

Cessna 310 Q Training Supplement

Faithful Guardian Aviation

Adapted from ERAU Multiengine guide

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INTRODUCTION TO MULTIENGINE AIRCRAFT

The FGA Multi-Engine Aircraft Guide provides supplemental information to assist you in learning the many factors when dealing with flying a multi-engine (“light twin”) airplane.

The term “light-twin,” although not formally defined in the Federal Aviation Regulations, is defined as a small multi-engine airplane with a maximum certificated takeoff weight of 6,000 pounds or less.

The basic differences between operating multi-engine airplanes and single-engine airplanes are that multi-engine airplanes are:

- Generally capable of flying at faster airspeeds and higher altitudes,
- Typically larger in size and have more complex systems, and
- More demanding and that pilots have additional knowledge and understanding of the conditions associated with operating with one engine inoperative.

While there are a few differences between taxiing single-engine and multi-engine airplanes, the most noticeable difference is typically the increase in wingspan. With an increase in wingspan, there is an even greater need for vigilance when taxiing in close quarters. In addition, the multi-engine airplane may not be as nimble or responsive to steering inputs as the smaller single-engine airplane.

One advantage of a multi-engine airplane over a single-engine airplane is the differential power capability. Turning the airplane during taxi with the assistance from differential power minimizes the need for brakes during turns and while maintaining the same turning radius. Differential power, however, does NOT need to be used during every turn, or as the primary way to turn the airplane. It is also important to remember to keep engine power to a minimum and not “ride” the brakes.

When operating a multi-engine airplane with one engine inoperative, the penalties for loss of an engine are twofold: performance and control. The most obvious problem related to airplane performance is the loss of power (50%). This loss reduces climb performance by 80 - 90%, sometimes even more. The second problem affects aircraft control caused by the remaining thrust, which is now asymmetrical. Attention to both of these factors is crucial in maintaining safe, one-engine inoperative flight.

For pilots, flying a multi-engine airplane is an exhilarating yet challenging experience. To take full advantage of the airplanes capabilities, performance, and safety, the pilot must be well-trained, knowledgeable, and proficient.

VSPEEDS

Multi-Engine airplanes use the same “V”-speeds as single-engine airplanes. However, multi-engine airplanes have additional V-speeds and airspeed indicator markings relating to one engine inoperative flight.

Unless otherwise noted, V-speeds given in the AFM/POH/IM apply to sea level pressure, and standard day conditions at the airplane’s maximum certificated takeoff weight. Performance speeds will vary with aircraft weight, configuration, and atmospheric conditions.

V_R - Rotation speed. The speed at which back-pressure is applied to rotate the airplane to a takeoff attitude.

V_{LOF} - Lift-off speed. The speed at which the airplane leaves the surface. Some manufacturers reference takeoff performance data to V_R, others to V_{LOF}.

V_X - Best angle of climb speed. The speed at which the airplane will gain the greatest altitude for a given distance of forward travel.

V_{XSE} - Best angle-of-climb speed with one engine inoperative.

V_Y - Best rate of climb speed. The speed at which the airplane will gain the most altitude for a given unit of time.

V_{YSE} - Best rate-of-climb speed with one engine inoperative.

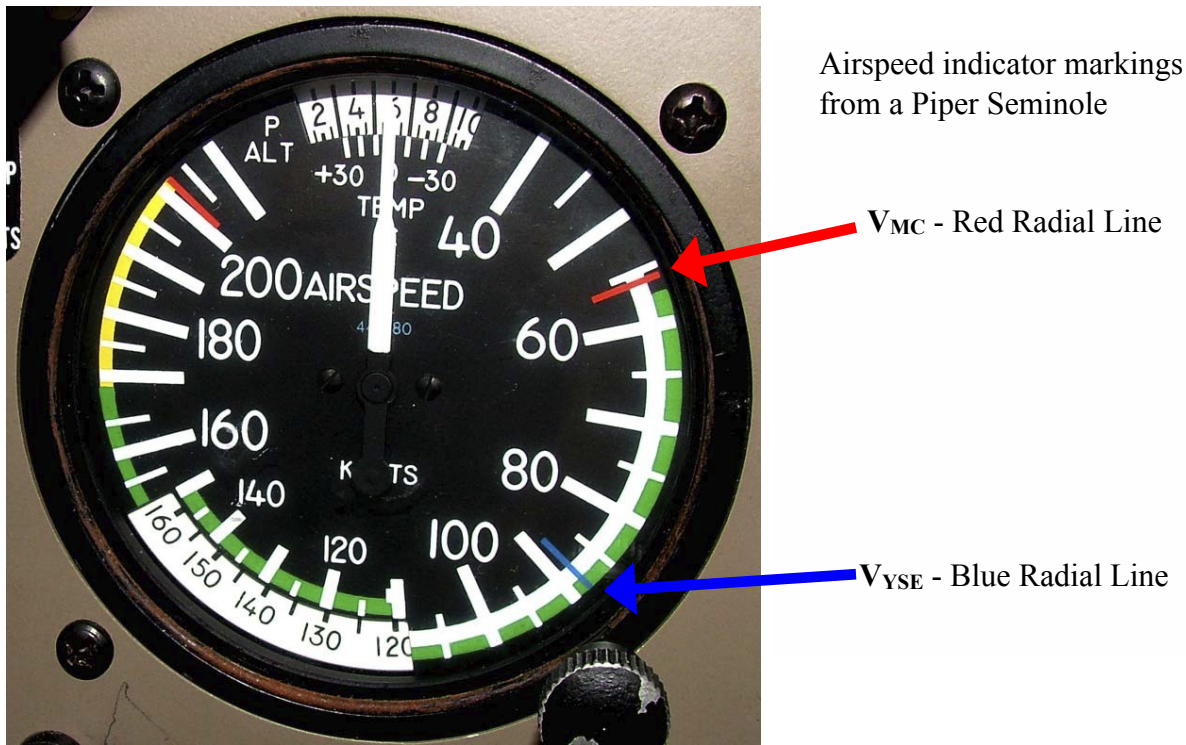
- Marked with a blue radial line on most airspeed indicators.

V_{SSE} - Safe, intentional one-engine-inoperative speed. Originally known as safe single-engine speed, it is the minimum speed to intentionally render the critical engine inoperative.

- Required by 14 CFR Part 23, Airworthiness Standards, to be established and published in the AFM/POH.

V_{MC} - Minimum control speed with the critical engine inoperative. The minimum speed at which directional control can be maintained under a very specific set of circumstances outlined in 14 CFR Part 23, Airworthiness Standards.

- Marked with a red radial line on most airspeed indicators.
- V_{MC} only addresses directional control. There is no requirement that the airplane be capable of climbing at this airspeed.



If an engine failure occurs below V_{MC} while the airplane is on the ground, the takeoff must be rejected. Directional control can only be maintained by promptly closing both throttles and using rudder and brakes as required.

If an engine fails below V_{MC} while airborne, directional control is not possible with the remaining engine producing takeoff power. So for safety reasons, the airplane should never be airborne during takeoff before the airspeed reaches AND exceeds V_{MC} .

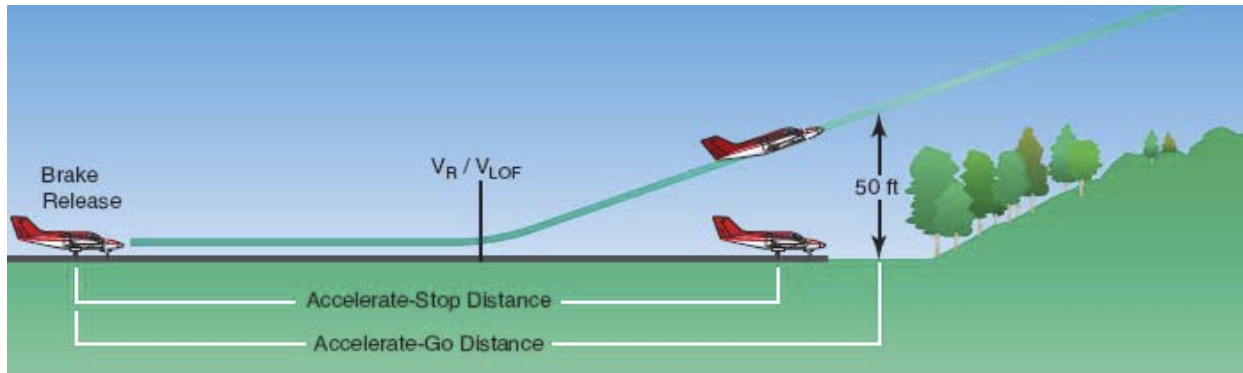
After liftoff, gain altitude as rapidly as possible. Once leaving the ground, **altitude gain is more important than achieving excess of airspeed**. Altitude also gives the pilot time to think and react if an engine failure occurs. V_Y should be established and maintained until reaching a safe single-engine maneuvering altitude. Considering terrain and obstructions, this is typically achieved at a minimum of 400-500' AGL.

There will be more information on all the factors involved in single engine operation of the airplane and the factors affecting V_{MC} speed later in this guide.

PERFORMANCE AND LIMITATIONS

Accelerate-stop distance is the runway length required to accelerate to a specified speed (either V_R or V_{LOF} , as specified by the manufacturer), experience an engine failure, and bring the airplane to a complete stop.

Accelerate-go distance is the horizontal distance required to continue the takeoff and climb to 50' AGL., assuming an engine failure occurs at V_R or V_{LOF} , as specified by the manufacturer (see diagram below).



The FARs do not specifically require that the runway length be equal to or greater than the accelerate-stop distance. Most AFM/POH publish accelerate-stop distances only as an advisory. It becomes a limitation only when published in the limitations section of the AFM/POH. Using runway lengths of at least the accelerate-stop distance is a good operating and safety practice.

ENGINE CEILINGS

AllEngine Service Ceiling - the highest altitude at which the airplane can maintain a steady rate of climb of 100 fpm with both engines operating at full power.

AllEngine Absolute Ceiling - the altitude where climb is no longer possible with both engines operating at full power.

SingleEngine Service Ceiling - the highest altitude at which the airplane can maintain a steady rate of climb of 50 fpm with one engine operating at full power and one engine's propeller feathered.

SingleEngine Absolute Ceiling - the altitude where climb is no longer possible with one engine operating at full power and one engine's propeller feathered.

If the airplane is flying above the single-engine service ceiling and one engine fails in flight, the airplane will drift down from its current altitude to the single-engine service ceiling.

- Above the single-engine absolute ceiling, V_{YSE} yields the minimum rate of sink.
- For example if an airplane's single-engine absolute ceiling is 5,000 ft. and while cruising at 9,000 ft. an engine fails, the airplane will drift down (descend) to 5,000 ft.

SINGLE ENGINE CLIMB PERFORMANCE

FAR 23.67 provides the single-engine climb performance requirements to airplane manufacturers for FAA certification of multi-engine aircraft.

For aircraft with a maximum weight of 6,000 lbs., or less and a V_{SO} of 61 knots or less: The single-engine rate of climb at 5,000' MSL must simply be determined with the—

1. Critical engine inoperative and its propeller in the minimum drag position
2. Remaining engine(s) at no more than maximum continuous power
3. Landing gear retracted
4. Wing flaps retracted
5. Climb speed not less than $1.2V_{S1}$

- The rate of climb could be a negative number - meaning a descent
- There is no requirement for a single-engine positive rate of climb at 5,000 ft., or any other altitude.

For Aircraft with a maximum weight of 6,000 lbs. or less, and/or V_{SO} more than 61 knots:

If certified *before* February 4, 1991: the single engine rate of climb in feet per minute at 5,000' MSL must be equal to at least $.027 V_{SO}^2$ (V_{SO} Squared)

If certified *after* February 4, 1991: maintain a steady climb gradient of at least 1.5 percent at a pressure altitude of 5,000 ft. with the—

1. Critical engine inoperative and its propeller in the minimum drag position
2. Remaining engine(s) at no more than maximum continuous power
3. Landing gear retracted
4. Wing flaps retracted
5. Climb speed not less than $1.2 V_{S1}$

NOTE

Do not confuse the date of type certification with the airplane's model year.

Rate of climb is the altitude gain per unit of time.

Climb gradient is the actual measure of altitude gained per 100 ft. of horizontal travel, expressed as a percentage.

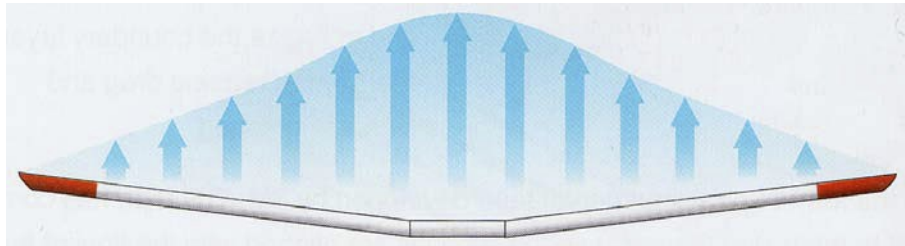
$\frac{3}{4}$ An altitude gain of 1.5 ft. per 100 ft. of horizontal travel (or 15 ft. per 1,000, or 150 ft. per 10,000) is a climb gradient of 1.5 percent.

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 (e.g., 50:1). Unlike rate of climb, the climb gradient is affected by wind. A climb gradient is improved with a headwind component and reduced with a tailwind component.

MULTIENGINE AERODYNAMICS

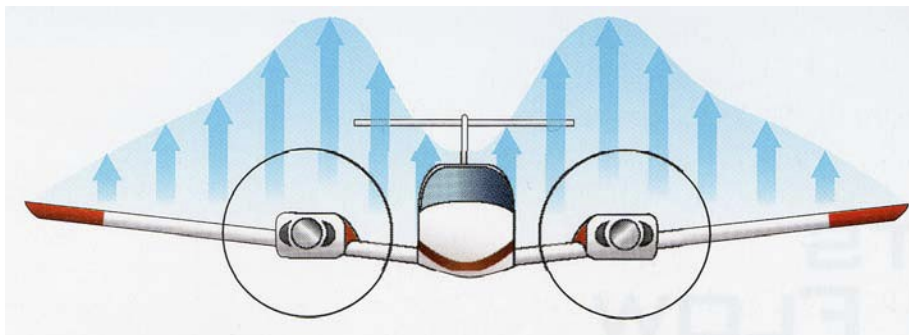
INDUCED FLOW

Looking at the airplane without the engines and the fuselage, the amount of lift created by the wings would look like this:



Jeppesen Multi-Engine Manual

The propellers of the wing mounted engines create an accelerated flow or accelerated slipstream of air over the wings called induced flow. The amount of lift created by a multi engine airplane looks like this:



Jeppesen Multi-Engine Manual

Induced flow does occur in single-engine airplanes, but it is not as much of a factor because of the location of the engine in relation to the wings.

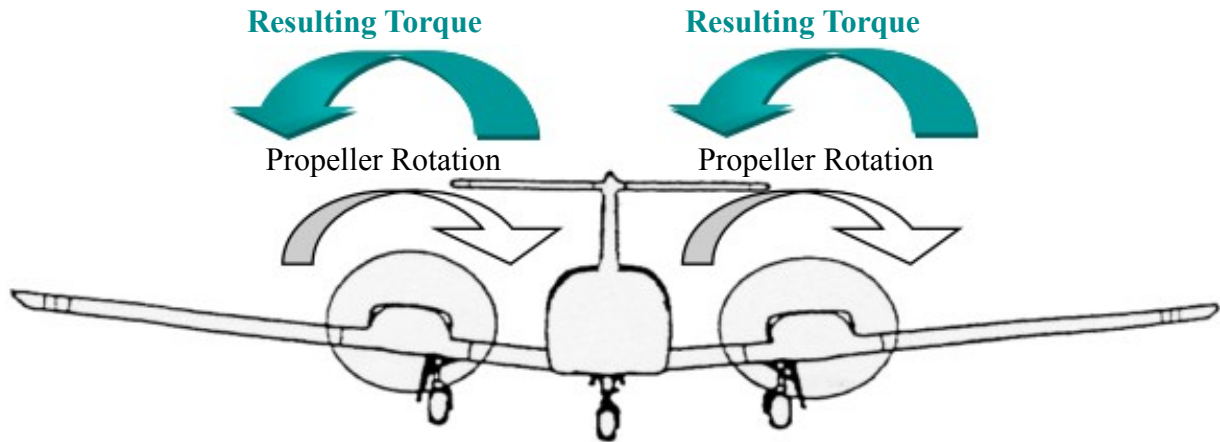
TURNING TENDENCIES

The turning tendencies that affect single engine airplanes (i.e. torque and P-factor) also affect multi-engine airplanes. Since the multi-engine airplane has at least two engines, these effects are increased.

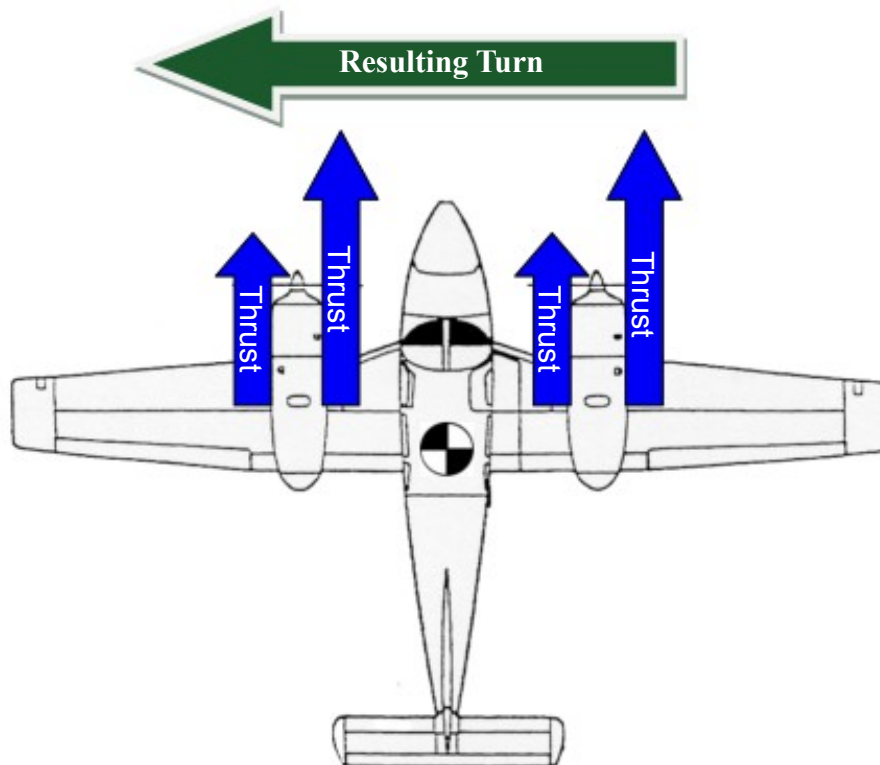
Twin-engine airplanes where the propellers for each engine rotate in the same direction are called **conventional** twins. To combat the torque and P-factor tendencies, twin-engine airplanes with **counterrotating** propellers, or propellers that rotate in opposite directions, and engines have been developed. The effects of torque and p-factor with counter-rotating propellers will cancel each other out, resulting in less rudder needed to oppose these forces.

A Conventional Twin

Result of Torque = Roll to the Left

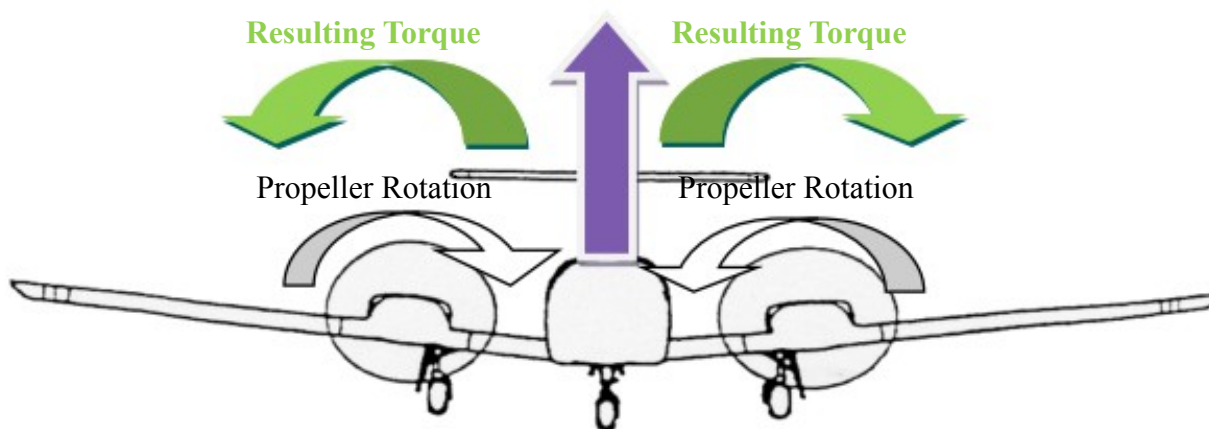


Result of P Factor = Yaw to the left

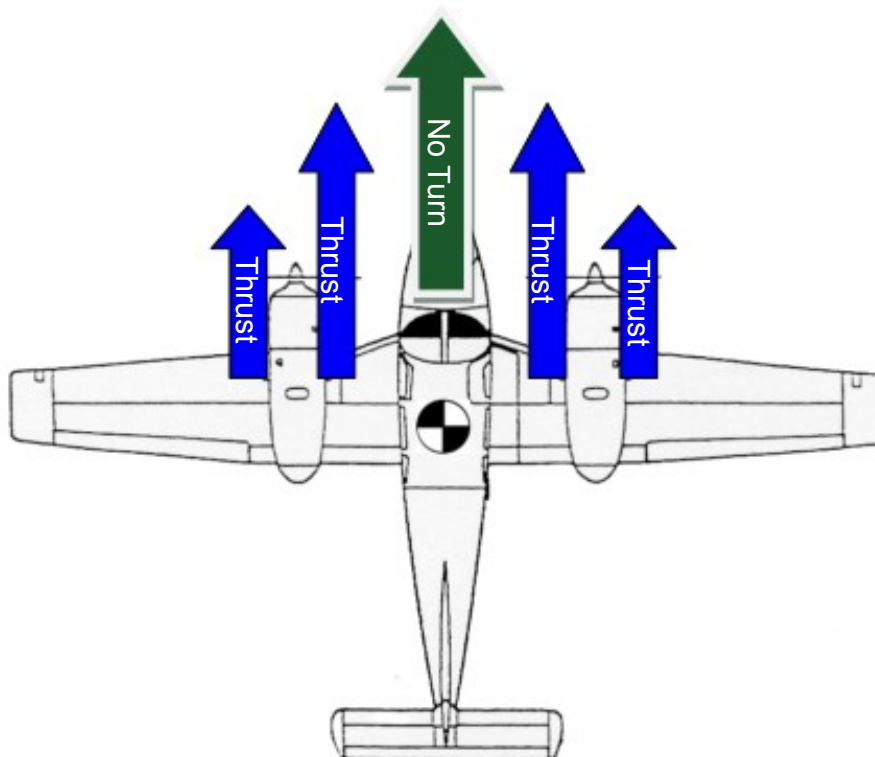


A CounterRotating Twin

Result of Torque = NONE = Both Engines Cancel Each Other Out.



