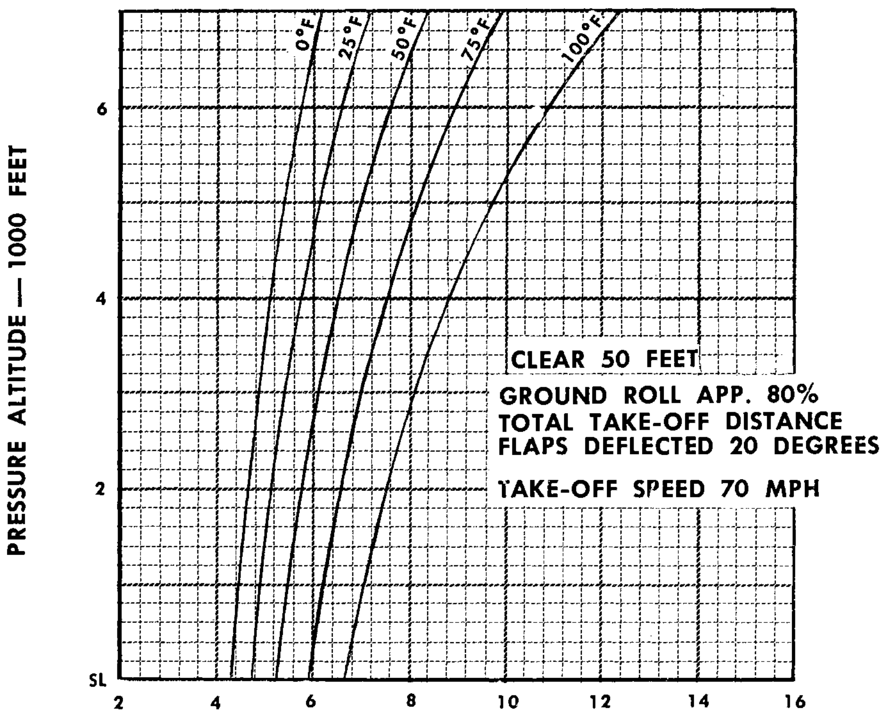
# MINIMUM RUN TAKE-OFF

## 30 MPH WIND

TAKE-OFF DISTANCE VS ALTITUDE
GROSS WEIGHT 4000 LBS.



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level flight attitude during the take-off run, until lift-off speed of approximately *70 mph* is attained, then smoothly and positively apply back pressure, to assume a nose-high, climb angle. After you have positively cleared the ground, retract the landing gear and maintain the nose-high attitude to obtain the maximum angle of climb until the obstacle is cleared. The best *angle* of climb speed, *95 mph,* will allow you to climb clear of an obstruction in the shortest distance. After you are in the clear, level off and accelerate to normal climb speed and retract the wing flaps.

## CROSSWIND TAKE-OFF

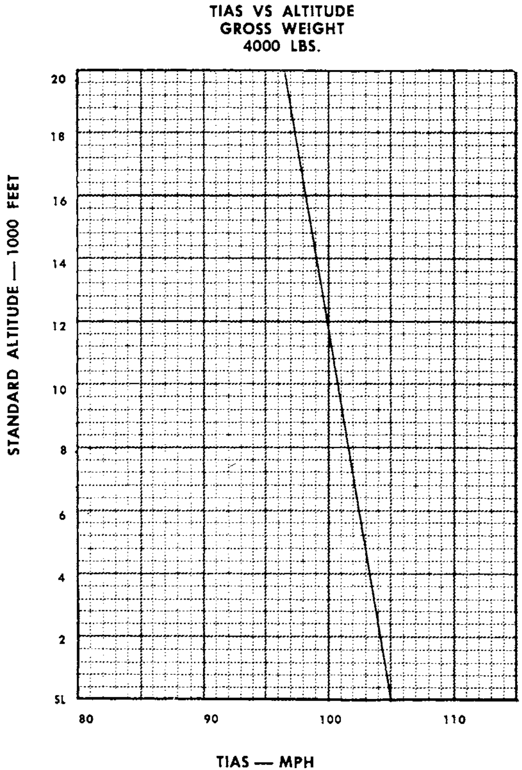
Under normal crosswind conditions, take-off procedures differ from the standard into-the-wind technique only during the latter part of the take-off run and during the actual lift-off. Wing flap and trim tab settings that correspond to a normal take-off operation may be used. As power is applied and flying speed is gained, apply forward pressure on the control wheel to keep the nose gear solidly on the ground for maintaining positive directional control. At the same time counter the crosswind action by holding the wings level with the ailerons. When you have attained lift-off speed, approximately *75 mph,* pull the aircraft off with a definite back pressure on the control wheel, and relax aileron and rudder pressures to allow the aircraft to establish its own crab angle. This will effect a straight track in reference to your ground roll. Lower the nose as you accelerate to the normal climb speed, and retract the landing gear.

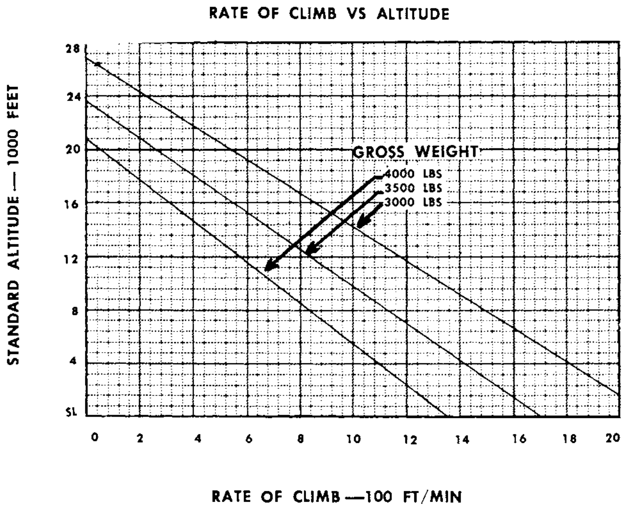
## CLIMB

With the Travel Air's exceptional climb performance, you have a choice of two satisfactory methods for reaching a cruising altitude.

A climb at best rate-of-climb speed will get you to altitude quickly. It may be mandatory in IFR conditions; or save some fuel over-all if you have a good tailwind aloft. However, you will have reduced forward visibility due to the high climb angle and the ascent will be less comfortable for your passengers. On the other hand, a cruising climb will give you good visibility, it will be more comfortable and with good fuel management it may save both time and fuel, since you can make shallow climbs at near cruise speeds with only moderate power increases. Your choice of method will depend on the weather, the length of the flight, your load and your own preference.

# TWO-ENGINE CLIMB PERFORMANCE



For the best rate-of-climb, which will give the greatest gain in altitude per minute, use normal rated power of 2700 rpm and full throttle. Hold the best rate-of-climb speed shown on the climb graph for your altitude; note that the speed reduces approximately 1 mph for each 2000 feet you climb.

For a cruising climb, which is generally recommended, use a power setting between 2450 and 2500 rpm and up to 25 inches of manifold pressure. Set your climb to hold an IAS of 130 to 140 mph. Cowl flaps should be closed at or above 130 mph.

**CAUTION**

> Never use full throttle with an engine speed of less than 2450 rpm, below 5000 feet. With an engine rpm of 2350 or less, do not exceed 65% power.

To obtain optimum fuel economy, you may lean during a climb, at reduced power – 2450 rpm or less – beginning at an altitude of 3500 feet. Do not lean, however, under 5000 feet at power settings in excess of 2450 rpm.

To commence leaning, after you have the desired rpm and manifold pressure settings, pull the mixture controls aft in small increments. While observing the cylinder head temperature indicators closely, continue to lean out until peak temperature has been reached. If a sudden temperature rise occurs during leaning out, or if maximum permissible temperature is reached, return the mixture controls to full rich immediately. *Keep the cylinder head temperatures under 450°F at all times.* When applying carburetor heat, adjust power setting and mixture as necessary.

**CAUTION**

> If during the course of your flight, dense haze or clouds are encountered, the rotating anti-collision beacon should be turned "OFF." The reflection of these lights, particularly at night, can produce optical illusions and severe vertigo.

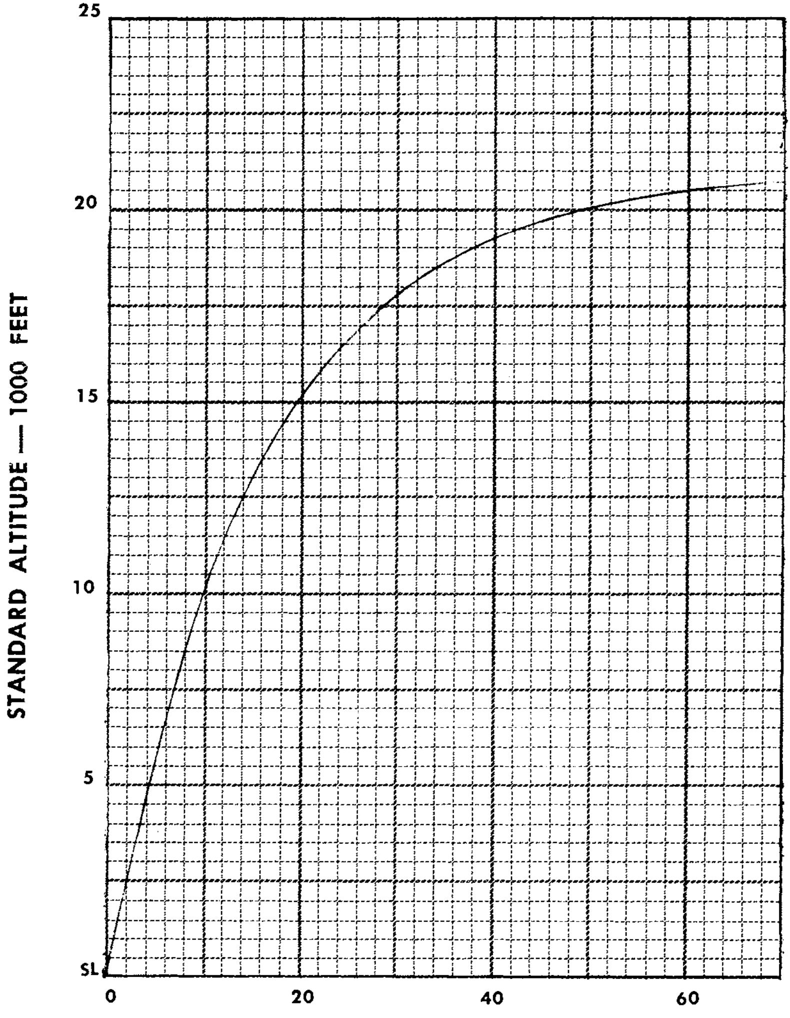
**CRUISE**

Level-off when you have reached your intended cruising altitude and maintain climb power, until you have accelerated to your intended cruising IAS. This procedure will allow your airspeed,

# TIME TO CLIMB

VS
ALTITUDE

GROSS WEIGHT
4000 LBS.



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engine temperatures and power settings to become stabilized in a shorter period of time.

As cruising speed approaches, reduce your power settings. There is no "best" cruise power setting for all flights. Your choice of power settings will depend on load, temperature, altitude and perhaps most important, the purpose of your flight. You should, however, weigh these factors in advance and decide on your approximate power settings during your flight planning prior to take-off. The graphs and discussion in the section on Cruise Control were placed there to aid you in doing so.

Since the efficiency of the aircraft in cruise — the airspeed obtainable with a given horsepower — is affected considerably by its trim, your trimming procedure becomes an important task. Using the turn-and-bank indicator, adjust the rudder trim as required to zero the ball, then adjust the elevator and aileron trim. This sequence is of particular importance in twin-engine aircraft. By stabilizing your directional control first, you eliminate any slipping or skidding and the excess drag that results. For maximum efficiency, merely trimming "hands-off" is not sufficient. Use the turn-and-bank, rate-of-climb, airspeed and gyro instruments as trimming aids. They supply a far more reliable reading of what the aircraft is actually doing than may otherwise be detected.

Synchronization of the propellers is accomplished by setting one propeller at the desired engine speed, and then adjusting the other propeller control. An intermittent "beat" will be slightly audible if the propellers are not exactly synchronized.

Final mixture adjustments may be accomplished using the same leaning procedure as applied during the climb-out. Remember, do not permit the cylinder head temperatures to exceed 500°F.

The fuel selector valves may be positioned to use fuel as desired while normal cruising operations are continued. However, since your take-offs, climbs and landings must be made using the main fuel cells only, a sufficient reserve for a safe landing at your destination must be maintained. Providing the length of a flight will allow enough fuel for this reserve, the main cells only may be used for the operation. Otherwise, you should switch to the auxiliary fuel cells when you have established your cruising altitude. Also, remember that the auxiliary fuel and crossfeed systems may



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be used in level flight only. When one selector valve is positioned on crossfeed, both engines are using fuel from the cell indicated by the remaining selector valve. If both selector valves are on crossfeed, the fuel supply for both engines is cut-off. Normal operation allows fuel to be consumed from the cells as indicated by the fuel selector valves.

Also, during cruise operation, be alert for signs of carburetor icing which is most likely to be encountered during operations where you are traveling through one kind of weather and into another. The conditions under which you are most likely to find carburetor ice are diagnosed and discussed more completely under "cold and all weather operation" in the following pages of this section.

## DESCENT EN ROUTE

For a cruising descent en route, with the intention of continued cruising operation at another altitude, relieve only enough power to obtain the desired let-down IAS and rate of descent. Power should be sufficient to keep the engines warm and the cylinders clear. Richen the mixture slightly to avoid lean mixtures at lower altitudes.

When a sharp rate of descent is necessary, apply carburetor heat, reduce power and diminish your IAS to 150 mph; extend the landing gear and trim the aircraft as required. Maintain your desired rate of descent by varying the power settings. The propeller controls may be left in the cruise rpm position.

**NOTE**

> Unless you are a rated instrument pilot with recent instrument experience in the type airplane you are flying, stay out of IFR conditions; however, if you are caught in such conditions, lower the landing gear before entering a cloud bank.

As you attain your new cruising altitude retract your landing gear, if lowered, reset your power settings as applicable to your particular altitude, and position the carburetor heat controls as necessary. Re-trim the aircraft and lean the mixtures as required.

## CLIMB EN ROUTE

Where circumstances require ascending to a new cruising altitude, apply full throttle for all climb power settings provided you are operating above 5000 feet. Full throttle will be necessary since your engine power decreases slightly, at a steady rate, as your altitude increases.

For a normal cruising climb, which will require only slight power increases over your cruise settings, use an engine speed between 2450 and 2500 rpm, with an IAS of 130 to 140 mph.

For best rate of climb, which may be used to quickly gain altitude or pass through an undesirable level, use 2700 rpm and the climb speed shown in the graph for your particular altitude.

After you have reached your new altitude and attained the desired cruising speed, adjust your power as required; trim the aircraft and lean the mixtures.

## STALLS AND SLOW FLIGHT

The stability and handling characteristics of the Travel Air are better than average in all stall configurations and during slow flight maneuvering. Only conventional control movements are required throughout these maneuvers in maintaining the desired aircraft attitude, and all the controls remain effective. Aileron control remains particularly good throughout the entire stall.

During a normal stall approach, a slight buffeting will provide sufficient warning to permit a normal recovery; the severity of these warnings will increase slightly with power on. In addition, a stall warning indicator gives visual and aural indication of an impending stall approximately 4 to 6 mph above the actual stall.

The best recovery to level flight, with the least loss of altitude, generally may be made by lowering the nose and smoothly applying power. Diving to regain airspeed is not necessary or advisable.

## SPINS

A spin is a prolonged full stall in which rapid rotation around the center of gravity, while descending in a nose down attitude, prevents the aircraft from recovery. Intentional spinning is prohibited, but if a spin has been accidently entered, a recovery may be accomplished using basically the same procedure as used for any other full stall, except that power should not be applied during the pull out due to the existing nose down attitude.

If a spin is entered inadvertently cut the power on both engines, apply full rudder opposite the direction of rotation and then move elevator forward until rotation stops. When the controls are fully effective, bring the nose up smoothly to a level flight attitude. Don't pull out too abruptly.

## AEROBATIC FLIGHT

The Travel Air is licensed under NORMAL category limitations and is intended for only nonaerobatic, nonscheduled passenger and cargo operation. Only those maneuvers incidental to normal flying including stalls (except whip stalls) and turns in which the angle of bank does not exceed 60° are permitted.

CAR 43:48 No pilot shall intentionally fly an aircraft in aerobatic flight carrying passengers unless all occupants are equipped with approved type parachutes.

43:48-1 Aerobatic flight, insofar as it concerns the wearing of parachutes, is considered to exist when any maneuver intentionally performed results in a bank in excess of 60° relative to the horizon, or a nose up or nose down attitude in excess of 30° relative to the horizon.

## DIVING

The never-exceed speed in smooth air is 240 mph. Because of the Travel Air's clean design, speed is picked up rapidly in a nose-low attitude. Dissipation of excess speed should be carefully controlled, especially if a "red line" speed is approached or rough air is encountered unexpectedly. During a pull-out be aware of the amount of control pressure that you must use to complete a safe recovery in the altitude you have available, and the loads you can apply to the structure in a pull-out. Avoid any abrupt maneuvering or sudden application of the controls; the rate at which you change direction in part determines the G-loads imposed.

## FLIGHT THROUGH ROUGH AIR

When flight through a storm area or extremely rough air cannot be avoided, the problem basically becomes one of choosing the correct airspeed for safe operation under your present weight configuration. If you maintain a high airspeed, structural damage or complete failure may result, yet you must maintain sufficient airspeed for full control. Your safe operating range, between these two danger zones, varies with the severity of the gusts: the stronger the gusts, the narrower your safe operating range.



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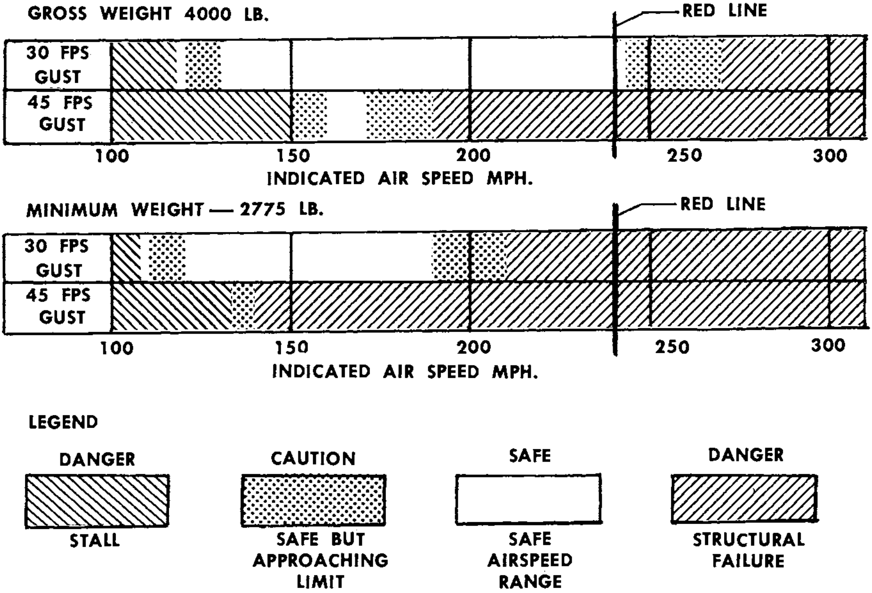
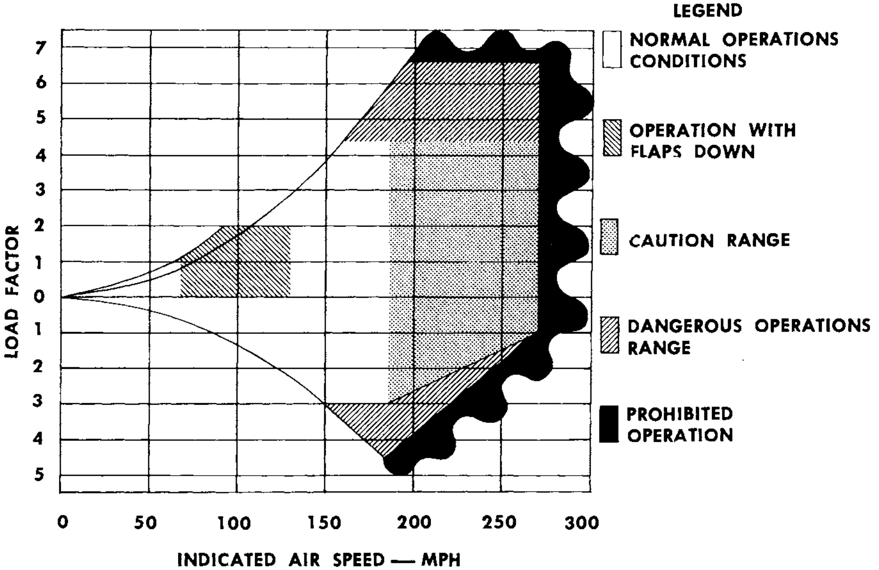
# TURBULENT AIR PENETRATION SPEEDS




# FLIGHT LOAD FACTORS



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The airplane loaded weight also has some influence upon the behavior of your airplane in turbulent air and upon your safe operating speeds.

No single graph can adequately portray the effects of the gusts or turbulence upon any or all portions of the airplane. Lightly loaded airplanes undergo higher accelerations than heavily loaded ones, producing higher stress on the supports of fixed weight structures such as the engines. On the other hand, heavily loaded airplanes are subjected to greater positive wing loads but less negative wing loads than lightly loaded airplanes. The extent of these differences depends also upon the wing fuel loadings which, of course, cannot be predetermined. Therefore, two graphs appear, one for heavily loaded airplanes and one for lightly loaded airplanes.

The two gust intensities shown are for moderately heavy and severe turbulence. No graph is shown for mild turbulence. The 43-foot-per-second gusts are of the magnitude found in thunderstorm centers, while the 30-foot-per-second gusts can be encountered in frontal areas and near thunderstorm centers. Although you may operate near the design cruising speed of 185 mph IAS in ordinary rough air with a reasonable margin of safety, in any turbulence severe enough to cause discomfort to your passengers, you should slow down to approximately 130 mph IAS.

Once you have established your chosen airspeed and trimmed for level flight, you can increase the stability of the aircraft still more by extending the landing gear; the landing gear may be lowered at speeds up to 200 mph IAS, as an extreme emergency measure. If you lower the landing gear as an aid to reducing your speed, you should be alert for the changes in spiral control, elevator trim and rate-of-sink which will result, and make the necessary corrections and allowances. Lower the gear while you still are in level flight, as a preventive measure against excessive speed build-up, rather than attempting it as a corrective measure once the airplane is in a dive.

**NOTE**

> After any emergency extension of the landing gear at high speed, the landing gear doors and supporting structure should be inspected for possible damage.

Do not lower the flaps however, unless you are letting down.

If heavy precipitation, cooler air or icing conditions which often accompany turbulence are anticipated, keep the cowl flaps closed to maintain engine temperatures and turn on the pitot heat; always keep carburetor air temperatures in the green range on the carburetor mixture temperature indicators. If you have leaned the engines, you should place the mixture controls in full rich, switch to the main fuel cells and turn on the boost pumps since you may encounter abrupt and severe changes in altitude and attitude as you fly through the turbulence.

## DESCENT AND PRE-LANDING CHECK

Either of two procedures, depending upon the situation at hand and pilot preference, may be chosen for a descent from your cruising altitude to the traffic pattern altitude at your destination. However, your pre-flight planning should have determined the procedure you intend to use. Generally a slow cruising descent starting well out from your destination is more comfortable and with the higher cruising speed attained during the shallow descent with reduced power settings, an over-all saving in fuel will result. Adverse weather, however, if encountered at these lowering altitudes might nullify these advantages and make a sharp rate of descent more profitable.

Throughout the course of the descent, watch your engine temperatures and regulate the cowl flaps accordingly. Since you will have a combination of relatively high airspeed and reduced power settings, the engines will run cooler than in level flight, and particularly in cold weather, temperatures may go below a safe minimum for full power, which you may need during your approach and landing.

**CAUTION**

> Before you commit yourself to a landing, check for the possibility of encountering the severe turbulence in the wake of a large multi-engine or jet aircraft taking off or landing, particularly if the ground winds are light and parallel the runway. In a dead calm, this turbulence has been observed as long as several minutes after the departure of a multi-engine or jet aircraft and it may be severe enough to make even a large airplane uncontrollable.

During the final portion of the let-down and prior to traffic pattern entry, check the following items. With these checks out of the way, you will be able to concentrate on traffic pattern problems and final landing preparations.

1. Safety belts snug; shoulder harness as desired.

2. Mixture controls full rich.

3. Check main cell fuel quantity, then switch both fuel selector valves on main cells.

4. Set propellers in higher rpm.

5. Carburetor heat controls should be in the "COLD" position unless icing conditions exist.

6. Battery switch "ON."

7. Fuel boost pumps "ON."

8. Parking brake "OFF." Check brake system by depressing brake pedals and noting the resistance.

9. Set the altimeter to the local setting.

10. Check instrument readings.

Slow your airspeed to 150 mph or less as you enter the traffic pattern and extend the landing gear; increase rpm if desired and adjust the power to maintain 120 to 130 mph. Trim the aircraft as required and check the landing gear position indicators for a full down reading. Slow the aircraft from 110 rpm at the start of the base leg to approximately 90 mph as you turn on final. Flaps should be lowered as dictated by obstacles, wind, aircraft loading, and runway length and condition. Retrim as necessary for approach configuration, and maintain 90 mph either with or without power. If airport conditions will permit, at least the last 1,000 feet of final approach before crossing the airport boundary, should be straight with no turning other than minor correction maneuvers. On final approach, adjust propellers to full high rpm position.

## NORMAL LANDING

Landing technique in the Travel Air is easy and conventional in all respects, due to its excellent visibility and positive control and the stability of the tricycle landing gear. As with take-off procedure, there are several satisfactory methods for landing the Travel Air under different conditions.

A normal approach and landing may be made by using full flap and holding an IAS of approximately 90 mph on final. The approach speed on final is governed by changing wind conditions, aircraft loading, weather, pilot technique, etc. As you cross the end of the active runway, start decreasing the power settings to idle rpm and maintain sufficient back pressure to hold a slightly nose high attitude just off the runway. As airspeed is dissipated constantly increase back pressure until the aircraft settles to the runway in a nose high attitude just as stalling speed is reached. Touch down should be on the main wheels with only partial relaxation of back pressure. As speed continues to diminish, back pressure may be slowly relaxed and the nose wheel lowered gently to the runway. Apply brakes only after the nose wheel is down and avoid any hard breaking action unless absolutely necessary. On any landing retract the wing flaps near the end of the landing roll, set the elevator trim to a "O" reading and open the cowl flaps.

During high altitude landing operations, watch your airspeed closely. Don't attempt to estimate your actual speed from your rate of ground travel. While the required IAS for maneuvering at high altitude will not change, the allowances you must make in take-off and landing distances will be almost doubled at an elevation of 6000 feet as compared to the same conditions at sea level. This is due to the decrease in air density as altitude increases. The exact allowance increases you must use for your particular altitude, temperature and loading may be seen by studying the performance graphs provided for this purpose.

## SOFT OR ROUGH FIELD AND MINIMUM RUN LANDING

To land the aircraft in the shortest forward distance, use full flaps and approach with as little power as practicable; maintain an approach speed of approximately 80 mph, trimming as necessary. Cross the approach end of the runway with a slightly nose-high attitude and dissipate the remaining altitude and airspeed with throttle and elevator coordination in such manner as necessary to cause the aircraft to touch-down in the shortest horizontal distance traveled, just as a stall is reached. The remaining procedure, after touch-down of the main gear, is determined by the type of landing surface used and available runway length.

On a soft field, leave the flaps down for maximum lift and braking (drag) effect, and hold the nose wheel off as long as possible. Rough field landing procedure varies only in that the flaps should be retracted immediately after touch-down if the landing surface is such that the flaps may become damaged by stones etc. thrown up by the wheels. During a minimum run landing, the nose wheel should be lowered immediately after touch-down of the main gear and the brakes applied as soon as possible.

## LANDING OVER AN OBSTACLE

To approach over an obstacle, and land with a minimum of roll, your final approach must be higher than normal, both to clear the obstacle and allow you to set up your desired rate of descent. Since you will need a fairly sharp descent, use full flaps and an IAS of approximately 90 mph. Maintain your airspeed with elevator control and your rate of descent with power. Hold your airspeed within close tolerances as your sharp rate of descent will make it necessary to lead your normal flare out by a few extra feet of altitude; if necessary add power. Lower the nose wheel immediately after the main gear touches down and apply the brakes as required.

## CROSSWIND LANDING

In any crosswind procedure, the principles are the same, namely: the ground track must be maintained and the side loads on the landing gear must be kept to a minimum at touch-down by aligning the wheels with the ground path. All control surfaces give normal effect, but a more pronounced degree of deflection will be necessary. Usually, flap settings should be decreased as wind velocity increase.

The recognized procedures for a crosswind landing are: slipping into the wind on final approach just enough to maintain a straight ground track and hold a heading to the intended landing strip, and by crabbing. Usually crabbing into the wind on final approach to correct for drift, and so maintain a straight track toward the landing strip, will handle a greater crosswind component than will the slipping approach. In addition the crab method maintains normal glide angles and allows the best view of the landing area.

When considerable crosswind persists all the way to the ground, touch-down on the up-wind main wheel first. Otherwise, turn to the runway heading soon enough to prevent contacting the surface with the heading you used for drift correction. After the nose gear has settled to the surface, maintain your directional control through nose wheel steering and throttles. Use the brakes only as necessary.

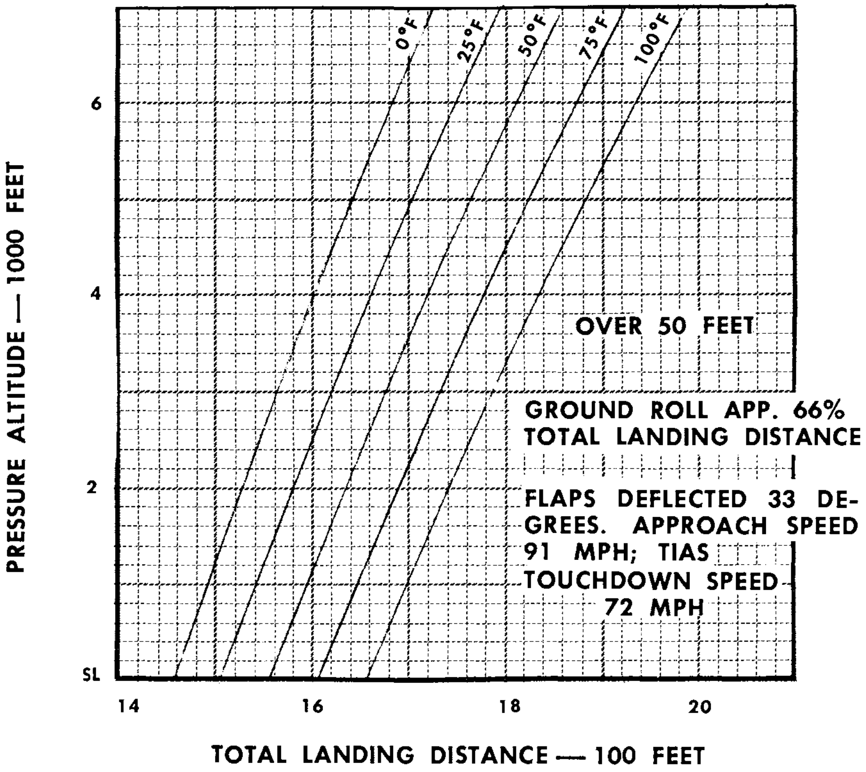
## NIGHT LANDING

The pre-landing procedures for night operation are the same as used during a normal landing with the exception of using the different lighting elements. Many experienced pilots prefer power usage completely through the approach, flare-out and actual touch-

# NORMAL LANDING

## NO WIND

LANDING DISTANCE VS ALTITUDE
GROSS WEIGHT — 4000 LBS.



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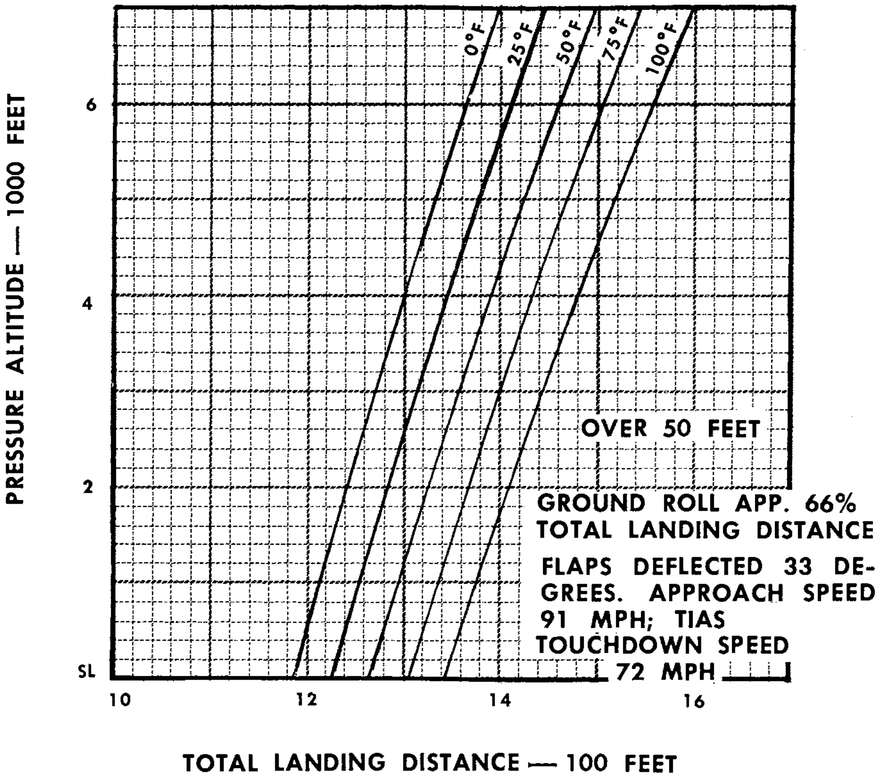
# NORMAL LANDING

## 10 MPH WIND

LANDING DISTANCE VS ALTITUDE
GROSS WEIGHT 4000 LBS.

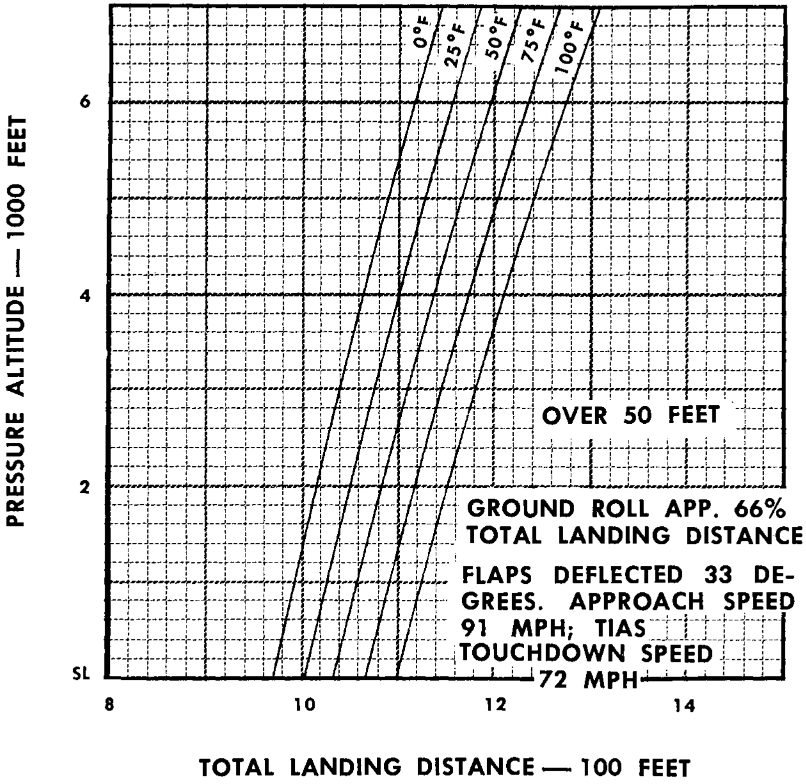


# NORMAL LANDING

## 20 MPH WIND

LANDING DISTANCE VS ALTITUDE

GROSS WEIGHT 4000 LBS.



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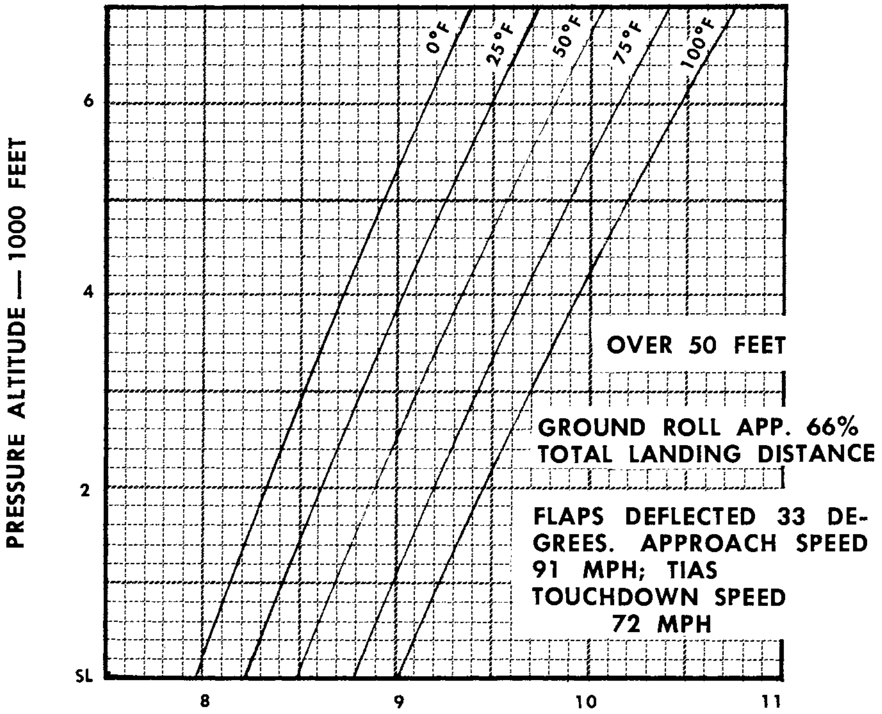
# NORMAL LANDING

## 30 MPH WIND

LANDING DISTANCE VS ALTITUDE

GROSS WEIGHT 4000 LBS.




TOTAL LANDING DISTANCE — 100 FEET

down which is most desirable when it is difficult to estimate the aircraft's exact altitude as is often the case without runway lights. By holding this partial power, the aircraft will settle to the runway in a semi-power stall; just as the ground is contacted the power should be cut-off. At any time during a power-on approach, simply by increasing power, the rate-of-descent may be reduced sharply to allow for errors in judgment or a go-around if necessary.

The use of landing lights is not always entirely beneficial as a certain glare is associated with their use, especially in hazy conditions. However, if you decide to use them, they should be turned on while the aircraft is well above the ground in order to avoid sudden changes in the appearance of the landing area as the landing position is approached. In haze it is often beneficial to use only the landing light on the side away from the pilot, to reduce the reflected glare.

## BALKED LANDING

The decision to go around should never be delayed until the aircraft is near the ground in the landing position. The more altitude and airspeed remaining in the approach, the wider the margin of safety. Hence, the less chance there is of trouble.

Having decided to go around, advance the throttles to take-off power and simultaneously apply sufficient pressure to the control column to maintain a safe climb attitude for your present airspeed. Raise the landing gear, if you are solidly airborne, and push the carburetor heat controls in (COLD), if they were applied for the landing. Raise the wing flaps. However, unless it is of genuine emergency, do not raise the flaps rapidly when very close to the ground, because of the rapid loss of lift. Climb out at best angle-of-climb speed, which will vary with your pressure altitude, until you can level off safely. Remember that you are close to stalling speed; the best angle-of-climb speed is the speed resulting from an angle of attack as high as possible without stalling. As soon as you can do so safely, trim the aircraft and continue your normal climb-out procedure.

## PARKING

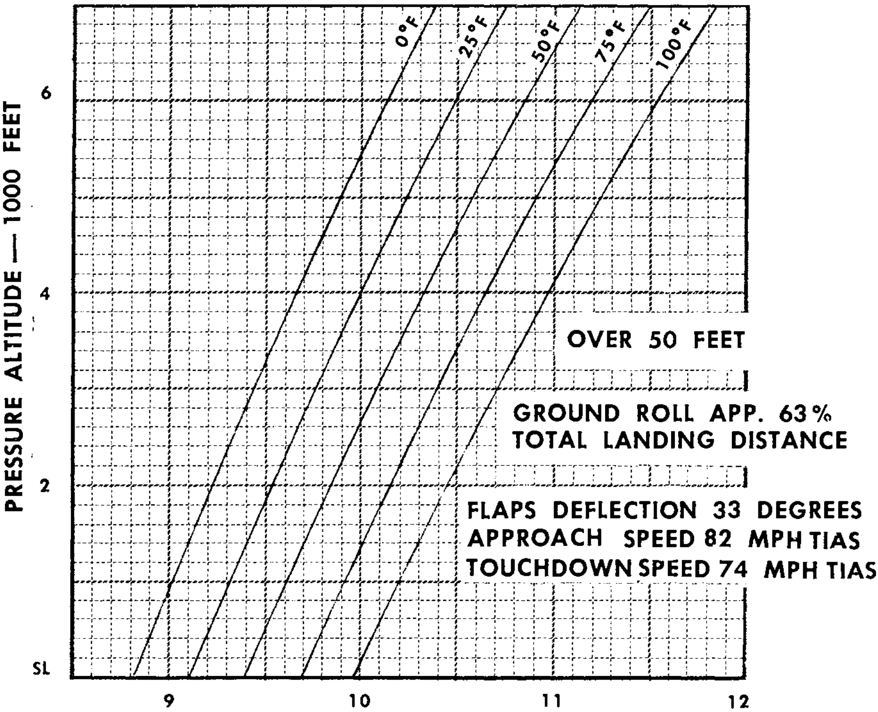
If the aircraft is to be parked outside, if possible choose a position and heading that will nose the aircraft into the wind and at the same time avoid the propeller blast of other aircraft.

As you turn to your selected heading, roll straight ahead enough

# MINIMUM RUN LANDING

## NO WIND

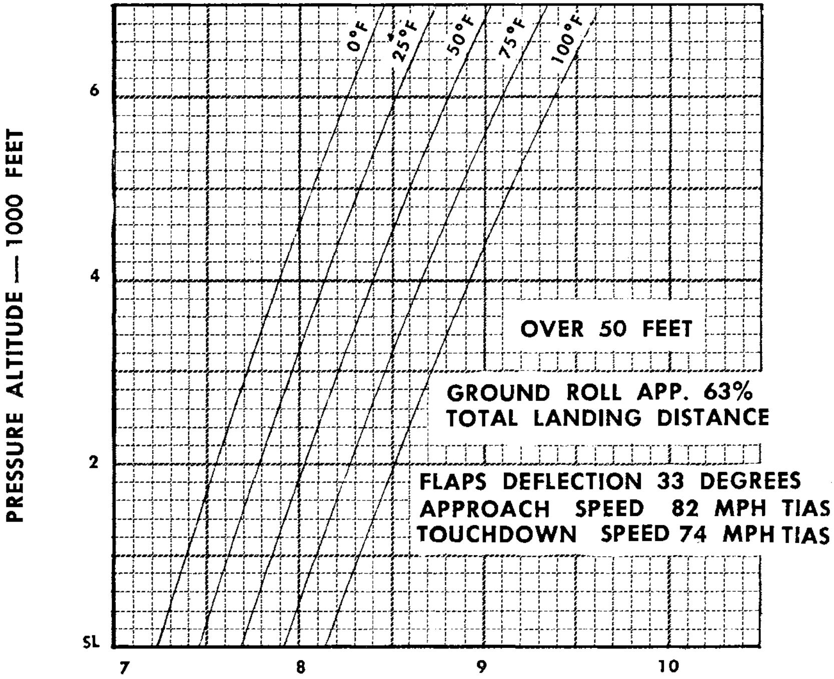
LANDING DISTANCE VS ALTITUDE
GROSS WEIGHT 4000 LBS.



# MINIMUM RUN LANDING

## 10 MPH WIND

LANDING DISTANCE VS ALTITUDE
GROSS WEIGHT 4000 LBS.



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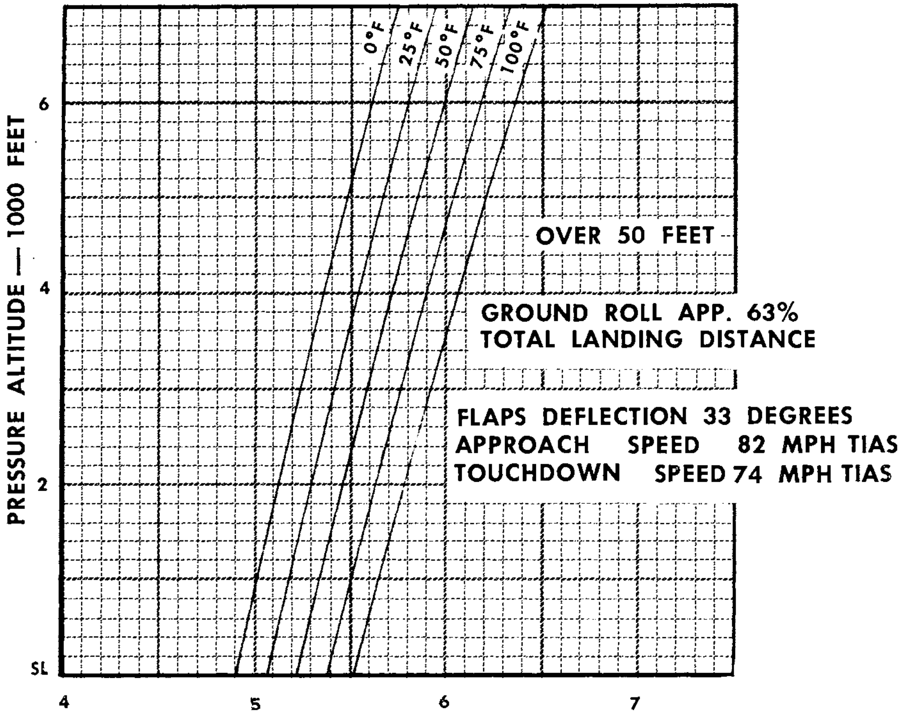
# MINIMUM RUN LANDING

## 20 MPH WIND

LANDING DISTANCE VS ALTITUDE
GROSS WEIGHT 4000 LBS.

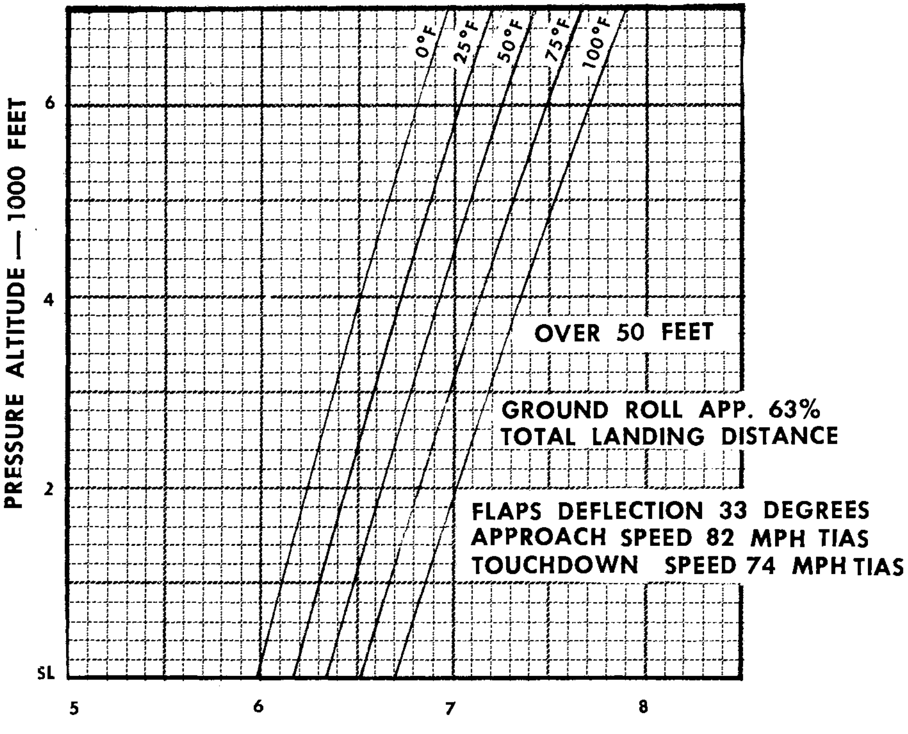



TOTAL LANDING DISTANCE — 100 FEET

# MINIMUM RUN LANDING

## 30 MPH WIND

LANDING DISTANCE VS ALTITUDE
GROSS WEIGHT 4000 LBS.



to straighten the nose wheel. Since the nose wheel steering system and the rudder system are interconnected, straightening the nose wheel will also neutralize the rudder, lessening the chances for rudder damage from wind or propeller blast.

Set the parking brake before you run up the engines for shut down. If you have used an abnormal amount of brake in taxiing, allow the brakes to cool before setting the parking brake; otherwise, the contraction of the brake discs and linings as they cool may leave insufficient pressure to hold the aircraft.

## STOPPING ENGINES

Check all instruments for readings within specified limitations. If cylinder head temperatures are excessive, advance the throttles to approximately 1300 rpm until the temperatures are normal. If your temperatures are normal, turn off the radio equipment, heater and fuel boost pumps, and advance the throttles to an engine speed of approximately 1500 rpm. Position the propeller controls in low pitch (high rpm) and pull the mixture controls back to the idle cut-off position. As the engines slow, move the throttles to the full aft position until the engines quit firing. Switch off the magneto switches after the engines have stopped rotating and re-check the panel for all desired switches and controls in the "OFF" position. The fuel selector valves may be turned off; however, it is not necessary to do so since no fuel will escape from the carburetor with no fuel pressure and the mixture controls in the idle cut-off position.

## SECURING AND GROUND MANEUVERING

Unless the wind is calm and the aircraft is to be left unattended for only a short time, you should install the control lock. Never leave the cabin door standing open. If you are to remain parked for more than a few hours, the pitot cover, wheel chocks and tie-down lines should be installed.

For hand maneuvering on the ramp or into a hangar, the hand towbar gives sufficient leverage to turn the nose wheel for steering. Remember, never push or pull on the propellers nor, except at their root sections, on the outboard wing panels or the tail group. In using the towbar, do not exceed the nose wheel turning limits.

## ALL WEATHER OPERATION

The operation of the Travel Air under adverse conditions, due to temperature and meteorological circumstance, is relatively easy provided proper preflight planning and piloting proficiency are employed. Some specific procedures and checks, for a more efficient operation under these variables, are presented in the following paragraphs. However, these discussions must be largely general in nature due to the variation of situations that will be encountered from time to time. ANY procedures or checks, within the bounds of good operating practice and safety, should be used for particular situations if they will prove beneficial to the intended operation.

Flight in icing conditions should not be attempted as there are no provisions for the wing and empennage deicing.

## HOT WEATHER PROCEDURES

When operating under extremely hot conditions, the main cause of aircraft damage is usually dust and wind. Dust clouds in the desert may be found at altitudes up to 10,000 feet. Therefore, particular attention must be given to keeping the carburetor air intake filters clean and well oiled.

When parking or leaving the aircraft, install the pitot cover and any other dust preventive shields as required. Leave at least one window slightly open to aid air circulation and avoid excessive cabin temperatures.

Fuel and oil servicing must also receive special attention. In addition to being sure that the aircraft and all fueling equipment is well grounded, take special pains to prevent the entry of dust or sand into the fuel and oil system requires special attention.

Engine starting procedures are normal. However, ground operation must be held to a minimum since high engine operating temperatures will be attained quickly. Cylinder head temperatures especially will require close attention. During take-off, remember that the maximum power developed by your engines will be less than rated due to the high temperature of the inducted air.

The effect of excessive heat on the actual flying of the aircraft is in the form of reduced wing lift which results in decreased climb performance and longer than normal take-off and landing runs, therefore, always start from the end of the runway.

## COLD WEATHER PROCEDURES

Proper pre-flight planning and the correct and more demanding care of the aircraft's systems are the backbone of your cold weather operation. If possible, the aircraft should be hangared in a warm area. However, if secured outside in sub-zero temperatures, certain precautionary measures should be taken in addition to a most thorough pre-flight inspection prior to each operation.

**NOTE**

> If extremely cold temperatures are expected, it is a good idea to remove the battery from the aircraft and store it in a warm place; in addition to protecting it from freezing, its output will be higher when it is re-installed.

In addition to the normal pre-flight exterior inspection, remove ice, snow, and frost from the wings, tail, control surfaces and hinges, propeller, windshield, pitot tube, fuel cell filler caps and fuel and oil tank vents. If you have no way of removing these formations of ice, snow, and frost, leave the aircraft on the ground, as these deposits will not blow off. The wing contour may be changed by these formations sufficiently that its lift qualities are considerably disturbed and sometimes completely destroyed. Complete your normal pre-flight procedures including a check of the flight controls for complete freedom of movement.

Conditions for accumulating moisture, in both the engine oil sumps and the fuel cells, are most favorable at low temperatures due to the condensation increase in the tanks, and the moisture that enters as the systems are serviced. Therefore, close attention to draining the fuel cells and oil sumps will assume particular importance during cold weather.

Engine oil viscosity weights should be changed according to the oil weight and temperature table, provided a sufficient amount of your flying is going to be in cold weather. Under extremely cold conditions it may be necessary to pre-heat the engine oil prior to a start. Always pull the propeller through by hand several times to clear the engine and "limber-up" the cold, heavy oil before using the starter. This also will save battery energy if an auxiliary power unit is not available.

Normal engine starting procedures will ordinarily be used, with the exception of priming which will probably require an extra few shots. Use carburetor heat as necessary for smooth engine operation during the warm-up period. If there is no oil pressure within the first 30 seconds of running, or if oil pressure drops after a few minutes of ground operation, shut down and check for broken oil lines or radiator.

Cold engine starts normally require a more retarded throttle setting than usual. Also, moisture forms quickly on the spark plug electrodes during cold weather starts, so if you have made three or four unsuccessful starting attempts, remove at least one plug from each cylinder. Heat the plugs to dry the electrodes, replace them, and attempt a restart immediately.

Avoid taxiing through water, slush or muddy surfaces if possible. Water, slush or mud, when splashed on the wing and tail surfaces, may freeze, increasing weight and drag and perhaps limiting control surface movement.

Use your brakes with caution; taxi slowly for best control.

During warm-up, watch your engine temperatures closely since it is quite possible to exceed the cylinder head temperature limit in trying to bring up the oil temperature. According to the engine manufacturer normally the engines are warm enough for take-off when the throttles can be opened without backfiring or skipping of the engines.

During the engine run-up, carburetor heat controls should be in the "cold" position; however, if your run-up is not immediately prior to take-off, make a special check using carburetor heat, to eliminate any possible carburetor ice that may have accumulated during taxi operations or other take-off delays. Return the carburetor heat controls to the "cold" position for take-off. Turn on the pitot heat and run the propellers through their pitch range several times to flush cold oil from the actuating cylinders.

Use normal take-off procedure, but be prepared to use carburetor heat as soon as full power is not needed. Since you may have an accumulation of mud, slush, ice, etc., on the landing gear and gear doors, unless it is essential to the safety of the take-off operation, leave the landing gear down for a reasonable length of time to allow this mud, slush, ice, etc., to dry, be blown off or to freeze, reducing the chances of the landing gear or doors freezing in the up position during the course of the flight.

For in-flight operation, use carburetor heat as required and adjust power and mixture as necessary. Cycle the propellers occasionally, to flush cold oil from the propeller hubs. This action assures smoother operation, easier and more accurate power loading adjustments and minimizes the chance for cold oil to congeal in the propeller actuating cylinders. Should propeller icing be encountered, and an accumulation is resulting in rough engine operation, it can sometimes be eliminated by rapidly increasing and decreasing rpm.



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During your let-down and landing, complete the normal checks and procedures, giving special attention to the engine operational temperatures which will have a tendency toward over-cooling. Keep your descent gradual; holding the airspeed within normal landing gear and wing flap operating range. If over-cooling then prevails, lower the gear and flaps, and increase the engine rpm. Use carburetor heat as necessary until reaching the landing pattern or if severe freezing conditions prevail, just prior to the flare-out.

Be prepared to change to normal air if you should need full power for a go-around.

As soon as the aircraft is on the ground retract the flaps and use the brakes sparingly.

## ENGINE ICE PROTECTION

### I. Cold Weather Operation

Induction system icing may occur during flight through visible moisture at plus 5 degrees C. (plus 41 degrees F.) or below. To minimize the possibility of icing, always apply FULL CARBURETOR HEAT before entering these conditions. Indications of possible icing may be engine roughness or a decrease in manifold pressure. When either of these conditions occurs in visible moisture, immediately apply full carburetor heat. Continue using full carburetor heat until you are assured that all ice has been removed and you are well clear of icing conditions. If a return to filtered air causes engine roughness, due to melting snow or ice remaining in the air scoop, return immediately to full carburetor heat. Application of carburetor heat will result in a slight loss of power.

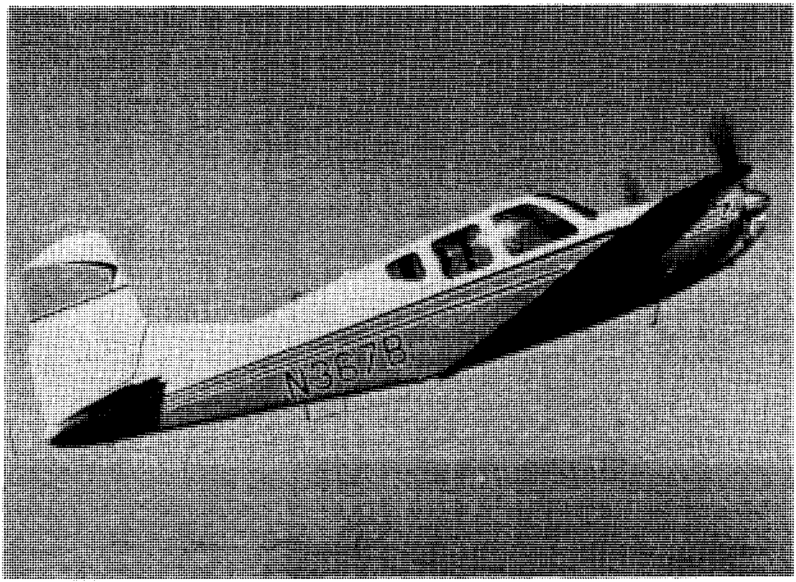
### II. Warm Weather Operation

Under certain moist atmospheric conditions it is also possible for ice to form in the mixture chamber even in summer weather. This ice may build up to such an extent that a drop in manifold pressure results. If not detected, this condition will continue to such an extent that the reduced power will cause complete stoppage. To avoid this condition, use full carburetor heat to remove the ice and then sufficient heat to prevent its reforming.

## INSTRUMENTS AND WEATHER

Properly equipped, your Travel Air is an instrument airplane, but are you an instrument pilot? If you have an instrument flight rating, with recent practice in instrument flight in your Travel Air, you are. Otherwise, you are a VFR pilot. There can be no compromise on this rule, nor on its corollary: If you are a VFR pilot, don't fly in instrument weather.

The problem of the VFR pilot in instrument weather is more serious than merely getting lost and burning up all his fuel trying to discover where he is and how to get where he's going. Generally, as accident investigations have borne out, VFR pilots caught in weather don't have time to get lost. Rather, they lose control




of their airplanes, which go into turns that shortly become spirals, or into dives. The untrained pilot's efforts to correct the situation make it worse, until shortly G-loads on the airplane build up to the point of structural failure. Accidents of this type have happened with all types of modern commercial aircraft.

Even the most careful VFR pilots occasionally will encounter weather conditions beyond their piloting skill, and for this reason, a technique perfected by the University of Illinois Institute of

Aviation should be made a part of your own skill. Known as the "180-Degree Turn," it is a technique designed to return the VFR pilot to VFR conditions, safely.

Essentially, the technique consists of (1) increasing drag by lowering the gear – *in an extreme emergency the gear may be lowered at speeds up to 200 mph IAS;* (2) reducing airspeed; (3) trimming the airplane for a predetermined slow-flight speed; and (4) WITH THE HANDS OFF THE WHEEL, making a turn with the rudders only, to a heading 180 degrees from the heading on which you were flying when you lost visual contact.

If you lower the landing gear as an aid to reducing your speed, you should be alert for the changes in spiral control, elevator trim and rate-of-sink which will result, and make the necessary corrections and allowances. Lower the gear while you still are in level flight, as a preventive measure against excessive speed build-up, rather than attempting it as a corrective measure once the airplane is in a dive.

**NOTE**

> After any emergency extension of the landing gear at high speed, the landing gear doors and supporting structure should be inspected for possible damage.

This technique is simple, but rapid, smooth and precise execution is essential to its success, and you should learn it from a qualified instructor, preferably in your own airplane, so that it can become completely familiar and automatic. We suggest that you contact the University of Illinois for more precise details on this procedure.

Always operate your Travel Air so that you and your passengers are comfortable; discomfort will usually appear well in advance of danger. Remember – the final responsibility for safe flight falls squarely upon your shoulders as the pilot.

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# Cruise Control

WITH the Travel Air's higher fuel capacity, higher gross weight and twin-engine utility, longer flights under more variable conditions are practical and efficient operation assumes greater importance.

The term "Cruise Control" means the intelligent flight planning and operation of an aircraft, in order to accomplish a flight most efficiently. The effects of airspeed, engine power, aircraft loading and air density, are the main factors to be considered. The calculation and execution of a good flight plan, allowing for these variables, is an accomplishment that any pilot may well be proud of.

In this section are graphs showing the performance of your Travel Air which you can use to make estimates in flight planning: true airspeeds, range and fuel consumption at various altitudes and powers and time-to-climb from sea level to various altitudes. Having made a flight plan based on estimates taken from the graphs, you should check your actual performance and review the difference between your forecast conditions and actual conditions during the flight, so that your future estimates may be more accurate.

In using the graphs, bear in mind that they have no allowances for reserves, nor for variable factors such as winds and fuel consumed in warm-up and taxiing; you must make allowances for these conditions as they actually exist from one flight to the next. Also, the flight tests from which the performance data was obtained were flown with a new, clean aircraft, correctly rigged and loaded and with engines capable of delivering full rated power. If your airplane is dirty, poorly-loaded and poorly-maintained, you cannot expect to obtain the performance indicated by the graphs. Good maintenance, such as that offered by BEECHCRAFT Certified Service Stations, will pay you dividends in actual performance as well as safety and lower over-all operating costs.

## EVERYDAY CRUISE CONTROL

Consciously or otherwise, you practice cruise control on every flight you make. Whether your cruise control is good or bad — that is, whether or not it results in your getting the most from



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your aircraft is determined, to a certain degree, by which method you use. The difference between cruise control for normal, or average, flights and for long range largely is a matter of degree. The principles are the same.

Normal cruise control should be used for all flying when weather and distance are well within the normal operating limitations of the aircraft and its pilot. The power settings used, however, will be governed basically by the objective of the flight – high speed, economy, or comfort. In general, your climb operations should not exceed 80% power. Level flight cruise operations should be at the lowest power that will satisfy the speed requirements, usually not to exceed 65% power. Observing these limits will normally result in the optimum balance between aircraft performance and over-all operation economy.

To obtain best engine power, the mixture may be leaned during a climb, at 80% power or less – starting at an altitude of 3500 feet. Do not lean, however, below 5000 feet at power settings in excess of 80%. Full throttle operation should be avoided below 5000 feet, with an engine speed of less than 2450 rpm.

## MAXIMUM-RANGE CRUISE CONTROL

Maximum-range cruise control is the type of operation which will achieve the greatest number of miles flown per gallon of fuel used.

Cruise control for maximum range differs from that for maximum endurance chiefly in the airspeeds used. Range increases with increased airspeed, due to the improvement in aerodynamic efficiency, until the speed reaches a point where the increased drag and the proportionally-higher fuel requirements of the engines begin to offset the aerodynamic improvement. Conversely, a speed below this point also will result in fewer miles per gallon and longer flight time, due to increased drag from the less efficient flight attitude of the aircraft and a decrease in both engine and propeller performance.

This point of maximum range, in terms of optimum airspeed, must be correctly selected for a given altitude, and must be closely maintained if maximum aircraft performance is to be realized. The selection of this airspeed is complicated by several variables: altitude, wind conditions at that altitude, and propeller and engine efficiency. As shown on the range at altitude graphs, the airspeed



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necessary for maximum range may be as much as 20% less than maximum cruise airspeed. In selecting the power settings you should use and in predicting your performance, you must also consider weather and terrain, since they will greatly influence your altitude choice.

## MAXIMUM ENDURANCE CRUISE CONTROL

As the name implies, this is a flight technique which will keep the airplane in flight the longest time with the fuel available. To obtain minimum fuel consumption, the power is reduced to the lowest value at which the aircraft will fly and handle satisfactorily. In practice, this method of operation is used only in emergencies occasioned by weather, traffic, or other conditions. This is efficient operation only in terms of fuel consumption per hour. With reduced power, the angle of attack of the wing must be increased to maintain lift. This, in turn, produces increased drag and low flight speeds. In terms of miles per gallon, the flight operation is inefficient; it should be used only when you are going nowhere—for example, in a holding pattern. If power is increased above that for maximum endurance, efficiency in terms of miles per gallon of fuel burned will increase. Aircraft speed will increase at a greater rate than the increase in fuel consumption per hour due to the more efficient flight attitude. Thus, for any flight, the elapsed time is reduced and less total fuel will be burned than if operations were continued at maximum-endurance power.

## USE OF THE GRAPHS

In cruise control, your altimeter's usual function of giving your height above the ground is of secondary importance; its chief virtue is its ability to give you barometric pressure, expressed in feet above sea level, which in turn can be converted to a measure of air density. Since air density is a major factor in all aircraft performance, the altimeter function is vital to cruise control. To permit the use of the altimeter for this purpose, the terms "pressure altitude" and "standard altitude" are used in the performance graphs.

Standard altitude, a convenient expression of air density, is the product of two variables: the actual barometric pressure and the outside air temperature. You must allow for these two factors in converting actual indicator readings into standard conditions, or translating a performance figure in the graphs into an indicator reading under your actual conditions, since both temperature and barometric pressure vary not only at a fairly constant rate with altitude, but most inconsistently, with the weather. Presenting performance data for all the possible temperature/pressure combinations you may encounter obviously is impossible.

Pressure altitude is an expression of barometric pressure in terms of feet above sea level, rather than inches of mercury. Standard (or density) altitude, used in presenting data on range, speeds, fuel consumption and similar information, is pressure altitude corrected to a standard temperature.

In order to find your standard (or density) altitude at a given time and place, set your altimeter for a barometric pressure of 29.92; it then will read pressure altitude. Note the outside air temperature. On the altitude conversion chart, go up the line representing your air temperature to the point where it intersects the curving line representing your pressure altitude. Then read horizontally across the graph to your left to your standard altitude. You must set your altimeter to 29.92 (sea level standard pressure) in order to remove any correction in it for local barometric pressure. This correction is necessary when the altimeter is used as an altitude meter; i.e., to determine your distance above the ground. However, when you are determining pressure altitude, barometric pressure compensation will introduce an error, rather than making a correction.

If you desire to find your TAS at a particular time and place, as corrected for your current temperature and altitude, on the altitude conversion chart go up the line representing your outside air temperature to a point where it intersects the curving line representing your pressure altitude. Then read horizontally across the graph to the right along the line representing your standard (or density) altitude. There you will find a density-ratio figure. From your airspeed indicator, read your IAS, then multiply the reading by the density-ratio figure. The result will be your TAS in mph.

Like the altimeter, your airspeed indicator shows pressure, in this instance the difference between the ram air pressure imposed on the pitot tube and the ambient barometric pressure picked up by the static air ports, expressing this differential as miles per hour of indicated airspeed. Since variations in both barometric pressure and temperature will affect the pressure differential, and hence the indicated airspeed, the data presented in the graphs has been converted to true airspeed. To find *true airspeed* you must know your *pressure altitude, indicated airspeed* and *ambient air temperature.*

Several airspeeds in the performance data are given as true indicated airspeed (TIAS). In these instances true indicated airspeed is preferable to true airspeed since the performance – rate-of-climb, take-off and landing speeds, etc. – is affected by barometric pressure and temperature in the same proportion as indicated airspeed so that correction is not desirable. The recommended take-off, maneuvering and landing speeds in the technique discussions throughout the book are given as IAS for the same reason. The use of TIAS in the performance graphs does not make any allowance for inaccurate airspeed indications peculiar to the individual aircraft or its operation.

