MULTI ENGINE
PILOT TRAINING GUIDE

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Keys to Success

1. Start studying early. Use the **Tests** to study this guide to form a knowledge base. Have the Open Book and Closed Book Test completed around 2 days prior to training.

2. Use the **Cockpit Guide** with the **Checklists** to become familiar with the aircraft prior to your training.

3. Use the **Preflight Guide** to be prepared to complete the preflight inspection as efficiently as possible.

4. Commit the **Maneuvers, Approach Brief, and Approach Timeline** to memory. Chair fly instrument approaches while referencing the **Approach Brief and Timeline** to get a feeling of the flow.

5. Review the **Safety and Expectations Brief** prior to your training.

6. Have all your paperwork prepared in advance. Completed **Tests** are required prior to flying.

7. Use the **IACRA Guide** and start your FAA 8710 prior to flying. At least get logged in as well as have your flight times totaled.

Section I

Multi-Engine Aerodynamics

This section covers multi-engine aerodynamics and One Engine Inoperative (OEI) flight. You can expect to discuss these knowledge items with the examiner even if you already possess an unrestricted multiengine certificate. All the elements that require satisfactory knowledge as per the ACS are discussed. After studying this section you should be able to answer questions on the following areas:

- Meaning of the term “critical engine.”
- Effects of density altitude on the V_{MC} demonstration.
- Effects of airplane weight and center of gravity on control.
- Effects of angle of bank on V_{MC}.
- Relationship of V_{MC} to stall speed.
- Reasons for loss of directional control.
- Indications of loss of directional control.
- Importance of maintaining the proper pitch and bank attitude, and the proper coordination of controls.
- Loss of directional control recovery procedure.
- Engine failure during takeoff including planning, decisions, and single-engine operations.

These concepts can be broken down by discussing the certain concepts that apply to multi-engine flying.

- Directional Control
- Performance
- Stall/Spin awareness
- Engine failure procedures and decision making

Directional Control

A thorough knowledge of the factors that affect V_{MC}, as well as its definition as per FAR 23.149, is essential for multiengine pilots, and as such an essential part of that required task on the checkride. Minimum Control Airspeed (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. 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. Because V_{MC} deals with directional control, any factor that makes V_{MC} increase therefore decreases directional control.

In order to understand the factors that affect V_{MC} and how it is determined you can use the acronym **C-O-M-B-A-T-S.**

FAR 23.149 Minimum control speed.

(a) ***V_{MC} is 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.*** *The method used to simulate critical engine failure must represent the most critical mode of powerplant failure expected in service with respect to controllability.*

(b) V_{MC} for takeoff must not exceed 1.2 V_{S1}, where V_{S1} is determined at the maximum takeoff weight. V_{MC} must be determined with the most unfavorable weight and center of gravity position and with the airplane airborne and the ground effect negligible, for the takeoff configuration(s) with—

(1) Maximum available takeoff power initially on each engine;
(2) The airplane trimmed for takeoff;
(3) Flaps in the takeoff position(s);
(4) Landing gear retracted; and
(5) All propeller controls in the recommended takeoff position throughout..

(d) A minimum speed to intentionally render the critical engine inoperative must be established and designated as the safe, intentional, one-engine-inoperative speed, V_{SSE}.

(e) At V_{MC}, the rudder pedal force required to maintain control must not exceed 150 pounds and it must not be necessary to reduce power of the operative engine(s). During the maneuver, the airplane must not assume any dangerous attitude and it must be possible to prevent a heading change of more than 20 degrees.

Critical Engine Failed and Windmilling

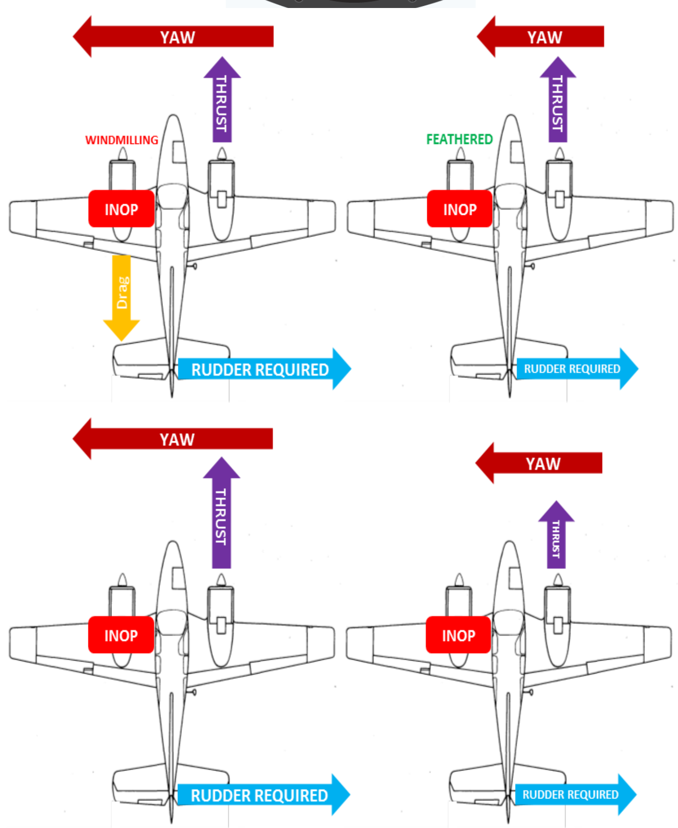
V_{MC} increases with increased drag on the inoperative engine. V_{MC} is highest, therefore, when the critical engine propeller is windmilling at the low pitch, high RPM blade angle and therefore is determined with the critical engine propeller windmilling in the takeoff position.

Operating Engine at Max Available Takeoff Power

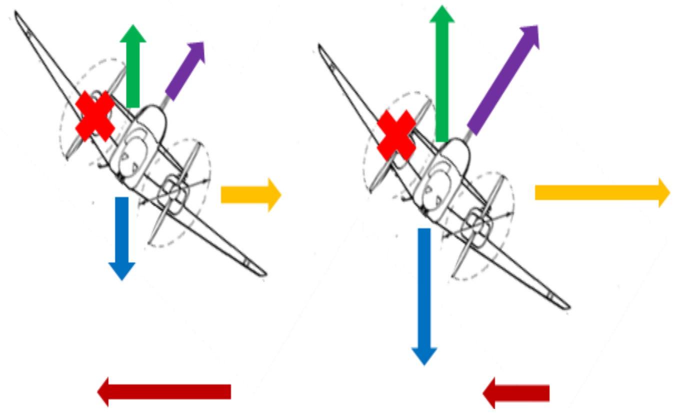
V_{MC} increases as power is increased on the operating engine. With normally aspirated engines, V_{MC} is highest at takeoff power and sea level, and decreases with altitude. With turbocharged engines, takeoff power, and therefore V_{MC}, remains constant with increases in altitude up to the engine's critical altitude (the altitude where the engine can no longer maintain 100 percent power). V_{MC} tests are conducted at a variety of altitudes. The results of those tests are then extrapolated to a single, sea level value.

Max Gross Weight

More weight lowers V_{MC} because the amount of horizontal lift component is increased while banking into the operating engine with increased weight. The most unfavorable weight is low weight which increases V_{MC}. The manufacturer normally determines V_{MC} at max gross weight to negate different weights of test pilots and to determine a more accurate airspeed.

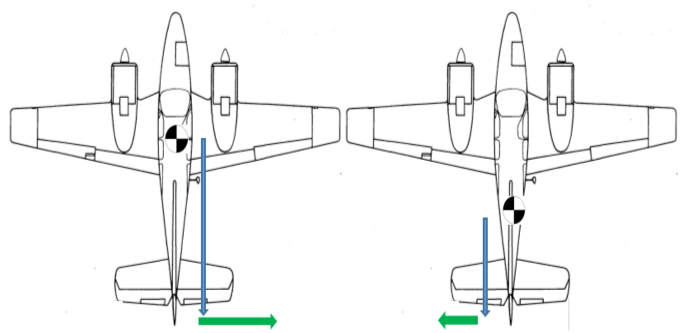


Bank Up to 5º into Good Engine



V_{MC} is reduced significantly with increases in bank angle due to the horizontal component of lift counteracting the yaw generated by an engine failure. Conversely, V_{MC} increases significantly with decreases in bank angle. Tests have shown that V_{MC} may increase more than 3 knots for each degree of bank angle less than 5°. Loss of directional control may be experienced at speeds almost 20 knots above published V_{MC} when the wings are held level.

Aft CG



V_{MC} increases as the center of gravity is moved aft. The moment arm of the rudder is reduced, and therefore its effectiveness is reduced, as the center of gravity is moved aft.

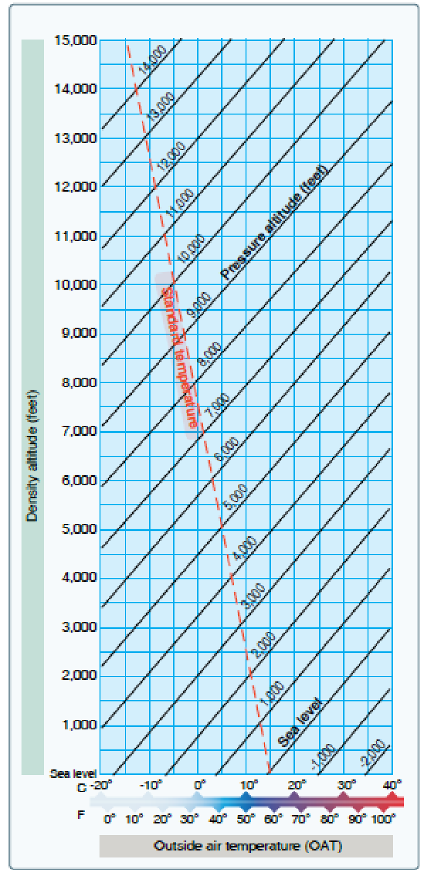
Takeoff Configuration and in Ground Effect

V_{MC} is actually lower with the landing gear extended because it acts as a stability device (weathervane) counteracting yaw, thereby improving directional control. Drag is a side effect, but since determining V_{MC} is about directional control over climb performance it is determined with gear retracted (worse directional control).

With the flaps down the wings create more lift than if the flaps were up, however drag is also created (as lift increase, drag increases). The side with the operating engine is creating even more lift because of the accelerated air flowing over the wing. The drag caused by the accelerated flow opposes the yaw caused by the inoperative engine allowing the pilot to use less rudder to maintain heading. Having more rudder available to the pilot lowers V_{MC}.

Trim is considered in the determination of V_{MC} since it can either help or hinder directional control based on where it is set at the time of an engine failure, specifically rudder trim.

Ground effect reduces induced drag, thereby increasing the excess thrust which in turn generates more yaw and less directional control, thereby increasing V_{MC}.



Standard Day (29.92 in Hg and 15 º C / 59 º F)

This corresponds to operating the engine at maximum available takeoff power. Normally aspirated engines lose power as temperature increases and pressure decreases. This occurs naturally as a plane climbs, but also near sea level as density altitude increases. Less power output from the operating engine means that the yaw generated during an engine failure will be less, thus improving directional control and lowering V_{MC}. Therefore, any temperature below standard increases V_{MC} and any airspeed above standard decreases V_{MC}, and vice versa for pressure changes.

Factor	Effect on V_{MC}
Critical Engine Failed	**Up**- P-factor, Accelerated Slipstream, Torque makes yaw worst
Windmilling Propeller	**Up-** more drag, more yaw
Feathered Propeller	**Down**- less drag, less yaw
Power Increase	**Up- more yaw**
Heavier Weight	**Down**- more lift needed in level flight more horizontal lift available during turn helps prevent turn
Level (0 bank)	**Up**- sideslip plane- less AOA on rudder because of sideslip airflow less rudder effectiveness more rudder needed
Zero Sideslip (2-3° bank)	**Middle**- Use horizontal lift to stop turn not slipping means more rudder effectiveness
Banked (5°)	**Down**- plane turning toward good engine + rudder used to stop turn = slip toward good engine high AOA on rudder
Aft CG	**Up**- less distance between rudder and CG- less rudder effectiveness
Gear Down	Depends on location of CG to gear and direction of travel (V_{MC} down, keel effect)
Flaps Down	**Down**- more induced drag from good engine side prevents yaw towards dead engine
Density Altitude Increase	**Down**- less dense, less power, less yaw
Temp Increase	**Down**- less dense, less power, less yaw
Pressure Decrease	**Down**- less dense, less power, less yaw
In Ground Effect	**Up**- less drag = more excess thrust = more yaw

Critical Engine

A key component of V_{MC} is understanding the concept of a critical engine. Most conventional multi-engine airplanes engines rotate clockwise (viewed from the pilot's seat) and therefore the **left engine** is the critical engine.

14 CFR 1.1

Critical engine means the engine whose failure would most adversely affect the performance or handling qualities of an aircraft.

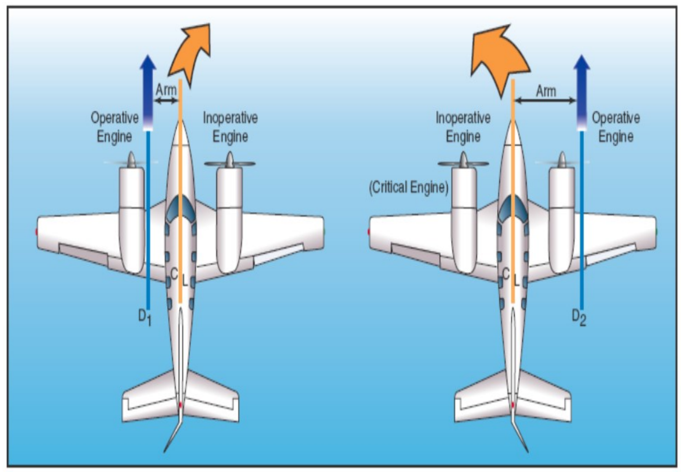
Thorough knowledge of the principles associated with a critical engine is still required on the Checkride regardless if you have a centerline thrust restriction or not.

The factors that determine the critical engine can be remembered using the acronym ***P-A-S-T***

P-factor

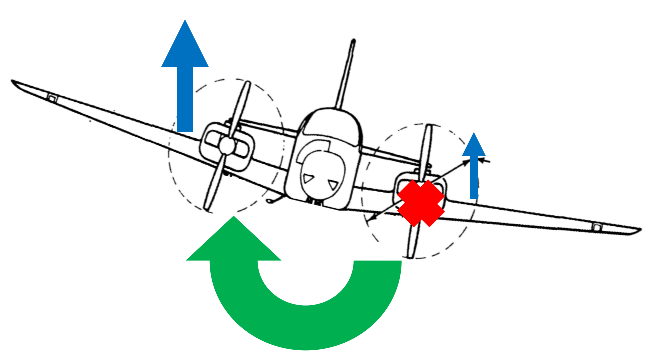
The descending blades of clockwise rotating propellers produce more thrust than ascending blades, due to their increased angle of attack in relation to the relative wind.

When an aircraft is flying with a high AOA, the "bite" of the downward moving blade is greater than the "bite" of the upward moving blade. This moves the center of thrust to the right of the prop disc area, causing a yawing moment toward the left around the vertical axis. Yaw produced by the loss of the left engine will be greater than that produced due to the increased moment arm in relation to the longitudinal axis, thus making the left engine critical.

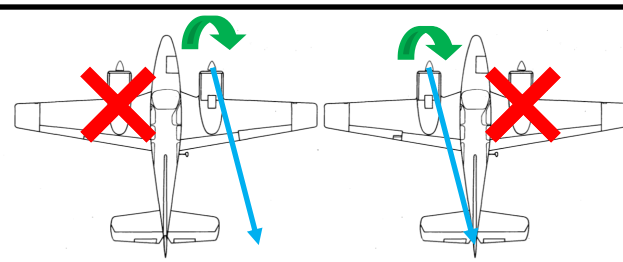


Accelerated Slipstream

P-factor and propeller induced airflow over the wing results in a greater center of lift on the side closest to the aircraft's longitudinal axis with the left engine and further from the longitudinal axis with the right engine, as well as loss of lift over the tail (down force). The roll generated by loss of the left engine will be greater than the roll generated by loss of the right engine, making the left engine critical. Also, with failure of the left engine, less lift or down force is generated by the tail, resulting in a pitch down moment.



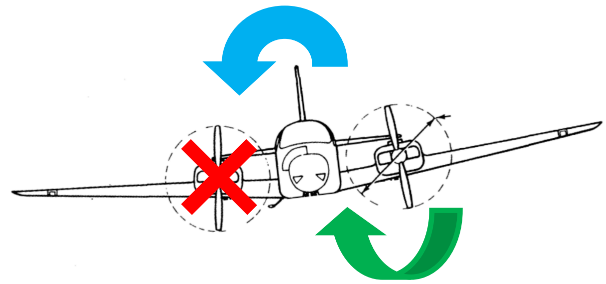
Spiraling Slipstream

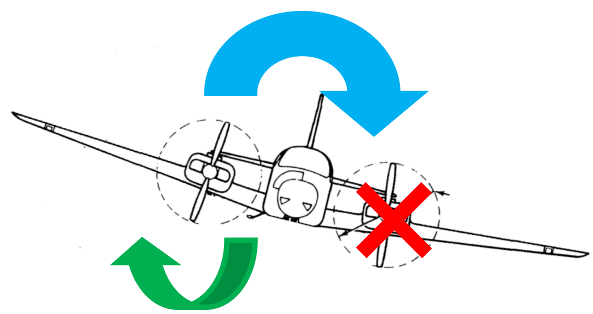


A spiraling slipstream, flowing from the LEFT propeller over the wing, impacts on the left side of the vertical stabilizer. This helps counteract the yaw produced when losing the right engine.

However, with failure of the left engine, the slipstream spirals away from the vertical stabilizer and toward the right, reducing the directional control of the aircraft and therefore contributing to making the left engine critical.

Torque





Clockwise rotation of propellers produces a counter-clockwise roll of the airplane. Failure of **right** engine produces a roll to the right, and the rolling motion will be reduced due to the torque generated by left engine. Failure of **left** engine airplane rolls left and torque generated by right engine adds to the rolling motion, requiring aileron input and increasing drag, contributing to making the left engine critical.

Performance

The best single-engine rate of climb is called V_{YSE}, also known as blue line due to the blue radial line that marks it on the airspeed indicator.

FAR 23.67 governs single-engine climb performance of multi-engine airplanes. Light twins such as the Aztec that have a maximum gross weight less than 6,000 lbs. fall into one of two categories for single engine climb performance based on their V_{SO} (stall speed in the landing configuration). Because the Azrec's V_{SO} is greater than 61 knots (59 Knots-converted from 68 MPH) it was not required to demonstrate a single engine climb gradient of at least 1.5% at 5,000 feet in standard atmospheric conditions to be certified. The gradient was only required to be determined under certain conditions and could be negative.

When one engine on a twin fails, **50% of the thrust is lost**, but there is approximately **80% loss of climb performance**.

14 CFR 23.67 Climb: One engine inoperative

(a) For normal, utility, and acrobatic category reciprocating engine-powered airplanes of 6,000 pounds or less maximum weight, the following apply:

(1) Except for those airplanes that meet the requirements prescribed in §23.562(d), each airplane with a V_{SO} of more than 61 knots must be able to maintain a steady climb gradient of at least 1.5 percent at a pressure altitude of 5,000 feet with the—

(i) Critical engine inoperative and its propeller in the minimum drag position;
(ii) Remaining engine(s) at not more than maximum continuous power;
(iii) Landing gear retracted;
(iv) Wing flaps retracted; and
(v) Climb speed not less than 1.2 V_{S1}.