Result of P Factor = NONE = Both Engines Cancel Each Other Out.

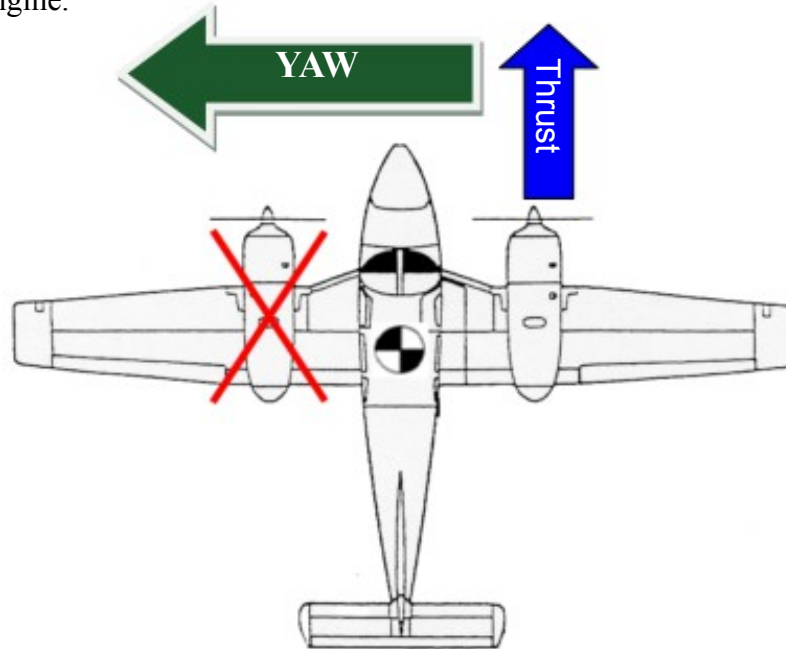


ENGINE FAILURES

WHAT HAPPENS WHEN AN ENGINE FAILS

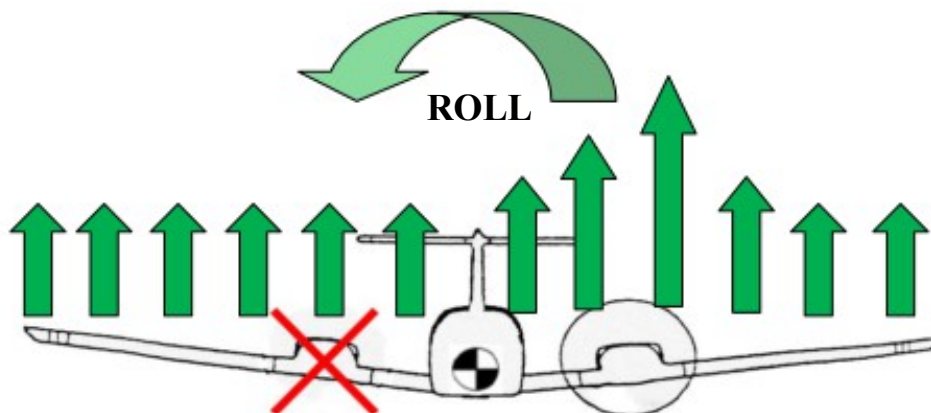
Two motions happen when an engine fails: YAW and ROLL.

1. **YAW**- Asymmetrical thrust will cause a yawing moment around the C.G. towards the inoperative engine.



2. **ROLL** - The yawing moment from above will cause the wing with the operating engine to move faster through the air as the airplane yaws. This causes a faster velocity of air over the wing with the operative engine meaning more lift on that wing and results in a roll towards the inoperative engine.

3. **ROLL** - Induced flow (accelerated slipstream) over the wing from the operating engine and lack of induced flow (accelerated slipstream) over the inoperative engine causes asymmetrical lift on the wings, resulting in a rolling moment around the C.G. towards the inoperative engine.



CRITICAL ENGINE

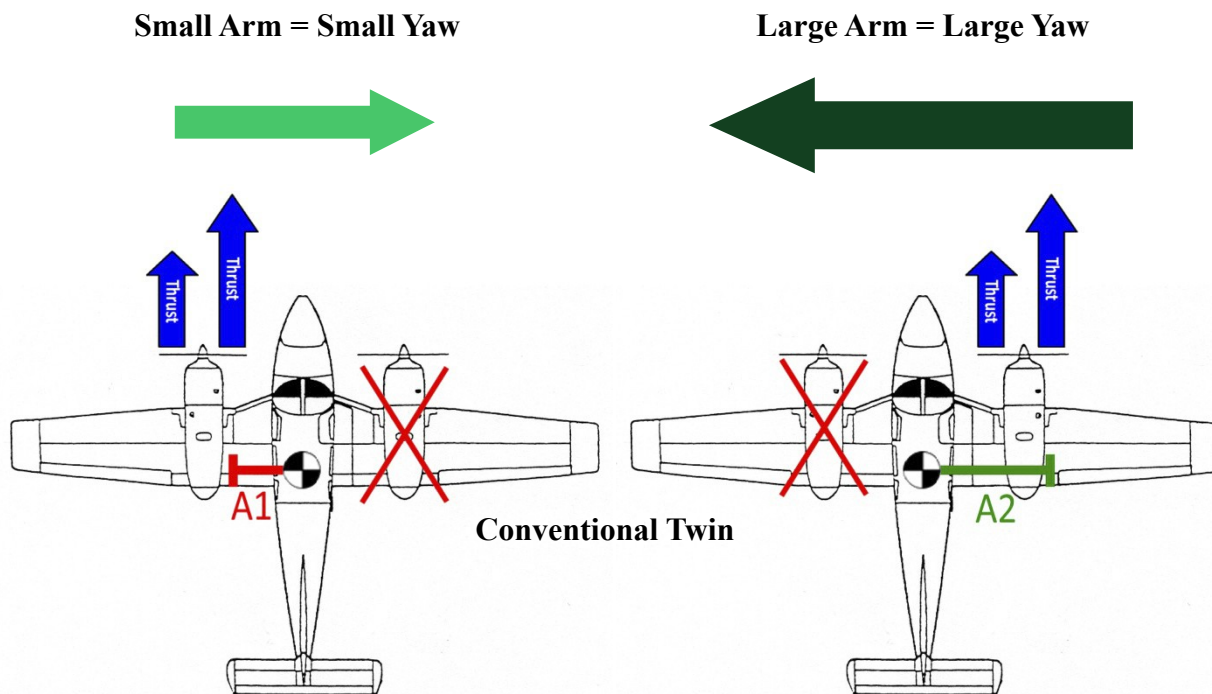
The critical engine is the engine that, if it were to fail, would most adversely affect the performance or handling characteristics of the airplane.

On **conventional twins** (with propellers rotating to the right) the critical engine is the **left engine**. On a twin engine airplane with **counterrotating** propellers there is **not a critical engine** since the yawing and rolling effects of losing one engine will be identical no matter which engine fails.

There are three factors that determine if an engine is critical.

1. P-Factor
2. Accelerated Slipstream
3. Torque

P FACTOR P-factor is where the descending propeller blade creates more thrust than the ascending blade. This causes asymmetrical thrust on each side of the propeller. To figure out the effect on the airplane, the formula **THRUST x Arm = Moment** can be used. This means that the longer the arm from the C.G. to the thrust, the larger the yawing moment will be.

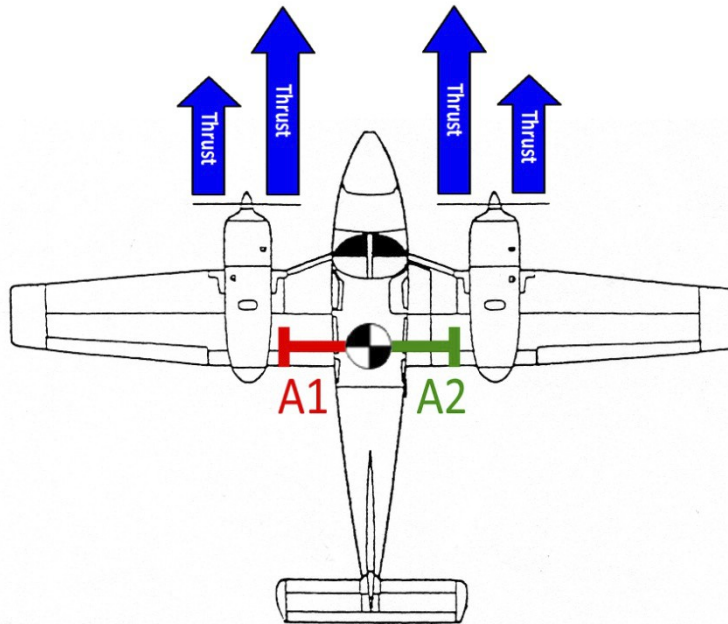


Because the descending propeller blade on the right wing engine has a longer arm (A2) than the descending propeller blade on the left wing engine (A1), the airplane will have a greater yawing moment to the left if the left engine fails than if the right engine fails.

Since the effect of the yaw is greater if the left engine fails, **the left engine is the critical engine**.

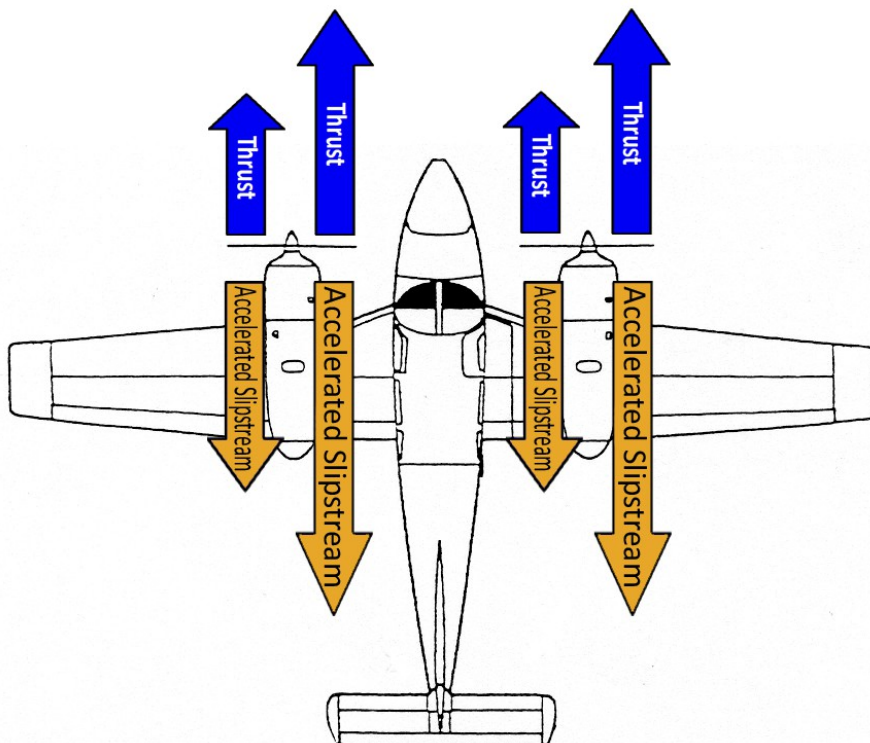
On a counter-rotating twin-engine airplane, arms (A1, A2) to the descending propeller blades are the same length, resulting in the same amount of yaw regardless of which engine fails.

Counterrotating Twin = Arms are the Same Length



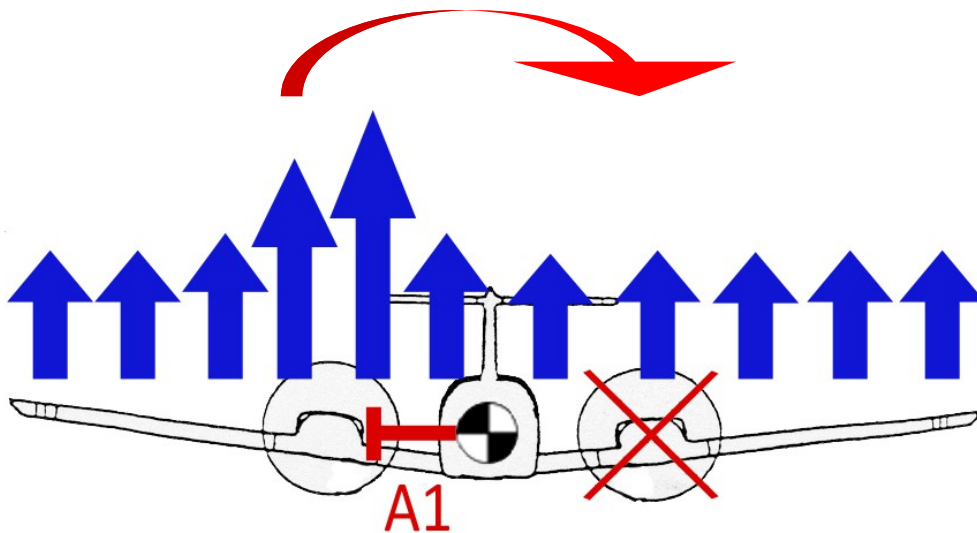
ACCELERATED SLIPSTREAM - The propellers will accelerate air over the wings. More lift is produced where the propellers accelerate the air over the wing. Just as P-factor causes asymmetrical thrust forward, it also produces the same effect in the asymmetrical airflow behind the propeller.

Conventional Twin

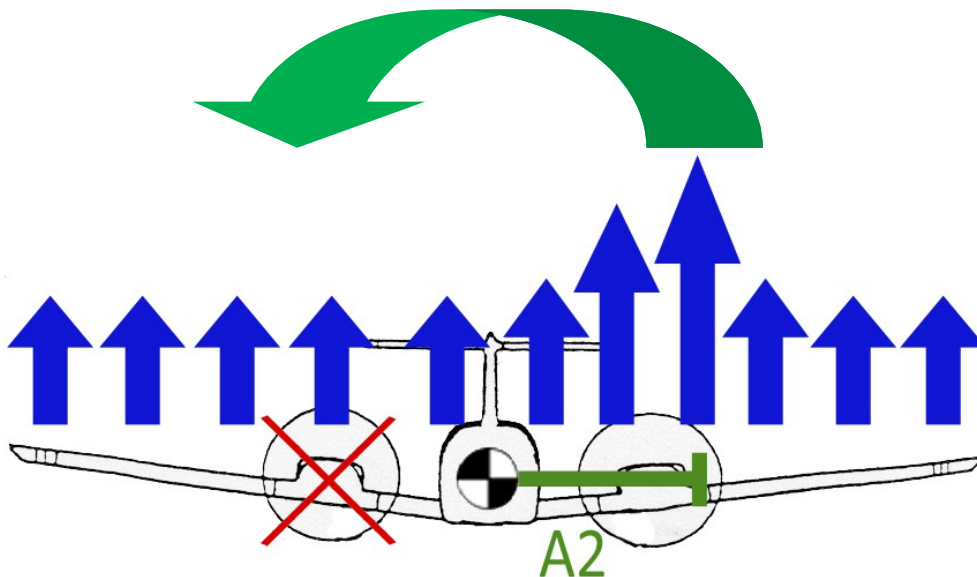


When one engine fails, the accelerated slipstream causes a roll towards the inoperative engine. To figure out the effect on the airplane the formula **LIFT x Arm = Moment** can be used. Just like P-factor, the arm to the right engine is longer than the arm to the left engine. This means that if the left engine fails, the roll moment will be greater to the left than if the right engine fails. **Therefore the left engine is the critical engine.**

Small Arm = Small Roll

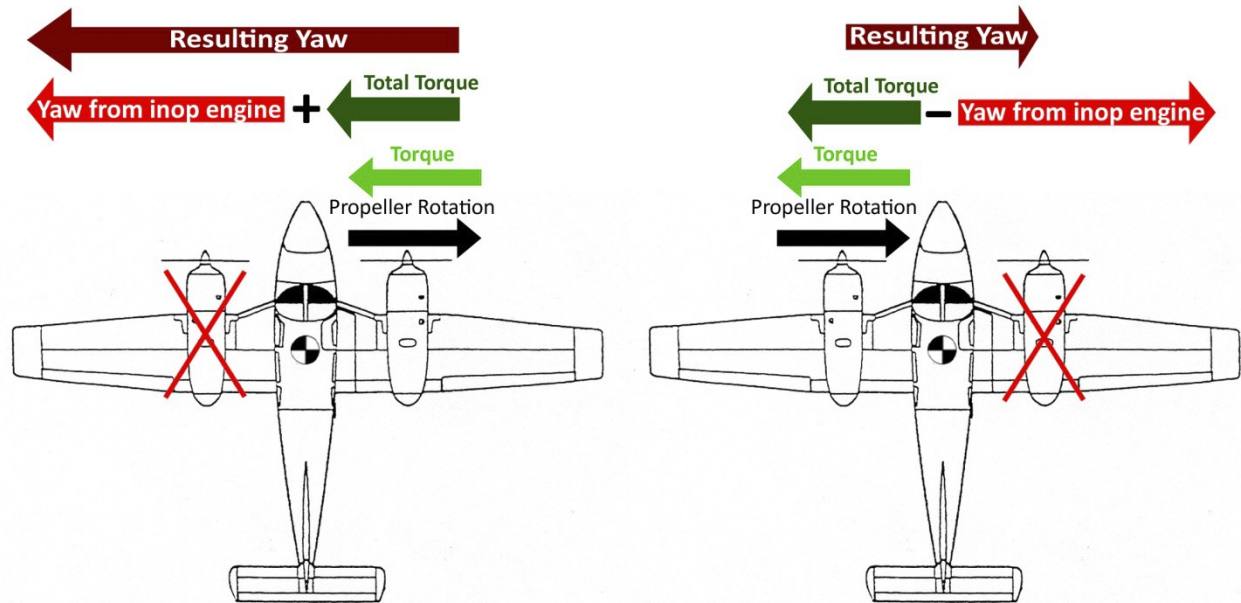


Large Arm = Large Roll



TORQUE - As the engine and propeller rotate in one direction, they, in turn, try to rotate the airplane in the other direction. This is due to Newton's third law which states, "For every action there is an equal and opposite reaction." This force also acts when an engine fails because there is still a second operating engine.

Conventional Twin



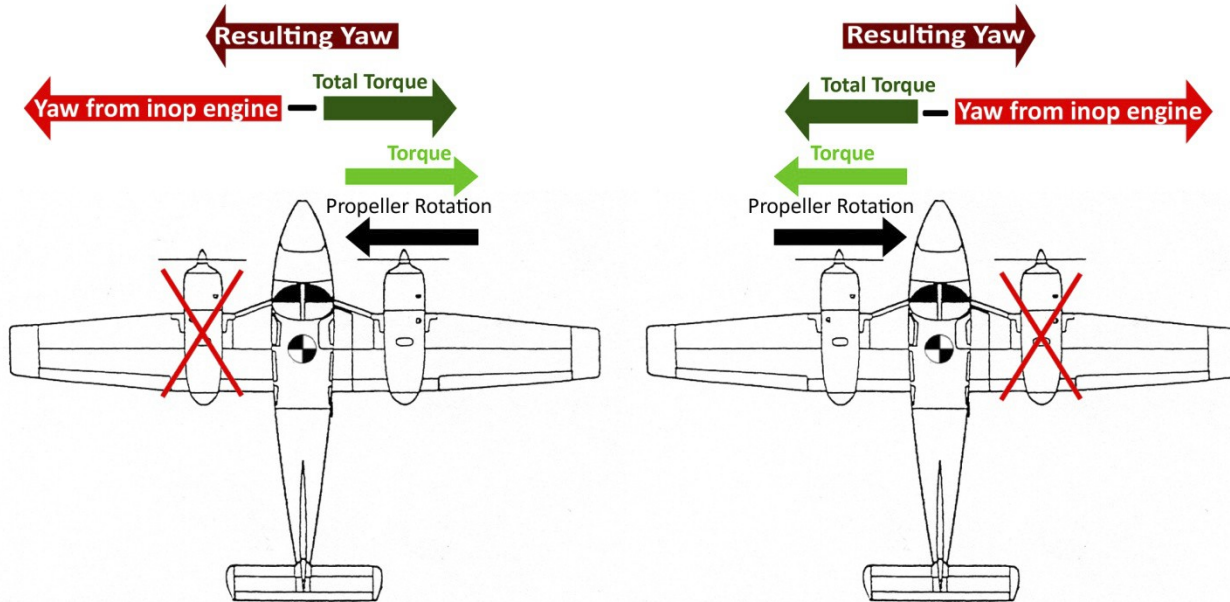
The result of the torque is roll, but it will also combine with the other factors previously mentioned as well.

If the left engine fails, the yawing moment from the right engine (thrust) and the total torque will both work together to yaw and roll the airplane to the left.

If the right engine fails, the yawing moment from the left engine (thrust) and the total torque (opposite direction) will still result, although to a lesser degree (compared to failure of the left engine), in a yaw and roll of the airplane to the right.

This means that the yaw will be worse if the left engine fails which means that the **left engine is the critical engine**.