The effect of temperature and pressure altitude may be seen by applying some hypothetical conditions to the Normal Take-off graph. If, for example, you take off at an altitude near sea level, when the temperature is 25°F, you can expect to clear 50 feet approximately 1820 feet from starting, assuming no wind and average piloting techniques. However, with a pressure altitude of perhaps 6000 feet and an OAT of 75°F, it will take you approximately 3750 feet to attain the same altitude.

Reference to the cruising operation graph shows that optimum cruising speed and altitude at maximum gross weight is 195 miles an hour TAS at approximately 10,500 feet standard altitude. In general, the best performance is realized at the highest altitude at which the percentage of power to be used is available, since speed increases with both horsepower and altitude. The speeds shown on the graph are based on a maximum aircraft gross weight figure of 4000 pounds; as loading and total gross weight decreases, performance and speed will increase proportionally.

In the planning phase of a flight, the cruise operation graph is to be used in predicting your performance, and in flight for checking and comparison. Selecting a cruising altitude should be the starting point in your plan. From this your standard (or density) altitude may be determined from the altitude conversion chart. (Use the standard temperature lapse rate of 2°C or 3.5°F per thousand feet



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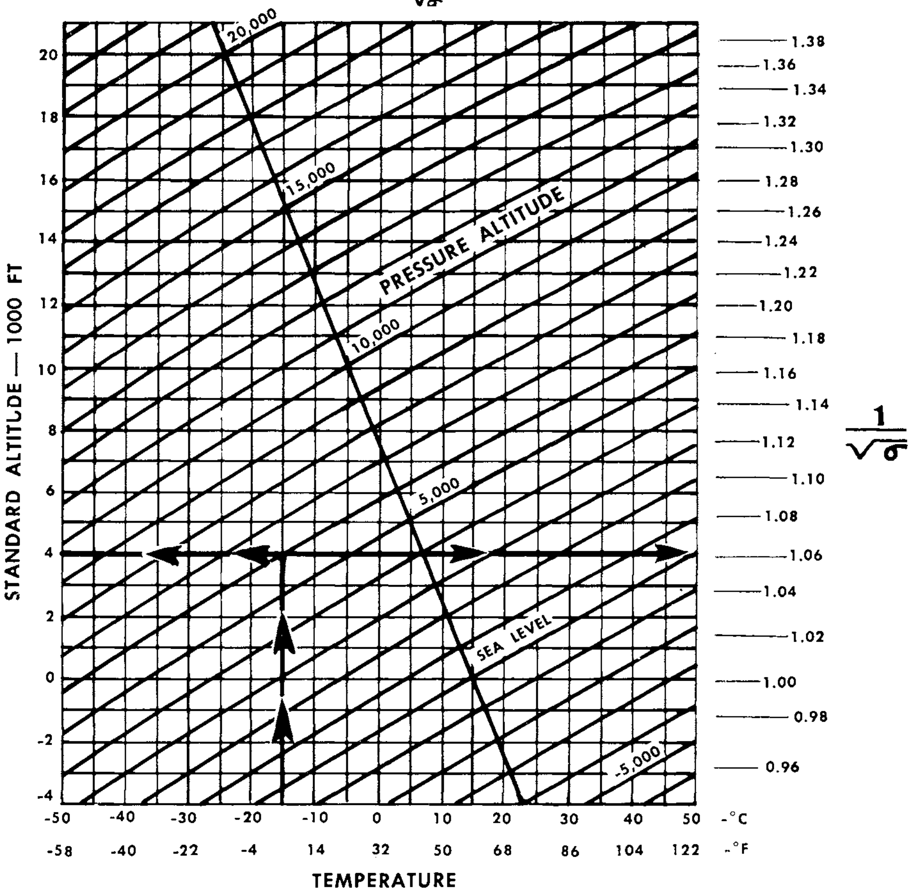
of ascent. Also, for flight planning purposes, use indicated altitude for pressure altitude; the errors will be within reason for estimating purpose.) On the cruise operation graph, locate your standard altitude and considering your gross weight, weather, winds, etc., select your intended power settings and expected true airspeed.

Once cruising altitude is reached, the actual power currently being used to hold an airspeed may be computed with the Travel Air's horsepower calculator. Thus, fly an airspeed, or a power setting — then check your performance through the calculator and graphs. Remember, the calculator is based on outside air temperature, as read from the free air instrument, not carburetor mixture temperature; an allowance has been made for the temperature rise in the intake duct.

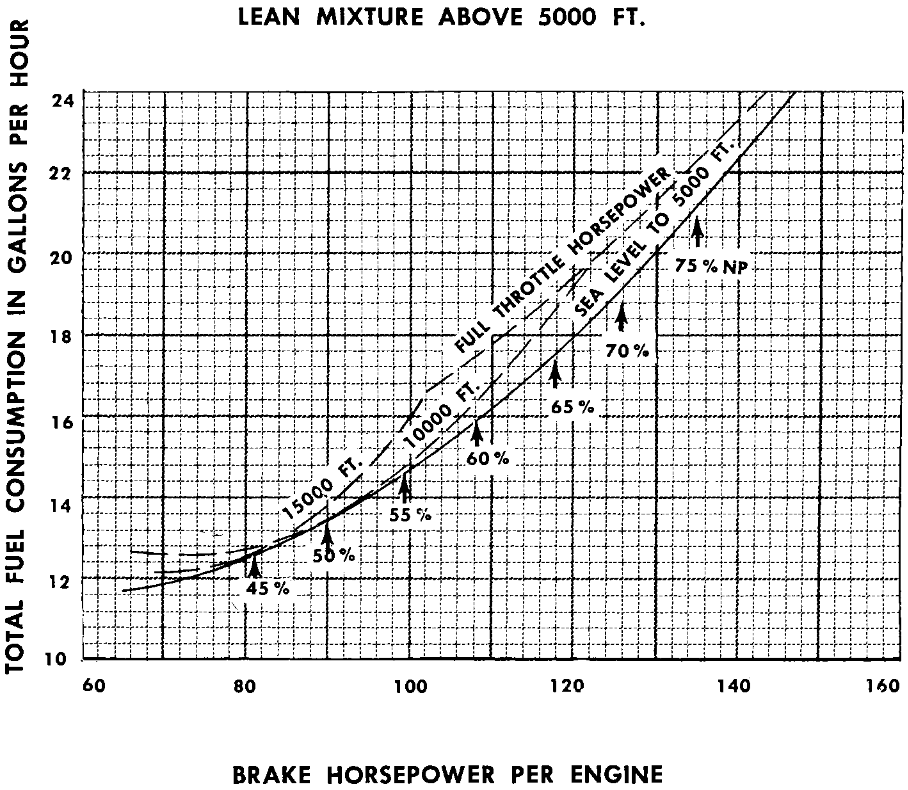
Fuel consumption varies with horsepower and to a lesser extent with altitude, as the fuel consumption graph shows. In using the fuel consumption graph, bear in mind that the fuel flows are for specific brake horsepowers and that if you expect your fuel consumption to be as estimated from the graph you must set up your horsepower accurately and make adjustments to maintain it as altitude and temperature changes occur during the flight. Also, above 5000 feet you must lean the mixtures to best power.

# ALTITUDE CONVERSION

EXAMPLE: IF AMBIENT TEMP. IS -15°C AND PRESSURE ALT. IS 6000 FEET, THE STANDARD ALT. IS 4000 FEET AND $\frac{1}{\sqrt{\sigma}}$ IS 1.06



# HORSEPOWER VS. FUEL CONSUMPTION

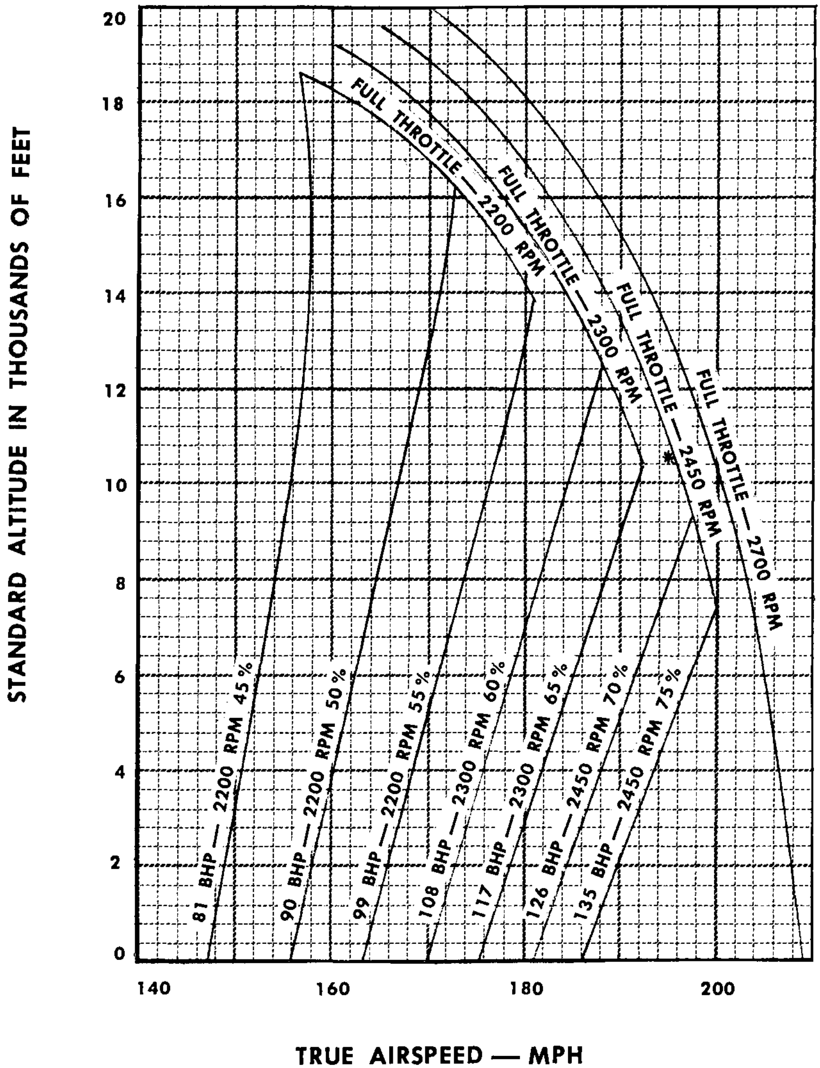


# CRUISING OPERATION

## 4000 LBS. LOAD

*GUARANTEED @ 65% POWER AT 10,000 FT.

CRUISING OPERATION CHART AT 4000 LB.
LEAN MIXTURE ABOVE 5000 FT.



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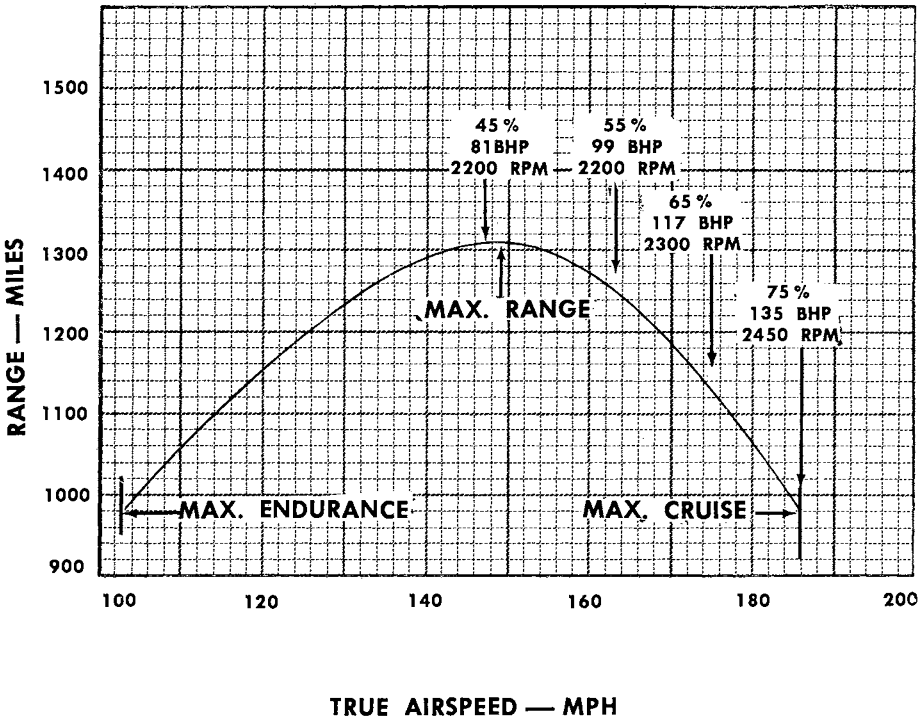
# RANGE AT ALTITUDE

## SEA LEVEL

RICH MIXTURE

4000 POUNDS
NO RESERVE
112 GALLONS

SEA LEVEL

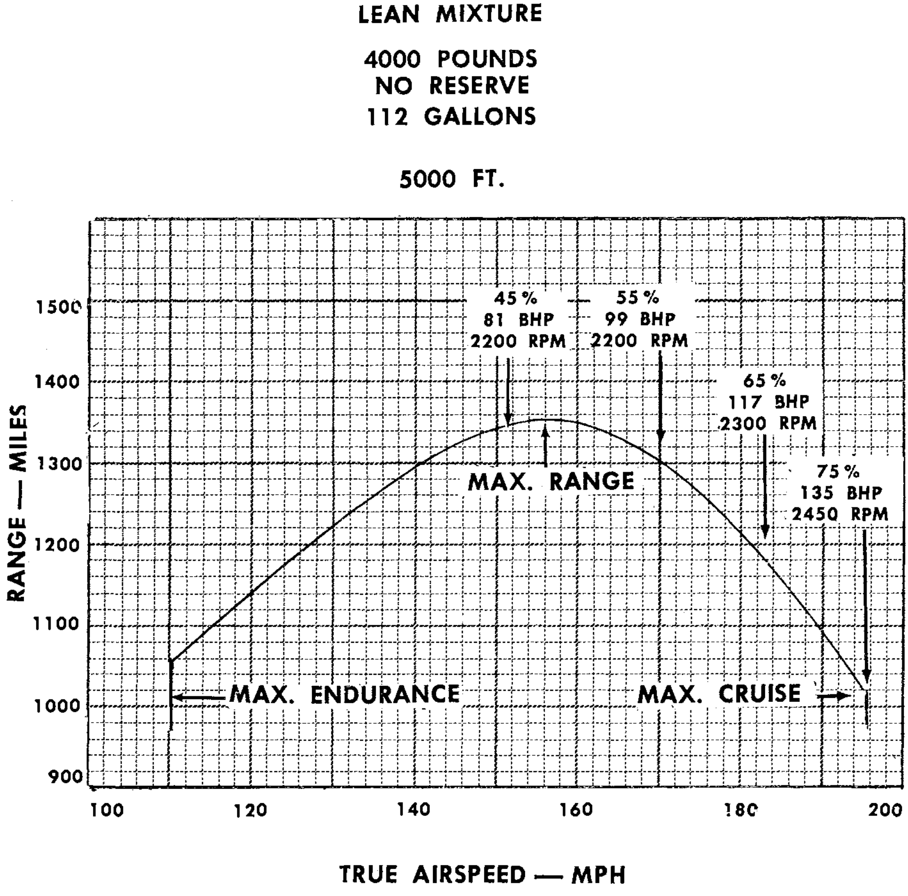





*Revised November 10, 1958*

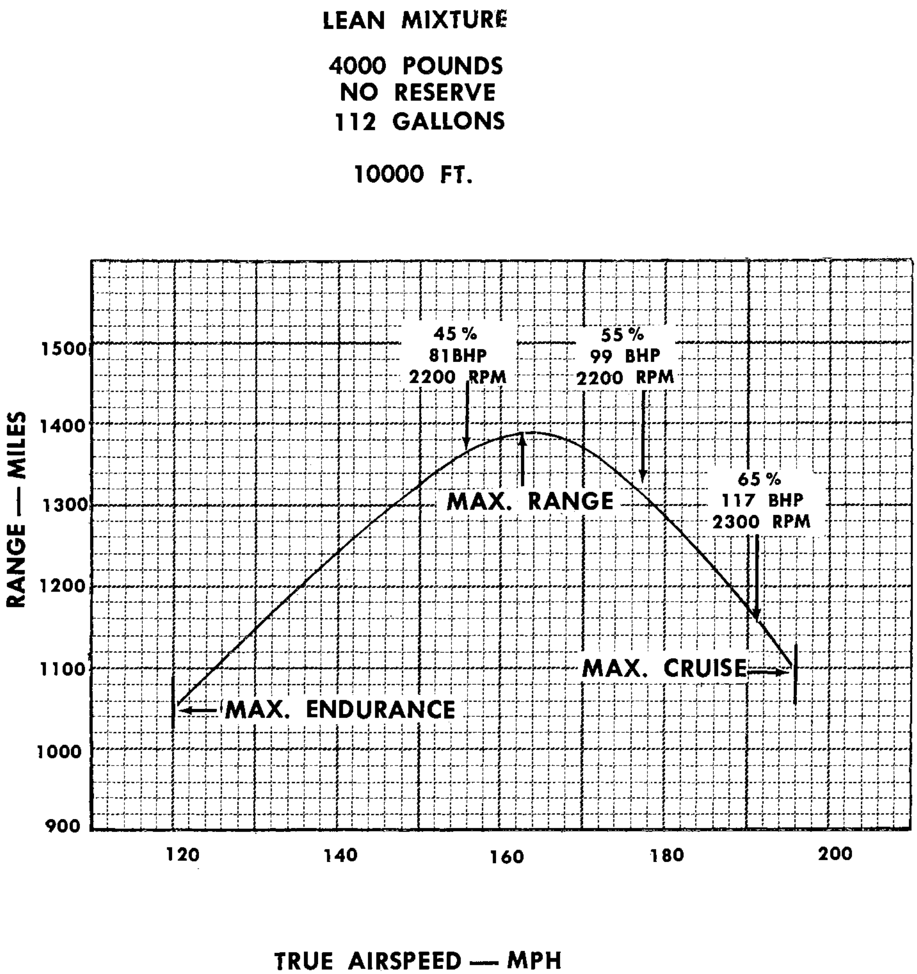
# RANGE AT ALTITUDE

## 5000 FEET



# RANGE AT ALTITUDE

## 10,000 FEET





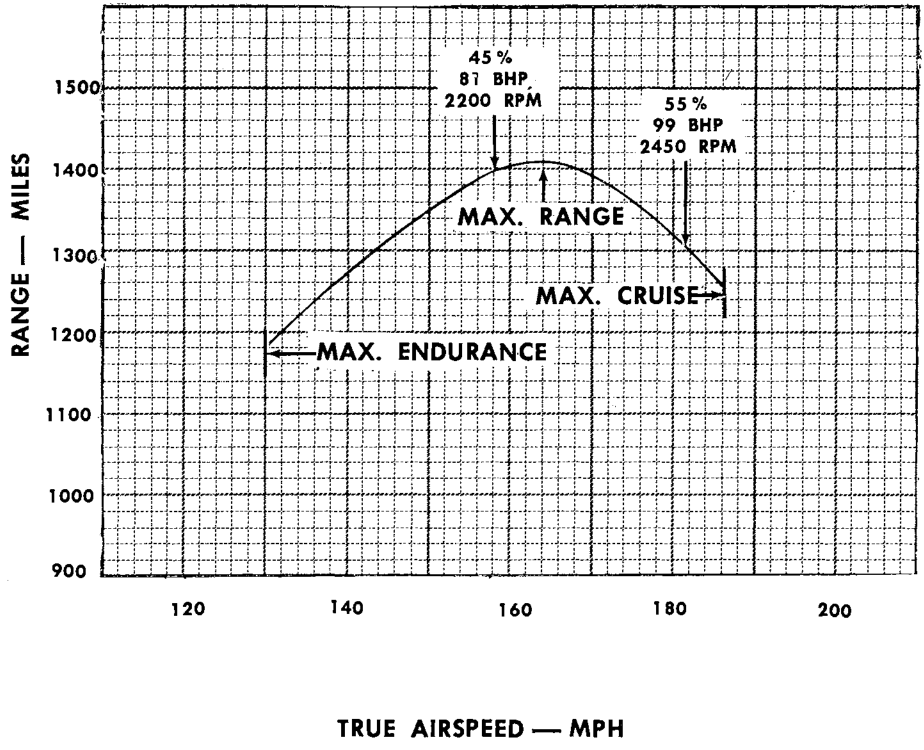

*Revised November 10, 1958*

# RANGE AT ALTITUDE

## 15,000 FEET

LEAN MIXTURE
4000 POUNDS
NO RESERVE
112 GALLONS

15000 FT.



# *Loading Your Travel Air*

YOU MAY, of course, fill the tanks, load your baggage and passengers, start up and go about your business, and as long as your loading stays within the weight limit and C.G. range, your Travel Air will fly easily and be surprisingly efficient. However, if you wish to realize the *most* your airplane is capable of giving you in fast, economical transportation, try investing a little time and effort in placing your loads to the best advantage. You will find that you can not only fly faster, but you will fly farther on less fuel.

As in flight planning, the complexity of weight and balance computations is relative: you alone, your brief case and a load of fuel should not require a check; at the other extreme, with full fuel and four people aboard, you may not be able to carry all their baggage and some high-priority cargo as well. In the following paragraphs, the weight and balance system used on the Travel Air is explained. You should study this portion of the handbook until you are completely familiar with it.

### *WEIGHT AND BALANCE*

Careful loading will pay dividends not only in safety and handling ease, but in actual performance and over-all economy. Any departure of the center of gravity from the optimum must be compensated by elevator or elevator trim tab deflection, the amount of deflection depending directly on the gross weight of the airplane and the amount of departure from optimum of the center of gravity. Deflection of any control surface results in increased drag, sacrificing some performance and economy. Thus, while for safety's sake you must load the airplane within the center of gravity limits, for the sake of efficiency you should load it so the center of gravity is as close to optimum, or roughly halfway between the two limits, as practical. The Travel Air's two baggage compartments, one ahead of and the other behind the center of gravity, make it easier to maintain a good balance.

Since proper balance is essential to the safe operation of an airplane, a system of loading and computing the center of gravity is required by the Civil Aeronautics Administration in order to obtain a license and certificate of airworthiness. The airplane's manufacturer must obtain approval by the CAA of the system of computing balance and the forms he will supply with each airplane. This system, plus a statement of the airplane's empty weight, empty weight center of gravity, equipment list and loading instructions then become a portion of the CAA-Approved Airplane Flight Manual, a document executed individually for each airplane and required by Civil Air Regulations to be kept in the airplane at all times.

## WEIGHT AND BALANCE

The Weight and Balance portion of the CAA-Approved Airplane Flight Manual for your Travel Air contains the following information: a statement of the actual weight, arm and moment of your empty airplane, with a diagram showing the weighing and leveling points; a graph of the center of gravity limits for different gross weights; tables giving the weights and moments of fuel, oil, passengers, baggage and cargo; an equipment list giving the weights and arms of all equipment items installed at the factory and included in the empty weight; and a center of gravity table giving the limits for various weights in terms of moment. The CAA-Approved Airplane Flight Manual will be found in your airplane, usually in the pocket on the back of the pilot's seat or in the map case. Because of the importance of the information it contains, Section IV of the manual is discussed in detail in the following paragraphs and facsimiles of the forms it contains are reproduced here. A thorough study of this information will pay you substantial dividends in safer, more economical flying.

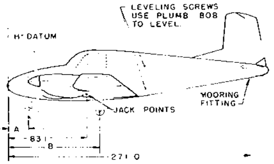
## BASIC WEIGHT STATEMENT

The first page of the Weight and Balance section contains a diagram of the airplane with the datum line, jack points, leveling provisions and other information necessary to properly weigh the airplane. You will note that it lists the serial and registration number of your airplane and the initials of the technicians who weighed it and checked the computations. The form lists the actual empty weight and moment of your airplane, when it was delivered from the factory; it is with this weight and moment that your balance computations will begin. The equipment included in the empty weight is listed, along with the weight and arm of each item, in the equipment list, page 4 of the Weight and Balance section.

BEECH AIRCRAFT CORPORATION

MODEL 95 TRAVEL AIR

## IV. WEIGHT AND BALANCE




Serial TD-00

Registration N000T

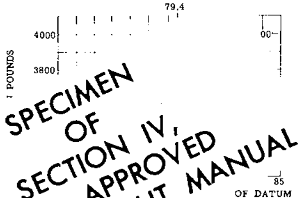
Computed by KES

Checked by

Date 9-16-57

| | A | B |
|---|---|---|
| Extended | 11.8 | 96.0 |
| Compressed | 13.1 | 97.0 |

| Actual Weight | Scale Reading | Tare | Net Weight | Arm | Moment |
|---|---|---|---|---|---|
| Main Jack Reaction | 2731 | — | 2731 | 83.1 | 226946 |
| Mooring Fitting Reaction | 60 | 153 | -93 | 271.0 | -25203 |
| Total as Weighed | 2791 | 153 | 2638 | 76.5 | 201743 |
| Remove: | | | | | |
| Seat Covers | | | -4 | 100 | -400 |
| Add: | | | | | |
| System Oil | | | 9 | 42 | 378 |
| System Fuel | | | | | |
| Undrainable Fuel | | | 5 | | 420 |
| Unusable Fuel | | | 13 | | 1110 |
| Air Conditioner Water | | | 4 | 154 | 616 |
| Empty Weight (Actual) | | | 2665 | 76.5 | 203867 |




SPECIMEN OF SECTION IV, CAA - APPROVED AIRPLANE FLIGHT MANUAL

It is the ... weight and ... been altere... the airplane is loaded properly. The empty ...as delivered from the factory. If the airplane has ...ion Form ACA-337 for this information.

LANCE
S

BAGGAGE

| FORWARD Weight | FORWARD Moment/100 | REAR Weight | REAR Moment/100 |
|---|---|---|---|
| | 3 | 10 | 14 |
| | 6 | 20 | 28 |
| | 9 | 30 | 42 |
| | 12 | 40 | 56 |
| | 16 | 50 | 70 |
| | 19 | 60 | 84 |
| | 22 | 70 | 98 |
| | 25 | 80 | 112 |
| | 28 | 90 | 126 |
| | 31 | 100 | 140 |
| | 34 | 110 | 154 |
| | 37 | 120 | 168 |
| | 40 | 130 | 182 |
| | 43 | 140 | 196 |
| 150 | 47 | 150 | 210 |
| 160 | 50 | 160 | 224 |
| 170 | 53 | 170 | 238 |
| 180 | 56 | 180 | 252 |
| 190 | 59 | 190 | 266 |
| 200 | 62 | 200 | 280 |
| 210 | 65 | 210 | 294 |
| 220 | 68 | 220 | 308 |
| 230 | 71 | 230 | 322 |
| 240 | 74 | 240 | 336 |
| 250 | 78 | 250 | 350 |
| 260 | 81 | 260 | 364 |
| 270 | 84 | 270 | 378 |

| ...ATS Weight | ...ATS Moment/100 | REAR SEATS Weight | REAR SEATS Moment/100 |
|---|---|---|---|
| 120 | 102 | 120 | 142 |
| 130 | 110 | 130 | 153 |
| 140 | 119 | 140 | 165 |
| 150 | 128 | 150 | 177 |
| 160 | 136 | 160 | 189 |
| 170 | 144 | 170 | 201 |
| 180 | 153 | 180 | 212 |
| 190 | 162 | 190 | 224 |
| 200 | 170 | 200 | 236 |

OIL

| Gallons | Weight | Moment/100 |
|---|---|---|
| 4.0 | 30 | 14 |

CARGO (With Rear Seat Removed)

| Ahead of Spar Weight | Ahead of Spar Moment/100 | Aft of Spar Weight | Aft of Spar Moment/100 |
|---|---|---|---|
| 20 | 22 | 20 | 27 |
| 40 | 43 | 40 | 54 |
| 60 | 65 | 60 | 81 |
| 80 | 86 | 80 | 108 |
| 100 | 108 | 100 | 135 |
| 120 | 130 | 120 | 162 |
| 140 | 151 | 140 | 189 |
| 160 | 173 | 160 | 216 |
| 180 | 194 | 180 | 243 |
| 200 | 216 | 200 | 270 |
| | | 220 | 297 |
| | | 240 | 324 |
| | | 260 | 351 |
| | | 270 | 364 |

SAMPLE LOADING CALCULATION:

| | Weight | Moment/100 |
|---|---|---|
| Empty Weight | 2665 | 2039 |
| Oil | 30 | 14 |
| Main Fuel | 300 | 225 |
| Auxiliary Fuel | 180 | 167 |
| Front Seat | 340 | 288 |
| Rear Seat | 340 | 402 |
| Forward Baggage | 45 | 14 |
| Rear Baggage | 100 | 140 |
| Total Takeoff Weight | 4000 | 3289 |
| Use Main Fuel | -150 | -113 |
| Use Auxiliary Fuel | -180 | -167 |
| Total Landing Weight | 3670 | 3009 |

Serial TD-00

Registration NOOOT

Date 9-16-57

BEECHCRAFT MODEL 95 TRAVEL AIR
PAGE 4 - EQUIPMENT LIST

X - Installed in Airplane    O - Not Installed in Airplane

| | Item No. | | Weight | Arm |
|---|---|---|---|---|
| | 1. | Two Hartzell Full Feathering Propellers | | |
| X | | (a) Hartzell HC-92ZK-2 Hub with 8447-12 aluminum alloy blades and 835-7 spinner | 75 ea. | 22 |
| X | | (b) Woodward propeller governor, (B210195) | 3 ea. | 52 |
| X | | (c) Beech Unfeathering Accumulator, 95-960011 | 6 ea. | 65 |
| | 101. | Fuel Pumps | | |
| X | | (a) Two electric booster pumps, Bendix 476411 | 2 ea. | 88 |
| X | | (b) Two engine driven, AC type AH | 3 ea. | 53 |
| X | 102. | Two oil radiators (a) Harrison 8523517 | 2 ea. | 30 |
| X | 103. | Two carburetor air cleaners (a) Air-Maze 121128 | 1 ea. | 33 |
| X | 104. | Two vacuum pumps (a) Pesco 3P-194F or Aro A513-DB | 3 ea. | 50 |
| X | 105 | Two starters (a) Lycoming 71348 | 18 ea. | 31 |
| X | 106. | Two 30 gal. auxiliary fuel tanks at (93) Replacing two standard 17 gal. fuel tanks | +8 | 91 |
| X | 201. | Two main wheel - brake assemblies, 6.50-8 Type III (a) Goodyear Wheel Assembly No. 9531711 | 7 ea. | 96 |
| | | Brake Assembly No. 9531712 | 4 ea. | 97 |
| X | 202 | (a) Two main wheel 6 ply rating tires, 6.50-8 with regular tubes | 14 ea. | |
| X | 205. | One nose wheel 5.00-5, Type III (a) Goodyear Wheel Assembly No. 952[illegible] or B. F. Goodrich No. 3-897 | | |
| X | 206 | (a) One nose wheel [illegible] with re[illegible] | | |
| O | 210. | [illegible] | | |
| O | | | | |
| X | | | | |
| O | | | | |
| X | | | | |

| | Item No. | | Weight | Arm |
|---|---|---|---|---|
| X | 303. | Two landing lights, General Electric 4523 | 1 ea. | 75 |
| X | 304. | Paralleling relay (a) Delco-Remy 1116902 or Lycoming 71349 | 1 | 49 |
| X | 401. | DMCR Approved Airplane Flight Manual (a) Model 95 dated June 18, 1957 | | |
| X | 402. | Heater installation (a) Beech 95-550000 cabin heater installation (Modified surface combustion heater Model 83A28) | 48 | 22 |
| x | 403. | Air conditioner installation (a) Beech 35-050085-1 (including water) | 18 | 148 |
| O | 404. | Dual control column (T-Type) Beech 35-524575 | +3 | 72 |
| X | 601. | Stall warning indicator - Safe Flight No. 151 | 1 | 58 |
| X | 602. | Heated Pitot Head Installation | 1 | 75 |

MISCELLANEOUS

Instruments, Extra

| | Weight | Arm |
|---|---|---|
| Turn and Bank | 1 | 67 |
| Rate of Climb | 1 | 67 |
| Directional Gyro | 4 | 66 |
| Attitude Gyro | 3 | 66 |
| Horizon Gyro | 4 | 66 |
| Headrests (2) | 3 | 100 |
| Rear Seat | 45 | 124 |

ADDITIONAL EQUIPMENT

| | Weight | Arm |
|---|---|---|
| Nose Taxi Light | 2 | -9 |
| Rotating Beacon Light | 2 | 182 |
| | | 77 |

**SPECIMEN OF SECTION IV, CAA - APPROVED AIRPLANE FLIGHT MANUAL**

IR WEIGHT AND BALANCE
RAVITY TABLE

| | | | Weight | Minimum Moment/100 | Maximum Moment/100 | Weight | Minimum Moment/100 | Maximum Moment/100 |
|---|---|---|---|---|---|---|---|---|
| | | 2324 | 3200 | 2400 | 2656 | 3600 | 2737 | 2988 |
| | 2108 | 2332 | 3210 | 2408 | 2664 | 3610 | 2747 | 2996 |
| | 2115 | 2341 | 3220 | 2415 | 2673 | 3620 | 2758 | 3005 |
| 2830 | 2123 | 2349 | 3230 | 2423 | 2681 | 3630 | 2769 | 3013 |
| 2840 | 2130 | 2357 | 3240 | 2430 | 2689 | 3640 | 2779 | 3021 |
| 2850 | 2138 | 2366 | 3250 | 2438 | 2698 | 3650 | 2790 | 3030 |
| 2860 | 2145 | 2374 | 3260 | 2445 | 2706 | 3660 | 2801 | 3038 |
| 2870 | 2153 | 2382 | 3270 | 2453 | 2714 | 3670 | 2812 | 3046 |
| 2880 | 2160 | 2390 | 3280 | 2460 | 2722 | 3680 | 2822 | 3054 |
| 2890 | 2168 | 2399 | 3290 | 2468 | 2731 | 3690 | 2833 | 3063 |
| 2900 | 2175 | 2407 | 3300 | 2475 | 2739 | 3700 | 2844 | 3071 |
| 2910 | 2183 | 2415 | 3310 | 2483 | 2747 | 3710 | 2855 | 3079 |
| 2920 | 2190 | 2424 | 3320 | 2490 | 2756 | 3720 | 2866 | 3088 |
| 2930 | 2198 | 2432 | 3330 | 2498 | 2764 | 3730 | 2876 | 3096 |
| 2940 | 2205 | 2440 | 3340 | 2505 | 2772 | 3740 | 2887 | 3104 |
| 2950 | 2213 | 2449 | 3350 | 2513 | 2781 | 3750 | 2898 | 3113 |
| 2960 | 2220 | 2457 | 3360 | 2520 | 2789 | 3760 | 2909 | 3121 |
| 2970 | 2228 | 2465 | 3370 | 2528 | 2797 | 3770 | 2920 | 3129 |
| 2980 | 2235 | 2473 | 3380 | 2535 | 2805 | 3780 | 2931 | 3137 |
| 2990 | 2243 | 2482 | 3390 | 2543 | 2814 | 3790 | 2942 | 3146 |
| 3000 | 2250 | 2490 | 3400 | 2550 | 2822 | 3800 | 2953 | 3154 |
| 3010 | 2258 | 2498 | 3410 | 2558 | 2830 | 3810 | 2964 | 3162 |
| 3020 | 2265 | 2507 | 3420 | 2565 | 2839 | 3820 | 2975 | 3171 |
| 3030 | 2273 | 2515 | 3430 | 2573 | 2847 | 3830 | 2986 | 3179 |
| 3040 | 2280 | 2523 | 3440 | 2580 | 2855 | 3840 | 2997 | 3187 |
| 3050 | 2288 | 2532 | 3450 | 2588 | 2864 | 3850 | 3008 | 3196 |
| 3060 | 2295 | 2540 | 3460 | 2595 | 2872 | 3860 | 3019 | 3204 |
| 3070 | 2303 | 2548 | 3470 | 2603 | 2880 | 3870 | 3030 | 3212 |
| 3080 | 2310 | 2556 | 3480 | 2610 | 2888 | 3880 | 3041 | 3220 |
| 3090 | 2318 | 2565 | 3490 | 2620 | 2897 | 3890 | 3052 | 3229 |
| 3100 | 2325 | 2573 | 3500 | 2631 | 2905 | 3900 | 3064 | 3237 |
| 3110 | 2333 | 2581 | 3510 | 2641 | 2913 | 3910 | 3075 | 3245 |
| 3120 | 2340 | 2590 | 3520 | 2652 | 2922 | 3920 | 3086 | 3254 |
| 3130 | 2348 | 2598 | 3530 | 2662 | 2930 | 3930 | 3097 | 3262 |
| 3140 | 2355 | 2606 | 3540 | 2673 | 2938 | 3940 | 3108 | 3270 |
| 3150 | 2363 | 2615 | 3550 | 2684 | 2947 | 3950 | 3120 | 3279 |
| 3160 | 2370 | 2623 | 3560 | 2694 | 2955 | 3960 | 3131 | 3287 |
| 3170 | 2378 | 2631 | 3570 | 2705 | 2963 | 3970 | 3142 | 3295 |
| 3180 | 2385 | 2639 | 3580 | 2715 | 2971 | 3980 | 3153 | 3303 |
| 3190 | 2393 | 2648 | 3590 | 2726 | 2980 | 3990 | 3165 | 3312 |
| | | | | | | 4000 | 3176 | 3320 |

INSTRUCTIONS

The Weight and Balance information is arranged for the airplane operator to secure the best possible loading of his Travel Air with a minimum amount of computation. The empty weight and center of gravity of this airplane is shown on Page 1 (or on the latest CAA Form ACA-337 if the airplane has been altered.) To calculate a loading, copy the current empty weight and moment, 100. (All moments are divided by 100 for mathematical convenience.) Then add the useful load items to be carried to the empty weight. The total weight at takeoff must not exceed 4000 pounds and the total moment, 100 must be between the limits in the Center of Gravity Table above. Then remove fuel as it would be used for the intended flight and check the total moment again to be sure it has remained within the limits for the landing condition. A sample loading calculation is shown on Page 2.

The datum, or reference line from which horizontal measurements are taken, is located 83.1 inches forward of the center line through the forward jack points. Moments of useful load items to be added to the airplane are arrived at by multiplying the weight of the item by the arm of the item, that is, the distance from the datum line to the item.

When the airplane is flown at a weight of 3480 pounds or less, the forward center of gravity limit is 75.0 inches aft of the datum and the rear center of gravity limit is 83.0 inches aft of the datum. As the weight increases, the forward center of gravity limit shifts aft in a straight-line variation to 79.4 inches aft of datum at 4000 pounds. The rear center of gravity limit remains constant at 83.0 inches aft of datum. These limits are shown on a graph on the basic weight statement.

## COMPUTING YOUR LOAD

To simplify the arithmetic necessary to compute the center of gravity, in the system approved by the CAA for BEECHCRAFT airplanes, the weights and arms of the empty airplane, its items and the fuel, oil, passengers, baggage and movable equipment are reduced to moments; i.e. the products of the various weights multiplied by their respective arms. All arms are taken from an imaginary point, or datum line forward of the center of gravity. The center of gravity limits are expressed in terms of moments with the datum line as a reaction point. Thus, computing your weight and balance becomes simply a matter of adding to the empty weight and empty weight moment of the airplane, given in the basic weight statement, the weights and moments of your load — fuel, oil, baggage and passengers. The totals will be your gross weight and total moment and to see if your loading is satisfactory, you have only to compare your totals with the figures in the Center of Gravity Table. If your total weight is not in excess of the allowable gross, and your total moment is between the minimum and maximum moments shown for your total weight, your loading is satisfactory.

## USEFUL LOAD WEIGHT AND MOMENTS

The tables on page 2 of the Weight and Balance section show the weights and moments of variable items such as fuel, passengers, and baggage. The empty weight moment and the moments of all useful load items are divided by 100 for mathematical convenience.

## CENTER OF GRAVITY TABLE

To assist in loading the airplane, minimum and maximum moments for gross weights from 2800 pounds to 4000 pounds, in 10-pound increments, are listed in the Center of Gravity Table. These moments correspond to the forward and rear center of gravity limits at each listed weight.

The weight and moment are determined with the landing gear down. The moments given in the Center of Gravity Table are such that when the landing gear down C.G. condition falls within the limits shown, the landing gear up condition will be satisfactory also.

## SAMPLE LOADING CALCULATION

1. Write down the airplane empty weight and moment/100 as referenced in the Weight and Balance section or latest Form 337.

2. Add the weight and moment/100 of all useful load items.

3. Check this loading to see that it is within the allowable limits shown in the Center of Gravity Table.

The total weight at take-off must not exceed 4000 pounds. Obviously, if the total moment/100 is outside the minimum or maximum values in the Center of Gravity Table, some useful load items must be moved, reduced, or omitted to bring the airplane within allowable limits.

4. Remove the weight and moment of fuel as it would be used for the intended flight, and check the total again to be sure it has remained within approved limits for the landing condition.

Sample Loading Calculation

| | Weight | Moment/100 |
|---|---|---|
| Empty Weight | 2665 | 2039 |
| Oil | 30 | 14 |
| Main Fuel | 300 | 225 |
| Auxiliary Fuel | 180 | 167 |
| Front Seat | 340 | 288 |
| Rear Seat | 340 | 402 |
| Forward Baggage | 45 | 14 |
| Rear Baggage | 100 | 140 |
| Total Takeoff Weight | 4000 | 3,289 |
| Use Main Fuel | -150 | -113 |
| Use Auxiliary Fuel | -180 | -167 |
| Total Landing Weight | 3670 | 3009 |

# Emergency Procedures

"THE best time to know procedures and the worst time to practice them is during an EMERGENCY."

Emergencies, created by the failure or malfunction of one or more components or accessories, may be broadly classified in one of two groups: those requiring immediate action and those in which you have sufficient time to decide on and execute a plan of action according to the demands of the particular situation.

In this discussion of emergencies, the situations requiring immediate corrective action are treated in check-list style for easy reference and familiarization. Other situations are discussed with respect to cause, condition, effect and possible corrective measures. Your practice of these suggested techniques should be frequent enough for you to maintain proficiency in the rapid initiation of the proper procedures. Complete mastery of emergency procedures peculiar to multi-engine flying cannot be over impressed.

Emergency situations seldom will occur, if you follow good inspection and maintenance practices. Otherwise your need for a complete understanding of this section is multiplied.

## *SINGLE ENGINE OPERATION*

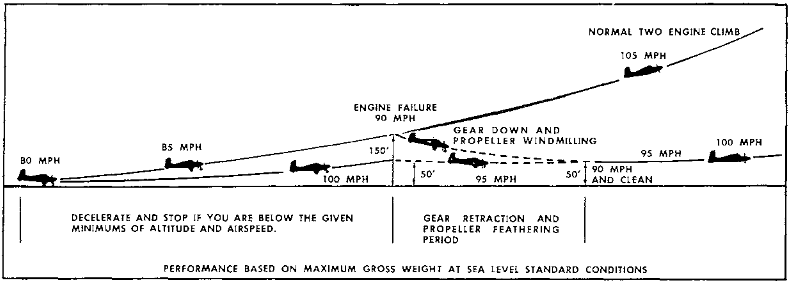
The flight and handling characteristics of your Travel Air on one engine are excellent. The aircraft may be safely maneuvered or trimmed for normal hands-off operation, which is easily sustained by the operative engine, *as long as sufficient airspeed is maintained.* However, to properly use these safety and performance characteristics, you must have a sound understanding of single-engine performance and the limitations resulting from an unbalance of power.

Two major factors govern single-engine operation: airspeed, and directional control. The minimum control speed, 84 mph IAS, is the speed at which you still have directional control with the aircraft in take-off configuration, one engine inoperative and full take-off power on the operating engine. However, bear in mind that this speed is a minimum for control, and *below the speed at which the aircraft will climb.*

The best single-engine rate-of-climb speed, at sea level, is 100 mph IAS (the "blue line" on the airspeed indicator). This speed is extremely important for best performance in an emergency; if the speed is allowed to vary from the optimum, your rate-of-climb will decrease, or if you are above the critical single-engine altitude, your rate-of-sink will increase. The variation in best rate-of-climb speed with altitude is shown on the graph, page 108.

The safe single-engine speed, *also* 100 mph IAS, is probably the most important speed you will be concerned with during your practice of emergency procedures and should an actual emergency occur. If you have safe single-engine speed, normal single-engine procedures may be followed. Otherwise, you must attain this necessary airspeed, through an altitude loss, or make a landing. The technique to be used in a given situation and the decisions you must make, will depend entirely upon your altitude and airspeed at the particular time the emergency arises.

These airspeeds are recommended for average piloting techniques,



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under average conditions; they do not represent the maximum aircraft performance under ideal conditions, but have been determined on the basis of actual flight tests, to afford you a reasonable margin of safety.

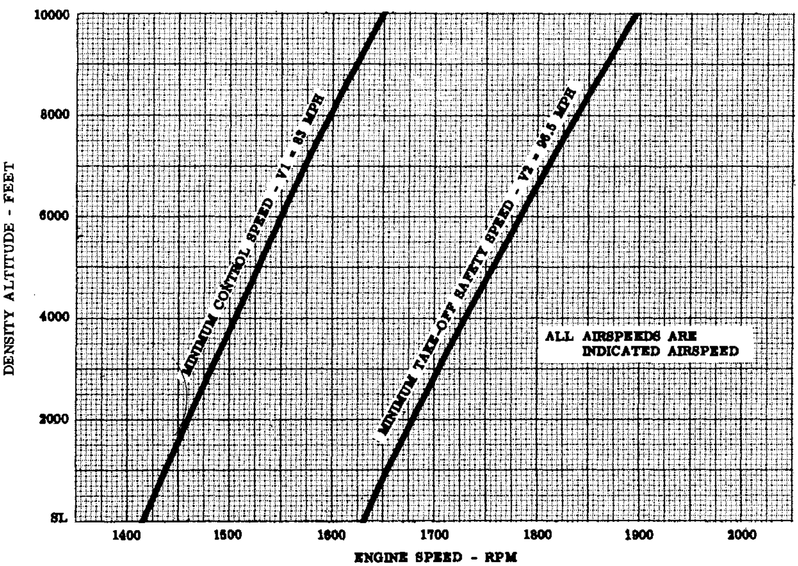
The chief advantage of an additional engine is the ability of the aircraft to go on flying if one engine fails. However, having two engines, like having blind flying instruments, is a safety factor which depends on the knowledge, technique and the recent experience of the pilot.

A Zero-Thrust Graph with instructions for simulated one-engine-out conditions is provided to aid in reduction of risks involved in single-engine practice. Practice these techniques until they become instinctive.

## SIMULATED ONE-ENGINE-OUT PROCEDURE

Simulated one-engine-out conditions may be set up whereby zero-thrust power settings may be used instead of complete engine shutdown in order to avoid the risks involved in the training or practicing of single-engine technique. The two airspeeds represented in the accompanying graph are V1 minimum control speed and V2 minimum take-off safety speed with the landing gear up and the

ENGINE SPEED FOR ZERO THRUST AT ALTITUDE



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propeller feathered. In order to set up a zero-thrust condition for single engine practice, use the following procedure:

## USE OF THE ZERO-THRUST GRAPH

1. Select your pressure altitude (altimeter set at 29.92 inches Hg) and either the V1 or V2 air speed.

2. Observe the OAT and determine the standard altitude from the altitude conversion chart.

3. To find the correct engine rpm, read horizontally across the zero-thrust graph at the standard altitude, calculated in step 2, to the selected airspeed where it intersects the airspeed curve, then read the engine rpm directly below.

## APPLICATION

1. To obtain zero-thrust rpm, adjust power to a minimum throttle setting for the required rpm and air speed with the prop control in the full high rpm position.

2. After setting up the above zero-thrust practice conditions, single engine flight characteristics will be as set forth in the following paragraphs. The engine speed for obtaining zero-propeller-thrust can be affected quite markedly by variation in atmospheric conditions and indicated air speed. Care should be exercised in determining the standard altitude and setting up the zero-thrust power at the proper rpm and minimum manifold pressure at the air speed for the given condition.

3. For recovery after the practice condition, apply throttle and retrim as necessary.

## DETERMINING INOPERATIVE ENGINE

Once an engine has actually failed, your first consideration is to continue to fly the aircraft. Apply all available power immediately: *all six levers full forward.* Then determine for certain which engine has failed, since there is a chance you may feather the propeller on the good engine. The following checks will aid you in deciding which engine has failed:

1. *Dead foot — dead engine.* The rudder pressure required to maintain directional control will be on the side of the good engine.



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2. *The cylinder head temperature gage* immediately will indicate a lower-than-normal reading for the inoperative engine.

3. *Partially retard the throttle* on the engine that is believed inoperative. There should be no change in control pressures or in the sound of the engine, if the correct throttle has been selected. Under conditions of low altitude and IAS, this particular check must be accomplished with extreme caution.

Never try to determine the inoperative engine by reading the tachometer or the manifold pressure gages. After power has been lost on an engine the tachometer often will indicate the correct rpm and the manifold pressure gage frequently will indicate approximate atmospheric pressure or above.

## NORMAL SINGLE-ENGINE PROCEDURE

After determining the inoperative engine, if your IAS is at or above safe single-engine speed, use the following shutdown procedure. The over-all goal of these steps is to reduce all unnecessary drag in as short a time as possible.



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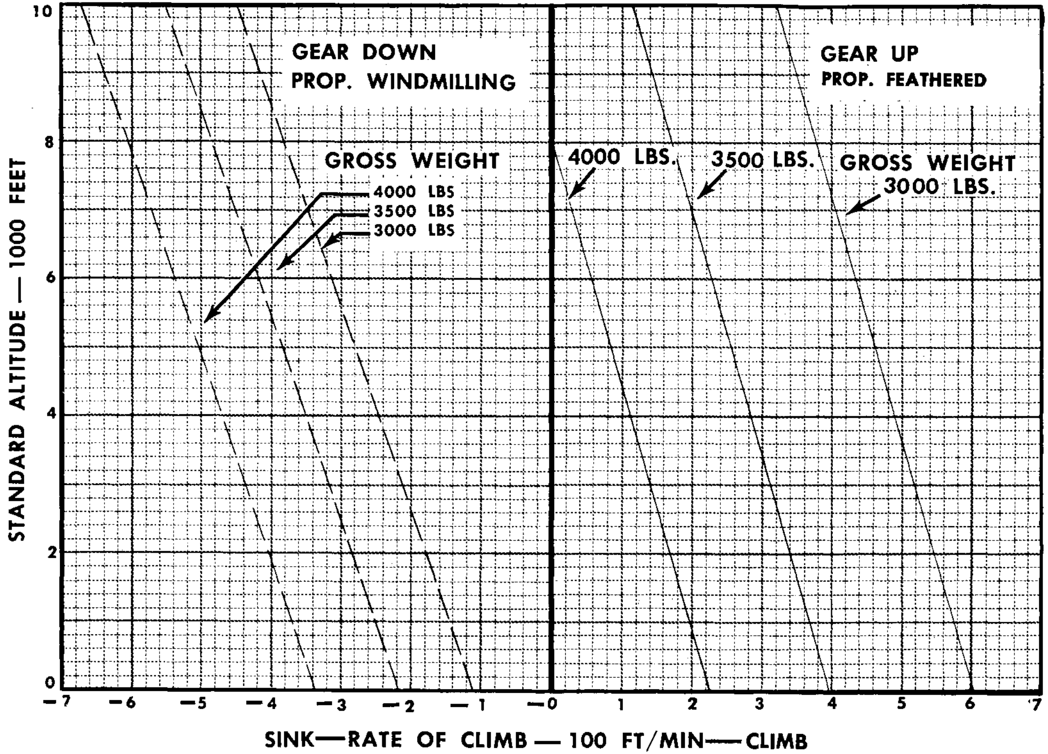
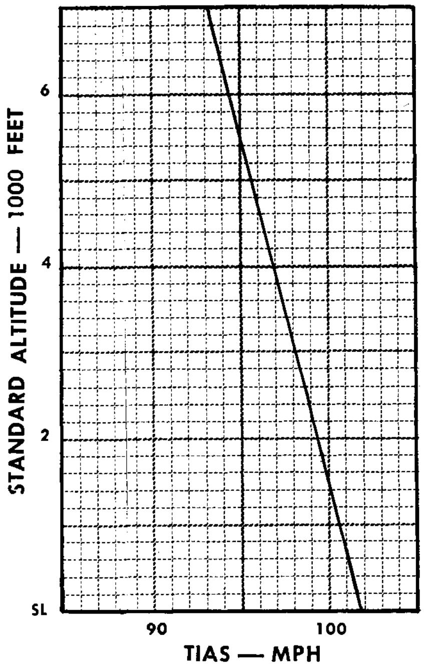
# RATE OF CLIMB VS. ALTITUDE AND WEIGHT

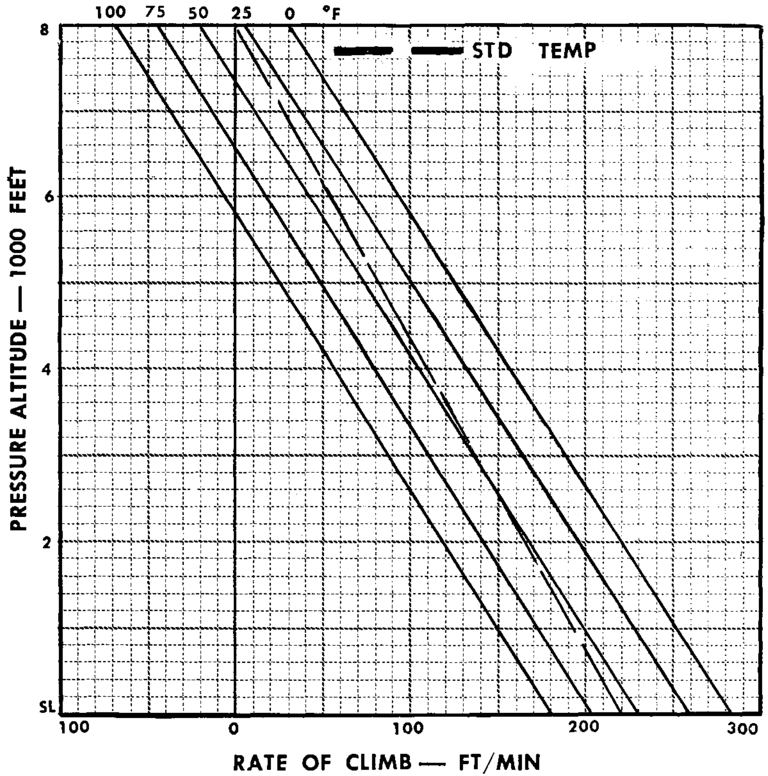


## BEST RATE OF CLIMB SPEED SINGLE-ENGINE

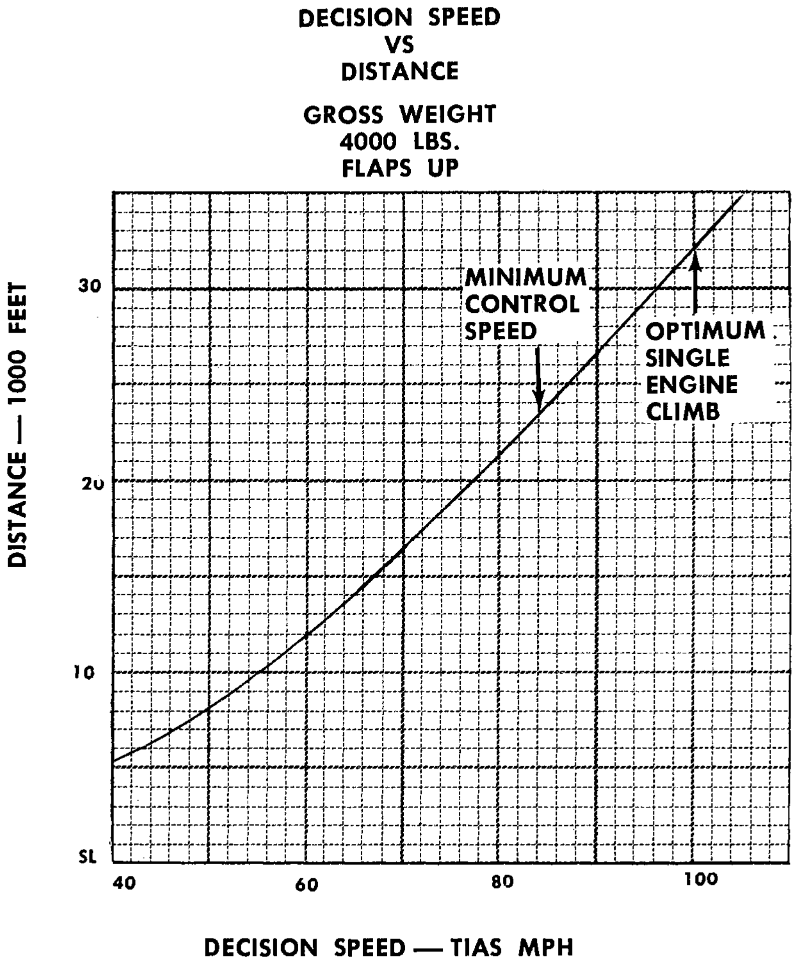
TIAS VS ALTITUDE
GROSS WEIGHT
4000 LBS




## RATE OF CLIMB VS. TEMPERATURE AND ALTITUDE — SINGLE-ENGINE



# ACCELERATE AND STOP DISTANCE



1. Apply take-off power, 2700 rpm (throttles, propellers and mixtures for both engines full forward), to obtain or maintain desired altitude and airspeed. Add rudder pressure as necessary to maintain directional control and at the same time bank approximately 5 degrees into the heavy rudder.

2. Retract the landing gear.

3. Determine which engine failed, then for the inoperative engine, pull the propeller and mixture controls back into full feathered and idle-cut-off positions.

4. Close the cowl flap on the inoperative engine.

**NOTE**

If flaps are in use, they should be retracted gradually particularly if your airspeed and altitude are low. This will prevent sinking that would occur due to loss of lift with fast retraction of flaps.

5. As the propeller feathers and the engine stops rotating, shut off the generator and magneto switches.

**NOTE**

If a propeller fails to completely stop rotating, it sometimes can be stopped by slightly decreasing airspeed.

6. Turn the fuel selector valve for the inoperative engine to "OFF," and check the fuel boost pump "OFF."

7. Turn off as much electrical equipment as necessary to prevent excessive battery drain.

8. Maintain take-off power until a safe altitude is attained or until all the single-engine procedures and checks are satisfactorily accomplished, then select a cruise power setting for the good engine which will maintain at least 110 mph IAS, the minimum speed for hands-off trim on one engine.

9. Set the rudder trim for single-engine flight and trim the wing on the side of the operative engine to hold approximately



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3 to 5 degrees low. This trimming procedure will balance the drag effect of the inoperative engine with the tendency of the aircraft to turn into the good engine.

10. Land as soon as practicable.

## ENGINE FAILURE DURING TAKE-OFF

The major factor in a take-off emergency, caused by engine failure, is your airspeed *at the time you decide* either to continue or to abort the take-off. The variable factors of remaining runway, obstructions in the take-off path, and the type of take-off attempted, will dictate the sequence of procedures you must follow once the decision to take-off or land has been made.

A take-off attempt should be abandoned early in the take-off run if there is any indication of malfunction or loss of power. If you are airborne, however, and landing appears hazardous, lifting the wing with the weak engine will make directional control easier.

Emergencies requiring the use of an extended landing gear are a good reason for not making an early gear retraction unless a critical situation already exists. Flaps, also, should not be used for take-off except in abnormal situations where high performance is necessary.

If an engine failure has occurred with an IAS of less than safe single-engine speed (100 mph) and the gear extended, cut your power, get the nose wheel on the runway and apply the brakes. If the aircraft cannot be stopped within field limits and ground looping is not feasible, prepare to stop straight ahead; turn no more than necessary to avoid obstructions. To minimize the chances of fire, turn off all switches and controls you can.

If an engine fails after you have gained safe single-engine speed, retract the landing gear immediately and follow normal single-engine procedure. If the failure occurs after you are airborne, but before you have safe single-engine speed, reduce power and land straight ahead. A glance at the single-engine climb graph will show clearly that the first requirement for continuing flight after an engine failure is to clean up the airplane as quickly as possible. *With the airplane clean, you can climb; with gear down, windmilling propeller and cowl flaps open, you will not be able to maintain altitude.* Bear in mind, also, that the performance shown on the graph is for standard altitude; if your ambient temperature is higher than standard, your rate of climb will be less than that shown, while on a cold day it will be better. To visualize the amount of these variations, determine a few density altitudes based on typical summer and winter conditions and check the performance shown on the graph for these densities. Note also the effect of temperature on single-engine climb.

## ENGINE FAILURE DURING FLIGHT

Follow normal single-engine procedures, if the difficulty is apparent and cannot be remedied. Otherwise, if you have a safe altitude, the following checks may be accomplished in addition to the usual procedures, in an effort to locate the trouble and resume normal operation. These checks should be made prior to feathering the propeller and turning off the magneto switches on the inoperative engine.

1. Check fuel pressure and, if deficient, turn on the fuel boost pump.

2. Check fuel quantity and switch to another fuel cell if necessary.

3. Check oil pressure and oil temperature indications; shut down the engine if oil pressure is low.

4. Check magneto switches.

If the proper corrective action has been taken the engine should re-start. Otherwise, if the cause of failure was not determined, complete the normal shut-down procedure.

Any time an engine fails, whether normal operation has been resumed or not, a landing at the nearest suitable airport and an investigation of the cause is in order.

If an engine should fail at a safe altitude and airspeed then at the pilots discretion it may not be necessary to use 2700 rpm and Full Throttle on the good engine. Power may be adjusted to produce desired performance.



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## RE-STARTING FEATHERED ENGINE

Prior to a re-start of an engine that has failed, the cause of failure should be located and corrected. It is wiser to continue on one engine rather than chance ruining an engine that may need only minor repairs.

The procedures given for re-starting purposes are suitable for use during practice of single-engine procedures or for a re-start after an engine failure, should you so decide. During cold weather your re-start should be completed within a few minutes after shut-down, since cold oil in the governor passages and propeller may impede unfeathering.

For engine to be started:

1. Turn the fuel selector valve to either the main or auxiliary position; the boost pump can be used on any cell selected.

2. Adjust the throttle to the normal starting position.

3. Turn on the magneto switches.

4. Move the propeller control full forward to the low pitch (high rpm) range.

5. Turn the engine over with the starter.

6. After several engine revolutions, advance the mixture control to full rich.

7. As soon as the engine starts, adjust the throttle setting as necessary to prevent an engine overspeed condition. Check immediately for fuel and oil pressure, particularly if you are restarting an engine which has failed, since the cause of the failure may be indicated by lack of, or abnormal, indications from either gage. If both do not respond normally, abandon the attempt at starting, re-feather and secure the engine.

8. After the engine starts, turn off the fuel boost pump.

9. Let the engine warm up at approximately 2000 rpm and 15 inches manifold pressure. Observe the oil pressure closely; if it does not come up to normal in 30 seconds, shut-down and re-feather.

10. When the oil temperature has come up to normal, bring the engine up to normal power and re-trim. Set the rpm first, then open the throttle.

If engine failure has been due to an actual malfunction, just prior to switching on the magnetos turn the engine over several times with the starter. If the starter will not turn the engine, an internal failure is indicated; re-feather and secure the engine.

If your aircraft is not equipped with the propeller accumulator installation, which is optional equipment, the above un-feathering procedures may still be used. However, the engine starting operation will be more difficult, particularly if the engine is inoperative for a time and has cooled down.

## SINGLE-ENGINE LANDING

Essentially, a single-engine landing is the same as a normal landing, except that you should allow a larger safety margin during the pre-landing pattern and final approach. This safety margin is in the form of more airspeed, a slightly higher pattern and final approach altitude and a wider pattern which will eliminate any steeply banked turns.

Since you have more altitude, your final approach may be higher, and because of the larger pattern you may line up with the runway further out; thus, you will have time to correct for any wind drift, stabilize your final approach speed and rate of descent and judge more accurately your use of gear and flaps. Also you can ease off the power on your good engine a little sooner; rudder trim should be reduced to neutral as power is decreased.

Lower the landing gear only after final approach is established. If a base leg is used, the gear may be lowered as you roll out of the turn on final; if making a straight-in approach, aim for the first few feet of the runway and set up a glide path to overshoot rather than undershoot, then lower the gear.

With one propeller feathered, drag is considerably reduced, resulting in a longer flare-out and landing roll. Make allowances accordingly as you play your final approach.

Do not lower the flaps until the gear is down and locked and you are sure of making the field. Full flaps may be used to shorten the landing roll or to steepen the approach if you are overshooting.

With full flaps and gear down, level flight cannot be maintained at full gross weight on one engine; unless you have a safe margin of airspeed and altitude you are committed to the landing. *Unless you are light, do not attempt to go around.* Make a normal touch-down, easing power off during flare-out, but do not make a full-stall landing. Avoid making abrupt corrections with the throttle, which may induce a severe yaw.

If the landing must be made crosswind, and conditions permit, the good engine should be on the upwind side of the runway.

## SINGLE ENGINE GO-AROUND

The decision to go around must be made as early as possible, since the conditions governing any single-engine go-around are critical. The more altitude and airspeed remaining in the approach, the wider the margin of safety. *A single-engine go-around may be executed at less than maximum gross weight, when it appears this is the only way to avoid a possible accident with an aircraft that has not cleared the runway. The following procedure should be used, and rapid execution of the individual steps is very important. You must obtain 100 mph IAS as quickly as possible.*

1. Apply full power, 2700 rpm, and correct for yaw as the throttle opens. Simultaneously, apply sufficient pressure on the control wheel, to hold 100 mph IAS.

2. Retract the landing gear and close the cowl flaps on dead engine.

3. If the flaps are full down, their retraction to approximately half flap is important. Since it will be impractical at this time to make a visual check on the exact flap setting in degrees, judge their position from the length of time the flap motor is running. The flaps will retract completely in approximately eight seconds.

4. Retract remaining flap as soon as practical, to obtain maximum rate of climb.

5. Trim for single-engine climb.

### *FIRE*

The most demanding situation that may occur in an aircraft is fire. Naturally the most important task, once fire is discovered, is its elimination. Your most useful tool in this situation is a thorough knowledge of each system and its components, and the performance you can expect of the aircraft with the affected system or component inoperative.

### ENGINE FIRE ON THE GROUND

During starting, engine fire may occur in either the induction or exhaust systems. In either case keep the engine turning over with the starter, in an attempt to clear or start the engine, since the fire may be blown out the exhaust or drawn through the engine and extinguished. Should fire occur:

1. Try to get engine started; open throttle and keep cranking with starter.

2. If fire does not go out and if engine does not start, place mixture control in IDLE CUT-OFF, turn fuel selector valve handle to OFF and continue cranking.

3. Turn ignition switches to OFF and release starter switch. Turn battery and generator switches OFF.

4. Signal ground personnel to use fire extinguishers, and get clear of the aircraft.

If the engine starts and fire persists or if the fire is other than in the exhaust or induction system, shut the engine down or discontinue the starting attempt; signal for fire extinguishing equipment and clear the aircraft.

### ENGINE FIRE IN FLIGHT

In case of fire in an engine compartment during flight, shut down the affected engine as follows and land immediately:

1. Fuel selector valve handle — OFF.
2. Mixture control — IDLE CUT-OFF.
3. Propeller lever — FEATHER.

4. Boost pump — OFF.

5. Magneto switches — OFF.

6. Generator switch — OFF.

A procedure for establishing sufficient power for continued operation has been omitted since where a loss of altitude is not important, neither is the immediate application of more power. In other situations the loss of altitude may be as serious as the fire. Thus, you must vary your procedures as dictated by the individual problem.

## FUSELAGE FIRE IN FLIGHT

Should a fuselage fire occur in flight:

1. Reduce airspeed and close off all heating and ventilating openings to minimize draft through the cabin.

2. Battery and generator switches — OFF.

3. All electrical equipment — OFF.

4. Turn battery and generator switches on separately, *after the fire is out* in an attempt to determine the nature of the fire.

5. If generator and battery circuits are all right, monitor the remaining switches one at a time to locate and isolate the defective circuit. If the defective circuit is not located, use only the minimum equipment necessary.

6. Land the aircraft immediately.

## WING FIRE IN FLIGHT

If a wing fire should develop, do the following:

1. Shut-off any systems that may be contributing to the fire, or which could aggravate it, and turn off all electrical circuits to that wing.

2. Attempt to extinguish the flames by slipping the aircraft away from the fire.



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3. Prepare for an emergency landing and land as rapidly as practicable.

## SINGLE-ENGINE OPERATION ON CROSS-FEED

The design of the suction-type cross-feed system enables the operating engine to use the entire fuel supply of either wing. This selective usage of fuel allows you to maintain an equal weight distribution of the aircraft's fuel load, so that under single-engine operation your performance may be improved and handling may be made easier.

Once you have completed your single-engine procedures, if you desire to use up the fuel in the opposite wing cells, turn the fuel selector valve handle for the operating engine to CROSS-FEED and the dead engine's selector handle to the desired fuel cell, either main or auxiliary. You will gain more in balance and controllability if auxiliary fuel is used first, since these cells are further outboard. Remember, if both fuel selector valves are set on cross-feed, the fuel supply for both engines is cut-off. Also remember the cross-feed system is designed for level flight use.