(2) For each airplane that meets the requirements prescribed in §23.562(d), or that has a V_{SO} of 61 knots or less, the steady gradient of climb or descent at a pressure altitude of 5,000 feet must be determined with the—

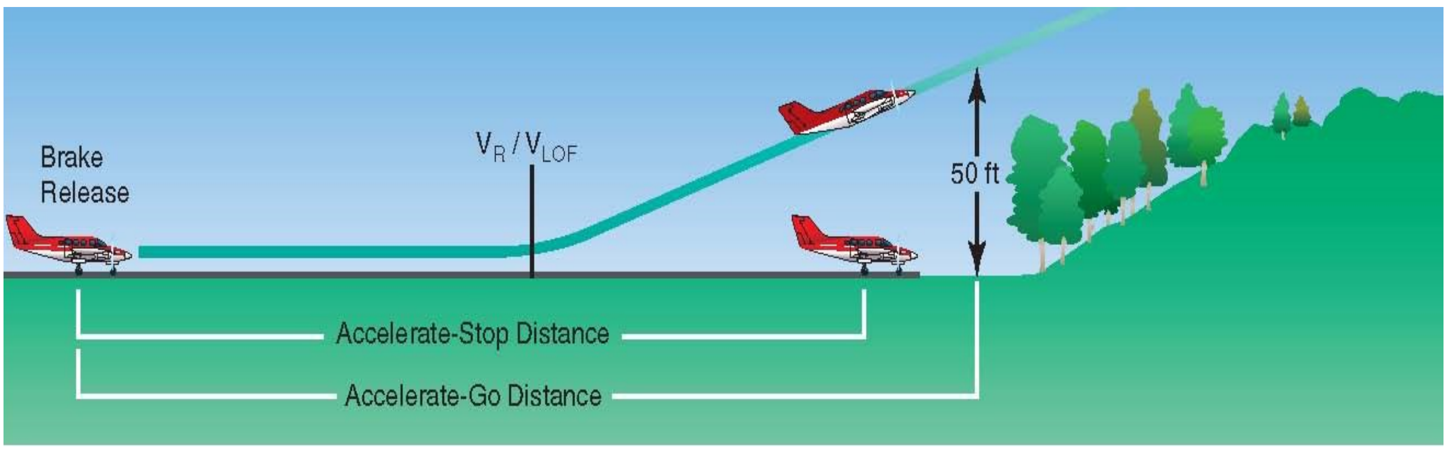
(i) Critical engine inoperative and its propeller in the minimum drag position;
(ii) Remaining engine(s) at not more than maximum continuous power;
(iii) Landing gear retracted;
(iv) Wing flaps retracted; and
(v) Climb speed not less than 1.2V_{S1}.

Accelerate-stop distance

The runway length required to accelerate to a specified speed (80 MPH), experience an engine failure, and bring the airplane to a complete stop. Assumptions in most performance charts are that the runway is paved and dry so make sure to take into account realistic runway conditions when calculating expected performance. Taking the difference between Accelerate Stop distance and usable runway and correlating that to your calculated landing distance will give you a good idea as to how much brake pressure will be required in the event you do have to abort.

Accelerate-go distance

The horizontal distance required to continue the takeoff and climb to 50 feet, assuming an engine failure at Rotation Speed (V_R). The Aztec Performance Section does not include an Accelerate-Go Chart. Performance charts for other multi engine aircraft allow the pilot to calculate two numbers. The first is the ground roll, which is the distance you will travel down the runway before you have an engine failure based on the variables in the chart. The second number calculates the total horizontal distance travelled to clear a 50 foot obstacle. You don't add the two together to get the total distance.

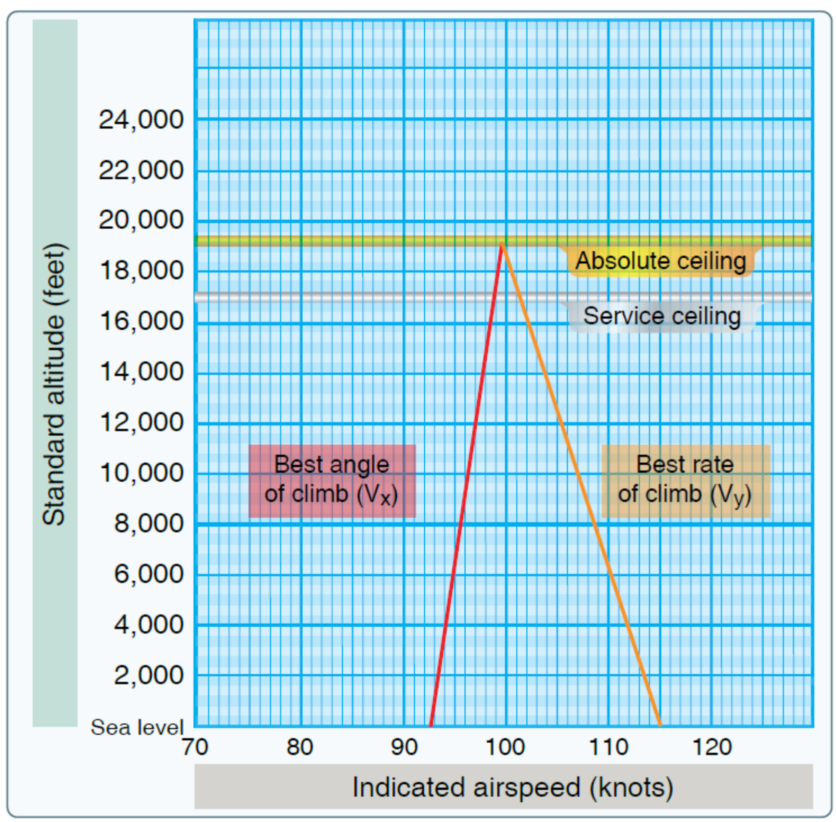


All-engine service ceiling

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.

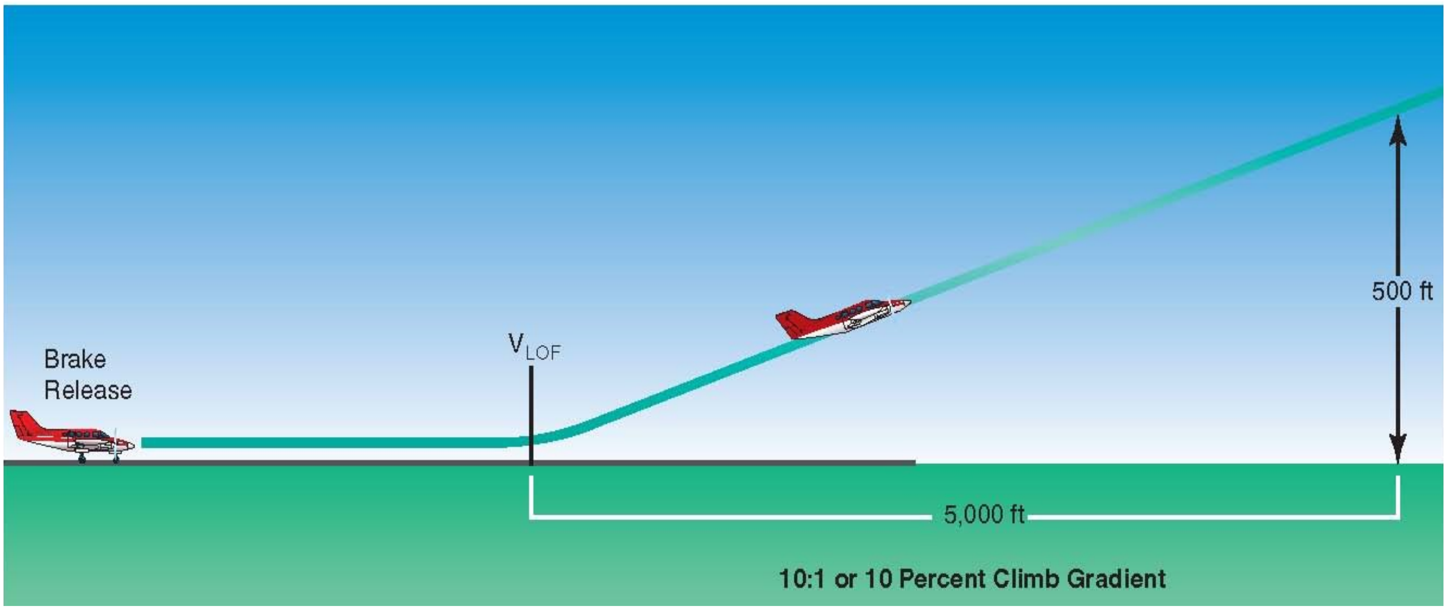
Single-engine service ceiling

Altitude when the multiengine airplane can no longer maintain a 50 FPM rate of climb with one engine inoperative, and its single-engine absolute ceiling when climb is no longer possible. This is good to know anytime, but especially important when flying in high terrain as obstacle clearance may not be available under certain conditions.



Climb gradient

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, or as a ratio of the horizontal distance to the vertical distance (50:1, for example). Unlike rate of climb, climb gradient is affected by wind. Climb gradient is improved with a headwind component, and reduced with a tailwind component. The number to calculate for this program is the foot per nautical mile since it directly applies to takeoff minimums when planning a flight. Climb gradient should always be calculated for both engines and single engine operating. Only with both figures will you be able to effectively determine the risk of departing a specific runway under Instrument Meteorological Conditions.



TAKE-OFF CLIMB GRADIENT - ONE ENGINE INOPERATIVE

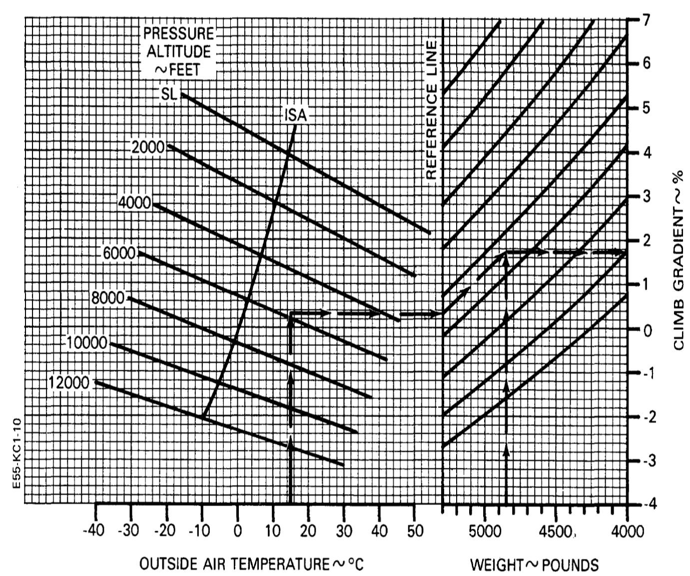
ASSOCIATED CONDITIONS:

POWER	TAKE-OFF
LANDING GEAR	UP
FLAPS	UP
INOPERATIVE PROPELLER	FEATHERED

CLIMB SPEED (ALL WEIGHTS)
92 KTS
(106 MPH)

EXAMPLE:

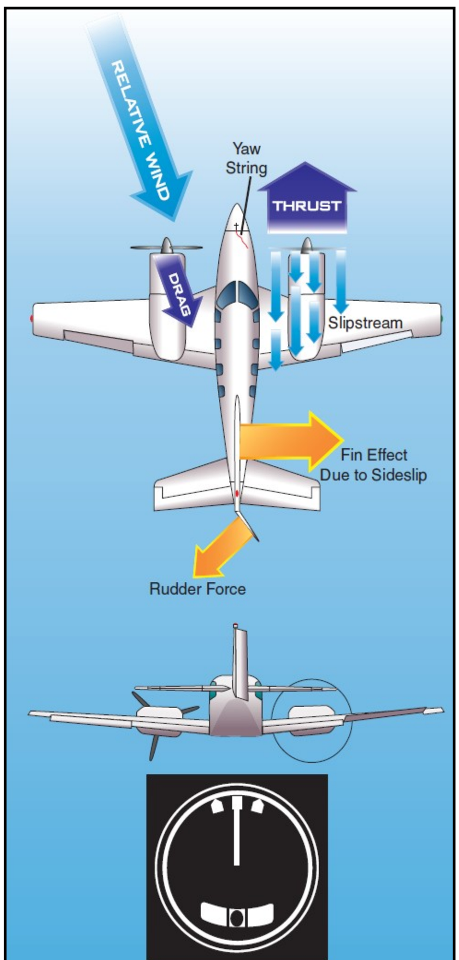
OAT	15°C
PRESSURE ALTITUDE	5650 FEET
WEIGHT	4850 LBS
GRADIENT OF CLIMB	1.75%
CLIMB SPEED	92 KTS (106 MPH)



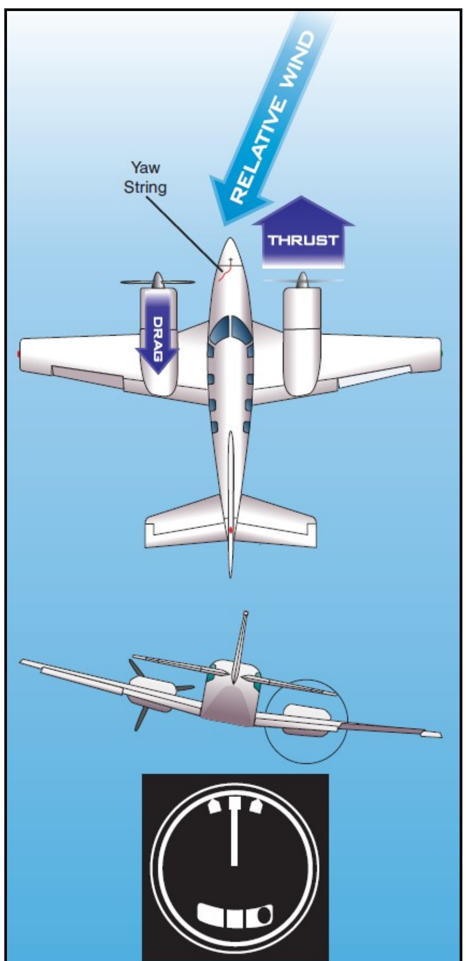
Sideslip vs. Zero Sideslip

When an engine failure occurs, thrust from the operating engine yaws the aircraft. To maintain aircraft heading with the wings level, rudder must be applied toward the operating engine. This rudder force results in the sideslip condition by moving the nose of the aircraft in a direction resulting in the misalignment of the fuselage and the relative wind. This condition usually allows the pilot to maintain aircraft heading; however, it produces a high drag condition that significantly reduces aircraft performance. Adding just angle of bank without rudder also produces a sideslip, increasing drag and reducing climb performance.

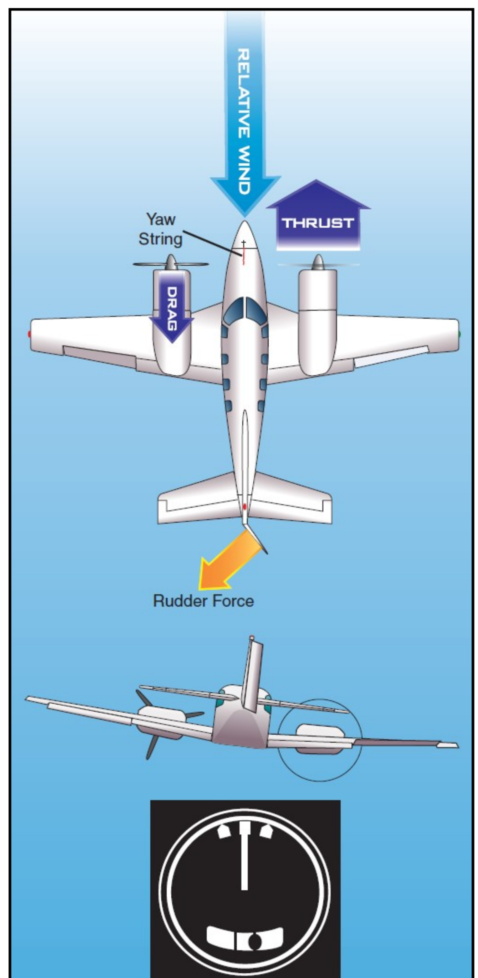
The solution to maintaining aircraft heading and reducing drag to improve performance is the Zero Sideslip Condition. When the aircraft is banked into the operating engine (usually 2˚-5˚), the bank angle creates a horizontal component of lift. The horizontal lift component aids in counteracting the turning moment of the operating engine, minimizing the rudder deflection required to align the longitudinal axis of the aircraft to the relative wind. In addition to banking into the operating engine, the appropriate amount of rudder required is indicated by the inclinometer ball being “split” towards the operating engine side. The Zero Sideslip Condition aligns the fuselage with the relative wind to minimize drag and must be flown for optimum aircraft performance.



Wings level, ball centered, airplane slips toward dead engine. Results: high drag, large control surface deflections required, and rudder and fin in opposition due to sideslip.



Excess bank toward operating engine, no rudder input. Result: large sideslip toward operating engine and greatly reduced climb performance.



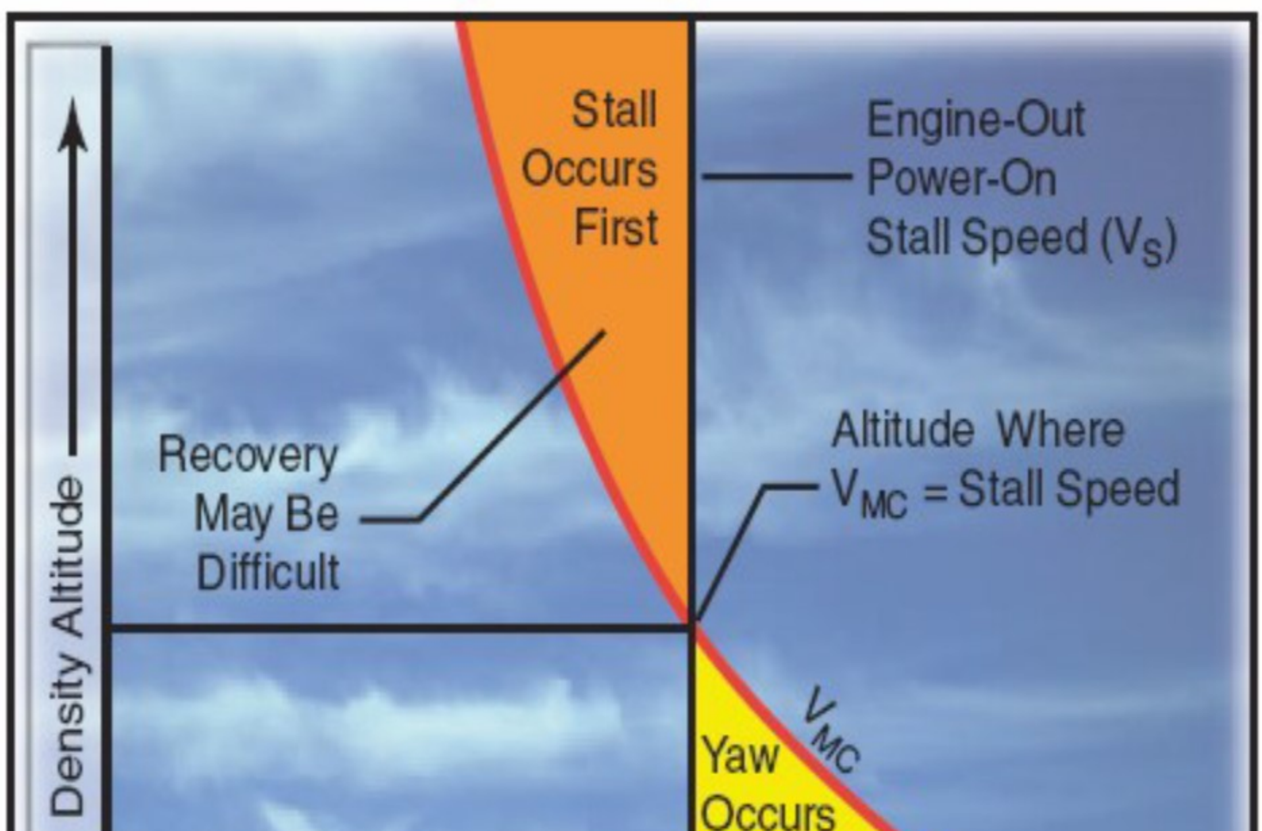
Bank toward operating engine, no sideslip. Results: much lower drag and smaller control surface deflections.

Stall/Spin

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} (80 MPH) and V_S (74 MPH), but the margin decreases with altitude, and at some altitude, V_{MC} and V_S are the same, this is called critical density altitude. Should a stall occur above critical density altitude while the airplane is under asymmetrical power, particularly high 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 the 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 at or before V_{MC}, the departure from controlled flight may be quite sudden, with strong yawing and rolling tendencies to the inverted position, 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 rapid decay in control effectiveness, the maneuver should be terminated immediately, the angle of attack reduced as the throttle is retarded, and the airplane returned to the entry airspeed.