CounterRotating Twin



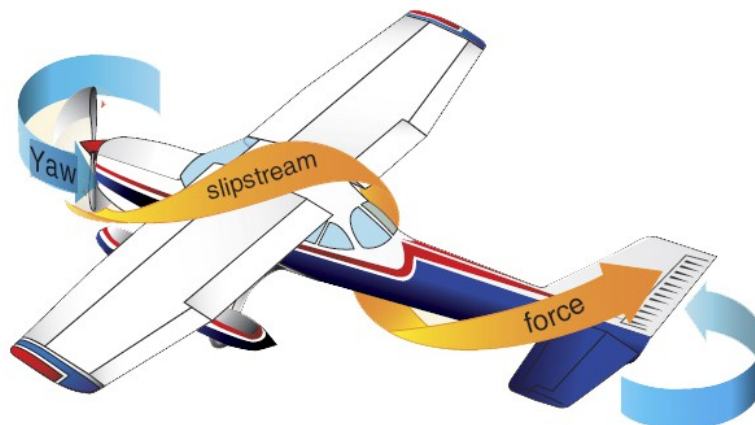
In the counter-rotating twin, the torque will oppose the yawing and rolling moment caused by an inoperative engine. The resulting yaw will be the same no matter which engine fails. Therefore, there is no critical engine.

One other factor that could affect the critical engine is **Spiraling Slipstream**.

NOTE

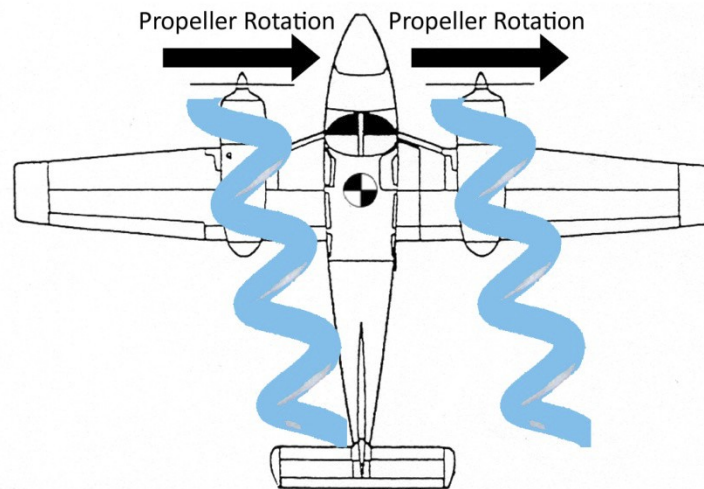
The effect of **Spiraling Slipstream** is usually so minimal that some will even ignore its effects altogether.

The high-speed rotation of an airplane propeller gives a corkscrew or spiraling rotation to the slipstream. At high propeller speeds and low forward speed (as in takeoffs and approaches to power on stalls), this spiraling rotation is very compact and exerts a strong sideward force on the airplane's vertical tail surface.

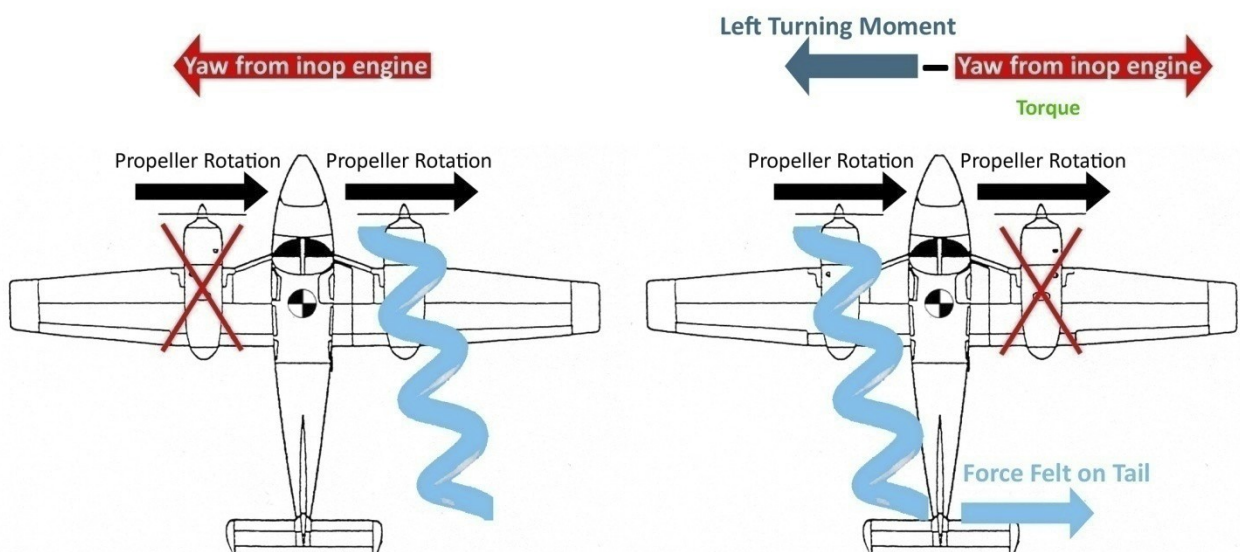


When this spiraling slipstream strikes the vertical fin on the left, it causes a left turning moment, or yaw, about the airplane's vertical axis. The more compact the spiral, the more prominent the force. As the forward speed increases, however, the spiral elongates and becomes less of a force on the vertical fin.

Here is what spiral slipstream would look like on a conventional twin with both engines operating. As the propeller turns right, the air is also moved to the right.



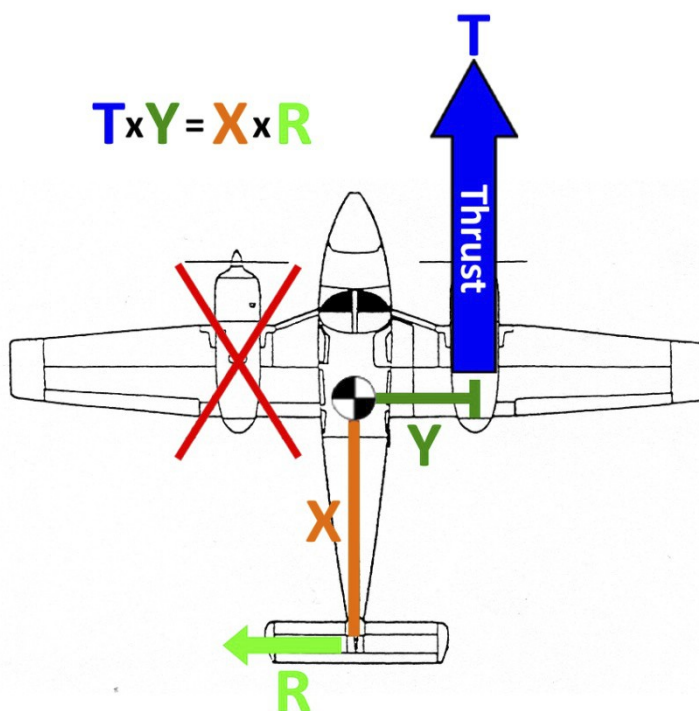
If the left engine fails the spiral slipstream will not hit the tail at all, resulting in no additional yawing force. If the right engine fails the spiral slipstream will hit the left side of the tail causing a yaw to the left in the opposite direction of the yaw to the right caused by the failed engine. This yaw from the spiral slipstream will help oppose the yaw from the failed engine. This makes the left engine critical.



V_{MC}

When a multi-engine airplane loses an engine it experiences a yaw and roll. To counteract this, the rudder can be used to stop the yaw and the resulting roll.

As airspeed is decreased, the rudder becomes less effective. Therefore, more rudder deflection will be required to maintain directional control. Eventually, an airspeed will be reached where full rudder deflection will be required to maintain directional control. At this point, any further decrease in airspeed will lead to loss of directional control. It is this airspeed at which the airplane reaches V_{MC} .



V_{MC} can be defined as:

1. Minimum control speed with the critical engine inoperative.
2. The minimum speed at which directional control can be maintained under a very specific set of circumstances as outlined in 14 CFR Part 23.

V_{MC} is the speed at which it is still possible to maintain directional control with an engine inoperative.

NOTE

V_{MC} only addresses directional control.

V_{MC} FOR CERTIFICATION - FAR 23.149

Every multi-engine airplane must go through a certification process which includes calculating a V_{MC} speed. 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 by FAR 23.149.

§23.149 Minimum control speed

V_{MC} is the calibrated airspeed at which, when the critical engine is suddenly made inoperative it is possible to:

1. Maintain control of the airplane with that engine still inoperative,
2. 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.

V_{MC} must not exceed 1.2 V_{S1} at maximum takeoff weight.

V_{MC} must be determined with:

1. Most unfavorable weight - (not necessarily maximum gross weight)
2. Most unfavorable center of gravity position
3. The airplane airborne and the ground effect negligible
4. Maximum available takeoff power initially on each engine
5. The airplane trimmed for takeoff
6. Flaps in the takeoff position
7. Landing gear retracted
8. All propeller controls in the recommended takeoff position.

When recovering from V_{MC}:

1. The rudder pedal force required to maintain control must not exceed 150 pounds.
2. It must not be necessary to reduce power of the operative engine(s).
3. The airplane must not assume any dangerous attitude.
4. It must be possible to prevent a heading change of more than 20 degrees.

NOTE

V_{MC} deals only with directional control not performance.

FAR 23.149 also requires the calculation of a minimum speed to intentionally render the critical engine inoperative and to be designated as the safe, intentional, one-engine-inoperative speed, or V_{SSE}.

Remember, published V_{MC} and actual V_{MC} are two different speeds. There are many factors that can affect V_{MC} speed and they will be covered in the following pages.

RECOGNIZING AND RECOVERING FROM V_{MC}

To recognize V_{MC} is occurring or about to occur there are four warning signs.

1. **Loss of directional control** - the rudder pedal is depressed to its fullest travel and the airplane is still turning towards the inoperative engine.
2. **Stall warning horn** - a single-engine stall could be just as dangerous as running out of rudder authority and could even result in a spin.
3. **Buffeting before the stall** - same reason as the stall warning horn.
4. **A rapid decay of control effectiveness** - any loss of control effectiveness could result in loss of control of the airplane.

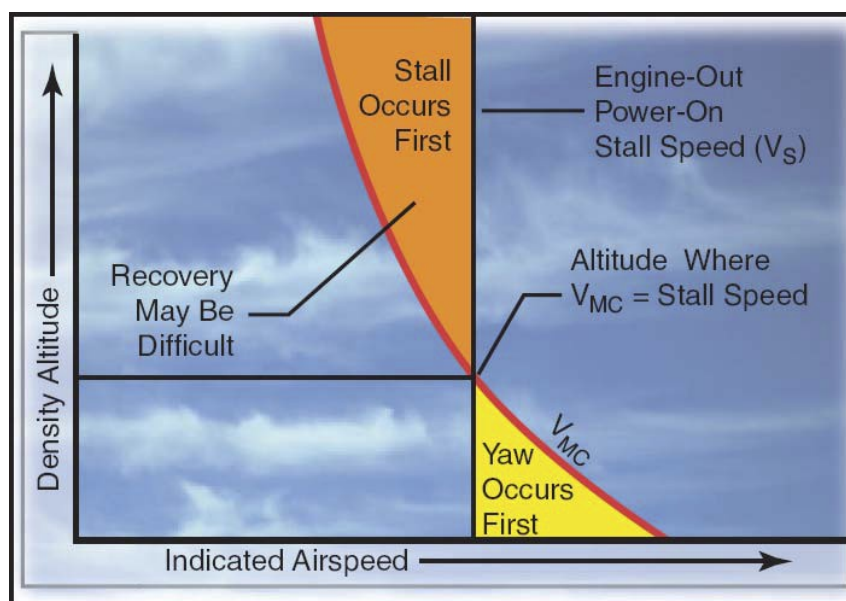
To recover from V_{MC} , two actions must occur (simultaneously):

1. **Reduce power on the operating engine** - this will reduce the asymmetrical thrust causing the V_{MC} in the first place.
 - ¾ Reducing the power all the way to idle may help stop the V_{MC} , but the loss of power and resulting loss of airspeed could lead to a stall.
2. **Pitch down** - Lowering the nose of the airplane will increase the forward airspeed making the rudder more effective in regaining and maintaining directional control.

V_{MC} vs. STALL SPEED

As density altitude increases, V_{MC} speed decreases due to the fact that as density altitude increases engine power will decrease. The decrease in engine power results in less asymmetrical thrust, meaning the yawing from a failed engine will be less at a high density altitude than a lower density altitude.

Stall speed is an indicated airspeed and will remain constant as altitude increases or decreases.



FACTORS AFFECTING V_{MC}

Published V_{MC} will almost always be different than actual V_{MC} . There are a lot of factors that can affect this speed, but there are a few important things to remember:

V_{MC} becoming a lower airspeed is good because the airplane can go slower before losing directional control.

Things that causes V_{MC} to decrease:

- ¾ Anything that will move the C.G. forward will make the rudder more effective.
 - Large arm to rudder = Larger rudder moment = Rudder more effective.
- ¾ Anything that will allow less rudder to be used, making more rudder available to the pilot.

V_{MC} becoming a higher airspeed is bad because the airplane will lose directional control at a higher airspeed.

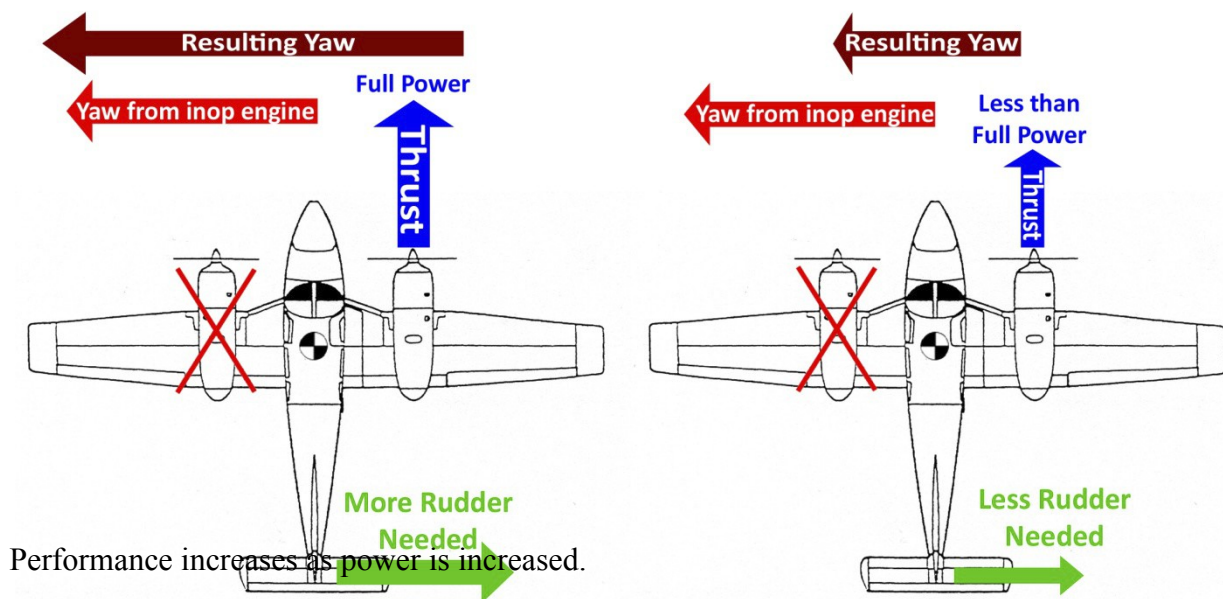
Things that make V_{MC} increase:

- ¾ Anything that will move the C.G. aft will make the rudder less effective.
 - Small arm to rudder = Smaller rudder moment = Rudder less effective.
- ¾ Anything that will cause more rudder to be used, making less rudder available to the pilot.

Performance of the airplane is not related to V_{MC} speed. Performance can be viewed as single engine climb performance or relating to the amount of drag on the airplane.

POWER

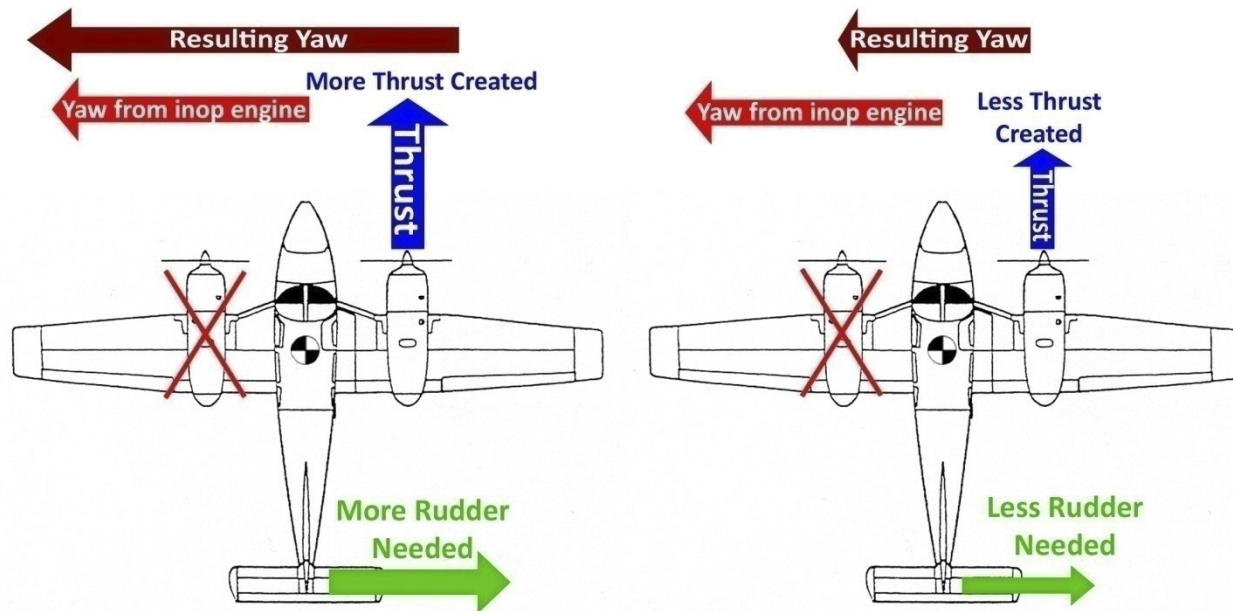
The more power (thrust) on the operating engine, the more rudder is needed to stop the resulting yaw. Using more rudder leaves less available to the pilot = V_{MC} speed increases as power on the operating engine is increased.



DENSITY ALTITUDE

As density altitude increases, temperature increases, pressure decreases, and/or humidity increases the output of the engine or thrust created by the engine decreases. The less thrust that is created, the less rudder input needed to oppose the yaw.

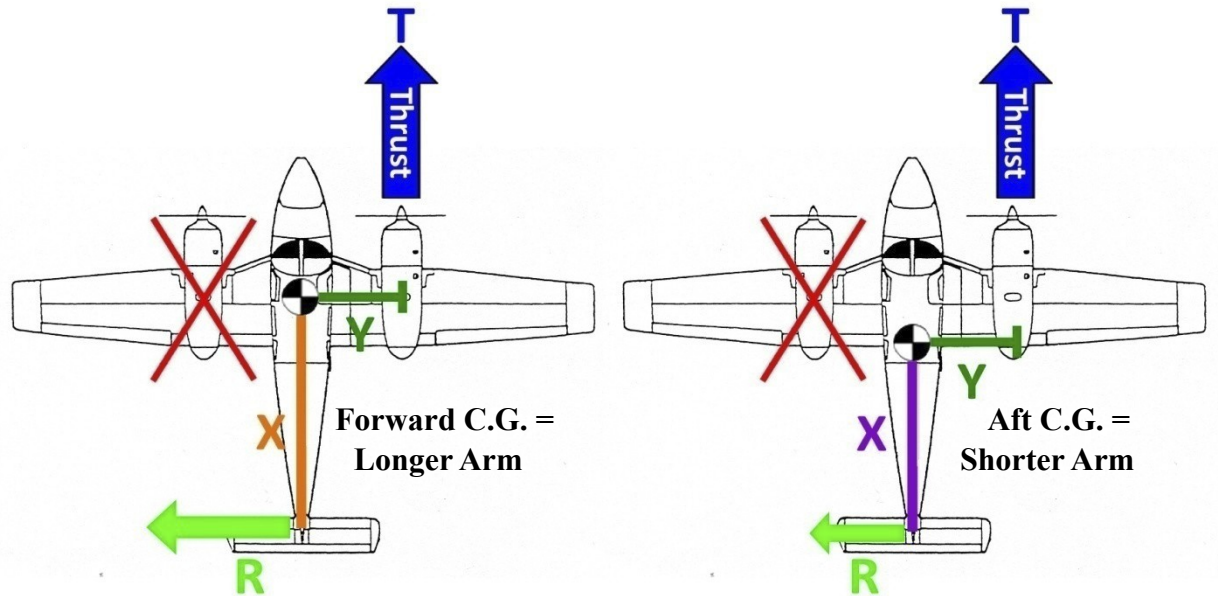
Using less rudder leaves more rudder available to the pilot. Therefore, V_{MC} decreases. So, as density altitude increases, temperature increases, pressure decreases, and/or humidity increases V_{MC} decreases.



Performance decreases as density altitude increases, temperature increases, humidity increases, and/or pressure decreases. With air being less dense, not only does the engine become less efficient, but the propeller and wings also have decreased performance due to having less air molecules available to make thrust and lift.

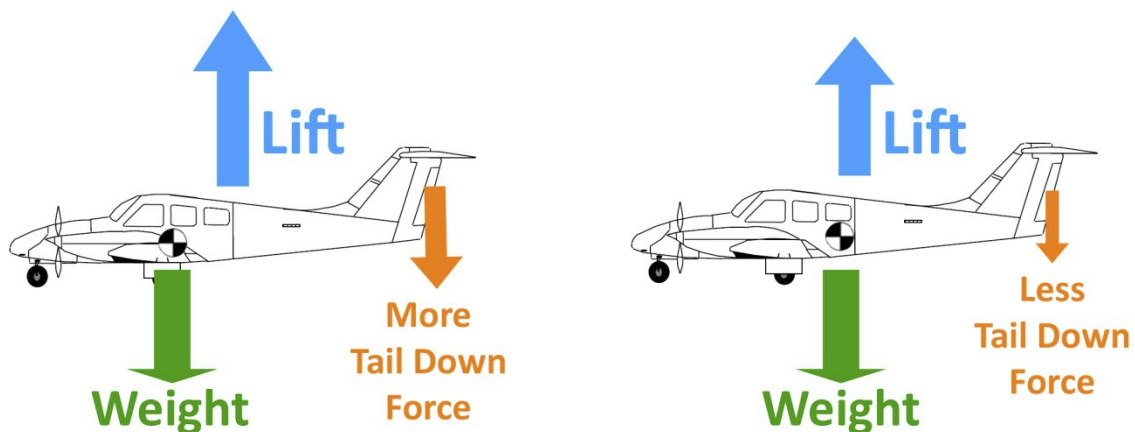
C.G. LOCATION

The C.G. location changes the length of the arm to the rudder: the longer the arm, the more effective the rudder; the more effective the rudder, the lower V_{MC} . As the C.G. moves forward, V_{MC} decreases; as the C.G. moves aft, V_{MC} increases.