Normally, the engine will operate satisfactorily from cross-feed but if necessary the fuel boost pump for the operative engine may be turned on to supplement the engine-driven pump.

## *LOSS OF FUEL PRESSURE*

Fuel system difficulties usually will be noted first in the form of a pressure drop. There may be several causes for loss of fuel pressure; lack of fuel in the tanks probably is the usual cause, however engine-driven fuel pump failure, instrument failure, line breakage or leakage, and clogged screens or lines also are possible. Fuel pressure, in most instances, may be maintained with the boost pump, unless other serious malfunction exists, or is suspected, which might create a fire hazard. For doubtful situations three possible courses of action, are listed as follows:

1. CUT THE ENGINE IMMEDIATELY – Do this if the power is not necessary to sustain flight or to reach a safe destination.

2. CONTINUE OPERATING THE ENGINE NORMALLY – This may be done if you can determine unquestionably that the indicated fuel pressure drop has not resulted from a fuel leak.

3. KEEP THE AFFECTED ENGINE IN OPERATION AT OR ABOVE CRUISING SPEED WHILE MAINTAINING A WATCH FOR FIRE – This can be done if you cannot determine whether or not an actual leak exists and the engine is required either to sustain flight or maintain the required altitude for arrival at a safe destination. However, prior to power reduction for entrance to the landing pattern, cut the affected engine completely by turning its fuel selector valve to the "OFF" position and completing a normal shut-down procedure *after* the engine is dead; then make a normal single-engine landing. Unless the added power is absolutely essential to effect a safe landing, do not reduce airspeed until the affected engine is shut-down. Air flow over the engine and nacelle, due to its cooling and dispersing effect, frequently will serve to keep a fire from breaking out, even though an actual fuel leak exists – until the speed of the aircraft is reduced sufficiently, as during a landing; then, the unsuspecting pilot is confronted with a fire, too late to do anything about it.

All other factors being equal, course 1 generally is the best. However, action to be taken depends entirely upon the circumstances at the time. Such factors as the known condition of the aircraft and the remaining engine, stage and purpose of the flight, and power requirements of the aircraft should be considered.

## *GENERATOR AND ELECTRICAL POWER FAILURE*

Electrical failures are emergency conditions in that they restrict the aircraft in some specific phases of its operation, but your prompt corrective action can greatly lessen the adverse effects of a power loss. Naturally, the sooner you detect failure the less critical the emergency is likely to become.

The loss of either engine precipitates a partial failure of the electrical power supply system and non-essential electrical equipment should be used judiciously to avoid overloading the remaining generator. Loads in excess of single generator output will drain the batteries, with the resultant loss of reserve and emergency power. Choice of equipment to use will naturally be determined by conditions; and you should be familiar with the relative current load imposed by various operating equipment, such as radio, heater and accessories such as the cigarette lighter, which has a very high drain.

A negative ammeter indication of more than a moment's duration indicates a reversal of current flow through the generator, which can damage both the generator and the battery. If such an indication appears, turn off the affected generator at once and leave it off until the malfunction has been corrected.

If both generators must be shut off, all equipment should be turned off to preserve battery power for lowering the gear and flaps; electrical equipment, such as indicator lights and electrically-operated instruments, cannot be shut-off except by turning off the battery master switch.

In the event both generators and the batteries must be shut off, boost pumps and flaps will be inoperative and the landing gear must be lowered manually. Warning horns, all indicator circuits, oil temperature and fuel quantity gages and radio navigation instruments also will be inoperative.

## *PROPELLER FAILURES*

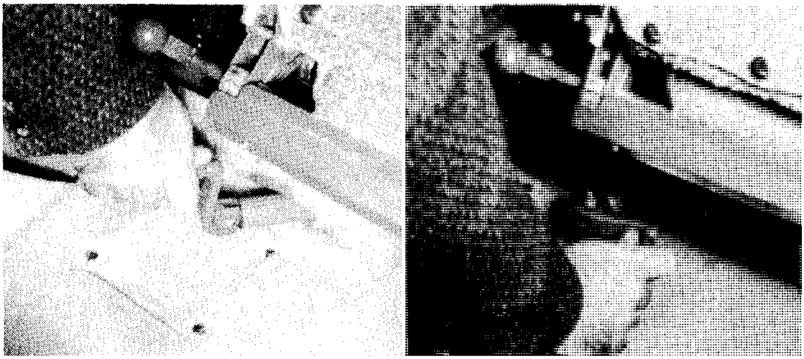
Most propeller failures can be attributed to one or more of the following: loss of oil supply, failure of the propeller governor or failure of the mechanical linkage between the governor and the propeller control levers. In the event of mechanical linkage failure, resulting in a runaway propeller condition, close the throttle immediately, shut down the engine and prepare to land as soon as possible. If the propeller feathers inadvertently, due to loss of oil supply, close the throttle and attempt to unfeather the propeller by operation of the propeller control lever. If all efforts to unfeather the propeller fail, shut down the engine completely.

## *LANDING EMERGENCIES*

Landing emergencies usually are the result of an equipment failure or operational conditions which were not foreseen and taken into account at the beginning of a flight. By anticipating these emergency conditions, and through conscientious practice of the necessary procedures and techniques, the hazards of a critical situation are effectively reduced.

### LANDING GEAR EMERGENCY EXTENSION

The landing gear handcrank will lower the gear manually if the electrical system fails or if you wish to do so for some other reason.



The handcrank is designed only to lower the gear; you should not attempt to retract it manually. The maximum air speed for a normal gear extension is 150 mph IAS. However, to preclude an excessive speed build-up in an extreme emergency situation, the gear may be lowered at 200 mph IAS.

**NOTE**

> After any emergency extension of the landing gear at high speeds, the landing gear doors and supporting structure should be inspected for possible damage.

Manually extending the gear will be easier if you can reduce your airspeed first. Use the following procedure for manual extension:

1. Landing gear circuit breaker – pulled.

2. Landing gear switch – down position.

3. Remove the safety boot from the handcrank handle (at the rear of the front seat), move the handle into the cranking position, and turn it counter-clockwise as far as possible. About 50 turns will be required to get the gear down and locked.

4. Check the mechanical indicator to ascertain that the gear is down. If possible, get a visual check from the tower or another aircraft. If the electrical system is operative, you also may check the gear position light and warning horn.



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## FORCED LANDING

If possible, for example with a fuel shortage, land before the engines stop; landing with power will allow you to select the best area available and make a short field approach if necessary. The type of landing surface will determine whether you should land with the gear extended or retracted.

If you have a complete power failure, accomplish the single-engine procedure as applicable for shutting down both engines, but leave the battery master switch on. If the terrain is doubtful and the landing is to be made gear-up, turn the engines over with the starters until both propellers are horizontal, to reduce damage on landing. Feathering the propellers will nearly double your glide distance.

A circular descent over the field will provide the best observation of ground conditions and wind direction and velocity. When the condition of the terrain has been noted and the landing area picked, warn the passengers and check safety belts *and shoulder harness tight*. If necessary instruct the passengers in the procedure for unlocking the cabin entrance door, and pulling the emergency release pins in the rear seat main windows. Just before touchdown, have the entrance door unlocked and held slightly open to prevent jamming upon impact.

If the landing surface is of sufficient length and firmness to permit a gear-down landing, set up a rectangular pattern and lower the gear on a downwind or base leg. Use flaps as required in the approach and landing; keep in mind the variation in gliding distance if the gear is not lowered. After the flaps are lowered turn off the battery. Maintain sufficient air-speed throughout the approach to avoid a stalled condition.

## MAXIMUM GLIDE

In the event of a failure of both engines, the maximum gliding distance can be obtained by maintaining 120 mph IAS, and feathering both propellers, retracting the wing flaps, landing gear and cowl flaps. The glide ratio under this configuration, as shown on the graph, is 13.6 feet of forward distance traveled to every 1 foot of descent, which will give you approximately 2½ miles of gliding distance for every 1000 feet of altitude you have.



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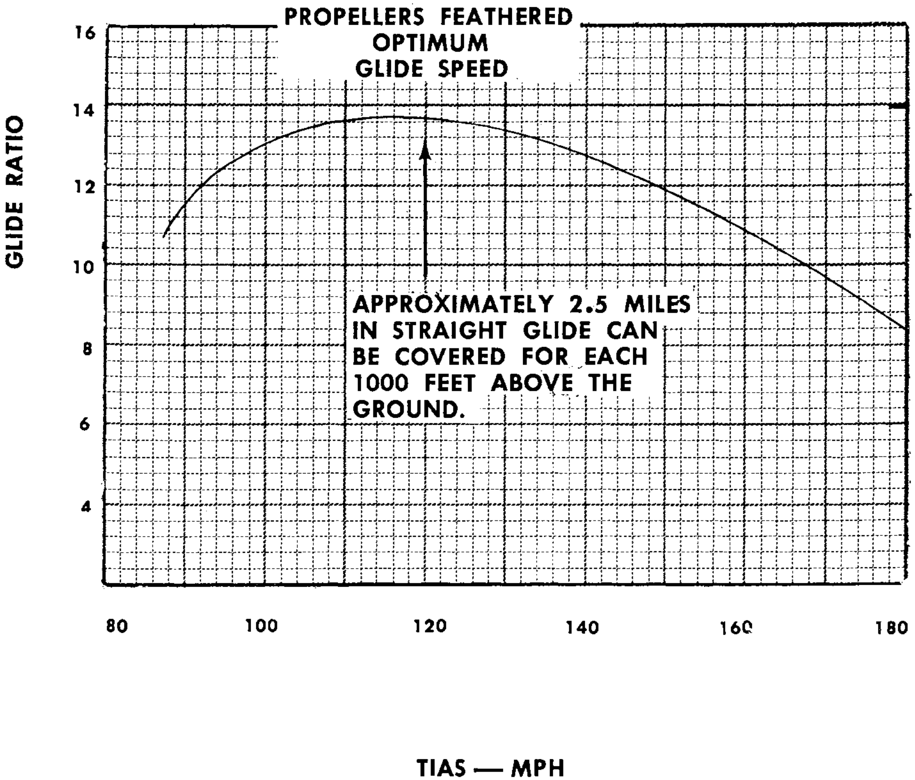
# GLIDE DISTANCE

TIAS VS GLIDE RATIO
GROSS WEIGHT
4000 LBS.
NO WIND



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Whether you choose to land with your wheels up or down depends on the field you are going into and how much time you have to look it over before you land. A wheels-up landing will, of course, use up less distance on the ground; however, with the gear extended, the nose gear will absorb part of the shock loads from obstructions. The progressive failure of the nose structure will reduce the loads transmitted to you and your passengers. Whichever method you choose, *fasten your shoulder harness tightly.*

## LANDING WITH A FLAT TIRE

A flat tire on a main wheel will act as a brake when on the ground, tending to turn the aircraft into the flat. Touch down well over to the opposite side of the runway to allow room for a swerve and hold directional control with opposite brake. A flat nose wheel tire will reduce nose wheel stability; hard applications of brake should be avoided. After landing with a flat tire, park the aircraft clear of the runway and shut down the engines; do not taxi in with a flat tire.

## LANDING ON UNPREPARED SURFACES

Landing procedure for unprepared runways should be similar to minimum-run landings. If the ground is soft, use caution in applying brakes to eliminate undue strain on the landing gear and to avoid digging the nose wheel into the ground. If the ground is extremely rough, again use caution in applying brakes while crossing the rough areas. To minimize the possibility of damage from loose gravel or sod kicked up by propellers, raise the flaps as soon as possible after landing and taxi with a minimum of throttle; avoid coming to a stop in sand or other surface where considerable power might be required to move the aircraft again.

## GEAR-UP LANDING

If you are to make a gear-up landing, make a normal approach and if possible, choose a hard surface to land on. During your pre-landing procedures, check the passengers for shoulder harness and safety belts tight and inform them how to unlock the cabin entrance door and pull the emergency release pins in the rear seat windows. Just before touchdown, have the entrance door unlocked and held slightly open to prevent jamming upon impact. Use flaps as necessary to avoid overshooting the runway and flatten your glide angle. When you are sure of making the runway, close the throttles, move the mixture control levers to "IDLE CUT-OFF," cut the battery master and all ignition switches and turn the fuel selector valves to the "OFF" position. Keep the wings level and make the touchdown as gentle as conditions will permit. If possible, avoid a gear-up landing on soft ground, since sod has a tendency to roll up into chunks which may damage the aircraft structure.

# Keeping Your Travel Air New

## PREVENTIVE MAINTENANCE

Preventive maintenance is a program designed to keep things from going wrong, or not going at all, or quitting before they should reasonably be expected to quit.

Preventive maintenance is in part the responsibility of the airplane's owner or pilot . . . the best service facility is helpless until the airplane is in the shop with instructions to do the necessary work. The purpose of this section is twofold: first, to provide you with the information necessary for you to decide when the airplane should be sent to a shop; and second, to guide you should you choose or be obliged by circumstances to do some minor servicing yourself. It is in no sense a substitute for the services of your BEECHCRAFT Certified Service Station.

This section includes also information on ground handling, hangar clearances, oil and grease specifications and tire and strut inflation, which will be useful on a strange airport.

Carefully followed, the suggestions and recommendations in this section will help you keep your Travel Air at peak efficiency throughout its long, useful life.

## BEECHCRAFT CERTIFIED SERVICE

Aware of our responsibility to our customers to insure that good servicing facilities are available to them, Beech Aircraft Corporation and BEECHCRAFT distributors and dealers have established a world-wide network of Certified Service Stations. Service facilities, to qualify for certification, are required to have available special tools designed to do the best job in the least time, on BEECHCRAFT airplanes; to maintain a complete and current file of BEECHCRAFT service publications; and to carry in stock a carefully predetermined quantity of genuine BEECHCRAFT parts. In



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addition, key personnel must have factory training in BEECHCRAFT servicing techniques, as well as CAA certificates in engine, airframe and radio maintenance. A Certified Service Station must be a CAA-approved repair station or employ an A & E mechanic with inspection authorization.

Certified Service Stations also benefit from frequently scheduled mechanics' training schools held at the factory, and from the visits of factory service representatives, to the end that their personnel are kept informed of the latest techniques in servicing BEECHCRAFTS.

## BEECHCRAFT SERVICE PUBLICATIONS

To bring the latest authoritative information to BEECHCRAFT distributors, dealers and Certified Service Stations and to you as the owner of a BEECHCRAFT, the Customer Service Division of Beech Aircraft Corporation publishes and revises as necessary the operating instructions, shop/maintenance manuals and parts catalogs for all BEECHCRAFT airplanes, as well as service bulletins and service letters. All of these publications are available from your BEECHCRAFT distributor or dealer.

## SERVICE BULLETINS AND SERVICE LETTERS

BEECHCRAFT Service Bulletins and Service Letters are occasional publications dealing with improved operating techniques, revised servicing instructions, special inspections, and changes in detail parts or equipment. Service Bulletins and Service Letters differ mainly in the degree of urgency of their subject matter: Service Letters usually will announce changes or new equipment which are available for purchase if you choose, or discuss improved operating techniques; Service Bulletins, on the other hand, deal with operating techniques, special inspections, or changes in the airplane which have a direct bearing on the safety, performance or service life of your Travel Air. Service Bulletins carry definite time intervals for compliance, depending on the urgency of their subjects, and you should see that they are complied with before the expiration of the allotted time. One of the services offered by BEECHCRAFT Certified Service Stations is maintaining a record of all service bulletins complied with by them on your airplane.

## YOUR SERVICE INFORMATION KIT

In addition to this handbook and the CAA-approved Airplane Flight Manual, the Service Information Kit you received with your Travel Air contains a copy of the official BEECHCRAFT Certified Service Station Directory, an Abbreviated Check List, a horsepower calculator for reference in flight, several booklets discussing different aspects of flying, of general interest, and a complete set of BEECHCRAFT Safety Suggestions to date.

## BEECHCRAFT CUSTOMER SERVICE

Should a special problem arise concerning your Travel Air, your BEECHCRAFT Certified Service Station, dealer or distributor will supply the information, or if necessary, he will enlist the services of factory personnel, through the Customer Service Division. His query will be answered by men who are thoroughly familiar with all parts of your Travel Air, and in addition to their own knowledge, may call on the engineers who designed it and the expert workmen who built it. The Customer Service Division maintains service records containing all information received by the factory on all BEECHCRAFT airplanes.

The work of the Customer Service Division also includes conducting service schools at the factory for BEECHCRAFT mechanics and annual Service Clinics at the facilities of various BEECHCRAFT distributors, to which you will be invited to bring your Travel Air, each year. During the Service Clinic, factory experts will inspect your Travel Air and give you a written report of their findings, without obligation to you.

## *GROUND HANDLING*

Knowing how to handle the airplane on the ground is fully as important as knowing how to handle it in the air. In addition to taxiing, parking and mooring, you may find it necessary to maneuver your Travel Air into a hangar by hand or with a tug; or to jack up a wheel. Doing these jobs is not difficult, but if they are done incorrectly, structural damage may result.

So that you may make certain a strange hangar with doubtful clearances is adequate, the three-view drawing on page vi shows the minimum hangar clearances for a standard airplane. You must of course, make allowances for any special radio antennas you have installed; their height should be checked and noted on the drawing for future reference.

## MAIN WHEEL JACKING

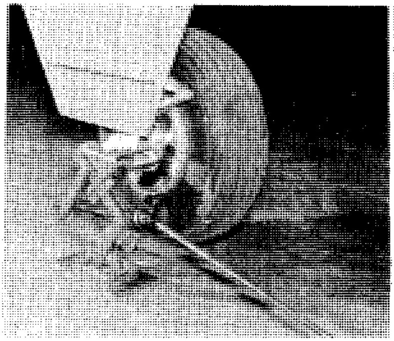
If it becomes necessary to replace a wheel or tire, proceed as follows: Make certain the shock strut is properly inflated to the correct height. Insert the main wheel jack adapter, furnished with the airplane as part of the loose equipment, into the main wheel axle. If the strut is not inflated to the recommended height it will be impossible to insert the jack adapter into the main wheel axle. Raise and lower the main wheel as necessary. A scissor type jack is recommended. When lowering the airplane care should be taken not to compress the shock strut, thus forcing the landing gear door against the jack adapter.

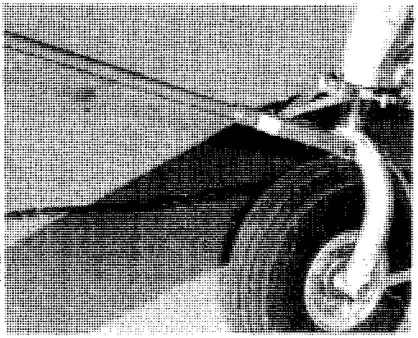
**NOTE**

Do not walk on the wing walk while the airplane is on the main wheel jack.

## TOWING

To tow the Travel Air, attach the hand tow bar to the tow lugs on the nose gear lower torque knee. One man can move the aircraft on a smooth and level surface with the tow bar.







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**CAUTION**

Do not push on the propeller or control surfaces. Do not place your weight on the horizontal stabilizers to raise the nose wheel off the ground.

To tow the aircraft with a tractor or tug, secure ropes around both main landing gear struts near the joint of the V-brace and the shock absorber. Place a man in the cockpit to handle the brakes and nose gear steering. Tow the aircraft backward to avoid fouling the nose gear, leaving sufficient clearance between the airplane and the power unit to allow the aircraft to be stopped safely. Pick up slack in the tow lines slowly and evenly, taking care to avoid jerks.

**NOTE**

Do not attempt to tow the aircraft backward by the fitting in the tail skid. This tail skid was designed only to protect the tail in a tail-low landing and to provide a mooring point.

## EXTERNAL POWER (Optional Equipment)

Before connecting an auxiliary power unit, turn off the battery and generator switches and any other electrically operated equipment. If the auxiliary power unit does not have a standard AN type plug, check the polarity of the unit and connect the positive lead to the center post and the negative lead to the front post of the aircraft's external power receptacle. The aircraft, having a negative-ground system requires a negative-ground auxiliary power unit.

After the engine has been started and the auxiliary power unit disconnected, the electrical system switches may be turned on and normal procedure resumed.

Recharging a battery without removing it from the aircraft may be accomplished by connecting a known negative-ground auxiliary power unit to the aircraft's external power receptacle and turning on the battery master switch. In case of an extremely weak battery, removal and pre-charging may be necessary since the battery may not have sufficient capacity to close the battery solenoid. **It is essential that you make certain the power unit is negative-ground. Otherwise, a battery fire may result.**

## *SERVICING*

The following service procedures will keep your Travel Air in top condition between visits to your Certified Service Station. These procedures were developed from engineering information, factory practice and the recommendations of engine and parts suppliers, as well as operating experience with thousands of BEECHCRAFTS using identical or similar components. They are the essence of "preventive maintenance."

## MAGNETOS

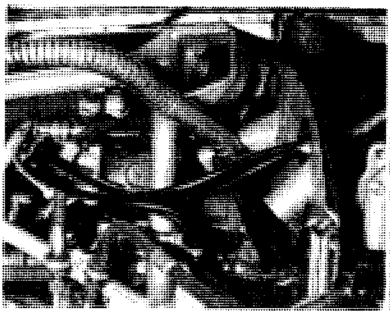
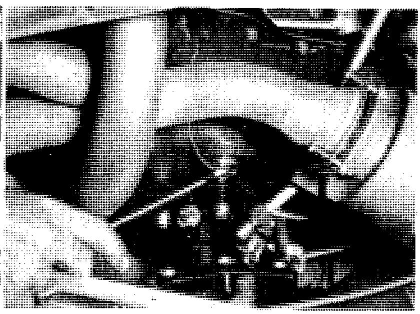
Ordinarily, the magnetos will require only occasional adjustment, lubrication and breaker point replacement, which should be done by your Certified Service Station.

### CAUTION

> To be safe, treat the magnetos as hot whenever a switch lead is disconnected at any point; they do not have internal, automatic grounding devices. The magnetos may be grounded by replacing the switch lead at the noise filter capacitor with a wire which is grounded to the engine case. Otherwise, all spark plug leads should be disconnected or the cable outlet plate on the rear of the magneto should be removed.

## SERVICING THE OIL SYSTEM

The Travel Air is provided with a wet sump, pressure-type oil system. Each engine sump capacity is 8 quarts with an absolute minimum capacity of 2 quarts required for safe engine operation. To service the oil system, open the right hand section of the cowling

# SERVICING POINTS

A OIL PRESSURE SCREEN — PAGE 134
B AUXILIARY FUEL TANK FILLER — PAGE 135
C MAIN FUEL TANK FILLER — PAGE 135
D FUEL SUMP DRAIN — PAGE 135
E FUEL STRAINER DRAIN — PAGE 135
F OIL SUMP DRAIN — PAGE 134
G OIL FILLER — PAGE 133
H OIL SUCTION SCREEN — PAGE 134
I BATTERY — PAGE 141
J AIR CONDITIONER — PAGE 138
K EXTERNAL POWER RECEPTACLE — PAGE 131
L CARBURETOR AIR FILTER — PAGE 141
M STATIC AIR DRAIN — PAGE 140
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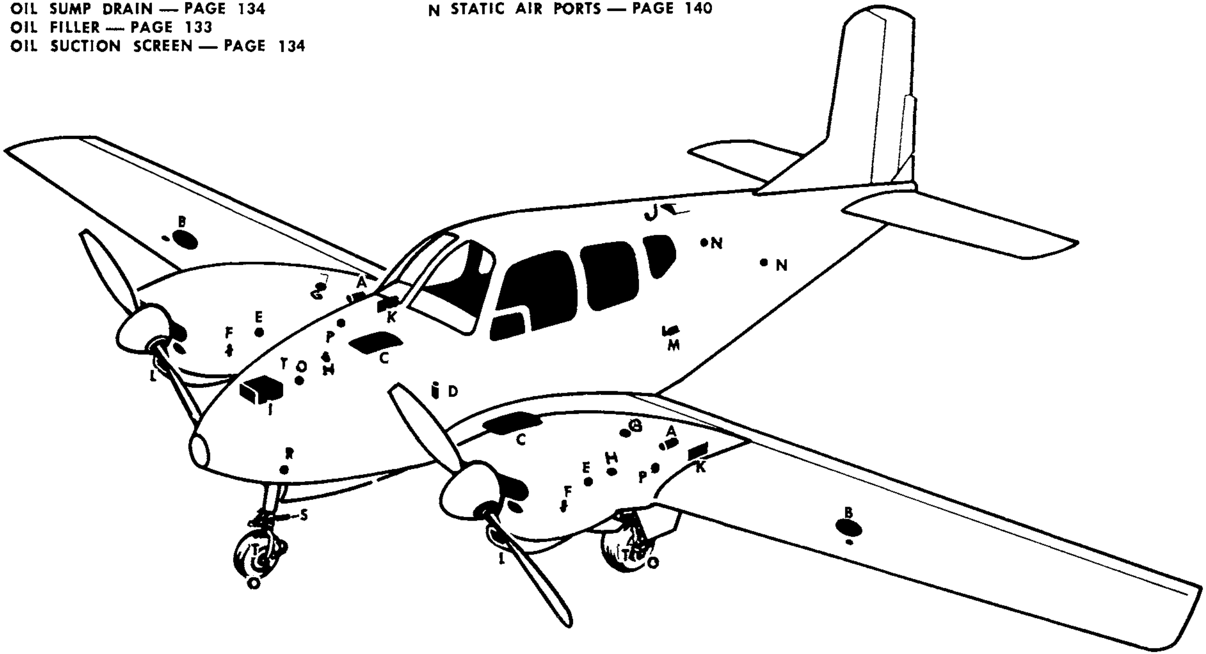
P MAIN STRUT FILLER — PAGE 135
R NOSE STRUT FILLER — PAGE 135
S SHIMMY DAMPENER — PAGE 136
T BRAKES — PAGE 137



and remove the filler cap. On aircraft TD-174 and after access doors are provided in the cowling to service the oil system. A calibrated dip stick attached to the filler cap indicates the oil level. The oil should be changed every 50 hours under normal operating conditions. When operating under adverse weather conditions or continuous high power settings, the oil should be changed more frequently.

**NOTE**

The special preservative oil in the engines of the Travel Air when the airplane is delivered from the factory should be changed for normal oil after 25 hours of engine operation.

The oil may be drained by removing the pipe plug from the bottom inboard side of the oil sump, the low spot of the system. The engines should be warmed up to operating temperature to assure complete draining of the oil. Moisture that may have condensed and settled in the oil sump should be drained by occasionally removing the oil drain plug and allowing a small amount of oil to escape; this is particularly important in winter, when the moisture will collect more rapidly and may freeze.

The oil suction and pressure screens should be cleaned at each periodic oil change. To clean the suction screen, remove the hex head plug at the rear of the oil sump and pull out the screen. To clean pressure screen, remove four bolts that secure screen housing to engine accessory section. Pull housing back and remove screen. Wash the screens in Stoddard Solvent, Federal Specification P-S-661 A.

The oil grades listed below are general recommendations only, and will vary with individual circumstances. The determining factor for choosing the correct grade of oil is the oil inlet temperature observed during flight; inlet temperatures consistently near the maximum allowable indicates a heavier oil is needed.

RECOMMENDED OIL FOR MODEL 95 ENGINES

| Aviation Grade Oil | Average Ambient Air Temperature | Oil Inlet Temperature Desired | Oil Inlet Temperature Maximum |
|---|---|---|---|
| SAE 50 | Above 40° F | 180° F | 245° F |
| SAE 30 | Below 40° F | 170° F | 220° F |
| SAE 20 | Below 10° F | 160° F | 200° F |

**NOTE**

Use only non-detergent aviation grade engine oils.

During cold weather the oil sumps should be checked at pre-flight inspection to be sure that they are not blocked with ice.

Also, since there may be more cylinder blow-by during cold weather starting, with an attendant increase in oil sludge, the oil pressure screens should be checked more frequently and if indicated, the oil drain intervals should be shortened.

## SERVICING THE FUEL SYSTEM

Service the fuel cells with 91/96 octane or next higher grade of fuel. A 25-gallon main fuel cell is installed in each wing stub and a standard 17-gallon auxiliary fuel cell or an optional 31-gallon auxiliary fuel cell is installed in the wing panels outboard of each nacelle. Fill each cell separately through the filler neck by removing the flush-type filler caps from the upper wing skins.

Prior to transferring fuel, ground the refueling hose to one of the aircraft grounding jacks. Open each of the eight snap-type fuel drains daily to allow contaminated fuel to drain from the system. The four sump drains extend through the bottom of the wing skins; the two selector valve drains are located at the system low spot to drain the interconnecting lines, and extend through the bottom of the fuselage center section skin; the fuel strainers are provided with drains that extend through the lower inboard cowling skins. Fuel strainers and drains on aircraft TD-127 and TD-174 and after are located in the wheel wells.

### CAUTION

> Never leave the fuel cells completely empty or the cell inner liners may dry out and crack, permitting fuel to diffuse through the walls of the cell after refueling. See section on storage.

## SERVICING THE LANDING GEAR

The landing gear retract system is a complex system with very small clearances between working parts. Adjustments should be made only at a BEECHCRAFT Certified Service Station. Any malfunction should be corrected by a Certified Service Station.

## SHOCK STRUTS

The shock struts are filled with compressed air and MIL-0-5606 hydraulic fluid. The same procedure is used for servicing both



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the main and nose gear shock struts. To service a strut proceed as follows:

a. Remove the air valve cap and depress the valve core to release the air pressure.

**WARNING**

Do not unscrew the air valve assembly until all air pressure has been released or it may be blown off with considerable force, causing injury to personnel or property damage.

b. With the weight of the aircraft on the gear, loosen the filler plug slowly to assure that all air has escaped, then remove the filler plug.

c. With the shock strut fully deflated, jack the strut barrel ¼ inch off fully compressed, block it there and fill to the level of the filler plug hole with MIL-0-5606 hydraulic fluid.

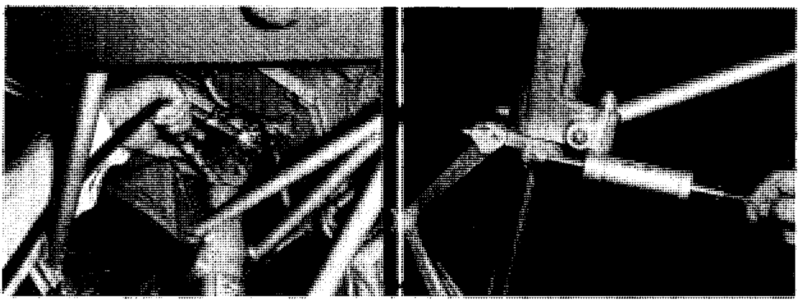
d. Jack the main strut an additional 2 inches, then replace the filler plug, depress the valve core and lower the jack, releasing the excess oil and air. On the nose strut, merely remove the block and allow the excess oil to drain away, then install the filler plug.

e. Rocking the airplane gently to prevent possible binding of the piston in the barrel, inflate the strut to an extension of 2 inches of exposed piston (aircraft resting on the gear).

f. The shock strut pistons must be clean. Remove foreign material by wiping the strut with a cloth containing hydraulic oil.

## SHIMMY DAMPENER

To check the fluid level in the shimmy dampener, insert a wire of approximately 1/16-inch diameter through the hole in the disc at the end of the piston rod until it touches the bottom of the hole in the floating piston. Mark the wire, remove and measure the



depth of insertion. Inserting the wire in the hole of the floating piston, rather than letting it rest against the face of the piston, will give a more accurate check.

**NOTE**

> To determine if the wire is inserted in the hole of the floating piston, insert the wire several times, noting each insertion depth. When the wire is correctly inserted the length will be approximately ¼ inch greater.

When the shimmy dampener is full, the insertion depth is 2-3/16 inches. The empty reading is 3-1/16 inches. To add MIL-0-5606 hydraulic fluid remove the shimmy dampener and proceed as follows:

a. Remove the cotter key, washer, and spring from the piston rod.

b. Remove the internal snap ring, scraper ring and the end seal from the aft end of the barrel. (Opposite clevis end.)

c. Insert a 6/32 threaded rod into the floating piston and remove the piston, using extreme care when moving the "O" ring seal of the floating piston past the drilled holes in the piston rod.

d. Push the piston rod to the clevis end and fill the barrel with MIL-0-5606 hydraulic fluid.

e. Slowly actuate the piston rod, allowing the fluid to flow into the clevis end chamber, then return the piston to the clevis end of the barrel.

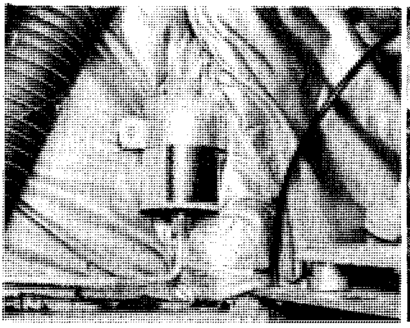
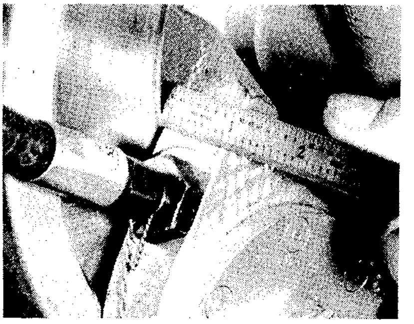
f. Refill the displaced fluid and replace the end seal, scraper ring and internal snap ring.

g. Fill the piston rod with fluid.

h. Reinstall the floating piston, spring, washer and cotter key. Spread the cotter pin to allow clearance for the measuring wire.

## SERVICING THE BRAKES

The Goodyear single-disc, hydraulic brakes require no adjustments, as the pistons move outward to compensate for lining wear. Linings should be checked for small nicks or sharp edges which could damage the brake discs. Worn, dished or distorted brake discs should be replaced. The fluid reservoir, accessible through the forward baggage compartment, should be checked regularly and a visible fluid level maintained on the dip stick at all times by adding MIL-0-5606 hydraulic fluid.

In service, the brake discs will lose their green (prime) color and become bright, then will assume a light straw color as the result of heat. These changes in color are normal and need not be a cause for concern. A glazed appearance of the brake linings also is normal; the glaze actually improves the effectiveness of the brakes.

## SERVICING TIRES

The main wheel tires are 6-ply, 6.50 x 8 tires and require 36 pounds air pressure. The nose wheel tire is a 6-ply, 5.00 x 5 tire and requires 28 pounds air pressure. Maintaining proper tire inflation will minimize tread wear and aid in preventing tire rupture caused from running over sharp stones and ruts. When inflating tires, visually inspect them for cracks and breaks.

In service, tire carcasses grow slightly due to shock loads in landing. Normally, this growth is balanced by tread wear so there is no increase in tire diameter. However, if a full tread is applied in recapping a tire, the diameter may be greater than a new tire. Since clearances in the wheel well when the gear is retracted are not large, if you install recapped tires, have a retraction test made before the airplane is flown.

Oil and other hydrocarbons spilled on tires not only weaken the rubber but may cause it to swell. Avoid spilling oil, fuel or solvents on the tires and clean off any accidental spillage as soon as possible.

## SERVICING THE AIR CONDITIONER

The water supply in the air conditioner wick box is sufficient for two to four hours of operation, depending on the temperature and humidity of the outside air.

Fill the air conditioner by opening the air scoop and pouring in demineralized water until it flows from the drain line. In cold weather, when the air conditioner will not be in operation, the drain valve should be left open to allow condensed moisture to drain off and prevent freezing and breaking of the wicks.

At least twice a year the system should be drained and flushed to remove dirt and pollen that has washed in from the airstream. If operation of the air conditioner has been normal, it is not necessary to remove the wicks; however, if tap water has been used continuously, the drain and wicks may be filled with mineral deposits, which will reduce their efficiency; wicks clogged with such deposits should be replaced. This operation should be performed by a Certified Service Station.

## HEAT AND VENT SYSTEM MAINTENANCE

The cabin heater ignition unit is equipped with two sets of points; if one set of points fail, a toggle switch located under the left subpanel may be positioned to place the alternate contact points in service. The switch should be repositioned when the points are replaced to indicate that the alternate set of points is available.

## OVERHEAT FUSE

The overheat fuse should not be replaced until a thorough inspection of the system has determined the cause of its blowing and the malfunction has been corrected.

## HEATER FUEL PUMP

After every 25 hours of heater operation, remove the heater fuel pump strainer by turning the base of the pump counterclockwise. Wash the strainer in clean unleaded gasoline and dry with compressed air.

## HEATER FUEL FILTER

A fuel filter is installed in the nose wheel well next to the heater fuel pump and filters foreign matter from the fuel. The strainer is equipped with a snap-type drain and should be drained daily during cold weather to remove accumulated moisture which, if allowed to freeze, could cause heater malfunction.

## IRIS VALVE

Lubricate the iris valve at the blower inlet occasionally with MIL-L-7866 molybdenum disulfide, never with oil or any liquid lubricant, which will collect dust.

## PITOT AND STATIC SYSTEM MAINTENANCE

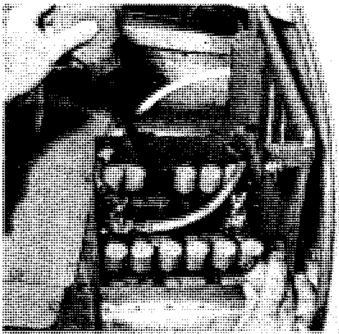
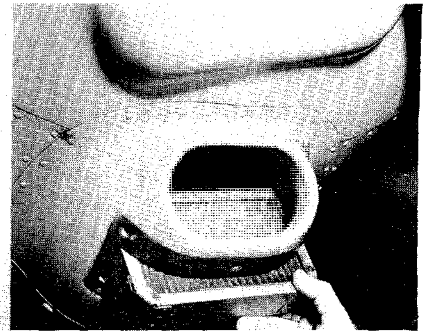
Clean foreign matter from the pitot plumbing by disconnecting the pitot line at the airspeed indicator and pitot mast and carefully blowing dry low pressure air through the line. Remove the pitot mast to connect the source of air pressure. After blowing the line clear, check the base connections in the system to see that they have not been disturbed.

Clean the static lines by blowing low pressure air through the lines from the disconnected line at the airspeed indicator to the static ports. Also disconnect the section of line running from the airspeed indicator to the altimeter, to the rate of climb indicator. Cover each static port separately when blowing, to insure that each line is clear. Instrument error or possible damage could result if one or both ports are clogged with dirt or foreign matter. Drain the static air line by opening the access door in the rear baggage compartment and removing the section of rubber hose.

Static air buttons should be kept free of all foreign matter including wax and polish. The exposed surface of the buttons should be cleaned periodically with Stoddard Solvent, Federal Specification P-S-661A to remove any existing film.

The vacuum-operated gyros are fitted with individual air filters, located in the back side of each instrument case, to remove dust, grit and other foreign matter from the air. The filters should be replaced after every 100 hours of operation, or oftener if the airplane is operated in dusty conditions. To replace the filters proceed as follows:

1. Remove the screws, lugs, safety wire, and snap rings attaching the filter to the instrument.
2. Remove and discard the old filter.
3. Install a new filter in the instrument.
4. Reinstall snap rings, lugs and screws, and safety wire.

## SERVICING THE BATTERY

To service the battery, open the forward utility compartment door and remove the battery box cover. Maintain the electrolyte level to cover the plates by adding distilled battery water. Avoid filling over the baffles and never fill more than ¼ inch over the separator tops. The specific gravity should be checked weekly and maintained within the limits placarded on the battery. The battery box is vented overboard to dispose of electrolyte and hydrogen gas fumes discharged during the normal charging operation. To insure the disposal of these fumes the vent hose connections at the battery box should be checked frequently for obstructions.

## CARBURETOR AIR INTAKE FILTERS

To clean the carburetor air intake filters, remove from the aircraft and flush them thoroughly with cleaning solvent; if possible, use an air blast for drying and to remove excess solvent. After the filters are completely dry, saturate with clean engine oil and allow to drain before re-installation.

## *CLEANING*

To clean your Travel Air properly, both outside and inside, follow these instructions:

## EXTERIOR CLEANING

Prior to cleaning the exterior, cover the wheels, making certain the brake discs are covered; attach pitot covers securely; install plugs in, or mask off, all other openings. Be particularly careful to mask off both static air buttons before washing or waxing.

### CAUTION

Do not apply wax or polish for a period of 90 days after delivery. This will give the paint a chance to cure by the natural process of oxidation. Waxes and polishes seal the paint from the air and prevent curing. If it is necessary to clean the painted surface before the expiration of the 90-day curing period, use cold or lukewarm (never hot) water and a mild soap. Never use detergents. Any rubbing of the painted surface should be done gently and held to a minimum to avoid cracking the paint film.

The airplane should be washed with a mild soap and water; loose dirt should be flushed away first, with clean water. Harsh or abrasive soaps or detergents, which could cause corrosion or make scratches, should never be used.

Soft cleaning cloths or a chamois should be used to prevent scratches when cleaning and polishing. Any ordinary automobile wax may be used to polish painted surfaces.

To remove stubborn oil and grease, use a rag dampened with naphtha.

## CLEANING WINDSHIELD AND WINDOWS

Since the Plexiglass used in the windshield and windows can be very easily scratched, extreme care should be used in cleaning it. Never wipe the windshield or windows when dry. First flush the surface with clean water or a mild soap solution, then rub lightly with a grit-free soft cloth, sponge, or chamois. Use trisodium phospate completely dissolved in water to remove oil and grease film. To remove stubborn grease and oil deposits, use hexane, naphtha, or methanol. Rinse with clean water and avoid prolonged rubbing.

After the windshield and windows are dry and free of dirt, wax them with a good grade of commercial wax to prevent scratching or crazing. Apply the wax in a thin, even coat and bring to a high polish with a clean, soft cloth.

### NOTE

Do not use gasoline, benzene, acetone, carbon tetrachlo-



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ride, fire extinguisher fluid, de-icing fluid, or lacquer thinners on windshield or windows as they have a tendency to soften and craze the surface.

## PROPELLERS

Since propellers are subject to severe wear and atmospheric conditions, blades and hub should be periodically checked for oxidation and corrosion. Brush corroded or oxidized areas with a phosphatizing agent to remove superficial corrosion, then smooth etched and pitted areas by buffing with an aluminum polish.

Take the following precautions while cleaning propellers:

1. Be sure ignition switch is off.
2. Make sure the engine has cooled down completely. When moving the propeller, STAND IN THE CLEAR. There always is some danger of a cylinder firing when a propeller is moved.
3. If a liquid cleaner is used, avoid using excessive amounts because it may spatter or run down the blade and enter the hub or engine.
4. After cleaning, check the area around the hub to be sure all compound is removed.

## ENGINE

The engine may be cleaned with kerosene, white furnace oil, Stoddard solvent, or any standard engine cleaning solvent. Spray or brush the solvent over the engine, then wash off with water and allow to dry. Blow excess oil off the engine with compressed air.

## LANDING GEAR AND TIRES

Emulsion type cleaners are recommended for cleaning the landing gear. These solutions usually contain solvents which are injurious to rubber if allowed to remain in contact for any length of time. If these solvents come in contact with tires as a result of other cleaning operations, the solvent should be removed immediately with a thorough water rinse. To clean the tires, rinse with plain water and scrub with a brush.

## WHEEL WELLS

Use a cleaning compound containing an emulsifying agent to remove oil, grease and surface dirt from the wheel wells. These



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compounds, when mixed with petroleum solvents, emulsify the oil, grease and dirt. The emulsion is then removed by rinsing with water or by spraying with a petroleum solvent. Be sure to cover openings and air scoops before cleaning. If water is used as a rinse in cold weather, blow all water from the wheel well with an air hose. Water allowed to stand may freeze and lock the controls.

## INTERIOR CLEANING

The seats, rugs, upholstery panels and head lining should be vacuum-cleaned frequently to remove as much surface dust and dirt as possible. Commercial foam-type cleaners or shampoos can be used to clean rugs, fabrics or upholstery. Mix a small amount of the cleaner in a bucket of water and beat the mixture to a heavy foam. After the upholstery is vacuum-cleaned, apply the foam uniformly over the surface to be cleaned and remove with a vacuum cleaner or wipe off with a brush or cloth.

Unlacquered metal fittings and furnishings can be cleaned with an ordinary commercial metal polish.

For removal of stains from any interior fabric, refer to the Stain Removal Chart.

## STAIN REMOVAL CHART

### NOTE

The following information covers general stain removal procedures. When solvents are specified, it is wise to test them before actually working with a stained location on the various fabrics in the Travel Air. Some of the newer fabrics react in different ways to solvents, and damage can be incurred during removal of a stain if caution is not used. When a solvent is specified, test it on a similar piece of fabric in a location that will not show before proceeding with the actual stain removal.

| TYPE OF STAIN | CLEANING METHOD |
|---|---|
| **Battery acid** | Saturate spot with diluted solution of household ammonia. Allow to stand for one minute. Thoroughly rinse with cold water. Treat spot as soon as possible. |



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| | |
|---|---|
| **Blood** | Rub with cold water. If some stain remains, brush with diluted household ammonia, allow to stand for one minute, and rinse with cold water. If some stain still remains, apply thick corn starch paste, allow to dry, pick off dried portion and brush surface to remove starch particles. Do not use hot water or soap. |
| **Candy (except chocolate)** | Hot water or cleaning solvent*. For cream-type candy, rub with a cloth soaked in lukewarm soap suds and scrape with a blunt tool. |
| **Chewing gum** | Moisten with cleaning solvent* and work off with a blunt tool, or hold a piece of ice against the gum and remove while still cold. |
| **Chocolate** | Remove with lukewarm water, rinse with cleaning solvent*. |
| **Coffee** | Sponge with soap and water, rinse with clean water. |
| **Milk** | Wash with soap and water, rinse with cold water. |
| **Shoe and rubber markings** | Brush with cleaning solvent*. |
| **Tar** | Moisten with cleaning solvent*, work off with blunt tool. Rinse with cleaning solvent*. |
| **Tobacco** | Sponge with alcohol, follow immediately with glycerin. Brush vigorously, rinse with water. |
| **Fruit** | Hot water or cleaning solvent*. |
| **Grease and oil** | Sponge with cleaning solvent, rub with clean cloth. |
| **Ice cream** | Hot water. If stain persists, use warm soap suds, rinse with cold water, sponge remaining stains with cleaning solvent*. |
| **Ink** | (a.) Rub Iron Rust soap into stain with fingers, allow to stand for one minute and wipe with dry cloth. Repeat as necessary. Rinse with cold water.<br>(b.) Apply Ink Eradicator Solution No. 1 to spot with eye dropper, blot with blotting paper. Repeat as necessary. Rinse with cold water. Do not use Solution No. 2. |
| **Lipstick** | Apply cleaning solvent*, blot with blotting paper. Repeat until blotting paper no longer shows stain. |
| **Liquor and wine** | Sponge with very hot water, rub vigorously. If any stain remains, use cleaning solvent*. |

*Use Perchlorethylene, Turco-Solv or Pro-Fresh cleaning solvent.

## *INSPECTIONS*

Correct servicing being half the secret of preventive maintenance, the other half is inspection. Proper servicing will prolong the life of your Travel Air and careful, regular inspections will not only assure that servicing has been done correctly, but will disclose minor troubles so they can be corrected before they become malfunctions.

Two inspections are listed here: daily, which should be made before the first flight each day, and after 50 hours of operation. Inspections at intervals greater than 50 hours involve disassembly of the airplane and engine to various degrees and should be made only by a BEECHCRAFT Certified Service Station, where the special tools and equipment for such work, genuine BEECHCRAFT parts and factory-trained mechanics will assure you of a satisfactory job.

The 50-hour inspection should be made by a qualified mechanic, and your BEECHCRAFT Certified Service Station can best perform this operation. However, since it may be impractical occasionally to take your Travel Air to a Certified Service Station, the 50-hour inspection list has been included in this manual.

The daily, preflight inspection you should perform yourself or have it performed under your personal supervision. From the standpoint of day-to-day safety and satisfactory operation, it is the most important inspection of all. It need not be time-consuming; principally it consists of look, shake, feel and smell, and the entire inspection can be performed while you walk around the airplane once.

## DAILY PRE-FLIGHT INSPECTIONS

The daily pre-flight inspection is a check of the complete airplane prior to the first flight of the day, to determine the general condition of the airplane. It duplicates in some items the pre-flight check list (walk-around) on page 36, which is intended for use before each take-off. This inspection, however, should be made in greater detail and more time should be spent on it. After the first 25 hours, give the engine a 50 hour inspection, including replacing the engine oil.

Check both POWER PLANTS to insure that:

1. Oil levels are adequate.

2. The engine has no oil leaks.
3. The carburetor and fuel lines are intact.
4. The carburetor air filter is clean.
5. Battery terminals are secure and vent hose is clear of obstructions (make electrolyte specific gravity check and capacity check every 7 days).
6. Heat and vent air inlet is not obstructed.
7. Cowling is secure and undamaged.
8. Propeller blades are not damaged.
9. Propeller is not leaking oil.

Check the AIRFRAME to insure that:

1. Fairings, panels and doors are secure and undamaged.
2. Wings, fuselage and control surfaces are not damaged.
3. Windshield is clean, inside and out.
4. General airframe skin is in good shape.
5. Trim tabs are streamlined with control surfaces, with flight and trim tab controls in neutral.
6. All access doors and inspection openings are covered and secure.
7. Static air buttons are not clogged, covered or obstructed.
8. The pitot tube is not obstructed.
9. All drain plugs and covers are properly safetied.

Check the LANDING GEAR to insure that:

1. Shock struts and tires are clean and properly inflated.
2. Landing gear safety switch is secure and undamaged.

Check the CABIN to insure that:

1. Flight control surfaces (including trim tabs) move freely and correctly respond to movements of controls.
2. Readings of fuel quantity gages correspond to known contents of the tanks.
3. Fuel selector valves and fuel booster pumps operate correctly by assuring that no pressure is indicated with pumps ON and valves OFF; and that proper pressure is indicated when valves are operated with pumps ON.
4. Cockpit lights, navigation lights, landing lights, instrument lights all work properly.
5. Engine controls operate freely and are in good condition.
6. Directional gyro and artificial horizon caging mechanisms work properly.
7. Pitot heater operates (note temperature rise of pitot head).

8. All shoulder harnesses are properly secured and the buckles work correctly.

## 50 HOUR INSPECTION

In addition to the daily inspection items, which should receive a more intensive check at this time, add the following items:

1. Spark plug elbows and shielding nuts are secure.
2. Priming system is checked for leaks.
3. Fuel lines are checked for leaks and wear due to rubbing or vibration.
4. Oil sumps are drained and filled with new oil after completing step 5.
5. Suction and pressure oil strainers are removed and cleaned.
6. Intake and exhaust systems are checked for leaks and looseness.
7. Fuel strainers are cleaned.
8. Gyro instrument air filters are cleaned.

## *STORAGE*

The storage procedures listed in tabular form below are intended to protect the aircraft from deterioration while it is not in use. The primary objectives of these measures are to prevent corrosion and damage from exposure to the elements.

Three types of storage are considered: short-term, in which the aircraft is simply unused for a short period and is to be kept ready to go with the least possible preparation; long term, in which an extended period of inactivity is contemplated; and extended, in which the aircraft is actually placed on an inactive status for an indefinite time.

### SHORT TERM STORAGE (Not Exceeding Two Weeks)

| ITEM | PROCEDURE |
|---|---|
| Mooring | 1. If airplane cannot be placed in a hangar, tie down securely.<br>2. Deflate nose gear strut and place support under tail to create negative angle of attack.<br>3. Install wing spoilers consisting of fabric bags filled with fine dry sand. Place spoilers along approximately 75% of wing span. |

| | | |
|---|---|---|
| **Engines** | 1. Run up twice a week. |
| **Fuel Cells** | 1. Fill to capacity to minimize fuel vapor and protect cell inner liners. |
| **Flight control surfaces** | 1. Lock with internal and external locks. |
| **Grounding** | 1. Static ground airplane securely and effectively. |
| **Pitot tube** | 1. Install cover. |
| **Windshield and windows** | 1. Close all windows and window vents.<br>2. Install covers over windshield and windows. |

## LONG TERM STORAGE (Active)

**Engines**

1. Run up twice a week or preserve as follows:
   a. Drain oil sump.
   b. Fill crankcase with a suitable mixture of engine lubricating oil and corrosion preventive compound.
   c. Warm up engine until oil temperature is normal.
   d. Stop engine and remove air filter. Restart engine and spray preservative oil mixture into air intake until a fog appears at exhaust outlet; stop engine while spray is still in operation.
   e. Remove spark plugs. Rotate propeller and spray mixture into all cylinders; spray each cylinder after stopping propeller and do not turn propeller thereafter. Coat the propeller hub and blades with a light weight oil.
   f. Replace spark plugs with dehydrator plugs in all cylinders. Protect cable terminals.

**Carburetors**

1. No processing necessary if engines are to be run up regularly.
2. If engines are to be preserved, treat carburetors as follows:
   a. Remove fuel lines and drain all fuel from carburetor; apply 10 psi air pressure to carburetor inlet until all fuel is discharged from discharge nozzle.
   b. Plug fittings from which fuel lines were removed and force oil, Specification MIL-0-6081, Grade 1010 filtered through a 10-micron filter, into the carburetor fuel filter at 13 to 15 psi until oil is discharged from the discharge nozzle.



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c. Remove plugs from fuel line fittings and replace fuel lines.

**CAUTION**

Do not exceed the above air and oil pressures as internal damage to the carburetor may result.

**Fuel Cells**

1. Fill to capacity to minimize vapor pressure and protect cell inner liners if engines are to be run up regularly.
2. If engines are to be preserved, process fuel cells as follows:

   a. Drain fuel cells.
   b. Flush or spray a thin coating of light engine oil on the inner liners of all fuel cells which have contained gasoline.

**Instruments**

1. Remove magnetic compass.

**Batteries**

1. Remove and store according to standard practices.

**Mooring, flight control surfaces, grounding, pitot tube, windshield and windows and tires**

1. See short term storage procedures.

## EXTENDED STORAGE (Decommission)

**Mooring**

1. Follow procedure for short term storage; place support under tail when engines are removed.

**Engines**

1. Remove and preserve as prescribed by the manufacturer.
2. Cap all lines which were connected to engine.
3. Install dehydrator bag in nacelle.
4. Close and seal all nacelle openings.

**Propellers**

1. Remove and store according to standard practices.

**Fuel cells**

1. Drain fuel cells.
2. Flush, spray or rub a thin coating of light engine oil on the inner liners of all fuel cells which have contained gasoline.
3. After 24 hours remove cells and store according to standard practices. Do not remove or handle fuel cells until 24 hours after oil has been applied.

| | |
|---|---|
| **Flight control surfaces** | 1. Lubricate all flight control surface hinge pins, bearings, bell cranks, chains, control rods and quadrants and coat lightly with corrosion preventive compound.<br>2. Lock with internal and external locks. |
| **Grounding** | 1. Static ground airplane securely and effectively. |
| **Pitot tube** | 1. Apply a thin coating of grease, Specification MIL-G-2108.<br>2. Install cover. |
| **Windshield and windows** | 1. Close all windows and window vents.<br>2. Install covers over windshield and windows. |
| **Landing Gear** | 1. Coat the extended portion of the shock struts with light weight oil. |
| **Tires** | 1. Install covers.<br>2. Check air pressure periodically; inflate as necessary. |
| **Wing flap tracks and rollers** | 1. Coat with corrosion preventive compound.<br>2. Place flaps in retracted position. |
| **Batteries** | 1. Remove and store according to standard practices. |
| **Instrument panel** | 1. Cover with barrier material and secure with tape. |
| **Seats** | 1. Install protective covers. |
| **Landing lights** | 1. Cover with barrier material and secure with tape. |
| **Stall warning unit** | 1. Remove and store according to standard practices.<br>2. Tape connections. |
| **Loose tools and equipment** | 1. Remove and store in a dry temperate room. |
| **Airframe** | 1. Cover static ports and all openings with barrier material and secure with tape to exclude rain, sun and foreign matter. |



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## HEATER SYSTEM TROUBLE SHOOTING

| TROUBLE | PROBABLE CAUSE | CORRECTION |
|---|---|---|
| 1. Blower runs but heater will not start. | a. Blown fuse. | a. Check ductstat operation; check combustion chamber and ducts for obstructions. |
| | b. Faulty ignition unit vibrator. | b. Switch to reserve vibrator contacts. If this corrects trouble, replace vibrator at first opportunity. |
| | c. Faulty ignition unit coil. | c. Remove lead from spark plug and hold so spark may jump to structure. If no spark, repair or replace ignition unit. |
| | d. Faulty spark plug. | d. If test in (c) produces spark, remove and clean or replace spark plug. |
| | e. Fuel solenoid valve not energized. | e. Check electrical connections. Disconnect fuel line and check for fuel flow. Replace defective valve. |
| | f. Fuel filter clogged. | f. Clean filter. |
| | g. Spray nozzle clogged. | g. Clean spray nozzle. |
| | h. Insufficient combustion air. | h. Remove obstructions or repair leaks. |

| | | |
|---|---|---|
| 2. Heater will not shut off automatically. | a. Defective ductstat. | a. Connect voltmeter across ductstat leads and operate control. As the ductstat is pulled out, voltage should decrease. If not, replace ductstat. |
| 3. Heater backfires intermittently. | a. Loose connection in control circuit or loose ignition lead to spark plug. | a. Check electrical connections. |
| | b. Mixture too rich. | b. Make checks in item 4 below. |
| 4. Fuel mixture too rich; exhaust smudges fuselage. | a. Restriction in combustion air duct. | a. Check iris valve. Check ducts for obstructions. |
| | b. Restriction in exhaust duct. | b. Check exhaust outlet. |
| | c. Loose core in fuel nozzle. | c. Clean nozzle. Make sure core is seated tightly in shell. |

## ELECTRICAL TROUBLE SHOOTING

In general, electrical troubles will fall in three classes: internal failures in the units themselves, faults in the wiring or failures in the power source. With a few exceptions, such as those components which are relay-controlled, ordinary continuity checks with a test lamp or meter should isolate these faults and the corrections then will be obvious. The trouble-shooting tables given here deal with the more complex electrical systems and contain specific suggestions for isolating and correcting troubles. Certain operations, such as flashing a generator field, should be done only by qualified mechanics — preferably at a Beechcraft Certified Service Station.

| TROUBLE | PROBABLE CAUSE | CORRECTION |
|---|---|---|
| | **BATTERY SYSTEM** | |
| 1. No power indicated with battery master switch on. | a. Batteries discharged or defective. | a. Test with hydrometer and voltmeter. |
| | b. Open circuit between battery relay and master switch. | b. Check continuity. |
| | c. Master switch defective. | c. Check switch for operation. Replace if necessary. |
| | d. Defective battery relay. | d. Check relay for operation. Replace if necessary. |
| 2. Power on with master switch off. | a. Master switch defective. | a. Check switch for operation. Replace if necessary. |
| | b. Battery relay contacts stuck. | b. Replace relay. |
| | **STARTERS** | |
| 1. Both starters inoperative. | a. Circuit breaker tripped in starter switch circuit. | a. Reset. |
| | b. Starter relay inoperative. | b. Check continuity of starter system. |
| | c. Low batteries. | c. Test batteries. If low, replace or start with external power. |

| | | |
|---|---|---|
| | d. Loose connection or open circuit between battery positive relay and left starter relay. | d. Check connections and continuity. |
| 2. One starter inoperative. | a. Starter relay inoperative. | a. Check relay terminal connections and continuity of solenoid energizing circuit. If energizing circuit is closed and relay does not operate, replace relay. |
| | b. Poor ground at starter. | b. Test continuity from armature lead to ground. Repair if necessary. |
| | c. Open circuit. | c. Check continuity to starter. |
| | d. Defective starting motor. | d. Check brushes, springs, condition of commutator; replace if necessary. |

## GENERATORS

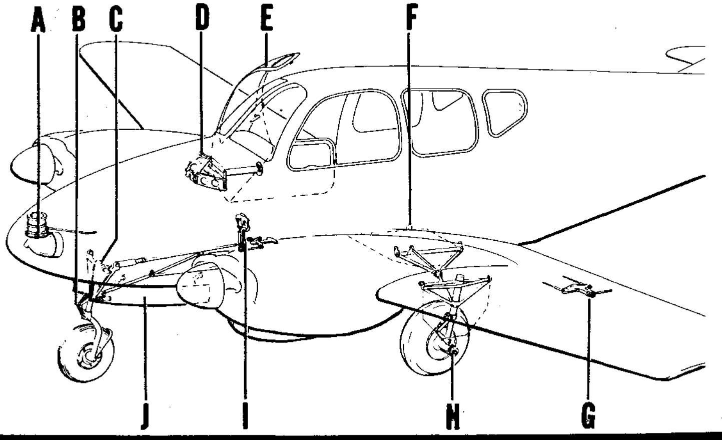
| | | |
|---|---|---|
| 1. No ammeter indication. | a. Engine speed too low. | a. Increase speed. |
| | b. Loose connection. | b. Check connections throughout system. |
| | c. Open field circuit in generator; defective armature. | c. Test resistance of field. Check field circuit connections. Replace generator if defective. |

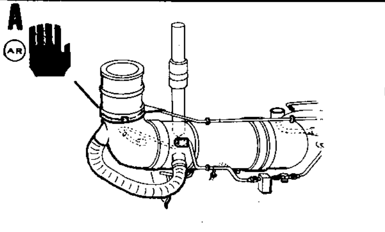
| TROUBLE | PROBABLE CAUSE | CORRECTION |
|---|---|---|
| | d. Brushes not contacting commutator. | d. Clean brushes and holders with a clean, lint-free, dry cloth. Replace weak springs. |
| | e. Brushes worn out. | e. Replace brushes if worn to a length of ½ inch or less. |
| | f. Dirty commutator. | f. With generator running, clean commutator with No. 0000 sandpaper. Use air jet to remove grit. |
| | g. Defective voltage regulator. | g. Replace regulator. |
| | h. Defective ammeter. | h. Replace ammeter. |
| 2. No generator output. | a. Circuit breaker tripped. | a. Reset. |
| | b. Open circuit. | b. Check continuity of circuit. |
| | c. Loss of residual magnetism. | c. Flash generator field. |
| | d. Defective generator control switch or reverse current relay. | d. Test switches. Replace if defective. |
| 3. Low generator output. | a. Generators not paralleled. | a. Readjust minimum-load voltage, then readjust paralleling relay. |
| 4. Ammeter reads off scale in wrong direction. | a. Defective reverse-current relay. | a. Replace relay. |

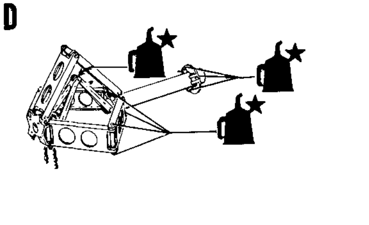
## LANDING GEAR ELECTRICAL SYSTEM TROUBLE SHOOTING

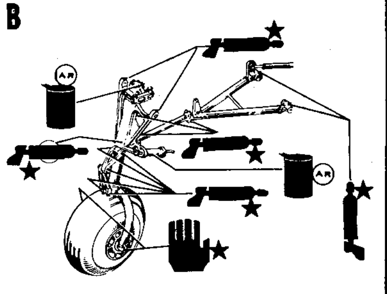
| TROUBLE | PROBABLE CAUSE | CORRECTION |
|---|---|---|
| 1. Landing gear motor fails to shut off when gear is retracted. | a. Up limit switch out of adjustment.<br>b. Defective switch. | a. Readjust switch.<br>b. Replace switch. |
| 2. Landing gear fails to retract. | a. Safety switch not closing<br>b. Up limit switch remaining open. | a. Readjust.<br>b. Replace up switch. |
| 3. Landing gear motor fails to shut off when gear is extended. | a. Down limit switch does not open.<br>b. Defective down limit switch. | a. Readjust limit switch.<br>b. Replace switch. |
| 4. Landing gear actuator is hitting internal stops. | a. Limit switch out of adjustment.<br>b. Dynamic brake switch defective. | a. Readjust limit switch.<br>b. Replace. |
| 5. Warning horn inoperative or malfunctioning. | a. Open or grounded circuit.<br>b. Throttle switches inoperative. | a. Check continuity.<br>b. Check and adjust as necessary. |
| 6. Landing gear fails to extend. | a. Tripped circuit breaker.<br>b. Down limit switch open.<br>c. Open circuit. | a. Reset circuit breaker.<br>b. Check down limit switch. With the gear retracted the down limit switch should be closed.<br>c. Run a continuity check on the down limit switch. |
| 7. Landing gear will not retract or extend. | a. Bad electrical connections.<br>b. Landing gear motor not grounded.<br>c. Defective control circuit. | a. Run a continuity check from circuit breaker to switch. Inspect the dynamic brake relay.<br>b. Check motor ground.<br>c. Check items 1 through 3. |

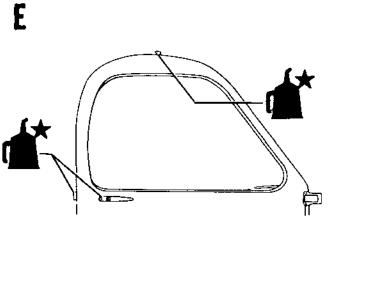
# LUBRICATION POINTS

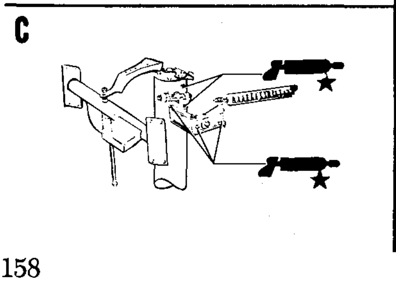


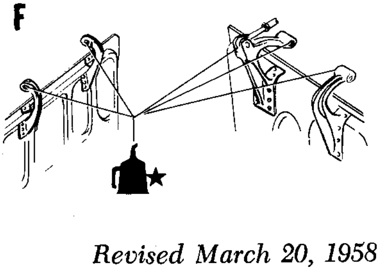



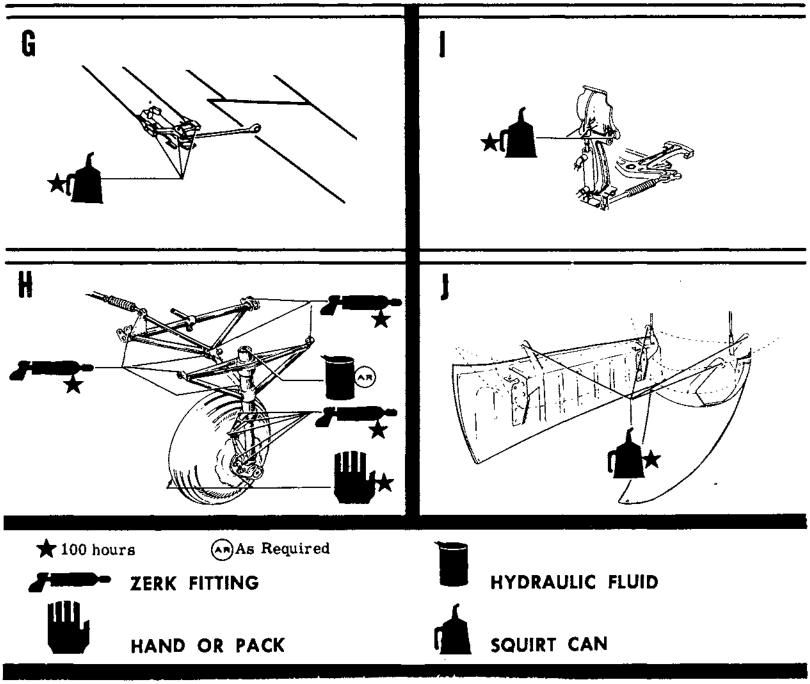






| ITEM | LOCATION | LUBRICANT | INTERVAL |
|---|---|---|---|
| DETAIL A | Ventilation air intake valve (1) | MIL-M-7866A | AR |
| DETAIL B | Nose shock strut (1) | MIL-O-5606 | AR |
| | Shimmy dampener (1) | MIL-O-5606 | AR |
| | Nose gear hinge points (2) | MIL-L-7711 | 100 Hr. |
| | Nose gear linkage (3) | MIL-L-7711 | 100 Hr. |
| | Nose gear torque knee (6) | MIL-L-7711 | 100 Hr. |
| | Nose wheel bearings (2) | MIL-L-3545 | 100 Hr. |
| | Nose gear swivel (2) | MIL-L-7711 | 100 Hr. |
| DETAIL C | Steering mechanism linkage (3) | MIL-L-7711 | 100 Hr. |
| | Steering mechanism (2) | MIL-L-7711 | 100 Hr. |
| DETAIL D | Control column linkage (6) | SAE No. 20 | 100 Hr. |
| | Control column head (3) | SAE No. 20 | 100 Hr. |
| | Control column aileron links (1) | SAE No. 20 | 100 Hr. |
| DETAIL E | Door handle (2) | SAE No. 20 | 100 Hr. |
| | Door handle (1) | SAE No. 20 | 100 Hr. |
| DETAIL F | Landing gear door hinges (10) | SAE No. 20 | 100 Hr. |
| DETAIL G | Aileron control linkage (6) | SAE No. 20 | 100 Hr. |
| DETAIL H | Main shock struts (2) | MIL-O-5606 | AR |
| | Landing gear retract links (8) | MIL-L-7711 | 100 Hr. |
| | Landing gear torque knee (12) | MIL-L-7711 | 100 Hr. |
| | Main wheel bearings (4) | MIL-L-3545 | 100 Hr. |
| DETAIL I | Rudder pedal and bellcrank (9) | SAE No. 20 | 100 Hr. |
| DETAIL J | Nose wheel door hinges (4) | SAE No. 20 | 100 Hr. |

( ) Indicates number of places to lubricate.