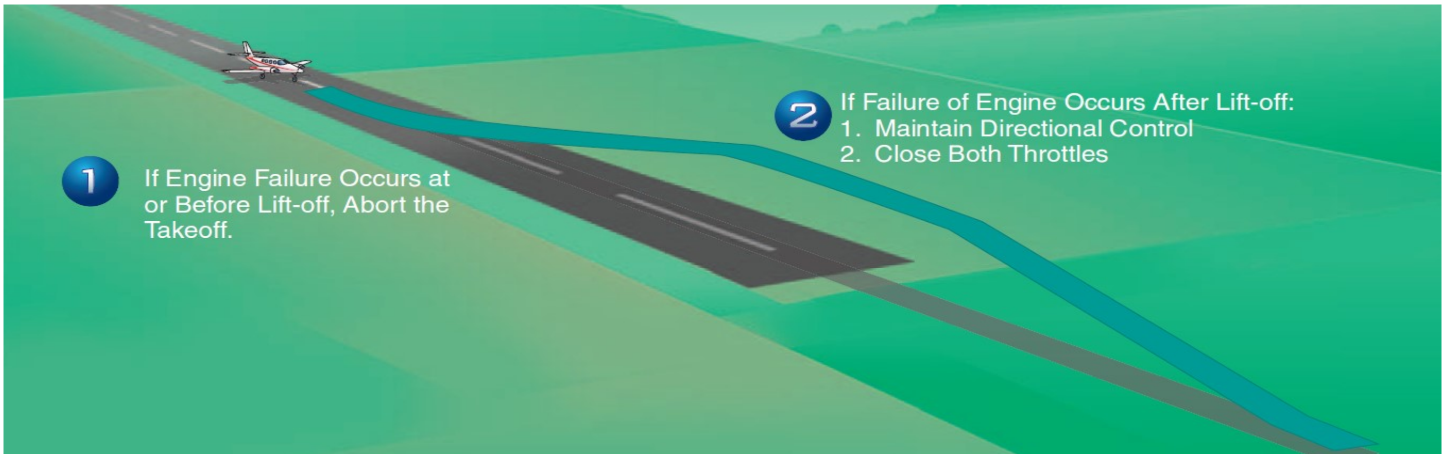


Engine Failure Procedures

With loss of an engine, it is paramount to maintain airplane control. Complete failure of one engine shortly after takeoff can be broadly categorized into one of three following scenarios:

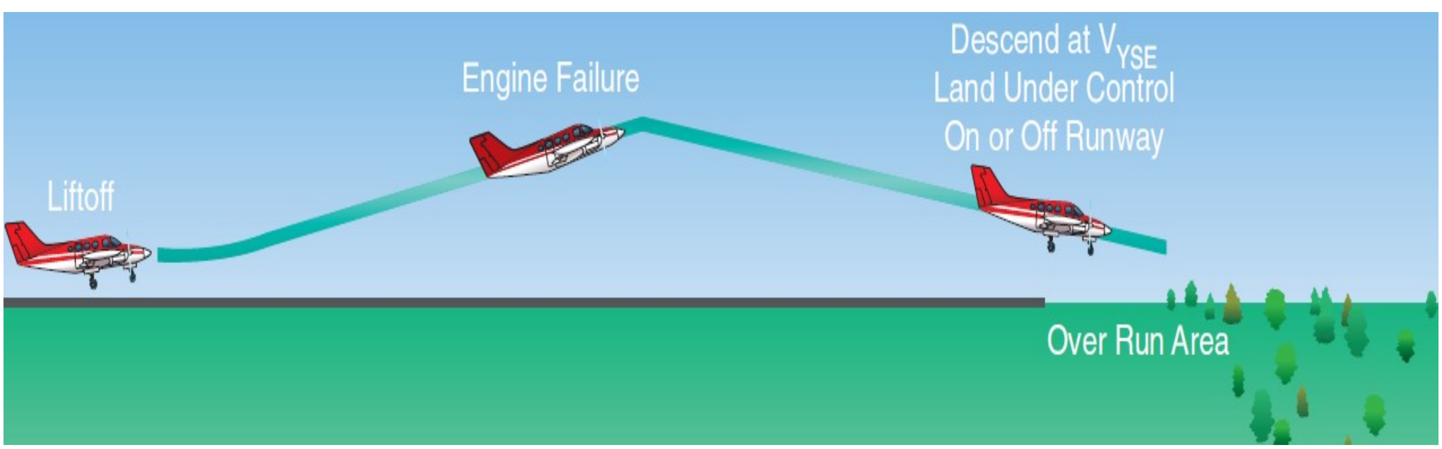
1. Landing gear down.

If the engine failure occurs prior to selecting the landing gear to the UP position, close both throttles and 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.



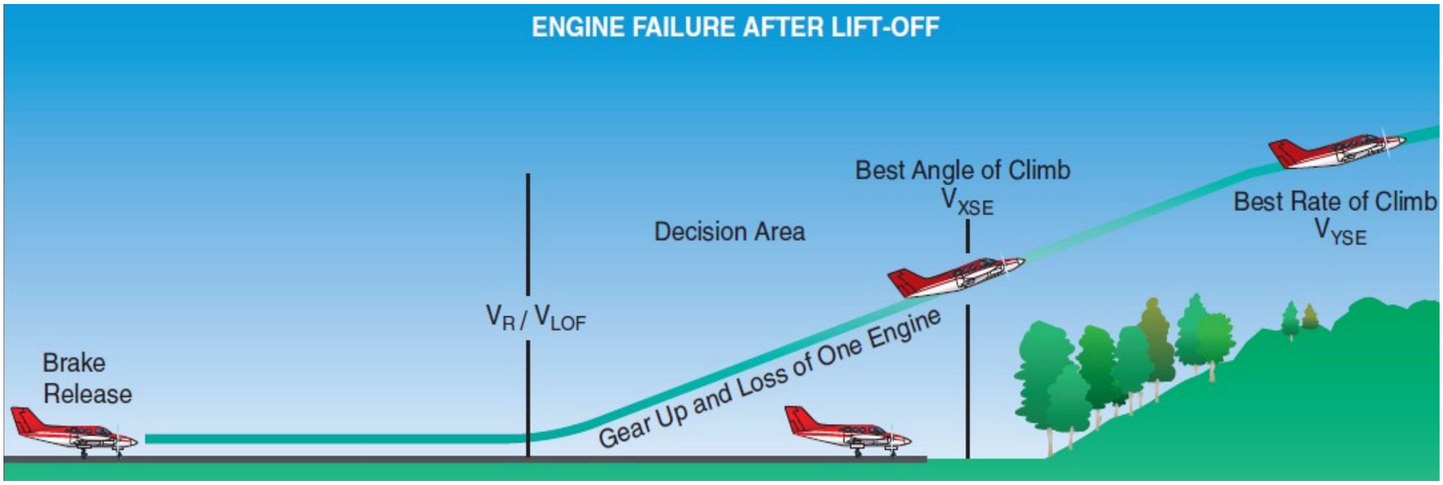
2. Landing gear control selected up, single-engine climb performance inadequate.

When operating near or above the single-engine ceiling and an engine failure is experienced shortly after lift-off, a landing must be accomplished on whatever essentially lies ahead. 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, 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. 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.



3. 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. There are four areas of concern: **control**, **configuration**, **climb**, and **checklist**.



Maintain Control

The first consideration following engine failure during takeoff is control of the airplane. Upon detecting an engine failure, aileron should be used to bank the airplane and rudder pressure applied, aggressively if necessary, to counteract the yaw and roll from asymmetrical thrust. The control forces, particularly on the rudder, may be high. Pitch attitude should be lowered to 3° to 5° nose up attitude as this will prevent excessive airspeed loss as well as minimize altitude loss for most scenarios. At least 5° of bank should be used, if necessary, 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.

Configuration

The memory items from the "engine failure after takeoff" checklist should be promptly executed to configure the airplane for climb. In the Aztec, as with most multi engine airplanes, after control has been maintained full power (mixtures, props, and throttles) should be applied. Following that ensure that the landing gear and flaps are retracted. Unlike stall recovery where you wait until positive rate is accomplished, an engine failure may not yield a positive rate until after the previous steps are completed as well as the prop feathered so do not hesitate in retracting the gear and flaps. Once the airplane has been configured for the engine failure, methodically identify, verify and feather the affected engine 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.

There are two time-tested memory aids the pilot may find useful in dealing with engine-out scenarios.

1. "Dead foot–dead engine" is used to assist in identifying the failed engine. Depending on the failure mode, the pilot won't be able to consistently identify the failed engine in a timely manner from the engine gauges. In maintaining directional control, however, rudder pressure will be 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."

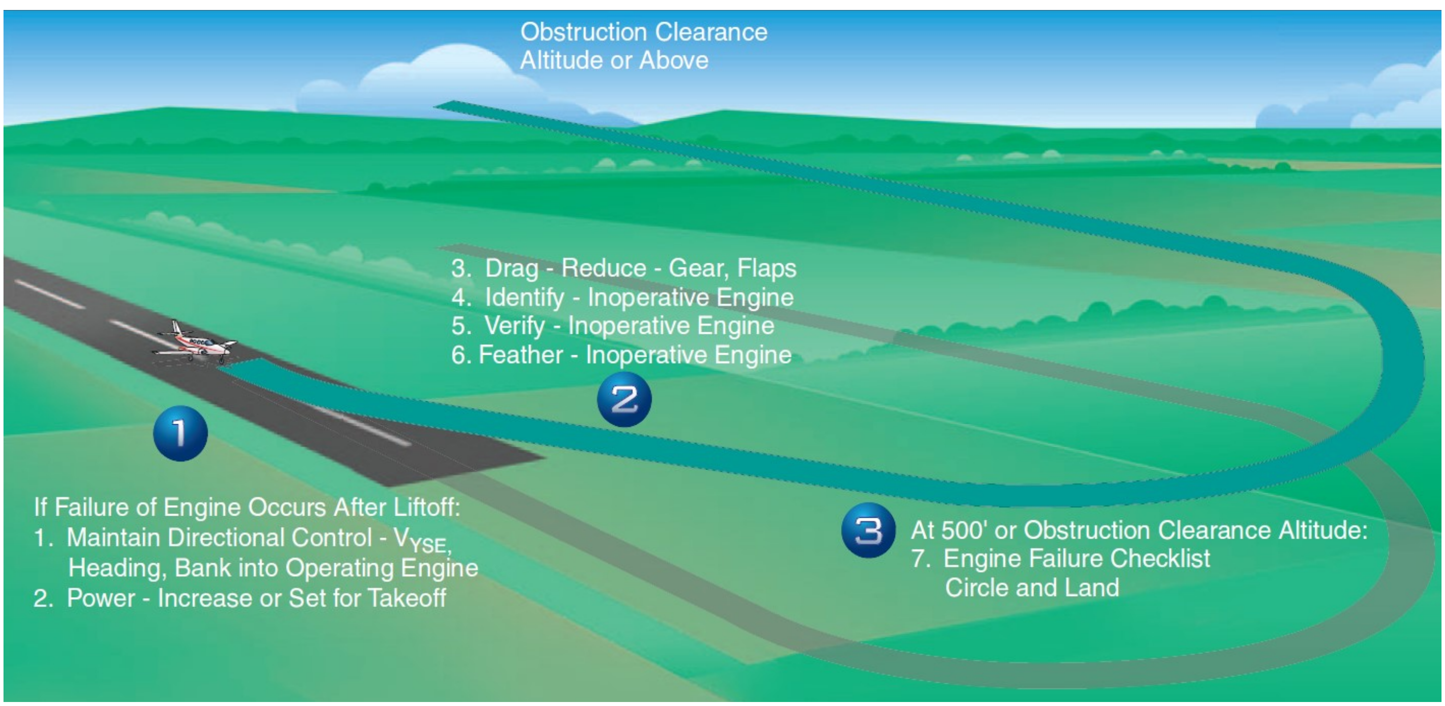
2. The second memory aid has to do with climb performance. The phrase "Raise the dead" is a reminder that the best climb performance is obtained with a very shallow bank, about 2° toward the operating engine. Therefore, the inoperative, or "dead" engine should be "raised" with a very slight bank.

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 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 "secure" checklist should then be accomplished. The best way to prevent inadvertent loss of control is to trim the aircraft once the prop is feathered then turn on the autopilot and trim and remaining rudder forces to establish zero side slip. 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.



Section III

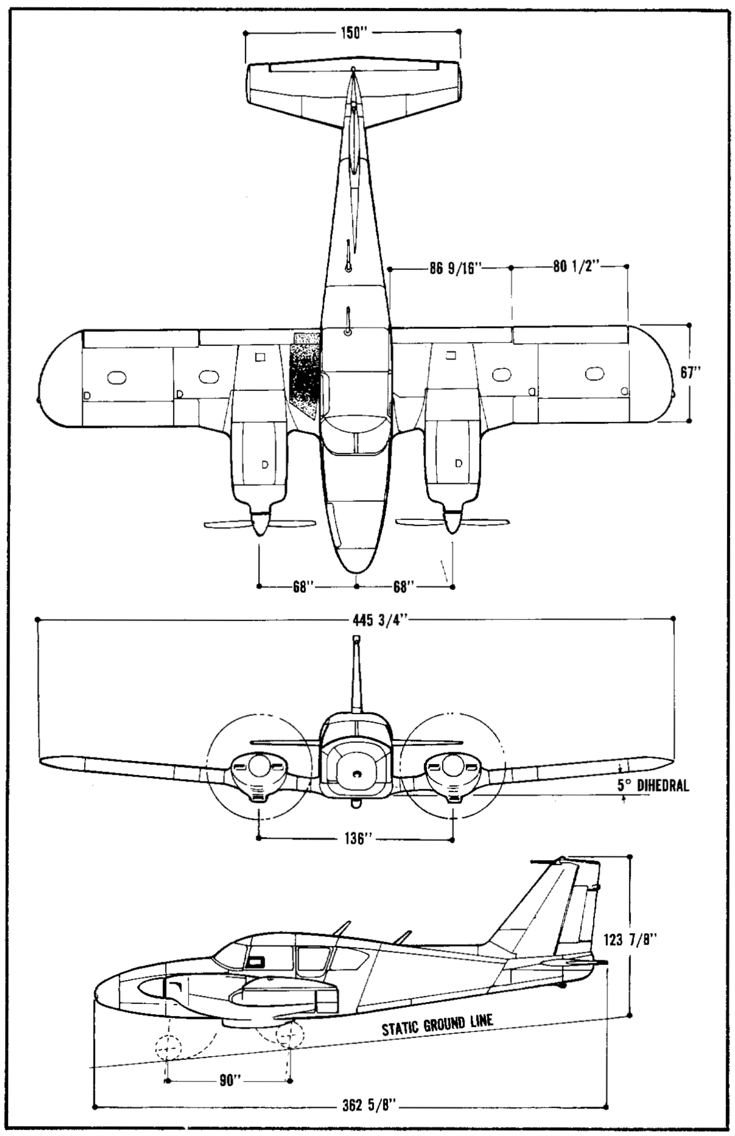
Piper PA-23-250 Aztec C Systems

Private and Commercial ACS (Area I Task G)
ATP ACS (Area I Task A)
Flight Instructor PTS (Area III Task C)

This section is designed as a supplement to the POH. It is recommended that you at least know how to navigate the POH anytime when operating an aircraft as Pilot In Command and especially on your Checkride.

Overview

Piper designed the first variant of the PA-23, the Apache, in 1959 and was the first multi engine aircraft developed by the manufacturer. Eventually the Apache evolved into the Aztec, which had an increased seating capacity of six, more powerful engines, and new vertical stabilizer and rudder. The Aztec is a cantilever low-wing monoplane with an all-metal structure, six seats, retractable tricycle undercarriage and a conventional tail. It is powered by two Lycoming IO-540 engines, which drive two-bladed Hartzell propellers. The serial number of N6644Y is 27-3958.



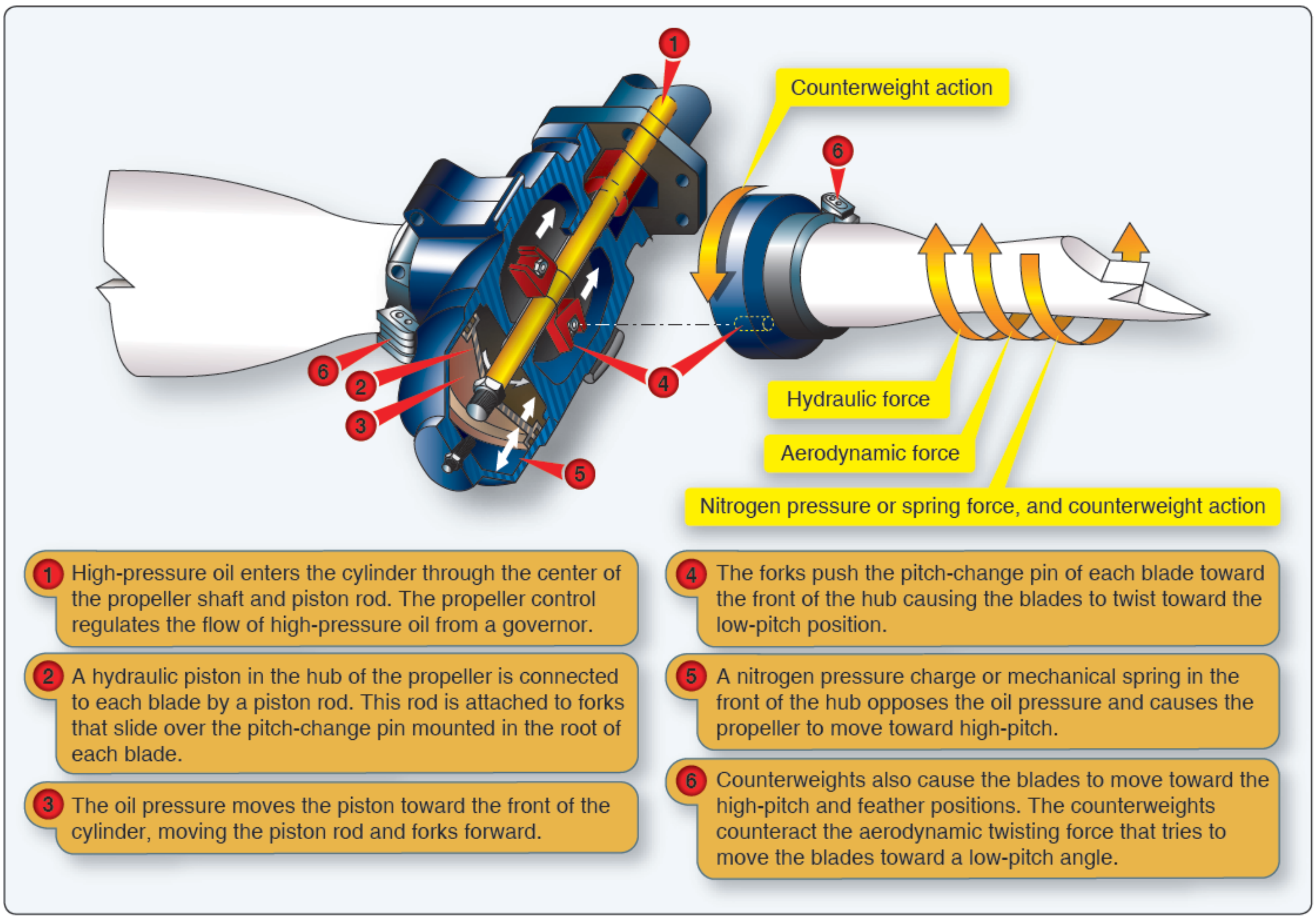
Engines

Two IO-540-C engines are installed. The engines are six-cylinder, Horizontally opposed, Air cooled, Normally aspirated, Direct drive and each rated at 250 horsepower at 2575 RPM. The engines use a full pressure wet sump oil system with a 12 quart capacity (3 quarts minimum). Oil temperatures are controlled by an automatic thermostat bypass control. Engine ignition is provided through a dual engine-driven magneto system which is independent of the electric system. The engine is started by gear-driven starters. Cowl flaps are controlled manually by push-pull controls located on fuel control panel in between the front seats. The cowl flap is closed in the up position and open in the down position. Cowl flaps create a low pressure area below the nacelle thereby pulling through the engine compartment for increased cylinder and oil cooling.

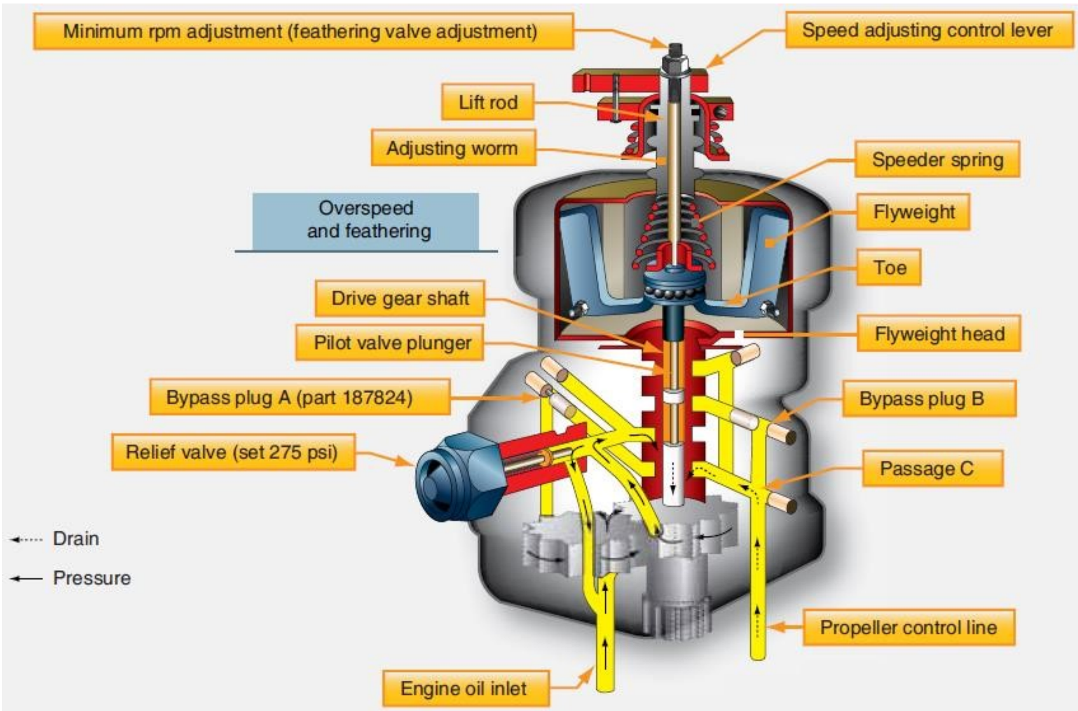
Propellers

The airplane is equipped with two, constant-speed, full feathering, two-blade propellers. Propeller RPM is controlled by the engine-driven propeller governor which regulates oil pressure in the hub. The propeller controls allow the pilot to select the governor's RPM range. Nitrogen pressure aided by counterweights, move the blades to high pitch (low RPM). Engine oil under governor-boosted pressure as well as aerodynamic forces moves the blades to the low pitch position (high RPM).