Performance increases as the C.G. is moved aft. As the C.G. moves forward, more tail-down force is needed to keep the airplane level. The more tail-down force needed, the more total lift is required. When more lift is created (airplane flying at a higher angle of attack), more drag is also created. The increase in drag causes the overall speed to decrease.

$$\text{Total Lift Required} = \text{Weight} + \text{Tail Down Force}$$



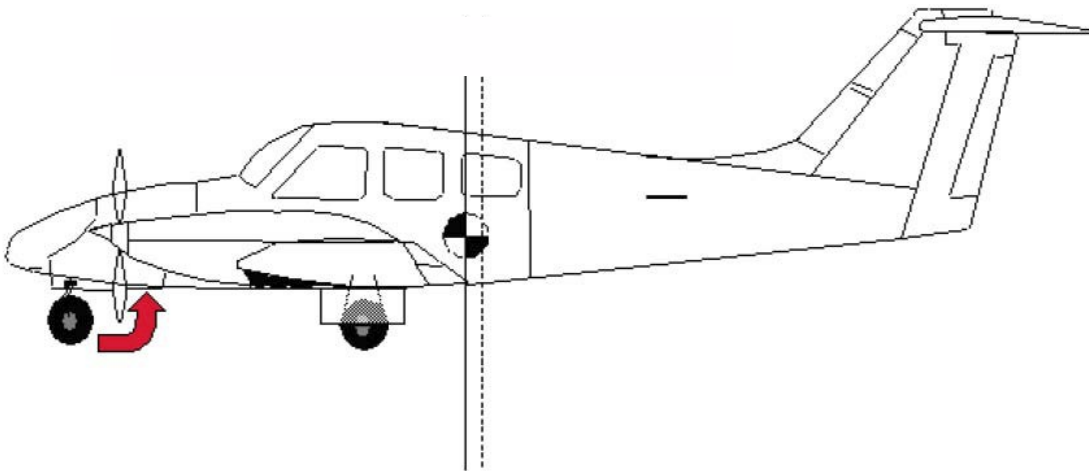
Effects of Forward C.G.

Aft C.G. effects are just the opposite of the Forward C.G. effects.

GEAR POSITION

As the landing gear operates to retract or extend, the C.G. location moves in the direction of travel of the nose gear.

Nose wheel goes aft = C.G. moves Aft

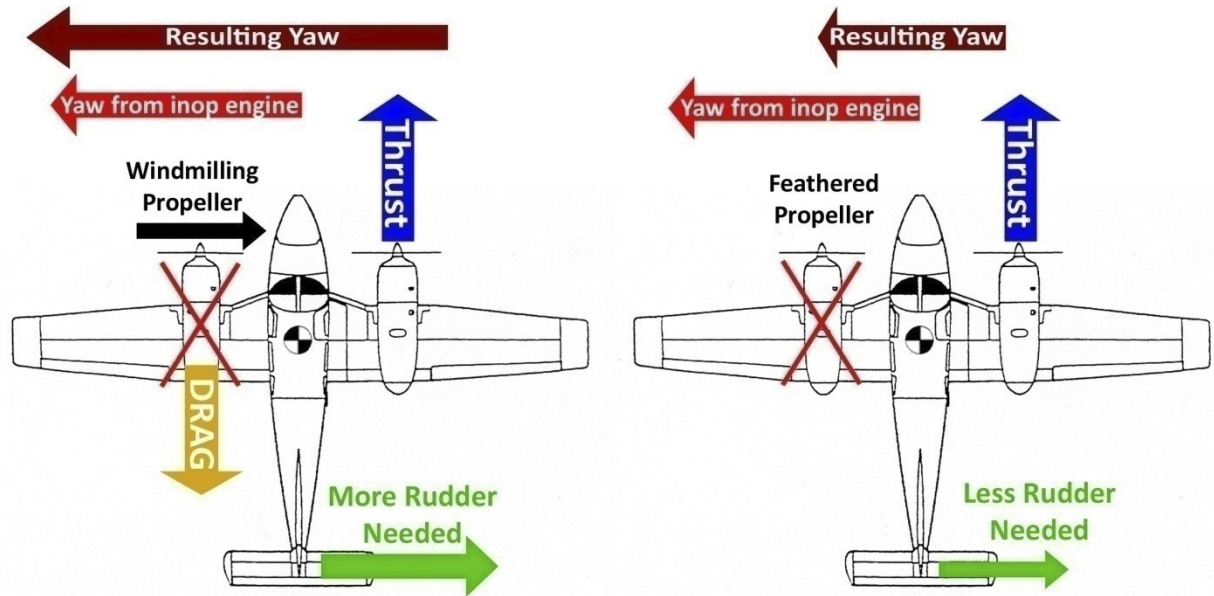


The change in C.G. affects V_{MC} speed just as stated before. In the extended (down) position, the landing gear can also act like the keel of a boat, giving the airplane a stabilizing effect. This stabilizing effect helps prevent a turn, thereby lowering V_{MC} .

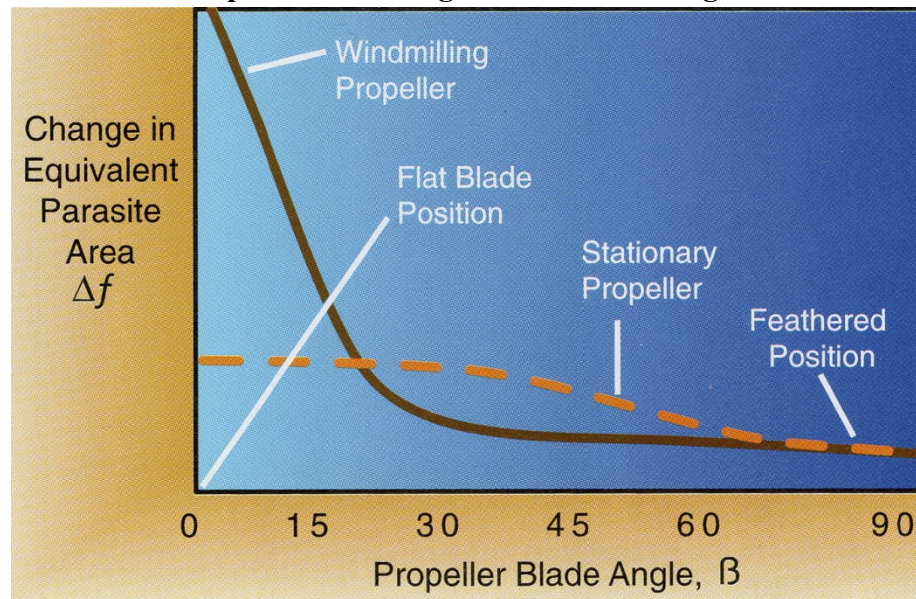
The landing gear extended (down) always decreases performance due to parasite drag.

PROPELLER WINDMILLING VS. FEATHERED PROPELLER

A windmilling propeller creates more drag than a feathered propeller. This extra drag adds to the yawing from a failed engine to make the total effect worse. This situation will require more rudder deflection to maintain directional control, which means that less rudder is available to the pilot, thereby increasing V_{MC} . Once the propeller is feathered the drag is reduced, thereby reducing V_{MC} .



Propeller Blade Angle vs. Parasite Drag



Jeppesen Multi-Engine Manual

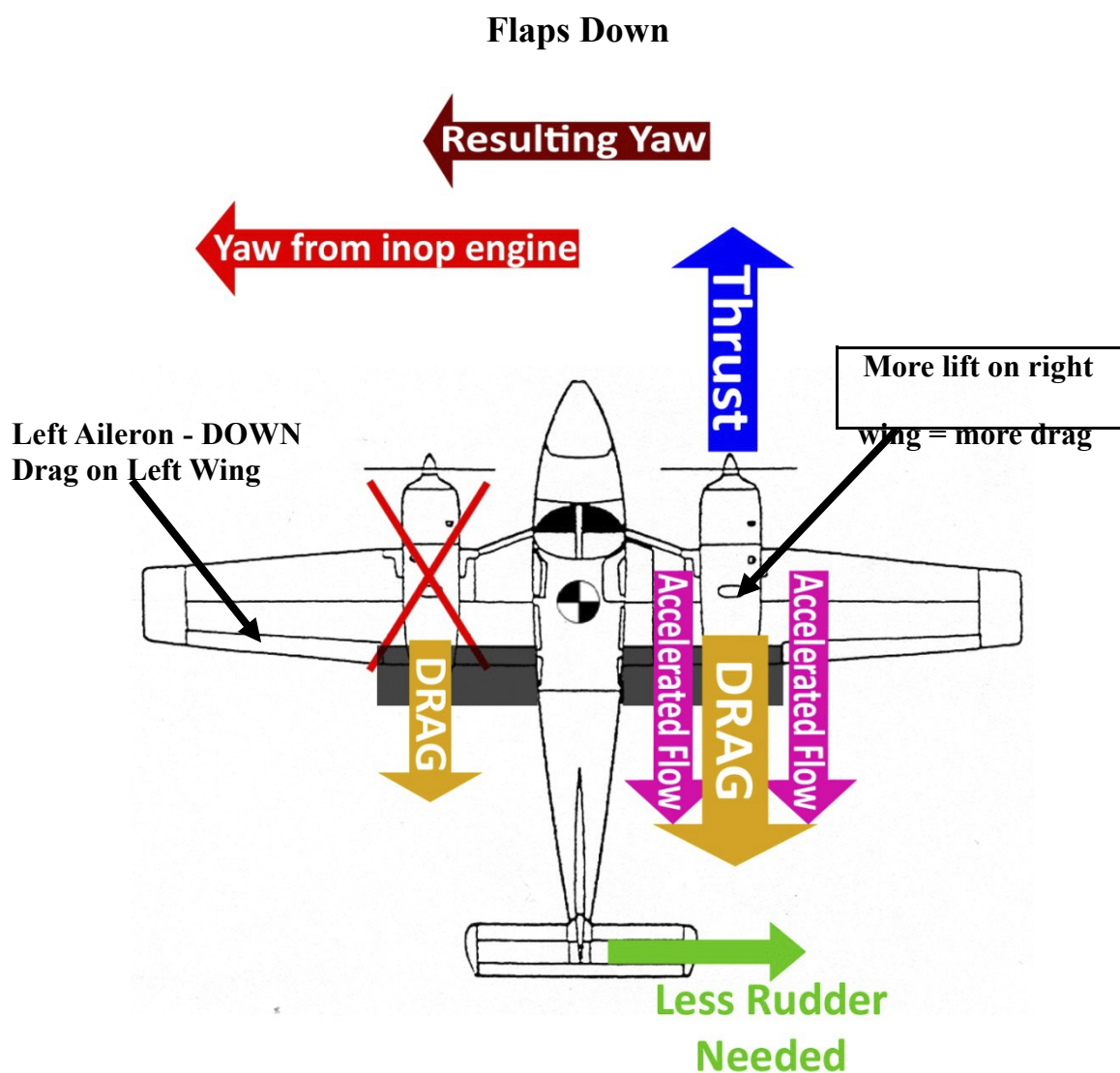
A windmilling propeller decreases performance due to the parasite drag created by the propeller blades.

FLAPS DOWN

When the flaps are down the wings create more lift than if the flaps were up. However, when lift is created, 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. When the flaps are extended, 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} .

It should be noted more lift on the right wing will cause a roll to the left. If ailerons are used to counteract the rolling of the airplane, the drag from the adverse aileron yaw will actually increase the yaw towards the inoperative engine.



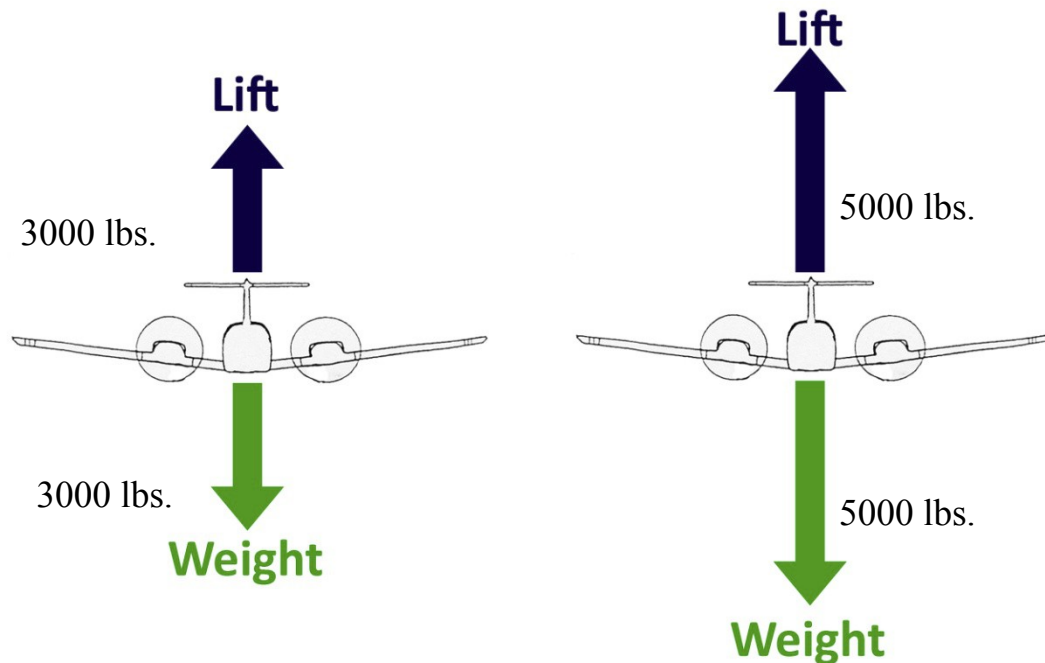
Because the flaps create more drag and the control surfaces will be deflected a greater amount, overall performance will decrease.

WEIGHT

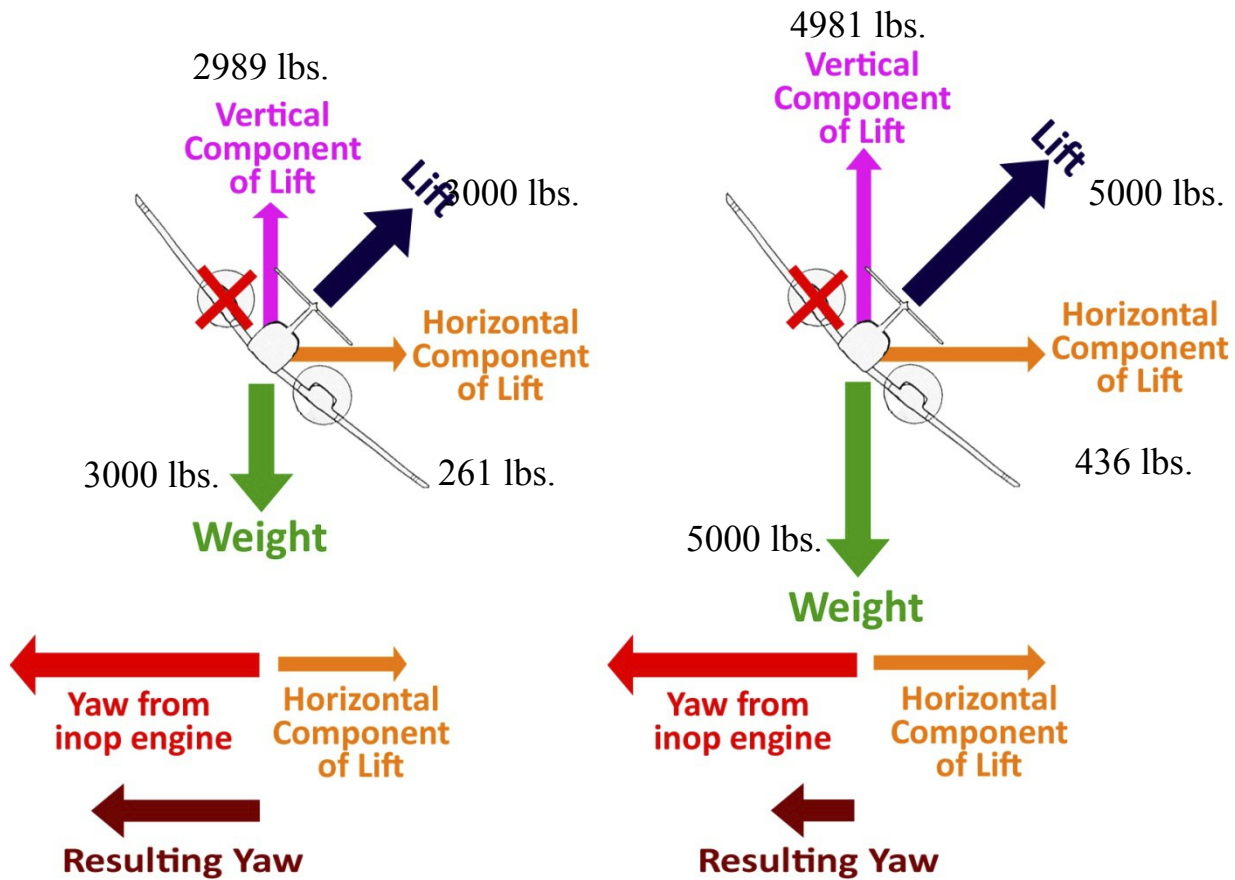
The weight of the airplane determines the amount of total lift required by the airplane to maintain level flight. As the airplane is banked, the lift is separated into horizontal and vertical components of lift.

The horizontal component of lift (the force that causes the airplane to turn) will help oppose the yaw due to an inoperative engine. The more weight, the more horizontal lift is available to oppose the turn from the inoperative engine.

This means that horizontal lift can be used along with rudder to stop the turn. When more horizontal lift is available, less rudder is needed, which means more rudder is available to the pilot and V_{MC} decreases. So, as weight increases, V_{MC} speed decreases. As weight decreases, V_{MC} increases.



With a 5° Angle of Bank:



The larger horizontal component of lift on the heavier airplane will make the resulting yaw smaller. This also reduces the amount of rudder needed to maintain the airplane's heading.

A higher weight always lowers performance because it decreases the amount of excess thrust available. This is especially true during one-engine inoperative operations.

Fuel consumption will also lower the weight of an aircraft during flight, increasing V_{MC} and airplane performance. The amount it affects weight depends on the rate at which the fuel is consumed.

BANK ANGLE

Bank angle can affect V_{MC} and performance both positively and negatively. Just like the weight example, when an engine fails, the horizontal component of lift can be used to stop the yaw, but that is not the only affect of bank angle. Bank angle is related to VMC and performance in a few ways:

This chart shows bank angle and the amount of lift in both the horizontal and vertical directions. Notice that at a 5° bank, a loss of 14 lbs. of vertical lift equals to a turning force of 314 lbs.

Bank Angle	Total Lift	Vertical Lift	Horizontal Lift
0	3600	3600	0
1	3600	3599	63
2	3600	3598	126
3	3600	3595	188
4	3600	3591	251
5	3600	3586	314
10	3600	3545	625
15	3600	3477	932
30	3600	3118	1800
45	3600	2546	2546
60	3600	1800	3118

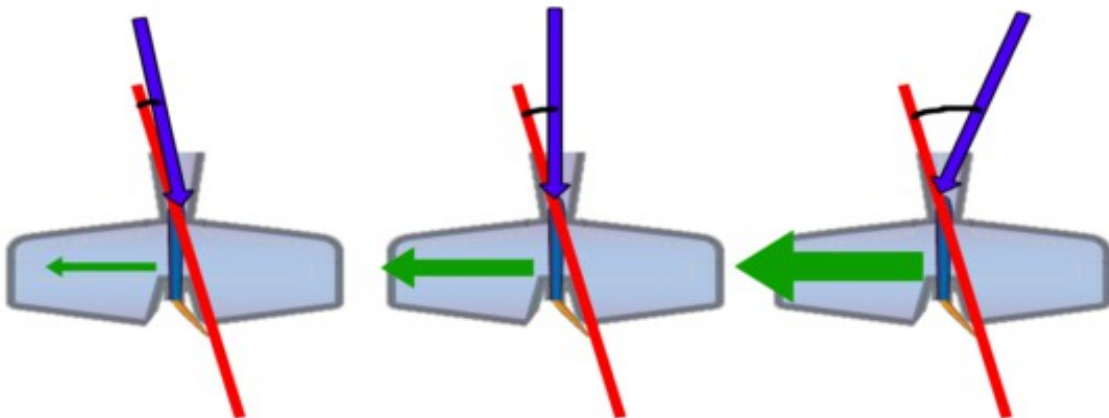
$$\begin{aligned}\text{Vertical Component of Lift} &= \cos(\text{Bank Angle}) \times \text{Weight} \\ \text{Horizontal Component of Lift} &= \sin(\text{Bank Angle}) \times \text{Weight}\end{aligned}$$

The angle of attack on the rudder determines how much force the rudder can create. It is dependent on the angle of the relative wind to the chord line of the rudder. The larger the angle of attack, the larger the force produced by the rudder. When the airplane is banked, rudder forces will act both in the vertical and horizontal directions.