NOTE I: MIL-L-7711 grease may be used in the place of MIL-G-3278 grease in all normal climates. In extremely cold climates, MIL-G-3278 grease may be used.

NOTE II: Landing gear components may require lubrication every 25 or 50 hours, depending on operation.

# LAMP REPLACEMENT GUIDE

| LOCATION | NUMBER |
|---|---|
| Wing Navigation Lights | 1524 |
| Tail Light | 1203 |
| Landing Light | 4523 |
| Cabin Dome Light | 303 |
| Overhead Instrument Light | 303 |
| Map Light | 303 |
| Tab Position Indicator Light | 356 |
| Tab Position Indicator Light | AN 3121-1819 |
| L. G. Visual Indicator Light | 95-324006-75 |
| Compass Light | 327 |
| Stall Warning Light | AN 3121-1819 |
| Instrument Light | 327 |
| Rotating Beacon | A-7079-24 |
| Taxi Light | 4570 |
| Flap Position Light | AN 3121-313 |
| Landing Gear Position Light | AN 3121-313 |
| Cowl Flap Position Light | AN 3121-313 |
| Fuel Pump Placard Light | AN 3121-1819 |
| Console Light | AN 3121-1819 |
| R. H. C. B. and Switch Panel Light | AN 3140-327 |
| Ignition Panel Light | AN 3140-327 |



POH TOC

Main Menu

THIS MANUAL MUST BE KEPT IN THE AIRPLANE AT ALL TIMES

BEECH AIRCRAFT CORPORATION, WICHITA 1, KANSAS

**CAA Identification** Airplane Serial Manufactured
**CAA Approved, Based on CAR 3, Normal Category** **Type Certificate 3A16**

# MODEL 95 LANDPLANE

# AIRPLANE FLIGHT MANUAL

I. **LIMITATIONS.** The following limitations must be observed in the operation of this airplane:

A. Engine Limits (Two Lycoming 0-360-A1A engines): 2700 rpm, 28.5 in. manifold pressure (180 hp) for all operations.

B. Fuel: Aviation gasoline, 91/96 minimum octane. *Usable fuel,* two 25-gallon main tanks and two 17-gallon auxiliary tanks in wings. *Optional capacity:* two 25-gallon main tanks and two 31-gallon auxiliary tanks in wings. See Equipment List.

C. Propellers: Two Hartzell constant-speed, full-feathering, two-blade propellers, model HC-92ZK-2 hubs with 8447-12A blades and 835-6 spinners. Pitch setting at 30-inch station: low, 14°, high 84°. Diameter 70 - 72 inches.

D. Power Plant Instruments:
Oil Temperature: yellow arc, 60°F to 140°F; green arc, 140°F to 245°F; red radial, 245°F.
Oil Pressure: red radial (minimum idling) 25 psi; green arc, 65 psi to 85 psi; red radial, 85 psi.
Fuel Pressure: red radial, 0.5 psi; green arc, 0.5 psi to 5.0 psi; red radial, 5.0 psi.
Cylinder Head Temperature: green arc, 250°F to 500°F; red radial, 500°F.
Tachometer: green arc, 2000 rpm to 2700 rpm; red radial, 2700 rpm.
Manifold Pressure: green arc, 14.5 in. Hg to 28.5 in. Hg; red radial, 28.5 in. Hg.
Suction Gage: red radial, 4.4 in. Hg; green arc, 4.8 in. Hg to 5.2 in. Hg; red radial, 5.5 in. Hg.

E. Airspeed Limits: (true indicated airspeed)

| | |
|---|---|
| Never Exceed: | 240 mph (208 knots) (red radial). |
| Caution Range: | 185 mph to 240 mph (161 knots to 208 knots) (yellow arc). |
| Normal Operating Range: | 70 mph to 185 mph (60.8 knots to 161 knots) (green arc). |
| Maximum Flap Extension Speed: | 130 mph (113 knots). |
| Maximum Gear Down Speed: | 150 mph (130 knots). |
| Maximum Design Maneuvering Speed: | 160 mph (139 knots). |
| Design Cruising Speed: | 185 mph (161 knots). |

F. Maneuvers: This is a normal category airplane. Acrobatic maneuvers, including spins, prohibited.

G. Flight Load Factors: At design gross weight, 4000 lbs.; Maneuver - positive, 4.4 G; negative, 3.0 G. Gust - positive, 4.32 G; negative 2.32 G.

NOTE: Use controls with caution above 160 mph (139 knots) and with extreme caution above 185 mph (161 knots).

H. Maximum Weight: 4000 pounds.

I. Center of Gravity Limits (gear extended):
Forward Limit - 75 inches aft of datum to gross weight of 3480.; then straight line variation to 79.4 inches aft of datum at gross weight of 4000 lbs.
Aft Limit - 83 inches aft of datum at all weights.

J. Placards:
*On pilot's window frame:* 'This airplane must be operated as a normal category airplane in compliance with the airplane flight manual. No acrobatic maneuvers including spins approved.
'AIRSPEED LIMITATIONS Max speed with landing gear extended (normal) 150 MPH. Max speed with flaps extended (normal) 130 MPH. Max design maneuver speed 160 MPH. Min control speed single engine 84 MPH.'
*On rear windows:* 'Do not open in flight. Latch window before take-off.'
*On pilot's storm window:* 'CAUTION Do not open above 145 MPH.'
*On rear window frames:* 'Latch window before take-off.'

*On inner side of glove compartment door:* 'Emergency Landing Gear Instructions to Extend: Engage handle in rear of front seat and turn counterclockwise as far as possible (50 turns).'
*Inside each baggage compartment door:* 'Load in accordance with Airplane Flight Manual. Maximum structural capacity 270 pounds.'
*Between fuel selector handles:* 'Use aux tanks and crossfeed in level flight only.'

## II. PROCEDURES.

A. Normal Procedures:

1. Fuel System: Separate fuel system for each engine, with suction crossfeed. Take-off and land on main tanks only, without crossfeed. In-line electric boost pumps between engines and tank selector valves may be used on any tank; use boost pumps for starting, take-off, landing and emergencies.

2. Wing Flap Settings: Take-off, $0^{\circ}$; landing $33^{\circ}$.

3. Stall Warning Indicator - A stall warning indicator sounds a warning horn (steady note) and lights a red light on the instrument panel at 4 to 6 mph above stalling speed.

4. Vacuum System: A selector valve permits checking suction at the placarded positions in the system. Automatic check valves close if either pump fails; remaining pump will operate gyro instruments.

5. Electrical System: Individual circuit breakers protect all circuits except generators, which are protected by current limiters in engine compartments. Circuit breakers are push-to-reset or pull, then push to reset except circuit breaker switches, which are reset by moving toggle to OFF then to ON.

6. Rotating Anti-Collision Beacon: Particularly at night, reflections from rotating anti-collision lights on clouds, dense haze or dust can produce optical illusions and intense vertigo. All such lights should be turned off before entering an overcast; their use may not be advisable under any instrument or limited VFR condition.

B. Emergency Procedures:

1. Single-Engine Procedure: Minimum controllable single-engine speed is 84 mph (72.6 knots); recommended minimum single-engine rate-of-climb speed is 100 mph (86 knots) (blue radial on airspeed indicator). Add power to maintain altitude and airspeed. Pull propeller lever on dead engine back through detent to feathered position (full back). To re-start, move propeller lever into governing range, then follow normal starting procedure. When unfeathering accumulator is installed, engage starter as soon as blades start to unfeather. When engine starts, operate at reduced power until operating temperatures are normal.

2. Fuel Crossfeed: Either engine may be supplied from the other engine's tanks by placing its selector valve on crossfeed and the other selector valve on the desired tank.

   CAUTION: If both engines are operating and one selector is placed on crossfeed, both engines will feed from the same tank.

3. Landing Gear: To extend manually, place landing gear switch DOWN; pull landing gear circuit breaker. Engage handcrank at rear of front seat and turn counterclockwise as far as possible (approximately 50 turns). Gear cannot be retracted manually.

   CAUTION: Keep handle secured in disengaged position when not in use.

## III. PERFORMANCE.

| ITEM | | $0^{\circ}F$ | $25^{\circ}F$ | $50^{\circ}F$ | $75^{\circ}F$ | $100^{\circ}F$ |
|---|---|---|---|---|---|---|
| Take-off distance (ft). Distance required to take off and climb 50 feet, flaps up, full throttle, 2700 rpm. Take-off speed, 85 mph (74 knots) (TIAS) | SL | 1640 | 1810 | 1980 | 2180 | 2370 |
| | 2000 | 1920 | 2130 | 2335 | 2570 | 2780 |
| | 4000 | 2310 | 2550 | 2800 | 3100 | 3350 |
| | 6000 | 2820 | 3110 | 3425 | 3760 | 4120 |
| | 8000 | 3470 | 3830 | 4290 | 4710 | 5180 |
| Landing distance (ft). Distance required to land over 50-foot obstacle and stop. Flaps full down. Approach at 91 mph (79 knots) (TIAS) | SL | 1435 | 1500 | 1550 | 1610 | 1665 |
| | 2000 | 1520 | 1585 | 1640 | 1700 | 1755 |
| | 4000 | 1605 | 1670 | 1730 | 1790 | 1845 |
| | 6000 | 1690 | 1760 | 1820 | 1880 | 1940 |
| | 8000 | 1780 | 1850 | 1910 | 1970 | 2030 |
| Normal climb (ft/min). Normal rated power, flaps up, best rate-of-climb speed, 105 mph (91 knots) (TIAS) at SL,,reduce 1.0 mph per 2000 ft. increase in altitude | SL | 1478 | 1425 | 1378 | 1325 | 1278 |
| | 2000 | 1333 | 1282 | 1232 | 1182 | 1132 |
| | 4000 | 1190 | 1138 | 1088 | 1036 | 987 |
| | 6000 | 1045 | 995 | 941 | 892 | 842 |
| | 8000 | 903 | 853 | 800 | 745 | 697 |
| Balked landing climb (ft/min). Normal rated power, flaps and gear down. Best rate-of-climb speed 80 mph (69.5 knots) (TIAS) at SL. Reduce 1.0 mph per 3000 feet increase in altitude. | SL | 810 | 765 | 725 | 687 | 645 |
| | 2000 | 682 | 642 | 602 | 563 | 520 |
| | 4000 | 557 | 518 | 475 | 438 | 395 |
| | 6000 | 430 | 392 | 350 | 312 | 270 |
| | 8000 | 304 | 268 | 225 | 190 | 145 |
| Single engine climb (ft/min). Normal rated power, flaps and gear up, prop feathered on inoperative engine. Best rate-of-climb speed 102 mph (89 knots) (TIAS) at SL. Reduce 1.0 mph per 700 feet increase in altitude. | SL | 283 | 257 | 230 | 203 | 181 |
| | 2000 | 220 | 195 | 168 | 142 | 119 |
| | 4000 | 157 | 132 | 105 | 80 | 57 |
| | 6000 | 94 | 68 | 42 | 17 | -5 |
| | 8000 | 30 | 5 | -20 | -45 | -70 |

| Stalling Speeds, Power Off. | Angle of Bank | $0^{\circ}$ | $20^{\circ}$ | $40^{\circ}$ | $60^{\circ}$ |
|---|---|---|---|---|---|
| | Gear & Flaps Up | 84 mph (73 knots) | 87 mph (75.5 knots) | 96 mph (93.5 knots) | 119 mph (103.5 knots) |
| | Gear & Flaps Down | 70 mph (61 knots) | 72 mph (62.5 knots) | 80 mph (69.5 knots) | 99 mph (86 knots) |

Maximum altitude lost during a stall is approximately 250 feet.

Approved Virgil H Adamson

Virgil H. Adamson
DMCR 5-3



Main Menu

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**BEECH AIRCRAFT CORPORATION, WICHITA 1, KANSAS**

**CAA Identification** **Airplane Serial** **Manufactured**
**CAA Approved, Based on CAR 3, Normal Category** **Type Certificate 3A16**

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Approved *Virgil H Adamson*

Virgil H. Adamson
DMCR 5-3

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I. **LIMITATIONS.** The following limitations must be observed in the operation of this airplane:

A. Engine Limits (Two Lycoming 0-360-A1A engines): 2700 rpm, 28.5 in. manifold pressure (180 hp) for all operations.

B. Fuel: Aviation gasoline, 91/96 minimum octane. *Usable fuel,* two 25-gallon main tanks and two 17-gallon auxiliary tanks in wings. *Optional capacity:* two 25-gallon main tanks and two 31-gallon auxiliary tanks in wings. See Equipment List.

C. Propellers: Two Hartzell constant-speed, full-feathering, two-blade propellers, model HC-92ZK-2 hubs with 8447-12A blades and 835-6 spinners. Pitch setting at 30-inch station: low, 14°, high 84°. Diameter 70 - 72 inches.

D. Power Plant Instruments:
Oil Temperature: yellow arc, 60°F to 140°F; green arc, 140°F to 245°F; red radial, 245°F.
Oil Pressure: red radial (minimum idling) 25 psi; green arc, 65 psi to 85 psi; red radial, 85 psi.
Fuel Pressure: red radial, 0.5 psi; green arc, 0.5 psi to 6.0 psi; red radial, 6.0 psi.
Cylinder Head Temperature: green arc, 200°F to 500°F; red radial, 500°F.
Tachometer: green arc, 2000 rpm to 2700 rpm; red radial, 2700 rpm.
Manifold Pressure: green arc, 14.5 in. Hg to 28.5 in. Hg; red radial, 28.5 in. Hg.
Suction Gage: red radial, 4.4 in. Hg; green arc, 4.8 in. Hg to 5.2 in. Hg; red radial, 5.5 in. Hg.

E. Airspeed Limits: (true indicated airspeed)

| | |
|---|---|
| Never Exceed: | 240 mph (208 knots) (red radial). |
| Caution Range: | 185 mph to 240 mph (161 knots to 208 knots) (yellow arc). |
| Normal Operating Range: | 70 mph to 185 mph (60.8 knots to 161 knots) (green arc). |
| Maximum Flap Extension Speed: | 130 mph (113 knots). |
| Maximum Gear Down Speed: | 150 mph (130 knots). |
| Maximum Design Maneuvering Speed: | 160 mph (139 knots). |
| Design Cruising Speed: | 185 mph (161 knots). |

F. Maneuvers: This is a normal category airplane. Acrobatic maneuvers, including spins, prohibited.

G. Flight Load Factors: At design gross weight, 4000 lbs.; Maneuver - positive, 4.4 G; negative, 3.0 G. Gust - positive, 4.32 G; negative 2.32 G.

NOTE: Use controls with caution above 160 mph (139 knots) and with extreme caution above 185 mph (161 knots).

H. Maximum Weight: 4000 pounds.

I. Center of Gravity Limits (gear extended):
Forward Limit - 75 inches aft of datum to gross weight of 3480.; then straight line variation to 79.4 inches aft of datum at gross weight of 4000 lbs.
Aft Limit - 83 inches aft of datum at all weights.

J. Placards:
*On pilot's window frame:* 'This airplane must be operated as a normal category airplane in compliance with the airplane flight manual. No acrobatic maneuvers including spins approved.
'AIRSPEED LIMITATIONS Max speed with landing gear extended (normal) 150 MPH. Max speed with flaps extended (normal) 130 MPH. Max design maneuver speed 160 MPH. Min control speed single engine 84 MPH.'
*On rear windows:* 'Do not open in flight.'
*On pilot's storm window:* 'CAUTION Do not open above 145 MPH.'
*On rear window frames:* 'Latch window before take-off.'

*On inner side of glove compartment door:* 'Emergency Landing Gear Instructions to Extend: Engage handle in rear of front seat and turn counterclockwise as far as possible (50 turns).'
*Inside each baggage compartment door:* 'Load in accordance with Airplane Flight Manual. Maximum structural capacity 270 pounds.'
*Between fuel selector handles:* 'Use aux tanks and crossfeed in level flight only.'

## II. PROCEDURES.

### A. Normal Procedures:

1. Fuel System: Separate fuel system for each engine, with suction crossfeed. Take-off and land on main tanks only, without crossfeed. In-line electric boost pumps between engines and tank selector valves may be used on any tank; use boost pumps for starting, take-off, landing and emergencies.

2. Wing Flap Settings: Take-off, 0°; landing 33°.

3. Stall Warning Indicator - A stall warning indicator sounds a warning horn (steady note) and lights a red light on the instrument panel at 4 to 6 mph above stalling speed.

4. Vacuum System: A selector valve permits checking suction at the placarded positions in the system. Automatic check valves close if either pump fails; remaining pump will operate gyro instruments.

5. Electrical System: Individual circuit breakers protect all circuits except generators, which are protected by current limiters in engine compartments. Circuit breakers are push-to-reset or pull, then push to reset except circuit breaker switches, which are reset by moving toggle to OFF then to ON.

6. Rotating Anti-Collision Beacon: Particularly at night, reflections from rotating anti-collision lights on clouds, dense haze or dust can produce optical illusions and intense vertigo. All such lights should be turned off before entering an overcast; their use may not be advisable under any instrument or limited VFR condition.

### B. Emergency Procedures:

1. Single-Engine Procedure: Minimum controllable single-engine speed is 84 mph (72.6 knots); recommended minimum single-engine rate-of-climb speed is 100 mph (86 knots) (blue radial on airspeed indicator). Add power to maintain altitude and airspeed. Pull propeller lever on dead engine back through detent to feathered position (full back). To re-start, move propeller lever into governing range, then follow normal starting procedure. When unfeathering accumulator is installed, engage starter as soon as blades start to unfeather. When engine starts, operate at reduced power until operating temperatures are normal.

2. Fuel Crossfeed: Either engine may be supplied from the other engine's tanks by placing its selector valve on crossfeed and the other selector valve on the desired tank.

   CAUTION: If both engines are operating and one selector is placed on crossfeed, both engines will feed from the same tank.

3. Landing Gear: To extend manually, place landing gear switch DOWN; pull landing gear circuit breaker. Engage handcrank at rear of front seat and turn counterclockwise as far as possible (approximately 50 turns). Gear cannot be retracted manually.

   CAUTION: Keep handle secured in disengaged position when not in use.

## III. PERFORMANCE.

| ITEM | | 0°F | 25°F | 50°F | 75°F | 100°F |
|---|---|---|---|---|---|---|
| Take-off distance (ft). Distance required to take off and climb 50 feet, flaps up, full throttle, 2700 rpm. Take-off speed, 85 mph (74 knots) (TIAS) | SL | 1640 | 1810 | 1980 | 2180 | 2370 |
| | 2000 | 1920 | 2130 | 2335 | 2570 | 2780 |
| | 4000 | 2310 | 2550 | 2800 | 3100 | 3350 |
| | 6000 | 2820 | 3110 | 3425 | 3760 | 4120 |
| | 8000 | 3470 | 3830 | 4290 | 4710 | 5180 |
| Landing distance (ft). Distance required to land over 50-foot obstacle and stop. Flaps full down. Approach at 91 mph (79 knots) (TIAS) | SL | 1435 | 1500 | 1550 | 1610 | 1665 |
| | 2000 | 1520 | 1585 | 1640 | 1700 | 1755 |
| | 4000 | 1605 | 1670 | 1730 | 1790 | 1845 |
| | 6000 | 1690 | 1760 | 1820 | 1880 | 1940 |
| | 8000 | 1780 | 1850 | 1910 | 1970 | 2030 |
| Normal climb (ft/min). Normal rated power, flaps up, best rate-of-climb speed, 105 mph (91 knots) (TIAS) at SL,,reduce 1.0 mph per 2000 ft. increase in altitude | SL | 1478 | 1425 | 1378 | 1325 | 1278 |
| | 2000 | 1333 | 1282 | 1232 | 1182 | 1132 |
| | 4000 | 1190 | 1138 | 1088 | 1036 | 987 |
| | 6000 | 1045 | 995 | 941 | 892 | 842 |
| | 8000 | 903 | 853 | 800 | 745 | 697 |
| Balked landing climb (ft/min). Normal rated power, flaps and gear down. Best rate-of-climb speed 80 mph (69.5 knots) (TIAS) at SL. Reduce 1.0 mph per 3000 feet increase in altitude. | SL | 810 | 765 | 725 | 687 | 645 |
| | 2000 | 682 | 642 | 602 | 563 | 520 |
| | 4000 | 557 | 518 | 475 | 438 | 395 |
| | 6000 | 430 | 392 | 350 | 312 | 270 |
| | 8000 | 304 | 268 | 225 | 190 | 145 |
| Single engine climb (ft/min). Normal rated power, flaps and gear up, prop feathered on inoperative engine. Best rate-of-climb speed 102 mph (89 knots) (TIAS) at SL. Reduce 1.0 mph per 700 feet increase in altitude. | SL | 283 | 257 | 230 | 203 | 181 |
| | 2000 | 220 | 195 | 168 | 142 | 119 |
| | 4000 | 157 | 132 | 105 | 80 | 57 |
| | 6000 | 94 | 68 | 42 | 17 | -5 |
| | 8000 | 30 | 5 | -20 | -45 | -70 |

| Stalling Speeds, Power Off. | Angle of Bank | 0° | 20° | 40° | 60° |
|---|---|---|---|---|---|
| | Gear & Flaps Up | 84 mph (73 knots) | 87 mph (75.5 knots) | 96 mph (93.5 knots) | 119 mph (103.5 knots) |
| | Gear & Flaps Down | 70 mph (61 knots) | 72 mph (62.5 knots) | 80 mph (69.5 knots) | 99 mph (86 knots) |

Maximum altitude lost during a stall is approximately 250 feet.

Approved Virgil H Adamson

Virgil H. Adamson
DMCR 5-3

## MODEL 95 TRAVEL AIR

# PILOT'S CHECK LIST

**Never taxi with a flat strut!**

**BEFORE STARTING**

1. Exterior check, fuel and oil quantity and loading—Checked.
2. Parking brake—ON.
3. Battery and generator switches—ON.
4. All switches, circuit breakers and controls—Checked.
5. Cowl flaps—OPEN.
6. Fuel selector valves—On MAIN.
7. Carburetor heot—OFF.

**STARTING**

1. Throttles—Approximately 1/10 OPEN.
2. Propellers—High-rpm.

**NOTE**

*Cold engine starting:* Mixtures full rich; prime as required.

*Hot engine starting:* Mixture in idle-cut-off until cranking; do not prime.

3. Magneto switches—Both ON.
4. Fuel boost pump—ON.
5. Starter—Engage.
6. Warm-up—800 to 1300 rpm.
7. Fuel boost pump—OFF.
8. Normal readings all gages—Checked.
9. Repeat procedure for remaining engine.

**BEFORE TAKE-OFF**

1. Propellers—Exercised at 2200 rpm and left in high-rpm.
2. Carburetor heat—Checked.
3. Magnetos—Checked at static rpm (maximum drop, 75 rpm).
4. Trim—Set for take-off.
5. Freedom and full travel of flight controls—Checked.
6. Fuel boost pumps—ON (optional).
7. Normal readings all instruments—Checked.

**BEFORE LANDING**

1. Fuel selector valves—On MAIN.
2. Mixtures—Full rich.
3. Carburetor heat—As required.
4. Fuel boost pumps—ON (optional).
5. Landing gear—DOWN and Position Indicators checked.
6. Wing flaps—As desired.
7. Propellers—High-rpm.

**SHUT-DOWN**

1. Parking brake—ON.
2. Electrical equipment—OFF.
3. Propellers—High-rpm.
4. Throttles—Advance to approximately 1500 rpm.
5. Mixtures—Idle-cut-off.
6. Magneto switches—OFF.
7. Battery and generator switches—OFF.
8. Fuel selector valves—OFF.
9. Controls—Locked.

**SINGLE-ENGINE PROCEDURE**

1. Both engines—Propellers, throttles and mixtures, FULL FORWARD.
2. Maintain—Airspeed (100 mph IAS minimum), altitude if practicable.
3. Landing gear and wing flaps—UP.
4. For inoperative engine:
   - Propeller—FEATHER.
   - Mixture—Idle-cut-off.
   - Cowl flap—CLOSED.
   - Fuel selector valve—OFF.
   - Magneto switches—OFF.
   - Generator switch—OFF.
5. Power—Adjusted on good engine.
6. Trim—For single-engine flight.

## Critical Engine

A critical engine is the engine which; if lost, will most adversely affect the performance and handling characteristics of the aircraft.

## 4 Factors to Determine Critical Engine:

**P**- P-factor

**A**- Accelerated Slipstream

**S**- Spiraling Slipstream

**T**- Torque

## Vmc

Minimum Controllable Airspeed

## How Vmc is Determined:

**C**- Critical engine failed and windmilling

**O**- Operating engine at max T/O power

**M**- Max gross weight

**B**- Bank of no more than 5°

**A**- Aft center of gravity

**T**- Takeoff configuration

**S**- Standard temperature and pressure

## Lowers Vmc (good)

Add power to Critical Engine

Reduce Drag

Reduce power on the Operating Engine

Forward CG (longer rudder arm)

Gear Down

Lower Pressure

Higher Altitude

Higher Temperature

## Increases Vmc (bad)

Reducing Bank

Higher Pressure

Lower Temperature

Lower Altitude

## BE95 BEECH TRAVEL AIR N677Q

| ENGINE OPERATING LIMITS | | | |
|---|---|---|---|
| Indication | **Red Low / Yellow** | **Green** | **Red High** |
| Oil Temp | 60 - 140° | 140 - 245° | 245° - Up |
| Oil Pressure | 25 psi (min idle) | 65 - 85 psi | 85 psi - Up |
| Fuel Pressure | 0 – 0.5 psi | 0.5 – 6.0 psi | 6.0 psi – Up |
| Cylinder Head Temp | | 200 – 500° | 500° - Up |
| Prop Tach | | 2,000-2,700 RPM | 2,700 - Up RPM |
| Manifold Pressure | | 14.5 – 28.5” | 28.5” - Up |
| Suction | 0 – 4.5” | 4.5 – 5.5” | 5.5” - Up |

| Vspeeds MPH | | | |
|---|---|---|---|
| Vr | 85 | Vmc | 84 |
| Vx | 95 | Vxse | 100 |
| Vy | 105 | Vyse | 100 |
| Va | 160 | Vsse | 100 |
| Vne | 240 | Vle | 150 |
| Vno | 185 | Vfe | 130 |
| Vso | 70 | | |

| FUEL (TOTAL/USEABLE) | | BE95 MAX WT | |
|---|---|---|---|
| Total | 112 / 106 | Takeoff | 4,000 |
| Mains | 50 / 44 | Fwd Baggage | 270 |
| Aux | 62 / 62 | Aft Baggage | 270 |
| Each AUX; 31 / 31, Each MAIN; 25 / 22 | | | |

| ALTITUDE LIMITATIONS AT 4,000 lbs | |
|---|---|
| **Two Engine Service Ceiling** | **Single Engine Service Ceiling** |
| 19,300’ (100 fpm) | 6,200’ (50 fpm) |

### Engines

**Specs:** 2 x Lycoming O-360 A1A
4-cyl horizontally opposed, carbureted, air cooled, naturally aspirated, Max 28.5”
2 x 180 hp each = Total 360 hp
**Oil capacity:** 6-8 qts per engine (5 qt min)
**Fuel burn:** 10 gals / hr per side

### Propellers

**Specs:** Two-bladed Hartzell constant speed, full feathering props. Maximum 2700 RPM
**Maintains constant RPM:** With oil pressure through the prop governor
(speeder springs / flyweights / pilot valve)
**Nitrogen unfeathering accumulator:** Brings prop out of feather
**Locking pins:** Prevents props from feathering when engine is < 800 RPM. Saves wear and tear on starters.

### Fuel System

**Fuel Capacity:** 112 total (106 useable)
**4 Tanks: Two MAIN:** 25 gal ea (22 usable)
**Two AUX:** 31 gal ea (all usable)
**4 fuel pumps:** 2 eng drive & 2 elec boost
**9 fuel sumps:** 4 ea wing and 1 under nose
**Fuel grade:** 100LL (blue dyed & 6 lbs/gal)
**X-Feed:** Emergency Only
**Fuel Limitations:**
1. ALWAYS T/O & LAND on MAINS.
2. NEVER T/O with < 10 gals (yellow arc).
3. WAIT 30s before t/o after high-speed taxi.

### Heater

**Janitrol 35,000 BTU Combustion Heater:** Located in the nose compartment. Self-contained system.
Draws fuel from left main tank and ignites in the nose. Blower then circulates hot air throughout the cabin.

### Electrical

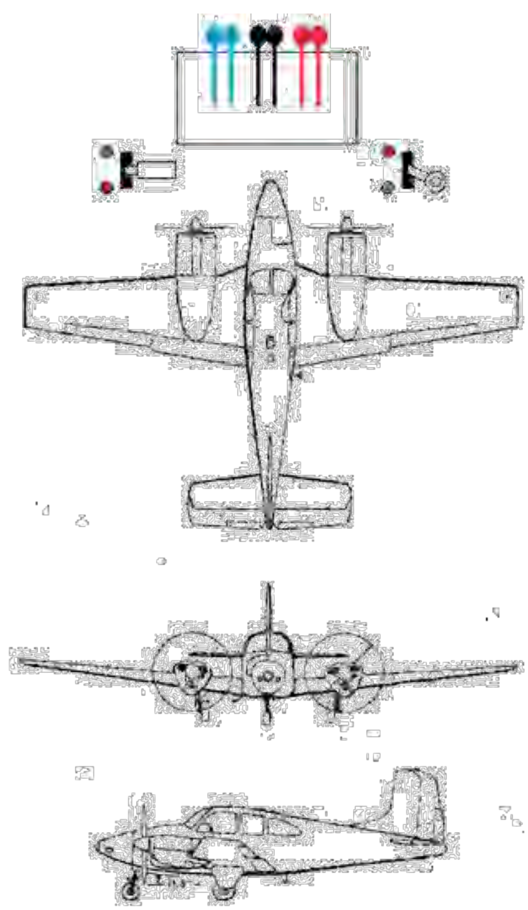
**28V system:** 2 x 12V battery (series)
2 x 28V generators – 60 amps
**Circuit breakers:** Protects the system
**Voltage regulator:** Parallels Loads
**Gear and Flaps System**: 100% electrical

### Landing Gear

**Sungear system:** Uses a torque motor to rotate a circular disk, which is connected to push pull rods attached to the landing gear. The push pull rods push the gear and doors out and pulls them in.
**‘WOW’ or Squat switch:** On L Main Gear. Prevents the gear from retracting on ground.
**Other safety systems:** Gear warning horn, nose gear indicator and nose gear mirror
**Gear hand crank:** For emergency use (roughly 50 turns counterclockwise)
**Landing checks:** “Down & Green” (verified twice and one in the mirror)
**Locks:** Mechanical Up-Locks, and over-center linkage w/ spring locks gear down

### Flaps

**Micro switch:** Up, Off, or Down position
**Full flaps:** 30° (10 / 20° marks on L Flap)
**Flaps:** Uses electric motor connected to flexible torsion cables which drive flaps down with jackscrews



## Oral Exam Prep

### Vmc

A thorough knowledge of Vmc is probably the most important subject on the oral exam.

1. Be able to define Vmc.
2. How does the manufacturer determine Vmc speed?
3. What happens to Vmc if the aircraft is loaded aft of the CG limit?
4. How is Vmc determined?
5. What factors affect Vmc?

### Critical Engine

1. Define a critical engine?
2. What determines a critical engine?
3. Why do some airplanes have a critical engine and some don't?
4. Does the Travel Air have a critical engine?

### Weight and Balance

Complete your weight & balance!
Be able to use the charts and graphs in the POH.
Explain zero fuel weight.

## Aircraft Systems

**Know your systems!**

Fuel system
Landing gear
Electrical system
Constant speed; full feathering props
Heater system
Pressure system

### Airspeeds

Red line / Vmc
Blue line / Vyse
Vy, Vx, Vyse, Vxse, Vmc, Va, Vlo, Vle, Vso, Vsse, Vno, Vne

### Performance Charts

**Know your performance!**

1. Takeoff distance
2. Accelerate-stop distance
3. Accelerate-go distance
4. Takeoff weight to achieve single engine climb
5. Climb performance: 2 eng, 1 eng
6. Cruise chart: TAS, fuel flow, range
7. Single engine service ceiling
8. Landing distance: flaps up, flaps down

# BE95

# TRAVEL AIR

## QUICK REFERENCE

## HANDBOOK

## PURPOSE

The BE95 Quick Reference Handbook (QRH) is designed to assist trained pilots to verify that the proper procedures have been carried out.
The QRH provides the pilot with abbreviated information derived from the Approved BE95 Owners Manual and VSL BE95 SOP to operate the airplane in most Normal and Non-normal/Emergency situations.
Pilots must be aware that checklists cannot be created for all conceivable situations and are not intended to preclude good judgment. In some cases deviation from the checklists may, at the discretion of the PIC, be necessary. Under all circumstances, the first priority is to maintain safety of the airplane for the duration of the flight.

## NORMAL CHECKLIST

The Normal Checklists are organized by phase of flight and assume completion of the previous checklist.

## EXPANED PROCEDURES & LIMITATIONS

The Expanded Procedures & Limitations contains detailed explanations of certain run-up checklist items and pertinent aircraft limitations.

## PERFORMANCE

The Performance Section contains partial selection of performance tables from the BE95 Travel Air Owners Manual.

## MANEUVERS

The Maneuvers Section contains checklists and abbreviated explanations of flight training maneuvers for the BE95. For more detailed explanations and flight profiles refer to the VSL BE95 SOP or Approved BE95 Owners Manual.

## ABNORMAL/EMERGENCY CHECKLISTS

The Abnormal/Emergency checklists contain only those items and procedures that differ from the normal operations of the airplane.

Each Abnormal/Emergency situation addressed in the checklist will contain the following conventions, as required:

1. Memory items enclosed within a red box must be read and verified after they are completed.
2. Checklist items/switch movement items preceded by a bullet (●).
3. Other instructions or actions proceeded by a dash (-).
4. Landing Considerations: This information specific to the malfunction and is used to supplement the normal operations of the airplane. The Landing Considerations must be reviewed as part of the approach briefing.
5. The Statement “Land as soon as possible” is defined as: - Land at the nearest suitable airport that offers sufficient landing distance available and if required, emergency services to support the emergency or abnormality. The primary consideration is the safety of the occupants. Extreme situations can require an off airport landing.
6. The Statement “Land as soon as practical” is defined as: - Land at a suitable airport. The primary consideration is the urgency of the emergency or abnormal situation. The training should be discontinued but continuing to the destination airport or an alternate airport with appropriate service facilities can be an option.

A decision flow pattern concept is used throughout the QRH as applicable, utilizing the decision rhomb symbol (♦).

This decision symbol indicates a flow pattern, which points to two or more possible courses of action. The procedure is completed once the (- END -) symbol is reached. Following completion of the appropriate Abnormal / Emergency checklist, the Normal checklist will be used as modified by the Abnormal / Emergency Checklist for the remainder of the flight.

Chapter 1

# NORMAL CHECKLISTS

## INTERIOR PREFLIGHT

Documents ........................................................................................ A.R.O.W.

A/C Logbook ............................................................ Inspections/Hobbs Noted

Control Wheel Lock ........................................................................... Removed

Fuel Selectors ........................................................................................ Main

Circuit Breakers ........................................................................................... In

Switches .......................................................................................................... Set

[ *Lights Off, Heater Off, & Cowl Flaps Matching* ]

Mixtures ....................................................................................... Cut-Off

Throttles .......................................................................................... Idle

Props ................................................................................................ Full

Flaps .................................................................................................. Up

Trims ............................................................................................ Reset

Carburetor Heat ................................................................................ Off

Alternate Static .............................................................................. Closed

Flight Controls .................................................. Checked; Free, Full, & Correct

Brakes ........................................................................................... Checked

Magnetos ......................................................................................... Off

Landing Gear Handle & Manual Extension Crank ........................ Down & Stowed

[ *Visually Confirm w/Mechanical Indicator* ]

Avionics Master............................................................................... Off

Battery ............................................................................................. On

Fuel Quantity Indicator ............................................................... Checked

Cowl Flaps ............................................................. Open/As Required

[ *Closed for ground operations below 32° F* ]

Check Lights .......................................................................... As Required

Battery ............................................................................................. Off

## EXTERIOR PREFLIGHT

### RIGHT WING

Fuel Sumps.......................................................................................Checked

[ *1 Engine, 1 Main Tank, 1 Aux Tank, & 1 Selector Valve (4 Per Wing)* ]

Aileron/Flap ..................................................................................... Checked

Wingtip ........................................................................................... Checked

Leading Edge .................................................................................. Checked

Fuel Quantity AUX ................................................ Check Visually, Secure Cap

Engine Oil ........................................................................................ Checked

[ *5-8 Quarts; Minimum for flight dispatch 5 Quarts* ]

Engine Compartment ........................................................................ Secured

Propeller .......................................................................................... Checked

Air Filter............................................................................................ Checked

Fuel Quantity MAIN .............................................. Check Visually, Secure Cap

Main Landing Gear/Tire ....................................................... Checked; 35 PSI

Brake/Pads ...................................................................................... Checked

Nose Compartment .......................................................................... Checked

[ *Sump Heater Fuel Strainer* ]

Windshield .......................................................................................... Clean

Nose Landing Gear/Tire ....................................................... Checked; 30 PSI

CONTINUED ON NEXT PAGE

## EXTERIOR PREFLIGHT (cont'd)

### LEFT WING

Fuel Quantity MAIN ................................................ Check Visually, Secure Cap
Main Landing Gear/Tire ........................................................ Checked; 35 PSI
Brake/Pads .................................................................................. Checked
WOW Switch ................................................................................ Checked
Engine Oil .................................................................................... Checked
[ *5-8 Quarts; Minimum for flight dispatch 5 Quarts* ]
Engine Compartment ................................................................... Secured
Propeller ...................................................................................... Checked
Air Filter....................................................................................... Checked
Fuel Quantity AUX ................................................ Check Visually, Secure Cap
Leading Edge .............................................................................. Checked
Pitot Tube ............................................................ Checked/Remove Cover
Stall Warning ............................................................................... Checked
Fuel Sumps...................................................................................Checked
[ *1 Engine, 1 Main Tank, 1 Aux Tank, & 1 Selector Valve (4 Per Wing)* ]
Wingtip ......................................................................................... Checked
Aileron/Flap ................................................................................. Checked

### EMPENNAGE

Static Port.........................................................................................Clear
Horizontal Stabilizer .................................................................... Checked
Elevator/Trim Tab ........................................................................ Checked
Vertical Stabilizer ........................................................................ Checked
Rudder/Trim Tab .......................................................................... Checked
Static Port.........................................................................................Clear
Baggage Door ............................................................................. Secured
Belly ............................................................................................. Checked

## BEFORE START

Int/Ext Preflight ........................................................................ Complete

A/C Documents/Charts ................................................................ Onboard

Weight & Balance ....................................................................... Complete

Doors/Cargo ............................................................................... Secured

Safety Briefing ........................................................................... Complete

Fuel Selectors ................................................................................ Main

Circuit Breakers ................................................................................. In

Switches ......................................................................................... Set

[ *Lights Off, Heater Off, & Cowl Flaps Matching* ]

Mixtures ......................................................................................... Rich

Throttles ......................................................................................... Idle

Props ............................................................................................. Full

Brakes ................................................................................ Checked/Hold

Landing Gear Handle ..................................................................... Down

Avionics Master ................................................................................ Off

Battery/Generators ........................................................................... On

Fuel Quantity ............................................................................ Checked

Cowl Flaps .......................................................................... Open/As Required

[ *Closed for ground operations below 32° F* ]

Beacon ............................................................................................. On

Seats and Belts.............................................................. Adjusted and Fastened

## START

Boost Pump .......................................................................................... On

Magnetos ............................................................................................ On

Prime ........................................................................................ 4-8 Pumps

[ Only prime for the 1st start of the day.  Below 40°F use 8 pumps]

Prop ................................................................................................ Clear

Starter ........................................................................................... Engage

[ *10 seconds on; 20 seconds off (x6); then 30 minutes off* ]

- - - - - - - - - - - - - - - - - - -**Repeat for Second Engine** - - - - - - - - - - - - - - - - - -

## AFTER START

Boost Pumps ........................................................................................ Off

Mixtures ............................................................................................ Lean

Generators/Alternators................................................................ On & Paralleled

[ *Generator Cut in Speed is 1600 RPM MIN* ]

Engine Instruments ....................................................................... Checked

[ *Engine Warm-Up - 1300 RPM MAX until Above 100°F Oil Temp* ]

Avionics Master.................................................................................. On

## TAXI

Brakes ........................................................................................... Checked

Flight Instruments ............................................................... Checked & Set

## ENGINE RUN-UP

Mixtures ........................................ Rich
Throttles ........................................ 1500 RPM
Prop Feather ........................................ Checked
Throttles ........................................ 2200 RPM
Magnetos ........................................ Checked
Carburetor Heat ........................................ Checked
Engine Instruments ........................................ Checked
Prop Governor ........................................ Checked

## BEFORE TAKEOFF

Takeoff Brief ........................................ Complete
Avionics ........................................ Set
Mixtures ........................................ Rich
Props ........................................ Full
Flaps ........................................ Set/Indicated/Visual L&R
Flight Controls ........................................ Free Full & Correct
Trims ........................................ Set for Takeoff
Carburetor Heat ........................................ Off
Fuel Selectors ........................................ Main
Boost Pumps ........................................ On
Lights ........................................ As Required
Cowl Flaps ........................................ Open/As Required

[ *Closed for ground operations below 32° F* ]

Transponder ........................................ Set/ON

| Vspeeds MPH | | | |
|---|---|---|---|
| Vr | 85 | Vmc | 84 |
| Vx | 95 | Vxse | 100 |
| Vy | 105 | Vyse | 100 |
| Va | 160 | Vsse | 100 |
| Vne | 240 | Vle | 150 |
| Vno | 185 | Vfe | 130 |
| Vso | 70 | | |

## CLIMB

Landing Gear ........................................................................................ Up

[ *Verified Twice*]

Flaps ........................................................................................ Up

Power ........................................................................................ Set

[ Passing 400AGL - *25" Manifold Pressure – 2500 RPM* ]

Engine Instruments ........................................................................ Checked

Lights ........................................................................................ As Required

Boost Pumps ........................................................................................ Off

Caps and Cowls ........................................................................ Checked L&R

Mixtures ........................................................................................ As Required

[ *Lean Above 3,000 ft MSL* ]

Cowl Flaps ........................................................................................ As Required

[ *Monitor OAT and CHT; Closed Above 130 MPH* ]

## CRUISE

Power ........................................................................................................ Set

[ *20"-24" Manifold Pressure – 2400 RPM* ]

Cowl Flaps ........................................................................ Closed/As Required

[ *Monitor OAT and CHT; Closed Above 130 MPH* ]

Fuel Selectors ........................................................................................ Aux

[ *Note Hobbs Time; 3hrs at Cruise Power* ]

Mixtures .................................................................................................. Lean

[ *50° Rich of Peak* ]

## DESCENT

Weather (ATTIS/AWOS) ........................................................... Tuned/Received

Altimeter .................................................................................................. Set

Mixtures ....................................................................................... As Required

[ *Rich Below 3,000 ft MSL* ]

## APPROACH

Avionics .................................................................................................. Set

Lights ............................................................................................ As Required

Boost Pumps ............................................................................................ On

Fuel Selectors ....................................................................................... Main

Seats and Belts............................................................. Adjusted and Fastened

Approach Brief ................................................................................. Complete

| APROACH AIRSPEEDS MPH | | | |
|---|---|---|---|
| **Flaps** | **Approach** | **Vref** | **Touchdown** |
| 0° | 110 | 100 | 85 |
| 20° | 110 | 100 | 85 |
| Full | 100 | 90 | 75 |

## LANDING

Landing Gear ........................................................................... Down & Green

[ *Verified Twice and the window* ]

Mixtures ........................................................................................ As Required

[ *Rich Below 3,000 ft MSL* ]

Props ............................................................................................................ Full

Brakes ...................................................................................................... Checked

Flaps ............................................................................................................. Set

[ *GUMP Short Final* ]

**G**as – Mains, **U**ndercarriage – Down, **M**ixture – Rich or As Req, **P**rops – Full

## AFTER LANDING

Mixtures ........................................................................................... Lean
Flaps ........................................................................................................ Up
Trims ....................................................................................................... Reset
Carburetor Heat ........................................................................................ Off
Boost Pumps ............................................................................................ Off
Lights ............................................................................................ As Required
Cowl Flaps .............................................................................. Open/As Required

[ *Closed for ground operations below 32° F* ]

Transponder ........................................................................ Standby/As Required

## PARKING

Five Radios ............................................................................................... Off
Props ....................................................................................................... Full
Throttles ............................................................................................ 1300 RPM
Mixtures ............................................................................................... Cut-Off
Throttles ................................................................................................... Idle
Beacon ..................................................................................................... Off
Magnetos .................................................................................................. Off
Battery/Generators ...................................................................................... Off
Fuel Selectors ............................................................................................ Off
Hobbs ...................................................................................................... Noted

| FUEL (TOTAL/USEABLE) | | BE95 MAX WT | |
|---|---|---|---|
| Total | 112 / 106 | Takeoff | 4,000 |
| Mains | 50 / 44 | Fwd Baggage | 270 |
| Aux | 62 / 62 | Aft Baggage | 270 |
| Each AUX; 31 / 31, Each MAIN; 25 / 22 | | | |

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Chapter 2

# EXPANDED PROCEDURES

## LIMITATIONS

### STARTING

Min Oil ..........................................................................................................5 QTS

Starter Duty Cycle Limits ............................**10** seconds **ON**, **20** seconds **OFF (x6)**

Then **30** minutes **OFF**

**[** *For a Total of 1 minute ON* ]


Oil Pressure Indication Within ........................................................... 30 Seconds

Oil Temp ............................................... 800-1000 RPM MAX until Above 100°F

[ *Bottom of the Yellow Arc* ]

### GROUND OPERATIONS

Cowl Flaps ........................................................................... Closed below 32°F

Engine Warm-Up .............................................................................. 1300 RPM

Oil Temp ....................................................... 1300 RPM MAX until Above 140°F

[ *Bottom of Green Arc* ]

Generator Cut In Speed ............................................................ 1250 RPM MIN

Minimum Runway Length ................................................................... 3000 ft

## FUEL / WEIGHT

| FUEL (TOTAL/USEABLE) | | BE95 MAX WT | |
|---|---|---|---|
| Total | 112 / 106 | Takeoff | 4,000 |
| Mains | 50 / 44 | Fwd Baggage | 270 |
| Aux | 62 / 62 | Aft Baggage | 270 |
| Each AUX; 31 / 31, Each MAIN; 25 / 22 | | | |

Fuel Quantity ........................................................... 10 Gal per Main Min for T/O

[ *Yellow Arc* ]

## FLIGHT OPERATIONS

Max Climb Power .................................................................25" MP - 2500 RPM

Cruise Climb ........................................................................... 130-140 MPH

Cowl Flaps .............................................................. Closed Above 130 MPH

Max Cruise Power ...............................................................24” MP – 2400 RPM

Max Cruise Mixture Lean...............................................EGT 50Â°F Rich of Peak

All Maneuvers / Simulated Single Eng .............................. 3,000 / 500 ft AGL Min

Actual Engine Shutdowns / Vmc & Drag Demo .........................5,000 ft AGL Min

## AIRSPEEDS

| Vspeeds MPH | | | |
|---|---|---|---|
| Vr | 85 | Vmc | 84 |
| Vx | 95 | Vxse | 100 |
| Vy | 105 | Vyse | 100 |
| Va | 160 | Vsse | 100 |
| Vne | 240 | Vle | 150 |
| Vno | 185 | Vfe | 130 |
| Vso | 70 | | |

| STALLING AIRSPEEDS MPH | | | | |
|---|---|---|---|---|
| **Angle of Bank** | **0°** | **20°** | **40°** | **60°** |
| **Gear & Flaps Up** | 85 | 87 | 95 | 120 |
| **Gear & Flaps Down** | 70 | 72 | 80 | 100 |



QRH TOC

Main Menu

## ENGINE RUN-UP

### MAGNETO CHECK

Mixtures .......................................................................................................... Rich

Throttles ................................................................................................ 2200 RPM

Magneto Switches ............................................................................... Checked

Left Engine

Left Mag OFF, RPM Drop

Left Mag ON, RPM Rise

Right Mag OFF, RPM Drop

Right Mag ON, RPM Rise

[ *Repeat for Right Engine* ]

RPM Drop .................................................. Noted; 125 Max Drop / 50 RPM Split

[ *More than 125 RPM Drop; Perform Clearing Procedure* ]

Magnetos ...................................................................................................... All On

### CLEARING PROCEDURE

Mixtures .......................................................................................................... Rich

Throttles ................................................................................................ 2200 RPM

Mixtures ......................................................................................................... Lean

[ *Lean until a 25-50 RPM Drop* ]

Run Engines ........................................................................................ One Minute

Mixtures .......................................................................................................... Rich

Throttles ................................................................................................ 2200 RPM

Magneto Check ...................................................................................... Repeat

CONTINUED ON NEXT PAGE

## ENGINE RUN-UP (cont'd)

### PROPELLOR GOVERNOR & FEATHER CHECKS

Mixtures ........................................................................................................ Rich

Throttles ........................................................................................ 2200 RPM

Both Prop Levers ........................................................... Reduce RPM; Then Full

[ *Pull levers back about halfway, then Full FWD* ]

RPM Drop then Return to 2200 ......................................................... Noted; Both

Manifold Pressure Rise then Drop ..................................................... Noted; Both

Both Prop Levers ........................................................... Reduce RPM; Then Full

[ *Pull levers back about halfway, then Full FWD* ]

Oil Pressure Drop then Rise ............................................................. Noted; Both

Throttles ........................................................................................ 1500 RPM

LH Prop Lever ................................................................... Feather; Then Full

[ *Note Propeller feathering then IMEDIATLEY FULL FWD* ]

RH Prop Lever ................................................................... Feather; Then Full

[ *Note Propeller feathering then IMEDIATLEY FULL FWD* ]

## ICING CONDITONS / CARB ICE

[ *In Visible Moisture at +5°C and below* ]

Icing Conditions ........................................................................... Exit ASAP

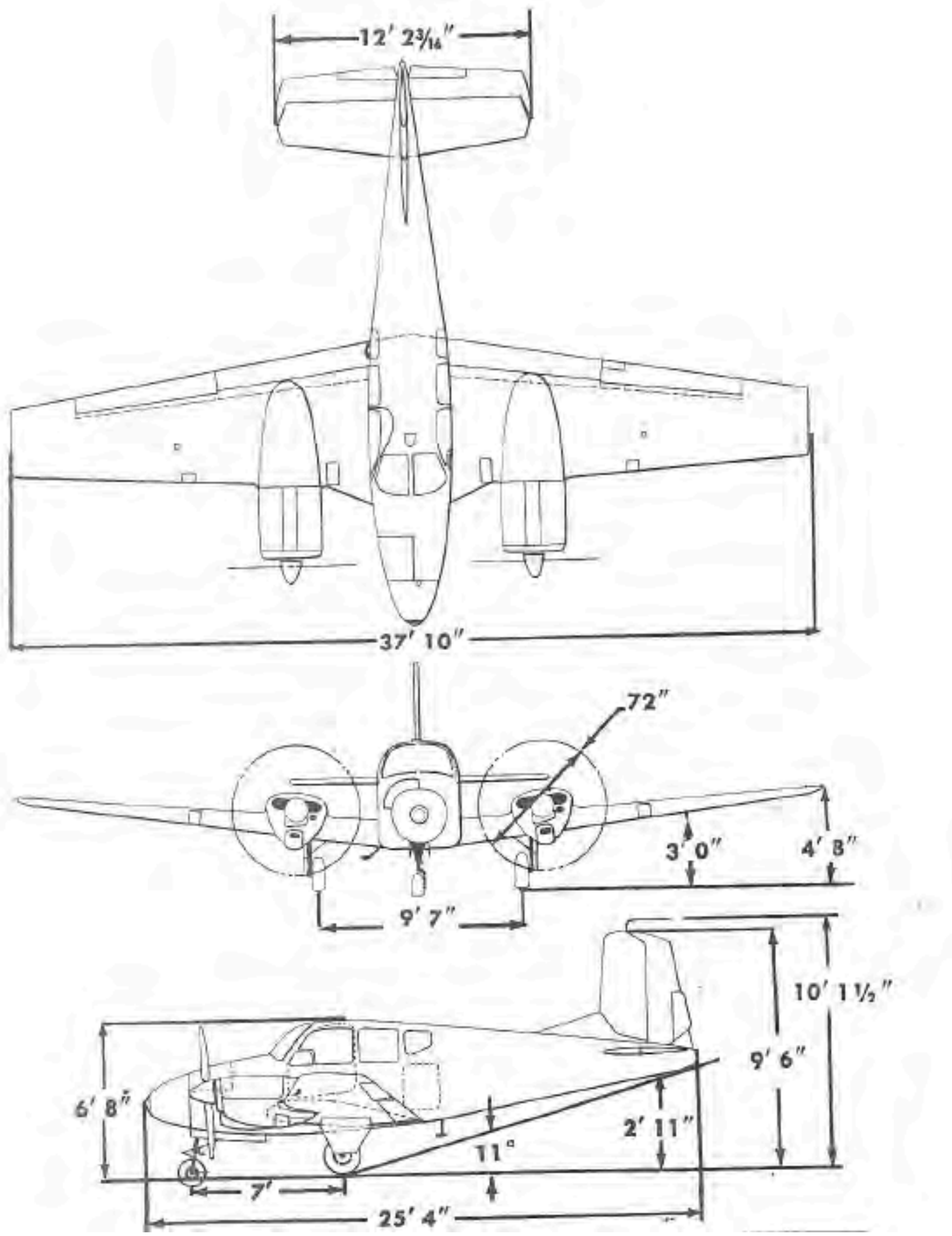
Carburetor Heat ........................................................................................ On

Pitot Heat .................................................................................................... On

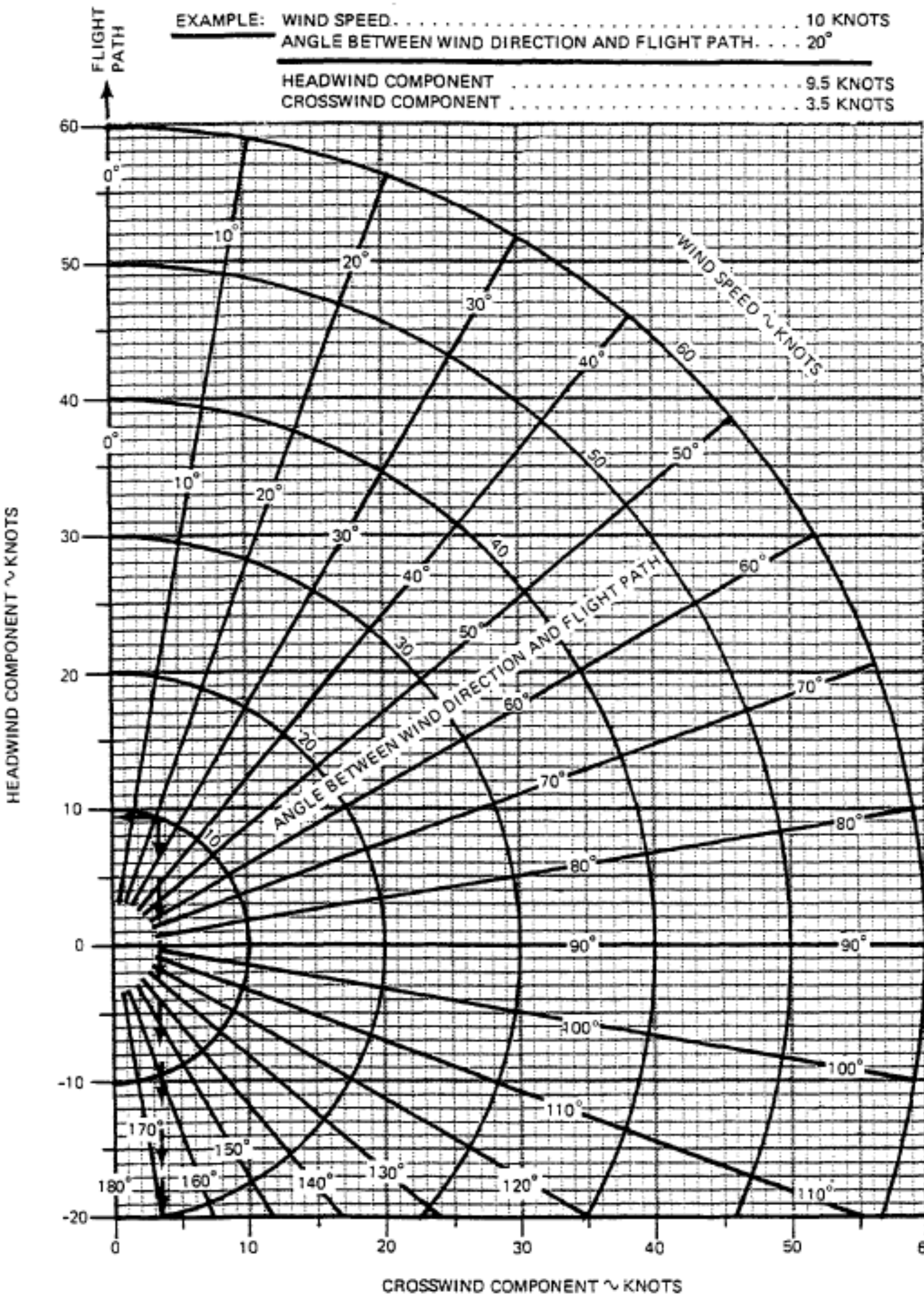
Defrost/Heater ........................................................................................... On

Chapter 3

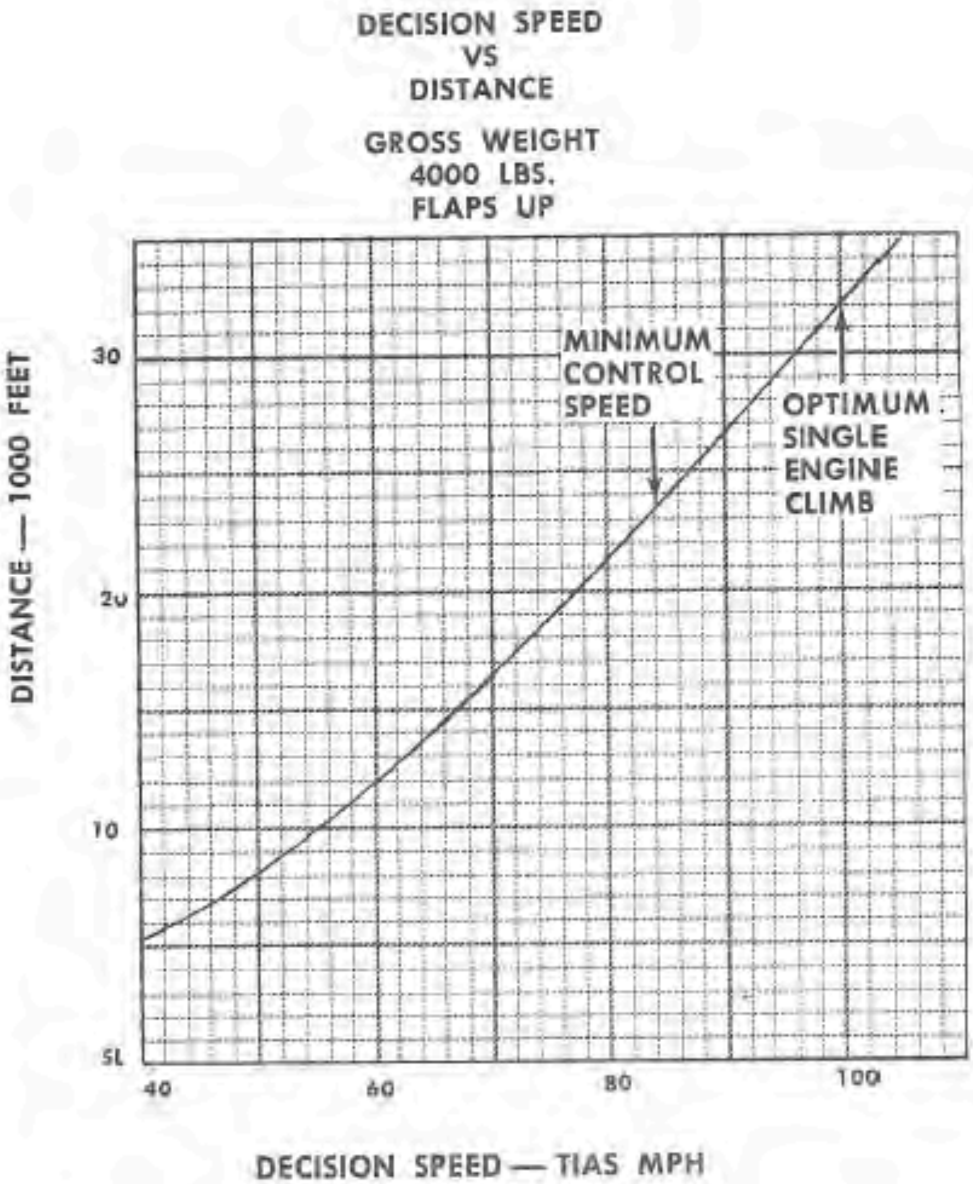
# PERFORMANCE



# WIND COMPONENTS

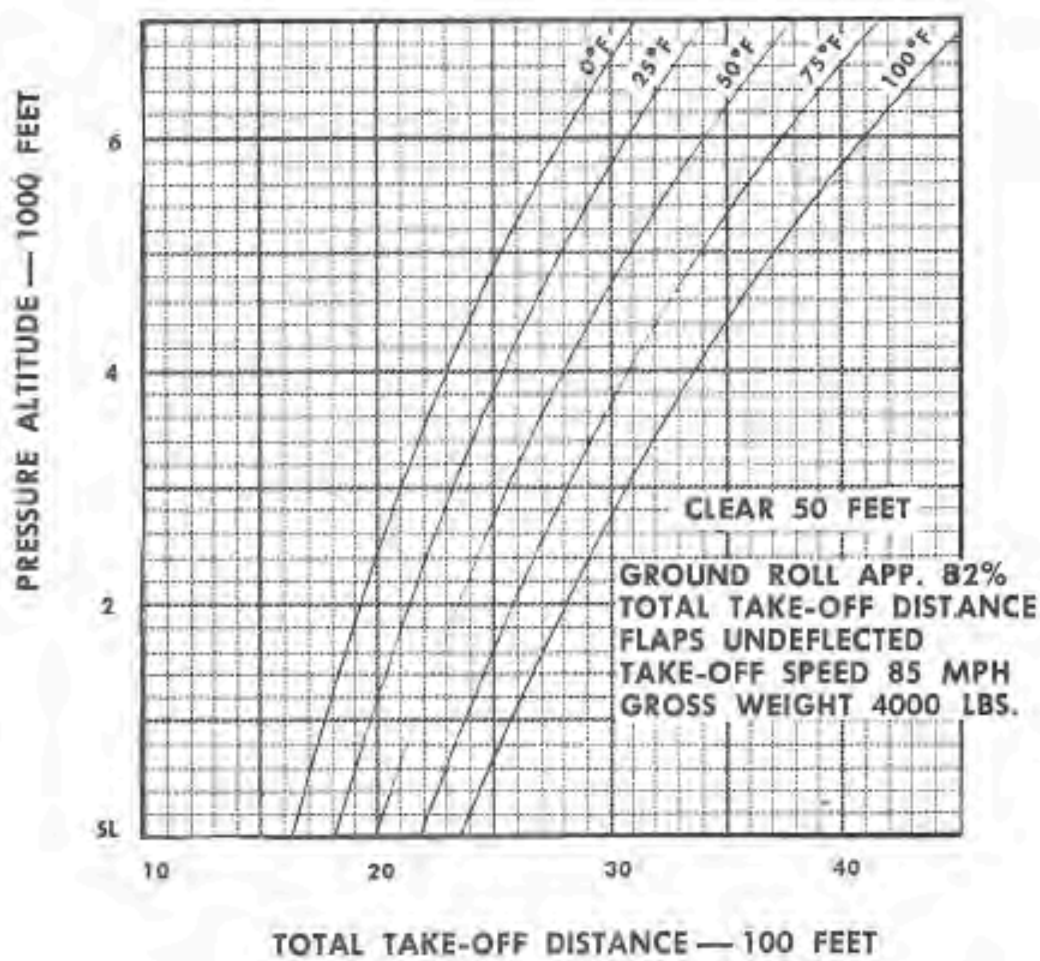


# ACCELERATE AND STOP DISTANCE



# NORMAL TAKE-OFF

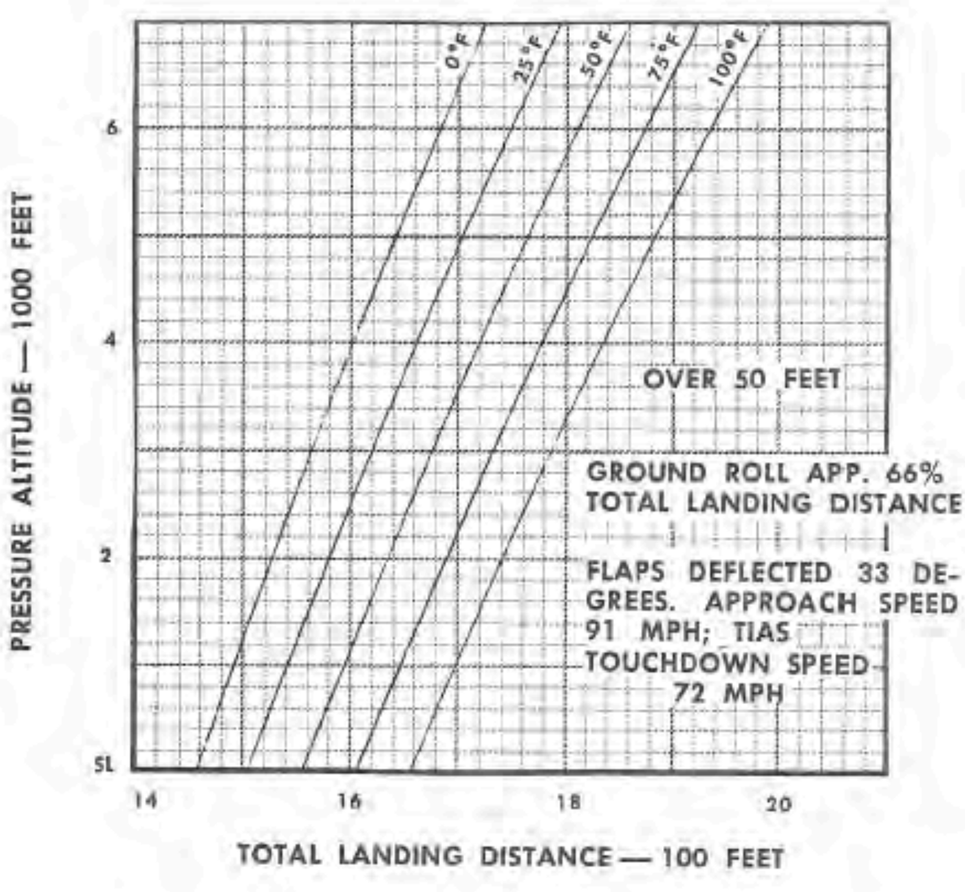
0 WIND



# NORMAL LANDING

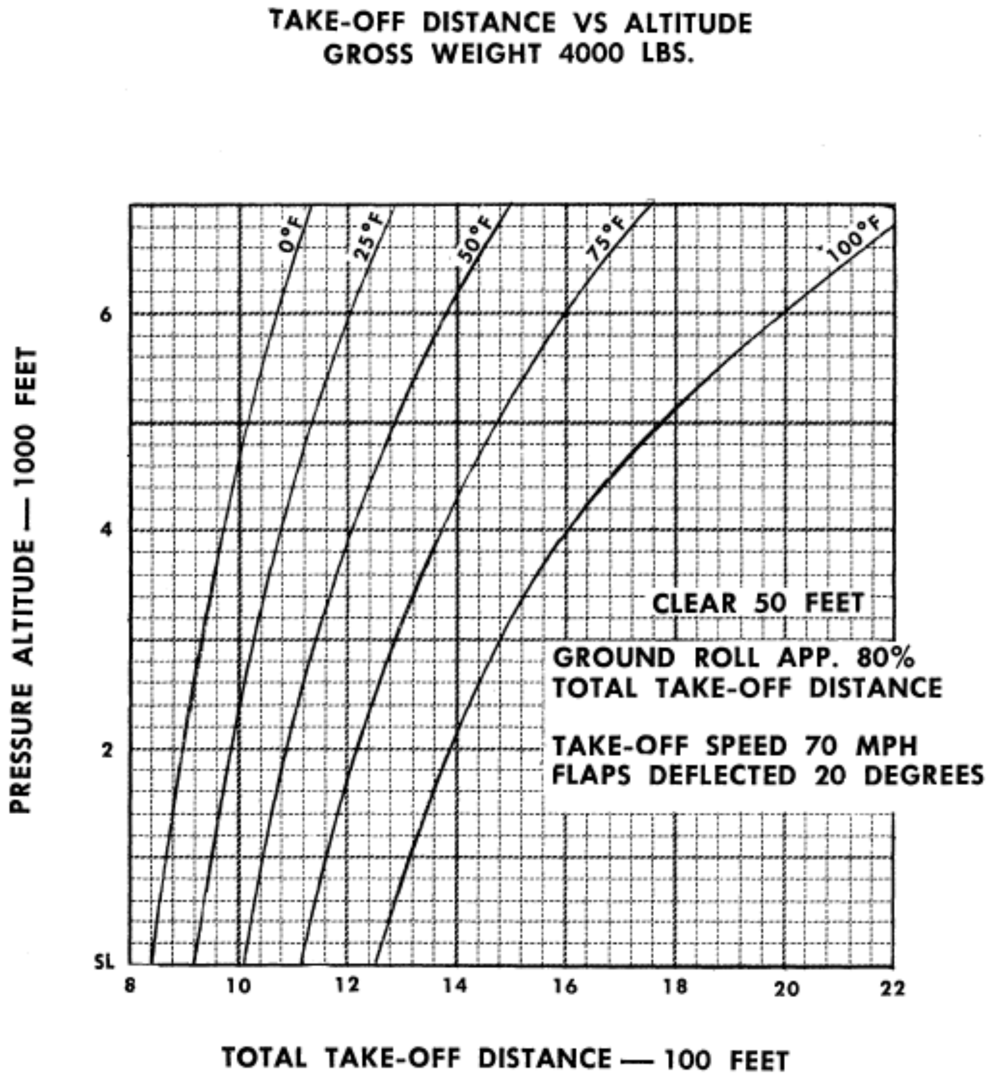
## NO WIND

LANDING DISTANCE VS ALTITUDE
GROSS WEIGHT — 4000 LBS.