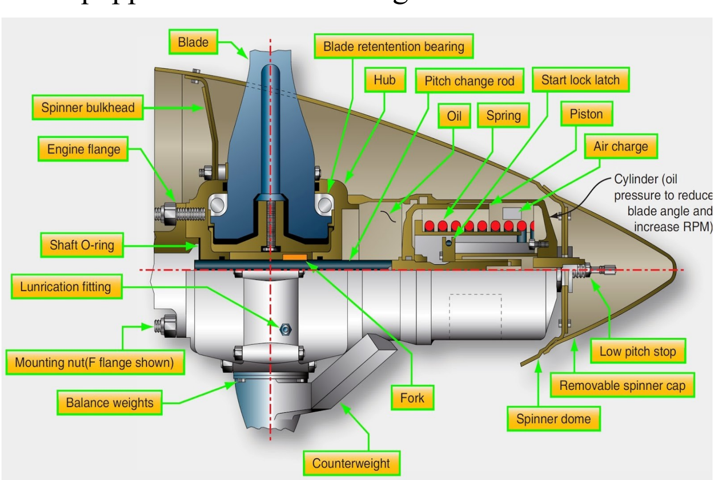
Constant Speed is the ability to maintain a specific RPM through the use of a propeller governor. When the propeller control is moved forward, positive oil pressure, regulated by a propeller governor, drives a piston, which rotates the blades to a low pitch/high RPM position. When the propeller control is moved aft, oil pressure is reduced by the propeller governor allowing the spring aided by counterweights to rotate the blade to a high pitch (low RPM) position. After an RPM is selected, the prop governor will automatically adjust oil pressure inside the propeller hub to maintain a constant speed (RPM) regardless of altitude or manifold pressure setting. Centrifugal pins prevent the propeller from feathering on shutdown, which lock the prop blades in low pitch at below approximately 1000 RPMs.
The basic governor configuration contains a hollow driveshaft which is connected to the engine drive train.

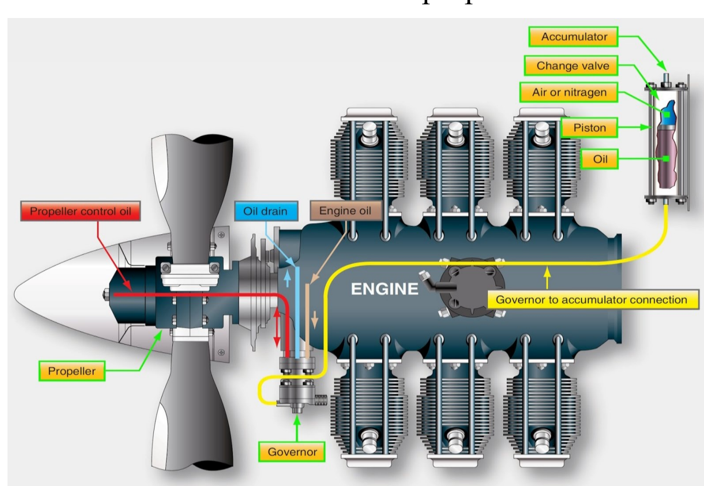


The driveshaft rotates at a speed which is directly proportional to the engine RPM. When the system is stable, rotating flyweights attached to the driveshaft provide an equal, opposing centrifugal force to balance the speeder spring tension, and the propeller maintains its RPM setting and blade angle. When forces act upon the system, the governor will always readjust the centrifugal force to match the selected speeder spring tension by changing the blade angle. The governor uses pressurized oil to change the blade angle. An oil pump drive gear, also located on the driveshaft, boosts engine oil pressure to the propeller operating pressure. The pressurized oil is routed through passages in the governor to a pilot valve which fits in the center of the hollow driveshaft. This pilot valve moves up and down in the driveshaft in response to the action of the flyweights and thereby directs or impedes the oil flow to the propeller hub as needed. These oil flow conditions allow the propeller blade angle to vary as required to maintain a constant system RPM.



Full feathering is the ability to align the propeller with the relative wind, thereby creating the lowest drag with an inoperative engine. This is accomplished by releasing the governor oil pressure, allowing the counter-weights and feathering spring to feather the blades. This is done by pulling the condition lever (pitch control) back to the limit of its travel, which opens up a port in the governor allowing the oil from the propeller to drain back into the engine. Feathering occurs because the summation of internal propeller forces causes the oil to drain out of the propeller until the feather stop position is reached. Unfeathering the propeller is accomplished by starting the engine so that the governor can pump oil back into the propeller dome or through the use of an unfeathering accumulator which releases oil accumulated during the feathering process back into the propeller dome to move the blades to a lower pitch until the oncoming air starts to windmill the propeller. N6644Y is not equipped with unfeathering accumulators so the starter must be used to unfeather the propeller.





Induction System

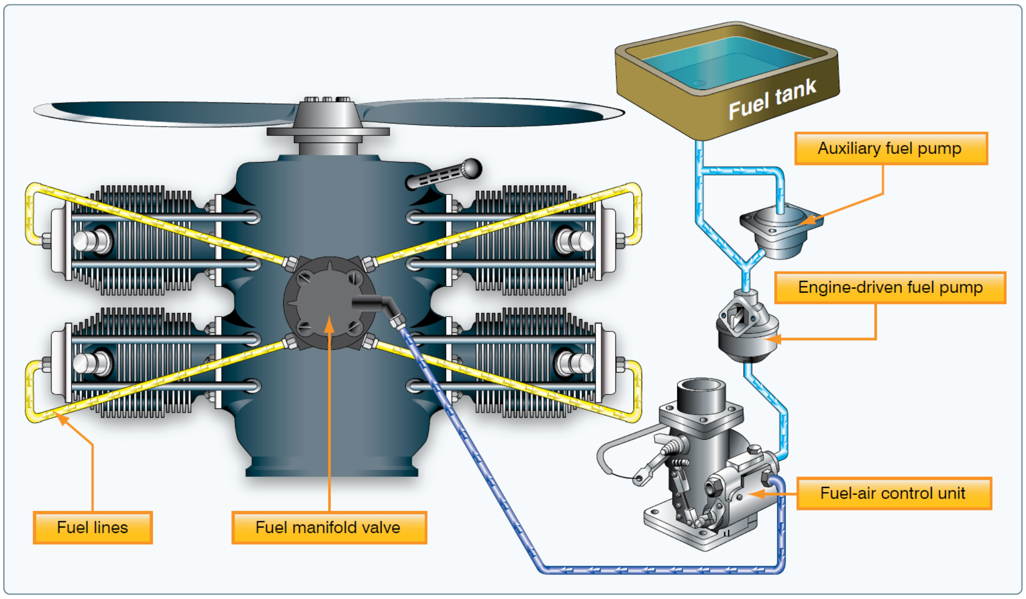
Induction air is available from filtered or unfiltered air. If the filtered air is blocked from impact icing on the air filter, a spring-loaded door on the side of the plenum will open automatically and the induction system will operate on alternate air. The alternate air door can also be manually operated using a push-pull control for each engine located on the control pedestal.

The IO-540 engine uses a fuel injected induction system. In a fuel injection system, the fuel is injected directly into the cylinders, or just ahead of the intake valve. The system incorporates six basic components: an engine-driven fuel pump, a fuel/air control unit, fuel manifold (fuel distributor), discharge nozzles, an auxiliary fuel pump, and fuel pressure/flow indicators.

An individual electric auxiliary fuel pump provides fuel under pressure to the fuel/air control unit to each engine. The electric pumps can be used to provide pressure in the event of failure of the engine-driven pumps. They are normally turned on to check their operation before starting the engines, turned off after starting, to check engine-driven pumps and left on during take-off and landing, to preclude the possibility of fuel pressure loss due to pump failure at critical times. If one of the engine-driven pumps fails, the electric pump to that engine can be turned on to supply the fuel. However, if desired, the fuel can be pumped by the operating engine-driven pump to the failed pump engine simply by turning on the crossfeed. The good pump will then be supplying both engines from its tank. If this tank runs low on fuel, fuel can be drawn from the opposite tank by turning on the electric pump on the failed pump side, leaving the crossfeed on, and turning the fuel valve on the empty side off. Then the electric pump on the failed pump side will be supplying both engines from its tank.

The fuel/air control unit, which essentially replaces the carburetor, meters fuel based on the mixture control setting, and sends it to the fuel manifold valve at a rate controlled by the throttle. After reaching the fuel manifold valve, the fuel is distributed to the individual fuel discharge nozzles. The discharge nozzles, which are located in each cylinder head, inject the fuel/air mixture directly into each cylinder intake port.

On aircraft equipped with a constant-speed propeller, power output is controlled by the throttle and indicated by a manifold pressure gauge. The gauge measures the absolute pressure of the fuel-air mixture inside the intake manifold and is more correctly a measure of manifold absolute pressure (MAP). At a constant rpm and altitude, the amount of power produced is directly related to the fuel-air mixture being delivered to the combustion chamber. As the throttle setting is increased, more fuel and air flows to the engine and MAP increases. When the engine is not running, the manifold pressure gauge indicates ambient air pressure (i.e., 29.92 inches mercury (29.92 "Hg)). When the engine is started, the manifold pressure indication decreases to a value less than ambient pressure (i.e., idle at 12 "Hg). Engine failure or power loss is indicated on the manifold gauge as an increase in manifold pressure to a value corresponding to the ambient air pressure at the altitude where the failure occurred.



Fuel

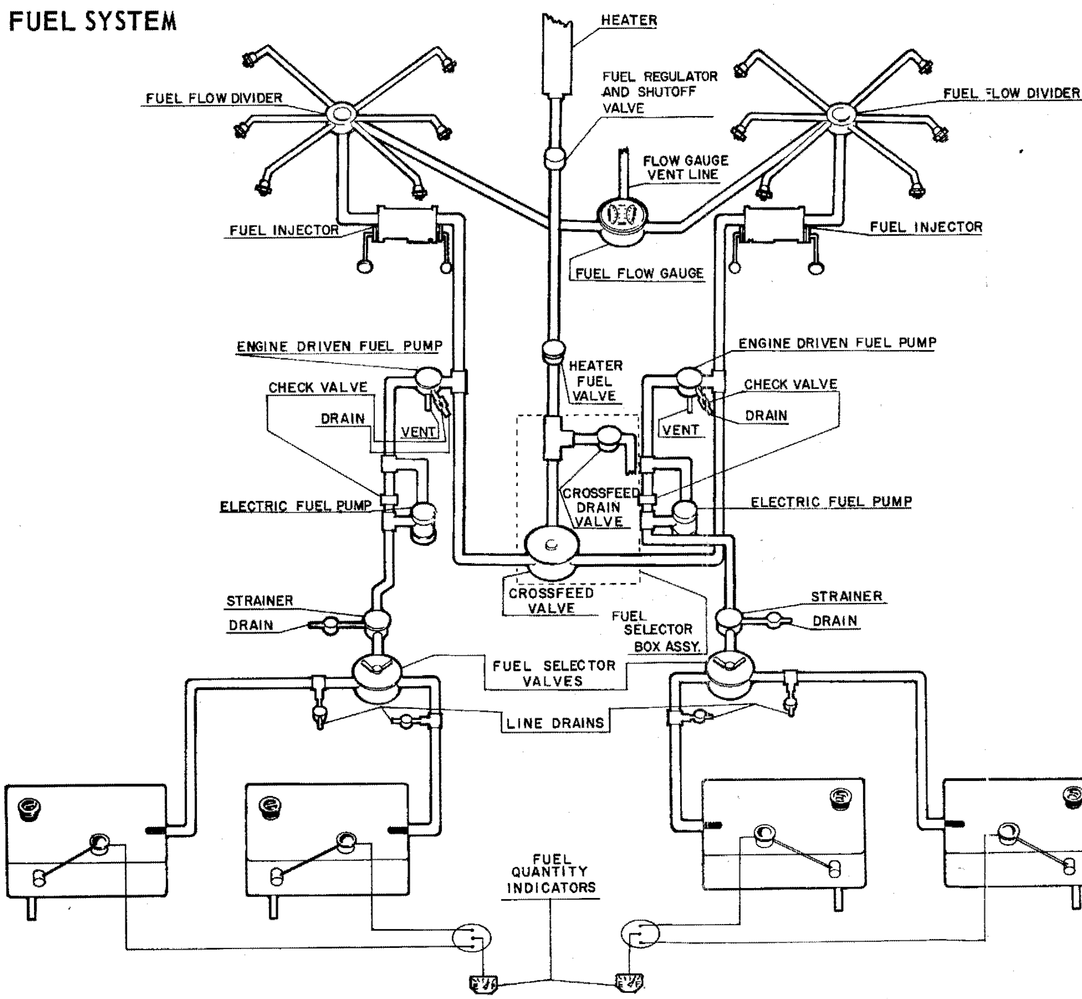
The Aztec uses AVGAS (91/96 minimum). The fuel system has an "OFF-ON" arrangement and controlled by the fuel selectors located on the lower center floor panel. There are four flexible bladder-type fuel cells (two in each wing) each having a fuel capacity of 36 gallons (35 usable) for a total of 144 gallons (140 usable).

The fuel system is drained at seven locations, three on the inboard side of each main wheel well and a crossfeed line drain valve control located on the front face of the fuel control panel in the cockpit.

There are two engine-driven and two electrically driven auxiliary fuel pumps. The electric auxiliary pump are located in bypass fuel lines in between the fuel tanks and the engine. They are normally turned on to check their operation before starting the engines, turned off after starting, to check engine-driven pumps and left on during take-off and landing, to preclude the possibility of fuel pressure loss due to pump failure at critical times.

Each fuel selector has a center OFF position and two ON positions, one for each tank. The electrically operated fuel quantity gauges indicate fuel for the tank selected. It remains in the ON position during normal operations, with each tank feeding its respective engine. Fuel cannot be transferred from tank to tank. However, an engine can use fuel from either wing using the crossfeed valve that is controlled by a lever on the fuel control panel.

If one of the engine-driven pumps fails, the electric pump to that engine can be turned on to supply the fuel. However, if desired, the fuel can be pumped by the operating engine-driven pump to the failed pump engine simply by turning on the crossfeed. The good pump will then be supplying both engines from its tank. If this tank runs low on fuel, fuel can be drawn from the opposite tank by turning on the electric pump on the failed pump side, leaving the crossfeed on, and turning the fuel valve on the empty side off. Then the electric pump on the failed pump side will be supplying both engines from its tank.



Flight Controls
The ailerons and rudder are connected by cables with the control wheel and rudder pedals. The rudder has a servo tab which also acts as a directional trim tab, actuated by a crank in the center of the forward cabin ceiling The horizontal tail is a stabilator, with an anti-servo tab which also acts as longitudinal trim tab, actuated by a larger crank adjacent to the rudder tab crank in the center of the forward cabin ceiling. The stabilator provides extra stability and controllability with less size, drag and weight than with conventional horizontal tail surfaces.

Electrical System
The Aztec is equipped with a 14-volt DC electrical system protected by push-pull type circuit breakers. The aircraft is equipped with one 12-volt, 35-amp battery located in the nose compartment. Two independent 70-amp, 12-volt, belt-driven alternators are controlled by a primary and auxiliary voltage regulators to control field voltage of both units. Also, incorporated in the system is an over-voltage relay supported by an auxiliary over-voltage relay. Its function is to open and remove field voltage to the unregulated alternators in the event of a failure of the voltage regulator, thus preventing an over-voltage condition which could damage the electrical equipment. Each set of regulators and relays is controlled by a switch located on the pedestal. The switch is placarded "Voltage Regulator Selector", "Main", and "Auxiliary". The switch should normally be in the "Main" position. The operation of the alternators may be checked by an ammeter switch located directly under the ammeter.

Electrical switches for the various systems, including the master switch, are located on the lower left side of the instrument panel. The circuit breakers, located below the electrical switches, automatically break the electrical circuit if an overload should occur. To reset the circuit breakers simply push in the reset button. The Owner's Handbook calls for a waiting period of approximately two minutes before resetting circuit breakers. However, Special Airworthiness Information Bulletin CE-10-11 supersedes this guidance by only allowing essential circuit brakers to be reset only once after waiting at least one minute.

Instrument lighting is provided by two spot lights (equipped with red lenses) installed in the center of the cabin ceiling. These lights are operated by a rheostat switch which is located directly aft of the lights. The lights are turned on with the first movement of the rheostat knob and the light intensity increased by further rotation of the control. Individual post lamps are mounted on the panel adjacent to each instrument. These lights are controlled by a rheostat switch located on the panel with the other electrical switches. It is important to know that the landing gear position lights are dimmed anytime the post light control is turned on. Operation of the rheostat is the same as for the spot lights.

Located in the cabin ceiling just aft of the windshield, on both the right and left sides, are two map lights equipped with clear lenses. Each light is operated by the switch located adjacent to the unit. For the passengers, reading lights are installed over each seat. A separate switch is incorporated for each of these units.

An overhead light is installed in both the forward and aft baggage compartments that will turn on automatically with the opening of the baggage door and turn off with the closing of the door. Should the forward baggage door not be completely closed and latched, a red warning light labeled "Door Ajar", located adjacent to the master switch will show an indication of this hazard when the master switch is on.

Ignition is provided by engine-driven magnetos that are controlled by individual switches (four total, two for each engine) located on the pilot subpanel. The starter switch is located immediately above the parking brake handle on the extreme left side of the instrument panel. This switch is spring loaded and locks in the center "Off" position. To operate, pull on the switch lever and hold to left or right as desired. After starting, release the switch and it will return to the off and locked position.

As optional equipment for starting, an external power receptacle is located on the underside of the nose on the right side.

Landing Gear and Flaps

The hydraulic system is used for the extension and retraction of both the landing gear and flaps. The operation of these units is accomplished by the landing gear and flap selectors of the hydraulic control unit which is housed within the control pedestal under the engine controls. Pressure is supplied to the control unit from an engine-driven pump mounted on the left engine. This system is serviced with MIL-H-5606 fluid.

To effect extension or retraction of the gear and flaps, the controls which protrude through the face of the pedestal are moved from the center "OFF" in the desired direction. When the selected component is fully extended or retracted, hydraulic pressure within the control unit forces the control back to a "Neutral" or "Off" position, which allows the hydraulic fluid to circulate freely between the pump and the control unit. Also, it isolates the activating cylinders and associated lines from the hydraulic fluid supply. This prevents complete loss of fluid in the event of a leak in the lines between the control unit and the component or at the actuating cylinders. The return of the control handle to the "OFF" position is also a secondary indication that the components have reached full extension or retraction. The landing gear position lights and the flap indication should be used as primary indications. Gear retraction and extension will occur normally in 14 to 16 seconds.