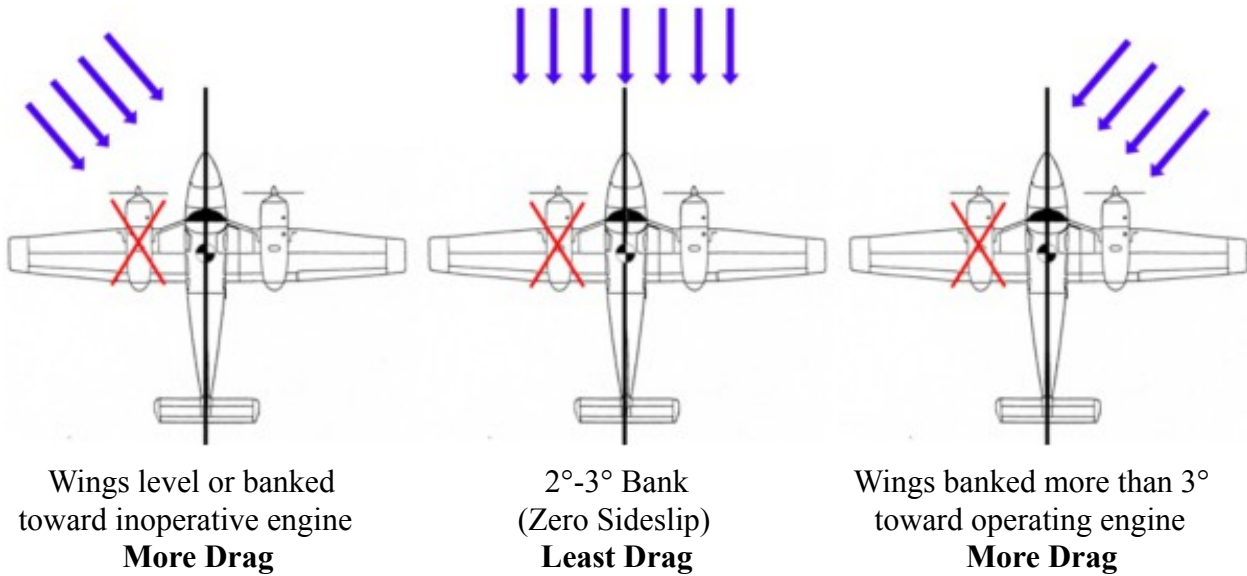
Red = Chord Line of Rudder

Blue = Direction of the Relative Wind on Rudder

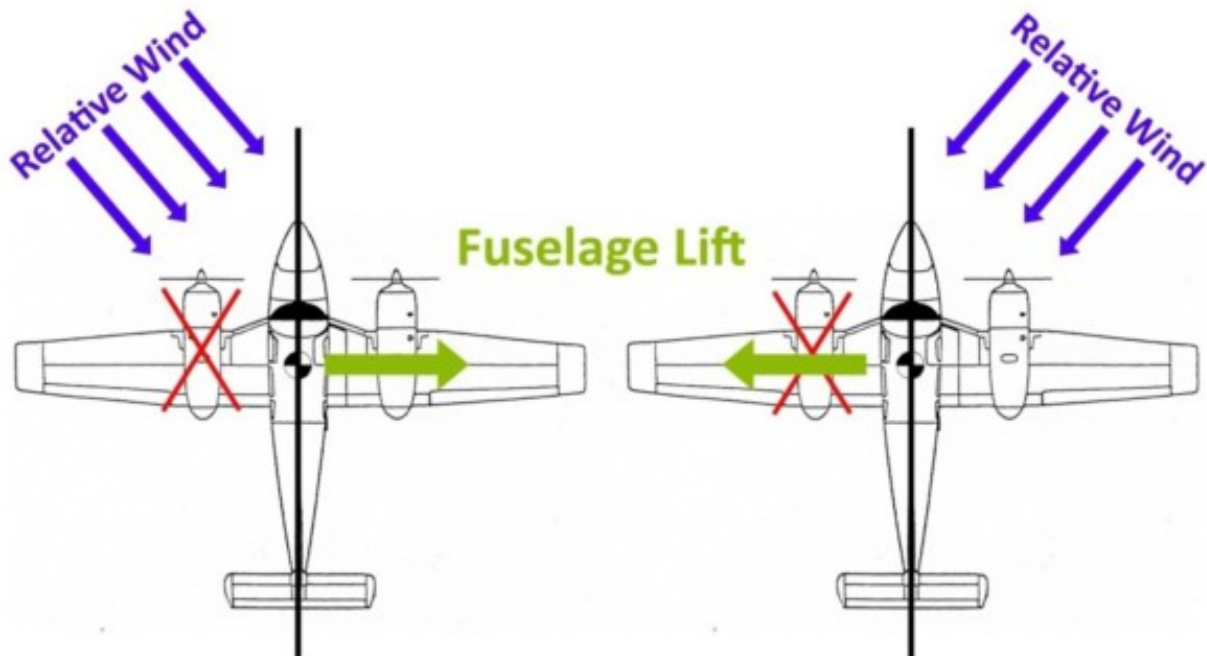
Green = Resulting Rudder Force



Anytime the relative wind is not parallel to the longitudinal axis of the airplane more drag is created.



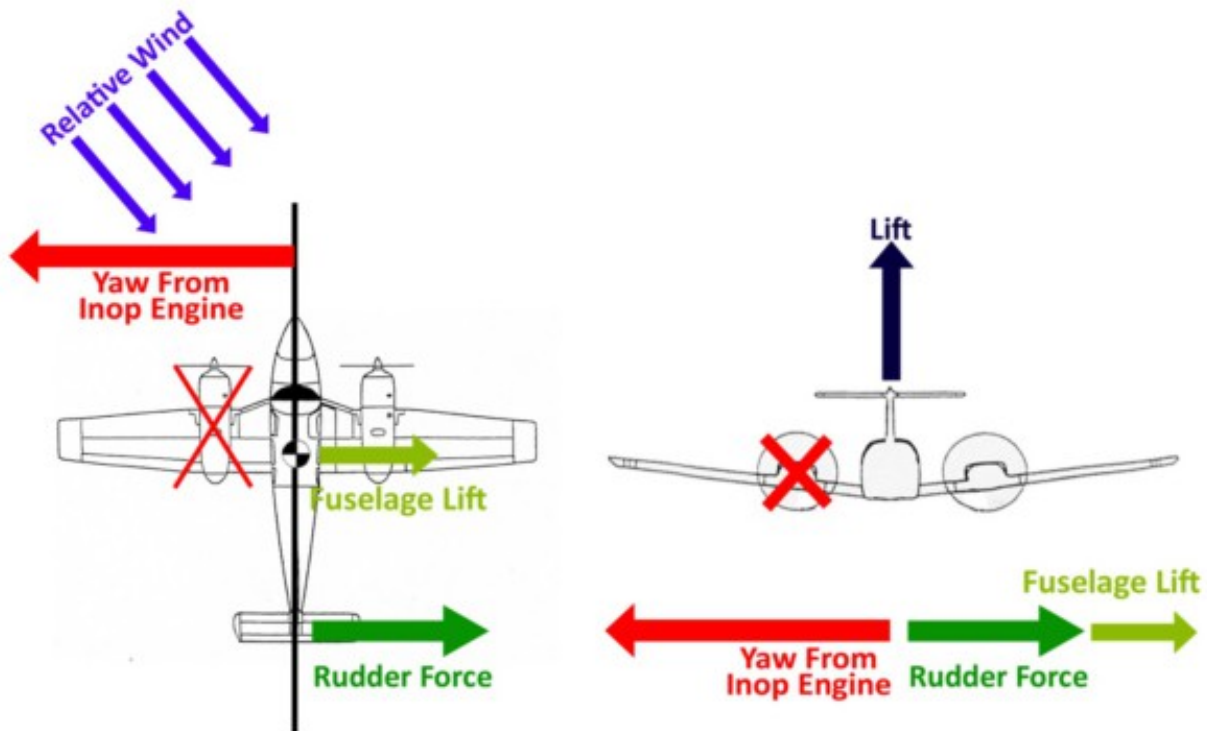
Just like the wings, the fuselage produces lift. However, the fuselage is just not as efficient at making lift as the wings. Fuselage lift is more noticeable when the relative wind is not flowing directly parallel to the longitudinal axis of the airplane.



BANK ANGLE EXAMPLES

By putting all these factors together, it is possible to see the overall effects of bank angle and how these factors affect both V_{MC} and performance. To compare the effects of V_{MC} and performance it is necessary to use a few different examples. In the following examples, the airplane is maintaining a constant heading after experiencing a failed left engine.

In this example, only the rudder is used to stop the yawing moment from the inoperative engine and the wings are kept level.

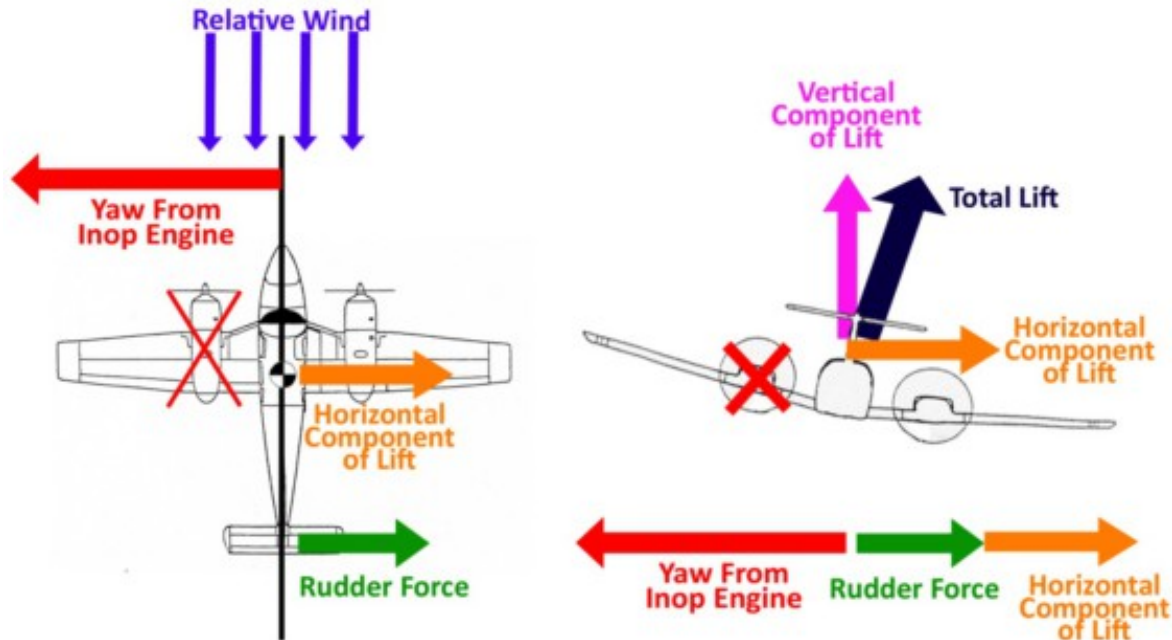


The relative wind, coming from the left of the nose, will cause the airplane to be in a slip. This causes the angle of attack on the rudder to be small and, therefore, makes it less effective.

It also creates fuselage lift in the direction opposite of the yaw from the inoperative engine. Since the angle of attack on the rudder is small, the amount of rudder required to maintain a constant heading is quite large. This makes V_{MC} a moderately high airspeed.

The slipping condition of the airplane will result in a moderate amount of drag which lowers overall performance.

In this example, both rudder and a small amount of bank are used to maintain a constant heading.



This bank angle results in a **Zero Sideslip** condition. A Zero Sideslip condition exists when the relative wind is directly parallel to the longitudinal axis of the airplane. This condition results in the minimum amount drag possible when an engine is failed.

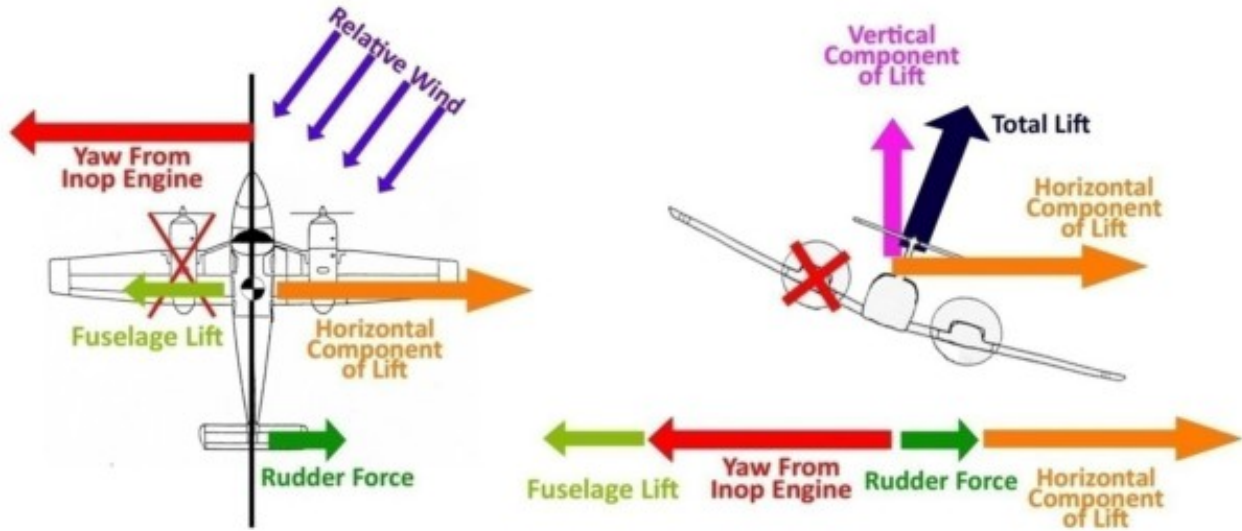
V_{MC} speed will be lower in this case (compared to 0° bank) for two reasons:

1. The angle of attack on the rudder is larger making it more effective.
2. The amount of rudder needed and used is less than in the 0° of bank scenario since it is more effective. Also, the horizontal component of lift is now helping to oppose the yaw from the inoperative engine (meaning less rudder will be required).

The result is more rudder is available to the pilot which will lower V_{MC} .

Performance will increase due to the smaller amount of drag.

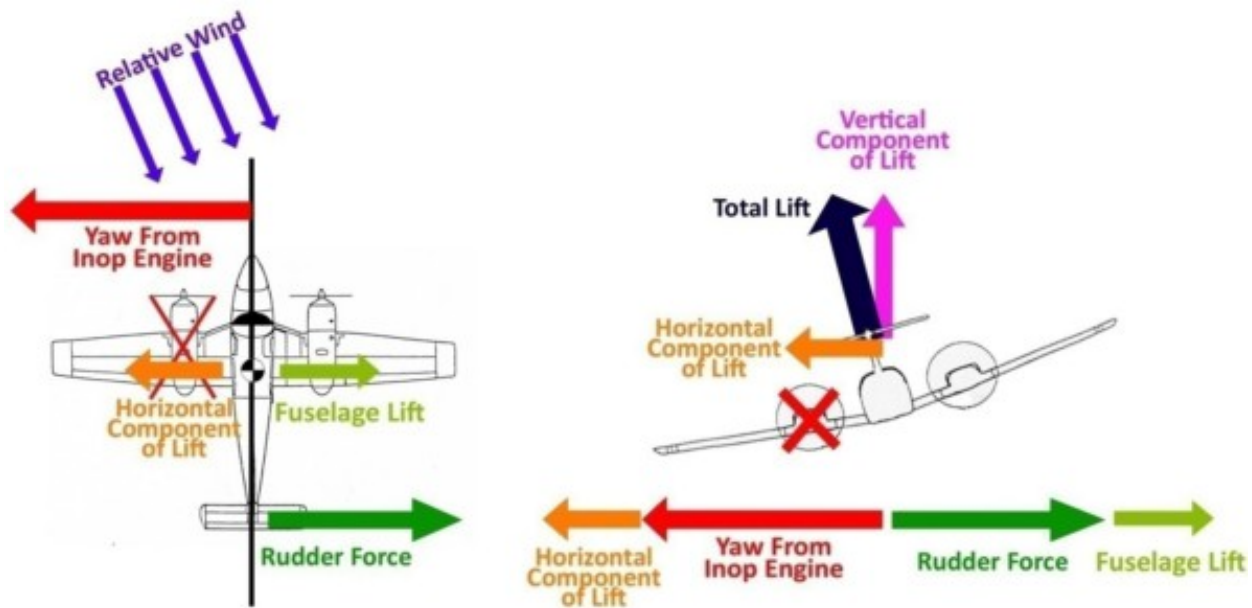
In this example, a greater amount of bank toward the operating engine is used along with a lesser amount of rudder.



The direction of the relative wind will create a large angle of attack on the rudder. This makes it more effective resulting in less rudder input needed by the pilot. Also, the greater amount of horizontal lift means that less rudder will be needed to maintain heading. This results in a lower V_{MC} .

The performance of the airplane will decrease because the angle of the relative wind will result in a slipping condition that produces a large amount of drag on the airplane.

In this example, the airplane is banked towards the **inoperative** engine.



Banking towards the inoperative engine will cause the horizontal lift from the wings to add to the yaw from the inoperative engine. The relative wind will create a fuselage lift that opposes the yaw. The angle of the relative wind with the rudder will create a small angle of attack making the rudder less effective. To maintain heading the pilot will have to use a very large amount of rudder. This increases V_{MC} significantly.

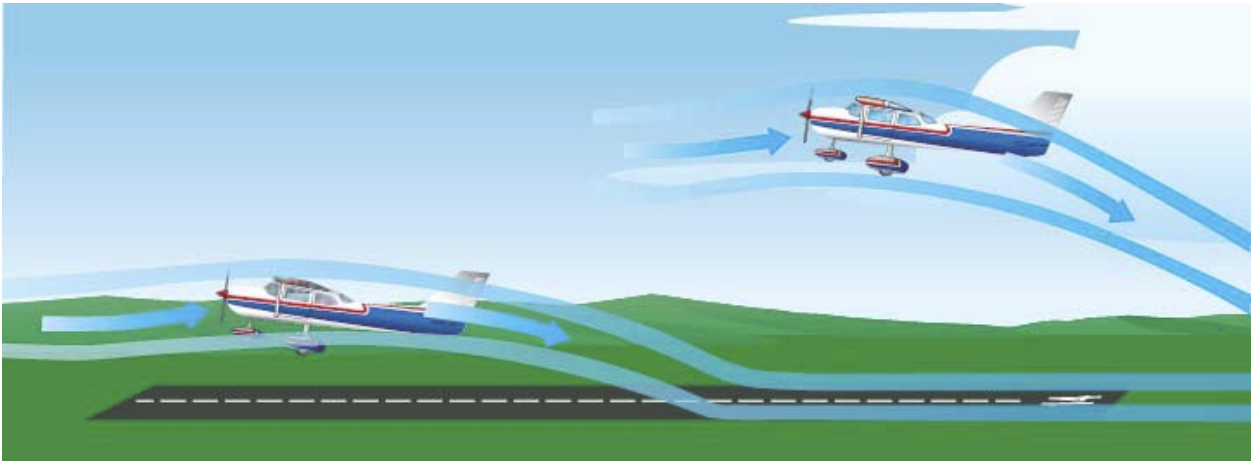
The performance of the airplane will decrease because the angle of the relative wind will result in a slipping condition and cause a large amount of drag on the airplane.

CRITICAL ENGINE FAILURE

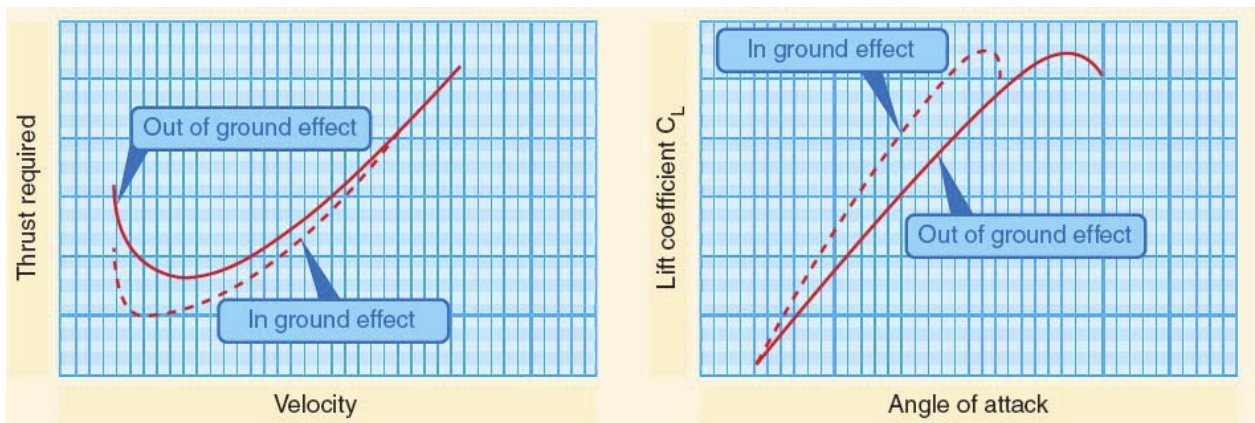
If the critical engine fails the resulting yaw and roll would be worse than if the non-critical engine had failed. The greater yaw and roll will require more rudder and control surface input to maintain directional control. The result is less rudder is available to the pilot which causes V_{MC} to increase. Performance will decrease because the greater control inputs and control surface deflection will cause a greater amount of drag to be created.