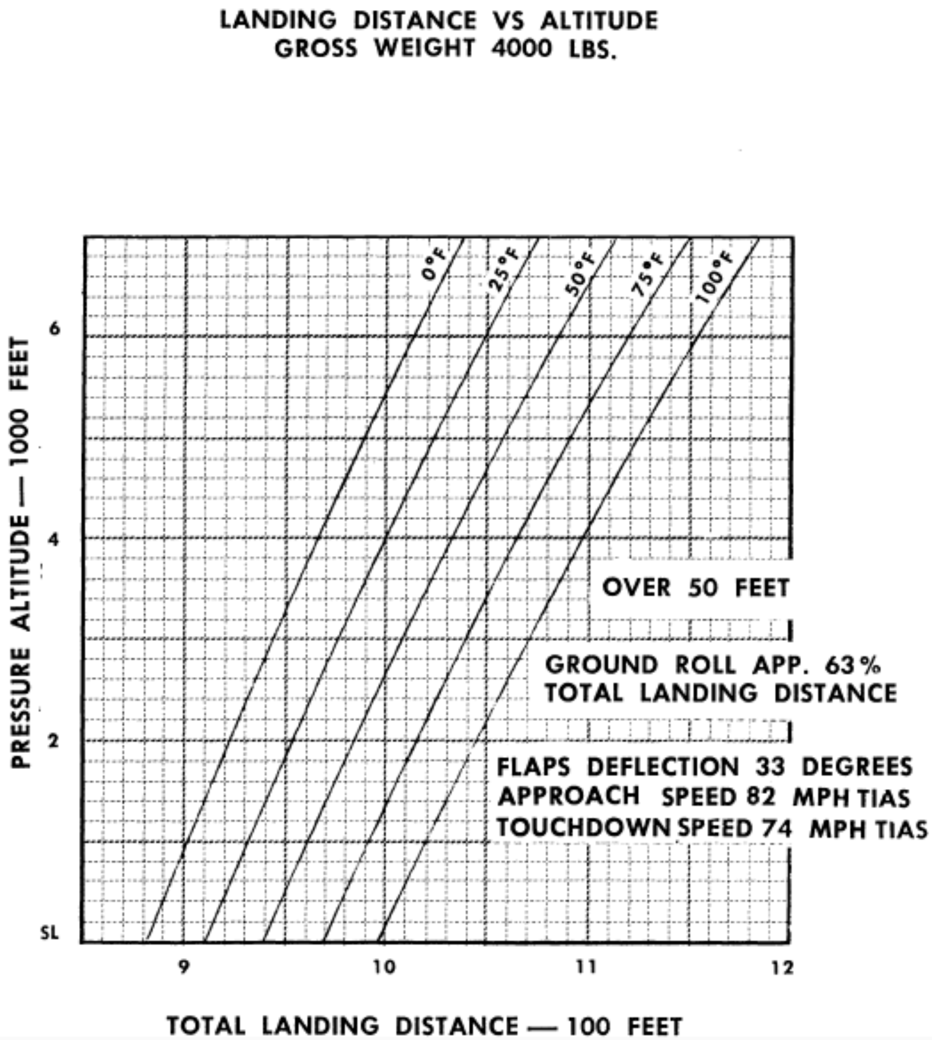
# MINIMUM RUN TAKE-OFF

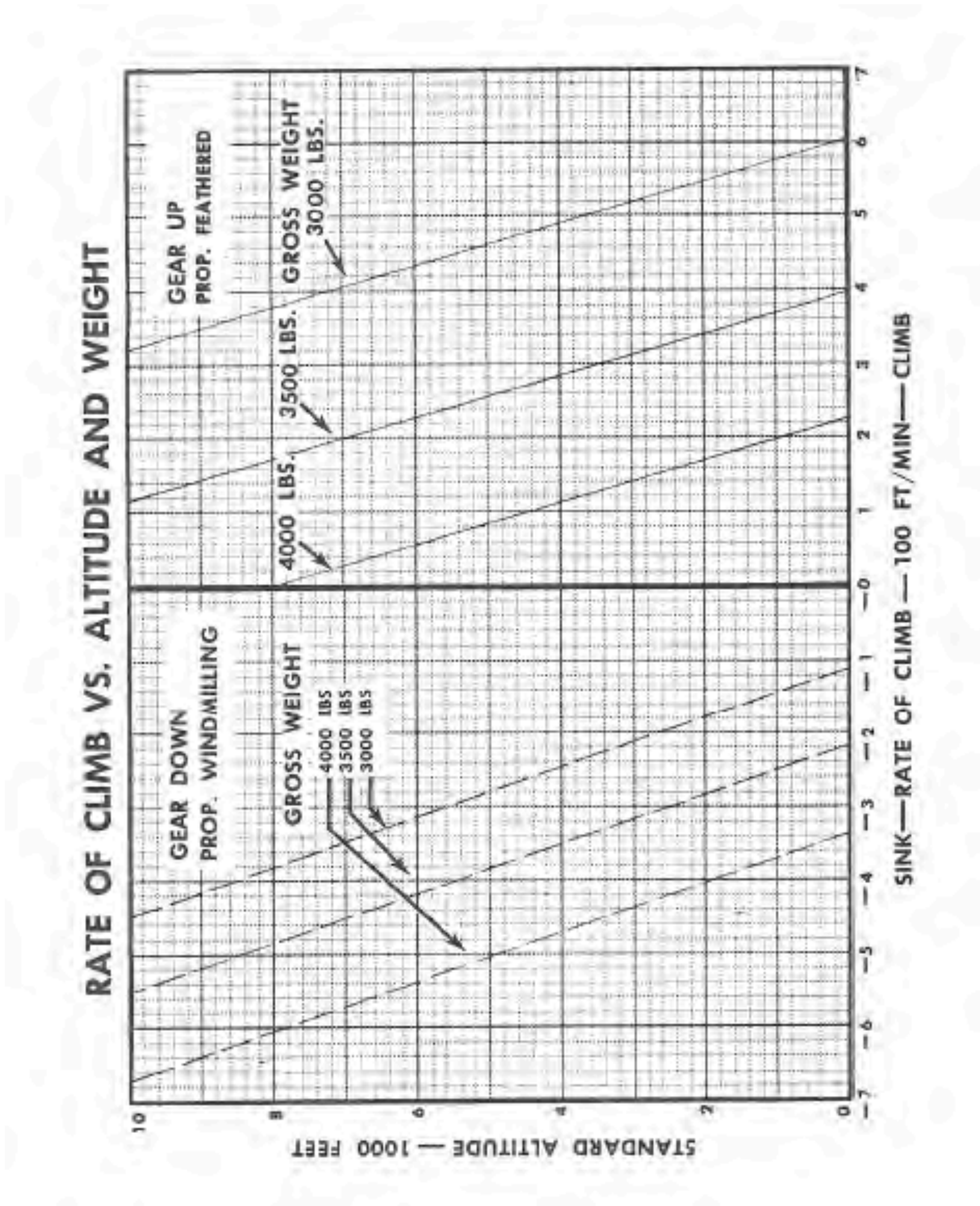
## NO WIND

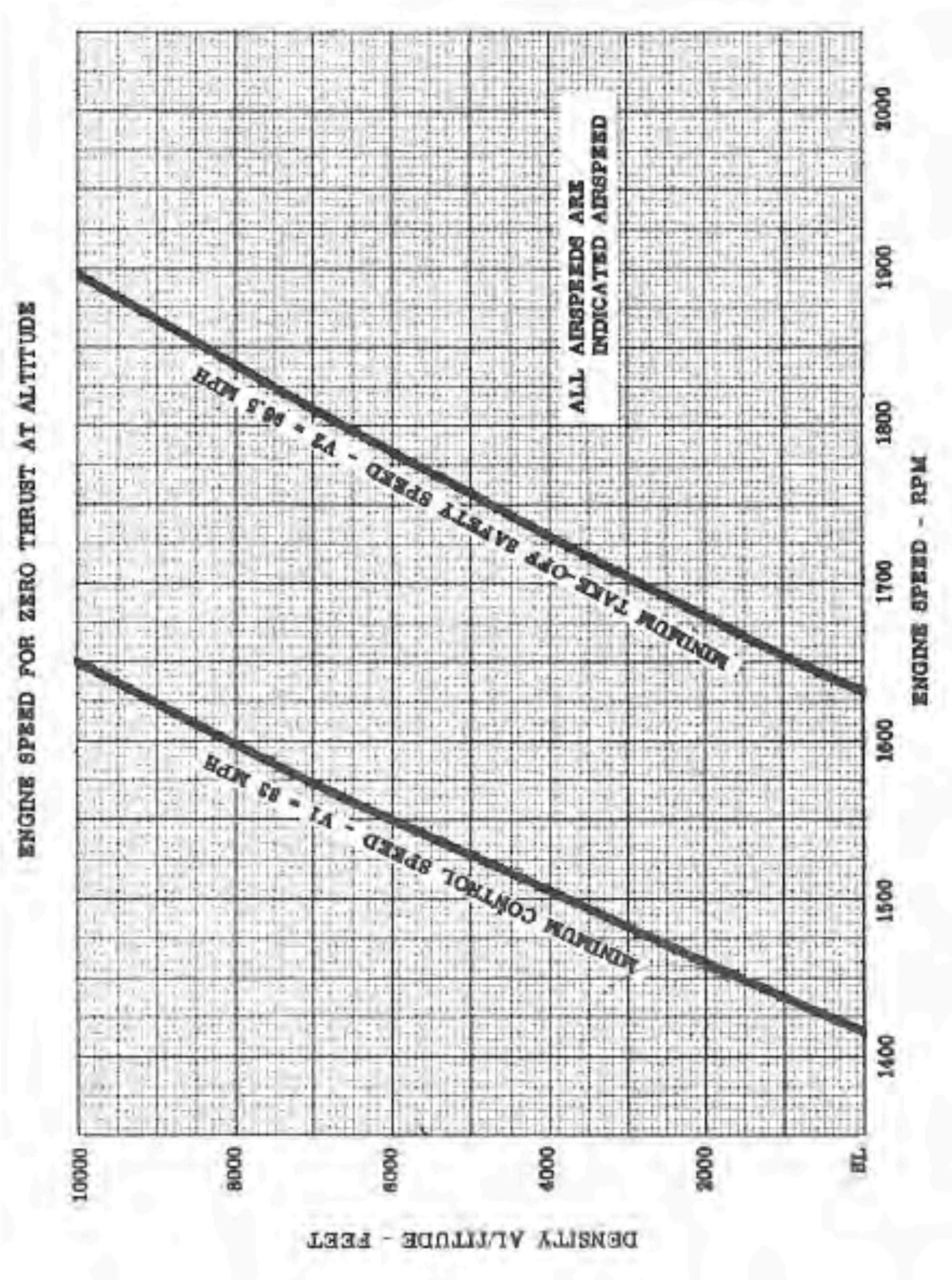


# MINIMUM RUN LANDING

## NO WIND




RATE OF CLIMB VS. ALTITUDE AND WEIGHT
GEAR UP
PROP. FEATHERED
GROSS WEIGHT
3000 LBS.
3500 LBS.
4000 LBS.
GEAR DOWN
PROP. WINDMILLING
GROSS WEIGHT
4000 LBS
3500 LBS
3000 LBS
SINK—RATE OF CLIMB — 100 FT/MIN—CLIMB
STANDARD ALTITUDE — 1000 FEET


ENGINE SPEED FOR ZERO THRUST AT ALTITUDE
ALL AIRSPEEDS ARE INDICATED AIRSPEED
MINIMUM TAKE-OFF SAFETY SPEED - V2 = 96.5 MPH
MINIMUM CONTROL SPEED - V1 = 85 MPH
ENGINE SPEED - RPM
1400
1500
1600
1700
1800
1900
2000
DENSITY ALTITUDE - FEET
SL
2000
4000
6000
8000
10000

| Vspeeds MPH | | | |
|---|---|---|---|
| Vr | 85 | Vmc | 84 |
| Vx | 95 | Vxse | 100 |
| Vy | 105 | Vyse | 100 |
| Va | 160 | Vsse | 100 |
| Vne | 240 | Vle | 150 |
| Vno | 185 | Vfe | 130 |
| Vso | 70 | | |

| APROACH AIRSPEEDS MPH | | | |
|---|---|---|---|
| **Flaps** | **Approach** | **Vref** | **Touchdown** |
| 0° | 110 | 100 | 85 |
| 20° | 110 | 100 | 85 |
| Full | 100 | 90 | 75 |

| STALLING AIRSPEEDS MPH | | | | |
|---|---|---|---|---|
| **Angle of Bank** | **0°** | **20°** | **40°** | **60°** |
| **Gear & Flaps Up** | 85 | 87 | 95 | 120 |
| **Gear & Flaps Down** | 70 | 72 | 80 | 100 |

| FUEL (TOTAL/USEABLE) | | BE95 MAX WT | |
|---|---|---|---|
| Total | 112 / 106 | Takeoff & Land | 4,000 |
| Mains | 50 / 44 | Fwd Baggage | 270 |
| Aux | 62 / 62 | Aft Baggage | 270 |
| Each AUX; 31 / 31, Each MAIN; 25 / 22 | | | |

Chapter 4

# MANEUVERS

***PERFORM CLEARING TURNS PRIOR TO EACH MANEUVER***

## PRE MANEUVER CHECKS

Cruise Checklist ........................................................................... Complete

Altitude ................................................................................... As Required

| ALTITUDE LIMITITATIONS | |
|---|---|
| All Maneuvers / Simulated Single Engine | 3,000 / 500 ft AGL Min |
| Actual Engine Shut-Downs / Vmc & Drag Demo | 5,000 ft AGL Min |

Throttles ..................................................................................... 15-20” MP

Props ......................................................... Full below 130 MPH or As Required

Mixtures ............................................................................. Rich or As Required

Cowl Flaps ............................................ Closed Above 130 MPH or As Required

Clearing Turns ........................................................................... Complete

## STEEP TURNS

Throttles .......................................................................................20” MP

Props ......................................................................................... As Required

Airspeed .......................................................................................... 140 MPH

Bank Angle ........................................................................................... 50°

[ *Through 30° of bank add 1-2” of MP and trim off back pressure* ]

360° Turn ........................................................................... 1 Left; 1 Right

[ *While rolling out of first turn; slight forward pressure* ]

Throttles ..................................................................................... 15-20” MP

## SLOW FLIGHT

Throttles .......... 15” MP
Props .......... Full below 130 MPH
Mixtures .......... Rich
Landing Gear .......... Down; Below 150 MPH
Flaps .......... Down; Below 130 MPH
Airspeed .......... 90 MPH
Throttles .......... 18-20” MP or As Required

### RECOVERY (if not doing p/o stalls)

Pitch Attitude .......... Hold Alt
Throttles .......... Max
Flaps .......... 20°
Landing Gear .......... Up
Blue Line .......... Flaps Up

## POWER OFF STALL (landing stall)

Slow Flight Configuration .......... Complete
Throttles .......... Idle
Pitch Attitude .......... Increase to Maintain Alt

[ *Slow Deceleration; 1 MPH per Second* ]

Stall Indication .......... Recover

### RECOVERY

Pitch Attitude .......... Reduce
Throttles .......... Max; Above Vmc
Flaps .......... Up
Pitch Attitude .......... 7-10° Nose Up
Positive Rate .......... Landing Gear; Up
Blue Line .......... Maintain

## POWER ON STALL (departure stall)

Throttles ....................................................................................................20" MP

Props ..............................................................................................AS REQUIRED

Mixtures ........................................................................................................ Rich

Landing Gear .................................................................................................. Up

Flaps ............................................................................................................... Up

Pitch Attitude .................................................................................... 15° Nose Up

[ *Slow Deceleration; 1 MPH per Second* ]

Stall Indication ....................................................................................... Recover

**RECOVERY**

Pitch Attitude ............................................................... Reduce (Level Attitude)

Flaps ............................................................................................... Verified Up

Pitch Attitude ................................................................................ 7-10° Nose Up

Positive Rate ...................................................... Landing Gear; Verified Up

## ACCELERATED STALL (g stall)

Throttles ................................................................................................ 15" MPH

Props ..............................................................................................AS REQUIRED

Airspeed ............................................................................................. 120 MPH

Mixtures ........................................................................................................ Rich

Landing Gear .................................................................................................. Up

Flaps ............................................................................................................... Up

Bank Angle ..................................................................................................... 50°

Back Pressure .............................................................. Smoothly Increase

Stall Indication ................................................... Reduce Back Pressure

Bank Angle ........................................................................... Wings Level

## VMC DEMONSTRATION

Throttles ........................................................................................ 15-20” MP

Props ............................................................................ Full below 130 MPH

Mixtures ..................................................................................................... Rich

Airspeed ........................................................................................... 110 MPH

Landing Gear .................................................................................................. Up

Flaps ............................................................................................................... Up

Throttle Critical Engine (left) .......................................................................... Idle

Throttle Operating Engine (right) ................................................................... Max

Flight Controls ..................................................................................HOLD

***Hold aileron and rudder inputs In a neutral position***

Pitch ................................................................................................................ Up

[ *Slow Deceleration; 1 MPH per Second* ]

Directional Control Loss...............................................................20° Bank or HDG

and/or Impending Stall Indication ........................................................ Observed

**RECOVER**

Operating Engine (right) .....................................................Reduce to at least 15"

Pitch .......................................................................................................... Reduce

Wings ........................................................................................................... Level

Airspeed ........................................................................................... Blue Line

Throttle Operating Engine (right) ............................. Max; Approaching Blue Line

Directional Control .................................................................. Back to entry HDG

## DRAG DEMONSTRATION (MEI)

Throttles .......................................................... 15” MP
Props .......................................................... Full below 130 MPH
Mixtures .......................................................... Rich
Landing Gear .......................................................... Down; Below 150 MPH
Flaps .......................................................... Down; Below 130 MPH
Throttle Critical Engine (left) .......................................................... Idle
Throttle Operating Engine (right) .......................................................... Max
Airspeed .......................................................... Blue Line
VSI .......................................................... Noted (-500 fpm)
Landing Gear .......................................................... Up
Airspeed .......................................................... Blue Line
VSI .......................................................... Noted (-250 fpm)
Flaps .......................................................... Up
Airspeed .......................................................... Blue Line
VSI .......................................................... Noted (+100 fpm)
Throttle Critical Engine (left) .......................................................... Zero Thrust

[ *Prop: Full – Throttle: 1600-1800 RPM* ]

Airspeed .......................................................... Blue Line
VSI .......................................................... Noted (+400 fpm)

Chapter 5

# ENGINES & PROPELLORS

## ENGINE FIRE ON-GROUND

- Starter ........................................................................ Continue Cranking
  - Observe Starter Limitations (10 Seconds On)
  - If Engine Doesn't Start and/or Fire Persists
- Evacuation ......................................................................... Initiate

## EVACUATION

- Mixtures ......................................................................... Cut-Off
- Throttles ......................................................................... Idle
- Magnetos ......................................................................... Off
- Battery/Generators ......................................................................... Off
- Fuel Selectors ......................................................................... Off
- Evacuation ......................................................................... Initiate

## ENGINE FAILURE / FIRE IN-FLIGHT

- Power ........................................................................ Max Available
- Landing Gear ...................................................................... Up
- Flaps ................................................................................ Up
- Identify .......................................................... Malfunction L or R
- Throttle Lever .................................................... Verify L or R
- Prop Lever ................................................... Feather L or R

### Affected Engine:

- Mixture Lever ............................................................... Cut-Off

**Note:** If engine fire is confirmed and affected engine is still producing power, secure engine with mixture lever prior to feathering.

- Fuel Selector ..................................................................... Off
- Cowl Flap ....................................................................... Closed
- Boost Pump ....................................................................... Off
- Generator ........................................................................... Off
- Magnetos ........................................................................... Off

  - Land as soon as possible

If flight time on single engine is to exceed 30 minutes:

- Reference CROSSFEED (One Engine Inoperative) checklist (pg 5.3)

## ENGINE ROUGHNESS

- Mixtures ........................................................................... Rich
- Boost Pumps ....................................................................... On
- Carburetor Heat .................................................................. On
- Fuel Selectors ............................................... Verify Fuel Quantity
- Magnetos ................................................................... Verify On

## CROSSFEED (One Engine Inoperative)

- Fuel Selector Inoperative Engine ............................................ Aux / Main
- Fuel Selector Operating Engine ................................................ Crossfeed

**Note:** Fuel Crossfeed is to be used for Emergencies ONLY.

**Caution:** If both fuel selectors are set to CROSSFEED, the fuel supply for both engines is cut-off.

## ENGINE RESTART

**Caution:** The reason for engine failure should be determined before attempting an air start.

- Complete the ENGINE FAILURE / FIRE IN-FLIGHT checklist (pg 5.2)

**Affected Engine:**

- Airspeed ............................................................................ 120 MPH
- Magnetos ............................................................................ On
- Generator ............................................................................ On
- Cowl Flap ............................................................................ Closed
- Boost Pump ............................................................................ On
- Fuel Selector ............................................................................ Aux / Main
- Throttle Lever ............................................................................ Idle
- Mixture Lever ............................................................................ Rich
- Prop Lever ............................................................................ Full
- Starter ............................................................ Engage / As Required
- Warm-Up ............................................................ 15” MP, 2000 RPM

## UN-COMMANDED FEATHER

**Affected Engine:**

- Throttle Lever ........................................................................... Idle
- Prop Lever ................................................................................ Cycle
- Oil Pressure ........................................................................... Check

**Oil Pressure In Limitations & Prop Control Returned:**

YES

- Prop Lever ................................................................................. Set
- Throttle Lever ............................................................................ Set

– Land as soon as practical

**- END -**

NO

**Affected Engine:**

- Prop Lever ............................................................................ Feather
- Mixture Lever ........................................................................ Cut-Off

- Perform the ENGINE FAILURE / FIRE IN-FLIGHT checklist (pg 5.2)

**---------------- END ----------------**

Chapter 6

# FUSELAGE FIRE, SMOKE & FUME

## FUSELAGE FIRE OR SMOKE & FUME

**Source of Fire, Smoke, or Fume is known:**

NO

- Air Vents ........................................................................ Close
- Heater ..............................................................................Off
- Battery/Generators ...........................................................Off

**Fire, Smoke, or Fume is eliminated:**

YES

- Electrical Switches ........................................................ Off
- Avionics ......................................................................... Off
- Battery/Generators ............................................. As Required
- Essential Equipment ........................................... As Required
- Storm Window .................................................... As Required

- Land as soon as practical

**- END -**

NO

- Storm Window .................................................... As Required
- Emergency Descent ...................................... As Required (pg 7.1)

- Land as soon as possible

**- END -**

**CONTINUED ON NEXT PAGE**

**Source of Fire, Smoke, or Fume is known:**

♦ YES

- Aggressively eliminate the source and fight the fire.

## Electrical Fire or Smoke:

- Electrical Power Source ........................................................................ Off
- Storm Window ........................................................................ As Required

– Extinguish fire with portable fire extinguisher.

– Land as soon as practical

## Combustion Heater Fire or Smoke:

- Air Vents ........................................................................ Close
- Heater ........................................................................Off
- Storm Window ........................................................................ As Required

– Extinguish fire with portable fire extinguisher.

– Land as soon as practical

**---------------- END ----------------**

Chapter 7

# LANDING EMERGENCIES

# & LANDING GEAR

## EMERGENCY DESCENT

- Autopilot .................................................................................... Off
- Throttles .................................................................................... Idle
- Props ......................................................................................... Full
- Landing Gear ........................................................ Down (Max 150 MPH)
- Airspeed ........................................................................ Max 150 MPH
- Altitude ....................................................... As Required; note MEA/MSA

**Note:** In the event of a dual engine failure the best glide speed (Vg) is 120 MPH, with both props feathered and landing gear / flaps retracted. The glide ratio is 2 ½ Miles for every 1,000' of ALT.

## LANDING GEAR EXTENSION MALFUNCTION

**Gear Unsafe Indications include:**

- No Green GEAR DOWN indicator light illuminated
- Gear Mechanical Indicator not indicating down
- Visual Confirmation of unsafe condition in Gear Mirror

**Caution:** Following any gear malfunction, once down and locked, do not retract the gear unless necessary for safety of flight.

- Landing Gear Relay C/B ............................................................ Verify In
- Landing GEAR DOWN Light ................................................ Push to Test

If Light is inop:

- Attempt to tighten the light assembly
- Verify dimming iris is open
- Replace of swap bulbs to confirm indication

CONTINUED ON NEXT PAGE

## LANDING GEAR EXTENSION MALFUNCTION (cont'd)

**Green GEAR DOWN Indication / Mechanical Down Indication:**

YES

- No Further action required

**- END -**

NO

**Note:** If extension was normal (sounds, feel, gen load, performance, motor stops, etc.) with the exception of the down and locked indication:

- Gear may be cycled once at PIC's discretion

**Green GEAR DOWN Indication / Mechanical Down Indication:**

YES

- No Further action required

**- END -**

NO

- Perform MANUAL GEAR EXTENSION checklist (pg 7.3)

**---------------- END ----------------**

## MANUAL GEAR EXTENSION

**Warning:** Keep cranking until the physical limit of the handle is reached. DO NOT rely on the green indicator light, as the gear may be down but not fully locked in this condition.

**Warning:** If the gear is manually extended in an actual emergency situation, DO NOT move any landing gear controls or reset any circuit breakers until the aircraft is on jacks, as the failure may be in the gear-up circuit. This could cause the gear to retract on the ground .

**Caution:** The manual extension system is designed only to lower the landing gear. DO NOT attempt to retract the landing gear manually.

- Landing Gear Relay C/B .............................................................. Pull
- Landing Gear Handle ................................................................ Down
- Handcrank .......................................................... Engage / Turn CC

**Note:** Pull Handcrank out to engage manual extension and turn the crank counter-clockwise about 50 turns; verify with mechanical indicator.

## LANDING GEAR RETRACTION
## (AFTER PRACTICE MANUAL EXTENSION)

- Handcrank ........................................................................... Stowed
- Landing Gear Relay C/B .................................................................. In
- Landing Gear Handle .................................................................... Up

**Caution:** DO NOT operate the landing gear electrically with the Handcrank engaged, damage to the mechanism could occur rendering the manual gear extension system inoperative.

# EMERGENCY LANDINGS

## Landing with an Unsafe Landing Gear Indication:

**Note:** Assumes completion of LANDING GEAR EXTENSION MALFUNCTION (pg 7.1) and MANUAL GEAR EXTENSION (pg 7.3) checklists.

- Emergency Briefing ............................................................. Complete
- Loose Equipment ..................................................................... Secured
- Seat Belts ............................................................................... Fastened
- Non-Essential Electrical Equipment ...................................................... Off
- Cabin Door ............................................................... Unlocked / Cracked

***Prior to touchdown unlock and hold cabin door slightly open***

## Landing Considerations:

- Fly a normal approach to touchdown
- Alert emergency services if available
- Notify airfield of intentions to shutdown on runway
- Arrange maintenance / tow services if available

If Landing Gear does NOT collapse:

- Stop straight ahead with minimal use of brakes
- Shutdown and chock the nose wheel
- Avoid going under Aircraft
- Do not move Aircraft until gear are conformed locked

If Landing Gear collapses:

- Maintain directional control with rudder and differential braking
- Perform EVACUATION procedure (pg 5.1)

**Note:** Move the Mixtures to Cut-Off as soon as the landing gear starts to collapse to minimize damage to aircraft.

## Gear-Up Landing:

**Note:** Assumes completion of LANDING GEAR EXTENSION MALFUNCTION (pg 7.1) and MANUAL GEAR EXTENSION (pg 7.3) checklists.

- Emergency Briefing ........................................................... Complete
- Loose Equipment ........................................................... Secured
- Seat Belts ........................................................... Fastened
- Non-Essential Electrical Equipment ........................................... Off
- Cabin Door ........................................................... Unlocked / Cracked

***Prior to touchdown unlock and hold cabin door slightly open***

## Landing Considerations:

- Fly a normal approach to touchdown
- Alert emergency services if available

### Landing Assured and Long Runway:

- Mixtures ........................................................... Cut-Off
- Props ........................................................... Feather
- Magnetos ........................................................... Off
- Fuel Selectors ........................................................... Off
- Starters ........................................ Bump to Horizontal the Propellers
- Battery / Generators ........................................................... Off
  - Evacuate once Aircraft has come to a complete stop

### Landing Assured and Short Runway:

- Mixtures ........................................................... Cut-Off
- Magnetos ........................................................... Off
- Fuel Selectors ........................................................... Off
- Battery / Generators ........................................................... Off
  - Evacuate once Aircraft has come to a complete stop

U.S. Department
of Transportation

**Federal Aviation Administration**

**FAA-S-ACS-7A**
**(with Change 1)**

# Commercial Pilot – Airplane
## Airman Certification Standards

Abbreviated version
This ACS only shows the events required for a commercial AMEL add-on rating

**June 2018**

All skill elements required to be evaluated are highlighted in yellow

**Flight Standards Service**
**Washington, DC 20591**

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***Addition of an Airplane Multiengine Land Rating to an existing Commercial Pilot Certificate***

Required Tasks are indicated by either the Task letter(s) that apply(s) or an indication that all or none of the Tasks must be tested based on the notes in each Area of Operation.

**Commercial Pilot Rating(s) Held**

| Areas of Operation | ASEL | ASES | AMES | RH | RG | PL | Glider | Balloon | Airship |
|---|---|---|---|---|---|---|---|---|---|
| **I** | F,G | F,G | F,G | F,G | F,G | F,G | D,F,G | D,F,G | F,G |
| **II** | A,B,C,D, F | A,B,C,D, F | A,D | A,B,C,D, F | A,B,C,D, F | A,B,C,D, F | A,B,C,D, F | A,B,C,D, F | A,B,C,D, F |
| **III** | None | B | B | B | D,F | B | B | B | B |
| **IV** | A,B,E,F | A,B,E,F | A,B,E,F | A,B,E,F, N | B | A,B,E,F, N | A,B,E,F, N | A,B,E,F, N | A,B,E,F, N |
| **V** | A | A | None | A | A, | A | A | A | A |
| **VI** | None | None | None | None | A | None | All | All | None |
| **VII** | All | All | None | All | All | All | All | All | All |
| **VIII** | None | None | None | All | All | None | All | All | All |
| **IX** | E,F,G | E,F,G | None | A,C,E,F, G | A,C,E,F, G | A,C,E,F, G | A,C,E,F, G | A,C,E,F, G | A,C,E,F, G |
| **X*** | All | All | None | All | All | All | All | All | All |
| **XI** | None | A | A | A | A | A | A | A | A |

Tap on each link to see the specific skills you will be required to demonstrate during the checkride/practical test

* Tasks C and D are not required for applicants who are instrument-rated and who have previously demonstrated instrument proficiency in a multiengine airplane or for applicants who do not hold an instrument rating.

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## I. Preflight Preparation

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|---|---|
| **Task** | ***F. Performance and Limitations*** |
| **References** | FAA-H-8083-1, FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating an airplane safely within the parameters of its performance capabilities and limitations. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.I.F.K1* | Elements related to performance and limitations by explaining the use of charts, tables, and data to determine performance. |
| *CA.I.F.K2* | Factors affecting performance, to include: |
| *CA.I.F.K2a* | a. Atmospheric conditions |
| *CA.I.F.K2b* | b. Pilot technique |
| *CA.I.F.K2c* | c. Airplane configuration |
| *CA.I.F.K2d* | d. Airport environment |
| *CA.I.F.K2e* | e. Loading (e.g., center of gravity) |
| *CA.I.F.K2f* | f. Weight and balance |
| *CA.I.F.K3* | Aerodynamics. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.I.F.R1* | Inaccurate use of manufacturer's performance charts, tables, and data. |
| *CA.I.F.R2* | Exceeding airplane limitations. |
| *CA.I.F.R3* | Possible differences between calculated performance and actual performance. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.I.F.S1* | Compute the weight and balance, correct out-of-center of gravity (CG) loading errors and determine if the weight and balance remains within limits during all phases of flight. |
| *CA.I.F.S2* | Utilize the appropriate airplane manufacturer's approved performance charts, tables, and data. |

## I. Preflight Preparation

| | |
|---|---|
| **Task** | ***G. Operation of Systems*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-23, FAA-H-8083-25; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with the safe operation of systems on the airplane provided for the flight test. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.I.G.K1* | Airplane systems, to include:<br>***Note:*** *If K1 is selected, the evaluator must assess the applicant's knowledge of at least three of the following sub-elements.* |
| *CA.I.G.K1a* | a. Primary flight controls |
| *CA.I.G.K1b* | b. Secondary flight controls |
| *CA.I.G.K1c* | c. Powerplant and propeller |
| *CA.I.G.K1d* | d. Landing gear |
| *CA.I.G.K1e* | e. Fuel, oil, and hydraulic |
| *CA.I.G.K1f* | f. Electrical |
| *CA.I.G.K1g* | g. Avionics |
| *CA.I.G.K1h* | h. Pitot-static, vacuum/pressure, and associated flight instruments |
| *CA.I.G.K1i* | i. Environmental |
| *CA.I.G.K1j* | j. Deicing and anti-icing |
| *CA.I.G.K1k* | k. Water rudders (ASES, AMES) |
| *CA.I.G.K1l* | l. Oxygen system |
| *CA.I.G.K2* | Indications of and procedures for managing system abnormalities or failures. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.I.G.R1* | Failure to detect system malfunctions or failures. |
| *CA.I.G.R2* | Improper management of a system failure. |
| *CA.I.G.R3* | Failure to monitor and manage automated systems. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.I.G.S1* | Operate at least three of the systems listed in K1a through K1l above, appropriately. |
| *CA.I.G.S2* | Use appropriate checklists properly. |

## II. Preflight Procedures

| | |
|---|---|
| **Task** | ***A. Preflight Assessment*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-23; POH/AFM; AC 00-6 |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with preparing for safe flight. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.II.A.K1* | Pilot self-assessment. |
| *CA.II.A.K2* | Determining that the airplane to be used is appropriate and airworthy. |
| *CA.II.A.K3* | Airplane preflight inspection including: |
| *CA.II.A.K3a* | a. Which items must be inspected |
| *CA.II.A.K3b* | b. The reasons for checking each item |
| *CA.II.A.K3c* | c. How to detect possible defects |
| *CA.II.A.K3d* | d. The associated regulations |
| *CA.II.A.K4* | Environmental factors including weather, terrain, route selection, and obstructions. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.II.A.R1* | Pilot. |
| *CA.II.A.R2* | Aircraft. |
| *CA.II.A.R3* | Environment (e.g., weather, airports, airspace, terrain, obstacles). |
| *CA.II.A.R4* | External pressures. |
| *CA.II.A.R5* | Aviation security concerns. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.II.A.S1* | Inspect the airplane with reference to an appropriate checklist. |
| *CA.II.A.S2* | Verify the airplane is in condition for safe flight and conforms to its type design. |

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## II. Preflight Procedures

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|---|---|
| **Task** | ***B. Flight Deck Management*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3; AC 120-71; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with safe flight deck management practices. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.II.B.K1* | Passenger briefing requirements, to include operation and required use of safety restraint systems. |
| *CA.II.B.K2* | Use of appropriate checklists. |
| *CA.II.B.K3* | Requirements for current and appropriate navigation data. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.II.B.R1* | Improper use of systems or equipment, to include automation and portable electronic devices. |
| *CA.II.B.R2* | Flying with unresolved discrepancies. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.II.B.S1* | Secure all items in the flight deck and cabin. |
| *CA.II.B.S2* | Conduct an appropriate pre-takeoff briefing, to include identifying the PIC, use of safety belts, shoulder harnesses, doors, sterile flight deck, and emergency procedures. |
| *CA.II.B.S3* | Program and manage the airplane’s automation properly. |

| Task | *C. Engine Starting* |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with recommended engine starting procedures. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.II.C.K1* | Starting under various conditions. |
| *CA.II.C.K2* | Starting the engine(s) by use of external power. |
| *CA.II.C.K3* | Engine limitations as they relate to starting. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.II.C.R1* | Propeller safety. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.II.C.S1* | Position the airplane properly considering structures, other aircraft, wind, and the safety of nearby persons and property. |
| *CA.II.C.S2* | Complete the appropriate checklist. |

| Task | *D. Taxiing (ASEL, AMEL)* |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM; AC 91-73; Chart Supplements; AIM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with safe taxi operations, including runway incursion avoidance. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.II.D.K1* | Current airport aeronautical references and information resources such as the Chart Supplement, airport diagram, and NOTAMS. |
| *CA.II.D.K2* | Taxi instructions/clearances. |
| *CA.II.D.K3* | Airport markings, signs, and lights. |
| *CA.II.D.K4* | Visual indicators for wind. |
| *CA.II.D.K5* | Aircraft lighting. |
| *CA.II.D.K6* | Procedures for: |
| *CA.II.D.K6a* | a. Appropriate flight deck activities prior to taxi, including route planning and identifying the location of Hot Spots |
| *CA.II.D.K6b* | b. Radio communications at towered and nontowered airports. |
| *CA.II.D.K6c* | c. Entering or crossing runways |
| *CA.II.D.K6d* | d. Night taxi operations |
| *CA.II.D.K6e* | e. Low visibility taxi operations |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.II.D.R1* | Inappropriate activities and distractions. |
| *CA.II.D.R2* | Confirmation or expectation bias as related to taxi instructions. |
| *CA.II.D.R3* | A taxi route or departure runway change. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.II.D.S1* | Receive and correctly read back clearances/instructions, if applicable. |
| *CA.II.D.S2* | Use an airport diagram or taxi chart during taxi, if published, and maintain situational awareness. |
| *CA.II.D.S3* | Position the flight controls for the existing wind. |
| *CA.II.D.S4* | Complete the appropriate checklist. |
| *CA.II.D.S5* | Perform a brake check immediately after the airplane begins moving. |
| *CA.II.D.S6* | Maintain positive control of the airplane during ground operations by controlling direction and speed without excessive use of brakes. |
| *CA.II.D.S7* | Comply with airport/taxiway markings, signals, and ATC clearances and instructions. |
| *CA.II.D.S8* | Position the airplane properly relative to hold lines. |

| Task | *G. Approach and Landing with an Inoperative Engine (Simulated) (AMEL, AMES)* |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3; FAA-P-8740-66; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with an approach and landing with an engine inoperative, including engine failure on final approach.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.IX.G.K1* | Factors affecting $V_{MC}$. |
| *CA.IX.G.K2* | $V_{MC}$ (red line) and $V_{YSE}$ (blue line). |
| *CA.IX.G.K3* | How to identify, verify, feather, and secure an inoperative engine. |
| *CA.IX.G.K4* | Importance of drag reduction, to include propeller feathering, gear and flap retraction, the manufacturer's recommended flight control input and its relation to zero sideslip. |
| *CA.IX.G.K5* | Applicant responsibilities during simulated feathering. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.IX.G.R1* | Failure to plan for engine failure inflight or during an approach. |
| *CA.IX.G.R2* | Collision hazards, to include aircraft, terrain, obstacles, and wires. |
| *CA.IX.G.R3* | Improper airplane configuration. |
| *CA.IX.G.R4* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.IX.G.R5* | Distractions, loss of situational awareness, or improper task management. |
| *CA.IX.G.R6* | Possible single-engine go-around. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.IX.G.S1* | Promptly recognize an engine failure and maintain positive aircraft control. |
| *CA.IX.G.S2* | Set the engine controls, reduce drag, identify and verify the inoperative engine, and simulate feathering of the propeller on the inoperative engine. (Evaluator should then establish zero thrust on the inoperative engine). |
| *CA.IX.G.S3* | Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required. |
| *CA.IX.G.S4* | Follow the manufacturer's recommended emergency procedures. |
| *CA.IX.G.S5* | Monitor the operating engine and make adjustments as necessary. |
| *CA.IX.G.S6* | Maintain the manufacturer's recommended approach airspeed ±5 knots in the landing configuration with a stabilized approach, until landing is assured. |
| *CA.IX.G.S7* | Make smooth, timely, and correct control application before, during, and after round out and touchdown. |
| *CA.IX.G.S8* | Touch down on the first one-third of available runway/landing surface, with no drift, and the airplane's longitudinal axis aligned with and over the runway center or landing path. |
| *CA.IX.G.S9* | Maintain directional control and appropriate crosswind correction throughout the approach and landing. |
| *CA.IX.G.S10* | Complete the appropriate checklist. |

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| **Task** | ***F. Before Takeoff Check*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-23; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with the before takeoff check. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.II.F.K1* | Purpose of pre-takeoff checklist items including: |
| *CA.II.F.K1a* | a. Reasons for checking each item |
| *CA.II.F.K1b* | b. Detecting malfunctions |
| *CA.II.F.K1c* | c. Ensuring the airplane is in safe operating condition as recommended by the manufacturer |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.II.F.R1* | Division of attention while conducting pre-flight checks. |
| *CA.II.F.R2* | Unexpected runway changes by ATC. |
| *CA.II.F.R3* | Wake turbulence. |
| *CA.II.F.R4* | A powerplant failure during takeoff or other malfunction considering operational factors such as airplane characteristics, runway/takeoff path length, surface conditions, environmental conditions, and obstructions. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.II.F.S1* | Review takeoff performance. |
| *CA.II.F.S2* | Complete the appropriate checklist. |
| *CA.II.F.S3* | Position the airplane appropriately considering other aircraft, vessels, and wind. |
| *CA.II.F.S4* | Divide attention inside and outside the flight deck. |
| *CA.II.F.S5* | Verify that engine parameters and airplane configuration are suitable. |

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## IV. Takeoffs, Landings, and Go-Arounds

| | |
|---|---|
| **Task** | ***A. Normal Takeoff and Climb*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-23; POH/AFM; AIM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a normal takeoff, climb operations, and rejected takeoff procedures.<br>***Note:*** *If a crosswind condition does not exist, the applicant's knowledge of crosswind elements must be evaluated through oral testing.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.IV.A.K1* | Effects of atmospheric conditions, including wind, on takeoff and climb performance. |
| *CA.IV.A.K2* | $V_X$ and $V_Y$. |
| *CA.IV.A.K3* | Appropriate airplane configuration. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.IV.A.R1* | Selection of runway based on pilot capability, airplane performance and limitations, available distance, and wind. |
| *CA.IV.A.R2* | Effects of: |
| *CA.IV.A.R2a* | a. Crosswind |
| *CA.IV.A.R2b* | b. Windshear |
| *CA.IV.A.R2c* | c. Tailwind |
| *CA.IV.A.R2d* | d. Wake turbulence |
| *CA.IV.A.R2e* | e. Runway surface/condition |
| *CA.IV.A.R3* | Abnormal operations, to include planning for: |
| *CA.IV.A.R3a* | a. Rejected takeoff |
| *CA.IV.A.R3b* | b. Engine failure in takeoff/climb phase of flight |
| *CA.IV.A.R4* | Collision hazards, to include aircraft, terrain, obstacles, wires, vehicles, vessels, persons, and wildlife. |
| *CA.IV.A.R5* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.IV.A.R6* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.IV.A.S1* | Complete the appropriate checklist. |
| *CA.IV.A.S2* | Make radio calls as appropriate. |
| *CA.IV.A.S3* | Verify assigned/correct runway. |
| *CA.IV.A.S4* | Ascertain wind direction with or without visible wind direction indicators. |
| *CA.IV.A.S5* | Position the flight controls for the existing wind. |
| *CA.IV.A.S6* | Clear the area; taxi into takeoff position and align the airplane on the runway centerline (ASEL, AMEL) or takeoff path (ASES, AMES). |
| *CA.IV.A.S7* | Confirm takeoff power and proper engine and flight instrument indications prior to rotation (ASEL, AMEL). |
| *CA.IV.A.S8* | Avoid excessive water spray on the propeller(s) (ASES, AMES). |
| *CA.IV.A.S9* | Rotate and lift off at the recommended airspeed and accelerate to $V_Y$. |
| *CA.IV.A.S10* | Retract the water rudders, as appropriate, establish and maintain the most efficient planing/liftoff attitude, and correct for porpoising and skipping (ASES, AMES). |
| *CA.IV.A.S11* | Establish a pitch attitude to maintain the manufacturer's recommended speed or $V_Y$, ±5 knots. |
| *CA.IV.A.S12* | Configure the airplane in accordance with manufacturer's guidance. |
| *CA.IV.A.S13* | Maintain $V_Y$ ±5 knots to a safe maneuvering altitude. |
| *CA.IV.A.S14* | Maintain directional control and proper wind-drift correction throughout takeoff and climb. |
| *CA.IV.A.S15* | Comply with noise abatement procedures. |

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| **Task** | ***B. Normal Approach and Landing*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-23; POH/AFM; AIM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a normal approach and landing with emphasis on proper use and coordination of flight controls.<br>***Note:*** *If a crosswind condition does not exist, the applicant's knowledge of crosswind elements must be evaluated through oral testing.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.IV.B.K1* | A stabilized approach, to include energy management concepts. |
| *CA.IV.B.K2* | Effects of atmospheric conditions, including wind, on approach and landing performance. |
| *CA.IV.B.K3* | Wind correction techniques on approach and landing. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.IV.B.R1* | Selection of runway or approach path and touchdown area based on pilot capability, airplane performance and limitations, available distance, and wind. |
| *CA.IV.B.R2* | Effects of: |
| *CA.IV.B.R2a* | a. Crosswind |
| *CA.IV.B.R2b* | b. Windshear |
| *CA.IV.B.R2c* | c. Tailwind |
| *CA.IV.B.R2d* | d. Wake turbulence |
| *CA.IV.B.R2e* | e. Runway surface/condition |
| *CA.IV.B.R3* | Planning for: |
| *CA.IV.B.R3a* | a. Go-around and rejected landing |
| *CA.IV.B.R3b* | b. Land and hold short operations (LAHSO) |
| *CA.IV.B.R4* | Collision hazards, to include aircraft, terrain, obstacles, wires, vehicles, vessels, persons, and wildlife. |
| *CA.IV.B.R5* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.IV.B.R6* | Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.IV.B.S1* | Complete the appropriate checklist. |
| *CA.IV.B.S2* | Make radio calls as appropriate. |
| *CA.IV.B.S3* | Ensure the airplane is aligned with the correct/assigned runway or landing surface. |
| *CA.IV.B.S4* | Scan the runway or landing surface and adjoining area for traffic and obstructions. |
| *CA.IV.B.S5* | Select and aim for a suitable touchdown point considering the wind, landing surface, and obstructions. |
| *CA.IV.B.S6* | Establish the recommended approach and landing configuration and airspeed, and adjust pitch attitude and power as required to maintain a stabilized approach. |
| *CA.IV.B.S7* | Maintain manufacturer's published approach airspeed or in its absence not more than 1.3 $V_{SO}$, ±5 knots with gust factor applied. |
| *CA.IV.B.S8* | Maintain directional control and appropriate crosswind correction throughout the approach and landing. |
| *CA.IV.B.S9* | Make smooth, timely, and correct control application during round out and touchdown. |
| *CA.IV.B.S10* | Touch down at a proper pitch attitude, within 200 feet beyond or on the specified point, with no side drift, and with the airplane's longitudinal axis aligned with and over the runway center/landing path. |
| *CA.IV.B.S11* | Execute a timely go-around if the approach cannot be made within the tolerances specified above or for any other condition that may result in an unsafe approach or landing. |
| *CA.IV.B.S12* | Utilize runway incursion avoidance procedures. |

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| **Task** | ***E. Short-Field Takeoff and Maximum Performance Climb (ASEL, AMEL)*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3; POH/AFM; AIM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a short-field takeoff, maximum performance climb operations, and rejected takeoff procedures. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.IV.E.K1* | Effects of atmospheric conditions, including wind, on takeoff and climb performance. |
| *CA.IV.E.K2* | $V_X$ and $V_Y$. |
| *CA.IV.E.K3* | Appropriate airplane configuration. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.IV.E.R1* | Selection of runway based on pilot capability, airplane performance and limitations, available distance, and wind. |
| *CA.IV.E.R2* | Effects of: |
| *CA.IV.E.R2a* | a. Crosswind |
| *CA.IV.E.R2b* | b. Windshear |
| *CA.IV.E.R2c* | c. Tailwind |
| *CA.IV.E.R2d* | d. Wake turbulence |
| *CA.IV.E.R2e* | e. Runway surface/condition |
| *CA.IV.E.R3* | Abnormal operations, to include planning for: |
| *CA.IV.E.R3a* | a. Rejected takeoff |
| *CA.IV.E.R3b* | b. Engine failure in takeoff/climb phase of flight |
| *CA.IV.E.R4* | Collision hazards, to include aircraft, terrain, obstacles, wires, vehicles, persons, and wildlife. |
| *CA.IV.E.R5* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.IV.E.R6* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.IV.E.S1* | Complete the appropriate checklist. |
| *CA.IV.E.S2* | Make radio calls as appropriate. |
| *CA.IV.E.S3* | Verify assigned/correct runway. |
| *CA.IV.E.S4* | Ascertain wind direction with or without visible wind direction indicators. |
| *CA.IV.E.S5* | Position the flight controls for the existing wind. |
| *CA.IV.E.S6* | Clear the area, taxi into takeoff position and align the airplane on the runway centerline utilizing maximum available takeoff area. |
| *CA.IV.E.S7* | Apply brakes while setting engine power to achieve maximum performance. |
| *CA.IV.E.S8* | Confirm takeoff power prior to brake release and verify proper engine and flight instrument indications prior to rotation. |
| *CA.IV.E.S9* | Rotate and lift off at the recommended airspeed and accelerate to the recommended obstacle clearance airspeed or $V_X$, ±5 knots. |
| *CA.IV.E.S10* | Establish a pitch attitude that will maintain the recommended obstacle clearance airspeed or $V_X$, ±5 knots until the obstacle is cleared or until the airplane is 50 feet above the surface. |
| *CA.IV.E.S11* | Establish a pitch attitude for $V_Y$ and accelerate to $V_Y$ ±5 knots after clearing the obstacle or at 50 feet AGL if simulating an obstacle. |
| *CA.IV.E.S12* | Configure the airplane in accordance with the manufacturer's guidance after a positive rate of climb has been verified. |
| *CA.IV.E.S13* | Maintain $V_Y$ ±5 knots to a safe maneuvering altitude. |
| *CA.IV.E.S14* | Maintain directional control and proper wind-drift correction throughout takeoff and climb. |
| *CA.IV.E.S15* | Comply with noise abatement procedures. |

| Task | *F. Short-Field Approach and Landing (ASEL, AMEL)* |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3; POH/AFM; AIM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a short-field approach and landing with emphasis on proper use and coordination of flight controls. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.IV.F.K1* | A stabilized approach, to include energy management concepts. |
| *CA.IV.F.K2* | Effects of atmospheric conditions, including wind, on approach and landing performance. |
| *CA.IV.F.K3* | Wind correction techniques on approach and landing. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.IV.F.R1* | Selection of runway based on pilot capability, airplane performance and limitations, available distance, and wind. |
| *CA.IV.F.R2* | Effects of: |
| *CA.IV.F.R2a* | a. Crosswind |
| *CA.IV.F.R2b* | b. Windshear |
| *CA.IV.F.R2c* | c. Tailwind |
| *CA.IV.F.R2d* | d. Wake turbulence |
| *CA.IV.F.R2e* | e. Runway surface/condition |
| *CA.IV.F.R3* | Planning for: |
| *CA.IV.F.R3a* | a. Go-around and rejected landing |
| *CA.IV.F.R3b* | b. Land and hold short operations (LAHSO) |
| *CA.IV.F.R4* | Collision hazards, to include aircraft, terrain, obstacles, wires, vehicles, persons, and wildlife. |
| *CA.IV.F.R5* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.IV.F.R6* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.IV.F.S1* | Complete the appropriate checklist. |
| *CA.IV.F.S2* | Make radio calls as appropriate. |
| *CA.IV.F.S3* | Ensure the airplane is aligned with the correct/assigned runway. |
| *CA.IV.F.S4* | Scan the landing runway and adjoining area for traffic and obstructions. |
| *CA.IV.F.S5* | Select and aim for a suitable touchdown point considering the wind, landing surface, and obstructions. |
| *CA.IV.F.S6* | Establish the recommended approach and landing configuration and airspeed, and adjust pitch attitude and power as required to maintain a stabilized approach. |
| *CA.IV.F.S7* | Maintain manufacturer's published approach airspeed or in its absence not more than 1.3 $V_{SO}$, ±5 knots with wind gust factor applied. |
| *CA.IV.F.S8* | Maintain directional control and appropriate crosswind correction throughout the approach and landing. |
| *CA.IV.F.S9* | Make smooth, timely, and correct control application during the round out and touchdown. |
| *CA.IV.F.S10* | Touch down at a proper pitch attitude within 100 feet beyond or on the specified point, threshold markings, or runway numbers, with no side drift, minimum float, and with the airplane's longitudinal axis aligned with and over runway centerline. |
| *CA.IV.F.S11* | Use manufacturer's recommended procedures for airplane configuration and braking. |
| *CA.IV.F.S12* | Execute a timely go-around if the approach cannot be made within the tolerances specified above or for any other condition that may result in an unsafe approach or landing. |
| *CA.IV.F.S13* | Utilize runway incursion avoidance procedures. |

## V. Performance and Ground Reference Maneuvers

| | |
|---|---|
| **Task** | ***A. Steep Turns*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with steep turns.<br>***Note:*** *See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.V.A.K1* | Purpose of steep turns. |
| *CA.V.A.K2* | Aerodynamics associated with steep turns, to include: |
| *CA.V.A.K2a* | a. Coordinated and uncoordinated flight |
| *CA.V.A.K2b* | b. Overbanking tendencies |
| *CA.V.A.K2c* | c. Maneuvering speed, including the impact of weight changes |
| *CA.V.A.K2d* | d. Load factor and accelerated stalls |
| *CA.V.A.K2e* | e. Rate and radius of turn |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.V.A.R1* | Failure to divide attention between airplane control and orientation. |
| *CA.V.A.R2* | Collision hazards, to include aircraft and terrain. |
| *CA.V.A.R3* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.V.A.R4* | Distractions, improper task management, loss of situational awareness, or disorientation. |
| *CA.V.A.R5* | Failure to maintain coordinated flight. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.V.A.S1* | Clear the area. |
| *CA.V.A.S2* | Establish the manufacturer's recommended airspeed; or if one is not available, an airspeed not to exceed $V_A$. |
| *CA.V.A.S3* | Roll into a coordinated 360° steep turn with approximately a 50° bank. |
| *CA.V.A.S4* | Perform the Task in the opposite direction. |
| *CA.V.A.S5* | Maintain the entry altitude ±100 feet, airspeed ±10 knots, bank ±5°, and roll out on the entry heading ±10°. |

## VII. Slow Flight and Stalls

| Task | *A. Maneuvering During Slow Flight* |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with maneuvering during slow flight.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.VII.A.K1* | Aerodynamics associated with slow flight in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.VII.A.R1* | Inadvertent slow flight and flight with a stall warning, which could lead to loss of control. |
| *CA.VII.A.R2* | Range and limitations of stall warning indicators (e.g., aircraft buffet, stall horn, etc.). |
| *CA.VII.A.R3* | Failure to maintain coordinated flight. |
| *CA.VII.A.R4* | Effect of environmental elements on airplane performance (e.g., turbulence, microbursts, and high-density altitude). |
| *CA.VII.A.R5* | Collision hazards, to include aircraft, terrain, obstacles, and wires. |
| *CA.VII.A.R6* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.VII.A.S1* | Clear the area. |
| *CA.VII.A.S2* | Select an entry altitude that will allow the Task to be completed no lower than 1,500 feet AGL (ASEL, ASES) **or** 3,000 feet AGL (AMEL, AMES). |
| *CA.VII.A.S3* | Establish and maintain an airspeed at which any further increase in angle of attack, increase in load factor, or reduction in power, would result in a stall warning (e.g., airplane buffet, stall horn, etc.). |
| *CA.VII.A.S4* | Accomplish coordinated straight-and-level flight, turns, climbs, and descents with the aircraft configured as specified by the evaluator without a stall warning (e.g., airplane buffet, stall horn, etc.). |
| *CA.VII.A.S5* | Maintain the specified altitude, ±50 feet; specified heading, ±10°; airspeed, +5/-0 knots; and specified angle of bank, ±5°. |

| Task | ***B. Power-Off Stalls*** |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power-off stalls.<br>***Note:*** *See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.VII.B.K1* | Aerodynamics associated with stalls in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects. |
| *CA.VII.B.K2* | Stall characteristics (i.e., airplane design) and impending stall and full stall indications (i.e., how to recognize by sight, sound, or feel). |
| *CA.VII.B.K3* | Factors and situations that can lead to a power-off stall and actions that can be taken to prevent it. |
| *CA.VII.B.K4* | Fundamentals of stall recovery. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.VII.B.R1* | Factors and situations that could lead to an inadvertent power-off stall, spin, and loss of control. |
| *CA.VII.B.R2* | Range and limitations of stall warning indicators (e.g., airplane buffet, stall horn, etc.). |
| *CA.VII.B.R3* | Failure to recognize and recover at the stall warning during normal operations. |
| *CA.VII.B.R4* | Improper stall recovery procedure. |
| *CA.VII.B.R5* | Secondary stalls, accelerated stalls, and cross-control stalls. |
| *CA.VII.B.R6* | Effect of environmental elements on airplane performance related to power-off stalls (e.g., turbulence, microbursts, and high-density altitude). |
| *CA.VII.B.R7* | Collision hazards, to include aircraft, terrain, obstacles, and wires. |
| *CA.VII.B.R8* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.VII.B.S1* | Clear the area. |
| *CA.VII.B.S2* | Select an entry altitude that will allow the Task to be completed no lower than 1,500 feet AGL (ASEL, ASES) or 3,000 feet AGL (AMEL, AMES). |
| *CA.VII.B.S3* | Configure the airplane in the approach or landing configuration, as specified by the evaluator, and maintain coordinated flight throughout the maneuver. |
| *CA.VII.B.S4* | Establish a stabilized descent. |
| *CA.VII.B.S5* | Transition smoothly from the approach or landing attitude to a pitch attitude that will induce a stall. |
| *CA.VII.B.S6* | Maintain a specified heading, ±10° if in straight flight; maintain a specified angle of bank not to exceed 20°, ±5°, if in turning flight, until an impending or full stall occurs, as specified by the evaluator. |
| *CA.VII.B.S7* | Acknowledge the cues at the first indication of a stall (e.g., airplane buffet, stall horn, etc.). |
| *CA.VII.B.S8* | Recover at the first indication of a stall or after a full stall has occurred, as specified by the evaluator. |
| *CA.VII.B.S9* | Configure the airplane as recommended by the manufacturer, and accelerate to $V_X$ or $V_Y$. |
| *CA.VII.B.S10* | Return to the altitude, heading, and airspeed specified by the evaluator. |

| Task | ***C. Power-On Stalls*** |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power-on stalls.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.VII.C.K1* | Aerodynamics associated with stalls in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects. |
| *CA.VII.C.K2* | Stall characteristics (i.e., airplane design) and impending stall and full stall indications (i.e., how to recognize by sight, sound, or feel). |
| *CA.VII.C.K3* | Factors and situations that can lead to a power-on stall and actions that can be taken to prevent it. |
| *CA.VII.C.K4* | Fundamentals of stall recovery. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.VII.C.R1* | Factors and situations that could lead to an inadvertent power-on stall, spin, and loss of control. |
| *CA.VII.C.R2* | Range and limitations of stall warning indicators (e.g., airplane buffet, stall horn, etc.). |
| *CA.VII.C.R3* | Failure to recognize and recover at the stall warning during normal operations. |
| *CA.VII.C.R4* | Improper stall recovery procedure. |
| *CA.VII.C.R5* | Secondary stalls, accelerated stalls, elevator trim stalls, and cross-control stalls. |
| *CA.VII.C.R6* | Effect of environmental elements on airplane performance related to power-on stalls (e.g., turbulence, microbursts, and high-density altitude). |
| *CA.VII.C.R7* | Collision hazards, to include aircraft, terrain, obstacles, and wires. |
| *CA.VII.C.R8* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.VII.C.S1* | Clear the area. |
| *CA.VII.C.S2* | Select an entry altitude that will allow the Task to be completed no lower than 1,500 feet AGL (ASEL, ASES) or 3,000 feet AGL (AMEL, AMES). |
| *CA.VII.C.S3* | Establish the takeoff, departure, or cruise configuration, as specified by the evaluator, and maintain coordinated flight throughout the maneuver. |
| *CA.VII.C.S4* | Set power (as assigned by the evaluator) to no less than 65 percent power. |
| *CA.VII.C.S5* | Transition smoothly from the takeoff or departure attitude to the pitch attitude that will induce a stall. |
| *CA.VII.C.S6* | Maintain a specified heading ±10° if in straight flight; maintain a specified angle of bank not to exceed 20°, ±10° if in turning flight, until an impending or full stall is reached, as specified by the evaluator. |
| *CA.VII.C.S7* | Acknowledge the cues at the first indication of a stall (e.g., airplane buffet, stall horn, etc.). |
| *CA.VII.C.S8* | Recover at the first indication of a stall or after a full stall has occurred, as specified by the evaluator. |
| *CA.VII.C.S9* | Configure the airplane as recommended by the manufacturer, and accelerate to $V_X$ or $V_Y$. |
| *CA.VII.C.S10* | Return to the altitude, heading, and airspeed specified by the evaluator. |

| | |
|---|---|
| **Task** | ***D. Accelerated Stalls*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management related to accelerated (power-on or power-off) stalls.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.VII.D.K1* | Aerodynamics associated with accelerated stalls in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects. |
| *CA.VII.D.K2* | Stall characteristics (i.e., airplane design), impending stall, and full stall indications (i.e., how to recognize by sight, sound, or feel). |
| *CA.VII.D.K3* | Factors and situations that can lead to an accelerated stall and actions that can be taken to prevent it. |
| *CA.VII.D.K4* | Fundamentals of stall recovery. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.VII.D.R1* | Factors and situations that could lead to an inadvertent accelerated stall, spin, and loss of control. |
| *CA.VII.D.R2* | Range and limitations of stall warning indicators (e.g., airplane buffet, stall horn, etc.). |
| *CA.VII.D.R3* | Failure to recognize and recover at the stall warning during normal operations. |
| *CA.VII.D.R4* | Improper stall recovery procedure. |
| *CA.VII.D.R5* | Secondary stalls, cross-control stalls, and spins. |
| *CA.VII.D.R6* | Effect of environmental elements on airplane performance related to accelerated stalls (e.g., turbulence, microbursts, and high-density altitude). |
| *CA.VII.D.R7* | Collision hazards, to include aircraft, terrain, obstacles, and wires. |
| *CA.VII.D.R8* | Distractions, improper task management, loss of situational awareness, or disorientation. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.VII.D.S1* | Clear the area. |
| *CA.VII.D.S2* | Select an entry altitude that will allow the Task to be completed no lower than 3,000 feet AGL. |
| *CA.VII.D.S3* | Establish the configuration as specified by the evaluator. |
| *CA.VII.D.S4* | Set power appropriate for the configuration, such that the airspeed does not exceed the maneuvering speed ($V_A$) or any other applicable POH/AFM limitation. |
| *CA.VII.D.S5* | Establish and maintain a coordinated turn in a 45° bank, increasing elevator back pressure smoothly and firmly until an impending stall is reached. |
| *CA.VII.D.S6* | Acknowledge the cue(s) and recover promptly at the first indication of an impending stall (e.g., aircraft buffet, stall horn, etc.). |
| *CA.VII.D.S7* | Execute a stall recovery in accordance with procedures set forth in the POH/AFM. |
| *CA.VII.D.S8* | Configure the airplane as recommended by the manufacturer, and accelerate to $V_X$ or $V_Y$. |
| *CA.VII.D.S9* | Return to the altitude, heading, and airspeed specified by the evaluator. |

| Task | *E. Spin Awareness* |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with spins, flight situations where unintentional spins may occur and procedures for recovery from unintentional spins. |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.VII.E.K1* | Aerodynamics associated with spins in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects. |
| *CA.VII.E.K2* | What causes a spin and how to identify the entry, incipient, and developed phases of a spin. |
| *CA.VII.E.K3* | Spin recovery procedure. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.VII.E.R1* | Factors and situations that could lead to inadvertent spin and loss of control. |
| *CA.VII.E.R2* | Range and limitations of stall warning indicators (e.g., aircraft buffet, stall horn, etc.). |
| *CA.VII.E.R3* | Improper spin recovery procedure. |
| *CA.VII.E.R4* | Effect of environmental elements on airplane performance related to spins (e.g., turbulence, microbursts, and high-density altitude). |
| *CA.VII.E.R5* | Collision hazards, to include aircraft, terrain, obstacles, and wires. |
| *CA.VII.E.R6* | Distractions, improper task management, loss of situational awareness, or disorientation. |
| **Skills** | [Intentionally left blank] |

## IX. Emergency Operations

| Task | *E. Engine Failure During Takeoff Before $V_{MC}$ (Simulated) (AMEL, AMES)* |
|---|---|
| References | FAA-H-8083-2, FAA-H-8083-3; FAA-P-8740-66; POH/AFM |
| Objective | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with an engine failure during takeoff before $V_{MC}$.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.IX.E.K1* | Factors affecting $V_{MC}$. |
| *CA.IX.E.K2* | $V_{MC}$ (red line) and $V_{YSE}$ (blue line). |
| *CA.IX.E.K3* | Accelerate/stop distance. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.IX.E.R1* | Failure to plan for engine failure during takeoff. |
| *CA.IX.E.R2* | Improper airplane configuration. |
| *CA.IX.E.R3* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.IX.E.S1* | Close the throttles smoothly and promptly when a simulated engine failure occurs. |
| *CA.IX.E.S2* | Maintain directional control and apply brakes (AMEL), or flight controls (AMES), as necessary. |