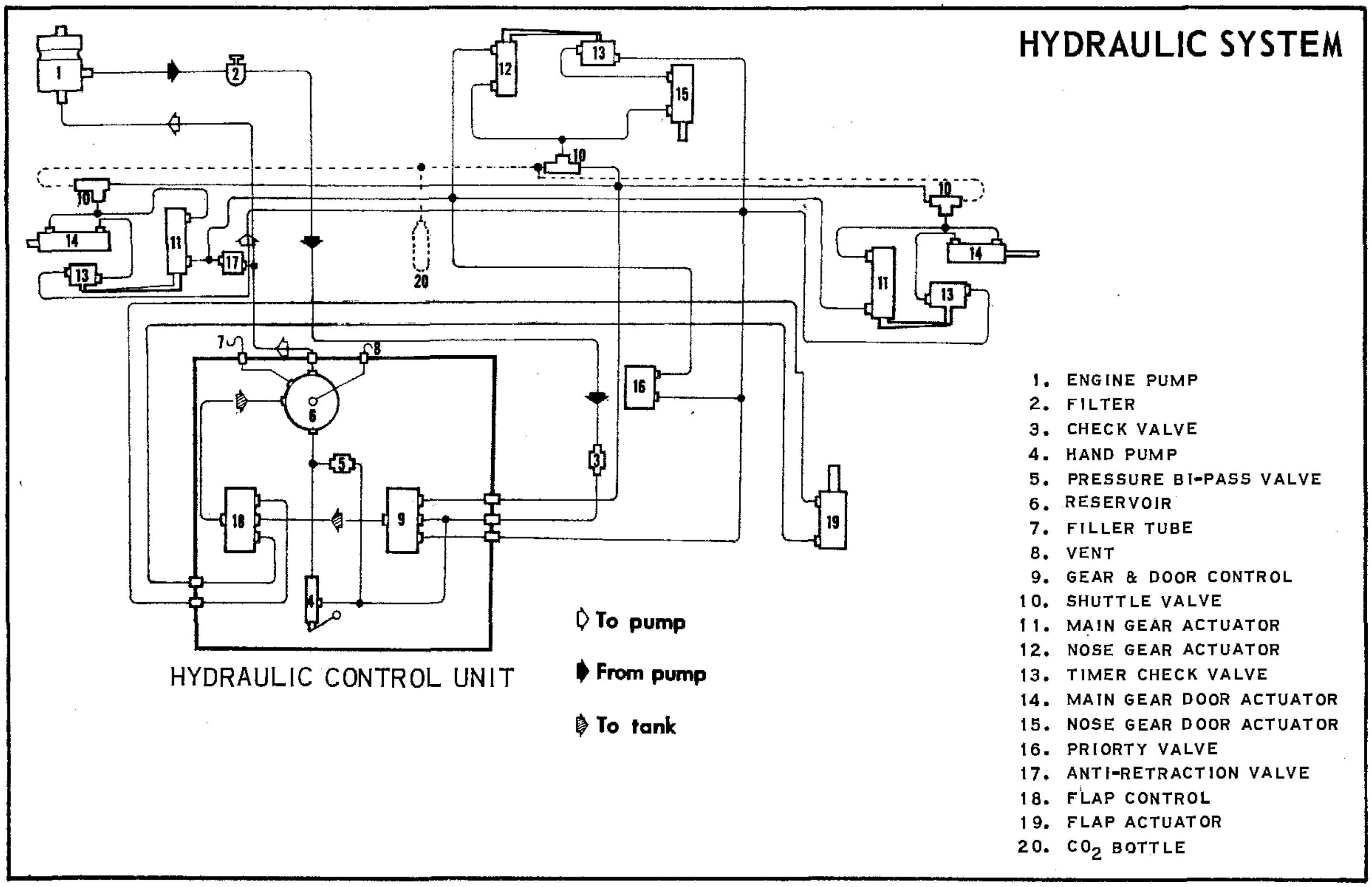
The emergency hydraulic hand pump, which is integral with the control unit, is used to obtain hydraulic pressure in event of failure of the hydraulic pump on the left engine. To operate the emergency pump, the handle should be extended to its full length by pulling aft and positioning the control handle as desired, 30 to 40 up and down pump strokes are required to raise or lower the landing gear. For emergency extension of the landing gear, if failure of the hydraulic system should occur due to line breakage or Anti-Retraction Valve hydraulic control unit malfunction, an independent C_{O2} system is available to extend the landing gear.

The position of the landing gear is indicated by four light bulbs located on the pedestal. When the three green lights are on, all three. legs of the gear are down and locked; when the amber light is on, the gear is entirely up and enclosed by the gear doors. When no light is on, the gear is in an intermediate position. Gear indication lights are automatically dimmed when the post light control is turned on. A red light in the landing gear control knob flashes when the gear is up and either one of the throttles is pulled back. When both throttles are closed beyond a given power setting, approximately 12 inches of manifold pressure with wheels not down, the landing gear warning horn sounds. To guard against inadvertent retraction of the landing gear on the ground, a mechanical latch, which must be operated before the landing gear control can be moved upward, is positioned just above the control lever. The control knob is in the shape of a wheel to differentiate from the flap control knob, which has an air-foil shape. There is also an anti-retraction valve located on the left main gear which prevents a build-up of hydraulic pressure in the retraction system while the weight of the airplane is resting on its wheels.

Included on the left main gear is an oleo actuated by-pass valve which makes it impossible to retract the landing gear while the weight of the airplane is on the gear. This valve is open when the oleo strut is compressed and by-passes all hydraulic fluid, on the pressure side of the system, to the return side, preventing any pressure build-up in the retraction system. When the oleo strut is extended as in flight, or when the aircraft is on jacks, the valve is closed permitting the system to operate in the normal manner.

The lading gear is held in the retracted and extended positions using mechanical up and downlocks. Incorporated with each gear assembly is a micro-switch which closes after full movement of the gear is down. The down switches are connected individually to green indicator lights on the pedestal. The up switches are in series and make contact after each gear door is closed. When this circuit is complete, the amber "gear up" light on the pedestal lights up. The microswitches must be adjusted carefully so that contact is made just as the gear and gear door reaches the required position. Located in the control pedestal below the throttles are three micro-switches. These switches operate the warning horn (located in the pedestal) and the red light in the gear handle. When one throttle is retarded and the gear is up, the red light in the gear handle will flash. When both throttles are retarded, and gear is up the warning light and horn will operate.

The Aztec is equipped with hydraulically operated plain flaps that deflect up to 50 degrees. The flaps are moved using an airfoil-shaped handle located on the face of the control pedestal. Flap position is indicated in the cockpit with an instrument that shows UP and DOWN positions and can be placed in any intermediate position. Flap operation requires about 4 seconds. The right flap can be used as a step to ease entry and exit, but only when the flaps are fully retracted.



Brakes and Nosewheel Steering
Main gear brakes (no ant-skid) are actuated by toe brake pedals on the left set of rudder pedals, independent of the hydraulic system that operates the landing gear and flaps. Hydraulic brake cylinders located in front of the left rudder pedals are readily accessible in the cockpit for servicing. Toe brakes for the right side are available as optional equipment. A brake fluid reservoir, which is connected to the brake cylinders with flexible lines provides a reserve of fluid for the brake system, and is mounted on the fuselage structure inside the left nose access panel. Parking brake valves, operated by a control on the left side of the instrument panel, are installed ahead of the forward cabin bulkhead and are also serviced through the left nose access panel. The nose wheel is mechanically steerable through a 30 degree arc, through use of the rudder pedals. As the nose gear retracts, the steering linkage becomes disconnected from the gear so that the rudder pedal action with the gear retracted is not impeded by nose gear operation. For maximum service from the tires, keep the Aztec main tire inflated to 46 lbs. and the nose tire to 27 lbs.

Environmental
The flow of air for cooling or heating the Aztec cabin is controlled by the five knobs on the cabin air control panel located at the bottom of the control pedestal.

The left control regulates air flowing to the front seat through the heater system and the second knob from the left controls air flowing to the rear seat through this system. The middle, knob controls the heater thermostat. The second knob from the right is the defroster control and the right hand control supplies, additional cold air to the front seat through a vent on the bulkhead.

Cabin air enters the heater system through an inlet below the landing light, and when the heater is not in operation, the inlet can serve as a source for cool air by pulling out. the heater controls.

A 35,000 B.T.U. Janitrol heater installed in the nose section furnishes a source of hot air for cabin heating and windshield defrosting. Operation of the heater is controlled by a three position switch located on the right side of the instrument panel, labeled "FAN", "OFF" and "HEAT". The "FAN" position will operate the vent blower only and may be used for cabin ventilation on the ground or windshield defogging when heat is not desired.

For heat the manual heater fuel valve located on the fuel selector panel must be on and the three position switch turned to "HEAT". This will start fuel flow and ignite the burner simultaneously. With instant starting and no need for priming, heat should be felt within a few seconds.

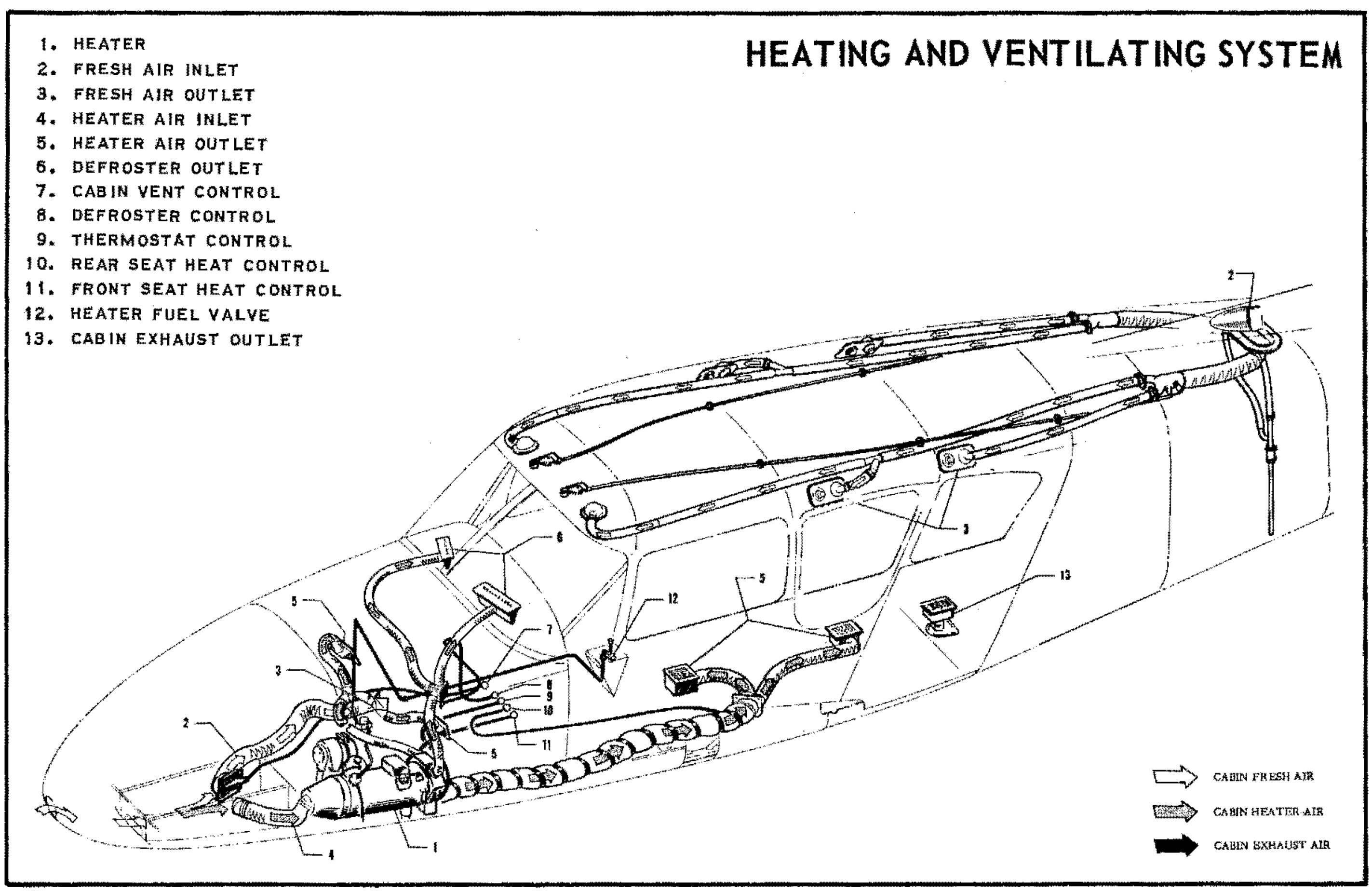
Regulation of heat, airflow and defroster operation is controlled by the push-pull knobs on the cabin air control panel. The middle knob is connected to an adjustable thermostat which makes it possible to select a desired temperature of heated air through a wide range.

Cabin temperature and air circulation can be maintained by using various combinations of knob settings, to suit individual Heating And Vent Controls desires. To minimize the feeling of drafts, a low air flow-high heat combination should be used. Windshield defrosting may be regulated by various settings of the defroster knob and in severe windshield fogging or icing conditions, it may be desirable to restrict the heater air, since this will drive more air through the defrosters.

When heat is no longer desired, the three position switch may be turned to the "OFF" position and the manual fuel valve closed. It is desirable that when the heater has been operating with the airplane on the ground, to turn the switch to "FAN" for several minutes to cool the heater and then to turn it to the "OFF" position.

Heat may be supplied to warm the cabin before flight by turning on the master switch, the left auxiliary fuel pump, and starting the heater. It should not be used in such a way as to deplete the battery. The cabin heater uses gasoline from the left main fuel tank when the crossfeed is off and from both tanks when the crossfeed is on.

Located in the heater is a heat limit switch, which acts as a safety device to render the heater system inoperative if a malfunction should occur causing excessively high temperatures. This control is located in the downstream end of the vent jacket, with the reset button on the heater shroud. It is reached only through the access



panel in the left side of the nose section to ensure that the malfunction causing the overheat condition is corrected prior to further heater operation.

For fresh air ventilation, an air scoop is mounted on the dorsal fin which draws air into the cabin through overhead vents in the ceiling. Each individual vent is adjustable for desired air flow as well as a master control regulating air from the right and left air source. These two knobs are located in the ceiling just aft of the windshield. Air is exhausted through an outlet on the floor of the aft baggage compartment.

Pitot-Static and Vacuum System

The pitot-static system (Airspeed, Altimeter, VSI) incorporates a pickup head that is mounted under the left wing, outboard of the engine nacelle. Pitot and static pressure are picked up by this head and carried through lines to the instrument. An alternate static air source can be installed on the control pedestal, below the hydraulic hand pump. When the alternate static source valve is open, the pitot-static instruments will operate on air from within the fuselage and may vary to from readings under normal pitot-static operation.

The Artificial Horizon and Directional Gyro in the flight group are vacuum operated through use of vacuum pumps installed on both engines. A check valve is installed in the vacuum system so that in case of a pump failure the system will automatically continue to operate on the remaining vacuum source. The Turn and Bank is an electrically operated instrument and serves as a standby for the Gyros in case of vacuum system failure. The vacuum gauge in the engine instrument group should indicate 4.8 to 5.1 inches of mercury suction, required to operate the gyros when drawing air through the central filter system.

Stall Warning

Stall warning is provided by a sensing vane installed on the leading edge of the left wing. The stall warning light is wired to the battery bus and will not actuate if the battery master switch is OFF.

Icing Equipment

The Aztec is equipped with two systems for icing. One is the pitot heat system, operated by a switch on the right side of the cockpit. The second is propeller deicing. Heating elements are located on each propeller blade near the hub. A switch on the right side of the cockpit heats up the elements while a separate indicator in the cockpit provides system amperage.

Seats and Exits

All seats in the Aztec are constructed of steel tubing, with no-sag springs and foam cushions. The front seats are adjustable fore and aft through a seven inch range by operation of a release control on the front of each seat. The right front seat is also adjustable aft beyond the normal range to provide ease of entry to the pilot's seat. Both front seats are easily removed by taking out the lower bolts in the stop plates at the rear of the seat structure, swinging the stop plates laterally and sliding the seats forward off their tracks.

The rear seat area is equipped with two individual bucket type seats and a couch type seat across the full width of the cabin which will accommodate two people. To remove the two rear bucket seats, stop plates on the track are taken off, and the seats moved fore or aft as required to disengage from their tracks. The rear seat can easily be removed for added cabin space. The back of tile seat is removed first by pulling it forward, then lifting it out. The bottom of the seat is pulled forward to disengage pins at the rear, then pushed back to disengage seat supports from the floorboards. The four reclining. seats are provided with headrests. The locks on both baggage doors are operated by one key, while the cabin door has a separate key.

There are two large baggage compartments, each compartment is placarded for 150 pounds. The forward compartment is accessible through a rectangular door . The rear compartment has a door hinged on the forward side.

VFR Day: TOMATOE A FLAMES (FAR 91.205)

Tachometer (for each engine)
Oil Pressure Gauge
Magnetic Direction Indicator (compass)
Airspeed Indicator
Temperature Gauge for each liquid cooled engine
Oil Temperature Gauge
Emergency equipment (beyond gliding distance over water) pyrotechnic signaling device, flotation device
Anti-collision Lights
Fuel Gauge for each tank
Landing gear position indicator
Altimeter
Manifold Pressure Gauge for each engine
Emergency Locator Transmitter
Safety Belts and **S**houlder Harnesses

VFR Night: FLAPS

Fuses
Landing light, if operated for hire
Anti-collision light (beacon and/or strobes)
Position Lights – Nav Lights (Red on the left, Green on the Right, White aft)
Source of electricity (battery, generator, alternator)

IFR: GRABCARD

Generator (source of electrical power)
Radios
Altimeter (must be sensitive)
Ball (turn coordinator)
Clock (must show seconds)
Attitude Indicator
Rate of Turn (Turn coordinator)
Directional Gyro / **D**ME - if above FL 240

Required Documents in the Airplane

Airworthiness Certificate
Registration
Operating Handbook/ AFM
Weight and Balance

Aircraft Equipment Inspections: AV1ATE

Annual - Every 12 months
VOR - Every 30 days
±4 degrees for VOT/ground checkpoint/Dual check
±6 degrees for airborne check
100 Hour - Every 100 hours of service
Altimeter (Pitot-Static) - every 24 calendar months
Transponder - every 24 calendar months
ELT Whichever occurs first: Every 12 months / Half the battery life / 1 hour of cumulative use

GPS Information

The GPS constellation of 24 satellites is designed so that a minimum of five is always observable by a user anywhere on earth. The receiver uses data from a minimum of four satellites above the mask angle (the lowest angle above the horizon at which it can use a satellite) to generate proper position information.

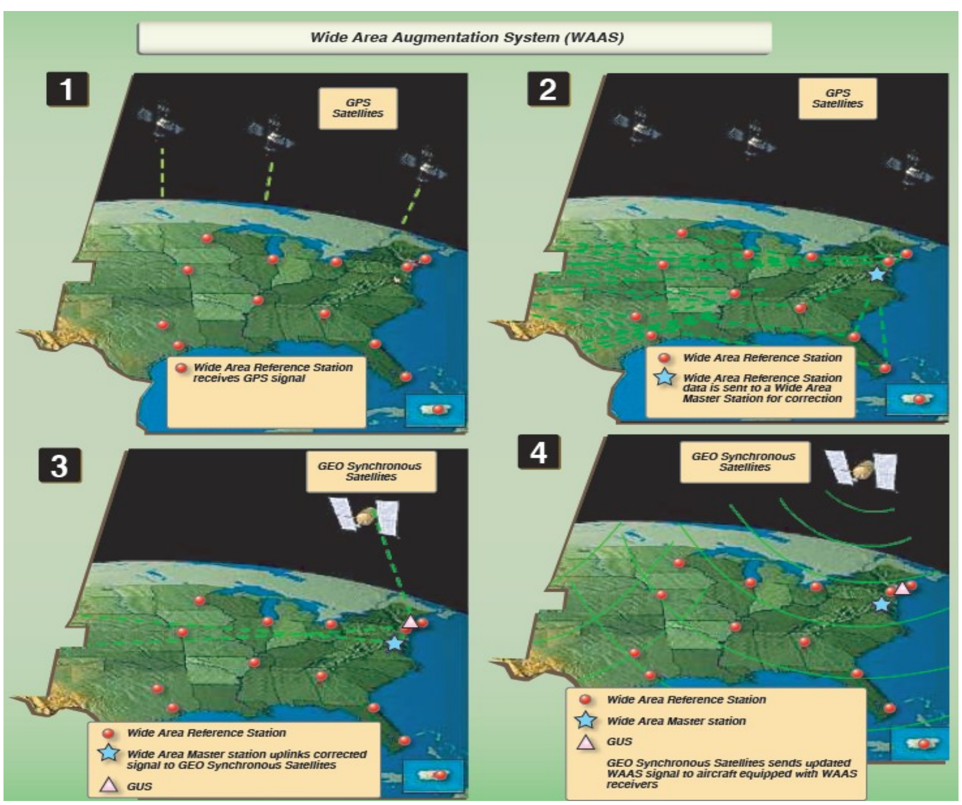
3 requirements to make GPS legal for IFR:

1. Current database (every 28 days)
2. GPS unit must be panel mounted
3. FAA Approved

The GPS receiver verifies the integrity (usability) of the signals received from the GPS constellation through receiver autonomous integrity monitoring (RAIM) to determine if a satellite is providing corrupted information. At least one satellite, in addition to those required for navigation, must be in view for the receiver to perform the RAIM function; thus, RAIM needs a minimum of 5 satellites in view, or 4 satellites and a barometric altimeter (baro-aiding) to detect an Integrity anomaly. (Baro-aiding satisfies the RAIM requirement in lieu of a fifth satellite.) For receivers capable of doing so, RAIM needs 6 satellites in view (or 5 satellites with baro-aiding) to isolate the corrupt satellite signal and remove it from the navigation solution. The "D" on the bottom of the satellite health page indicates that WAAS is available.