IN GROUND EFFECT

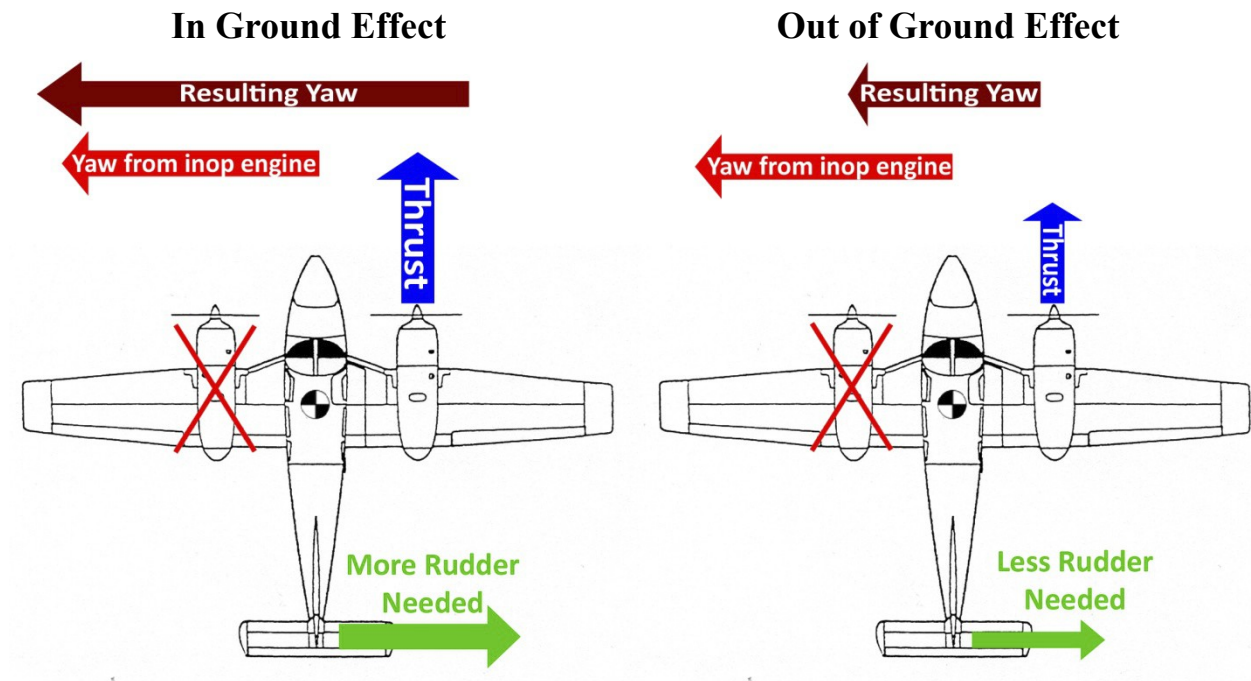
Ground effect is due to the interference of the ground surface with the airflow patterns around the aircraft in flight. As the wing encounters ground effect and is maintained at a constant amount of lift, there is a reduction in the upwash, downwash, and wingtip vortices.



The reduction in induced flow due to ground effect causes a significant reduction in induced drag, but causes no direct effect on parasite drag. As a result of the reduction in induced drag on the wings and propellers, **the thrust required at low speeds will be reduced.**



The reduction in thrust required means that the airplane will have extra thrust. The extra thrust on a good engine will cause a greater amount of yaw.



This is similar to the V_{MC} effect of power (i.e. the more yawing occurring in ground effect, requires more rudder to maintain heading). This condition increases V_{MC} .

Performance will increase in ground effect because of the reduction of induced drag.

CHART OF FACTORS AFFECTING V_{MC}

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

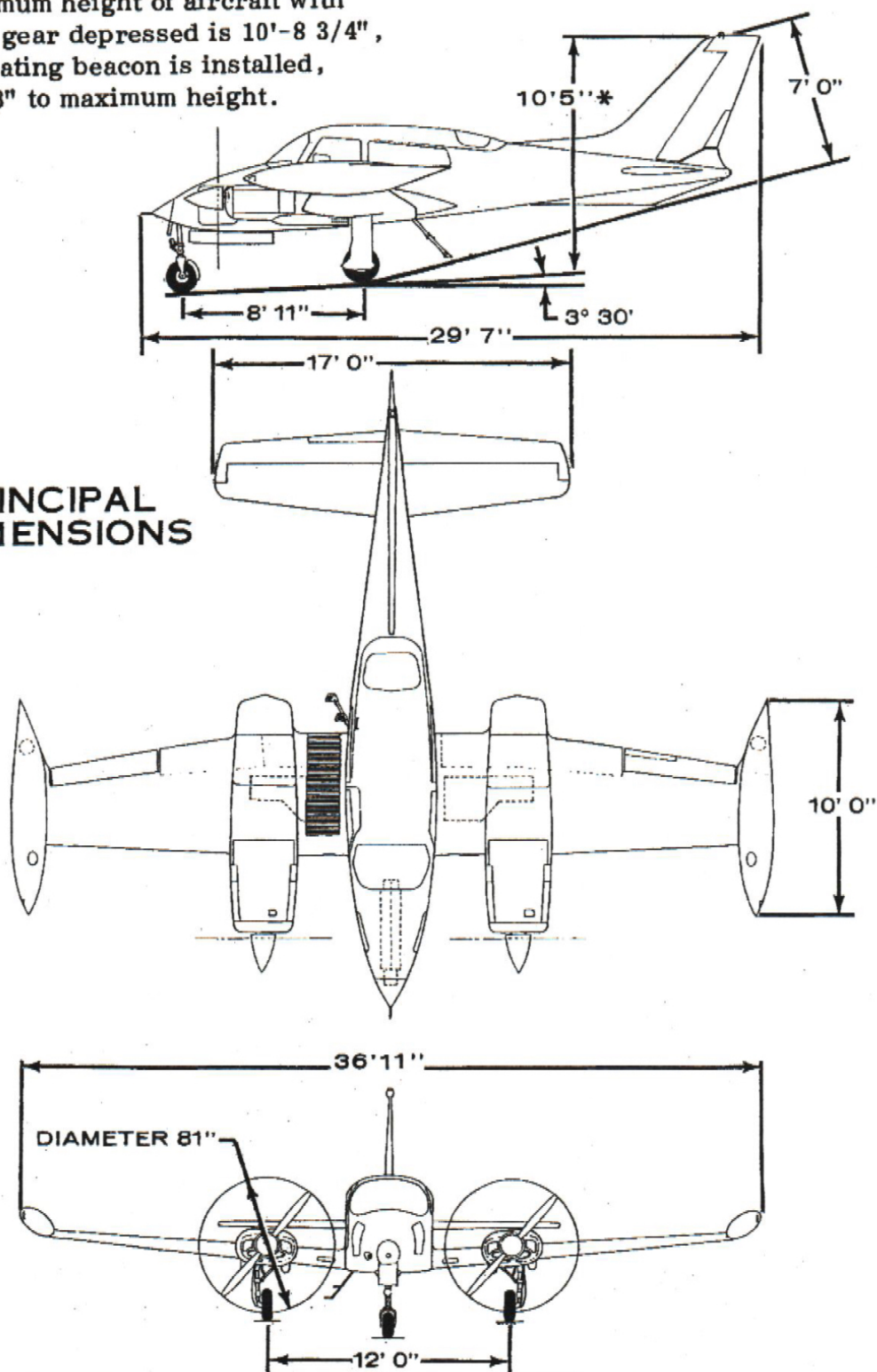
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CESSNA 310Q SYSTEMS

*Maximum height of aircraft with nose gear depressed is 10'-8 3/4", if rotating beacon is installed, add 3" to maximum height.

PRINCIPAL DIMENSIONS



PERFORMANCE AND SPECIFICATIONS

GROSS WEIGHT:	
Takeoff	5300 lbs.
Landing	5300 lbs.
SPEED BEST POWER MIXTURE:	
Maximum - Sea Level	205 Knots
Maximum Recommended Cruise	
75% Power at 6500 ft.	192 Knots
RANGE, RECOMMENDED LEAN MIXTURE:	
Maximum Recommended Cruise	
75% Power at 6500 ft.	672 Naut. Mi.
600 lbs., No Reserve	3.55 hrs.
	189 Knots
75% Power at 6500 ft.	1092 Naut. Mi.
978 lbs., No Reserve	5.77 hrs.
	189 Knots
75% Power at 6500 ft.	1359 Naut. Mi.
1218 lbs., No Reserve	7.18 hrs.
	189 Knots
Maximum Range	
10,000 ft., 600 lbs., No Reserve	834 Naut. Mi.
	5.25 hrs.
	159 Knots
10,000 ft., 978 lbs., No Reserve	1360 Naut. Mi.
	8.56 hrs.
	159 Knots
10,000 ft., 1218 lbs., No Reserve	1693 Naut. Mi.
	10.66 hrs.
	159 Knots
RATE OF CLIMB AT SEA LEVEL:	
Twin Engine	1495 fpm.
Single Engine	327 fpm.
SERVICE CEILING:	
Twin Engine	19,500 ft.
*Single Engine	6680 ft.
TAKEOFF PERFORMANCE: Takeoff Speed (78 KIAS 15° Flaps)	
Ground Run	1519 ft.
Total Distance Over 50-foot Obstacle	1795 ft.
LANDING PERFORMANCE: Approach Speed (89 KIAS, 5300 lbs.)	
Ground Roll	582 ft.
Total Distance Over 50-foot Obstacle	1697 ft.
EMPTY WEIGHT: (Approximate)	
310	3214 lbs.
310 II	3392 lbs.
BAGGAGE ALLOWANCE:	
	600 lbs.
WING LOADING:	
	29.6 lbs./sq. ft.
POWER LOADING:	
	10.2 lbs./hp.
FUEL CAPACITY: TOTAL	
Standard	102 gals.
With Auxiliary Tanks (40 gal. usable)	143 gals.
With Auxiliary Tanks (83 gal. usable)	166 gals.
With Auxiliary Tanks (63 gal. usable) and Wing Locker Tanks	207 gals.
OIL CAPACITY: TOTAL	
	6.0 gals.
ENGINES:	
Continental 6-Cylinder,	
Fuel Injection Engines	10-470-VO
250 Rated HP at 2625 RPM	
PROPELLERS:	
Constant Speed, Full Feathering,	
Two Blade (Std) 81" Diameter	D2AF34C71-L1/84JF-3
Three Blade (Opt) 78" Diameter	3AF32C87-L1/82NC-4

*Single engine service ceiling increases 425 feet for each 30 minutes of flight.

THIS OWNER'S MANUAL COVERS THE OPERATION OF 310 AND 310II AIRCRAFT SERIAL 0901 THRU 1300

FUEL SYSTEM

Fuel for each engine is supplied by a main tank (50 gallons usable) on each wing tip. Each engine has its own complete fuel system; the two systems are interconnected only by a cross-feed for emergency use. Vapor and excess fuel from the engines are returned to the main fuel tanks. Submerged electric auxiliary pumps in the main fuel tanks supply fuel for priming and starting, and for engine operation as a backup system to the engine-driven pumps. See Figure 2-2 for Fuel System Schematic and optional fuel systems paragraphs in Section VII for additional information.

NOTE

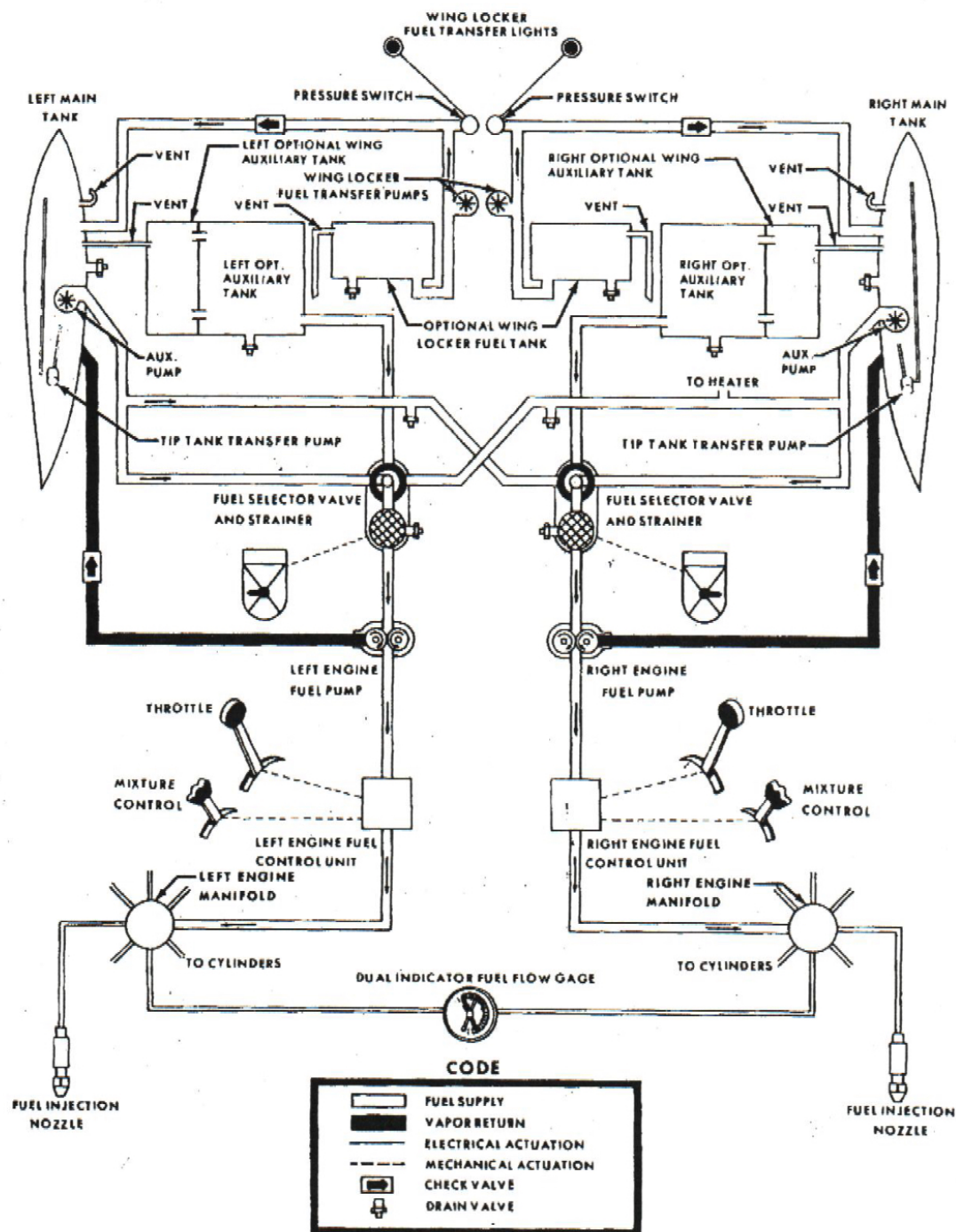
During very hot weather, if there is an indication of vapor in the fuel system (fluctuating fuel flow) or anytime when climbing above 12,000 feet, turn the auxiliary fuel pumps ON until cruising altitude has been obtained and the system is purged (usually 5 to 10 minutes after establishing cruising flight). It is recommended that the mixture remain at the climb mixture setting for approximately 5 minutes after establishing cruising flight before leaning is initiated.

A continuous duty tip tank transfer pump is installed in each main tip tank. The pumps assure availability of all tip tank fuel to the engine supply line during high angles of descent. Each pump is electrically protected by the respective landing light circuit breaker. When the right-hand landing light is not installed, a circuit breaker is installed to protect the right-hand transfer pump. During preflight inspection these pumps can be checked for operation by listening for a pulsing sound emanating from the aft tip tank fairings with the battery switch in the ON position.

FUEL SELECTOR VALVE HANDLES

The fuel selector valve placards are marked LEFT ENGINE OFF, LEFT MAIN and RIGHT MAIN for the left engine selector, and RIGHT ENGINE OFF, RIGHT

FUEL SYSTEM schematic



MAIN and LEFT MAIN for the right engine selector. The cross-feed position of each selector valve is the one marked for the opposite main tank.

The fuel selector valve handles form the pointers for the selectors. The ends of the handles are arrow-shaped and point to the position on the selector placard which corresponds to the valve position.

NOTE

- The fuel selector valve handles should be turned to LEFT MAIN for the left engine and RIGHT MAIN for the right engine, during takeoff, landing and all emergency operations.
- When fuel selector valve handles are changed from one position to another, the auxiliary fuel pumps should be switched to LOW, the mixture should be in FULL RICH and the pilot should feel for the detent to insure that fuel selector valve is properly positioned.

AUXILIARY FUEL PUMP SWITCHES

The LOW position runs the auxiliary fuel pumps at low speed, providing 36 pounds per hour fuel flow for purging. The ON position runs the auxiliary fuel pumps at low speed, as long as the engine-driven pumps are functioning. With an engine-driven pump failure and the switch in the ON position, the auxiliary pump on that side will switch to high speed automatically, providing sufficient fuel for all engine operations including emergency takeoff. The auxiliary fuel pump will not run in any position unless the engine oil pressure on that side is at least 20 PSI.

FUEL FLOW GAGE

The fuel flow gage, see Figure 2-3, is a dual instrument which indicates the approximate fuel consumption of each engine in pounds per hour. The fuel flow gage used with the Continental injection system senses the pressure at which fuel is delivered to the engine spray nozzles. Since fuel pressure at this point is approximately proportional to the fuel consumption of the engine, the gage is marked as a flowmeter.

The gage dial is marked with arc segments corresponding to proper fuel flow for various power settings and is used as a guide to quickly set the mix-

tures. The gage has markings for takeoff, climb and cruise power settings for various altitudes. The takeoff and climb markings indicate maximum performance mixtures for maximum power available for altitudes shown (2625 RPM and full throttle), making it practical to lean the mixtures on a high-altitude takeoff.

In the cruise power range, recommended lean mixtures are attained when the fuel flow pointers cover the green segment for that percentage of power. In the takeoff and climb range, each segment represents a maximum-power mixture for an altitude range; the low flow edge is the setting for the marked altitude and the high flow edge is the setting for a thousand feet lower. The sea level segment represents the range for maximum rated power at sea level.

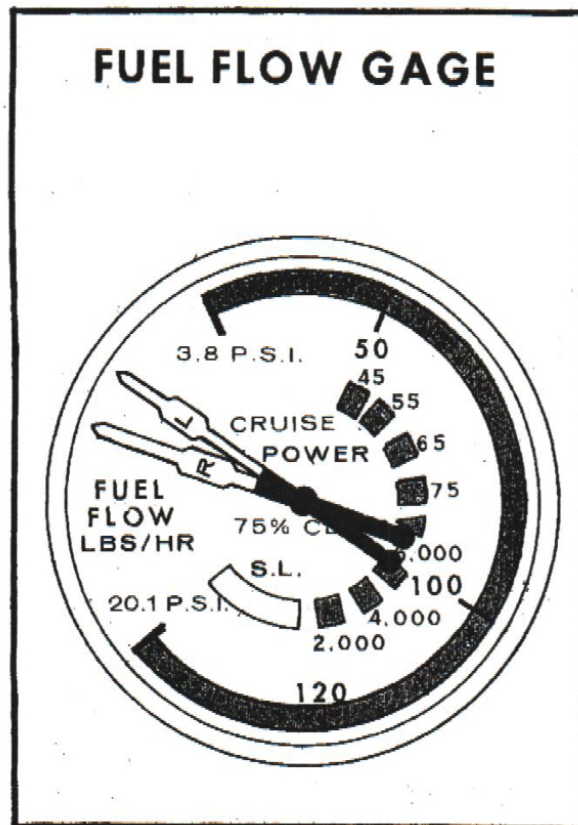


Figure 2-3

NOTE

The fuel flow settings on the takeoff and climb power segments of the dial are for 2625 RPM and full throttle, only. Climb power settings at lower RPM should be taken from your power computer.

FUEL FLOW MANAGEMENT

For normal cruise conditions, your power computer should be utilized to set the fuel flows for the recommended lean mixtures. The power computer is based on true OAT, which is obtained by subtracting the ram rise from the indicated OAT. A ram rise chart is provided in the pilot's checklist.

When range is not a primary consideration for setting the fuel flows, the Best Power Scale provided on the power computer should be used. This setting will result in a higher airspeed as well as increase the engine and component life because of the lower operating temperatures.

When the optional Economy Mixture Indicator (EGT) is provided, refer to Section VII.

FUEL QUANTITY INDICATOR

The fuel quantity indicators are calibrated in pounds and will accurately indicate the weight of fuel contained in the tanks. Since fuel density varies with temperature, a full tank will weigh more on a cold day than on a warm day. This will be reflected by the weight shown on the gage. A gallons scale is provided in blue on the indicator for convenience in allowing the pilot to determine the approximate volume of fuel on board.

FUEL STRAINER AND TANK SUMP DRAINS

See Preflight Inspection, Figure 1-1.

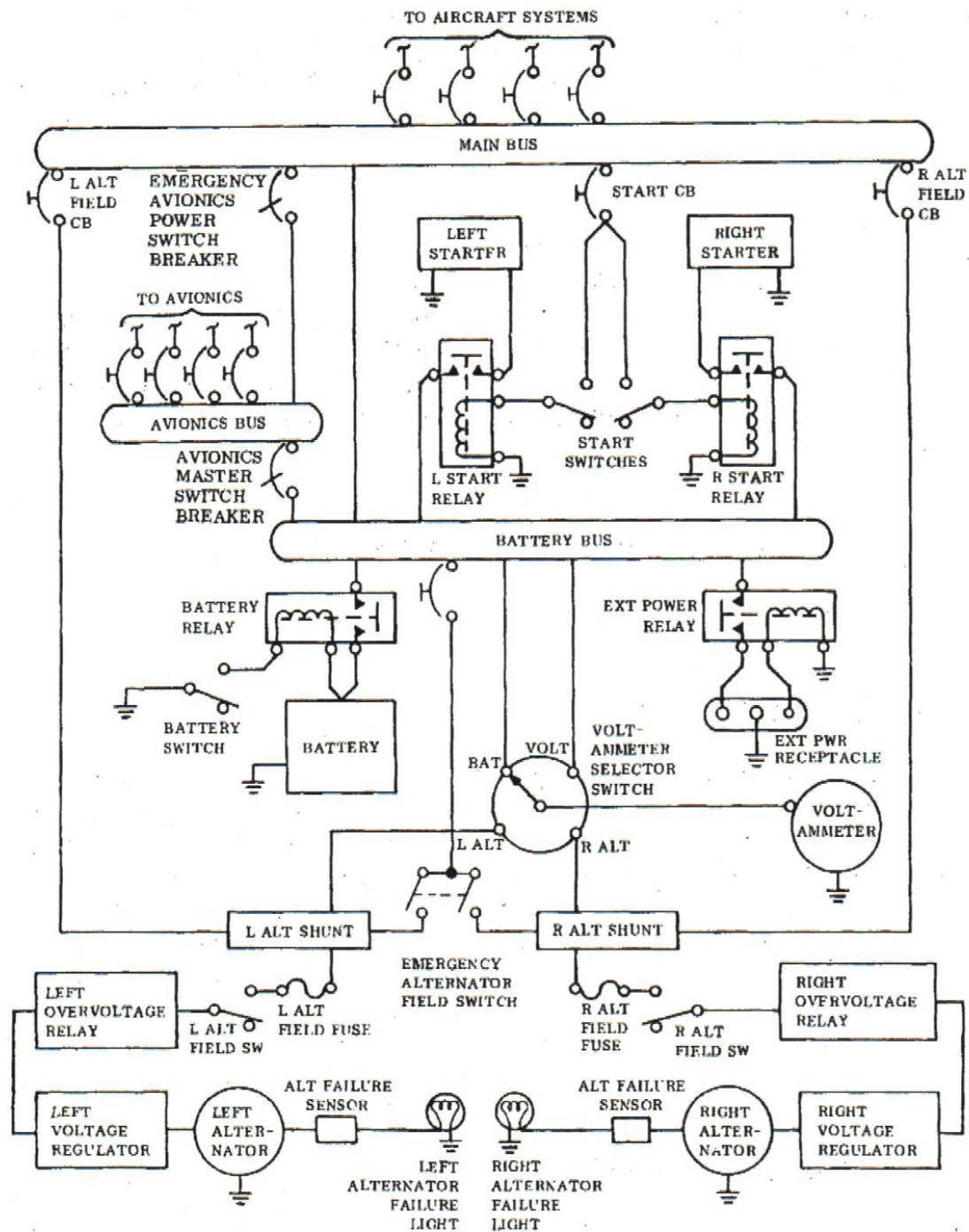
ELECTRICAL SYSTEM

Electrical energy is supplied by a 28-volt, negative-ground, direct-current system powered by a standard 50 ampere or optional 100 ampere engine-driven alternator on each engine. The electrical system has independent circuits for each side with each alternator having its own regulator and overvoltage protection relay. The voltage regulators are connected to provide proper load sharing. Two 12-volt batteries, connected in series, are located in the left wing just outboard of the engine nacelle. An optional external power receptacle can be installed in the aft nacelle fairing. The receptacle accepts a standard external power source plug. See Figure 2-4 for Electrical Power Distribution Schematic.