## IX. Emergency Operations

| Task | *F. Engine Failure After Liftoff (Simulated) (AMEL, AMES)* |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3; FAA-P-8740-66; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with an engine failure after liftoff.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.IX.F.K1* | Factors affecting $V_{MC}$. |
| *CA.IX.F.K2* | $V_{MC}$ (red line), $V_{YSE}$ (blue line), and $V_{SSE}$ (safe single-engine speed). |
| *CA.IX.F.K3* | Accelerate/stop and accelerate/go distances. |
| *CA.IX.F.K4* | How to identify, verify, feather, and secure an inoperative engine. |
| *CA.IX.F.K5* | Importance of drag reduction, to include propeller feathering, gear and flap retraction, the manufacturer's recommended control input and its relation to zero sideslip. |
| *CA.IX.F.K6* | Simulated propeller feathering and the evaluator's zero-thrust procedures and responsibilities. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.IX.F.R1* | Failure to plan for engine failure after liftoff. |
| *CA.IX.F.R2* | Collision hazards, to include aircraft, terrain, obstacles, and wires. |
| *CA.IX.F.R3* | Improper airplane configuration. |
| *CA.IX.F.R4* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.IX.F.R5* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.IX.F.S1* | Promptly recognize an engine failure, maintain control, and utilize appropriate emergency procedures. |
| *CA.IX.F.S2* | Establish $V_{YSE}$; if obstructions are present, establish $V_{XSE}$ or $V_{MC}$ +5 knots, whichever is greater, until obstructions are cleared. Then transition to $V_{YSE}$. |
| *CA.IX.F.S3* | Reduce drag by retracting landing gear and flaps in accordance with the manufacturer's guidance. |
| *CA.IX.F.S4* | Simulate feathering the propeller on the inoperative engine (evaluator should then establish zero thrust on the inoperative engine). |
| *CA.IX.F.S5* | Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required. |
| *CA.IX.F.S6* | Monitor the operating engine and make adjustments as necessary. |
| *CA.IX.F.S7* | Recognize the airplane's performance capabilities. If a climb is not possible at $V_{YSE}$, maintain $V_{YSE}$ and return to the departure airport for landing, or initiate an approach to the most suitable landing area available. |
| *CA.IX.F.S8* | Simulate securing the inoperative engine. |
| *CA.IX.F.S9* | Maintain heading ±10° and airspeed ±5 knots. |
| *CA.IX.F.S10* | Complete the appropriate checklist. |

## X. Multiengine Operations

| Task | **A. Maneuvering with One Engine Inoperative (AMEL, AMES)** |
|---|---|
| **References** | FAA-H-8083-2, FAA-H-8083-3; FAA-P-8740-66; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with one engine inoperative.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.X.A.K1* | Factors affecting $V_{MC}$. |
| *CA.X.A.K2* | $V_{MC}$ (red line) and $V_{YSE}$ (blue line). |
| *CA.X.A.K3* | How to identify, verify, feather, and secure an inoperative engine. |
| *CA.X.A.K4* | Importance of drag reduction, to include propeller feathering, gear and flap retraction, the manufacturer's recommended flight control input and its relation to zero sideslip. |
| *CA.X.A.K5* | Feathering, securing, unfeathering, and restarting. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.X.A.R1* | Failure to plan for engine failure during flight. |
| *CA.X.A.R2* | Collision hazards, to include aircraft, terrain, obstacles, and wires. |
| *CA.X.A.R3* | Improper airplane configuration. |
| *CA.X.A.R4* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.X.A.R5* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.X.A.S1* | Recognize an engine failure, maintain control, use manufacturer's memory item procedures, and utilize appropriate emergency procedures. |
| *CA.X.A.S2* | Set the engine controls, identify and verify the inoperative engine, and feather the appropriate propeller. |
| *CA.X.A.S3* | Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required. |
| *CA.X.A.S4* | Attempt to determine and resolve the reason for the engine failure. |
| *CA.X.A.S5* | Secure the inoperative engine and monitor the operating engine and make necessary adjustments. |
| *CA.X.A.S6* | Restart the inoperative engine using manufacturer's restart procedures. |
| *CA.X.A.S7* | Maintain altitude ±100 feet or a minimum sink rate if applicable, airspeed ±10 knots, and selected headings ±10°. |
| *CA.X.A.S8* | Complete the appropriate checklist. |

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| **Task** | ***B. $V_{MC}$ Demonstration (AMEL, AMES)*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3; FAA-P-8740-66; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a $V_{MC}$ demonstration.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.X.B.K1* | Factors affecting $V_{MC}$ and how $V_{MC}$ differs from stall speed ($V_S$). |
| *CA.X.B.K2* | $V_{MC}$ (red line), $V_{YSE}$ (blue line), and $V_{SSE}$ (safe single-engine speed). |
| *CA.X.B.K3* | Cause of loss of directional control at airspeeds below $V_{MC}$. |
| *CA.X.B.K4* | Proper procedures for maneuver entry and safe recovery. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.X.B.R1* | Improper airplane configuration. |
| *CA.X.B.R2* | Maneuvering with one engine inoperative. |
| *CA.X.B.R3* | Distractions, loss of situational awareness, or improper task management. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.X.B.S1* | Configure the airplane in accordance with the manufacturer's recommendations, in the absence of the manufacturer's recommendations, then at $V_{SSE}/V_{YSE}$, as appropriate, and: |
| *CA.X.B.S1a* | a. Landing gear retracted |
| *CA.X.B.S1b* | b. Flaps set for takeoff |
| *CA.X.B.S1c* | c. Cowl flaps set for takeoff |
| *CA.X.B.S1d* | d. Trim set for takeoff |
| *CA.X.B.S1e* | e. Propellers set for high RPM |
| *CA.X.B.S1f* | f. Power on critical engine reduced to idle and propeller windmilling |
| *CA.X.B.S1g* | g. Power on operating engine set to takeoff or maximum available power |
| *CA.X.B.S2* | Establish a single-engine climb attitude with the airspeed at approximately 10 knots above $V_{SSE}$. |
| *CA.X.B.S3* | Establish a bank angle not to exceed 5° toward the operating engine, as required for best performance and controllability. |
| *CA.X.B.S4* | Increase the pitch attitude slowly to reduce the airspeed at approximately 1 knot per second while applying rudder pressure to maintain directional control until full rudder is applied. |
| *CA.X.B.S5* | Recognize indications of loss of directional control, stall warning, or buffet. |
| *CA.X.B.S6* | Recover promptly by simultaneously reducing power sufficiently on the operating engine, decreasing the angle of attack as necessary to regain airspeed and directional control, and without adding power on the simulated failed engine. |
| *CA.X.B.S7* | Recover within 20° of entry heading. |
| *CA.X.B.S8* | Advance power smoothly on the operating engine and accelerate to $V_{SSE}/V_{YSE}$, as appropriate, ±5 knots during recovery. |

## X. Multiengine Operations

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| **Task** | ***C. One Engine Inoperative (Simulated) (solely by Reference to Instruments) During Straight-and-Level Flight and Turns (AMEL, AMES)*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3; FAA-P-8740-66; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with flight solely by reference to instruments with one engine inoperative.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.X.C.K1* | Procedures used if engine failure occurs during straight-and-level flight and turns while on instruments. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing: |
| *CA.X.C.R1* | Failure to identify the inoperative engine. |
| *CA.X.C.R2* | Inability to climb or maintain altitude with an inoperative engine. |
| *CA.X.C.R3* | Low altitude maneuvering including, stall, spin, or CFIT. |
| *CA.X.C.R4* | Distractions, loss of situational awareness, or improper task management. |
| *CA.X.C.R5* | Fuel management during single-engine operation. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.X.C.S1* | Promptly recognize an engine failure and maintain positive airplane control. |
| *CA.X.C.S2* | Set the engine controls, reduce drag, identify and verify the inoperative engine, and simulate feathering of the propeller on the inoperative engine. (Evaluator should then establish zero thrust on the inoperative engine.) |
| *CA.X.C.S3* | Establish the best engine-inoperative airspeed and trim the airplane. |
| *CA.X.C.S4* | Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required. |
| *CA.X.C.S5* | Verify the prescribed checklist procedures normally used for securing the inoperative engine. |
| *CA.X.C.S6* | Attempt to determine and resolve the reason for the engine failure. |
| *CA.X.C.S7* | Monitor engine functions and make necessary adjustments. |
| *CA.X.C.S8* | Maintain the specified altitude ±100 feet or minimum sink rate if applicable, airspeed ±10 knots, and the specified heading ±10°. |
| *CA.X.C.S9* | Assess the airplane's performance capability and decide an appropriate action to ensure a safe landing. |
| *CA.X.C.S10* | Avoid loss of airplane control or attempted flight contrary to the engine-inoperative operating limitations of the airplane. |
| *CA.X.C.S11* | Utilize SRM. |

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| **Task** | ***D. Instrument Approach and Landing with an Inoperative Engine (Simulated) (solely by Reference to Instruments) (AMEL, AMES)*** |
| **References** | FAA-H-8083-2, FAA-H-8083-3; FAA-P-8740-66; POH/AFM |
| **Objective** | To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with executing a published instrument approach solely by reference to instruments with one engine inoperative.<br>***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.* |
| **Knowledge** | The applicant demonstrates understanding of: |
| *CA.X.D.K1* | Instrument approach procedures with one engine inoperative. |
| **Risk Management** | The applicant demonstrates the ability to identify, assess, and mitigate risks, encompassing: |
| *CA.X.D.R1* | Failure to plan for engine failure during approach and landing. |
| *CA.X.D.R2* | Collision hazards, to include aircraft, terrain, obstacles, wires, vehicles, vessels, persons, and wildlife. |
| *CA.X.D.R3* | Improper airplane configuration. |
| *CA.X.D.R4* | Low altitude maneuvering including stall, spin, or CFIT |
| *CA.X.D.R5* | Distractions, loss of situational awareness, or improper task management. |
| *CA.X.D.R6* | Performing a go-around/rejected landing with a powerplant failure. |
| **Skills** | The applicant demonstrates the ability to: |
| *CA.X.D.S1* | Promptly recognize engine failure and maintain positive airplane control. |
| *CA.X.D.S2* | Set the engine controls, reduce drag, identify and verify the inoperative engine, and simulate feathering of the propeller on the inoperative engine. (Evaluator should then establish zero thrust on the inoperative engine). |
| *CA.X.D.S3* | Use flight controls in the proper combination as recommended by the manufacturer or as required to maintain best performance, and trim as required. |
| *CA.X.D.S4* | Follow the manufacturer's recommended emergency procedures. |
| *CA.X.D.S5* | Monitor the operating engine and make adjustments as necessary. |
| *CA.X.D.S6* | Request and follow an actual or a simulated ATC clearance for an instrument approach. |
| *CA.X.D.S7* | Maintain altitude ±100 feet or minimum sink rate if applicable, airspeed ±10 knots, and selected heading ±10°. |
| *CA.X.D.S8* | Establish a rate of descent that will ensure arrival at the MDA or DA/DH, with the airplane in a position from which a descent to a landing on the intended runway can be made, either straight in or circling as appropriate. |
| *CA.X.D.S9* | On final approach segment, maintain vertical (as applicable) and lateral guidance within ¾-scale deflection. |
| *CA.X.D.S10* | Avoid loss of airplane control or attempted flight contrary to the operating limitations of the airplane. |
| *CA.X.D.S11* | Comply with the published criteria for the aircraft approach category if circling. |
| *CA.X.D.S12* | Execute a normal landing. |
| *CA.X.D.S13* | Complete the appropriate checklist. |

# Chapter 13: Transition to Multiengine Airplanes

## Introduction

This chapter is devoted to the factors associated with the operation of small multiengine airplanes. For the purpose of this handbook, a "small" multiengine airplane is a reciprocating or turbopropeller-powered airplane with a maximum certificated takeoff weight of 12,500 pounds or less. This discussion assumes a conventional design with two engines—one mounted on each wing. Reciprocating engines are assumed unless otherwise noted. The term "light-twin," although not formally defined in the regulations, is used herein as a small multiengine airplane with a maximum certificated takeoff weight of 6,000 pounds or less.

There are several unique characteristics of multiengine airplanes that make them worthy of a separate class rating. The one engine inoperative (OEI) flight information presented in this chapter emphasizes the significant difference between flying a multiengine and a single-engine airplane. However, all pilots need appropriate knowledge, risk management strategies, and skills to fly safely in any airplane they fly, and mastery of OEI flight is only one aspect of safe multiengine flying. The modern, well-equipped multiengine airplane can be remarkably capable under many circumstances, but, the performance and system redundancy of a multiengine airplane only increase safety if the pilot is trained and proficient.

The airplane manufacturer is the final authority on the operation of a particular make and model airplane. Flight instructors and learners should use the Federal Aviation Administration's Approved Flight Manual (AFM) and/or the Pilot's Operating Handbook (POH). The airplane manufacturer's guidance and procedures take precedence over any general recommendations made in this handbook.

## General

Multiengine and single-engine airplanes operate differently during an engine failure. In a multiengine airplane, loss of thrust from one engine affects both *performance and control*. The most obvious problem is the loss of 50 percent of power, which reduces climb performance 80 to 90 percent. In some cases after an engine failure, the ability to climb or maintain altitude in a light-twin may not exist. After an engine failure, asymmetrical thrust also creates control issues for the pilot. Attention to both these factors is crucial to safe OEI flight.

## Terms and Definitions

Pilots of single-engine airplanes are already familiar with many performance "V" speeds and their definitions. Twin-engine airplanes have several additional V-speeds unique to OEI operation. These speeds are differentiated by the notation "SE" for single engine. A review of some key V-speeds and several new V-speeds unique to twin-engine airplanes are listed below.

- $V_R$—rotation speed—speed at which back pressure is applied to rotate the airplane to a takeoff attitude.

- $V_{LOF}$—lift-off speed—speed at which the airplane leaves the surface. (Note: Some manufacturers reference takeoff performance data to $V_R$, others to $V_{LOF}$.)

- $V_X$—best angle of climb speed—speed at which the airplane gains the greatest altitude for a given distance of forward travel.

- $V_{XSE}$—best angle-of-climb speed with OEI.

- $V_Y$—best rate of climb speed—speed at which the airplane gains the most altitude for a given unit of time.

- $V_{YSE}$—best rate of climb speed with OEI. Marked with a blue radial line on most airspeed indicators. Above the single-engine absolute ceiling, $V_{YSE}$ yields the minimum rate of sink.

- $V_{SSE}$—safe, intentional OEI speed—originally known as safe single-engine speed. It is the minimum speed to intentionally render the critical engine inoperative.

- $V_{REF}$—reference landing speed—an airspeed used for final approach, which is normally 1.3 times $V_{SO}$, the stall speed in the landing configuration. The pilot may adjust the approach speed for winds and gusty conditions by using $V_{REF}$ plus an additional number of units (e.g.,$V_{REF}$+5).

- $V_{MC}$—currently defined in 14 CFR part 23, section 23.2135(c) as the calibrated airspeed at which, following the sudden critical loss of thrust, it is possible to maintain control of the airplane. $V_{MC}$ is typically marked with a red radial line on most airspeed indicators [*Figure 13-1*]. $V_{MC}$ was previously defined in 14 CFR part 23, section 23.149 as the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane with that engine still inoperative, and thereafter maintain straight flight at the same speed with an angle of bank of not more than 5 degrees. This definition still applies to airplanes certified under that regulation. There is no requirement under either determination that the airplane be capable of climbing at this airspeed. $V_{MC}$ only addresses directional control. Further discussion of $V_{MC}$ as determined during airplane certification and demonstrated in pilot training follows later in this chapter.


**Figure 13-1.** *Airspeed indicator markings for a multiengine airplane*

Unless otherwise noted, when V-speeds are given in the AFM/POH, they apply to sea level, standard day conditions at maximum takeoff weight. Performance speeds vary with aircraft weight, configuration, and atmospheric conditions. The speeds may be stated in statute miles per hour (mph) or knots (kt), and they may be given as calibrated airspeeds (CAS) or indicated airspeeds (IAS). As a general rule, the newer AFM/POHs show V-speeds in knots indicated airspeed (KIAS). Some V-speeds are also stated in knots calibrated airspeed (KCAS) to meet certain regulatory requirements. Whenever available, pilots should operate the airplane from published indicated airspeeds.

Rate of climb is the altitude gain per unit of time, while climb gradient is the actual measure of altitude gained per 100 feet of horizontal travel, expressed as a percentage. An altitude gain of 1.5 feet per 100 feet of travel (or 15 feet per 1,000 or 150 feet per 10,000) is a climb gradient of 1.5 percent.

There is a dramatic performance loss associated with the loss of an engine, particularly just after takeoff. Any airplane's climb performance is a function of thrust horsepower, which is in excess of that required for level flight. In a hypothetical twin with each engine producing 200 thrust horsepower, assume that the total level flight thrust horsepower required is 175. In this situation, the airplane would ordinarily have a reserve of 225 thrust horsepower available for climb. Loss of one engine would leave only 25 (200 minus 175) thrust horsepower available for climb, a drastic reduction.

The performance characteristics of an airplane depend upon the rules in effect during type certification and do not depend on the production year after certification. The current amendment to 14 CFR part 23, 81 FR 96689, went into effect on December 30, 2016. This includes certification of normal category airplanes with passenger seating configuration of 19 or less and a maximum certificated takeoff weight of 19,000 pounds or less (section 23.2005(a)). Current 14 CFR part 23 certification rules (section 23.2005(b)) classify airplanes into certification levels 1 through 4 based on maximum passenger seating configuration. For example, a level 2 airplane has a passenger seating configuration between two and six passengers. The rule further divides airplanes into two different performance levels based on speed (section 23.2005(c)). After a critical loss of thrust, a level 2 low speed airplane ($V_{NO}$ or $V_{MO}$ less than or equal to 250 knots calibrated airspeed and $M_{MO}$ less than or equal to 0.6) that does not meet single-engine crashworthiness requirements requires a climb gradient of at least 1.5 percent at a pressure altitude of 5,000 feet in the cruise configuration for certification (section 23.2120(b)(1)).

While, the various subsets of airplanes receiving certification under the current part 23 meet specific single-engine climb performance criteria as listed in 14 CFR part 23, section 23.2120(b), the historical 14 CFR part 23 single-engine climb performance requirements for reciprocating engine-powered multiengine airplanes are broken down as follows:

- More than 6,000 pounds maximum weight and/or $V_{SO}$ more than 61 knots: the single-engine rate of climb in feet per minute (fpm) at 5,000 feet mean sea level (MSL) must be equal to at least 0.027 $V_{SO}$ 2. For airplanes type certificated February 4, 1991, or thereafter, the climb requirement is expressed in terms of a climb gradient, 1.5 percent. The climb gradient is not a direct equivalent of the .027 $V_{SO}$ 2 formula. Do not confuse the date of type certification with the airplane's model year. The type certification basis of many multiengine airplanes dates back to the Civil Aviation Regulations (CAR) 3.

- 6,000 pounds or less maximum weight and $V_{SO}$ 61 knots or less: the single-engine rate of climb at 5,000 feet MSL must simply be determined. The rate of climb could be a negative number. There is no requirement for a single-engine positive rate of climb at 5,000 feet or any other altitude. For light-twins type certificated February 4, 1991, or thereafter, the single-engine climb gradient (positive or negative) is simply determined.

## Operation of Systems

This section deals with systems and equipment that are generally installed in multiengine airplanes. Multiengine airplanes share many features with complex single-engine airplanes. However, there are certain features that are found more often in airplanes with two or more engines.

### Feathering Propellers

Although the propellers of a multiengine airplane may appear identical to a constant-speed propeller used in many single-engine airplanes, this is usually not the case. The pilot of a typical multiengine airplane can feather the propeller of an inoperative engine. Since it stops engine rotation with the propeller blade streamlined with the airplane's relative wind, feathering the propeller of an inoperative engine minimizes propeller drag. *[Figure 13-2]* Depending upon single-engine performance, this feature often permits continued flight to a suitable airport following an engine failure.

Feathering is important because of the change in parasite drag with propeller blade angle. *[Figure 13-3]* When the propeller blade angle is in the feathered position, parasite drag from the propeller is at a minimum. In a typical multiengine airplane, the parasite drag from a single, feathered propeller is a small part the airplane's total drag.

At the smaller blade angles near the flat pitch position, the drag added by the propeller is large. At these small blade angles, the propeller windmilling at high revolutions per minute (rpm) can create enough drag to make the airplane difficult or impossible to control. A propeller windmilling at high speed in the low range of blade angles can produce parasite drag as great as the parasite drag of the entire airframe.

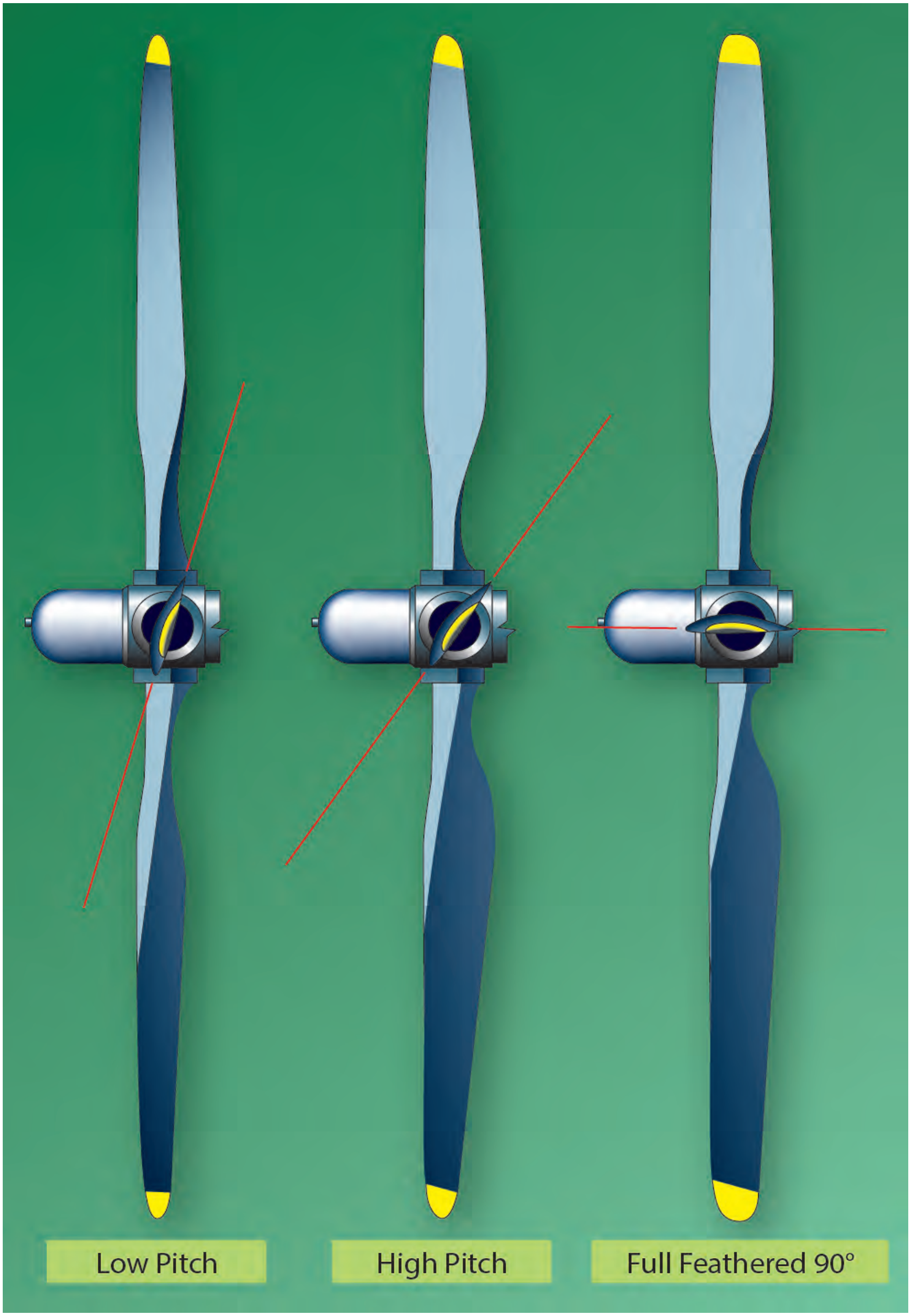


**Figure 13-2.** *Feathered propeller.*

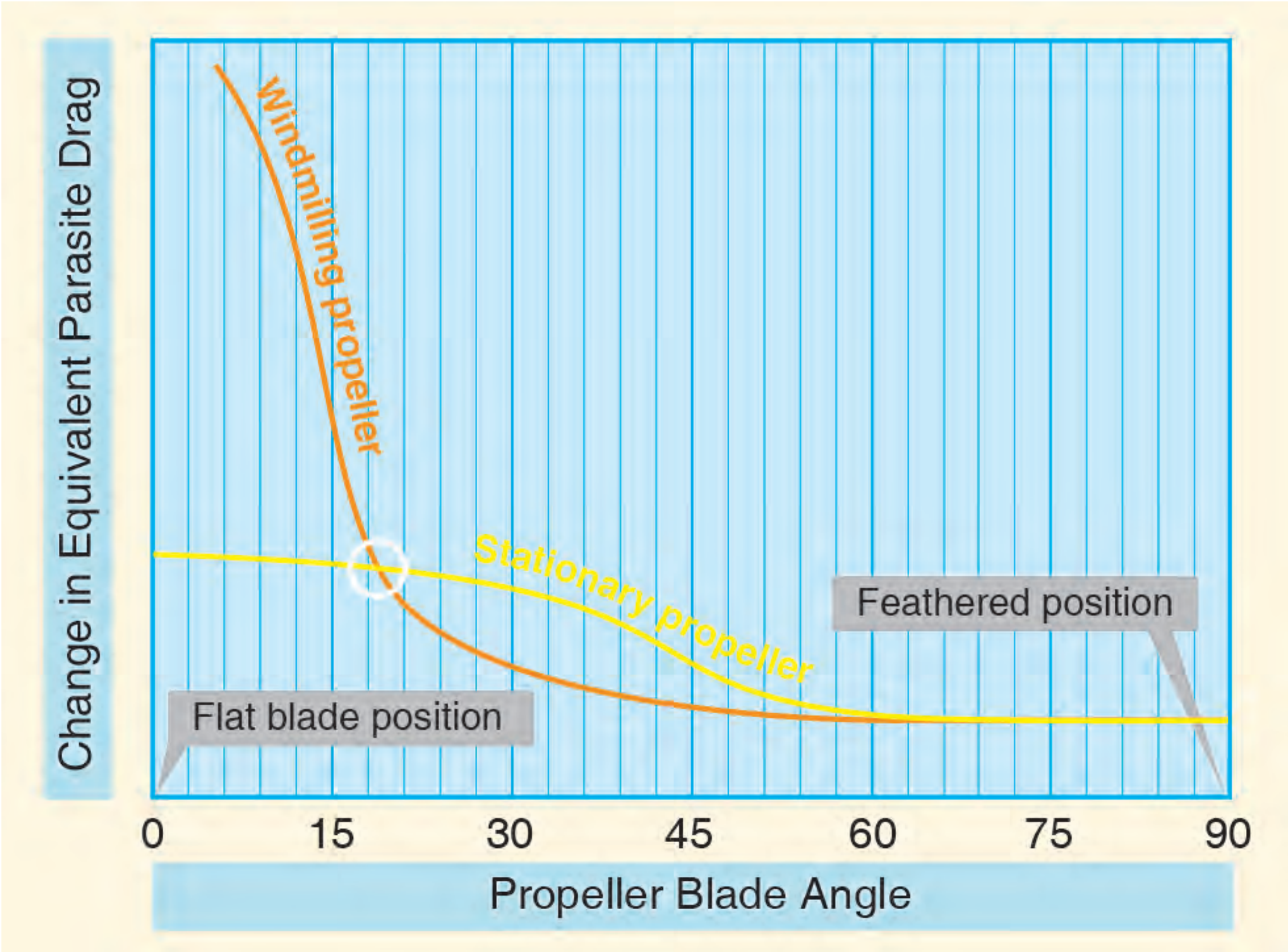


**Figure 13-3.** *Propeller drag contribution.*

As a review, the constant-speed propellers on almost all single-engine airplanes are of the non-feathering, oil-pressure-to-increase-pitch design. In this design, increased oil pressure from the propeller governor drives the blade angle towards high pitch, low rpm.

In contrast, the constant-speed propellers installed on most multiengine airplanes are full feathering, counterweighted, oil-pressure-to-decrease-pitch designs. In this design, increased oil pressure from the propeller governor drives the blade angle toward low pitch, high rpm—away from the feather blade angle. In effect, the only thing that keeps these propellers from feathering is a constant supply of high-pressure engine oil. This is a necessity to enable propeller feathering in the event of a loss of oil pressure or a propeller governor failure.

Aerodynamic forces acting upon a windmilling propeller tend to drive the blades to low pitch, high rpm. Counterweights attached to the shank of each blade tend to force the blades to high pitch, low rpm. Inertia, or the apparent force (called centrifugal force) acting through the counterweights, is generally slightly greater than the aerodynamic forces. Therefore, centrifugal force would drive the blades to high pitch and low rpm were it not for an additional force acting through the propeller governor. A controlling force generated from high pressure oil from the propeller governor pushes the propeller blade angles toward low pitch and high rpm. Thus, a reduction in oil pressure allows the counterweights to drive the blades to a higher pitch and decreases engine rpm. *[Figure 13-4]*

To feather the propeller, the propeller control is brought fully aft. All oil pressure is dumped from the governor, and the counterweights drive the propeller blades toward feather. As centrifugal force acting on the counterweights decays from decreasing rpm, additional forces are needed to completely feather the blades. This additional force comes from either a spring or high-pressure air stored in the propeller dome, which forces the blades into the feathered position. The entire process may take up to 10 seconds.

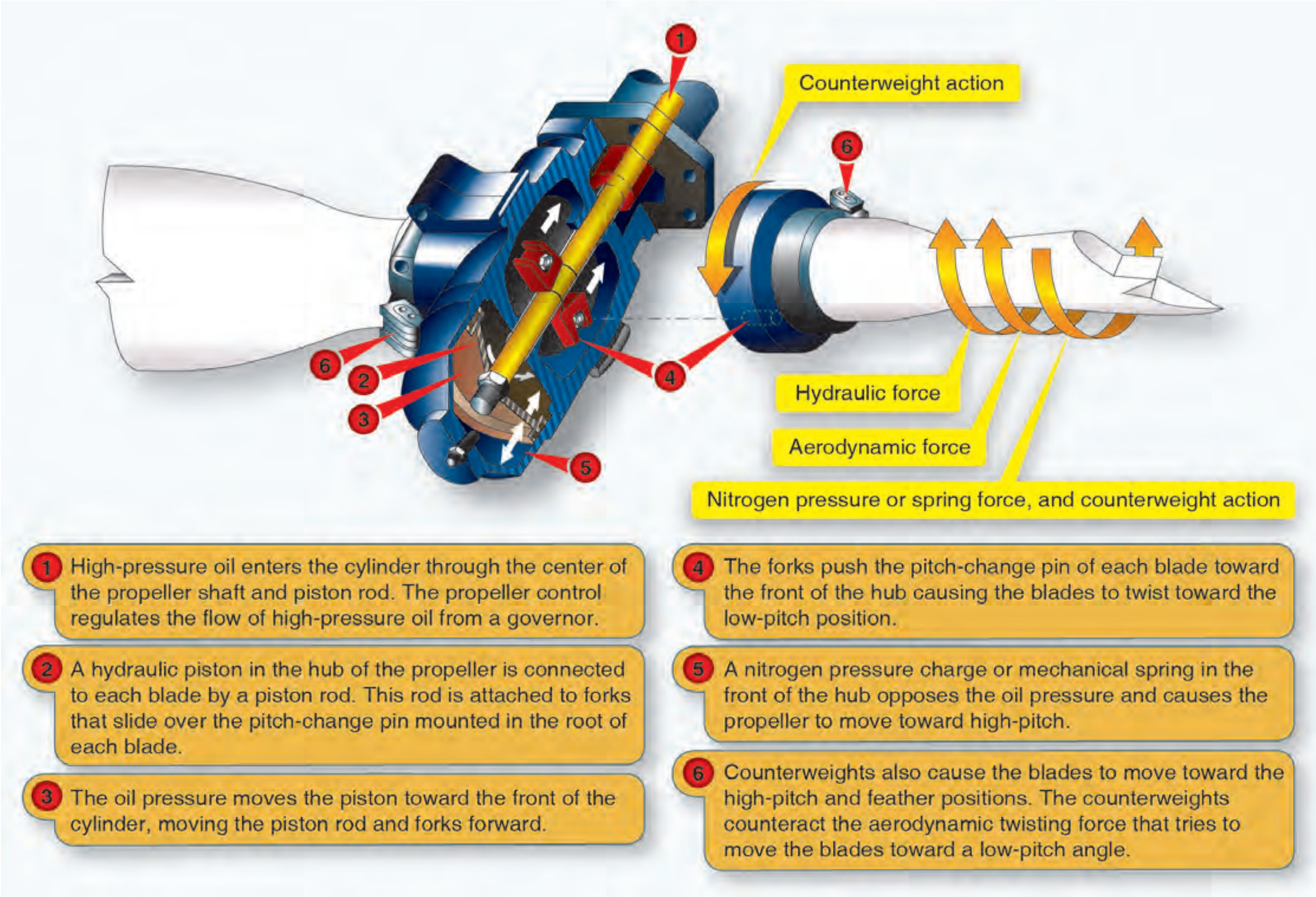


**Figure 13-4.** *Pitch change forces.*

Feathering a propeller only alters blade angle and stops engine rotation. To completely secure the engine, the pilot turns off the fuel (mixture, electric boost pump, and fuel selector), ignition, alternator/generator, and closes the cowl flaps. If the airplane is pressurized, there may also be an air bleed to close for the failed engine. Some airplanes are equipped with firewall shutoff valves that secure several of these systems with a single switch.

Completely securing a failed engine may not be necessary or even desirable depending upon the failure mode, altitude, and time available. The position of the fuel controls, ignition, and alternator/generator switches of the failed engine has no effect on aircraft performance, and the pilot might manipulate the incorrect switch under conditions of haste or pressure.

To unfeather a propeller, the engine should be rotated so that oil pressure can be generated to move the propeller blades from the feathered position. The ignition is turned on prior to engine rotation with the throttle at low idle and the mixture rich. With the propeller control in a high rpm position, the starter is engaged. The engine begins to windmill, start, and run as oil pressure moves the blades out of feather. As the engine starts, the propeller rpm should be immediately reduced until the engine has had several minutes to warm up; the pilot should monitor cylinder head and oil temperatures.

An unfeathering accumulator is a device that permits starting a feathered engine in-flight without the use of the electric starter. An accumulator is any device that stores a reserve of high pressure. On multiengine airplanes, the unfeathering accumulator stores a small reserve of engine oil under pressure from compressed air or nitrogen. To start a feathered engine in-flight, the pilot moves the propeller control out of the feather position to release the accumulator pressure. The oil flows under pressure to the propeller hub and drives the blades toward the high rpm, low pitch position, whereupon the propeller usually begins to windmill. If fuel and ignition are present, the engine starts and runs. High oil pressure from the propeller governor recharges the accumulator just moments after engine rotation begins making it available for another unfeathering cycle, if needed. For airplanes used in training, an unfeathering accumulator may prolong the life of the electric starter and battery. If the accumulator fails to bring the propeller out of feather, the electric starter may be engaged.

In any event, the AFM/POH procedures should be followed for the exact unfeathering procedure. Both feathering and starting a feathered reciprocating engine on the ground are strongly discouraged by manufacturers due to the excessive stress and vibrations generated.

As just described, a loss of oil pressure from the propeller governor allows the counterweights, spring, and/or dome charge to drive the blades to feather. Logically then, the propeller blades should feather every time an engine is shut down as oil pressure falls to zero. However, below approximately 800 rpm, a reduction in centrifugal force allows small anti-feathering lock pins in the pitch changing mechanism of the propeller hub to move into place and block feathering. Therefore, if a propeller is to be feathered, it needs to be done before engine rpm decays below approximately 800. On one popular model of turboprop engine, the propeller blades do, in fact, feather with each shutdown. This propeller is not equipped with such centrifugally-operated pins due to a unique engine design.

### Propeller Synchronization

Many multiengine airplanes have a propeller synchronizer (prop sync) installed to eliminate the annoying "drumming" or "beat" of propellers whose rpm are close, but not precisely the same. To use prop sync, the propeller rpms are coarsely matched by the pilot and the system is engaged. The prop sync adjusts the rpm of the "slave" engine to precisely match the rpm of the "master" engine and then maintains that relationship.

The prop sync should be disengaged when the pilot selects a new propeller rpm and then re-engaged after the new rpm is set. The prop sync should always be off for takeoff, landing, and single-engine operation. The AFM/POH should be consulted for system description and limitations.

A variation on the propeller synchronizer is the propeller synchrophaser. A propeller synchrophaser acts much like a synchronizer to precisely match rpm, but the synchrophaser goes one step further. It not only matches rpm but actually compares and adjusts the positions of the individual blades of the propellers in their arcs. There can be significant propeller noise and vibration reductions with a propeller synchrophaser. From the pilot's perspective, operation of a propeller synchronizer and a propeller synchrophaser are very similar. A synchrophaser is also commonly referred to as prop sync, although that is not entirely correct nomenclature from a technical standpoint.

As a pilot aid to manually synchronizing the propellers, some twins have a small gauge mounted in or by the tachometer(s) with a propeller symbol on a disk that spins. The pilot manually fine tunes the engine rpm so as to stop disk rotation, thereby synchronizing the propellers. This is a useful backup to synchronizing engine rpm using the audible propeller beat. This gauge is also found installed with most propeller synchronizer and synchrophase systems. Some synchrophase systems use a knob for the pilot to control the phase angle.

### Fuel Crossfeed

Fuel crossfeed systems are also unique to multiengine airplanes. Using crossfeed, an engine can draw fuel from a fuel tank located in the opposite wing.

On most multiengine airplanes, operation in the crossfeed mode is an emergency procedure used to extend airplane range and endurance in OEI flight. There are a few models that permit crossfeed as a normal, fuel balancing technique in normal operation, but these are not common. The AFM/POH describes crossfeed limitations and procedures that vary significantly among multiengine airplanes.

Checking crossfeed operation on the ground with a quick repositioning of the fuel selectors does nothing more than ensure freedom of motion of the handle. To actually check crossfeed operation, a complete, functional crossfeed system check should be accomplished. To do this, each engine should be operated from its crossfeed position during the run-up. The engines should be checked individually and allowed to run at moderate power (1,500 rpm minimum) for at least 1 minute to ensure that fuel flow can be established from the crossfeed source. Upon completion of the check, each engine should be operated for at least 1 minute at moderate power from the main (takeoff) fuel tanks to reconfirm fuel flow prior to takeoff.

This suggested check is not required prior to every flight. Crossfeed lines are ideal places for water and debris to accumulate unless they are used from time to time and drained using their external drains during preflight. Crossfeed is ordinarily not used for completing a flight with one engine inoperative when an alternate airport is nearby. Pilots should never use crossfeed during takeoff or for normal landing operations with both engines operating. A landing with one engine inoperative using crossfeed may be necessary if setting normal fuel flow would cause the operative engine to fail.

### Combustion Heater

Combustion heaters are another common item on multiengine airplanes not found on single-engine airplanes. A combustion heater is best described as a small furnace that burns gasoline to produce heated air for occupant comfort and windshield defogging. Most are thermostatically operated and have a separate hour meter to record time in service for maintenance purposes. Automatic over-temperature protection is provided by a thermal switch mounted on the unit that cannot be accessed in flight. This requires the pilot or mechanic to visually inspect the unit for possible heat damage in order to reset the switch.

Manufacturers often suggest a cool-down period when shutting down a combustion heater. Most heater instructions recommend that outside air be permitted to circulate through the unit for at least 15 seconds in flight or that the ventilation fan can be operated for at least 2 minutes on the ground. Failure to provide an adequate cool down usually trips the thermal switch and renders the heater inoperative until the switch is reset.

### Flight Director/Autopilot

Multiengine airplanes are often equipped with flight director/autopilot (FD/AP) systems. The system integrates pitch, roll, heading, altitude, and radio navigation signals in a computer. The outputs, called computed commands, are displayed on a flight command indicator (FCI). The FCI replaces the conventional attitude indicator on the instrument panel. The FCI is occasionally referred to as a flight director indicator (FDI) or as an attitude director indicator (ADI).

The entire flight director/autopilot system is called an integrated flight control system (IFCS) by some manufacturers. Others may use the term automatic flight control system (AFCS).

The FD/AP system may be employed at the following different levels:

- Off (raw data)
- Flight director (computed commands)
- Autopilot

With the system off, the FCI operates as an ordinary attitude indicator. On most FCIs, the command bars are biased out of view when the FD is off. The pilot maneuvers the airplane as though the system were not installed.

To maneuver the airplane using the FD, the pilot enters the desired modes of operation (heading, altitude, navigation (NAV) intercept, and tracking) on the FD/AP mode controller. The computed flight commands are then displayed to the pilot through either a single-cue or dual-cue system in the FCI. On a single-cue system, the commands are indicated by "V" bars. On a dual-cue system, the commands are displayed on two separate command bars, one for pitch and one for roll. To maneuver the airplane using computed commands, the pilot "flies" the symbolic airplane of the FCI to match the steering cues presented.

On most systems, the FD needs to be operating to engage the autopilot. At any time thereafter, the pilot may engage the autopilot through the mode controller. The autopilot then maneuvers the airplane to satisfy the computed commands of the FD.

Like any computer, the FD/AP system only does what it is told. The pilot should ensure that it has been programmed properly for the particular phase of flight desired. The armed and/or engaged modes are usually displayed on the mode controller or separate annunciator lights. When the airplane is being hand-flown, if the FD is not being used at any particular moment, it should be off so that the command bars are pulled from view.

Prior to system engagement, all FD/AP computer and trim checks should be accomplished. Many newer systems cannot be engaged without the completion of a self-test. The pilot should also be familiar with various methods of disengagement, both normal and emergency. System details, including approvals and limitations, can be found in the supplements section of the AFM/POH. Additionally, many avionics manufacturers can provide informative pilot operating guides upon request.

### Yaw Damper

The yaw damper is a servo that moves the rudder in response to inputs from a gyroscope or accelerometer that detects yaw rate or lateral Gs, respectively. The yaw damper reduces motion about the vertical axis caused by turbulence. (Yaw dampers on swept wing airplanes provide another, more vital function of damping Dutch roll characteristics.) Occupants feel a smoother ride, particularly if seated in the rear of the airplane, when the yaw damper is engaged. The yaw damper should be off for takeoff and landing. There may be additional restrictions against its use with one engine inoperative. Most yaw dampers can be engaged independently of the autopilot.

### Alternator/Generator

On a multiengine aircraft, each engine has an alternator or generator installed. Alternator or generator paralleling circuitry matches the output of each engine's alternator/generator so that the electrical system load is shared equally between them. In the event of an alternator/generator failure, the inoperative unit can be isolated and the entire electrical system powered from the remaining one. Depending upon the electrical capacity of the alternator/generator, the pilot may need to reduce the electrical load (referred to as load shedding) when operating on a single unit. The AFM/POH contains system description and limitations.

### Nose Baggage Compartment

Nose baggage compartments are common on multiengine airplanes (and are even found on a few single-engine airplanes). There is nothing strange or exotic about a nose baggage compartment, and the usual guidance concerning observation of load limits applies. Pilots occasionally neglect to secure the latches properly. When improperly secured, the door may open and the contents may be drawn out, usually into the propeller arc and just after takeoff. Even when the nose baggage compartment is empty, airplanes have been lost when the pilot became distracted by the open door. Security of the nose baggage compartment latches and locks is a vital preflight item.

Most airplanes continue to fly with a nose baggage door open. There may be some buffeting from the disturbed airflow, and there is an increase in noise. Pilots should never become so preoccupied with an open door (of any kind) that they fail to fly the airplane.

Inspection of the compartment interior is another important preflight item. More than one pilot has been surprised to find a supposedly empty compartment packed to capacity or loaded with ballast. The tow bars, engine inlet covers, windshield sun screens, oil containers, spare chocks, and miscellaneous small hand tools that find their way into baggage compartments should be secured to prevent damage from shifting in flight.

### Anti-Icing/Deicing Equipment

Anti-icing/deicing equipment is frequently installed on multiengine airplanes and may consist of a combination of different systems. These may be classified as either anti-icing or deicing, depending upon function. The presence of anti-icing and deicing equipment, even though it may appear elaborate and complete, does not necessarily mean that the airplane is approved for flight in icing conditions. The AFM/POH, placards, and even the manufacturer should be consulted for specific determination of approvals and limitations. Anti-icing equipment is provided to prevent ice from forming on certain protected surfaces. Examples of anti-icing equipment include heated pitot tubes, heated or non-icing static ports and fuel vents, propeller blades with electrothermal boots or alcohol slingers, windshields with alcohol spray or electrical resistance heating, windshield defoggers, and heated stall warning lift detectors. On many turboprop engines, the "lip" surrounding the air intake is heated either electrically or with bleed air. In the absence of AFM/POH guidance to the contrary, anti-icing equipment should be actuated prior to flight into known or suspected icing conditions.

Deicing equipment is generally limited to pneumatic boots on wing and tail leading edges. Deicing equipment is installed to remove ice that has already formed on protected surfaces. Upon pilot actuation, the boots inflate with air from the pneumatic pumps to break off accumulated ice. After a few seconds of inflation, they are deflated back to their normal position with the assistance of a vacuum. The pilot monitors the buildup of ice and cycles the boots as directed in the AFM/POH. An ice light on the left engine nacelle allows the pilot to monitor wing ice accumulation at night.

Other airframe equipment necessary for flight in icing conditions includes an alternate induction air source and an alternate static system source. Ice tolerant antennas are also installed.

In the event of impact ice accumulating over normal engine air induction sources, carburetor heat (carbureted engines) or alternate air (fuel-injected engines) should be selected. Ice buildup on normal induction sources can be detected by a loss of engine rpm with fixed-pitch propellers and a loss of manifold pressure with constant-speed propellers. On some fuel-injected engines, an alternate air source is automatically activated with blockage of the normal air source.

An alternate static system provides an alternate source of static air for the pitot-static system in the unlikely event that the primary static source becomes blocked. In non-pressurized airplanes, most alternate static sources are plumbed to the cabin. On pressurized airplanes, they are usually plumbed to a non-pressurized baggage compartment. The pilot may activate the alternate static source by opening a valve or a fitting in the flight deck. Activation may create airspeed indicator, altimeter, or vertical speed indicator (VSI) errors. A correction table is frequently provided in the AFM/POH.

Anti-icing/deicing equipment only eliminates ice from the protected surfaces. Significant ice accumulations may form on unprotected areas, even with proper use of anti-ice and deice systems. Flight at high angles of attack (AOA) or even normal climb speeds permit significant ice accumulations on lower wing surfaces, which are unprotected. Many AFM/POHs provide minimum speeds to be maintained in icing conditions. Degradation of all flight characteristics and large performance losses can be expected with ice accumulations. Pilots should not rely upon the stall warning devices for adequate stall warning with ice accumulations.

Ice accumulates unevenly on the airplane. It adds weight and drag (primarily drag) and decreases thrust and lift. Even wing shape affects ice accumulation; thin airfoil sections are more prone to ice accumulation than thick, highly-cambered sections. For this reason, certain surfaces, such as the horizontal stabilizer, are more prone to icing than the wing. With ice accumulations, landing approaches should be made with a minimum wing flap setting (flap extension increases the AOA of the horizontal stabilizer) and with an added margin of airspeed. Sudden and large configuration and airspeed changes should be avoided.

Unless otherwise recommended in the AFM/POH, the autopilot should not be used in icing conditions. Continuous use of the autopilot masks trim and handling changes that occur with ice accumulation. Without this control feedback, the pilot may not be aware of ice accumulation building to hazardous levels. The autopilot suddenly disconnects when it reaches design limits, and the pilot may find the airplane has assumed unsatisfactory handling characteristics.

The installation of anti-ice/deice equipment on airplanes without AFM/POH approval for flight into icing conditions is to facilitate escape when such conditions are inadvertently encountered. Even with AFM/POH approval, the prudent pilot avoids icing conditions to the maximum extent practicable and avoids extended flight in any icing conditions. No multiengine airplane is approved for flight into severe icing conditions and none are intended for indefinite flight in continuous icing conditions.

## Performance and Limitations

Discussion of performance and limitations requires the definition of the following terms.

- Accelerate-stop distance is the runway length required to accelerate to a specified speed (either $V_R$ or $V_{LOF}$, as specified by the manufacturer), experience an engine failure, and bring the airplane to a complete stop. *[Figure 13-5A]*

- Accelerate-go distance is the horizontal distance required to continue the takeoff and climb to 50 feet, assuming an engine failure at $V_R$ or $V_{LOF}$, as specified by the manufacturer. *[Figure 13-5A]*

- Climb gradient is a slope most frequently expressed in terms of altitude gain per 100 feet of horizontal distance, whereupon it is stated as a percentage. A 1.5 percent climb gradient is an altitude gain of one and one-half feet per 100 feet of horizontal travel. Climb gradient may also be expressed as a function of altitude gain per nautical mile (NM), or as a ratio of the horizontal distance to the vertical distance (10:1, for example). *[Figure 13-5B]* Unlike rate of climb, climb gradient is affected by wind. Climb gradient is improved with a headwind component and reduced with a tailwind component.

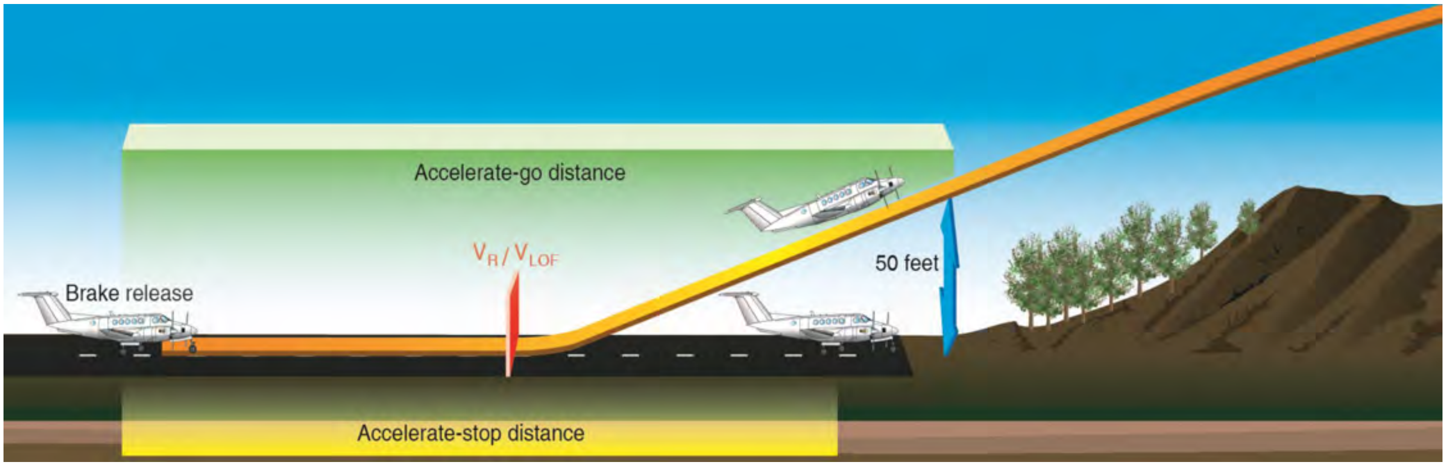


**Figure 13-5A.** *Accelerate-stop distance and accelerate-go distance.*

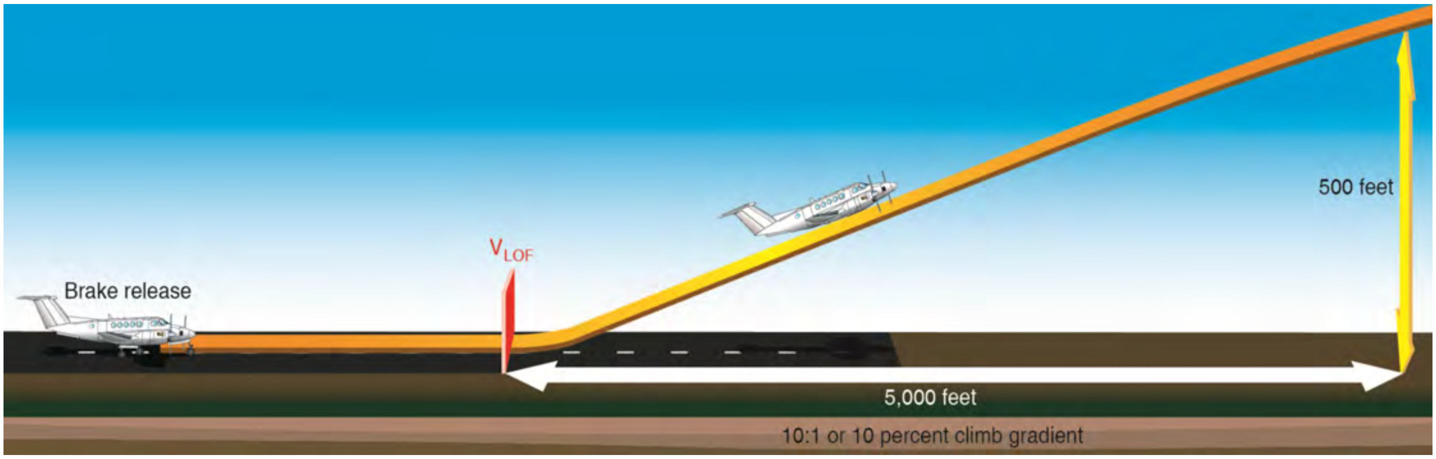


**Figure 13-5B.** *Climb gradient.*

- The all-engine service ceiling of multiengine airplanes is the highest altitude at which the airplane can maintain a steady rate of climb of 100 fpm with both engines operating. The airplane has reached its absolute ceiling when climb is no longer possible.

- The single-engine service ceiling is reached when the multiengine airplane can no longer maintain a 50 fpm rate of climb with OEI, and its single-engine absolute ceiling when climb is no longer possible.

The takeoff in a multiengine airplane should be planned in sufficient detail so that the appropriate action is taken in the event of an engine failure. The pilot should be thoroughly familiar with the airplane's performance capabilities and limitations in order to make an informed takeoff decision as part of the preflight planning. That decision should be reviewed as the last item of the "before takeoff" checklist.

In the event of an engine failure shortly after takeoff, the decision is basically one of continuing flight or landing, even off-airport. If single-engine climb performance is adequate for continued flight, and the airplane has been promptly and correctly configured, the climb after takeoff may be continued. If single-engine climb performance is such that climb is unlikely or impossible, a landing has to be made in the most suitable area. To be avoided above all is attempting to continue flight when it is not within the airplane's performance capability to do so. *[Figure 13-6]*

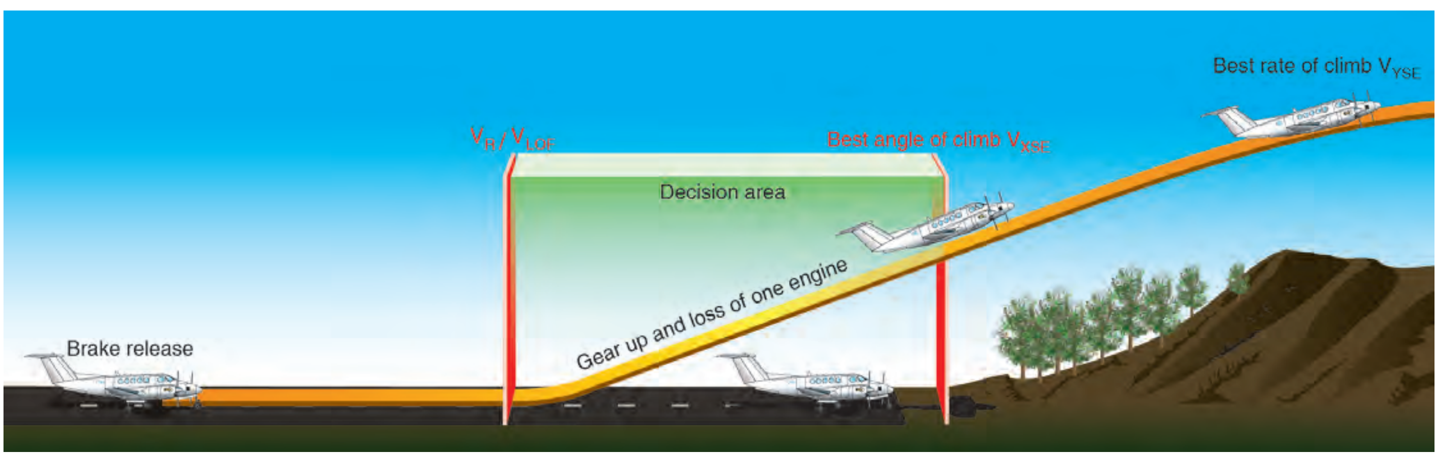


**Figure 13-6.** *Area of decision for engine failure after lift-off.*

Takeoff planning factors include weight and balance, airplane performance (both single and multiengine), runway length, slope and contamination, terrain and obstacles in the area, weather conditions, and pilot proficiency. Most multiengine airplanes have AFM/POH performance charts and the pilot should be proficient in their use. Prior to takeoff, the multiengine pilot should ensure that the weight and balance limitations have been observed, the runway length is adequate, and the normal flightpath clears obstacles and terrain. The pilot should also consider the appropriate actions expected in the event of an engine failure at any point during the takeoff.

The regulations do not specifically require that the runway length be equal to or greater than the accelerate-stop distance. Most AFM/POHs publish accelerate-stop distances only as an advisory. It becomes a limitation only when published in the limitations section of the AFM/POH. Experienced multiengine pilots, however, recognize the safety margin of runway lengths in excess of the bare minimum required for normal takeoff, and they insist on runway lengths of at least accelerate-stop distance as a matter of safety and good operating practice.

The multiengine pilot considers that under ideal circumstances, the accelerate-go distance only brings the airplane to a point a mere 50 feet above the takeoff elevation. To achieve even this meager climb, the pilot had to instantaneously recognize and react to an unanticipated engine failure, retract the landing gear, identify and feather the correct engine, all the while maintaining precise airspeed control and bank angle as the airspeed is nursed to $V_{YSE}$. Assuming flawless airmanship thus far, the airplane has now arrived at a point little more than one wingspan above the terrain, assuming it was absolutely level and without obstructions.

For the purpose of illustration, with a near 150 fpm rate of climb at a 90-knot $V_{YSE}$, it takes approximately 3 minutes to climb an additional 450 feet to reach 500 feet AGL. In doing so, the airplane has traveled an additional 5 NM beyond the original accelerate-go distance, with a climb gradient of about 1.6 percent. Any turn, such as to return to the airport, seriously degrades the already marginal climb performance of the airplane.

Not all multiengine airplanes have published accelerate-go distances in their AFM/POH and fewer still publish climb gradients. When such information is published, the figures have been determined under ideal flight testing conditions. It is unlikely that this performance is duplicated in service conditions.

The point of the previous discussion is to illustrate the marginal climb performance of a multiengine airplane that suffers an engine failure shortly after takeoff, even under ideal conditions. The prudent multiengine pilot should pick a decision point in the takeoff and climb sequence in advance. If an engine fails before this point, the takeoff should be rejected, even if airborne, for a landing on whatever runway or surface lies essentially ahead. If an engine fails after this point, the pilot should promptly execute the appropriate engine failure procedure and continue the climb, assuming the performance capability exists. As a general recommendation, if the landing gear has not been selected up, the takeoff should be rejected, even if airborne.

As a practical matter for planning purposes, the option of continuing the takeoff probably does not exist unless the published single-engine rate-of-climb performance is at least 100 to 200 fpm. Thermal turbulence, wind gusts, engine and propeller wear, or poor technique in airspeed, bank angle, and rudder control can easily negate even a 200 fpm rate of climb.

A pre-takeoff safety brief clearly defines all pre-planned emergency actions to all crewmembers. Even if operating the aircraft alone, the pilot should review and be familiar with takeoff emergency considerations. Indecision at the moment an emergency occurs degrades reaction time and the ability to make a proper response.

## Weight and Balance

The weight and balance concept is no different than that of a single-engine airplane. The actual execution, however, is almost invariably more complex due to a number of new loading areas, including nose and aft baggage compartments, nacelle lockers, main fuel tanks, auxiliary fuel tanks, nacelle fuel tanks, and numerous seating options in a variety of interior configurations. The flexibility in loading offered by the multiengine airplane places a responsibility on the pilot to address weight and balance prior to each flight.

The terms empty weight, licensed empty weight, standard empty weight, and basic empty weight as they appear on the manufacturer's original weight and balance documents are sometimes confused by pilots.

In 1975, the General Aviation Manufacturers Association (GAMA) adopted a standardized format for AFM/POHs. It was implemented by most manufacturers in model year 1976. Airplanes whose manufacturers conform to the GAMA standards utilize the following terminology for weight and balance:

standard empty weight + optional equipment = basic empty weight

Standard empty weight is the weight of the standard airplane, full hydraulic fluid, unusable fuel, and full oil. Optional equipment includes the weight of all equipment installed beyond standard. Basic empty weight is the standard empty weight plus optional equipment. Note that basic empty weight includes no usable fuel, but full oil.

Airplanes manufactured prior to the GAMA format generally utilize the following terminology for weight and balance, although the exact terms may vary somewhat:

empty weight + unusable fuel = standard empty weight

standard empty weight + optional equipment = licensed empty weight

Empty weight is the weight of the standard airplane, full hydraulic fluid, and undrainable oil. Unusable fuel is the fuel remaining in the airplane not available to the engines. Standard empty weight is the empty weight plus unusable fuel. When optional equipment is added to the standard empty weight, the result is licensed empty weight. Licensed empty weight, therefore, includes the standard airplane, optional equipment, full hydraulic fluid, unusable fuel, and undrainable oil.

The major difference between the two formats (GAMA and the old) is that basic empty weight includes full oil and licensed empty weight does not. Oil should always be added to any weight and balance utilizing a licensed empty weight.

When the airplane is placed in service, amended weight and balance documents are prepared by appropriately-rated maintenance personnel to reflect changes in installed equipment. The old weight and balance documents are customarily marked "superseded" and retained in the AFM/POH. Maintenance personnel are under no regulatory obligation to utilize the GAMA terminology, so weight and balance documents subsequent to the original may use a variety of terms. Pilots should use care to determine whether or not oil has to be added to the weight and balance calculations or if it is already included in the figures provided.

The multiengine airplane is where most pilots encounter the term "zero fuel weight" for the first time. Not all multiengine airplanes have a zero fuel weight limitation published in their AFM/POH, but many do. Zero fuel weight is simply the maximum allowable weight of the airplane and payload, assuming there is no usable fuel on board. The actual airplane is not devoid of fuel at the time of loading, of course. This is merely a calculation that assumes it was. If a zero fuel weight limitation is published, then all weight in excess of that figure should consist of usable fuel. The purpose of a zero fuel weight is to limit load forces on the wing spars with heavy fuselage loads.

Assume a hypothetical multiengine airplane with the following weights and capacities:

Basic empty weight 3,200 lbs
Zero fuel weight 4,400 lbs
Maximum takeoff weight 5,200 lbs
Maximum usable fuel 180 gal

1. Calculate the useful load:

Maximum takeoff weight 5,200 lbs
Basic empty weight –3,200 lbs
Useful load 2,000 lbs

The useful load is the maximum combination of usable fuel, passengers, baggage, and cargo that the airplane is capable of carrying.

2. Calculate the payload:

Zero fuel weight 4,400 lbs
Basic empty weight –3,200 lbs
Payload 1,200 lbs

The payload is the maximum combination of passengers, baggage, and cargo that the airplane is capable of carrying. A zero fuel weight, if published, is the limiting weight.

3. Calculate the fuel capacity at maximum payload (1,200 lb):

Maximum takeoff weight 5,200 lbs
Zero fuel weight –4,400 lbs
Fuel allowed 800 lbs

Assuming maximum payload, the only weight permitted in excess of the zero fuel weight should consist of usable fuel. In this case, 133.3 gallons (gal).

4. Calculate the payload at maximum fuel capacity (180 gal):

Basic empty weight 3,200 lbs
Maximum usable fuel +1,080 lbs
Weight with max. fuel 4,280 lbs
Maximum takeoff weight 5,200 lbs
Weight with max. fuel –4,280 lbs
Payload allowed 920 lbs

Assuming maximum fuel, the payload is the difference between the weight of the fueled airplane and the maximum takeoff weight.

Some multiengine airplanes have a ramp weight, which is in excess of the maximum takeoff weight. The ramp weight allows for fuel that would be burned during taxi and run-up, permitting a takeoff at full maximum takeoff weight. The airplane should weigh no more than maximum takeoff weight at the beginning of the takeoff roll.

A maximum landing weight is a limitation against landing at a weight in excess of the published value. This requires preflight planning of fuel burn to ensure that the airplane weight upon arrival at destination is at or below the maximum landing weight. In the event of an emergency requiring an immediate landing, the pilot should recognize that the structural margins designed into the airplane are not fully available when over landing weight. An overweight landing inspection may be advisable—the service manual or manufacturer should be consulted.

Although the foregoing problems only dealt with weight, the balance portion of weight and balance is equally vital. The flight characteristics of the multiengine airplane vary significantly with shifts of the center of gravity (CG) within the approved envelope.

At forward CG, the airplane is more stable, with a slightly higher stalling speed, a slightly slower cruising speed, and favorable stall characteristics. At aft CG, the airplane is less stable, with a slightly lower stalling speed, a slightly faster cruising speed, and less desirable stall characteristics. Forward CG limits are usually determined in certification by elevator/stabilator authority in the landing round out. Aft CG limits are determined by the minimum acceptable longitudinal stability. It is contrary to the airplane's operating limitations and 14 CFR to exceed any weight and balance parameter.

Some multiengine airplanes may require ballast to remain within CG limits under certain loading conditions. Several models require ballast in the aft baggage compartment with only a learner and instructor on board to avoid exceeding the forward CG limit. When passengers are seated in the aft-most seats of some models, ballast or baggage may be required in the nose baggage compartment to avoid exceeding the aft CG limit. The pilot should direct the seating of passengers and placement of baggage and cargo to achieve a CG within the approved envelope. Most multiengine airplanes have general loading recommendations in the weight and balance section of the AFM/POH. When ballast is added, it should be securely tied down, and it should not exceed the maximum allowable floor loading.

Some airplanes make use of a special weight and balance plotter. It consists of several movable parts that can be adjusted over a plotting board on which the CG envelope is printed. The reverse side of the typical plotter contains general loading recommendations for the particular airplane. A pencil line plot can be made directly on the CG envelope imprinted on the working side of the plotting board. This plot can easily be erased and recalculated anew for each flight. This plotter is to be used only for the make and model airplane for which it was designed.

## Ground Operation

Good habits learned with single-engine airplanes are directly applicable to multiengine airplanes for preflight and engine start. Upon placing the airplane in motion to taxi, the new multiengine pilot may notice several differences. The most obvious is the increased wingspan and the need for even greater vigilance while taxiing in close quarters. Ground handling may seem somewhat ponderous and the multiengine airplane is not as nimble as the typical two- or four-place single-engine airplane. As always, the pilot should use care not to ride the brakes by keeping engine power to a minimum. One ground handling advantage of the multiengine airplane over single-engine airplanes is the differential power capability. Turning with an assist from differential power minimizes both the need for brakes during turns and the turning radius.

The pilot should be aware, however, that making a sharp turn assisted by brakes and differential power can cause the airplane to pivot about a stationary inboard wheel and landing gear. The airplane was not designed for this action, and the pilot should not allow it to occur. Unless otherwise directed by the AFM/POH, all ground operations should be conducted with the cowl flaps fully open. The use of strobe lights is normally deferred until taxiing onto the active runway.

## Normal and Crosswind Takeoff and Climb

After completing the before takeoff checklist and pre-takeoff safety brief, and after receiving an air traffic control (ATC) clearance (if applicable), the pilot should check for approaching aircraft and line up on the runway centerline. If departing from an airport without an operating control tower, the pilot should listen on the appropriate frequency, make a careful check for traffic, and transmit a radio advisory before entering the runway. Sharp turns onto the runway combined with a rolling takeoff are not a good operating practice and may be prohibited by the AFM/POH due to the possibility of "unporting" a fuel tank pickup. The takeoff itself may be prohibited by the AFM/POH under any circumstances below certain fuel levels. The flight controls should be positioned for a crosswind, if present. Exterior lights, such as landing and taxi lights, and wingtip strobes should be illuminated immediately prior to initiating the takeoff roll, day or night. If holding in takeoff position for any length of time, particularly at night, the pilot should activate all exterior lights upon taxiing into position.

Takeoff power should be set as recommended in the AFM/POH. With normally aspirated (non-turbocharged) engines, this is full throttle. Full throttle is also used in most turbocharged engines. There are some turbocharged engines, however, that require the pilot to set a specific power setting, usually just below red line manifold pressure. This yields takeoff power with less than full throttle travel. Turbocharged engines often require special consideration. Throttle motion with turbocharged engines should be exceptionally smooth and deliberate. It is acceptable, and may even be desirable, to hold the airplane in position with brakes as the throttles are advanced. Brake release customarily occurs after significant boost from the turbocharger is established. This prevents utilizing the available runway with slow, partial throttle acceleration as the engine power is increased. If runway length or obstacle clearance is critical, full power should be set before brake release as specified in the performance charts. Note that for all airplanes equipped with constant speed propellers, the engines can turn at maximum rpm and can develop maximum engine power before brake release. Although the mass of air per revolution is small, the number of rpm is high and propeller thrust is maximized. Thrust is at a maximum at the beginning of the takeoff roll and then decreases as the airplane gains speed. The high slipstream velocity during takeoff increases the effective lift of the wing behind the propeller(s).