In terms of accuracy the VOR signal provides 9,500 within 20 miles and 475 feet within 1 mile of the station. Non-WAAS GPS is accurate to within 50 feet and WAAS provides 10 feet of accuracy 95% of the time.

Wide Area Augmentation System (WAAS) uses ground based reference stations to measure variations in satellite signals which enables higher precision of navigation. WAAS certified GPS receivers are capable of Localizer Performance Vertical guidance (LPV) and LNAV/VNAV approaches whereas non WAAS GPS receivers are not.



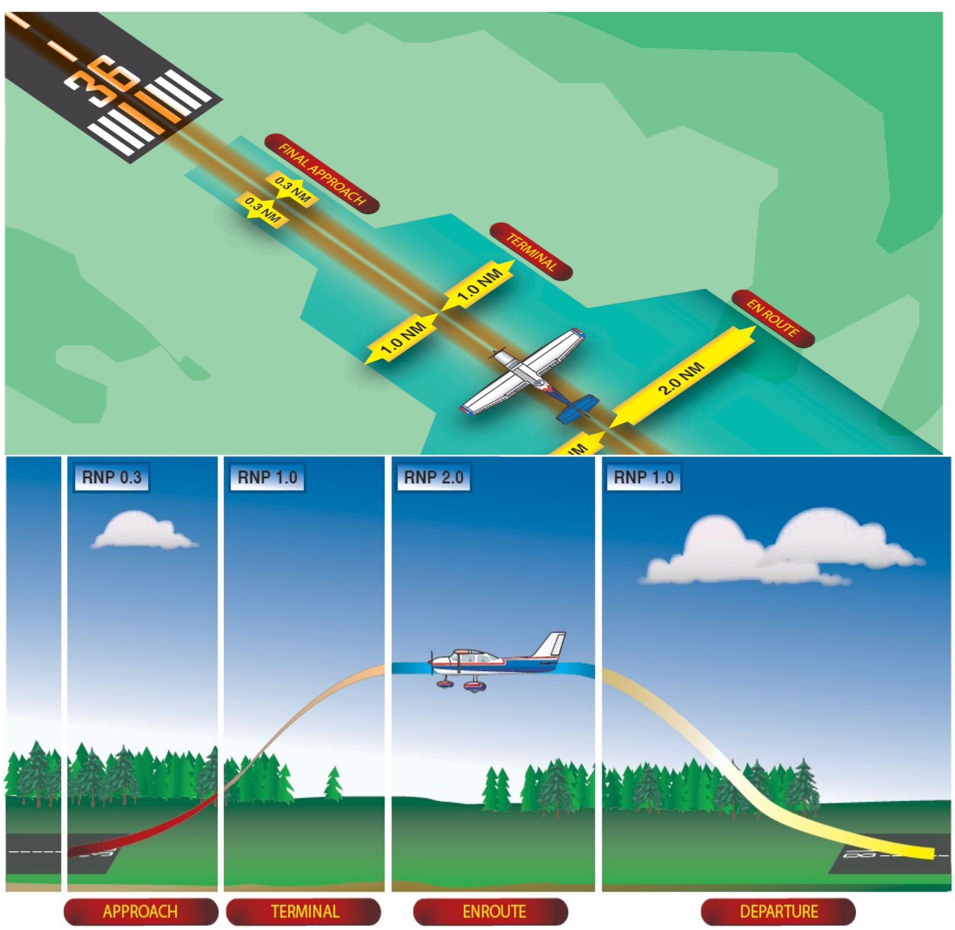
LPV (Localizer Performance Vertical Guidance) - Like an ILS, an LPV has vertical guidance and is flown to a Decision Altitude (DA). The design of an LPV approach incorporates angular guidance with increasing sensitivity as an aircraft gets closer to the runway. Sensitivities are nearly identical to those of the ILS at similar distances.

LNAV/VNAV (Lateral Navigation / Vertical Navigation) - provide both horizontal and approved vertical approach guidance. Vertical Navigation (VNAV) utilizes an internally generated glideslope based on WAAS or baro-VNAV systems. Minimums are published as a DA.

LP (Localizer Performance) - LPs are non-precision approaches with WAAS lateral guidance. They are added in locations where terrain or obstructions do not allow publication of vertically guided LPV procedures. Lateral sensitivity increases as an aircraft gets closer to the runway. LP is not a fail-down mode for an LPV. LP and LPV are independent. Minimums are published to Minimum Descent Altitudes (MDAs).

LNAV (Lateral Navigation) - Non-precision approaches that provide lateral guidance. The pilot must check RAIM (Receiver Autonomous Integrity Monitoring) prior to the approach when not using WAAS equipment. Minimums are published to Minimum Descent Altitudes (MDAs).

CDI sensitivity (RNP - Required Navigation Performance) on IFR-certified GPS receivers varies with the phase of flight. During the enroute phase of flight (outside of 30 nm) total course width is 4 nm (full deflection is 2nm). Within 30 nm of either the departure or destination airport, the receiver operates in terminal mode, and total course width becomes 2 nm (i.e., full needle deflection equals 1 nm). Finally, within 2 nm of the final approach fix (inbound), the receiver automatically enters approach mode. Total course width becomes 0.6 nm (i.e., full needle deflection equals 0.3 nm).



ADS-B Information

After January 1, 2020, when operating in the airspace designated in 14 CFR § 91.225 (outlined below) you must be equipped with ADS-B Out avionics that meet the performance requirements of 14 CFR §91.227. Aircraft not complying with the requirements may be denied access to this airspace.

ADS-B stands for Automatic Dependent Surveillance-Broadcast.

Automatic–properly-equipped aircraft automatically report their position, without need for a radar interrogation

Dependent–ADS-B depends on aircraft having an approved WAAS GPS on board and an ADS-B Out transmitter

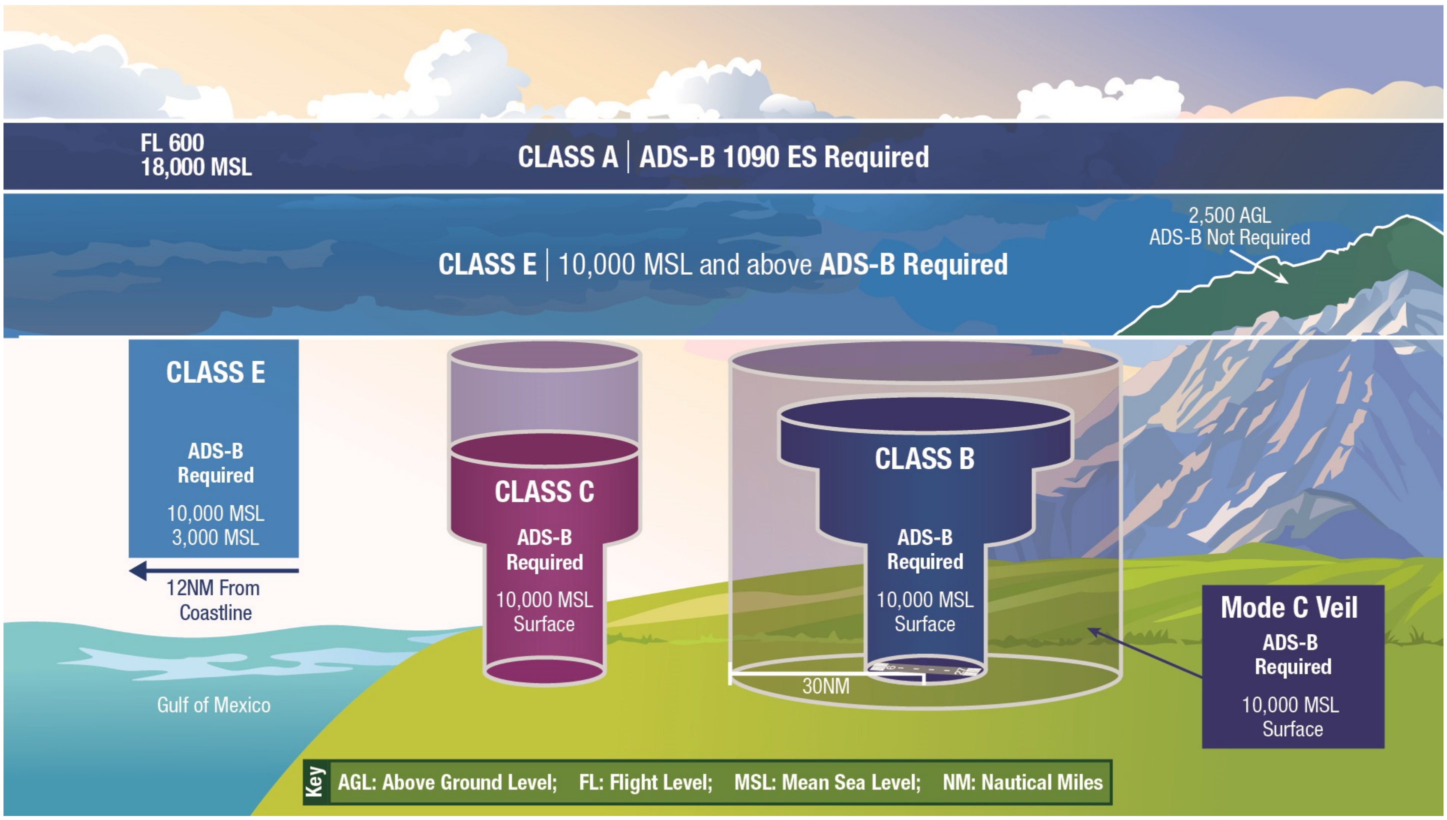
Surveillance–it is a surveillance technology that allows ATC to watch airplanes move around

Broadcast–aircraft broadcast their position information to airplanes and ATC

Any airspace that requires the use of a Transponder today will on January 01, 2020 also require aircraft to be equipped with a Version 2 ADS-B Out system. This can be either a 1090ES (DO-260B) ADS-B system or a UAT (DO-282B) ADS-B system.

For aircraft operating above FL180 (18,000 ft.) or to comply with ADS-B mandates outside the United States, you must be equipped with a Mode-S transponder-based ADS-B transmitter. For aircraft operating below 18,000 ft. and within the United States ADS-B rule airspace, you must be equipped with either a Mode-S transponder-based ADS-B transmitter or with UAT equipment.

You are still required to be equipped with ADS-B if you plan on flying along the coastline above 3,000 ft. MSL or within the Mode C Veil of most Class B airports Appendix D Section 1 of 14 CFR 91 lists the exact airports that apply.



Performance and Limitations

Center of Gravity
99.0 to 100.5 at 5,200 lbs.
97.0 to 100.5 at 5,000 lbs.
87.6 to 100.5 at 3,450 lbs. or less
Straight line deviation between points given.

Datum
Datum 80 inches ahead of the wing leading edge outboard of tapered sections.

Maneuvers
Aerobatic maneuvers, including spins, are prohibited.

Load Factors (5200 lbs.)
Positive……………………………………………………………………………………….3.68G
Negative……………………………………………………………………………………-1.47G

Engine Limitations
Continuous Power……………………………………………………………………..Full throttle, 2575 RPM
Maximum Oil Temp………………………………………………………………………………245 F
Minimum Take-off Oil Temperature…………………………………………………………………60 F
Maximum Cylinder Head Temp…………………………………………………………………….500 F
Minimum Oil Pressure (idle)……………………………………………………………………..25 psi
Maximum Oil Pressure……………………………………………………………………………100 psi
Maximum Fuel Flow……………………………………………………………………………..26 GPH
Maximum Manifold Pressure Below 2300 RPM…………………………………………………....27" HG
Maximum Manifold Pressure Below 2000 RPM…………………………………………………....25" HG
Maximum RPM…………………………………………………………………………………..2575 RPM

Fuel Limits
Total Capacity …………………………………………………………………………………..144 gal
Total Usable…………………………………………………………………………………….140 gal

Oil Limits
Maximum capacity……………………………………………………………………………12 quarts

Aircraft Weights
Basic Empty Weight……………………………………………………………………………..3143 lbs.
Maximum Take-off Weight……………………………………………………………………...5200 lbs.
Maximum Landing Weight……………………………………………………………………...4940 lbs.
Maximum Weight Forward and Aft Baggage Compartment……………………………………..150 lbs.
Maximum Useful Load…………………………………………………………………………..2057 lbs.

	Airspeed Limitations	MPH
V_{S0}	Stall in Landing Configuration	68
V_{S1}	Stall in Clean Configuration	74
V_{MC}	Minimum Control Airspeed – Single Engine	80
V_R	Rotation Speed	85
V_X	Best Angle of Climb	107
V_{SSE}	Simulated Single Engine Speed	92
V_Y	Best Rate of Climb	120
V_{XSE}	Best Angle of Climb – Single Engine	102
V_{YSE}	Best Rate of Climb – Single Engine	107
V_{FE}	Maximum Flaps Extended Speed (1/4 Flaps)	160
V_{FE}	Maximum Flaps Extended Speed (1/2 Flaps)	140
V_{FE}	Maximum Flaps Extended Speed (Full Flaps)	125
V_A	Maneuvering Speed	149
$V_{LO/LE}$	Max Gear Operating Speed / Extended	150
V_{NO}	Maximum structural cruising speed	198
V_{NE}	Never Exceed Speed	249
	Maximum Demonstrated Crosswind Component	12 Knots

Section IV

Procedures and Maneuvers

The maneuvers are broken up into 5 sections. They are:

Takeoff Procedures
Inflight Maneuvers
Emergency Procedures
Instrument Maneuvers
Landings and Approaches to Landings

Your commitment to this section will play a large part in the success of your flight training. It is recommended to become very familiar with all aspects of this section so that you spend the least amount of time in the airplane with the engines running.

The checklists are updated continuously to correspond with this section and are available in the cockpit as well as on the provided iPad for reference.

It should be understood that the AFM/POH is not a living document and thus the procedures have not changed since its creation by the manufacturer. The maneuvers in this program are designed to reflect current aviation standards in flow and structure without deviating from the AFM/POH and will suffice for the Checkride.

On the following page is a detailed matrix that lists all maneuvers individually and their respective tolerances as well as any specific notes that apply.

Links to the specific Airman Certification Standards (ACS) or Practical Test Standards (PTS) are available on the right side of each maneuver's page.

Private and Commercial Airman Certification Standards (ACS)

I. Preflight Preparation
F. Performance and Limitations
G. Operation of Systems

II. Preflight Procedures
A. Preflight Assessment
B. Airworthiness Requirements (*Private Only*)
C. Engine Starting
D. Cross Country Flight Planning (*Private Only*)
F. Before Takeoff Check

IV. Takeoffs, Landings, and Go-Arounds
A. Normal Takeoff and Climb
B. Normal Approach and Landing
E. Short-Field Takeoff and Maximum Performance Climb
F. Short-Field Approach and Landing

V. Performance and Ground Reference Maneuvers
A. Steep Turns

VII. Slow Flight and Stalls
A. Maneuvering During Slow Flight
B. Power-Off Stalls
C. Power-On Stalls
D. Accelerated Stalls (*Commercial Only*)
E. Spin Awareness

IX. Emergency Operations
A. Emergency Descent
C. Systems and Equipment Malfunctions
D. Emergency Equipment and Survival Gear
E. Engine Failure During Takeoff Before V_{MC} (Simulated)
F. Engine Failure After Liftoff (Simulated)
G. Approach and Landing with and Inoperative Engine (Simulated)

X. Multiengine Operations
A. Maneuvering with One Engine Inoperative
B. V_{MC} Demonstration
C. Engine Failure During Flight (By Reference to Instruments)
D. Instrument Approach and Landing with and Inoperative Engine (Simulated) (By Reference to Instruments)

ATP Airman Certification Standards (ACS)

Maneuver	Altitude	Airspeed	Heading	AOB	Required	Notes
Takeoff and Departure Procedures						
Norm & Xwind	N/A	± 5 Knots	± 5º	N/A	1	
Instrument Takeoff	N/A	± 5 Knots	± 5º	N/A	1	Simulate IMC ≤ 100’
Powerplant Fail During Takeoff	N/A	± 5 Knots	± 5º	~5º	1	≥ 400’
Rejected Takeoff	N/A	N/A	N/A	N/A	1	≤ 50% V_{MC}
Departure Procedures	± 100’	± 10 Knots	± 10º	N/A	1	
Inflight Maneuvers (All except V_{MC} simulated IMC)						
Steep Turns	± 100’ ≥ 3,000’	± 10 Knots	± 10º	45º ± 5º	1	180º/360º turn
Stalls	No Specific alt loss ≥ 3,000’	First indication of stall	N/A	1 with 15-30º	3	Clean Approach Landing (1 w/ AP)
Powerplant Failure	± 100’ ≥ 3,000’	± 10 Knots	± 10º	~5º	1	Shutdown and restart
Maneuvering with OEI	± 100’ ≥ 3,000’	N/A	± 10º	2-3º Zero Sideslip	1	
V_{MC} Demo	≥ 5,000’ (POH)	± 5 Knots	± 20º	2-3º Zero Sideslip	1	Slow @ 1 Knot/sec
Unusual Attitude	N/A	N/A	N/A	N/A	2	Nose High Nose Low
Instrument Procedures						
STAR/FMS	± 100’	± 10 Knots	± 10º	N/A	1	Garmin
Holding	± 100’	± 10 Knots	± 10º	N/A	1	
Precision Approach (PA)	± 100’ DH	± 10 Knots ± 5 Knots	± 5º ± ¼ CDI	N/A	2 (1 No AP)	1 SSE (No AP)
Nonprecision Approach (NPA)	± 100’ -0/+50’ MDA	± 10 Knots	± 5º ± ¼ CDI	N/A	2 (1 No AP)	Prior FAF After FAF
Circling Approach	-0/+100’ CIR min	± 5 Knots	± 5º		1	90º Hdg Change
Missed Approach	± 100’	± 5 Knots	± 5º	N/A	2	1 from PA 1 SSE
Landings and Approaches to Landings (3 required, 1 to full stop)						
Normal and Crosswind	N/A	± 5 Knots	Centerline between mains	N/A	1	-250’/+500’ Aimpoint for all LDGs
From PA	N/A	± 5 Knots		N/A	1	
SSE	± 100’ 	± 10 Knots ± 5 Knots	± 5º C/L mains	~5º	1	Prior FAF After FAF
From Circling	-0/+100’ CIR min	± 5 Knots	± 5º	≤30º	1	30º cone to descend
Rejected	N/A	N/A	N/A	N/A	1	~50’ above threshold
No Flap	N/A	N/A	N/A	N/A	1	Touchdown not required

Multi Engine Instructor Practical Test Standards (PTS)

II. Technical Subject Areas
B. Runway Incursion Avoidance
M. Logbook Entry and Certificate Endorsements

V. Preflight Procedures (Examiner must select 1 task)
A. Preflight Inspection
B. Cockpit Management
C. Engine Starting
D. Taxiing
G. Before Takeoff Check
VI. Airport and Seaplane Base Operations (Examiner must select 1 task)
A. Radio Communications and Light Signals
B. Traffic Patterns
C. Airport, Runway. And Taxiway Signs, Markings, and Lighting

VII. Takeoffs, Landings and Go-Arounds (Examiner must select at least 2 takeoff and landing tasks)
A. Normal and Crosswind Takeoff and Climb
B. Short-Field Takeoff and Maximum Performance Climb
E. Normal and Crosswind Approach and Landing
F. Go-Around / Rejected Landing
G. Short-Field Approach and Landing

IX. Performance Maneuvers
A. Steep Turns

XI. Slow Flight and Stalls (The examiner must select at least 1 Task.)
A. Maneuvering During Slow Flight
B. Power-On Stalls
C. Power-Off Stalls
D. Accelerated Maneuver Stalls (Demonstration)

XIII Emergency Operations (The examiner shall select Tasks B or C, D, and one other Task)
A. Engine Failure During Takeoff Before V_{MC}
B. Engine Failure After Liftoff
C. Approach and Landing with an Inoperative Engine
D. Emergency Descent
E. Emergency Equipment and Survival Gear

XIV. Multiengine Operations (The examiner must select Tasks D, E, and one other Task)
A. Operation of Systems
B. Performance and Limitations
C. Flight Principles - Engine Inoperative
D. Maneuvering with One Engine Inoperative
E. V_{MC} Demonstration
F. Demonstrating the Effects of Various Airspeeds and Configurations During Engine Inoperative Performance

Takeoff Procedures

Normal / Crosswind Takeoff

Instrument Takeoff (ATP)

	Private	Commercial	ATP
Altitude			
Airspeed	+10/-5	±5	±5
Heading			

Procedure

1. Brakes - Hold
2. Throttles - 20" MP
3. Engine Instruments - Check
4. Brakes - Release
5. Throttles - Full Open
6. Rotate - 85 MPH
7. Positive Rate - Gear Up
8. Airspeed - 120 MPH minimum
9. Above 400 Feet AGL - Climb Checklist

Climb Checklist

1. Airspeed - 135 MPH
2. Throttles - Full Open
3. Props - 2500 RPM
4. Mixtures - AS REQUIRED
5. Cowl Flaps - OPEN
6. Fuel Pumps - OFF
7. Taxi / Landing Light - OFF

ACS/PTS References

Private - Area IV Task A

Commercial - Area IV Task A

ATP - Area III Task A

MEI - Area VII Task A

Notes

Instrument Takeoff (ATP Only)

Perform the instrument takeoff with instrument meteorological conditions (IMC) simulated at or before reaching an altitude of 100 feet AGL.