BATTERY AND ALTERNATOR SWITCHES

Separate battery and alternator switches are provided as a means of checking for a malfunctioning alternator circuit and to permit such a circuit to be cut-off. If an alternator circuit fails or malfunctions, or when one engine is not running, the switch for that alternator should be turned off. Operation should

ELECTRICAL POWER DISTRIBUTION SCHEMATIC



be continued on the functioning alternator, using only necessary electrical equipment. If both alternator circuits should malfunction, equipment can be operated at short intervals and for a limited amount of time on the battery alone. In either case, a landing should be made as soon as practical to check and repair the circuits.

EMERGENCY ALTERNATOR FIELD SWITCH

An emergency alternator field switch is provided in the alternator system and is located on the circuit breaker panel. The emergency alternator field switch is used when the alternators will not self excite. Placing the switch in the ON position, provides excitation from the battery even though the battery is considered to have failed.

OVERVOLTAGE RELAYS

Two overvoltage relays in the electrical system constantly monitor their respective alternator output. Should an alternator exceed the normal operating voltage, that voltage relay will trip, taking the affected alternator off the line. The voltage relay can be reset by cycling the applicable alternator switch.

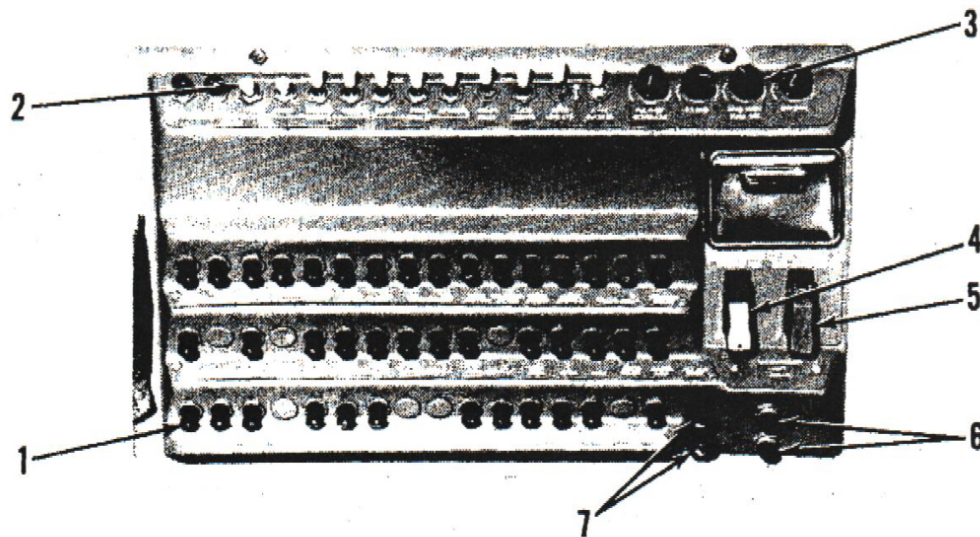
VOLTTMETER

A voltmeter, located on the instrument panel, is provided to monitor alternator current output, battery charge or discharge rate and bus voltage. A selector switch, labeled L ALT, R ALT, BAT and VOLTS is located to the left of the voltmeter. By positioning the switch to L ALT, R ALT, or BAT position, the respective alternator or battery amperage can be monitored. By positioning the switch to the VOLTS position, the electrical system bus voltage can be monitored.

CIRCUIT BREAKERS AND SWITCH BREAKERS

All electrical circuits in the aircraft are protected by push-to-reset type circuit breakers or switch breakers (except the alternator field circuit which is protected by a fuse). Should an overload occur in any circuit, the resulting heat rise will cause the controlling circuit breaker to "pop" out, opening the circuit or allowing the switch breaker to return to the OFF position. After allowing the circuit breaker to cool for approximately three minutes, it may be pushed in (until a click is heard or felt) to re-energize the circuit. However,

CIRCUIT BREAKER PANEL



- 1. SYSTEM CIRCUIT BREAKERS
- 2. SYSTEM SWITCHES
- 3. LIGHTING RHEOSTAT PANEL
- 4. EMERGENCY ALTERNATOR
FIELD SWITCH

- 5. EMERGENCY AVIONICS POWER SWITCH
- 6. LEFT AND RIGHT ALTERNATOR
CIRCUIT BREAKERS
- 7. LEFT AND RIGHT ALTERNATOR
FIELD FUSES

Figure 2-5

the circuit breaker should not be held in if it opens the circuit a second time, as this indicates a short circuit.

ROTATING BEACON

The rotating beacon should not be used when flying through clouds, fog or haze. The reflection of the rotating light beam can cause disorientation or vertigo. If optional strobe lights are installed, refer to Section VII for additional information.

LANDING GEAR SYSTEM

The electrically-operated landing gear is fully retractable and incorporates a steerable nosewheel. To help prevent accidental retraction, an automatic safety switch on the left shock strut prevents retraction as long as the weight of the aircraft is sufficient to compress the strut. The landing gear is operated by a switch, which is identified by a wheel-shaped knob. The switch positions are UP, off (center) and DOWN. To operate the gear, pull-out the switch knob and move to the desired position.

LANDING GEAR POSITION LIGHTS

Four landing gear position lights are provided, one above and three below the landing gear switch. The upper light is red and will illuminate when any or all the gears are unlocked (intermediate position). The three lower lights (one for each gear) are green and will illuminate when each gear is fully extended and locked. When the gear unlocked light and gear down lights are not illuminated, the landing gear is in the UP and locked position. The lights are push-to-test type with rotatable dimming shutters.

LANDING GEAR WARNING HORN

The landing gear warning horn is controlled by the throttles and the flap preselect handle. The warning horn will sound an intermittent note if either throttle is retarded below approximately 12 inches Hg. manifold pressure with the landing gear retracted or if the flap handle is lowered past the 15° position with the landing gear in any position except extended and locked. The warning horn can be activated by either the flap handle or by throttle position as each functions independently of the other. The warning horn is also connected to the UP position of the landing gear switch and will sound if the switch is placed in the UP position while the aircraft is on the ground.

NOTE

Do not pull landing gear warning circuit breaker to silence horn as this would also turn off the landing gear indicator lights.

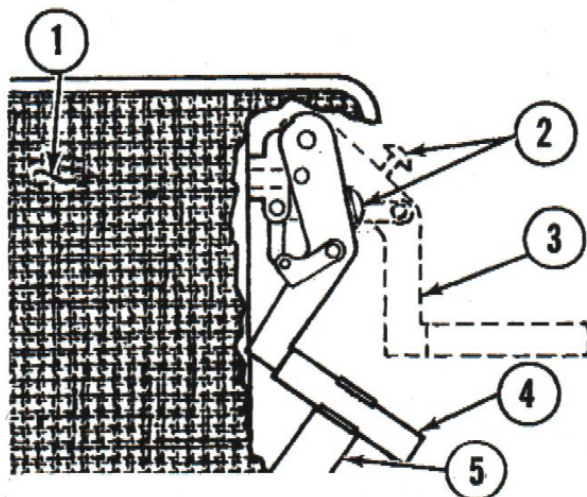
LANDING GEAR HANDCRANK

A landing gear handcrank, see Figure 2-6, for manually lowering the landing gear is located just below the right front edge of the pilot's seat. Normally the crank is folded and stowed in a clip beside the seat. To use the crank, tilt pilot's seat aft (std) or raise pilot's seat (opt), pull crank out from its storage clip and unfold it until it locks in operating position. The procedure for manually lowering the landing gear is given in Section III. To stow the crank, push the lock release button on the crank handle, fold handle and insert it in the storage clip.

NOTE

The handcrank handle must be stowed in its clip before the gear will operate electrically. When the handle is placed in the operating position, it disengages the landing gear motor from the actuator gear.

LANDING GEAR HANDCRANK



- ① PILOT'S SEAT
- ② RELEASE BUTTON
- ③ HANDCRANK (EXTENDED)
- ④ HANDCRANK (STOWED)
- ⑤ STOWAGE CLAMP

HEATING, VENTILATING AND DEFROSTING SYSTEM

A cabin heating, ventilating and windshield defrosting system, see Figure 2-7, is standard equipment in your aircraft. The system consists of an air inlet on the right side of the nose, a ventilating fan, a gasoline combustion-type heater, and controllable heat outlets in the cabin. Two outlets are located at the base of the windshield for defrosting purposes, one is located on the forward cabin bulkhead and one on each side of the forward cabin. Two additional outlets are located in the aft passenger compartment on the aft face of the main spar. Refer to Section VII for operation of the Air Conditioning System.

HEATING AND DEFROSTING

Fresh air is picked up from the front opening in the nose of the aircraft, heated by the heater, and ducted to the pilot and passenger compartments. The heat and vent air is not recirculated, but exhausts overboard through a passenger compartment air outlet.

The cabin heater depends upon the aircraft fuel system for its fuel supply. Fuel pressure is supplied by a fuel pump mounted on the heater assembly; the main fuel system auxiliary fuel pumps need not be turned on for proper heater operation.

On the ground, the cabin heating system can be used for ventilation by placing the cabin fan switch in the CABIN FAN position. The fan provides unheated, fresh air to the cabin through the cabin heat registers. In flight, the fan becomes inoperative and the heating system can be used for ventilation by placing the cabin heat switch to the OFF position, turning the cabin air knobs to OPEN, and opening the heat registers as desired.

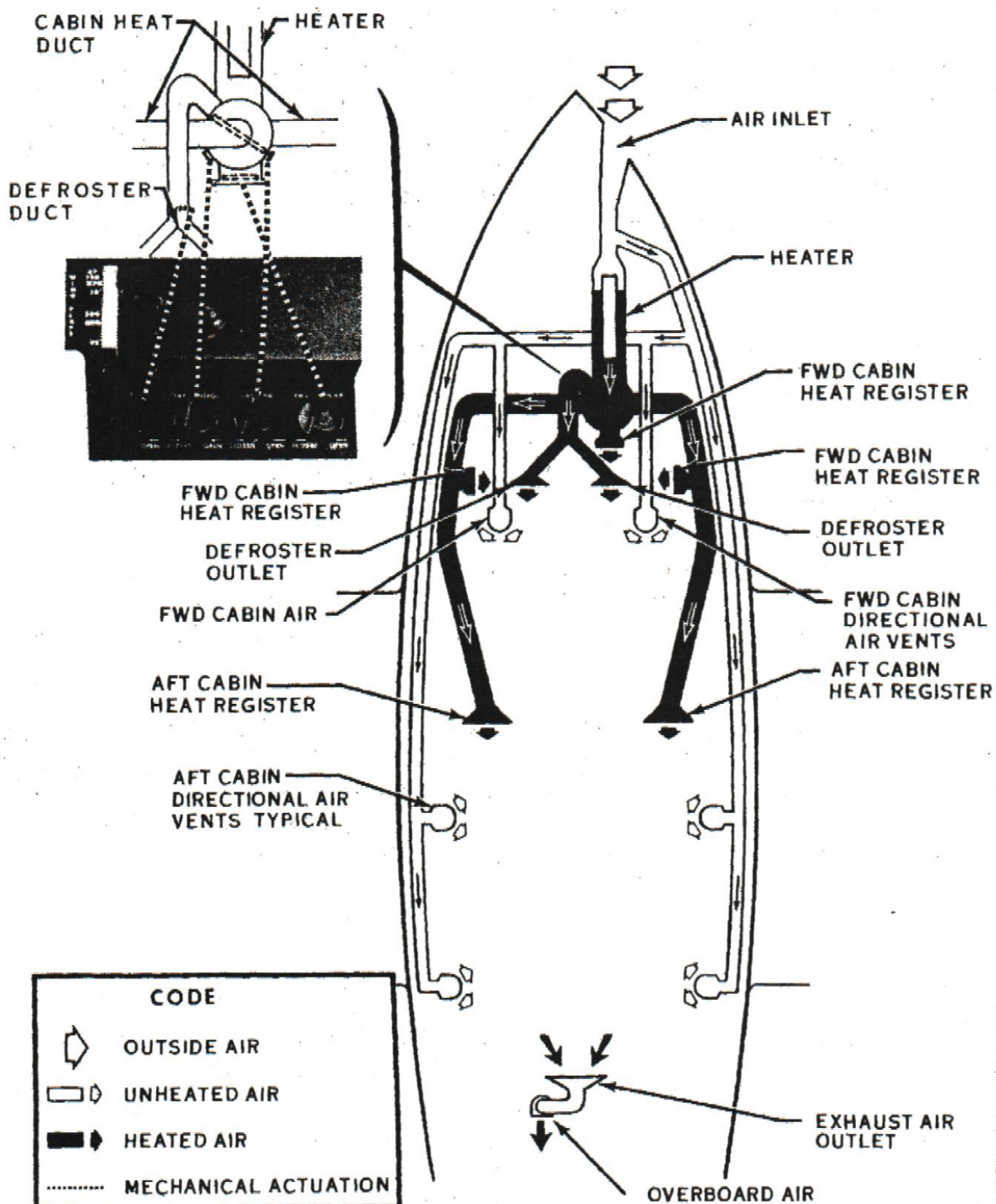
CABIN HEAT SWITCH

The cabin heat switch is a three position, center-off, toggle switch. Placing the switch in the HEAT position maintains cabin heater operation. Placing the switch in the FAN position provides ventilation for the cabin while the aircraft is on the ground.

CABIN AIR TEMPERATURE CONTROL KNOB

The cabin air temperature control knob is labeled TEMP CONTROL, CLOSED (counterclockwise position), and OPEN (clockwise position).

HEATING, VENTILATING AND DEFROST SYSTEM



Heater output is controlled by adjustment of the cabin air temperature control knob. This knob adjusts a thermostat, which in turn controls heated air temperature in a duct located just aft of the heater. When the temperature of the heated air exceeds the setting of the thermostat, the thermostat automatically opens and shuts off the heater. When the heated air cools to the thermostat setting, the heater starts again. Thus, the heater continuously cycles on and off to maintain an even air temperature. The heater also will be cycled by a thermostwitch in the cabin air duct, which shuts off the heater when the duct temperature reaches approximately 220°F. When the duct temperature drops to a normal operating level, the heater will restart automatically. The action of this switch is independent of the cabin thermostat setting, and is not adjustable in flight.

FORWARD CABIN AIR KNOB

The forward cabin air knob control directs warm air to the outlet located on the forward cabin bulkhead. This direct outlet allows fast warm-up when the aircraft is on the ground. Airflow through the direct outlet is completely shut off when the knob is turned to CLOSED. The knob may be set at any intermediate position to regulate the quantity of air to the pilot's compartment.

CABIN AIR KNOB

The airflow to all the heat registers in the passenger compartment is controlled by the CABIN AIR knob. When the knob is turned to OPEN, the air flows to the heat registers in the passenger compartment. Airflow to the heat registers is completely shutoff by turning the knob to CLOSED. The knob may be set in any intermediate position to regulate the quantity of air to the cabin.

CABIN HEAT REGISTERS

Two cabin heat registers are located on the aft side of the main spar beneath the pilot's and copilot's seats and one on each side in the forward cabin. Each register is provided with a lever operated, rotary-type valve which controls the amount of air coming from the heat registers. Each register is plainly marked for open or closed and may be placed in any intermediate position to regulate the amount of air coming from the registers.

DEFROST KNOB

Windshield defrosting and defogging is controlled by operating the knob labeled DEFROST. When the knob is turned to OPEN, the air flows from the defroster outlets at the base of the windshield. When the knob is turned to CLOSED, airflow to the defroster outlets is shut off. The knob may be set in any intermediate position to regulate the defroster airflow.

HEATER OVERHEAT WARNING LIGHT

An amber overheat warning light is provided and is labeled HEATER OVERHEAT. When illuminated, the light indicates that the heater overheat switch has been actuated and that the temperature of the air in the heater has exceeded 325°F. Once the heater overheat switch has been actuated, the heater turns off and cannot be restarted until the overheat switch, located in the right forward nose compartment, has been reset. Prior to having the overheat switch reset, the heater should be thoroughly checked to determine the reason for the malfunction.

HEATER OPERATION FOR HEATING AND DEFROSTING

- (1) Battery Switch - ON.
- (2) Cabin Air Knob - OPEN.
- (3) Defrost Knob - Adjust as desired (if defrosting is desired).
- (4) Temperature Control Knob - OPEN.
- (5) Cabin Heat Switch - HEAT.
- (6) Heat Registers - As Desired.

Cabin heated air temperature may be increased during operation in extremely cold weather by manually adjusting the defrost, forward cabin and aft cabin air controls to reduce total airflow into the cabin.

NOTE

If warm air is not felt coming out of the registers within one minute, turn cabin heat switch OFF, check circuit breaker and try another start. If heater still does not start, no further starting attempt should be made.

NOTE

During heater operation, defrost and/or cabin air knobs must be open.

HEATER USED FOR VENTILATION

- (1) Battery Switch - ON.
- (2) Cabin Air Knob - Open as desired.
- (3) Cabin Fan Switch - FAN.
- (4) Heat Registers - As Desired.

VENTILATING SYSTEM

In addition to the ventilation provided by the cabin heating system, a separate ventilation system obtains ram air from the air inlet just forward of the heater and ducts it to the directional vents. The ventilating system functions only in flight, since it depends entirely on ram air pressure. For ground ventilation, the ventilating fan of the heating system must be used.

STATIC PRESSURE ALTERNATE SOURCE VALVE

A static pressure alternate source valve, installed in the static system, directly below the parking brake handle, supplies an alternate static source should the external source malfunction. This valve also permits draining condensate from the static lines. When open, this valve vents to the static pressure in the cabin. Since this pressure is relatively low, the airspeed indicator and the altimeter will show slightly higher readings than normal. Therefore, the alternate static source should be used primarily as a drain valve to restore the original system. If the alternate static source must be used during flight increase indicated airspeeds approximately 10 knots and altitudes approximately 80 feet. Consult the pilot's checklist for an accurate calibration. If the dual heated pitot system is installed with or without the weather radar refer to Section VII for airspeed calibrations.

PITOT HEAT SWITCH

When the pitot heat switch is placed in the ON position, the heating element in the pitot tube, stall warning transmitter and the main fuel tank vents are

electrically heated to maintain proper operation of the system during icing conditions. The switch should always be in the OFF position while on the ground to prevent overheating of the heating elements.

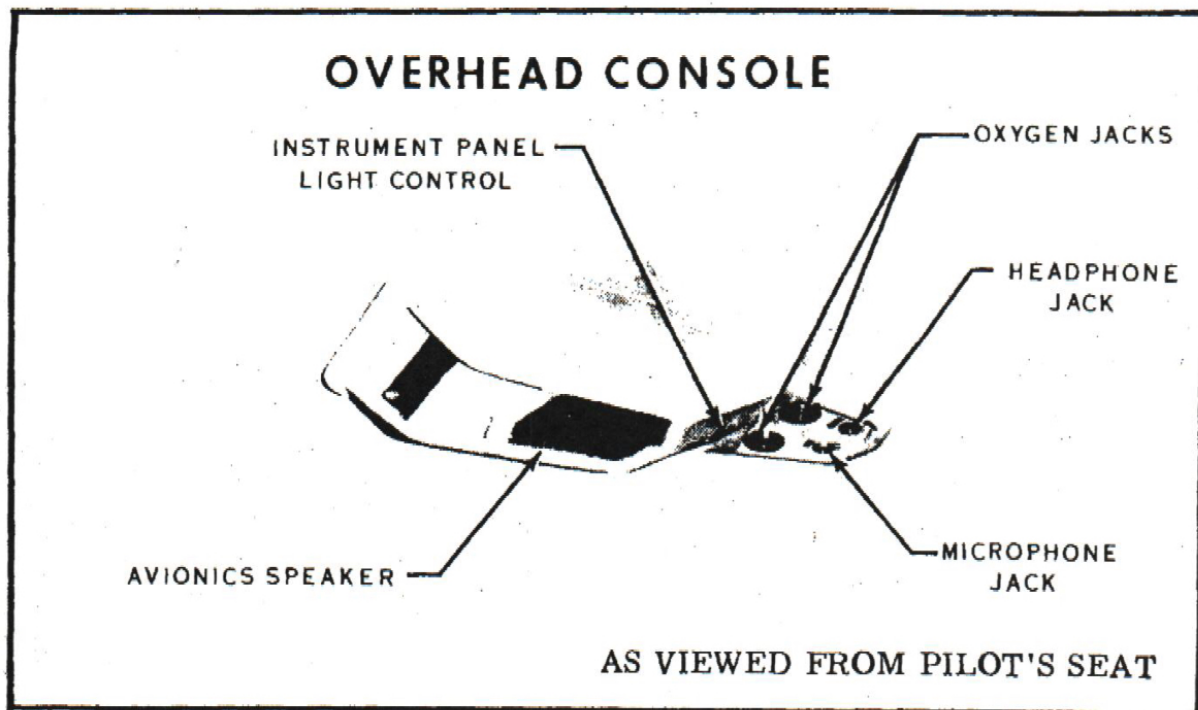
With optional systems installed, actuation of the pitot heat switch also anticipates the wing locker tank fuel vents, angle of attack lift sensor vane, dual pitot heads and dual static sources.