As takeoff power is established, initial attention should be divided between tracking the runway centerline and monitoring the engine gauges. Many novice multiengine pilots tend to fixate on the airspeed indicator just as soon as the airplane begins its takeoff roll. Instead, the pilot should confirm that both engines are developing full-rated manifold pressure and rpm, and that as the fuel flows, fuel pressures, exhaust gas temperatures (EGTs), and oil pressures are matched in their normal ranges. A directed and purposeful scan of the engine gauges can be accomplished well before the airplane approaches rotation speed. If a crosswind is present, the aileron displacement in the direction of the crosswind may be reduced as the airplane accelerates. The elevator/stabilator control should be held neutral throughout.

Full rated takeoff power should be used for every takeoff. Partial power takeoffs are not recommended. There is no evidence to suggest that the life of modern reciprocating engines is prolonged by partial power takeoffs. In actuality, excessive heat and engine wear can occur with partial power as the fuel metering system fails to deliver the slightly over-rich mixture vital for engine cooling during takeoff.

There are several key airspeeds to be noted during the takeoff and climb sequence in any twin. The first speed to consider is $V_{MC}$. If an engine fails below $V_{MC}$ while the airplane is on the ground, the takeoff needs to be rejected. Directional control can only be maintained by promptly closing both throttles and using rudder and brakes as required. If an engine fails below $V_{MC}$ while airborne, directional control is not possible with the remaining engine producing takeoff power. On takeoffs, therefore, the airplane should never be airborne before the airspeed exceeds $V_{MC}$. Pilots should use the manufacturer's recommended rotation speed ($V_R$) or lift-off speed ($V_{LOF}$). If no such speeds are published, a minimum of $V_{MC}$ plus 5 knots should be used for $V_R$.

The rotation to a takeoff pitch attitude is performed with smooth control inputs. With a crosswind, the pilot should ensure that the landing gear does not momentarily touch the runway after the airplane has lifted off, as a side drift is present. The rotation may be accomplished more positively and/or at a higher speed under these conditions. However, the pilot should keep in mind that the AFM/POH performance figures for accelerate-stop distance, takeoff ground roll, and distance to clear an obstacle were calculated at the recommended $V_R$ and/or $V_{LOF}$ speed.

After lift-off, the next consideration is to gain altitude as rapidly as possible. To assist the pilot in takeoff and initial climb profile, some AFM/POHs give a "50-foot" or "50-foot barrier" speed to use as a target during rotation, lift-off, and acceleration to $V_Y$. Prior to takeoff, pilots should review the takeoff distance to 50 feet above ground level (AGL) and the stopping distance from 50 feet AGL and add the distance together. If the runway is no longer than the total value, the odds are very good that if anything fails, it will be an off-runway landing at the least. After leaving the ground, altitude gain is more important than achieving an excess of airspeed. Experience has shown that excessive speed cannot be effectively converted into altitude in the event of an engine failure. Additional altitude increases the time available to recognize and respond to any aircraft abnormality or emergency during the climb segment.

Excessive climb attitudes can be just as dangerous as excessive airspeed. Steep climb attitudes limit forward visibility and impede the pilot's ability to detect and avoid other traffic. The airplane should be allowed to accelerate in a shallow climb to attain $V_Y$, the best all-engine rate-of-climb speed. $V_Y$ should then be maintained until achieving a safe single-engine maneuvering altitude, which considers terrain and obstructions. Any speed above or below $V_Y$ reduces the performance of the airplane. Even with all engines operating normally, terrain and obstruction clearance during the initial climb after takeoff is an important preflight consideration. Most airliners and most turbine-powered airplanes climb out at an attitude that yields best rate of climb ($V_Y$) usually utilizing a flight management system (FMS).

When to raise the landing gear after takeoff depends on several factors. Normally, the gear should be retracted when there is insufficient runway available for landing and after a positive rate of climb is established as indicated on the altimeter. If an excessive amount of runway is available, it would not be prudent to leave the landing gear down for an extended period of time and sacrifice climb performance and acceleration. Leaving the gear extended after the point at which a landing cannot be accomplished on the runway is a hazard. In some multiengine airplanes, operating in a high-density altitude environment, a positive rate of climb with the landing gear down is not possible. Waiting for a positive rate of climb under these conditions is not practicable. An important point to remember is that raising the landing gear as early as possible after liftoff drastically decreases the drag profile and significantly increases climb performance should an engine failure occur. An equally important point to remember is that leaving the gear down to land on sufficient runway or overrun is a much better option than landing with the gear retracted. A general recommendation is to raise the landing gear not later than $V_{YSE}$ airspeed, and once the gear is up, consider it a GO commitment if climb performance is available. Some AFM/POHs direct the pilot to apply the wheel brakes momentarily after lift-off to stop wheel rotation prior to landing gear retraction. If flaps were extended for takeoff, they should be retracted as recommended in the AFM/POH.

Once a safe, single-engine maneuvering altitude has been reached, typically a minimum of 400–500 feet AGL, the transition to an en route climb speed should be made. This speed is higher than $V_Y$ and is usually maintained to cruising altitude. En route climb speed gives better visibility, increased engine cooling, and a higher groundspeed. Takeoff power can be reduced, if desired, as the transition to en route climb speed is made.

Some airplanes have a climb power setting published in the AFM/POH as a recommendation (or sometimes as a limitation), which should then be set for en route climb. If there is no climb power setting published, it is customary, but not a requirement, to reduce manifold pressure and rpm somewhat for en route climb. The propellers are usually synchronized after the first power reduction and the yaw damper, if installed, engaged. The AFM/POH may also recommend leaning the mixtures during climb. The climb checklist should be accomplished as traffic and work load allow. *[Figure 13-7]*

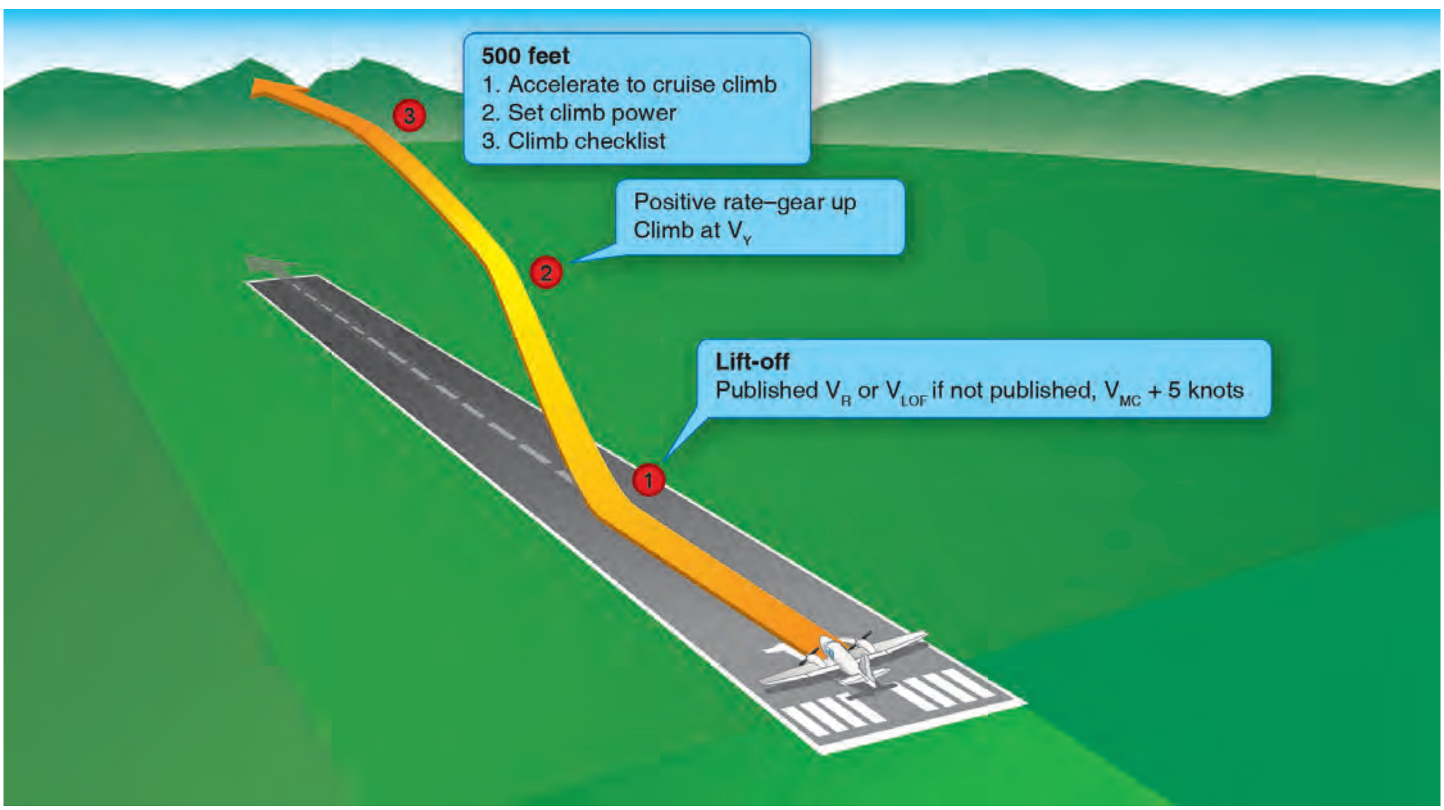


**Figure 13-7.** *Takeoff and climb profile.*

## Short-Field Takeoff and Climb

The short-field takeoff and climb differs from the normal takeoff and climb in the airspeeds and initial climb profile. Some AFM/POHs give separate short-field takeoff procedures and performance charts that recommend specific flap settings and airspeeds. Other AFM/POHs do not provide separate short-field procedures. In the absence of such specific procedures, the airplane should be operated only as recommended in the AFM/POH. No operations should be conducted contrary to the recommendations in the AFM/POH.

On short-field takeoffs in general, just after rotation and lift-off, the airplane should be allowed to accelerate to $V_X$, making the initial climb over obstacles at $V_X$ and transitioning to $V_Y$ as obstacles are cleared. *[Figure 13-8]*

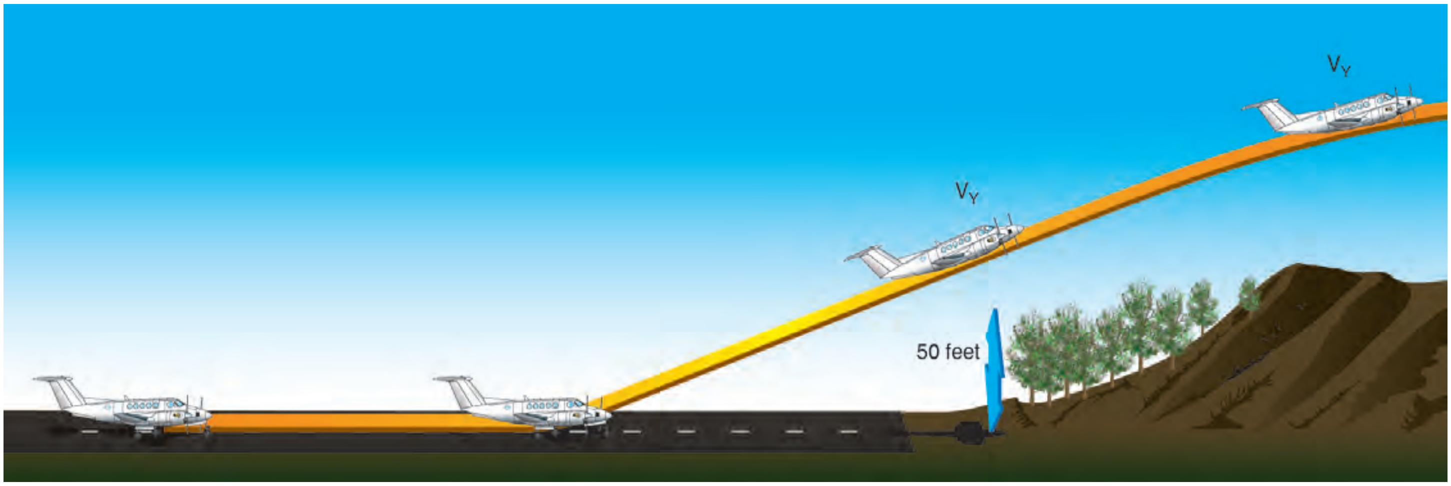


**Figure 13-8.** *Short-field takeoff and climb*

When partial flaps are recommended for short-field takeoffs, many light-twins have a strong tendency to become airborne prior to $V_{MC}$ plus 5 knots. Attempting to prevent premature lift-off with forward elevator pressure results in wheel barrowing. To prevent this, allow the airplane to become airborne, but only a few inches above the runway. The pilot should be prepared to promptly abort the takeoff and land in the event of engine failure on takeoff with landing gear and flaps extended at airspeeds below $V_X$.

Engine failure on takeoff, particularly with obstructions, is compounded by the low airspeeds and steep climb attitudes utilized in short-field takeoffs. $V_X$ and $V_{XSE}$ are often perilously close to $V_{MC}$, leaving scant margin for error in the event of engine failure as $V_{XSE}$ is assumed. If flaps were used for takeoff, the engine failure situation becomes even more critical due to the additional drag incurred. If $V_X$ is less than 5 knots higher than $V_{MC}$, give strong consideration to reducing useful load or using another runway in order to increase the takeoff margins so that a short-field technique is not required.

## Rejected Takeoff

A takeoff can be rejected for the same reasons a takeoff in a single-engine airplane would be rejected. Once the decision to reject a takeoff is made, the pilot should promptly close both throttles and maintain directional control with the rudder, nose-wheel steering, and brakes. Aggressive use of rudder, nose-wheel steering, and brakes may be required to keep the airplane on the runway, particularly if an engine failure is not immediately recognized and accompanied by prompt closure of both throttles. However, the primary objective is not necessarily to stop the airplane in the shortest distance, but to maintain control of the airplane as it decelerates. In some situations, it may be preferable to continue into the overrun area under control, rather than risk directional control loss, landing gear collapse, or tire/brake failure in an attempt to stop the airplane in the shortest possible distance.

## Level Off and Cruise

Upon leveling off at cruising altitude, the pilot should allow the airplane to accelerate at climb power until cruising airspeed is achieved, and then cruise power and rpm should be set. To extract the maximum cruise performance from any airplane, the power setting tables provided by the manufacturer should be closely followed. If the cylinder head and oil temperatures are within their normal ranges, the cowl flaps may be closed. When the engine temperatures have stabilized, the mixtures may be leaned per AFM/POH recommendations. The remainder of the cruise checklist should be completed by this point.

Fuel management in multiengine airplanes is often more complex than in single-engine airplanes. Depending upon system design, the pilot may need to select between main tanks and auxiliary tanks or even employ fuel transfer from one tank to another. In complex fuel systems, limitations are often found restricting the use of some tanks to level flight only or requiring a reserve of fuel in the main tanks for descent and landing. Electric fuel pump operation can also vary widely among different models, particularly during tank switching or fuel transfer. Some fuel pumps are to be on for takeoff and landing; others are to be off. There is simply no substitute for thorough systems and AFM/POH knowledge when operating complex aircraft.

## Slow Flight

There is nothing unusual about maneuvering during slow flight in a multiengine airplane. Slow flight may be conducted in straight-and-level flight, turns, climbs, or descents. It can also be conducted in the clean configuration, landing configuration, or at any other combination of landing gear and flaps. Slow flight in a multiengine airplane should be conducted so the maneuver can be completed no lower than 3,000 feet AGL or higher if recommended by the manufacturer. In all cases, practicing slow flight should be conducted at an adequate height above the ground for recovery should the airplane inadvertently stall.

Pilots should closely monitor cylinder head and oil temperatures during slow flight. Some high performance multiengine airplanes tend to heat up fairly quickly under some conditions of slow flight, particularly in the landing configuration. Simulated engine failures should not be conducted during slow flight. The airplane will be well below $V_{SSE}$ and very close to $V_{MC}$. Stability, stall warning, or stall avoidance devices should not be disabled while maneuvering during slow flight.

## Spin Awareness and Stalls

No multiengine airplane is approved for spins, and their spin recovery characteristics are generally very poor. It is therefore prudent to practice spin avoidance and maintain a high awareness of situations that can result in an inadvertent spin.

### Spin Awareness

In order to spin any airplane, a stalled condition needs to exist. At the stall, the presence or introduction of a yawing moment can initiate spin entry. In a multiengine airplane, the yawing moment may be generated by rudder input or asymmetrical thrust. It follows, then, that spin awareness be at its greatest during $V_{MC}$ demonstrations, stall practice, slow flight, or any condition of high asymmetrical thrust, particularly at low speed/high AOA. Single-engine stalls are not part of any multiengine training curriculum.

No engine failure should ever be introduced below safe, intentional one-engine inoperative speed ($V_{SSE}$). If no $V_{SSE}$ is published, use $V_{YSE}$. Other than training situations, the multiengine airplane is only operated below $V_{SSE}$ for mere seconds just after lift-off or during the last few dozen feet of altitude in preparation for landing.

For spin avoidance when practicing engine failures, the flight instructor should pay strict attention to the maintenance of proper airspeed and bank angle as the learner executes the appropriate procedure. The instructor should also be particularly alert during stall and slow flight practice. While flying with a center-of-gravity closer to the forward limit provides better stall and spin avoidance characteristics, it does not eliminate the hazard.

When performing a $V_{MC}$ demonstration, the instructor should also be alert for any sign of an impending stall. The learner may be highly focused on the directional control aspect of the maneuver to the extent that impending stall indications go unnoticed. If a $V_{MC}$ demonstration cannot be accomplished under existing conditions of density altitude, the instructor may, for training purposes, utilize a rudder blocking technique.

As very few twins have ever been spin-tested (none are required to), the recommended spin recovery techniques are based only on the best information available. The departure from controlled flight may be quite abrupt and possibly disorienting. The direction of an upright spin can be confirmed from the turn needle or the symbolic airplane of the turn coordinator, if necessary. Do not rely on the ball position or other instruments.

If a spin is entered, most manufacturers recommend immediately retarding both throttles to idle, applying full rudder opposite the direction of rotation, and applying full forward elevator/stabilator pressure (with ailerons neutral). These actions should be taken as near simultaneously as possible. The controls should then be held in that position until the spin has stopped. At that point adjust rudder pressure, back elevator pressure, and power as necessary to return to the desired flight path. Pilots should be aware that a spin recovery will take considerable altitude; therefore, it is critical that corrective action be taken immediately.

### Stall Training

It is recommended that stalls be practiced at an altitude that allows recovery no lower than 3,000 feet AGL for multiengine airplanes, or higher if recommended by the AFM/POH. Losing altitude during recovery from a stall is to be expected.

Stall characteristics vary among multiengine airplanes just as they do with single-engine airplanes, and therefore, a pilot should be familiar with them. Yet, the most important stall recovery step in a multiengine airplane is the same as it is in all airplanes: reduce the angle of attack (AOA). For reference, the stall recovery procedure described in Chapter 5 is included in *Figure 13-9*. Following a reduction in the AOA and the stall warning being eliminated, the wings should be rolled level and power added as needed. Immediate full application of power in a stalled condition has an associated risk due to the possibility of asymmetric thrust. In addition, single-engine stalls, or stalls with significantly more power on one engine than the other, should not be attempted due to the likelihood of a departure from controlled flight and possible spin entry. Similarly, simulated engine failures should not be performed during stall entry and recovery.

| Stall Recovery Template | |
|---|---|
| 1. Wing leveler or autopilot | 1. Disconnect |
| 2. a) Nose-down pitch control<br>b) Nose-down pitch trim | 2. a) Apply until impending stall indications are eliminated<br>b) As needed |
| 3. Bank | 3. Wings Level |
| 4. Thrust/Power | 4. As needed |
| 5. Speed brakes/spoilers | 5. Retract |
| 6. Return to the desired flight path | |

**Figure 13-9.** *Stall recovery procedure.*

### *Power-Off Approach to Stall (Approach and Landing)*

A power-off approach to stall is trained and checked to simulate problematic approach and landing scenarios. A power-off approach to stall may be performed with wings level, or from shallow turns (up to 20 degrees of bank). To initiate a power-off approach to stall maneuver, the area surrounding the airplane should first be cleared for possible traffic. The airplane should then be slowed and configured for an approach and landing. A stabilized descent should be established (approximately 500 fpm) and trim adjusted. A turn should be initiated at this point, if desired. The pilot should then smoothly increase the AOA to induce a stall warning. Power is reduced further during this phase, and trimming should cease at speeds slower than takeoff.

When the airplane reaches the stall warning (e.g., aural alert, buffet, etc.), the recovery is accomplished by first reducing the AOA until the stall warning is eliminated. The pilot then rolls the wings level with coordinated use of the rudder and smoothly applies power as required. The airplane should be accelerated to $V_X$ (if simulated obstacles are present) or $V_Y$ during recovery and climb. Considerable forward elevator/stabilator pressure will be required after the stall recovery as the airplane accelerates to $V_X$ or $V_Y$. Appropriate trim input should be anticipated. The flap setting should be reduced from full to approach, or as recommended by the manufacturer. Then, with a positive rate of climb, the landing gear is selected up. The remaining flaps are then retracted as a positive rate-of-climb continues.

### *Power-On Approach to Stall (Takeoff and Departure)*

A power-on approach to stall is trained and checked to simulate problematic takeoff scenarios. A power-on approach to stall may be performed from straight-and-level flight or from shallow and medium banked turns (up to 20 degrees of bank). To initiate a power-on approach to stall maneuver, the area surrounding the airplane should always be cleared to look for potential traffic. The airplane is slowed to the manufacturer's recommended lift-off speed. The airplane should be configured in the takeoff configuration. Trim should be adjusted for this speed. Engine power is then increased to that recommended in the AFM/POH for the practice of power-on approach to stall. In the absence of a recommended setting, use approximately 65 percent of maximum available power. Begin a turn, if desired, while increasing AOA to induce a stall warning (e.g., aural alert, buffet, etc.). Other specified (reduced) power settings may be used to simulate performance at higher gross weights and density altitudes.

When the airplane reaches the stall warning, the recovery is made first by reducing the AOA until the stall warning is eliminated. The pilot then rolls the wings level with coordinated use of the rudder and applying power as needed. However, if simulating limited power available for high gross weight and density altitude situations, the power during the recovery should be limited to that specified. The landing gear should be retracted when a positive rate of climb is attained, and flaps retracted, if flaps were set for takeoff. The target airspeed on recovery is $V_X$ if (simulated) obstructions are present, or $V_Y$. The pilot should anticipate the need for nose-down trim as the airplane accelerates to $V_X$ or $V_Y$ after recovery.

***Full Stall***

It is not recommended that full stalls be practiced unless a qualified flight instructor is present. A power-off or power-on full stall should only be practiced in a structured lesson with clear learning objectives and cautions discussed. The goals of the training are (a) to provide the pilots the experience of the handling characteristics and dynamic cues (e.g., buffet, roll off) near and at full stall and (b) to reinforce the proper application of the stall recovery procedures. Given the associated risk of asymmetric thrust at high angles of attack and low rudder effectiveness due to low airspeeds, this reinforces the primary step of first lowering the AOA, which allows all control surfaces to become more effective and allows for roll to be better controlled. Thrust should only be used as needed in the recovery.

***Accelerated Approach to Stall***

Accelerated approach to stall should be performed with a bank of approximately 45°, and in no case at a speed greater than the airplane manufacturer's recommended airspeed, the specified design maneuvering speed ($V_A$), or operating maneuvering speed ($V_O$). The pilot should select an entry altitude that will allow completion of the maneuver no lower than 3,000 feet AGL.

The entry method for the maneuver is no different than for a single-engine airplane. Once at an appropriate speed, begin increasing the back pressure on the elevator while maintaining a coordinated 45° turn. A good speed reduction rate is approximately 3 to 5 knots per second. Once a stall warning occurs, recover promptly by reducing the AOA until the stall warning stops. Then, roll the wings level with coordinated rudder and add power as necessary to return to the desired flightpath.

## Normal Approach and Landing

Given the higher cruising speed (and frequently altitude) of multiengine airplanes over most single-engine airplanes, the descent needs to be planned in advance. A hurried, last minute descent with power at or near idle is inefficient and can cause excessive engine cooling. It may also lead to passenger discomfort, particularly if the airplane is unpressurized. As a rule of thumb, if terrain and passenger conditions permit, a maximum of a 500 fpm rate of descent should be planned. Pressurized airplanes can plan for higher descent rates, if desired.

In a descent, some airplanes require a minimum EGT or may have a minimum power setting or cylinder head temperature to maintain. In any case, combinations of very low manifold pressure and high rpm settings are strongly discouraged by engine manufacturers. If higher descent rates are necessary, the pilot should consider extending partial flaps or lowering the landing gear before retarding the power excessively. The descent checklist should be initiated upon leaving cruising altitude and completed before arrival in the terminal area. Upon arrival in the terminal area, pilots are encouraged to turn on their landing and recognition lights when operating below 10,000 feet, day or night, and especially when operating within 10 miles of any airport or in conditions of reduced visibility.

The traffic pattern and approach are typically flown at somewhat higher indicated airspeeds in a multiengine airplane contrasted to most single-engine airplanes. The pilot may allow for this through an early start on the before-landing checklist. This provides time for proper planning, spacing, and thinking well ahead of the airplane. Many multiengine airplanes have partial flap extension speeds above $V_{FE}$, and partial flaps can be deployed prior to traffic pattern entry. Normally, the landing gear should be selected and confirmed down when abeam the intended point of landing as the downwind leg is flown. *[Figure 13-10]*

The FAA recommends a stabilized approach concept. To the greatest extent practical, on final approach and within 500 feet AGL, the airplane should be on speed, in trim, configured for landing, tracking the extended centerline of the runway, and established in a constant angle of descent toward an aim point in the touchdown zone. Absent unusual flight conditions, only minor corrections are required to maintain this approach to the round out and touchdown.

The final approach should be made with power and at a speed recommended by the manufacturer; if a recommended speed is not furnished, the speed should be no slower than the single-engine best rate-of-climb speed ($V_{YSE}$) until short final with the landing assured, but in no case less than critical engine-out minimum control speed ($V_{MC}$). Some multiengine pilots prefer to delay full flap extension to short final with the landing assured. This is an acceptable technique with appropriate experience and familiarity with the airplane.

In the round out for landing, residual power is gradually reduced to idle. With the higher wing loading of multiengine airplanes and with the drag from two windmilling propellers, there is minimal float. Full stall landings are generally undesirable in twins. The airplane should be held off as with a high performance single-engine model, allowing touchdown of the main wheels prior to a full stall.

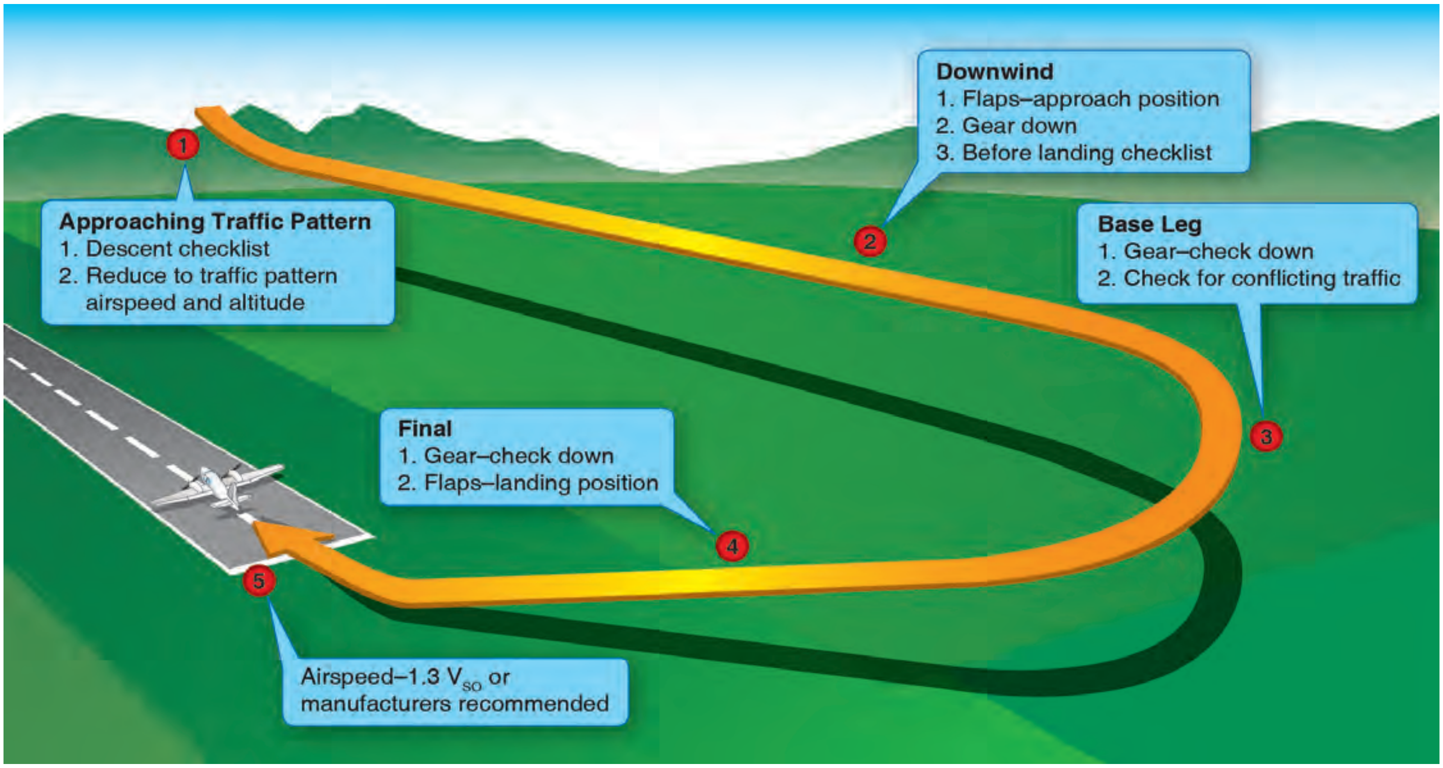


**Figure 13-10.** *Normal two-engine approach and landing.*

Under favorable wind and runway conditions, the nose-wheel can be held off for best aerodynamic braking. Even as the nose-wheel is gently lowered to the runway centerline, continued elevator back pressure greatly assists the wheel brakes in stopping the airplane.

If runway length is critical, or with a strong crosswind, or if the surface is contaminated with water, ice, or snow, it is undesirable to rely solely on aerodynamic braking after touchdown. The full weight of the airplane should be placed on the wheels as soon as practicable. The wheel brakes are more effective than aerodynamic braking alone in decelerating the airplane.

Once on the ground, elevator back pressure should be used to place additional weight on the main wheels. When necessary, wing flap retraction also adds additional weight to the wheels and improves braking effectivity. Flap retraction during the landing rollout is discouraged, however, unless there is a clear, operational need. It should not be accomplished as routine with each landing.

Some multiengine airplanes, particularly those of the cabin class variety, can be flown through the round out and touchdown with a small amount of power. This is an acceptable technique to prevent high sink rates and to cushion the touchdown. The pilot should keep in mind, however, that the primary purpose in landing is to get the airplane down and stopped. This technique should only be attempted when there is a generous margin of runway length. As propeller blast flows directly over the wings, lift as well as thrust is produced. The pilot should taxi clear of the runway as soon as speed and safety permit, and then accomplish the after-landing checklist. Ordinarily, no attempt should be made to retract the wing flaps or perform other checklist duties until the airplane has been brought to a halt when clear of the active runway. Exceptions to this would be the rare operational needs discussed above, to relieve the weight from the wings and place it on the wheels. In these cases, AFM/POH guidance should be followed. The pilot should not indiscriminately reach out for any switch or control on landing rollout. An inadvertent landing gear retraction while meaning to retract the wing flaps may result.

## Crosswind Approach and Landing

The multiengine airplane is often easier to land in a crosswind than a single-engine airplane due to its higher approach and landing speed. In any event, the principles are no different between singles and twins. Prior to touchdown, the longitudinal axis should be aligned with the runway centerline to avoid landing gear side loads.

The two primary methods, crab and wing-low, are typically used in conjunction with each other. As soon as the airplane rolls out onto final approach, the crab angle to track the extended runway centerline is established. This is coordinated flight with adjustments to heading to compensate for wind drift either left or right. Prior to touchdown, the transition to a sideslip is made with the upwind wing lowered and opposite rudder applied to prevent a turn. The airplane touches down on the landing gear of the upwind wing first, followed by that of the downwind wing, and then the nose gear. Follow-through with the flight controls involves an increasing application of aileron into the wind until full control deflection is reached.

The point at which the transition from the crab to the sideslip is made is dependent upon pilot familiarity with the airplane and experience. With high skill and experience levels, the transition can be made during the round out just before touchdown. With lesser skill and experience levels, the transition is made at increasing distances from the runway. Some multiengine airplanes (as some single-engine airplanes) have AFM/POH limitations against slips in excess of a certain time period; 30 seconds, for example. This is to prevent engine power loss from fuel starvation as the fuel in the tank of the lowered wing flows toward the wingtip, away from the fuel pickup point. This time limit should be observed if the wing-low method is utilized.

Some multiengine pilots prefer to use differential power to assist in crosswind landings. The asymmetrical thrust produces a yawing moment little different from that produced by the rudder. When the upwind wing is lowered, power on the upwind engine is increased to prevent the airplane from turning. This alternate technique is completely acceptable, but most pilots feel they can react to changing wind conditions quicker with rudder and aileron than throttle movement. This is especially true with turbocharged engines where the throttle response may lag momentarily. The differential power technique should be practiced with an instructor before being attempted alone.

## Short-Field Approach and Landing

The primary elements of a short-field approach and landing do not differ significantly from a normal approach and landing. Many manufacturers do not publish short-field landing techniques or performance charts in the AFM/POH. In the absence of specific short-field approach and landing procedures, the airplane should be operated as recommended in the AFM/POH. No operations should be conducted contrary to the AFM/POH recommendations.

The emphasis in a short-field approach is on configuration (full flaps), a stabilized approach with a constant angle of descent, and precise airspeed control. As part of a short-field approach and landing procedure, some AFM/POHs recommend a slightly slower than normal approach airspeed. If no such slower speed is published, use the AFM/POH-recommended normal approach speed.

Full flaps are used to provide the steepest approach angle. If obstacles are present, the approach should be planned so that no drastic power reductions are required after they are cleared. The power should be smoothly reduced to idle in the round out prior to touchdown. Pilots should keep in mind that the propeller blast blows over the wings providing some lift in addition to thrust. Reducing power significantly, just after obstacle clearance, usually results in a sudden, high sink rate that may lead to a hard landing. After the short-field touchdown, maximum stopping effort is achieved by retracting the wing flaps, adding back pressure to the elevator/stabilator, and applying heavy braking. However, if the runway length permits, the wing flaps should be left in the extended position until the airplane has been stopped clear of the runway. There is always a significant risk of retracting the landing gear instead of the wing flaps when flap retraction is attempted on the landing rollout.

Landing conditions that involve a short field, high winds, or strong crosswinds are just about the only situations where flap retraction on the landing rollout should be considered. When there is an operational need to retract the flaps just after touchdown, it needs to be done deliberately with the flap handle positively identified before it is moved.

## Go-Around

When the decision to go around is made, the throttles should be advanced to takeoff power and pitch adjusted to arrest the sink rate. With adequate airspeed, the airplane should be placed in a climb pitch attitude. These actions, which are accomplished sequentially, arrest the sink rate and place the airplane in the proper attitude for transition to a climb. The initial target airspeed is $V_Y$ or $V_X$ if obstructions are present. With sufficient airspeed, the flaps should be retracted from full to an intermediate position and the landing gear retracted when there is a positive rate of climb and no chance of runway contact. The remaining flaps should then be retracted. [Figure 13-11]

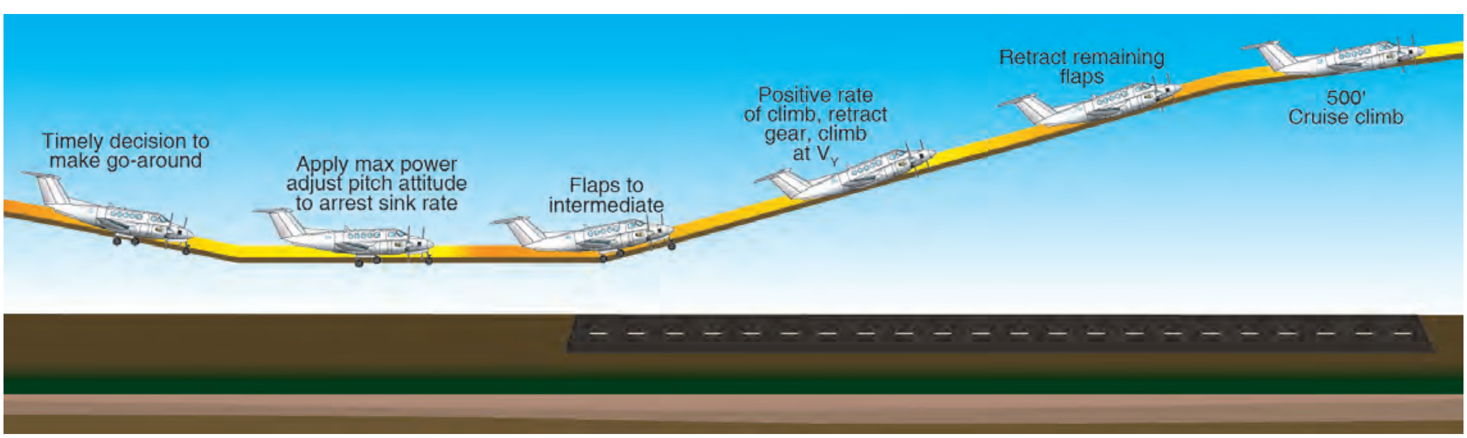


**Figure 13-11.** *Go-around procedure.*

If the go-around was initiated due to conflicting traffic on the ground or aloft, the pilot should consider maneuvering to the side to keep the conflicting traffic in sight. This may involve a slight turn to offset from the runway/landing area.

If the airplane was in trim for the landing approach when the go-around was commenced, it soon requires a great deal of forward elevator/stabilator pressure as the airplane accelerates away in a climb. The pilot should apply appropriate forward pressure to maintain the desired pitch attitude. Trim should be commenced immediately. The balked landing checklist should be reviewed as work load permits.

Flaps should be retracted before the landing gear for two reasons. First, on most airplanes, full flaps produce more drag than the extended landing gear. Secondly, the airplane tends to settle somewhat with flap retraction, and the landing gear should be down in the event of an inadvertent, momentary touchdown.

Many multiengine airplanes have a landing gear retraction speed significantly less than the extension speed. Care should be exercised during the go-around not to exceed the retraction speed. If the pilot desires to return for a landing, it is essential to re-accomplish the entire before-landing checklist. An interruption to a pilot's habit patterns, such as a go-around, is a classic scenario for a subsequent gear-up landing.

The preceding discussion about performing a go-around assumes that the maneuver was initiated from normal approach speeds or faster. If the go-around was initiated from a low airspeed, the initial pitch up to a climb attitude should be tempered with the necessity to maintain adequate flying speed throughout the maneuver. Examples of where this applies include a go-around initiated from the landing round out or recovery from a bad bounce, as well as a go-around initiated due to an inadvertent approach to a stall. The first priority is always to maintain control and obtain adequate flying speed. A few moments of level or near level flight may be required as the airplane accelerates up to climb speed.

## Engine Inoperative Flight Principles

There are two main considerations for OEI operations—*performance and control*. Multiengine pilots learn to operate the airplane for maximum *rate of climb performance* at the blue radial indicated airspeed by training to fly without sideslip. Pilots also learn to recognize and recover from loss of *directional control* associated with the red radial indicated airspeed by performing a $V_{MC}$ demonstration. Since the object of a $V_{MC}$ demonstration is not performance, sideslip occurs during the maneuver. Detailed discussion on both the loss of directional control and maximum OEI climb performance follows.

### Derivation of $V_{MC}$

$V_{MC}$ is a speed established by the manufacturer, published in the AFM/POH, and marked on most airspeed indicators with a red radial line. A knowledgeable and competent multiengine pilot understands that $V_{MC}$ is ***not*** a fixed airspeed under all conditions. $V_{MC}$ is a fixed airspeed only for the very specific set of circumstances under which it was determined during aircraft certification. In reality, $V_{MC}$ varies with a variety of factors as outlined below. The $V_{MC}$ noted in practice and demonstration, or in actual OEI operation, could be less or even greater than the published value, depending on conditions and pilot technique.

Historically, in aircraft certification, $V_{MC}$ is the sea level calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane with that engine still inoperative and then maintain straight flight at the same speed with an angle of bank not more than 5°.

The foregoing refers to the determination of $V_{MC}$ under *dynamic* conditions. This technique is only used by highly experienced test pilots during aircraft certification. It is unsafe to be attempted outside of these circumstances.

In aircraft certification, there is also a determination of $V_{MC}$ under *static*, or steady-state conditions. If there is a difference between the dynamic and static speeds, the higher of the two is published as $V_{MC}$. The *static* determination is simply the ability to maintain straight flight at $V_{MC}$ with a bank angle of not more than 5°. This more closely resembles the $V_{MC}$ demonstration task in the practical test for a multiengine rating.

The AFM/POH-published $V_{MC}$ is determined with the *critical* engine inoperative. The critical engine is the engine whose failure had the most adverse effect on directional control. On twins with each engine rotating in conventional, clockwise rotation as viewed from the pilot's seat, the critical engine will be the left engine.

Multiengine airplanes are subject to P-factor just as single-engine airplanes are. The descending propeller blade of each engine will produce greater thrust than the ascending blade when the airplane is operated under power and at positive angles of attack. The descending propeller blade of the right engine is also a greater distance from the center of gravity, and therefore has a longer moment arm than the descending propeller blade of the left engine. As a result, failure of the left engine will result in the most asymmetrical thrust (adverse yaw) as the right engine will be providing the remaining thrust. *[Figure 13-12]*

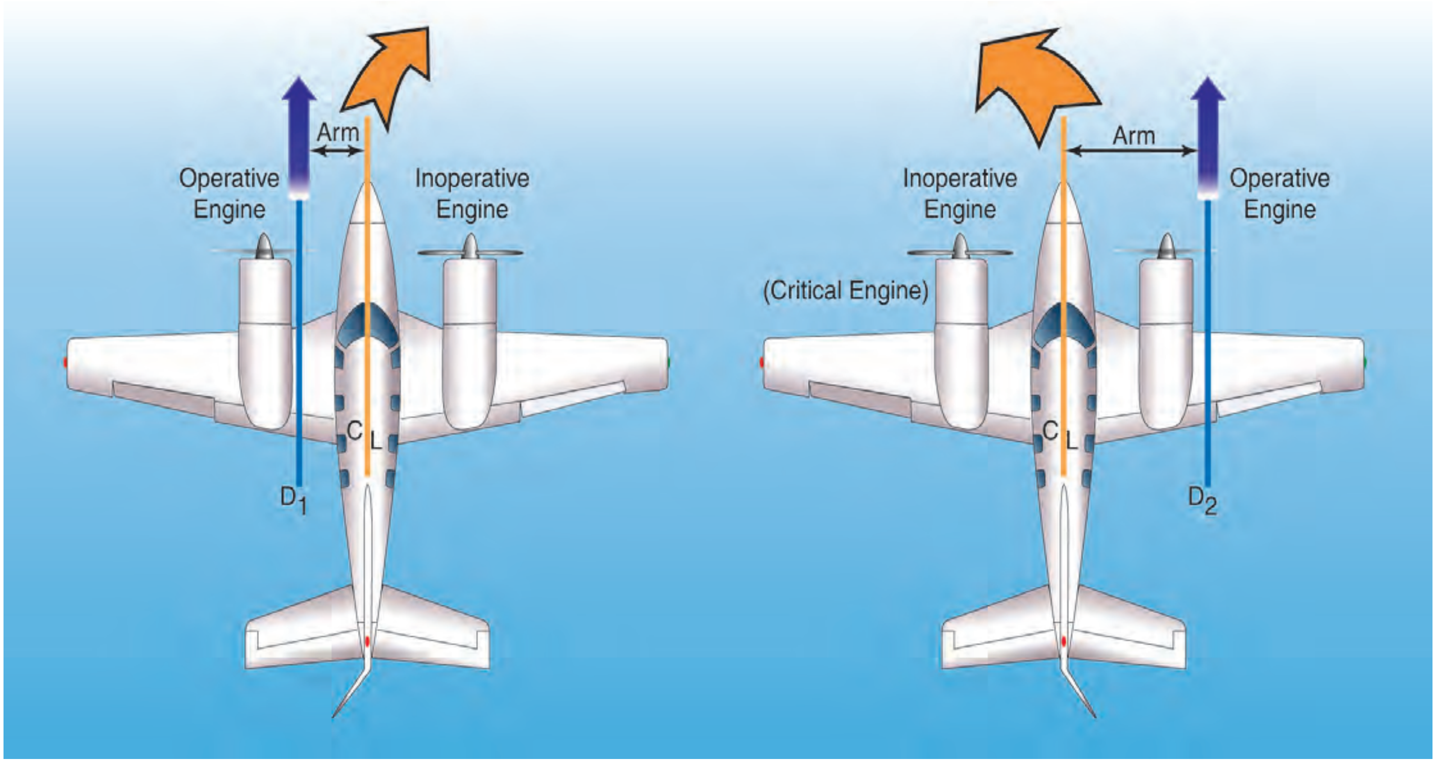


**Figure 13-12.** *Forces created during single-engine operation.*

Many twins are designed with a counter-rotating right engine. With this design, the degree of asymmetrical thrust is the same with either engine inoperative. No engine is more critical than the other, and a $V_{MC}$ demonstration may be performed with either engine windmilling.

The following bullets describe the way several factors affect $V_{MC}$ speed for those multiengine airplanes often used during training, which were certified in accordance with historical 14 CFR part 23, section 23.149. They also describe the conditions used to determine the manufacturer's published speed. Historically, in aircraft certification, *dynamic* $V_{MC}$ has been determined under the following conditions outlined in historical 14 CFR part 23, section 23.149:

- **Maximum available takeoff power initially on each engine (section 23.149(b)(1)).** $V_{MC}$ increases as power is increased on the operating engine. With normally aspirated engines, $V_{MC}$ is highest at takeoff power and sea level, and decreases with altitude. With turbocharged engines, takeoff power, and therefore $V_{MC}$, remains constant with increases in altitude up to the engine's critical altitude (the altitude where the engine can no longer maintain 100 percent power). Above the critical altitude, $V_{MC}$ decreases just as it would with a normally aspirated engine whose critical altitude is sea level. In order to avoid accidents, test pilots conduct $V_{MC}$ tests at a variety of altitudes, and the results of those tests are then extrapolated to a single, sea level value.

- **All propeller controls in the recommended takeoff position throughout $V_{MC}$ determination (section 23.149(b)(5)).** $V_{MC}$ increases with increased drag on the inoperative engine. $V_{MC}$ is highest, therefore, when the critical engine propeller is windmilling at the low pitch, high rpm blade angle. $V_{MC}$ is normally determined with the critical engine propeller windmilling in the takeoff position, unless the engine is equipped with an autofeather system.

- **Most unfavorable weight and center-of-gravity position (section 23.149(b)).** $V_{MC}$ increases as the center-of-gravity (CG) is moved aft. The moment arm of the rudder is reduced, and therefore its effectivity is reduced, as the CG is moved aft. For a typical light twin, the aft-most CG limit is the most unfavorable CG position. Historically, 14 CFR part 23 calls for $V_{MC}$ to be determined at the most unfavorable weight. For twins certificated under CAR 3 or early 14 CFR part 23, the weight at which $V_{MC}$ was determined was not specified. $V_{MC}$ increases as weight is reduced. [*Figure 13-13*]

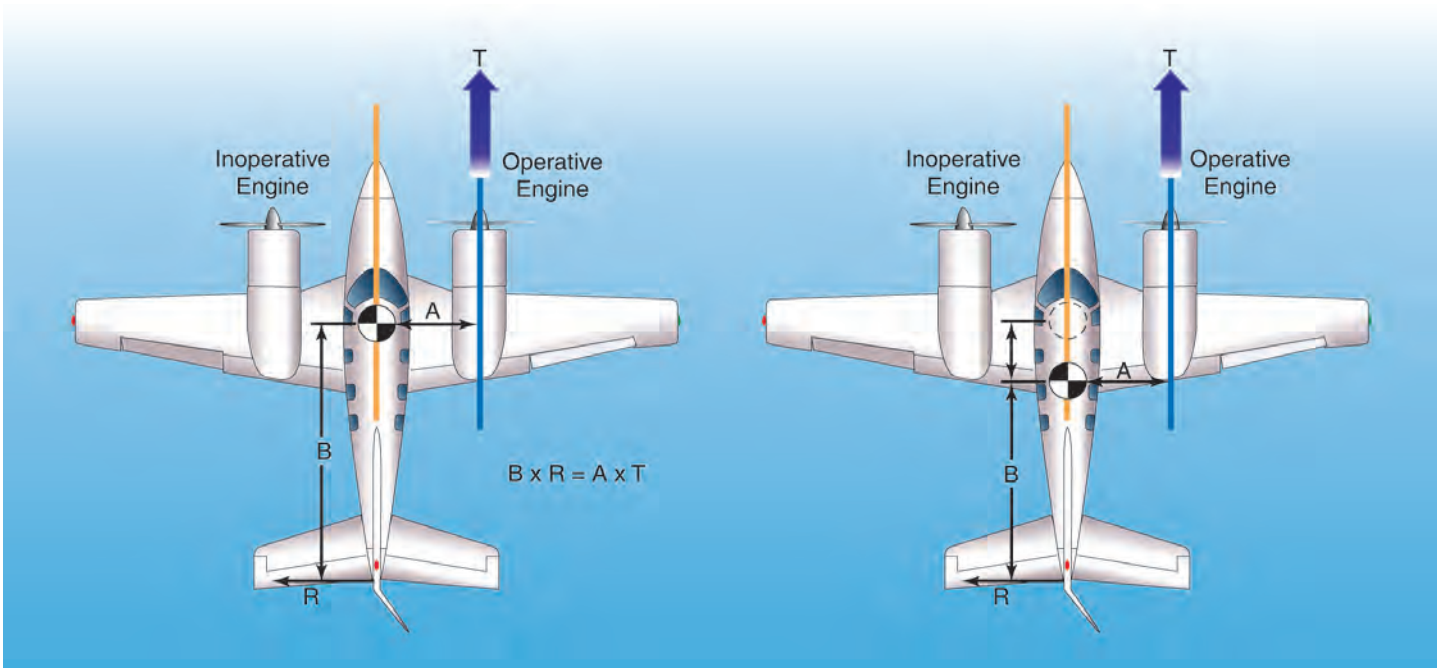


**Figure 13-13.** *Effect of CG location on yaw.*

- **Landing gear retracted (section 23.149(b)(4)).** $V_{MC}$ increases when the landing gear is retracted. Extended landing gear aids directional stability, which tends to decrease $V_{MC}$.

- **Flaps in the takeoff position (section 23.149(b)(3)).** This normally includes wing flaps and cowl flaps. For most twins, this will be 0° of flaps.

- **Airplane trimmed for takeoff (section 23.149(b)(2)).**

- **Airplane airborne and the ground effect negligible (section 23.149(b)).**

- **Maximum of 5° angle of bank (section 23.149(a)).** $V_{MC}$ is highly sensitive to bank angle. To prevent claims of an unrealistically low $V_{MC}$ speed in aircraft certification, the manufacturer is permitted to use a maximum of a 5° bank angle toward the operative engine. The horizontal component of lift generated by the bank balances the side force from the rudder, rather than using sideslip to do so. Sideslip requires more rudder deflection, which in turn increases $V_{MC}$. The bank angle works in the manufacturer's favor in lowering $V_{MC}$ since using high bank angles reduces required rudder deflection. However, this method may result in unsafe flight from both the large sideslip and the need to increase the angle of attack in order to maintain the vertical component of lift.

$V_{MC}$ increases as bank angle decreases. In fact, $V_{MC}$ may increase more than 3 knots for each degree of bank reduction between 5° and wings-level. Since $V_{MC}$ was determined with up to 5° of bank, loss of directional control may be experienced at speeds almost 20 knots above published $V_{MC}$ when the wings are held level.

The 5° bank angle maximum is a historical limit imposed upon manufacturers in aircraft certification. The 5° bank does not inherently establish zero sideslip or best single-engine climb performance. Zero sideslip, and therefore best single-engine climb performance, may occur at bank angles less than 5°. The determination of $V_{MC}$ in certification is solely concerned with the minimum speed for directional control under a very specific set of circumstances, and not the optimum airplane attitude or configuration for climb performance.

During *dynamic* $V_{MC}$ determination in aircraft certification, cuts of the critical engine using the mixture control are performed by flight test pilots while gradually reducing the speed with each attempt. $V_{MC}$ is the minimum speed at which directional control could be maintained within 20° of the original entry heading when a cut of the critical engine was made. During such tests, the climb angle with both engines operating was high, and the pitch attitude following the engine cut had to be quickly lowered to regain the initial speed. Transitioning pilots should understand that attempting to demonstrate $V_{MC}$ with an engine cut from high power, or intentionally failing an engine at speeds less than $V_{SSE}$ creates a high likelihood for loss of control and an accident.

### $V_{MC}$ Demo

The actual demonstration of $V_{MC}$ and recovery in flight training more closely resembles *static* $V_{MC}$ determination in aircraft certification. For a demonstration that avoids the hazard of unintended contact with the ground, the pilot selects an altitude that will allow performance of the maneuver at least 3,000 feet AGL. The following description assumes a twin with non-counter-rotating engines, where the left engine is critical.

With the landing gear retracted and the flaps set to the takeoff position, the pilot slows the airplane to approximately 10 knots above $V_{SSE}$ or $V_{YSE}$ (whichever is higher) and trims for takeoff. For the remainder of the maneuver, the trim setting remains unaltered. The pilot selects an entry heading and sets high rpm on both propeller controls. Power on the left engine is throttled back to idle as the right engine power is advanced to the takeoff setting. The landing gear warning horn will sound as long as a throttle is retarded, however the pilot listens carefully for the stall warning horn or watches for the stall warning light. The left yawing and rolling moment of the asymmetrical thrust is counteracted primarily with right rudder. A bank angle of up to 5° (a right bank in this case) may be established as appropriate for the airplane make and model.

While maintaining entry heading, the pitch attitude is slowly increased to decelerate at a rate of 1 knot per second (no faster). As the airplane slows and control effectivity decays, the pilot counteracts the increasing yawing tendency with additional rudder pressure. Aileron displacement will also increase in order to maintain the established bank. An airspeed is soon reached where full right rudder travel and up to a 5° right bank can no longer counteract the asymmetrical thrust, and the airplane will begin to yaw uncontrollably to the left.

The moment the pilot first recognizes the uncontrollable yaw, or experiences any symptom associated with a stall, the pilot simultaneously retards the throttle for the operating engine to stop the yaw and lowers the pitch attitude to regain speed. Recovery is made to straight flight on the entry heading at $V_{SSE}$ or $V_{YSE}$. The pilot increases power to the operating engine, and demonstrates controlled flight before restoring symmetrical power.

To keep the foregoing description simple, there were several important background details that were not covered. The rudder pressure during the demonstration can be quite high. During certification under historical 14 CFR part 23, section 23.149(e), 150 pounds of force was permitted. Most twins will run out of rudder travel long before 150 pounds of pressure is required. Still, the rudder pressure used during any $V_{MC}$ demonstration may seem considerable.

Maintaining altitude is not a criterion in accomplishing this maneuver. This is a demonstration of controllability, not performance. Many airplanes will lose (or gain) altitude during the demonstration. Remaining at or above a minimum of 3,000 feet AGL throughout the maneuver is considered to be effective risk mitigation of certain hazards.

### $V_{MC}$ Demo Stall Avoidance

As discussed earlier, with normally aspirated engines, $V_{MC}$ decreases with altitude. Stalling speed ($V_S$), however, remains the same. Except for a few models, published $V_{MC}$ is almost always higher than $V_S$. At sea level there is usually a margin of several knots between $V_{MC}$ and $V_S$, but the margin decreases with altitude, and at some altitude, $V_{MC}$ and $V_S$ are the same. *[Figure 13-14]*

Should a stall occur while the airplane is under asymmetrical power, a spin entry is likely. The yawing moment induced from asymmetrical thrust is little different from that induced by full rudder in an intentional spin in the appropriate model of single-engine airplane. In this case, however, the airplane will depart controlled flight in the direction of the idle engine, not in the direction of applied rudder. Twins are not required to demonstrate recoveries from spins, and their spin recovery characteristics are generally very poor.

Where $V_S$ is encountered before $V_{MC}$, the departure from controlled flight might be quite sudden, with strong yawing and rolling tendencies to the inverted orientation and a spin entry. Therefore, during a $V_{MC}$ demonstration, if there are any symptoms of an impending stall such as a stall warning light or horn, airframe or elevator buffet, or sudden loss of control effectiveness; the pilot should terminate the maneuver immediately by reducing the angle of attack as the throttle is retarded and return the airplane to the entry airspeed. Note that noise within the flight deck may mask the sound of the stall warning horn.

While the $V_{MC}$ demonstration shows the earliest onset of a loss of directional control when performed in accordance with the foregoing procedures, avoid a stalled condition. Avoid stalls with asymmetrical thrust, such that the $V_{MC}$ demonstration does not degrade into a single-engine stall. A $V_{MC}$ demonstration that is allowed to degrade into a single-engine stall with high asymmetrical thrust may result in an unrecoverable loss of control and a fatal accident.

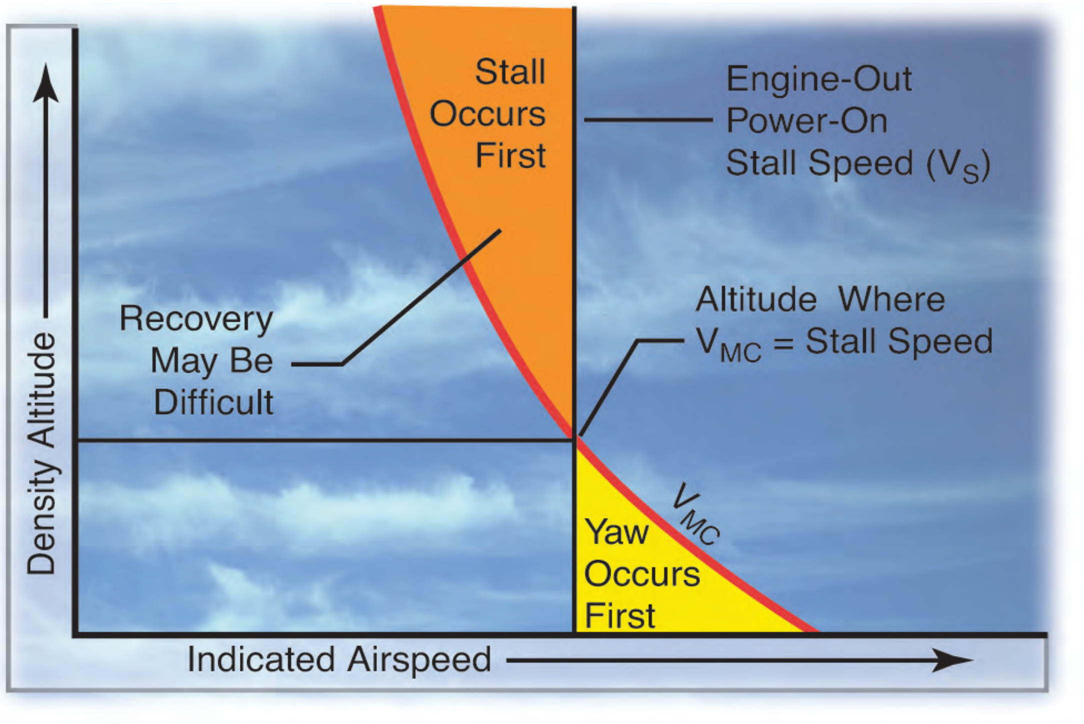


**Figure 13-14.** *Graph depicting relationship of $V_{MC}$ to $V_S$.*

An actual demonstration of $V_{MC}$ may not be possible under certain conditions of density altitude, or with airplanes whose $V_{MC}$ is equal to or less than $V_S$. Under those circumstances, as a training technique, a demonstration of $V_{MC}$ may safely be conducted by artificially limiting rudder travel to simulate maximum available rudder. A speed well above $V_S$ (approximately 20 knots) is recommended when limiting rudder travel.

The rudder limiting technique avoids the hazards of spinning as a result of stalling with high asymmetrical power, yet is effective in demonstrating the loss of directional control.

To reduce the risk of a loss of control, avoid performing any $V_{MC}$ demonstration from a high pitch attitude with both engines operating and then reducing power on one engine.

### OEI Climb Performance

Best OEI climb performance is obtained at $V_{YSE}$ with maximum available power and minimum drag. After the flaps and landing gear have been retracted and the propeller of the failed engine feathered, a key element in best climb performance is minimizing sideslip.

For any airplane, sideslip can be confirmed through the use of a yaw string. A yaw string is a piece of string or yarn approximately 18 to 36 inches in length taped to the base of the windshield or to the nose near the windshield along the airplane centerline. In two-engine coordinated flight, the relative wind causes the string to align itself with the longitudinal axis of the airplane, and it positions itself straight up the center of the windshield. This is zero sideslip. Experimentation with slips and skids vividly displays the location of the relative wind. A particular combination of aileron and rudder also establishes zero sideslip during OEI flight. Adequate altitude, flying speed, and caution should be maintained if attempting these maneuvers.

With a single-engine airplane or a multiengine airplane with both engines operative, sideslip is eliminated when the ball of the turn and bank instrument is centered. This is a condition of zero sideslip, and the airplane is presenting its smallest possible profile to the relative wind. As a result, drag is at its minimum. Pilots know this as coordinated flight.

In a multiengine airplane with an inoperative engine, the centered ball is no longer the indicator of zero sideslip due to asymmetric thrust. In fact, there is no flight deck instrument that directly indicates conditions for zero sideslip. In the absence of a yaw string, the pilot needs to place the airplane at a predetermined bank angle and ball position. Since the AFM/POH performance charts for one engine inoperative flight were determined at zero sideslip, this technique should be used to obtain the charted OEI performance. There are two different control inputs that can be used to counteract the asymmetric thrust of a failed engine:

1. Yaw from the rudder
2. The horizontal component of lift that results from bank with the ailerons

Used individually, neither is correct. Used together in the proper combination, zero sideslip and best climb performance are achieved.

Three different scenarios of airplane control inputs are presented below. The first two are not correct and can increase the risk of a loss of control. They are presented to illustrate the reasons for the zero sideslip approach to best climb performance.

1. Engine inoperative flight with wings level and ball centered requires large rudder input toward the operative engine. *[Figure 13-15]* The result is a moderate sideslip toward the inoperative engine. Climb performance is reduced by the moderate sideslip. With wings level, $V_{MC}$ is significantly higher than published as there is no horizontal component of lift available to help the rudder combat asymmetrical thrust.

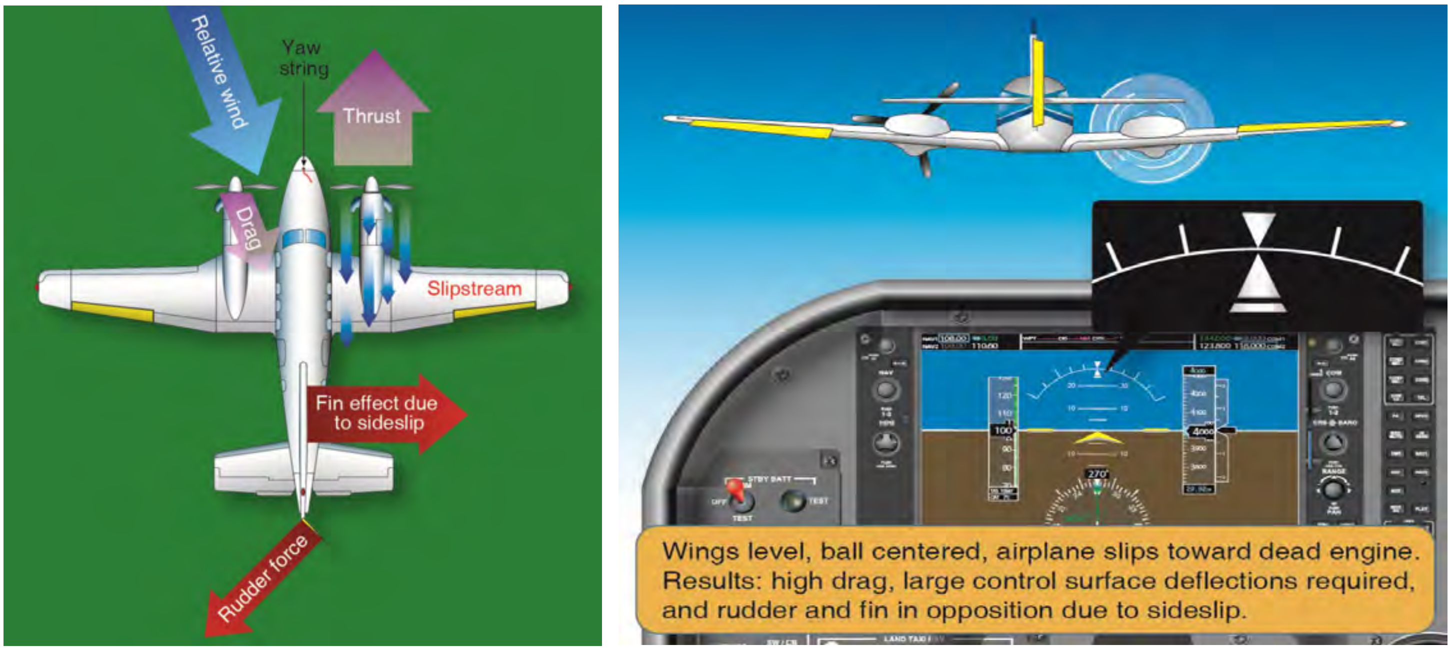


**Figure 13-15.** *Wings level engine-out flight.*

2. Engine inoperative flight using ailerons alone requires an 8–10° bank angle toward the operative engine. *[Figure 13-16]* This assumes no rudder input, the ball is displaced well toward the operative engine, and climb performance is greatly reduced by the large sideslip toward the operative engine. Due to the increased risk of loss of control, instructors should not normally demonstrate this.

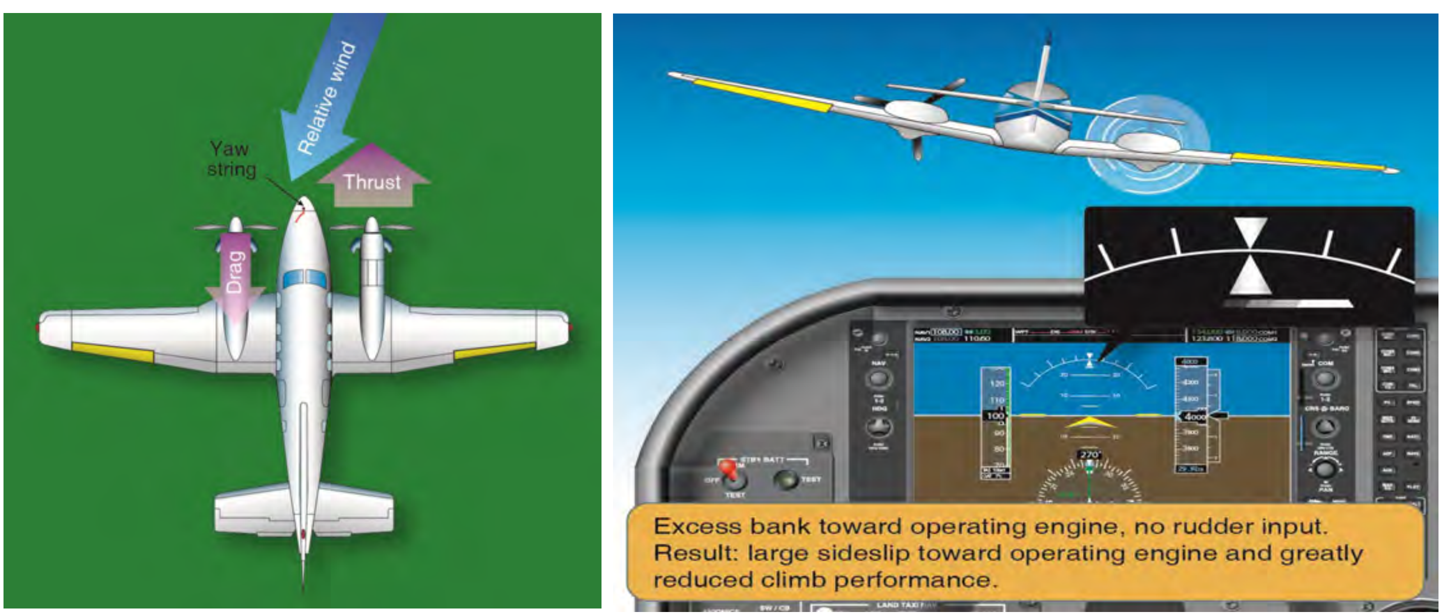


**Figure 13-16.** *Excessive bank engine-out flight.*

3. Rudder and ailerons used together in the proper combination result in a bank of approximately 2° toward the operative engine. The ball is displaced approximately one-third to one-half toward the operative engine. The result is zero sideslip and maximum climb performance. *[Figure 13-17]* Any attitude other than zero sideslip increases drag, decreasing performance. $V_{MC}$ under these circumstances is higher than published, as less than the 5° bank certification limit is employed.