This will be accomplished by placing the view limiting device on prior to releasing the brakes, looking underneath them to execute a visual takeoff then transitioning to simulated instrument conditions on takeoff.

Expectation is for the centerline to remain in between the main landing gear throughout the duration of the takeoff roll

Rotation speed is listed as 80 MPH by Piper, which is also V_{MC}. To align with the guidance in FAA's Flying Light Twins Safely V_{MC} +5 is used as rotation speed

Common Errors

Not using enough right rudder to keep the centerline between the main landing gear

Not keeping the left hand on the yoke and right hand on the throttle

Too Shallow of a climb angle resulting in minimal climb performance and higher airspeed

Short-Field Takeoff

	Private	Commercial	ATP
Altitude	Note	Note	N/A
Airspeed	+10/-5	±5	N/A
Heading			N/A

Procedure

1. Brakes - Hold
2. Throttles - Full Open
3. Engine Instruments - Check
4. Brakes - Release
5. Rotate - 85 MPH
6. Airspeed - 102 MPH

Clear of Obstacle(s)

7. Airspeed - 120 MPH
8. Landing Gear - UP
9. Above 400 Feet AGL - Climb Checklist

Climb Checklist

1. Airspeed - 135 MPH
2. Throttles - Full Open
3. Props - 2500 RPM
4. Mixtures - AS REQUIRED
5. Cowl Flaps - OPEN
6. Fuel Pumps - OFF
7. Taxi / Landing Light - OFF

ACS/PTS References

Private - Area IV Task E

Commercial - Area IV Task E

MEI - Area VII Task B

Notes

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.

If an engine failure occurs during the initial take-off climb, immediate lower of both throttles and pitch attitude is critical to maintaining control of the airplane.

Common Errors

Airspeed Management

Not utilizing maximum available runway

Rotation prior to V_{MC}

Aborted (Rejected) Takeoff

	Private	Commercial	ATP
Altitude			
Airspeed			
Heading			

Procedure

1. Throttles - CLOSE IMMEDIATELY
2. Brakes - AS REQUIRED
3. Maintain runway centerline to max extent possible
4. If insufficient runway remaining

   Fuel Selectors - Off

   Battery, Alternators and Magnetos - Off

An abort shall be made straight ahead on any available runway remaining anytime an engine failure occurs airborne prior to:

107 MPH (V_{YSE})

AND

Gear Handle UP

Abort criteria

Loss of directional control

Loss of thrust in one or both engines

Binding flight controls

Electrical failure if low IFR or night

ACS/PTS References

Private - Area IX Task E

Commercial - Area IX Task E

ATP - Area III Task I

MEI - Area XIII Task B

Notes

It is imperative that BOTH THROTTLES are quickly reduced to idle as the asymmetric thrust below V_{MC} could result in loss of directional control if action isn't taken quickly.

Accelerate-Stop distance will determine if an aborted takeoff can be made with the available runway to be used

Private and Commercial Standards

Close the throttles smoothly and promptly when a simulated engine failure occurs.

Maintain directional control and apply brakes (AMEL), or flight controls (AMES), as necessary.

ATP Standards

Abort the takeoff if the powerplant failure occurs at a point during the takeoff where the abort procedure can be initiated and the airplane can be safely stopped on the remaining runway/waterway (AMEL, AMES).

Promptly reduce the power and maintain positive aircraft control using drag and braking devices, as appropriate, to come to a stop.

Coordinate with crew, if applicable, and complete the appropriate procedures, checklist(s), and radio calls following a rejected takeoff in a timely manner.

Common Errors

Failure to maintain centerline smoothly

Failure to reduce both throttles to idle promptly

Overcontrolling rudder during recovery

Applying the brakes too heavily

Inflight Maneuvers

Steep Turns

	Private	Commercial	ATP
Altitude	±100	±100	±100
Airspeed	+10/-5	±5	±5
Heading	±10	±10	±10
AOB	45±5	50±5	45±5

Configuration - CLEAN
Altitude - NO LOWER THAN 3,000 FEET AGL
Airspeed - BELOW V_A (149 MPH)

1. Clearing Turns
2. GUMPF check
   - Gas - Fullest Tank / Fuel Pumps - OFF
   - Undercarriage - UP
   - Mixture - AS REQUIRED
   - Props - 2500 RPM
   - Flaps - UP
3. Instrument Check (Temps / Oil / Vacuum)
4. Throttles - 18” MP
5. Set Heading Bug on entry heading
6. Verify airspeed below 149 MPH
7. Bank to 45° or 50° while maintaining altitude
8. Trim - As required to maintain altitude in turn
9. Throttles as required to maintain airspeed
10. Reverse after 180 or 360 degrees of turn

ACS/PTS References

Private - Area V Task A

Commercial - Area V Task A

ATP - Area IV Task A

MEI - Area IX Task A

Notes

Private and Commercial ACS calls for 360 degree turns before reversal

ATP ACS calls for at least 180 degrees of turn before reversing

ATP steep turns executed with foggles on

Common Errors

Failure to execute clearing turns

Not trimming into the turn

Ballooning on turn reversal

Fixating on one parameter and omitting others

Overshooting Heading

Chasing altitude and airspeed

Maneuvering During Slow Flight

	Private	Commercial	ATP
Altitude	±100	±50	N/A
Airspeed	+10/-0	+5/-0	N/A
Heading	±10	±10	N/A
Bank	±10	±5	N/A

Configuration - GEAR DOWN / FLAPS FULL
Altitude - 3,000 FT. AGL
Airspeed - 120 MPH

1. Clearing Turn
2. GUMPF Check
   - Gas - ON (Fullest Tank)
   - Undercarriage - DOWN
   - Mixtures - AS REQUIRED
   - Props - 2500 RPM
   - Flaps - DOWN
3. Instrument Check (Temps / Oil / Vacuum)
4. Set Heading Bug on entry heading
5. Configure (Flap/Gear/Flap)
6. Slow to 75 MPH while maintaining altitude
7. Execute maneuvers as directed
8. Recover
   - Throttles - FULL OPEN
   - Flaps - HALF
   - Gear - UP
   - Flaps - UP

ACS/PTS References

Private - Area VII Task A

Commercial - Area VII Task A

MEI - Area XI Task A

Notes

Piper Aztec Stall Speeds

Gear and Flaps Down - 68 MPH

Gear and Flaps Up - 75 MPH

Common Errors

Overcontrolling the aircraft

Failure to maintain coordinated flight

Allowing aircraft to stall

Failure to maintain altitude while recovering

Stalls (PVT/COMM)

	Private	Commercial	ATP
Altitude			N/A
Airspeed			N/A
Heading	±10	±10	N/A
Bank	20±10	20±5	N/A

Configurations - SEE SPECIFIC STALL
Altitude - NO LOWER THAN 3,000 FEET AGL
Airspeed - SEE SPECIFIC STALL

Setup (GUMPF)
Gas - Fullest Tank / Fuel Pumps - OFF
Undercarriage - Per Stall
Mixture - AS REQUIRED
Props - 2500 RPM
Flaps - Per Stall

Recovery Procedure

1. Lower the nose and keep wings level (emphasis on rudder)
2. Throttles - Full Open
3. Pitch - Smoothly set to positive climb attittude
4. Flaps - Half (If extended)

Positive Rate of Climb (Altimeter & VSI)

5. Gear - Up (If extended)
6. Flaps - Up (If extended)

Power Off (Gear Down / Flaps Down)

1. Decelerate at idle
2. Maintain altitude with pitch
3. Recover

Power On (Gear Up / Flaps Up)

1. Decelerate to 90 MPH
2. Throttles - 21” MP
3. Pitch - Set climb attitude that will result in stall
4. Recover

Accelerated (Gear Up / Flaps Up) - Commercial Only

1. Slow and maintain 120 MPH (10-12” MP)
2. Establish 45º AOB while maintaining altitude
3. Rapidly increase AOA to indication of a stall
4. Recover

ACS/PTS References

Private - Area VII Task B, C

Commercial - Area VII Task B, C

ATP - Area V Task A, B, C

MEI - Area XI Task B, C, D

Notes

Private ACS recovery criteria

Acknowledge cues of the impending stall and then recover promptly after a full stall occurs.

Commercial ACS recovery criteria

Acknowledge the cues at the first indication of a stall (e.g., airplane buffet, stall horn, etc.).

Common Errors

Failure to maintain directional control with the rudder

Improper recovery procedure resulting in secondary stall

Gear up prior to positive VSI established

Not recognizing when to recover

Stall Prevention (ATP)

	Private	Commercial	ATP
Altitude	N/A	N/A	
Airspeed	N/A	N/A	
Heading	N/A	N/A	
Bank	N/A	N/A	

Recovery Procedure

1. Lower the nose and keep wings level (emphasis on rudder)
2. Throttles - Full Open
3. Pitch - Smoothly set to positive climb attitude
4. Flaps - Half (If extended)

Positive Rate of Climb (Altimeter & VSI)

5. Gear - Up (If extended)
6. Flaps - Up (If extended)

Clean Configuration

1. Straight and level, auto pilot on, throttles near idle.
2. Auto pilot attempts to hold altitude and inadvertently pulls the aircraft into a stall.
3. Disconnect the autopilot and recover.

Partial Flap Configuration

1. Flaps half, gear up, simulating a missed approach just after the gear has come up.
2. Command a left or right turn with the autopilot and a climb with full power.
3. As the auto pilot performs the climbing turn, pull the power back to simulate a power reduction for speed without paying attention.
4. Although you have gone to near idle, the autopilot continues to try and climb and turn, again inadvertently stalling the airplane.
5. Disconnect the autopilot and recover.
6. Emphasize reducing angle of attack and staying in the turn to allow positive G on the airplane vice an aggressive wings level push over.

Lading Configuration

1. Full flaps, gear down, full dirty configuration.
2. Auto pilot on, reduce power to idle and watch the auto pilot pull the aircraft into a stall.
3. Disconnect the auto pilot and recover.

ACS/PTS References

Private - Area VII Task B, C

Commercial - Area VII Task B, C

ATP - Area V Task A, B, C

MEI - Area XI Task B, C, D

Notes

Recovery criteria

Acknowledge the cue(s) and promptly recover at the first indication of an impending stall (buffet, stall horn, stick shaker, etc.).

All stall prevention maneuvers to be performed in simulated instrument conditions.

Common Errors

Failure to maintain directional control with the rudder

Gear up prior to positive VSI established

Not recognizing when to recover

V_{MC} Demonstration (PVT/COMM)

	Private	Commercial	ATP
Altitude			N/A
Airspeed	+10/-5	±5	N/A
Heading	-20	-20	N/A
Bank	5	5	N/A

Configuration - CLEAN
Altitude - NO LOWER THAN 5,000 FEET AGL
Airspeed - 102 MPH

1. Clearing Turn
2. GUMPF check
    - Gas - Fullest Tank, Fuel Boost Pumps - OFF
    - Undercarriage - Up
    - Mixture - As Required
    - Props - Full Forward
    - Flaps - Up
    - Cowl Flaps - Left Closed / Right Open
3. Stabilize at 102 MPH
4. Note entry heading with heading bug
5. Left Throttle - Idle
6. Maintain heading and altitude
7. Right Throttle - Full Power
8. Set a Pitch Attitude that results in a smooth deceleration (2 MPH per second approximately)
9. Recover after reaching full rudder deflection or stall horn (whichever occurs first)
    - Reduce throttle (~20” MP) and lower nose while maintaining directional control
    - Full Power on RIGHT ENGINE as airspeed approaches 95 MPH
    - Match both throttles once stabilized at 107 MPH

ACS/PTS References

Private - Area X Task B

Commercial - Area X Task B

MEI - Area XIV Task E

Notes

Recovering from a V_{MC} situation is arguably the most critical skill as a multi engine pilot as it can determine the survival of the crew and passengers

Performing this maneuver by increasing pitch attitude to a high angle with both engines operating and then reducing power on the critical engine should be avoided. This technique is hazardous and may result in loss of aircraft control.

Common Errors

Failure to start maneuver at proper airspeed

Recovering prior to reaching full rudder deflection

Not reducing power enough during recovery

Failure to recover within 20 degrees of heading

Recovering using inoperative engine

Not stabilizing single engine before matching throttles

Drag Demonstration (MEI)

	Private	Commercial	ATP
Altitude	N/A	N/A	N/A
Airspeed	N/A	N/A	N/A
Heading	N/A	N/A	N/A
Bank	N/A	N/A	N/A

Configuration - CLEAN
Altitude - 5,000 FEET AGL
Airspeed - 107 MPH

1. Clearing Turn
2. GUMPF check
    - Gas - Fullest Tank, Fuel Pumps - OFF
    - Undercarriage - UP
    - Mixture - As Required
    - Props - Full Forward
    - Flaps - UP
    - Cowl Flaps - Left Closed / Right Open
3. Note entry heading with heading bug
4. Left Engine - Set Simulated Feather
    - Left Throttle - 10” MP
    - Left Prop - 2200 RPM
5. Maintain heading and altitude
6. Right Throttle - Full Power
7. Maintain V_{YSE} (107 MPH)
8. Change configurations as follows noting the vertical speed after while maintaining VYSE (107 MPH)
    - A. Landing Gear DOWN / Flaps UP
    - B. Landing Gear UP / Flaps DOWN
    - C. Landing Gear DOWN / Flaps DOWN
    - D. Left Engine Windmilling

ACS/PTS References

MEI - Area XIV Task F

Notes

Common Errors

Inappropriate starting airspeed

Failure to maintain V_{YSE}

Not stabilizing after configuration change

Heading control

Unusual Attitude Recovery (ATP)

	Private	Commercial	ATP
Altitude	N/A	N/A	
Airspeed	N/A	N/A	
Heading	N/A	N/A	

Configuration - CLEAN
Altitude - NO LOWER THAN 3,000 FEET AGL
Airspeed - ANY

Nose low

Throttles - 15” MP

Controls - Roll to wings level and apply required amount of backpressure for altitude to minimize altitude loss

Instruments - Verify Altimeter and VSI to confirm recovery

Nose High

Throttles - 25” MP

Controls - Roll to wings level or back no more to 45º AOB to allow nose to slice through horizon if and apply forward pressure as required

ACS/PTS References

Private - Area VIII Task E

ATP - Area IV Task B

MEI - Area XII Task E

Notes

Determine if the airplane is above or below V_A (maneuvering / corner airspeed) prior to flight control input to prevent overstress.

Common Errors

Failure to recognize the correct attitude

Incorrect control/power inputs

Over-controlling the airplane

Emergency Procedures

Emergency Descent (PVT/COMM)

	Private	Commercial	ATP
Altitude	±100	±100	N/A
Airspeed	+0/-10	+0/-10	N/A
Heading			N/A
Bank	30 to 45	30 to 45	N/A

1. Throttles - Slowly Retard to Idle
2. Propellers - Forward (High RPM)
3. Airspeed - 198 MPH (149 MPH in rough air)
4. Cowl Flaps - Closed
5. Attitude - Bank 30-45° and establish a nose low attitude not to exceed 198 MPH or 149 MPH

ACS/PTS References

Private - Area IX Task A

Commercial - Area IX Task A

MEI - Area XIII Task E

Notes

Common Errors

Exceeding aircraft limitations

Improper configuration

Failing to descend quick enough

Failure to level off at designated altitude

Failure to reconfigure after leveling off

Powerplant Failure

	Private	Commercial	ATP
Altitude			±100
Airspeed	±5	±5	±10
Heading	±10	±10	±10

Configuration - VARYING
Altitude - NO LOWER THAN 3,000 FEET AGL
Airspeed - ABOVE 92 MPH

Procedure (*Commit to memory)

Directional Control, Pitch, Power, Performance, Identify, Verify, Feather, Secure”

***1. Maintain Directional Control**

***2. Pitch - 107 MPH**

***3. Power - Mixture, Props, Throttles Full Forward**

***4. Performance - Flaps Up / Gear Up**

***5. Identify-“Dead Foot, Dead Engine”**

***6. Verify - Quickly reduce throttle to idle and look for any change in aircraft yaw or noise**

***7. Feather - Set Prop to Feather and verify visually**

8. Secure Checklist - Execute (using checklist)

Powerplant Failures will occur:

On Takeoff prior to Liftoff

On Departure between 400-1000 ft. AGL

In flight as part of a scenario (shutdown and restart)

On approach prior to Final Approach Fix (FAF)

ACS/PTS References

Private - Area IX Task F

Commercial - Area IX Task F

ATP - Area VII Task D

MEI - Area XIII Task C

Notes

Common Errors

Failure to recognize failed engine

Failure to maintain heading/directional control

Failure to maintain V_{YSE}

Not completing checklist correctly

Holding

Procedure

	Private	Commercial	ATP
Altitude	N/A	N/A	±100
Airspeed	N/A	N/A	±10
Heading	N/A	N/A	±10

1. Slow to holding speed when advised to hold
2. Acquire EFC / holding instructions
3. Hold at 120-140 MPH
4. 3 T's (Turn, Throttle, Talk)

6 T's of Holding

Throttles - Set for holing airspeed (18-20" MP)

Twist - Course Line on CDI/HSI to INBOUND CRS

Toggle - Suspend GPS on holding point (OBS GNS 530)

Turn - to holding entry heading

Time - Start timing

Talk - Report established

ACS/PTS References

ATP - Area III Task A

Notes

6 T's of Holding

Throttles - Set for holing airspeed (~18" MP)

***T**wist - OBS on HSI to INBOUND CRS

***T**oggle - Suspend GPS on holding point

***T**urn - to holding entry heading

Time - Start timing

Talk - Report established

*Automatic using the GTN 650 with autopilot engaged in GPSS mode

Common Errors

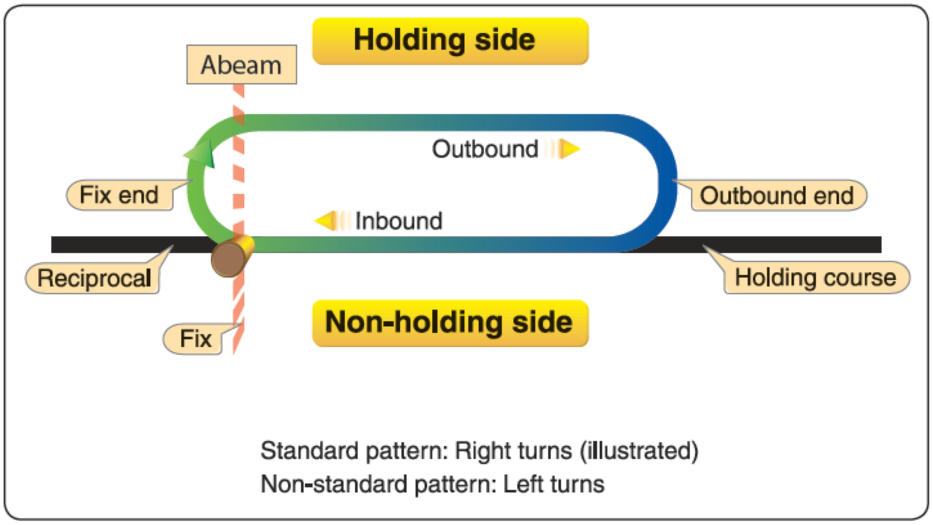
Incorrect entry procedure

Failing to communicate established in holding

Incorrect wind correction on outbound leg

Holding

Depending upon traffic and weather conditions, holding may be required. Holding is a predetermined maneuver that keeps aircraft within a specified airspace while awaiting further clearance from ATC. A standard holding pattern uses right turns, and a nonstandard holding pattern uses left turns. The ATC clearance always specifies left turns when a nonstandard pattern is to be flown.



If no holding pattern is charted and holding instructions have not been issued, the pilot should ask ATC for holding instructions prior to reaching the fix. This procedure will eliminate the possibility of an aircraft entering a holding pattern other than that desired by ATC. If unable to obtain holding instructions prior to reaching the fix (due to frequency congestion, stuck microphone, etc.), then enter a standard pattern on the course on which the aircraft approached the fix and request further clearance as soon as possible. In this event, the altitude/flight level of the aircraft at the clearance limit will be protected so that separation will be provided as required.