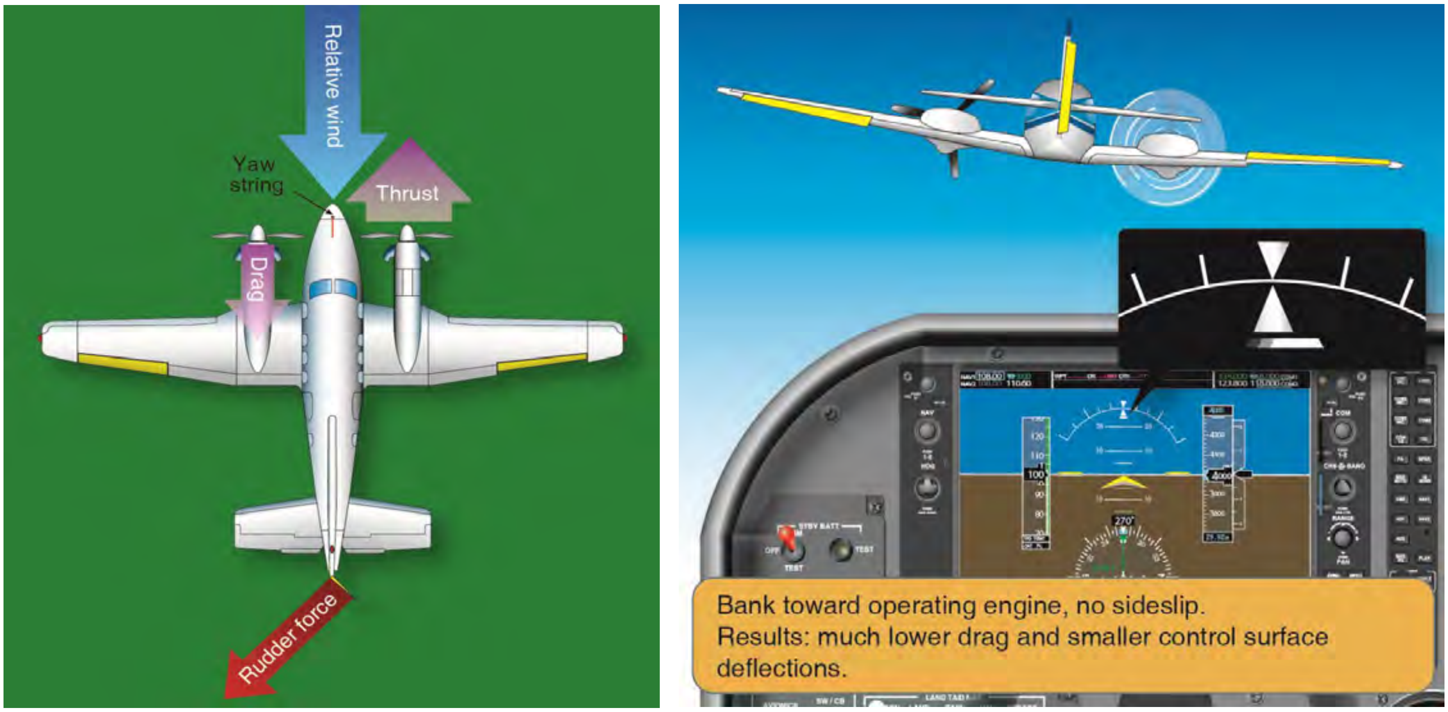


**Figure 13-17.** *Zero sideslip engine-out flight.*

When bank angle is plotted against climb performance for a hypothetical twin, zero sideslip results in the best (however marginal) climb performance or the least rate of descent. Whether the airplane can climb depends on the weight of the airplane, density altitude, and pilot technique. If the pilot uses zero bank (all rudder to counteract yaw), climb performance degrades as a result of moderate sideslip. Using bank angle alone (no rudder) severely degrades climb performance as a result of a large sideslip.

The precise condition of zero sideslip (bank angle and ball position) varies slightly from model to model and with available power and airspeed. If the airplane is not equipped with counter-rotating propellers, it also varies slightly with the engine failed due to P-factor. The foregoing zero sideslip recommendations apply to reciprocating engine multiengine airplanes flown at $V_{YSE}$ with the inoperative engine feathered. The zero sideslip ball position for straight flight is also the zero sideslip position for turning flight.

The actual bank angle for zero sideslip varies among airplanes from one and one-half to two and one-half degrees. The position of the ball varies from one-third to one-half of a ball width from instrument center toward the operative engine.

During certain flight training scenarios, pilots and instructors simulate propeller feathering. *Zero thrust* means the pilot sets power on one engine such that drag from its rotating propeller equals that of a stopped feathered propeller. With an engine set to zero thrust (or feathered) and the airplane slowed to $V_{YSE}$, a climb with maximum power on the remaining engine reveals the precise bank angle and ball deflection required for zero sideslip and best climb performance. Again, if a yaw string were present, it aligns itself vertically on the windshield as an indication of zero sideslip. There are very minor changes from this attitude depending upon the engine failed (with non-counter-rotating propellers), power available, airspeed, and weight; but without more sensitive testing equipment, these changes are difficult to detect. The only significant difference would be the pitch attitude required to maintain $V_{YSE}$ under different density altitude, power available, and weight conditions.

## Low Altitude Engine Failure Scenarios

In OEI flight at low altitudes and airspeeds such as the initial climb after takeoff, pilots should operate the airplane so as to guard against the three major accident factors: (1) loss of directional control, (2) loss of performance, and (3) loss of flying speed. All have equal potential to be lethal. Loss of flying speed is not a factor, however, when the airplane is operated with due regard for directional control and performance.

A takeoff or go-around is the most critical time to suffer an engine failure. The airplane will be slow, close to the ground, and may even have landing gear and flaps extended. Altitude and time is minimal. Until feathered, the propeller of the failed engine is windmilling, producing a great deal of drag and yawing tendency. Airplane climb performance is marginal or even non-existent, and obstructions may lie ahead. An emergency contingency plan and safety brief should be clearly understood well before the takeoff roll commences. An engine failure before a predetermined airspeed or point results in an aborted takeoff. An engine failure after a certain airspeed and point, with the gear up, and climb performance assured result in a continued takeoff. With loss of an engine, it is paramount to maintain airplane control and comply with the manufacturer's recommended emergency procedures. Complete failure of one engine shortly after takeoff can be broadly categorized into one of three following scenarios.

### Landing Gear Down

If the engine failure occurs prior to selecting the landing gear to the UP position *[Figure 13-18]*: Keep the nose as straight as possible, close both throttles, adjust pitch attitude to maintain adequate airspeed, and descend to the runway. Concentrate on a normal landing and do not force the aircraft on the ground. Land on the remaining runway or overrun. Depending upon how quickly the pilot reacts to the sudden yaw, the airplane may run off the side of the runway by the time action is taken. There are really no other practical options. As discussed earlier, the chances of maintaining directional control while retracting the flaps (if extended), landing gear, feathering the propeller, and accelerating are minimal. On some airplanes with a single-engine-driven hydraulic pump, failure of that engine means the only way to raise the landing gear is to allow the engine to windmill or to use a hand pump. This is not a viable alternative during takeoff.

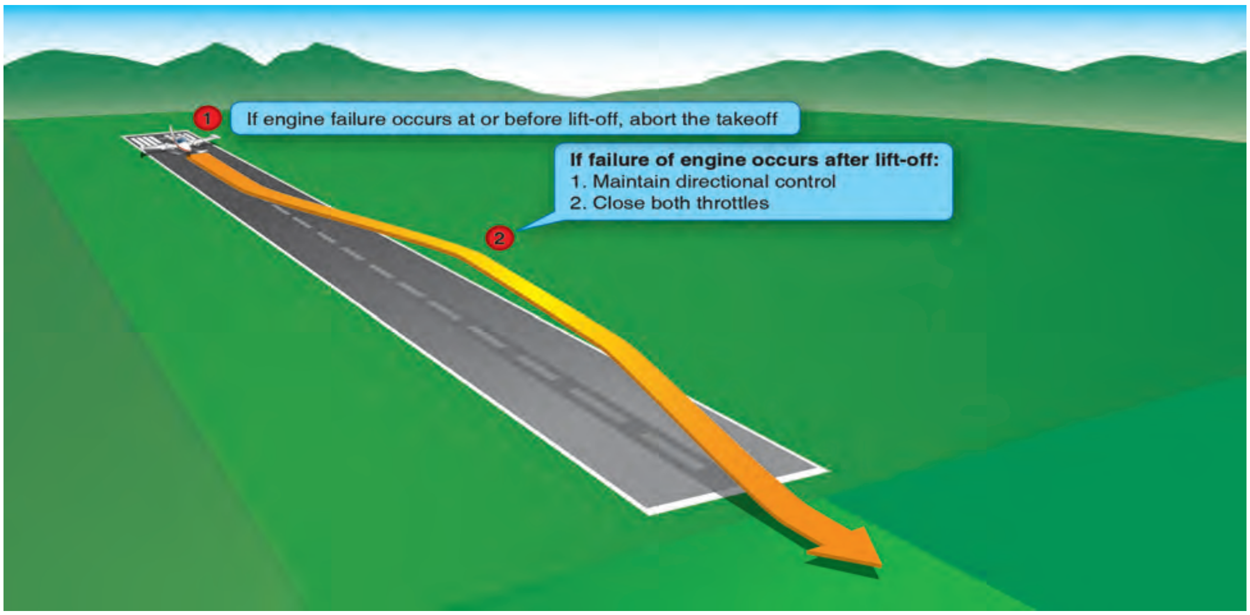


**Figure 13-18.** *Engine failure on takeoff, landing gear down.*

### Landing Gear Control Selected Up, Single-Engine Climb Performance Inadequate

When operating near or above the single-engine ceiling and an engine failure is experienced shortly after lift-off, a landing needs to be accomplished on whatever essentially lies ahead. *[Figure 13-19]* There is also the option of continuing ahead, in a descent at $V_{YSE}$ with the remaining engine producing power, as long as the pilot is not tempted to remain airborne beyond the airplane's performance capability. Remaining airborne and bleeding off airspeed in a futile attempt to maintain altitude is almost invariably fatal. Landing under control is paramount. The greatest hazard in a single-engine takeoff is attempting to fly when it is not within the performance capability of the airplane to do so. An accident is inevitable.

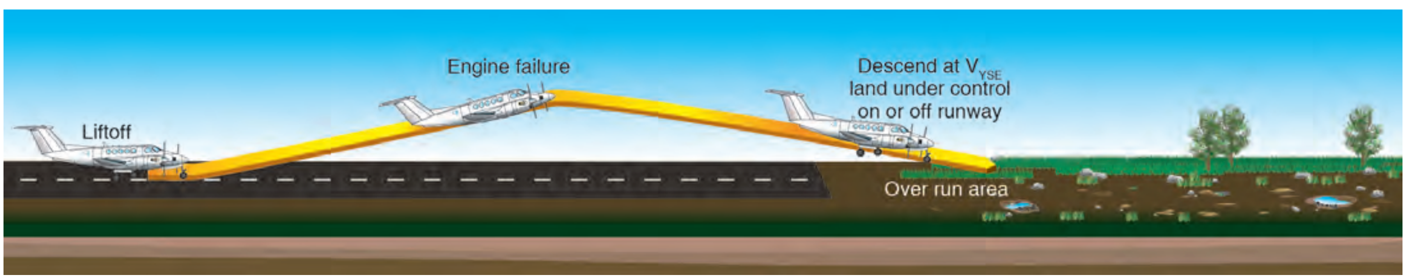


**Figure 13-19.** *Engine failure on takeoff, inadequate climb performance.*

Analysis of engine failures on takeoff reveals a very high success rate of off-airport engine inoperative landings when the airplane is landed under control. Analysis also reveals a very high fatality rate in stall spin accidents when the pilot attempts flight beyond the performance capability of the airplane.

As mentioned previously, if the airplane's landing gear retraction mechanism is dependent upon hydraulic pressure from a certain engine-driven pump, failure of that engine can mean a loss of hundreds of feet of altitude as the pilot either windmills the engine to provide hydraulic pressure to raise the gear or raises it manually with a backup pump.

### Landing Gear Control Selected Up, Single-Engine Climb Performance Adequate

If the single-engine rate of climb is adequate, the procedures for continued flight should be followed. *[Figure 13-20]* There are four areas of concern: control, configuration, climb, and checklist.

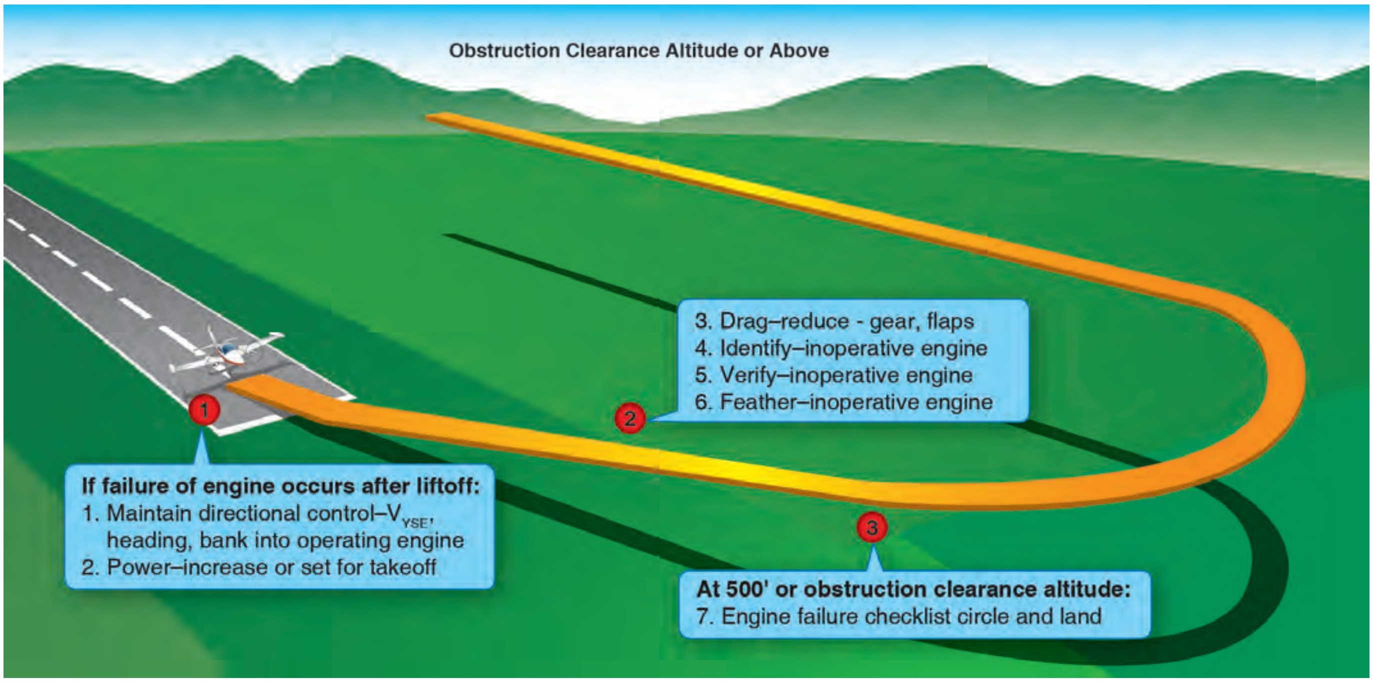


**Figure 13-20.** *Landing gear up—adequate climb performance.*

#### *Control*

The first consideration following engine failure during takeoff is to maintain control of the airplane. Maintaining directional control with prompt and often aggressive rudder application and STOPPING THE YAW is critical to the safety of flight. Ensure that airspeed stays above $V_{MC}$. If the yaw cannot be controlled with full rudder applied, reducing thrust on the operative engine is the only alternative. Attempting to correct the roll with aileron without first applying rudder increases drag and adverse yaw and further degrades directional control. After rudder is applied to stop the yaw, a slight amount of aileron should be used to bank the airplane toward the operative engine. This is the most efficient way to control the aircraft, minimize drag, and gain the most performance. Control forces, particularly on the rudder, may be high. The pitch attitude for $V_{YSE}$ has to be lowered from that of $V_Y$. At least 5° and a maximum of 10° of bank toward the operative engine should be used initially to stop the yaw and maintain directional control. This initial bank input is held only momentarily, just long enough to establish or ensure directional control. Climb performance suffers when bank angles exceed approximately 2 or 3°, but obtaining and maintaining $V_{YSE}$ and directional control are paramount. Trim should be adjusted to lower the control forces.

#### *Configuration*

The memory items from the engine failure after takeoff checklist should be promptly executed to configure the airplane for climb. *[Figure 13-21]* The specific procedures to follow are found in the AFM/POH and checklist for the particular airplane. Most direct the pilot to assume $V_{YSE}$, set takeoff power, retract the flaps and landing gear, identify, verify, and feather the failed engine. (On some airplanes, the landing gear is to be retracted before the flaps.)

The "identify" step is for the pilot to initially identify the failed engine. Confirmation on the engine gauges may or may not be possible, depending upon the failure mode. Identification should be primarily through the control inputs required to maintain straight flight, not the engine gauges. The "verify" step directs the pilot to retard the throttle of the engine thought to have failed. No change in performance when the suspected throttle is retarded is verification that the correct engine has been identified as failed. The corresponding propeller control should be brought fully aft to feather the engine.

**Engine Failure After Takeoff**

| | |
|---|---|
| Airspeed | Maintain $V_{YSE}$ |
| Mixtures | RICH |
| Propellers | HIGH RPM |
| Throttles | FULL POWER |
| Flaps | UP |
| Landing gear | UP |
| Identify | Determine failed engine |
| Verify | Close throttle of failed engine |
| Propeller | FEATHER |
| Trim tabs | ADJUST |
| Failed engine | SECURE |
| As soon as practical | LAND |

Bold-faced items require immediate action and are to be accomplished from memory.

**Figure 13-21.** *Typical "engine failure after takeoff" emergency checklist.*

### *Climb*

As soon as directional control is established and the airplane configured for climb, the bank angle should be reduced to that producing best climb performance. Without specific guidance for zero sideslip, a bank of 2° and one-third to one-half ball deflection on the slip/skid indicator toward the operative engine is suggested. $V_{YSE}$ is maintained with pitch control. As turning flight reduces climb performance, climb should be made straight ahead or with shallow turns to avoid obstacles to an altitude of at least 400 feet AGL before attempting a return to the airport.

### *Checklist*

Having accomplished the memory items from the engine failure after takeoff checklist, the printed copy should be reviewed as time permits. The securing failed engine checklist should then be accomplished. *[Figure 13-22]* Unless the pilot suspects an engine fire, the remaining items should be accomplished deliberately and without undue haste. Airplane control should never be sacrificed to execute the remaining checklists. The priority items have already been accomplished from memory.

## Securing Failed Engine

| | |
|---|---|
| Mixture | IDLE CUT OFF |
| Magnetos | OFF |
| Alternator | OFF |
| Cowl flap | CLOSE |
| Boost pump | OFF |
| Fuel selector | OFF |
| Prop sync | OFF |
| Electrical load | Reduce |
| Crossfeed | Consider |

**Figure 13-22.** *Typical "securing failed engine" emergency checklist.*

Other than closing the cowl flap of the failed engine, none of these items, if left undone, adversely affect airplane climb performance. There is a distinct possibility of actuating an incorrect switch or control if the procedure is rushed. The pilot should concentrate on flying the airplane and extracting maximum performance. If an ATC facility is available, an emergency should be declared.

The memory items in the engine failure after takeoff checklist may be redundant with the airplane's existing configuration. For example, in the third takeoff scenario, the gear and flaps were assumed to already be retracted, yet the memory items included gear and flaps. This is not an oversight. The purpose of the memory items is to either initiate the appropriate action or to confirm that a condition exists. Action on each item may not be required in all cases. The memory items also apply to more than one circumstance. In an engine failure from a go-around, for example, the landing gear and flaps would likely be extended when the failure occurred.

The three preceding takeoff scenarios all include the landing gear as a key element in the decision to land or continue. With the landing gear selector in the DOWN position, for example, continued takeoff and climb is not recommended. This situation, however, is not justification to retract the landing gear the moment the airplane lifts off the surface on takeoff as a normal procedure. The landing gear should remain selected down as long as there is usable runway or overrun available to land on. The use of wing flaps for takeoff virtually eliminates the likelihood of a single-engine climb until the flaps are retracted.

There are two time-tested memory aids the pilot may find useful in dealing with engine-out scenarios. The first, "dead foot—dead engine" is used to assist in identifying the failed engine. Depending on the failure mode, the pilot will not be able to consistently identify the failed engine in a timely manner from the engine gauges. In maintaining directional control, however, rudder pressure is exerted on the side (left or right) of the airplane with the operating engine. Thus, the "dead foot" is on the same side as the "dead engine." Variations on this saying include "idle foot—idle engine" and "working foot–working engine."

The second memory aid has to do with climb performance. The phrase "raise the dead" is a reminder that the best climb performance is obtained with a very shallow bank, about 2° toward the operating engine. Therefore, the inoperative, or "dead" engine should be "raised" with a very slight bank.

Not all engine failures result in complete power loss. If there is a performance loss when the throttle of the affected engine is retarded, some power is still available. In this case, the pilot may consider allowing the engine to run until the airplane reaches a safe altitude and airspeed for single-engine flight. While shutdown of a malfunctioning engine may prevent additional damage to the engine in certain circumstances, shutting down an engine that can still produce partial power may increase risk for an accident.



Main Menu

## Engine Failure During Flight

Engine failures well above the ground are handled differently than those occurring at lower speeds and altitudes. Cruise airspeed allows better airplane control and altitude, which may permit time for a possible diagnosis and remedy of the failure. Maintaining airplane control, however, is still paramount. Airplanes have been lost at altitude due to apparent fixation on the engine problem to the detriment of flying the airplane.

Not all engine failures or malfunctions are catastrophic in nature (catastrophic meaning a major mechanical failure that damages the engine and precludes further engine operation). Many cases of power loss are related to fuel starvation, where restoration of power may be made with the selection of another tank. An orderly inventory of gauges and switches may reveal the problem. Carburetor heat or alternate air can be selected. The affected engine may run smoothly on just one magneto or at a lower power setting. Altering the mixture may help. If fuel vapor formation is suspected, fuel boost pump operation may be used to eliminate flow and pressure fluctuations.

Although it is a natural desire among pilots to save an ailing engine with a precautionary shutdown, the engine should be left running if there is any doubt as to needing it for further safe flight. Catastrophic failure accompanied by heavy vibration, smoke, blistering paint, or large trails of oil, on the other hand, indicate a critical situation. The affected engine should be feathered and the securing failed engine checklist completed. The pilot should divert to the nearest suitable airport and declare an emergency with ATC for priority handling.

Fuel crossfeed is a method of getting fuel from a tank on one side of the airplane to an operating engine on the other. Crossfeed is used for extended single-engine operation. If a suitable airport is close at hand, there is no need to consider crossfeed. If prolonged flight on a single-engine is inevitable due to airport non-availability, then crossfeed allows use of fuel that would otherwise be unavailable to the operating engine. It also permits the pilot to balance the fuel consumption to avoid an out-of-balance wing heaviness.

The AFM/POH procedures for crossfeed vary widely. Thorough fuel system knowledge is essential if crossfeed is to be conducted. Fuel selector positions and fuel boost pump usage for crossfeed differ greatly among multiengine airplanes. Prior to landing, crossfeed should be terminated and the operating engine returned to its main tank fuel supply.

If the airplane is above its single-engine absolute ceiling at the time of engine failure, it slowly loses altitude. The pilot should maintain $V_{YSE}$ to minimize the rate of altitude loss. This "drift down" rate is greatest immediately following the failure and decreases as the single-engine ceiling is approached. Due to performance variations caused by engine and propeller wear, turbulence, and pilot technique, the airplane may not maintain altitude even at its published single-engine ceiling. Any further rate of sink, however, would likely be modest.

An engine failure in a descent or other low power setting can be deceiving. The dramatic yaw and performance loss is absent. At very low power settings, the pilot may not even be aware of a failure. If a failure is suspected, the pilot should advance both engine mixtures, propellers, and throttles significantly, to the takeoff settings if necessary, to correctly identify the failed engine. The power on the operative engine can always be reduced later.

## Engine Inoperative Approach and Landing

The approach and landing with OEI is essentially the same as a two-engine approach and landing. The traffic pattern should be flown at similar altitudes, airspeeds, and key positions as a two-engine approach. The differences are the reduced power available and the fact that the remaining thrust is asymmetrical. A higher-than-normal power setting is necessary on the operative engine.

With adequate airspeed and performance, the landing gear can still be extended on the downwind leg. In which case it should be confirmed DOWN no later than abeam the intended point of landing. Performance permitting, initial extension of wing flaps (typically 10°) and a descent from pattern altitude can also be initiated on the downwind leg. The airspeed should be no slower than $V_{YSE}$. The direction of the traffic pattern, and therefore the turns, is of no consequence as far as airplane controllability and performance are concerned. It is perfectly acceptable to make turns toward the failed engine.

On the base leg, if performance is adequate, the flaps may be extended to an intermediate setting (typically 25°). If the performance is inadequate, as measured by decay in airspeed or high sink rate, delay further flap extension until closer to the runway. $V_{YSE}$ is still the minimum airspeed to maintain.

On final approach, a normal 3° glidepath to a landing is desirable. Visual approach slope indicator (VASI) or other vertical path lighting aids should be utilized if available. Slightly steeper approaches may be acceptable. However, a long, flat, low approach should be avoided. Large, sudden power applications or reductions should also be avoided. Maintain $V_{YSE}$ until the landing is assured, then slow to 1.3 $V_{SO}$ or the AFM/POH recommended speed. The final flap setting may be delayed until the landing is assured or the airplane may be landed with partial flaps.

The airplane should remain in trim throughout. The pilot should be prepared, however, for a rudder trim change as the power of the operating engine is reduced to idle in the round out just prior to touchdown. With drag from only one windmilling propeller, the airplane tends to float more than on a two-engine approach. Precise airspeed control therefore is essential, especially when landing on a short, wet, and/or slippery surface.

Some pilots favor resetting the rudder trim to neutral on final and compensating for yaw by holding rudder pressure for the remainder of the approach. This eliminates the rudder trim change close to the ground as the throttle is closed during the round out for landing. This technique eliminates the need for groping for the rudder trim and manipulating it to neutral during final approach, which many pilots find to be highly distracting. AFM/POH recommendations or personal preference should be used.

A single-engine go-around on final approach may not be possible. As a practical matter in single-engine approaches, once the airplane is on final approach with landing gear and flaps extended, it is committed to land on the intended runway, on another runway, a taxiway, or grassy infield. Most light-twins do not have the performance to climb on one engine with landing gear and flaps extended. Considerable altitude is lost while maintaining $V_{YSE}$ and retracting landing gear and flaps. Losses of 500 feet or more are not unusual. If the landing gear has been lowered with an alternate means of extension, retraction may not be possible, virtually negating any climb capability.

## Multiengine Training Considerations

Flight training in a multiengine airplane can be safely accomplished if both the instructor and the learner consider the following factors.

- The participants should conduct a preflight briefing of the objectives, maneuvers, expected learner actions, and completion standards before the flight begins.

- A clear understanding exists as to how simulated emergencies will be introduced, and what action the learner is expected to take.

The introduction, practice, and testing of emergency procedures has always been a sensitive subject. Surprising a multiengine learner with an emergency without a thorough briefing beforehand creates a hazardous condition. Simulated engine failures, for example, can very quickly become actual emergencies or lead to loss of the airplane when approached carelessly. Stall-spin accidents in training for emergencies rival the number of stall-spin accidents from actual emergencies. The training risk normally gets mitigated by a briefing. Pulling circuit breakers is not recommended for training purposes and can lead to a subsequent gear up landing.

Many normal, abnormal, and emergency procedures can be introduced and practiced in the airplane as it sits on the ground without the engines running. In this respect, the airplane is used as a procedures trainer. The value of this training may be substantial. The engines do not have to be operating for real learning to occur. Upon completion of a training session, care should be taken to restore items to their proper positions.

Pilots who do not use a checklist effectively will be at a significant disadvantage in multiengine airplanes. Use of the checklist is essential to safe operation of airplanes, and it is risky to conduct a flight without one. The manufacturer's checklist or an aftermarket checklist that conforms to the manufacturer's procedures for the specific make, model, and model year may be used. If there is a procedural discrepancy between the checklist and the AFM/POH, then the AFM/POH always takes precedence.

Certain immediate action items (such as a response to an engine failure in a critical phase of flight) are best committed to memory. After they are accomplished, and as work load permits, the pilot can compare the action taken with a checklist.

Simulated engine failures during the takeoff ground roll may be accomplished with the mixture control. The simulated failure should be introduced at a speed no greater than 50 percent of $V_{MC}$. If a learner does not react promptly by retarding both throttles, the instructor can always pull the other mixture.

The FAA recommends that all in-flight simulated engine failures below 3,000 feet AGL, be introduced with a smooth reduction of the throttle. Thus, the engine is kept running and is available for instant use, if necessary. Smooth throttle reduction avoids abusing the engine and possibly causing damage. Simulation of inflight engine failures below $V_{SSE}$ introduces a very high and unnecessary training risk.

If the engines are equipped with dynamic crankshaft counterweights, it is essential to make throttle reductions for simulated failures smoothly. Other areas leading to dynamic counterweight damage include high rpm and low manifold pressure combinations, over-boosting, and propeller feathering. Severe damage or repetitive abuse to counterweights will eventually lead to engine failure. Dynamic counterweights are found on larger, more complex engines—instructors may check with maintenance personnel or the engine manufacturer to determine if their airplane engines are so equipped.

When an instructor simulates an engine failure, the learner should respond with the appropriate memory items and retard the appropriate propeller control toward the FEATHER position. Assuming zero thrust will be set, the instructor promptly moves the propeller control forward and sets the appropriate manifold pressure and rpm. It is vital that the learner be kept informed of the instructor's intentions. At this point the instructor may say words to the effect, "I have the right engine; you have the left. I have set zero thrust and the right engine is simulated feathered." Any ambiguity as to who is operating what systems or controls increases the likelihood of an unintended outcome.

Following a simulated engine failure, the instructor cares for the "failed" engine just as the learner cares for the operative engine. If zero thrust is set to simulate a feathered propeller, the cowl flap is normally closed and the mixture leaned. An occasional clearing of the engine is also desirable. If possible, avoid high power applications immediately following a prolonged cool-down at a zero-thrust power setting. A competent flight instructor teaches the multiengine learner about the critical importance of feathering the propeller in a timely manner should an actual engine failure situation ever be encountered. A windmilling propeller, in many cases, has given the improperly trained multiengine pilot the mistaken perception that the engine is still developing useful thrust, resulting in a psychological reluctance to feather, as feathering results in cessation of propeller rotation. The flight instructor should spend ample time demonstrating the difference in the performance capabilities of the airplane with a simulated feathered propeller (zero thrust) as opposed to a windmilling propeller.

Actual and safe propeller feathering for training is performed at altitudes and positions where safe landings on established airports may be readily accomplished if the propeller will not unfeather. Plan unfeathering and restart to be completed no lower than 3,000 feet AGL. At certain elevations and with many popular multiengine training airplanes, this may be above the single-engine service ceiling, and level flight will not be possible.

Repeated feathering and unfeathering is hard on the engine and airframe, and is done as necessary to ensure adequate training. The FAA's Airman Certification Standards for a multiengine class rating contains a task for feathering and unfeathering of one propeller during flight in airplanes in which it is safe to do so.

While much of this chapter has been devoted to the unique flight characteristics of a multiengine airplane with one engine inoperative, the modern well-maintained reciprocating engine is remarkably reliable. When training in an airplane, initiation of a simulated engine inoperative emergency at low altitude normally occurs at a minimum of 400 feet AGL to mitigate the risk involved and only after the learner has successfully mastered engine inoperative procedures at higher altitudes. Initiating a simulated low altitude engine inoperative emergency in the airplane at extremely low altitude, immediately after liftoff, or below $V_{SSE}$ creates a situation where there are non-existent safety margins.

For training in maneuvers that would be hazardous in flight, or for initial and recurrent qualification in an advanced multiengine airplane, consider a simulator training center or manufacturer's training course. Comprehensive training manuals and classroom instruction are available along with system training aids, audio/visuals, and flight training devices and simulators. Training under a wide variety of environmental and aircraft conditions is available through simulation. Emergency procedures that would be either dangerous or impossible to accomplish in an airplane can be done safely and effectively in a flight training device or simulator. The flight training device or simulator need not necessarily duplicate the specific make and model of airplane to be useful. Highly effective instruction can be obtained in training devices for other makes and models as well as generic training devices.

The majority of multiengine training is conducted in four-to-six place airplanes at weights significantly less than maximum. Single-engine performance, particularly, at low density altitudes, may be deceptively good. To experience the performance expected at higher weights, altitudes and temperatures, the instructor may occasionally artificially limit the amount of manifold pressure available on the operative engine. Airport operations above the single-engine ceiling can also be simulated in this matter. Avoid loading the airplane with passengers to practice emergencies at maximum takeoff weight since this practice creates an unnecessary training hazard.

The use of the touch-and-go landing and takeoff in multiengine flight training has always been somewhat controversial. The value of the learning experience may be offset by the hazards of reconfiguring the airplane for takeoff in extremely limited time as well as the loss of the follow-through ordinarily experienced in a full stop landing. Touch-and-goes are not recommended during initial aircraft familiarization in multiengine airplanes.

If touch-and-goes are to be performed at all, the learner and instructor responsibilities should be carefully briefed prior to each flight. Following touchdown, the learner will ordinarily maintain directional control while keeping the left hand on the yoke and the right hand on the throttles. The instructor resets the flaps and trim and announces when the airplane has been reconfigured. The multiengine airplane uses considerably more runway to perform a touch-and-go than a single-engine airplane. A full stop-taxi back landing is preferable during initial familiarization. Solo touch-and-goes in twins are strongly discouraged.

## Chapter Summary

Small multiengine airplanes handle much like single-engine airplanes as long as both engines are functioning normally. A competent multiengine pilot, however, acquires the additional knowledge, risk mitigation strategies, and practical skills required to fly a multiengine airplane in case a loss of thrust from one engine actually occurs. In that case, the pilot will be able to take appropriate action leading to a safe outcome. Much of this chapter discussed loss of directional control. How to obtain the best performance with an inoperative engine was also described in detail. These two considerations correspond to the red radial line ($V_{MC}$) and the blue radial line ($V_{YSE}$) on the airspeed indicator. The actions a pilot takes when dealing with stalls, $V_{MC}$, or best performance vary greatly. Understanding these concepts, knowing how to mitigate the risks, and possessing the skills to handle an engine failure in a variety of situations, allows a pilot to enjoy the increased performance and safety provided when flying a multiengine airplane.

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IDNT
OFF
VFR
FUNC
CRSR
CLR
ENT
0 1 2 3 4 5 6 7 8▲ 9▼
INOP
CARB AIR TEMP.
AVTRON
F O.A.T.
C O.A.T.
VOLTAGE
M303
LH
RH
FUEL GAGE
MAIN
AUX
OUTSIDE ANT COM #2
UP
LANDING
COWL FLAPS
LH RH
BOOST PUMPS
LH RH
STROBE LIGHTS
LOWER UPPER
LIGHTS
NAV
LDG LH
TAXI
LDG RH
PITOT HEAT
CABIN VENT
PTT
OPEN
OFF
OFF
OFF
LANDING GEAR
MOTOR
LTS
HORN
STL WRN
INST LTS
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FLAP MOTOR
OIL TEMP
CARB TEMP
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FUEL GAGES
OAT
WARN LTS
ALTERNATOR
LEFT RIGHT
MIC
PHONE
30 5 5 5 5 3 5 5 5 5 5 1 3 5 5
PARKING BRAKE
Go Back

HDG
NAV
REV
VS
ALT
50%
% MAX
EDM 760
OBS
PTT
A/P
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OFF
TEST
INOP
SLAVE
AMP1
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SLAVE
AMP2
MIC
EMEG
AV BUS
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OFF
CONTROL
YOKE PTT
L
R
JPI
DATA PORT
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FLAPS
DOWN
AV
MASTER
AUTO
PILOT
TURN
COORD
AUDIO
PANEL
NAV/COM
#1
#2
GPS
ENC
XPDR
HSI
JPI
GSB15
USB
GAD29
GMU13
STRK
FNDR
ADI
PHONE
CABIN VENT
PULL TO CLOSE
DEFROSTER
PULL
HEATER TEMP
PULL
DIRECTIONAL GYRO
L. PUMP
GYRO HORIZON
VACUUM
CHECK GAUGE
ELEV
TAB
NOSE UP

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AIRSPEED LIMITATIONS
Max. Airspeed - gear extended 150 MPH
flaps extended 130 MPH
design maneuver 160 MPH
min. control S.E. 84 MPH
ALTERNATOR
LH OFF RH
MASTER
OFF ON
OFF R L BOTH START
LH
RH
OFF R L BOTH START
PTT
MIC
PHONE
CABIN VENT
PULL TO CLOSE
AV
MASTER
INOP
AUTO
PILOT
OFF
TEST
TURN
COORD
DEFROSTER
PULL
This airplane must be operated as
a normal category airplane in compliance
with the airplane flight manual.
No acrobatic maneuvers including spins approved
LOCK

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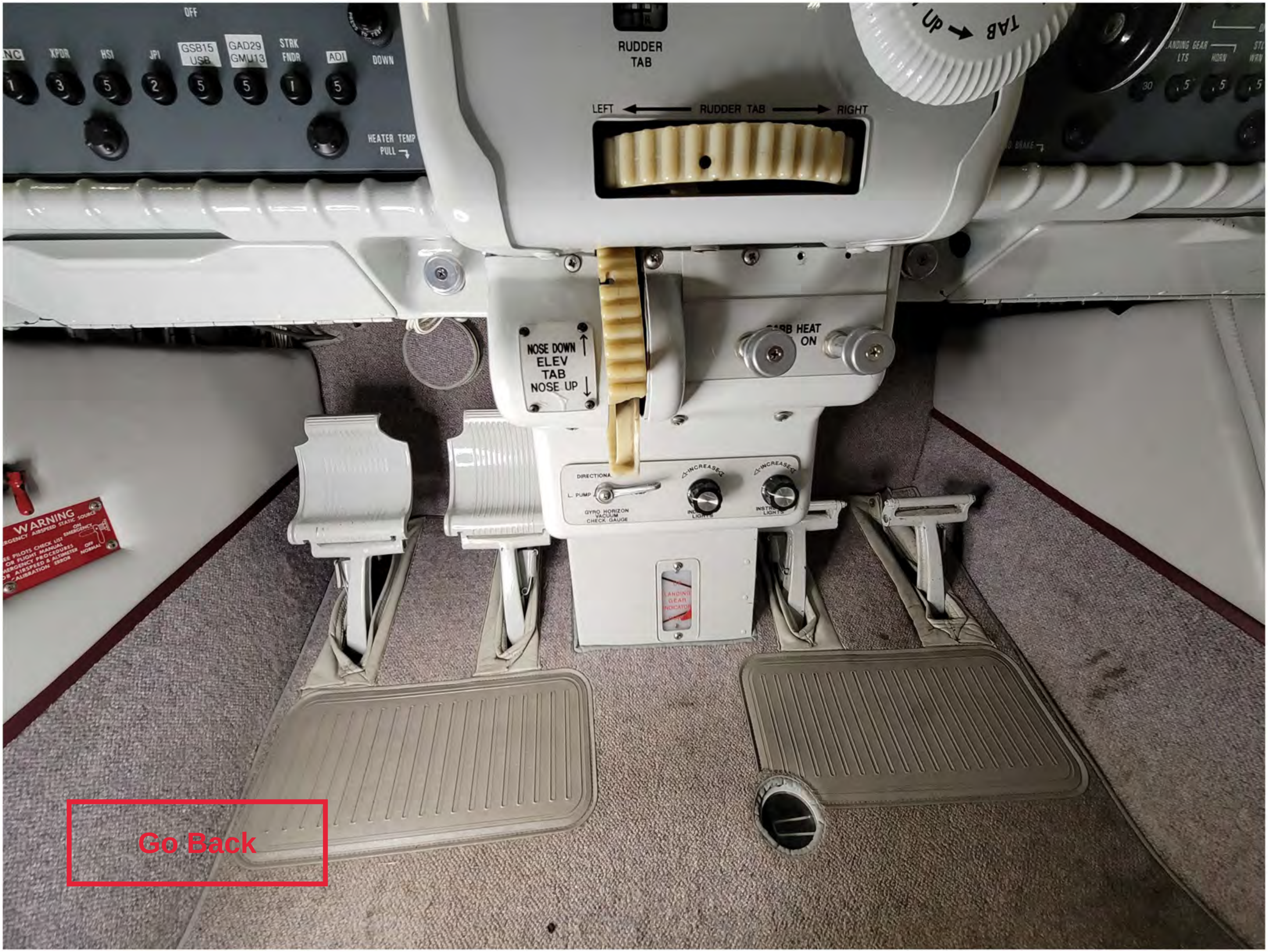
OFF
XPDR
HSI
JPI
GSB15 USB
GAD29 GMU13
STRK FNDR
ADI
DOWN
HEATER TEMP PULL
RUDDER TAB
LEFT RUDDER TAB RIGHT
Up TAB
NOSE DOWN ELEV TAB NOSE UP
CARB HEAT ON
INCREASE
INCREASE
GYRO HORIZON VACUUM CHECK GAUGE
LANDING GEAR INDICATOR
WARNING

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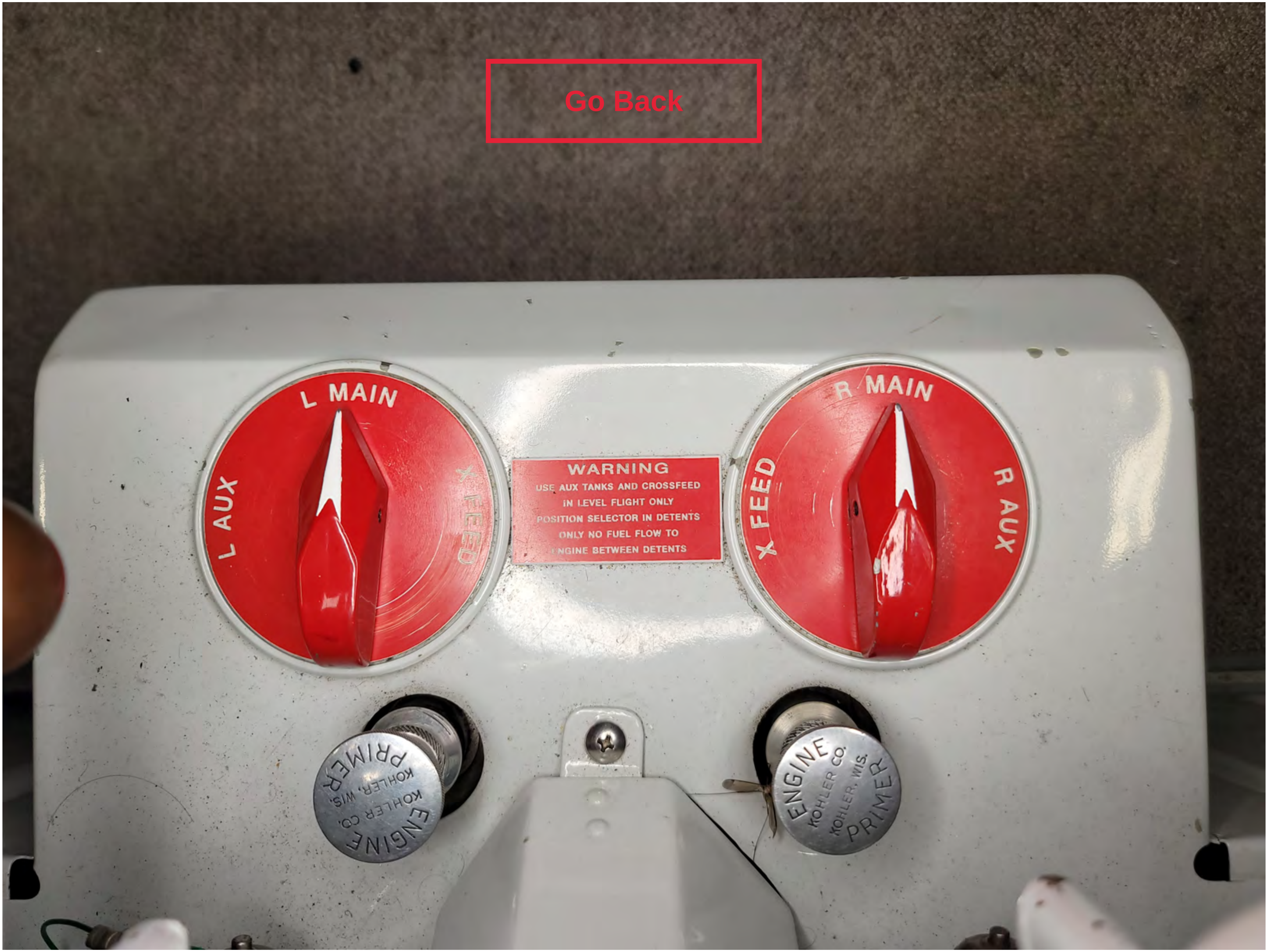
L MAIN
L AUX
X FEED
WARNING
USE AUX TANKS AND CROSSFEED
IN LEVEL FLIGHT ONLY
POSITION SELECTOR IN DETENTS
ONLY NO FUEL FLOW TO
ENGINE BETWEEN DETENTS
R MAIN
X FEED
R AUX
ENGINE PRIMER
KOHLER CO.
KOHLER, WIS.
ENGINE PRIMER
KOHLER CO.
KOHLER, WIS.

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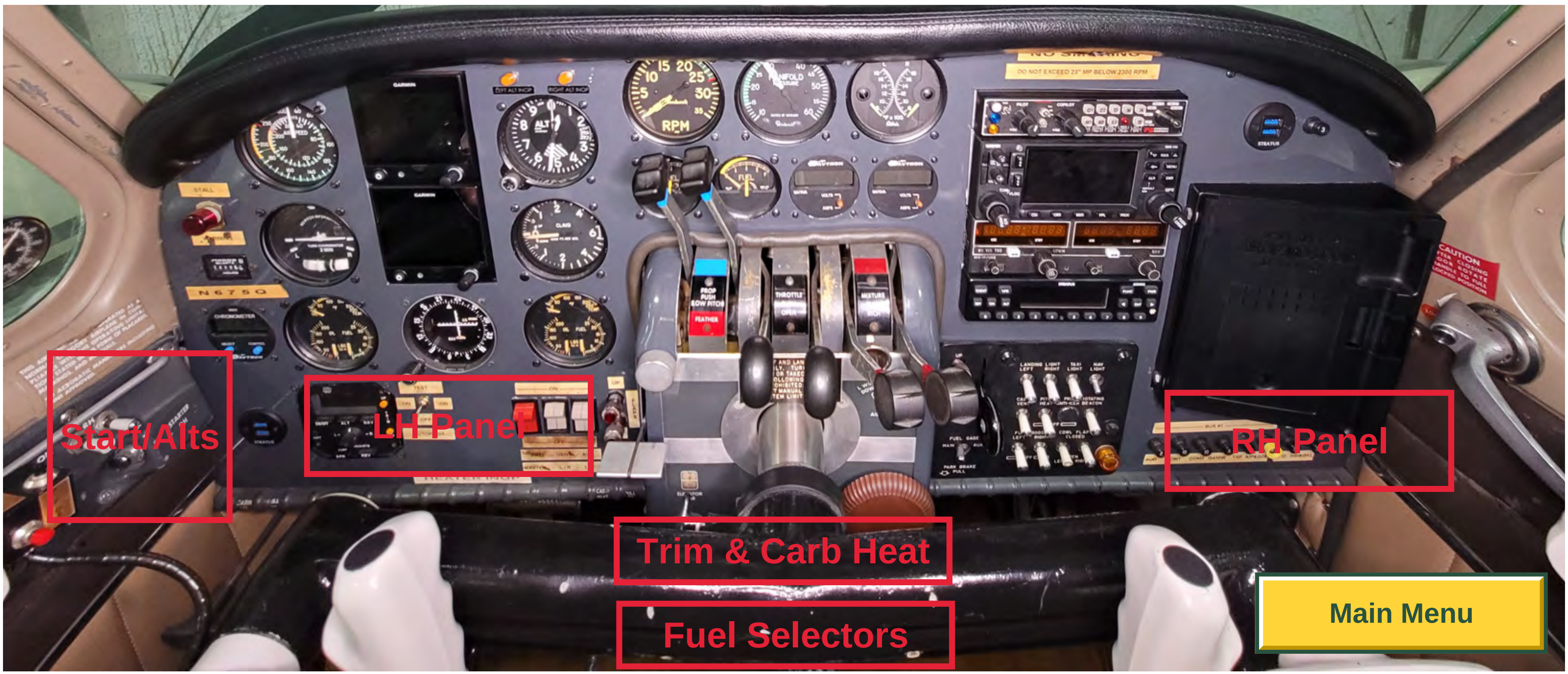


UP
LANDING GEAR
LANDING LEFT
LIGHT RIGHT
TAXI LIGHT
NAV LIGHT
CABIN VENT
PITOT HEAT
PROP ANTI-ICER
ROTATING BEACON
OFF
COWL FLA
CLOSED
LEFT
RIGHT
GAGE
AUX
PARK BRAKE PULL
OFF
BUS #1
BUS #2
2
10
10
5
5
AUD
COM1
COM2
G430W
TXP
A/P&G29

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CHRONOMETER
SELECT
CONTROL
DAVTRON
STRATUS
OIL
FUEL
LBS.
SQ IN.
OBS
BENDIX/KING
UP
TRIM
DN
ON/OFF
ALT
NAV
RDY
PUSH
PUSH HDG/STB
APR
REV
TEST
ON
ON
OFF
AUTOPILOT
ON
OFF
BATT - GENS - AVI
MASTER - L/R - 1/2
UP
DN
HEATER INOP
CABIN HEAT
PULL ON
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STALL
WARNING
NO PITCH INFORMATION
TURN COORDINATOR
2 MIN
L
R
Hobbs
QUARTZ
HOURS
N675Q
CHRONOMETER
SELECT
CONTROL
OIL
°F
TEMP
FUEL
LBS
OBS
ON
OFF
TEST
AUTOPILOT
MAGNETOS
LH
RH
STARTER LH
STARTER RH
BELOW -40C OAT PROHIBITED
AIRSPEED LIMITATIONS
MAX SPEED WITH LANDING GEAR EXTENDED (NORMAL) 150 MPH
MAX SPEED WITH FLAPS EXTENDED (NORMAL) 130 MPH
MAX DESIGN MANEUVERING SPEED 160 MPH
MIN CONTROL SPEED SINGLE ENGINE 84 MPH
THIS AIRPLANE [illegible] OPERATED AS A NORMAL CATEGORY AIRPLANE IN COMPLIANCE WITH THE OPERATING LIMITATIONS STATED IN THE FORM OF PLACARDS, MARKINGS, AND MANUALS.
NO ACROBATIC MANEUVERS INCLUDING SPINS APPROVED.

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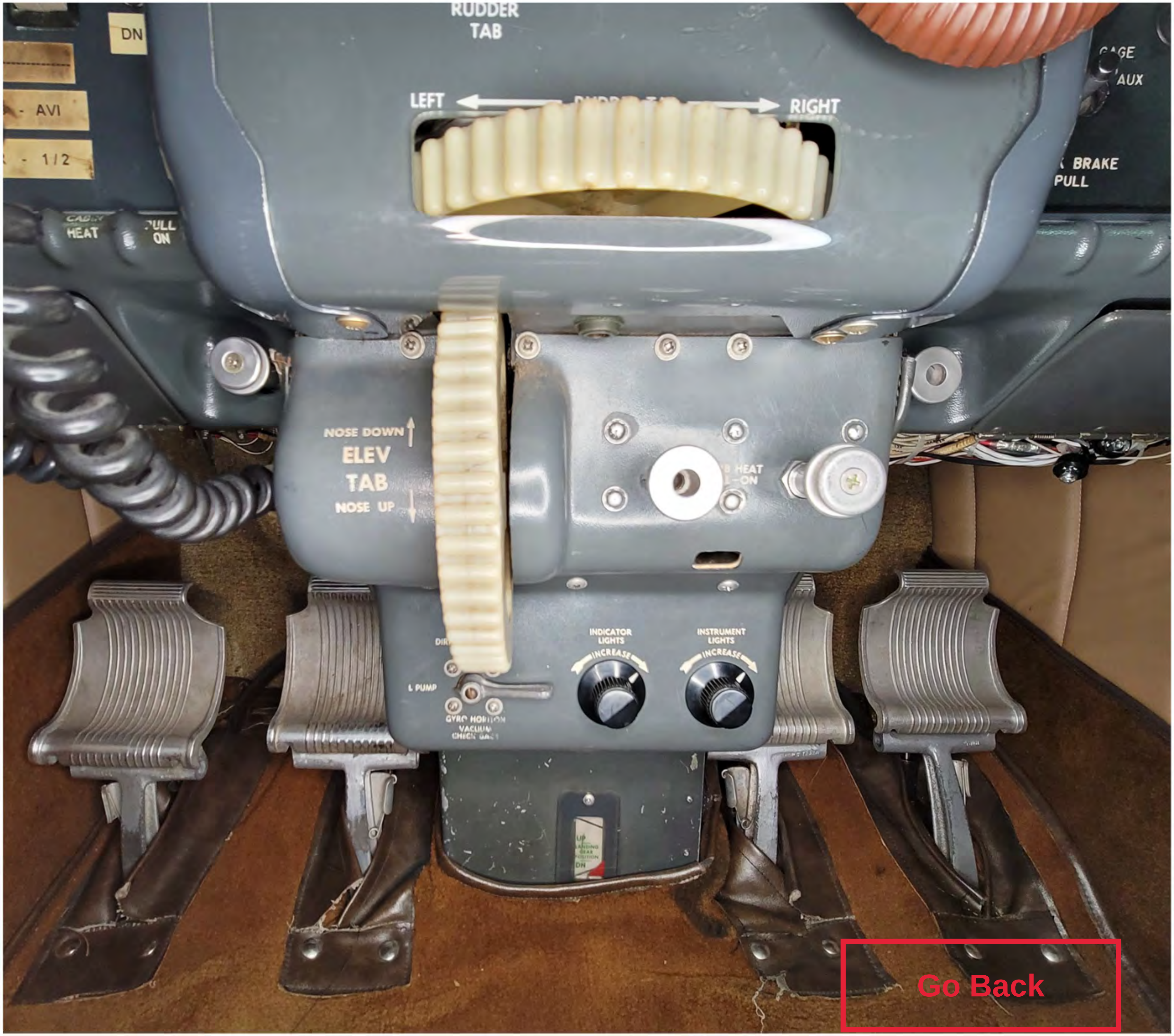

RUDDER
TAB
DN
AVI
1/2
LEFT
RIGHT
HEAT
ON
AUX
BRAKE
PULL
NOSE DOWN
ELEV
TAB
NOSE UP
INDICATOR
LIGHTS
INCREASE
INSTRUMENT
LIGHTS
INCREASE


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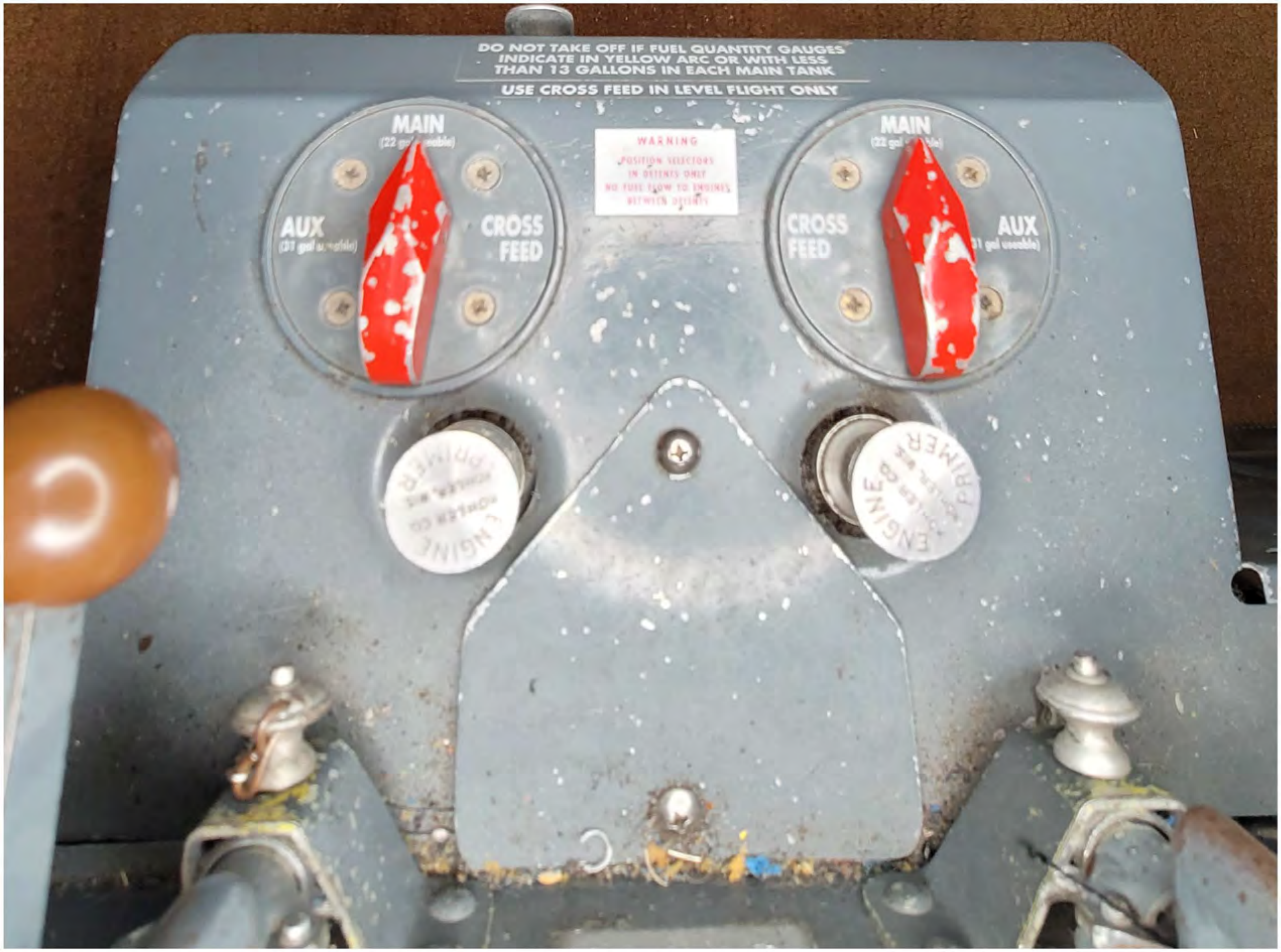
DO NOT TAKE OFF IF FUEL QUANTITY GAUGES INDICATE IN YELLOW ARC OR WITH LESS THAN 13 GALLONS IN EACH MAIN TANK
USE CROSS FEED IN LEVEL FLIGHT ONLY
WARNING
POSITION SELECTORS IN DETENTS ONLY
NO FUEL FLOW TO ENGINES BETWEEN DETENTS
MAIN
AUX
CROSS FEED
MAIN
CROSS FEED
AUX

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WARNING
TO AVOID OPTICAL ILLUSION AND SEVERE VERTIGO TURN ANTI-COLLISION LIGHTS OFF UPON ENTERING CLOUDS, FOG OR HAZE.
UP
LANDING LIGHT
LEFT
RIGHT
TAXI LIGHT
NAV LIGHT
CABIN VENT
PITOT HEAT
PROP ANTI-ICER
OFF
FUEL GAGE
MAIN
AUX
FUEL BOOST
LEFT
RIGHT
COWL FLAPS
CLOSED
OPEN
LEFT
RIGHT
PARK BRAKE
PULL
AUDIO
NAV 1
COM 1
COMM 2
XPDR
USB
G5
ADI
G5
HSI
GAD29B
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SINGLE ENGINE 84 MPH
MAGNETOS
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RH
STARTER LH
STARTER RH
WARNING
HOURS
ELECTRONIC
DATCON
OIL
P.S.I.
MIC
PHONE

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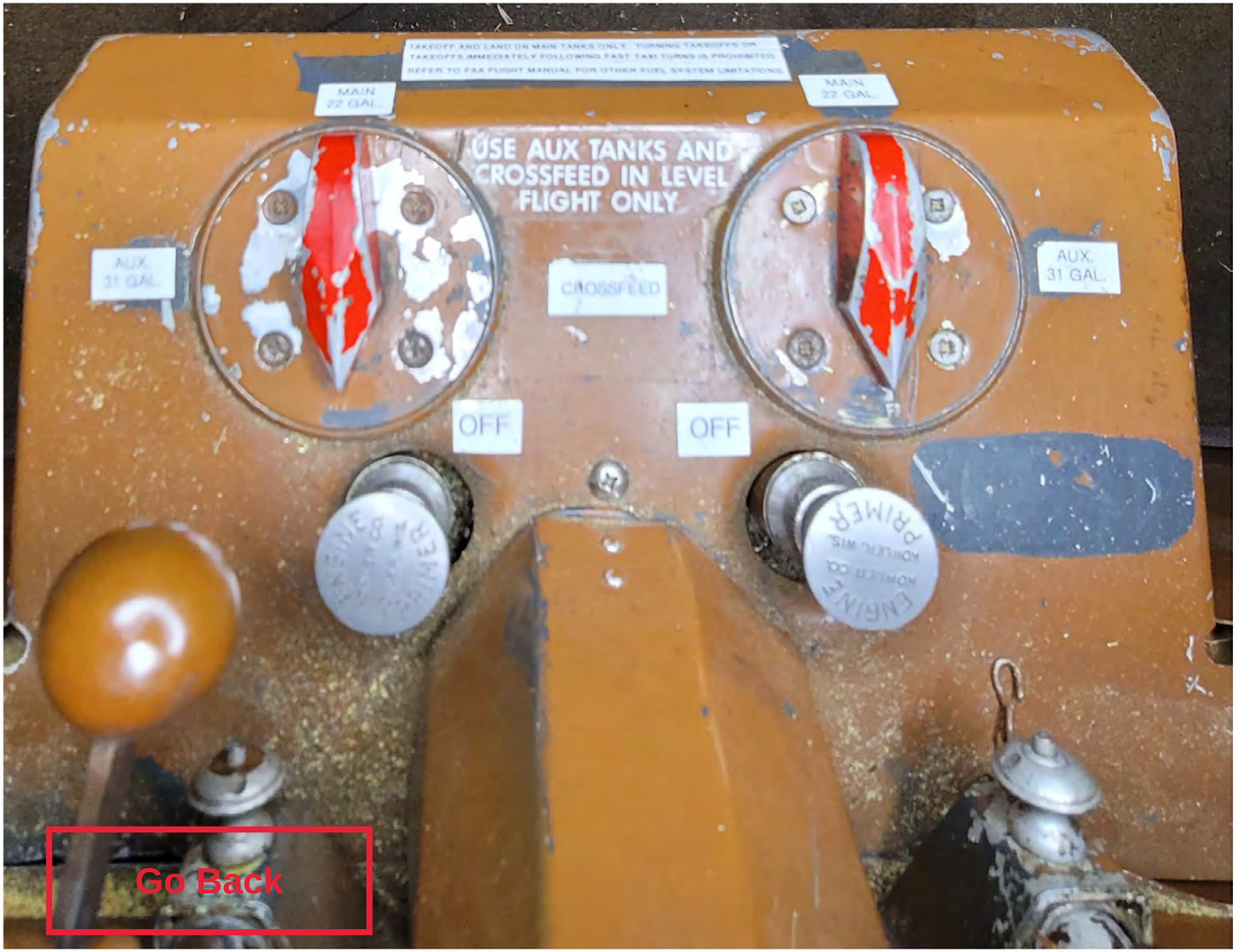
TAKEOFF AND LAND ON MAIN TANKS ONLY. TURNING TAKEOFFS OR
TAKEOFFS IMMEDIATELY FOLLOWING FAST TAXI TURNS IS PROHIBITED.
REFER TO FAA FLIGHT MANUAL FOR OTHER FUEL SYSTEM LIMITATIONS.
MAIN 22 GAL.
MAIN 22 GAL.
USE AUX TANKS AND CROSSFEED IN LEVEL FLIGHT ONLY
AUX. 31 GAL.
CROSSFEED
AUX. 31 GAL.
OFF
OFF
ENGINE PRIMER
ENGINE PRIMER
KOHLER CO. KOHLER, WIS.

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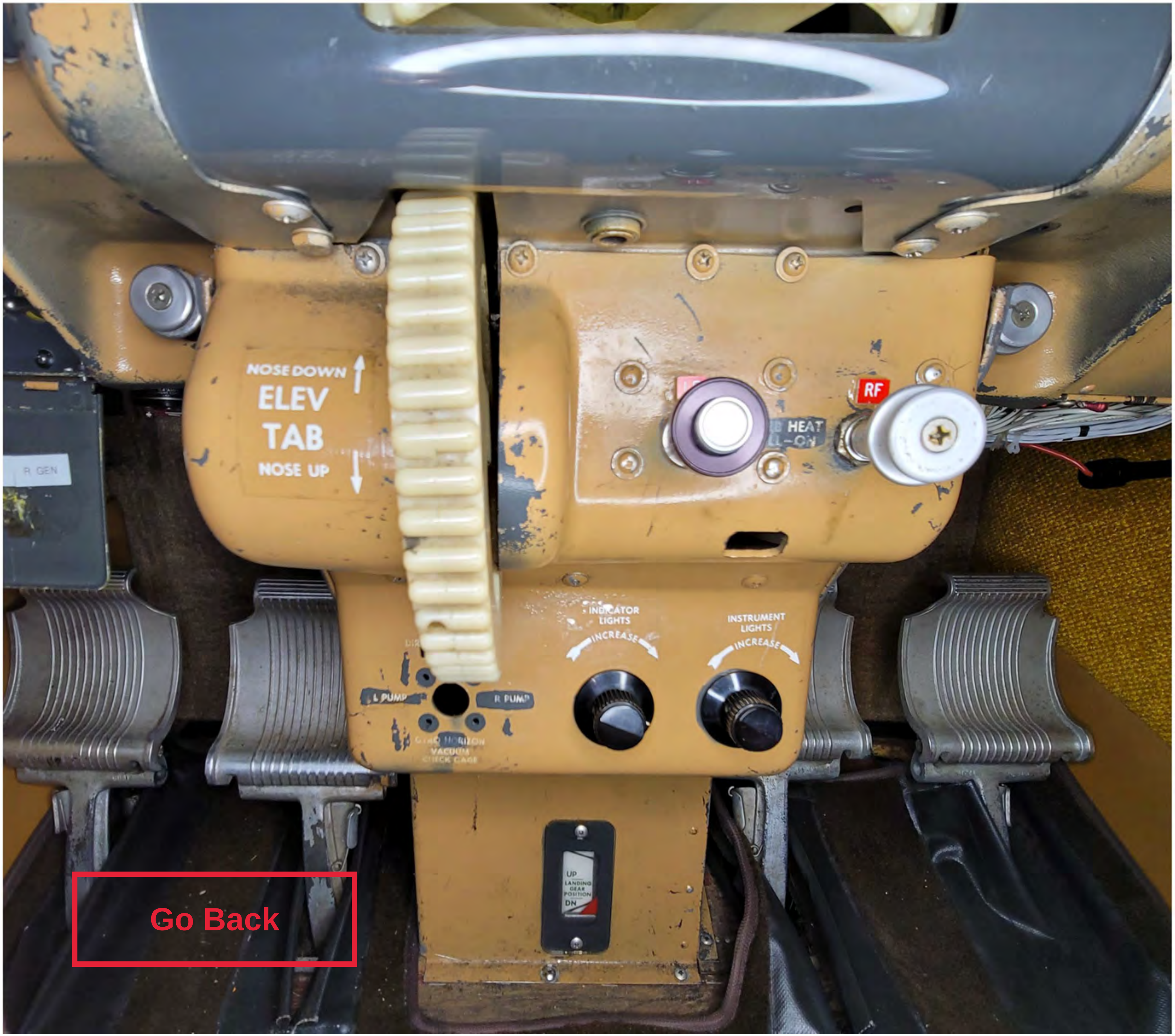
NOSE DOWN
ELEV
TAB
NOSE UP
RF
INDICATOR
LIGHTS
INCREASE
INSTRUMENT
LIGHTS
INCREASE
L PUMP
R PUMP
UP
LANDING
GEAR
POSITION
DN

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