When an aircraft is 3 minutes or less from a clearance limit and a clearance beyond the fix has not been received, the pilot is expected to start a speed reduction so that the aircraft will cross the fix, initially, at or below the maximum holding airspeed.

Surface to 6,000 ft. MSL - 200 KIAS
6,001 to 14,000 ft. MSL - 230 KIAS
14,001 ft. MSL and above - 265 KIAS

When no delay is expected, the controller should issue a clearance beyond the fix as soon as possible and, whenever possible, at least 5 minutes before the aircraft reaches the clearance limit. When a speed reduction is required, start the reduction when 3 minutes or less from the holding fix.

Pilots should report to ATC the time and altitude/flight level at which the aircraft reaches the clearance limit and report leaving the clearance limit.

In a standard holding pattern with no winds, the aircraft follows the specified course inbound to the holding fix, turns 180° to the right, flies a parallel straight course outbound for 1 minute, turns 180° to the right, and flies the inbound course to the fix. A standard symmetrical holding pattern cannot be flown when winds exist. In those situations, the pilot is expected to:

1. Compensate for the effect of a known wind except when turning
2. Adjust outbound timing to achieve a 1-minute (1 1/2 minutes above 14,000 feet) inbound leg

Normally, when no delay is anticipated, ATC issues holding instructions at least 5 minutes before the estimated arrival at the fix. Where a holding pattern is not charted, the ATC clearance specifies the following:

1. Direction of holding from the fix in terms of the eight cardinal compass points (N, NE, E, SE, etc.)
2. Holding fix (fix may be omitted if included at the beginning of the transmission)
3. Radial, course, bearing, airway, or route on which the aircraft is to hold.
4. Leg length in miles if DME or RNAV is to be used (leg length is specified in minutes on pilot

request or if the controller considers it necessary).

5. Direction of turn, if left turns are to be made, because the pilot requests or the controller considers it necessary.
6. Time to expect-further-clearance (EFC) and any pertinent additional delay information.

A pilot should make all turns during entry and while holding at:

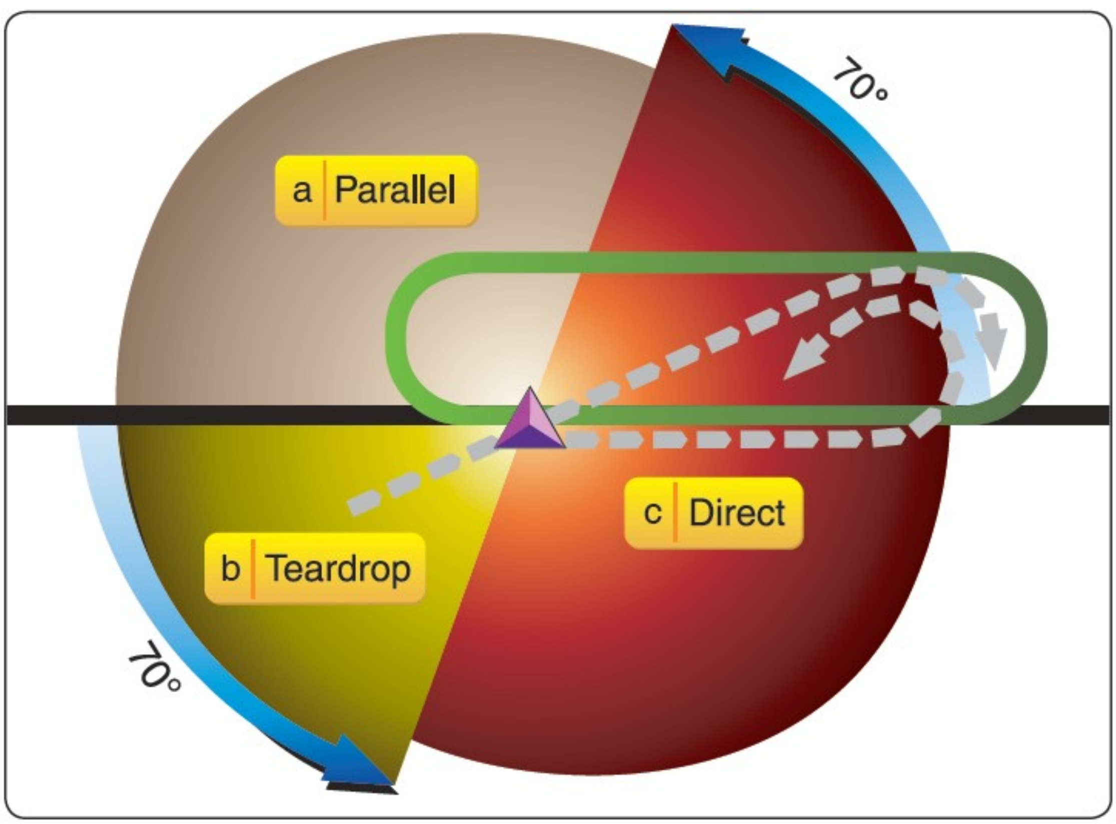
1. 3° per second, or
2. 30° bank angle, or
3. A bank angle provided by a flight director system

Time leaving the holding fix must be known to ATC before succeeding aircraft can be cleared to the vacated airspace. Leave the holding fix:

1. When ATC issues either further clearance en route or approach clearance;
2. As prescribed in 14 CFR part 91 (for IFR operations; two-way radio communications failure, and responsibility and authority of the pilot-in-command);
3. After the IFR flight plan has been cancelled, if the aircraft is holding in VFR conditions.

While other entry procedures may enable the aircraft to enter the holding pattern and remain within protected airspace, the parallel, teardrop, and direct entries are the procedures for entry and holding recommended by the FAA. Additionally, paragraph 5-3-7 in the AIM should be reviewed.

1. Parallel Procedure. When approaching the holding fix from anywhere in sector (a), fly to the fix. Afterwards, turn to a heading to parallel the holding course outbound. Fly outbound for 1 minute, turn in the direction of the holding pattern through more than 180°, and return to the holding fix or intercept the holding course inbound.
2. Teardrop Procedure. When approaching the holding fix from anywhere in sector (b), the teardrop entry procedure would be to fly to the fix, turn outbound to a heading for a 30° teardrop entry within the pattern (on the holding side) for a period of 1 minute, then turn in the direction of the holding pattern to intercept the inbound holding course.
3. Direct Entry Procedure. When approaching the holding fix from anywhere in sector (c), the direct entry procedure would be to fly directly to the fix and turn to follow the holding pattern.



Instrument Approach

	Private	Commercial	ATP
Prior to Final Approach Fix			
Altitude	±100	±100	±100
Airspeed	±10	±10	±10
Heading	±10	±5	±5
After Final Approach Fix			
Precision			DA/DH
Non Precision			+50/-0
Circling	N/A	N/A	+100/-0
Airspeed	±10	±10	±5
Heading	3/4 Scale	3/4 Scale	1/4 Scale

Instrument Approach Timeline

3 NM from FAF

Fuel Selectors - Fullest Tank / Fuel Pumps - On
Flaps - 1/4 (UP Single Engine)
Landing Lights
Airport Lights (7 Clicks)

2 NM from FAF

Mixtures - Full Rich
Props - 2500 RPMs
Throttles - Set for Approach

1 NM from FAF / 1 Dot above Glide Slope

Course - Tracking
Source - GPS/VLOC
Gear - Down
Flaps - 1/2

Stabilize on Approach (120 MPH)
Landing Checklist Complete

Once visual, transition to 90 MPH and land straight ahead or circle. Flaps can be placed to the Full Down position or left at Half. If singe engine, only extend flaps when landing is assured.

ACS/PTS References

Private - Area IV Task A

Commercial - Area IV Task A

ATP - Area VI Task D, E, G

MEI - Area XIII Task D

Notes

Approach Power Settings

Precision: 17” MP
Non-Precision: 15” MP
Single engine: 19” MP
MDA/Circling: 20” MP (Level)

Common Errors

Failure to configure properly

Late to descend

Chasing the needles

Failure to adhere to stepdown altitudes

STANDARD CIRCLING APPROACH MANEUVERING RADIUS

Circling approach protected areas developed prior to late 2012 used the radius distances shown in the following table, expressed in nautical miles (NM), dependent on aircraft approach category. The approaches using standard circling approach areas can be identified by the absence of the C symbol on the circling line of minima.

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
All Altitudes	1.3	1.5	1.7	2.3	4.5

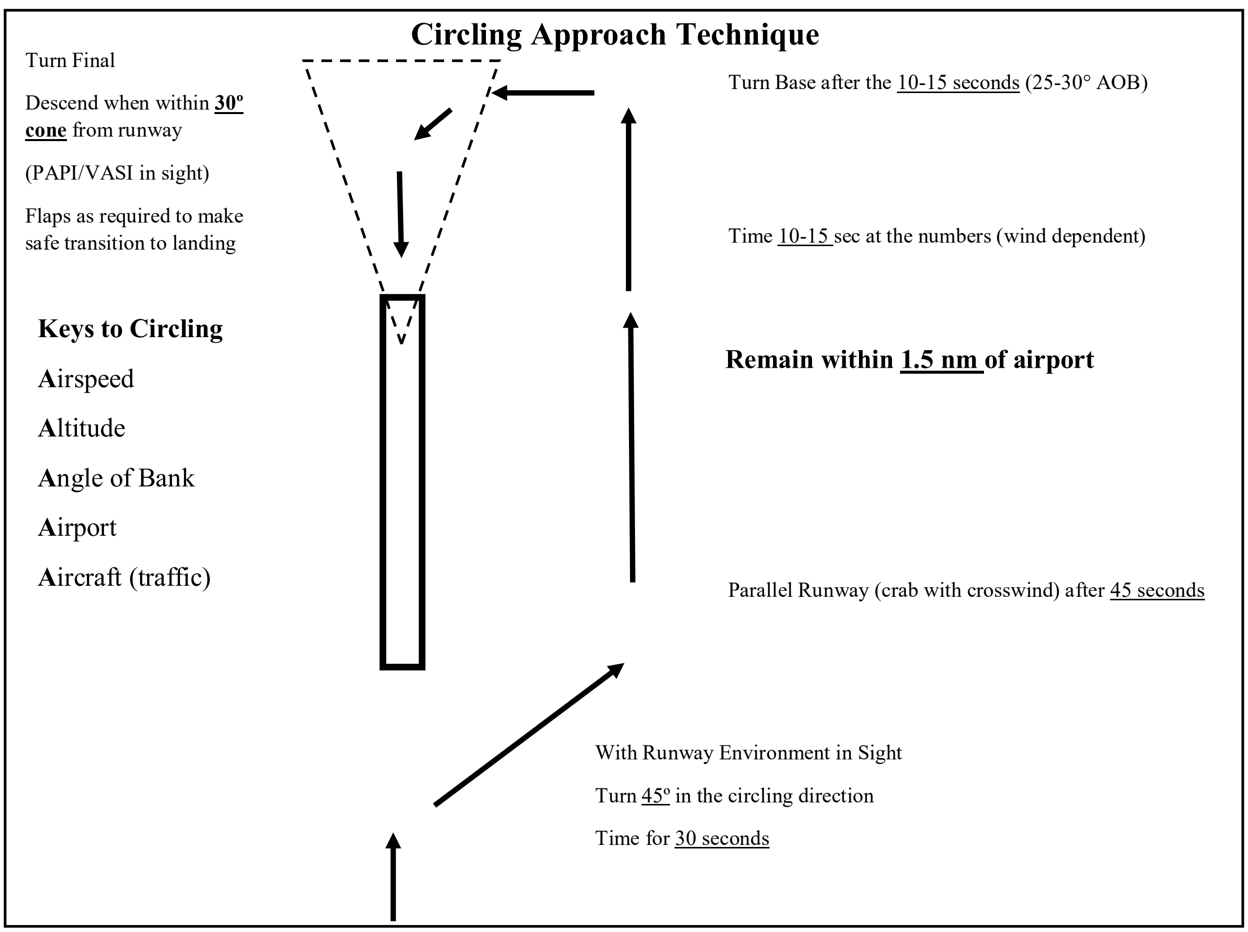
C EXPANDED CIRCLING APPROACH MANEUVERING AIRSPACE RADIUS

Circling approach protected areas developed after late 2012 use the radius distance shown in the following table, expressed in nautical miles (NM), dependent on aircraft approach category, and the altitude of the circling MDA, which accounts for true airspeed increase with altitude. The approaches using expanded circling approach areas can be identified by the presence of the C symbol on the circling line of minima.

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
1000 or less	1.3	1.7	2.7	3.6	4.5
1001-3000	1.3	1.8	2.8	3.7	4.6
3001-5000	1.3	1.8	2.9	3.8	4.8
5001-7000	1.3	1.9	3.0	4.0	5.0
7001-9000	1.4	2.0	3.2	4.2	5.3
9001 and above	1.4	2.1	3.3	4.4	5.5

Missed Approach while Circling

If visual reference is lost while circling-to-land from an instrument approach, the missed approach specified for that particular procedure must be followed (unless an alternate missed approach procedure is specified by ATC). To become established on the prescribed missed approach course, the pilot should make an initial climbing turn toward the landing runway and continue the turn until established on the missed approach course.



Takeoff Procedures

Normal Approach and Landing

	Private	Commercial	ATP
Altitude			N/A
Airspeed	+10/-5	±5	N/A
Heading	N/A	N/A	N/A
Touchdown	+400/-0	+200/-0	N/A

Procedure

1. Landing Point and Aim Point Determined
2. Landing Checklist Complete (GUMPF)
    - Gas - ON / Fuel Boost Pumps - OFF
    - Undercarriage - DOWN
    - Mixtures - RICH
    - Props - FORWARD (High RPM)
    - Flaps - AS REQUIRED
3. Airspeed - AS REQUIRED

Crossing Runway Threshold

4. Throttles - IDLE
5. After Touchdown - BRAKE AS REQUIRED

See the next page for configuration, power settings, and airspeeds for the traffic pattern.

ACS/PTS References

Private - Area IV Task F

Commercial - Area IV Task F

MEI - Area VII Task G

Notes

Maintain manufacturer's published airspeed or in its absence not more than 1.3 V_{SO} (90).

Touch down at a proper pitch attitude, within 100/200 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.

Common Errors

Airspeed Management

Improper touchdown point selection

Failure to communicate touchdown point effectively

Failure to manage crosswind

Touchdown prior to point

Not Stable on Final Approach

TRAFFIC PATTERN

AIRMAN CERTIFICATION STANDARDS		
	PRIVATE PILOT AREA IV TASK B	COMMERCIAL PILOT AREA IV TASK B
ALTITUDE	±100 FT.	±100 FT.
AIRSPEED	±10 KTS.	±10 KTS.

Properly identify and interpret airport/seaplane base runways, taxiways, markings, signs, and lighting.

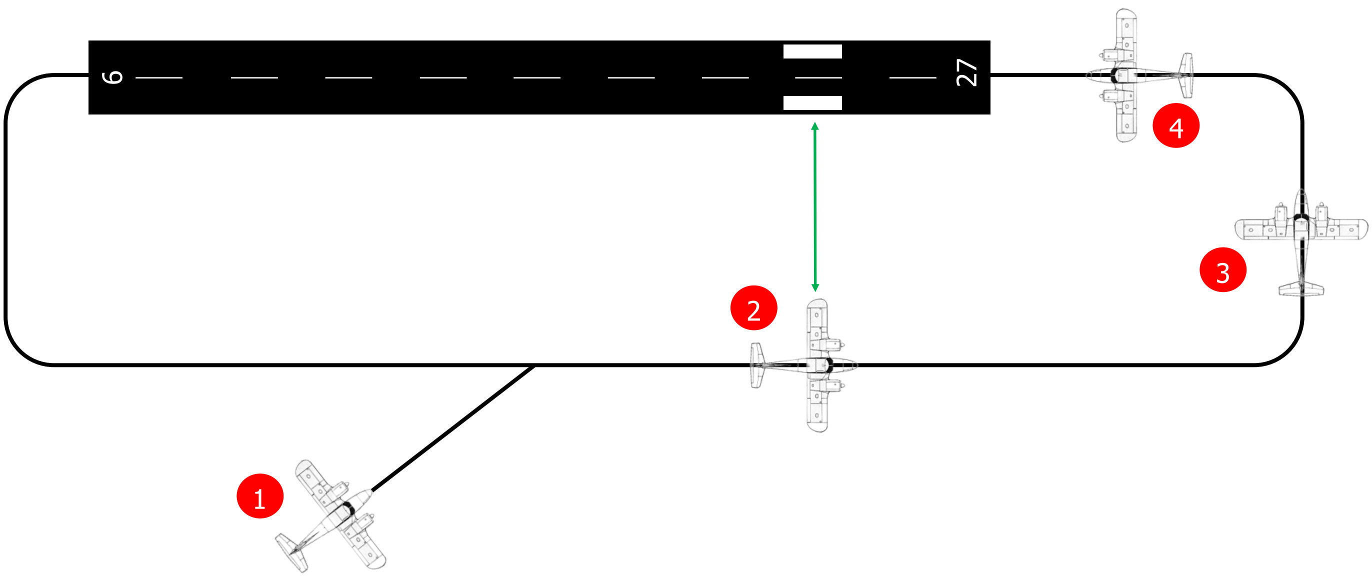
Comply with recommended traffic pattern procedures.

Correct for wind drift to maintain the proper ground track.

Maintain orientation with the runway/landing area in use.

Maintain traffic pattern altitude, ±100 feet, and the appropriate airspeed, ±10 knots.

Maintain situational awareness and proper spacing from other aircraft in the traffic pattern.



	1 Entry Leg	2 Downwind Leg	3 Base Leg	4 Final Approach
Landing Gear	**EXTEND**	**DOWN (3 Green)**	**DOWN (3 Green)**	**DOWN (3 Green)**
Flaps	**HALF**	**EXTEND FULL**	**HALF/FULL**	**HALF/FULL**
Throttle	**20” MP**	**15” MP**	**12” MP**	**AS REQUIRED**
Airspeed	**120 MPH**	**110 MPH**	**100 MPH**	**90 MPH**

Inadequate wind drift correction on the base leg.

Overshooting or undershooting the turn onto final approach resulting in too steep or too shallow a turn onto final approach.

Flat or skidding turns from base leg to final approach as a result of overshooting/inadequate wind drift correction.

Poor coordination during turn from base to final approach.

Failure to complete the landing checklist in a timely manner.

Unstable approach.

Failure to adequately compensate for flap extension.

Poor trim technique on final approach.

Attempting to maintain altitude or reach the runway using elevator alone.

Focusing too close to the airplane resulting in a too high round out.

Short-Field Landing

	Private	Commercial	ATP
Altitude			N/A
Airspeed	+10/-5	±5	N/A
Heading	N/A	N/A	N/A
Touchdown	+200/-0	+100/-0	N/A

Procedure

1. Landing Point and Aim Point Determined
2. Landing Checklist Complete (GUMPF)

    Gas - ON / Fuel Boost Pumps - OFF

    Undercarriage - DOWN

    Mixtures - RICH

    Props - FORWARD (High RPM)

    Flaps - FULL

3. Airspeed - 90 MPH

Just prior to touchdown point

4. Throttles - IDLE
5. After Touchdown - BRAKE AS REQUIRED

ACS/PTS References

Private - Area IV Task F

Commercial - Area IV Task F

MEI - Area VII Task G

Notes

Maintain manufacturer's published airspeed or in its absence not more than 1.3 V_{SO} (90 MPH).

Touch down at a proper pitch attitude, within 100/200 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.

Common Errors

Airspeed Management

Improper touchdown point selection

Failure to communicate touchdown point effectively

Failure to manage crosswind

Touchdown prior to point

Not Stable on Final Approach

Missed Approach / Go Around

	Private	Commercial	ATP
Altitude	N/A	N/A	±100
Airspeed	N/A	N/A	±5
Heading	N/A	N/A	±5

Procedure

1. Throttles - Full Open
2. Pitch - Set Positive Climb Attitude
3. Flaps - Half

Positive Rate of Climb (Altimeter+VSI)

4. Landing Gear - Up
5. Flaps - Up
6. Airspeed - 120 MPH
7. Fly Published/Assigned Missed Approach or Pattern
8. 1000 Ft. AGL - Activate Missed Approach (OBS)
9. Climb Checklist - Execute

ACS/PTS References

Private - Area IV Task A

Commercial - Area IV Task A

ATP - Area III Task A

MEI - Area VII Task A

Notes

Aviate

Full Throttle

Positive Climb Attitude

Gear and Flaps Up

Navigate

Execute Turn To Intercept Missed Approach Procedure

Activate Missed Approach (GNS 530 - OBS)

Communicate

Notify ATC of Missed Approach

Cram (All power controls forward)

Climb (pitch for 120 MPH)

Clean up

Course and source

Communicate

Checklist

Common Errors

Not prioritizing properly

Failure to climb

Not executing the assigned or published procedure

Not reconfiguring in the proper order or timely

Airspeed control

Improper use of the Avionics