EMERGENCY EXIT

For emergency exit, the pilot's window (left side) can be jettisoned. Pull off the plastic cover over the emergency release ring under the window and pull the ring to release the window retainers, then push the window out.

OVERHEAD CONSOLE

The overhead console, see Figure 2-8, includes the instrument panel light and control, avionics speaker, headphone jack, microphone jack, and individual pilot and copilot oxygen jacks.



System Description

Airframe

The Cessna 310 is a 6-place, all metal, low-wing airplane. The wing uses 2 main spars which attach to the carry-thru spars. The retractable landing gear is a tricycle design using air-over-oil shock struts.

Flight Control System

The flight controls consist of the ailerons, elevators and rudder and their respective trim systems. All of these surfaces are constructed of aluminum and are statically mass balanced. All control surfaces are actuated by cables attached to the pilot's control wheel respective rudder pedals. Also the trim tabs on the control surfaces are actuated by cables attached to trim wheels on the control pedestal.

Nosewheel Steering System

The nosewheel is controlled by the rudder pedals which are connected to the nose wheel steering system via cables and a bungee spring assembly. This system provides positive control up to 18° left or right, and free turning from 18° to 55° for sharp turns during taxiing.

Wing Flaps System

The wing flaps are of split flap design. Each wing flap (two on each side) is actuated by two push-pull rods attached to bell cranks in the wing. The bell cranks in each wing are ganged together with push-pull rods. Each inboard rod is attached to a cable which is actuated by an electric motor in the fuselage. The maximum extension is 35°.

Landing Gear System

The landing gear is a fully retractable tricycle landing gear consisting of a main gear located in each wing and a nose gear in the forward fuselage. Each landing gear is connected to a single gear box located aft of the pilot's seat. The gear box is driven by an electric motor attached to the box. During ground operation, accidental gear retraction is prevented by a safety switch located on the left gear strut preventing retraction as long as the strut is compressed by the weight of the aircraft. The gear doors are mechanically linked to their respective landing gears.

Below the landing gear actuating knob are 4 position indicator lights. Three of them are green and will illuminate when the gear is down and locked. The other light is red and will illuminate when any or all of the gears are unlocked. When no light is illuminated the gear is in the UP and locked position.

The landing gear warning horn is controlled by the throttles and the wing flap position. The horn will sound when the throttles are retarded below approximately 12" MAP or the flaps are lowered past the 15° position with gear retracted.

The horn will also sound when the airplane is on ground with the gear switch in the UP position.

The landing gear can be manually lowered by a handcrank located below the right front edge of the pilot's seat.

To use the crank, tilt pilot's seat aft, pull the crank out of its storage clip and unfold it until it locks in the operating position. The procedure to lower the gear manually is given in the emergency checklist (section 3 Pilots operating handbook). To stow the crank, push the lock release button on the crank handle, fold the handle and insert it in the storage clip. When the handle is not stored, the gear will not operate electrically.

Fuel System

The fuel system consists of two main tanks, two auxiliary tanks, fuel selectors for selection of main, auxiliary or crossfeed fuel, two auxiliary fuel pumps and two engine driven pumps.

The main tanks are aluminum tanks mounted on the wing tips. Each tank contains an auxiliary fuel pump and transfer pump. The auxiliary pump provides fuel pressure for starting the engines and supplies fuel in an emergency. The transfer pump transfers fuel from the nose section of the tank to the center sump, where it is picked up and routed to the engine. The transfer pump allows steep descents with low fuel quantity and are operating continuously when the battery switch is on.

The auxiliary tanks are bladder type cells located in the outboard wings. These tanks provide fuel supply during cruise operation. the auxiliary tanks are vented to the main tanks.

Two fuel selectors, one for each engine, are located on the floor between the pilot's and copilot's seat. The selectors allow selection of main fuel, auxiliary fuel, crossfeed and shut off.

Quick drain valves are provided for each fuel tank, fuel selector and crossfeed line.

Each engine is equipped with a mechanically driven fuel pump which provides fuel to the metering unit. Each pump also contains a bypass which returns excess fuel and vapor back to the main tanks all the times.

Each auxiliary fuel pump on the main tank is operated by a 3-position switch. In the LOW position, the pump operates at low speed, providing adequate fuel flow for purging. The ON position runs the auxiliary pump at low

speed as long as the engine driven pump is operating. With an engine driven pump failure the auxiliary pump will then automatically switch to high speed, providing sufficient fuel for all partial power operations.

The dual indicating fuel quantity gage is calibrated in pounds and will accurately indicate the weight of fuel contained in the tanks, regardless of temperature. A gallons scale is provided in blue on the indicator allowing the pilot to determine the approximate volume of fuel on board.

The fuel gage shows remaining fuel in the tank selected on the fuel selector. When one fuel selector is switched to the auxiliary tank, the gage will show remaining fuel in this tank and a yellow auxiliary tank indication light will illuminate. With a 3-position switch, adjacent to the auxiliary tank indicator lights the fuel gauge can be switched to each tank regardless of the position of the fuel selectors.

Additionally to the fuel gages two low fuel indicator lights will provide a warning when the left/right main tank contains less than approximately 60 pounds of fuel. These lights are operating independently from the other fuel gages.

Brake System

The airplane is provided with an independent hydraulically actuated brake system for each main wheel. A hydraulic master cylinder is attached to each pilot's rudder pedal. The brakes can be operated from each pilot's seat.

The parking brake is set with depressing the brake pedals and pulling the parking brake knob. To release the parking brake push the parking brake handle in.

Electrical System

Electrical Energy is supplied by a 28-volt, negative ground, direct current system powered by an 100 ampere alternator on each engine. The electrical system has independent circuits for each side with each alternator having its own regulator and overvoltage protection relay. The voltage regulators are connected to provide proper load sharing.

A 24-volt battery is located in the left wing outboard of the engine nacelle.

Separate battery and alternator switches are provided as a means of checking for a malfunctioning alternator circuit and to permit such a circuit to be turned off.

An emergency alternator field switch is located on the right side of the switch and circuit breaker panel. The switch is used when the alternators will not self-excite. Placing the switch in the on position provides excitation from the battery even though the battery is considered to have failed.

Two overvoltage relays constantly monitor their respective alternator output. Should an alternator exceed the normal operating voltage, the relay will trip, taking the alternator off the line. The overvoltage relay can be reset by cycling the applicable alternator switch.

A voltmeter on the instrument panel is provided to monitor alternator current output, battery charge and bus voltage.

A low voltage light will illuminate when the bus voltage decreases below 25 volts.

Pitot Static System and associated Flight Instruments

A heated pitot tube is located on the left side of fuselage nose cap. Static pressure ports are on both sides of the fuselage behind the cabin. An alternate static source, installed in the static system below the parking brake handle, supplies an alternate static source should the external static source malfunction. When open, this valve vents to the pressure in the cabin. Since this pressure is relatively low, the airspeed indicator and the altimeter will show slightly higher readings than normal. Refer to section 5 of the pilot's operating handbook for airspeed and altimeter corrections.

The pitot static system is connected as in any other light airplane: Static pressure is connected to altimeter, vertical speed and airspeed indicator, the pitot tube is connected to the airspeed indicator.

Vacuum System

The vacuum system is powered by two engine driven vacuum pumps. The suction gage incorporates two red source indicator buttons, which during normal operation are retracted from view. Should a vacuum pump fail the respective indicator button will be visible. The malfunctioning vacuum pump is automatically isolated from the system, the second pump will provide enough suction to operate the system.

The vacuum powered flight instruments are the horizontal situation indicator and the attitude indicator.

Stall Warning System

A stall warning system is required equipment which consists of a stall warning transmitter vane located in the outboard wing leading edge, a cockpit warning horn and the necessary wiring to complete the system. The stall warning horn will sound about 4 to 9 KCAS above the actual stall in all flight configurations.

Engines

The airplane is equipped with two, 6-cylinder, fuel-injected engines. Each engine is rated at 285 horsepower at 2700 RPM. The control pedestal contains all engine controls. The three primary engine controls are in groups of two at the top of the pedestal, they are throttles, propeller controls and mixtures. A quadrant friction lock is provided to prevent the three primary engine controls from creeping once they have been set. The locking knob is located on the right side of the pedestal. Two cowl flap controls are located just below the rudder trim tab wheel; one for each engine. These controls are used to set the cowl flaps in any desired position. An alternate air control is provided for each engine. These mechanically actuated controls are located on the right side of the control pedestal. Normally the controls are pushed in, providing cold filtered ram air to the engines. When the controls are pulled out, warm unfiltered air from inside the cowling is provided to the engines. Each engine is equipped with a dual ignition system. Fuel is supplied to the engine using a low pressure injection system. The fuel is injected into the cylinder heads adjacent to the intake valve on all cylinders. Manual mixture controls, fuel flow gauges and exhaust gas temperature gauges are provided for precise leaning.

Propellers

The airplane is equipped with all-metal, three-bladed, constant speed, full feathering, single-acting, governor regulated propellers. Each propeller utilizes oil pressure which opposes the force of springs and counterweights to obtain correct pitch for engine load. Oil pressure from the governor drives the blade angle toward low pitch (increasing RPM) while the springs and counterweights drive blades toward high pitch (decreasing RPM) and the feather position. The propeller blades are continuously adjusted by the governor, which boosts the engine oil pressure by the governor gear pump to the level needed to control blade angle. The props are fail safe toward feather, and loss of oil pressure will cause them to feather. This would also cause them to feather on engine shut down on the ground, which would cause excessive stress and vibration during engine start. To prevent this, the propeller hubs incorporate centrifugal latch pins, which at an RPM below 700 engage the hub mechanism and prevent feathering. Above 700 RPM the latch pins are retracted by centrifugal force. The latches will not prevent feathering after an engine failure in flight, because airflow through the propeller will keep its RPM well above 700. To feather the propeller blades, the propeller control levers on the control pedestal must be placed in the feather position (full aft).

The synchrophaser system is designed to match propeller RPM and propeller phase angle of the two engines. The propeller RPM and phase angle of the slaved (left) engine will follow changes in RPM and phase angle of the master (right) engine over a limited range. This limited range will prevent the left engine from losing more than 50 RPM should the right engine be feathered with the synchrophaser on. To set the synchrophaser system the propellers must first be synchronized manually. Then the synchrophaser is switched to SYNC, in this mode it is maintaining the RPM of both propellers the same. In the phase mode, the phase angle between the propeller blades of the left and right engine can be adjusted by using the rheostat. The phase position should only be used in level cruising flight in smooth air. The synchrophaser light is illuminated all the time when the propellers are synchronized. If the difference of both engines exceeds 50 RPM the light starts flashing.

Propeller Deice System

The propeller deice system consists of electrically heated boots on the propeller blades. Each boot consists of an inner and outer heating element, which receives its electrical power through a deice timer, to reduce the power drain and maintain propeller balance. A reading below the green arc on the propeller deice ammeter indicates that the blades are not being deiced uniformly. The system then has to be turned OFF, since uneven deicing results in propeller unbalance and can cause an engine failure. Energizing the propeller anti-ice before entering icing conditions will prevent ice build up which will be thrown off and can chip the fuselage.

Deice Boot System

This system is designed to remove ice after accumulation. The system consists of pneumatically operated boots, engine-driven pneumatic pumps, push switches with annunciator light and necessary hardware to complete system. The deice boots are attached to the leading edges of the wing and horizontal stabilizers. The boots expand and retract, using pressure and vacuum from the engine-driven vacuum pumps. Normally, vacuum is applied to all boots to hold them against the leading edge surfaces. When a deicing cycle is initiated, the vacuum is removed and a pressure is applied to "blow up" the boots. This change in contour will break the ice accumulation on the leading edges. Ice formation aft of this area will then be removed by normal air forces. At least 1/4 inch (6 mm) of ice accumulation is necessary for good deicing results. If used too early the ice is shaped to the contour of the inflated boots and deicing will become impossible. To activate the system just press the "PUSH ON" switch, the system will then execute one deice cycle. If the boots fail to deflate automatically press the deflate switch.

Despite the heated propellers and the deice boots this aircraft is not certified for flight into known icing.

Oxygen System

The oxygen system provides oxygen for each occupant individually up to an altitude of 30,000 feet. The oxygen is stored in a 76 cubic foot bottle located in the nose compartment. The system is activated by pulling the oxygen control knob to the ON position, allowing oxygen to flow from the regulator to all cabin outlets. The valve in the outlets is normally closed it is opened by inserting the connector of the mask. Permit no smoking when using oxygen. Oil grease, soap, lipstick, lip balm or any other fatty material constitute a serious fire hazard when in contact with oxygen. Be sure hands and clothing are oilfree before handling oxygen equipment. Be sure the oxygen control knob is not left in an intermediate position between ON and OFF, it may allow oxygen to bleed through the regulator into the nose compartment of the airplane.

400B Integrated Flight Control System (Autopilot)

The Cessna 400B Integrated Flight Control System (IFCS) provides a capability of automatic flight control or manual control with precision flight direction provided by computed command information. The complete presentation for the system is displayed on the flight director indicator (FDI), the mode selector and the horizontal situation indicator (HSI). Operation of the manual and automatic system is basically the same. the difference is whether the pilot follows the flight director commands or allows the autopilot to fly the airplane.

Precision flight direction information for manual control is provided on the FDI. The pilot flies the airplane to satisfy the two command bars, thus following the calculated flight path determined by the computer.

The HSI displays a pictorial presentation of the airplane's position relative to VOR radials, localizer and glide slope beams. The HSI also gives heading reference with respect to magnetic north and provides selection of the desired heading, VOR radials and LOC runway heading.

The autopilot is activated with the ON/OFF switch on the autopilot control head. Pitch and roll manual command controls are also located on these control head. All other normal modes of flight are controlled from the mode selector on the left side in the instrument panel.

An automatic autopilot disengage function is provided to disengage the autopilot any time the airplane pitches up or down more than a normal amount from level flight attitude. The operational capability should be tested by pressing the autopilot disconnect test button before takeoff. Do not press this button in flight, the airplane will pitch up sharply and the autopilot will disconnect.

The autopilot off (A/P OFF) light located adjacent to the FDI, will illuminate when the autopilot is disengaged by any means other than the control wheel disengage switch. Whenever the autopilot disengages the autopilot warning horn will sound. The A/P OFF light will remain on until it is cancelled by pressing the control wheel autopilot disengage switch.

Maneuvers

Engine Runup (should be committed to memory)

- | | |
|-----------------------|--|
| 1. Brakes | SET |
| 2. Throttles | 1700 RPM |
| 3. Alternators | CHECK |
| 4. Vacuum System | CHECK 4.75 to 5.25 inches HG |
| 5. Magnetos | CHECK 150 RPM maximum drop, with a maximum differential of 50 RPM |
| 6. Propellers | CHECK feathering; return to high RPM
(Do not allow RPM to fall below 1000 RPM!) |
| 7. Engine Instruments | CHECK green arc |
| 8. Throttles | 1000 RPM |

Normal Takeoff

- | | |
|---|---|
| 1. Wing Flaps | UP |
| 2. Smoothly apply Power to | FULL THROTTLE and 2700 RPM |
| 3. Mixtures | LEAN for field elevation (see Figure 5-27) |
| 4. Engine Instruments | CHECK |
| 5. Air Minimum Control Speed | 80 KIAS |
| 7. Elevator Control | Raise Nosewheel at 83 KIAS |
| 8. Lift-Off | 92 KIAS (ref. to Section 5 for speeds at reduced weight) |
| 9. When positive Rate-of-Climb and out of usable Runway | APPLY BRAKES and GEAR UP |
| 10. Airspeed | ACCELERATE to 107 KIAS (best Rate-of-Climb ME) |
| 11. At or above 500 ft AGL | Undercarriage up (check no lights)
Power to 24.5 ins.MAP/2500 RPM
Switches - Auxiliary Fuel Pumps OFF |
| 12. Mixtures | LEAN (see Figure 5-27) |
| 13. Cowl Flaps | AS REQUIRED |

Maximum Performance Takeoff (Short Field Takeoff)

- | | |
|--|---|
| 1. Wing Flaps | 15° |
| 2. Foot Brakes | APPLY and HOLD |
| 3. Smoothly apply Power to | FULL THROTTLE and 2700 RPM |
| 4. Mixtures | LEAN for field elevation (see Figure 5-27) |
| 5. Engine Instruments | CHECK |
| 6. Brakes | RELEASE |
| 7. Air Minimum Control Speed | 80 KIAS |
| 8. Elevator Control | Raise Nosewheel at 70 KIAS |
| 9. Lift-Off | 82 KIAS (ref. to Section 5 for speeds at reduced weight) |
| 10. When positive Rate-of-Climb and out of usable Runway | APPLY BRAKES and GEAR UP |
| 11. Airspeed | ACCELERATE to 85 KIAS (best Angle-of-Climb ME) |
| 12. After clearing obstacle | ACCELERATE to 107 KIAS (best Rate-of-Climb ME) and WING FLAPS UP |
| 13. At or above 500 ft AGL | Undercarriage up (check no lights)
Power to 24.5 ins.MAP/2500 RPM
Switches - Auxiliary Fuel Pumps OFF |
| 14. Mixtures | LEAN (see Figure 5-27) |
| 15. Cowl Flaps | AS REQUIRED |

Normal Landing

1. Descent Checklist complete before entering traffic pattern
2. Throttles 19" MAP
3. Propellers 2200 RPM
4. Speed REDUCE TO MAX. 158 KIAS
5. Wing Flaps 15°
6. Speed REDUCE TO MAX. 138 KIAS
7. By Midfield on Downwind
GAS - MAIN TANKS
UNDERCARRIAGE - DOWN
MIXTURES - AS REQUIRED
POWER - 19" MAP/2200 RPM
SWITCHES - PUMPS ON
8. Abeam Touchdown Point
THROTTLES - 17" MAP
SPEED - 110 KIAS
CONFIRM - 3 GREEN LIGHTS
9. Final Approach
Wing Flaps - FULL DOWN
Trim to 93 KIAS
10. Short Final
Propellers - FULL FORWARD
Mixtures - RICH
RECHECK - 3 GREEN LIGHTS
11. Touchdown
ON MAINWHEELS FIRST
12. After Clear of Runway
Auxiliary Pumps - LOW
Cowl Flaps - OPEN
Wing Flaps - UP
Cabin Heater - SWITCH to FAN

Short Field Landing (Runway 08 Approach at Michelstadt)

1. Normal Procedures until Final
2. Final Approach
Wing Flaps - Full Down
Trim to 82 KIAS at 4200 lbs.
increasing to 93 KIAS at 5400 lbs. (see Fig. 5-26)
Hold Airspeed with trim and correct sink-rate with power!
You are on approach-slope, when the tree-tops are aligned with the runway-threshold!
3. Short Final Check
Before reaching the tree-line
4. Over the Obstacle (Trees)
Clear Trees with about 10 feet or less
IMMEDIATE THROTTLES TO IDLE
SLIGHTLY lower the nose until in GROUND-EFFECT
then start to FLARE-OUT.
5. Touchdown
With Mainwheels first AT THE THRESHOLD, don't let the airplane float into the runway.
Apply brakes smoothly and evenly when airplane has firmly settled down on the runway. **DO NOT LOCK THE BRAKES!**
Because of the downhill slope of the last third of the runway, you can not see the end. You can guess the remaining runway length by watching the yellow mid-runway markings.
6. After Clear of Runway
Normal after Landing Check

Balked Landing

1. Increase engine speed to 2700 RPM and apply full throttle if necessary.
2. Mixtures - AS REQUIRED for balked landing power setting.
3. Balked Landing Transition Speed - 85 KIAS
4. Landing Gear - RETRACT when positive Rate-of-Climb is established.
5. Wing Flaps - 15°
6. Trim airplane for climb.
7. Cowl Flaps - OPEN
8. Wing Flaps - UP as soon as all obstacles are cleared and a safe altitude and airspeed are obtained.

In the practical flight test the applicant has to show some or all of the following maneuvers:

As the Practical Test Standards (PTS) demand all maneuvers have to be completed not lower than 3000 feet AGL. Before executing any maneuver CLEAR THE AREA for other traffic!

Power on Stall (Climb Configuration)

1. Stabilize in **Normal Climb** or at **Approach Cruise**
2. Apply climb power (24.5" MAP/2500 RPM)
3. Gradually establish pitch attitude of 15° to 20° nose up, straight ahead or in a turn with a bank of 20°
4. Gradually but firmly increase right rudder to maintain coordinated flight while maintaining wings level or specified bank angle with ailerons
5. Recognize and announce the onset of the stall by identifying the first aerodynamic buffeting
6. Recover promptly as the stall occurs by immediately lowering the angle of attack, applying additional right rudder and leveling the wings

NOTE: Due to P-factor and torque the airplane will always tend to roll left as the stall occurs.

7. Recovery Procedure:
Pitch level, wings level (do not let the nose drop too far because of too much altitude loss)
After 1 second pitch up to approx. 10° (airspeed at $V_x = 85$ KIAS)
When positive climb is established lower pitch to 5° and gradually accelerate to $V_y = 107$ KIAS
8. Re-establish approach cruise or normal climb as specified.

Practical Test Standard (PTS) for the maneuver is heading $\pm 10^\circ$ or in turning flight 20° bank $\pm 10^\circ$

Power off Stall (Landing Configuration)

NOTE: Even though the practical test standards refers to the maneuver as a Power Off Stall the airplane is configured in the landing configuration at a normal approach power setting.

1. Reduce throttle to 18-19" MAP and let the airplane decelerate to less than 158 KIAS
2. Wing Flaps - 15°
3. Reduce throttle to 15" MAP and decelerate to less than 138 KIAS
4. Landing Gear - DOWN
5. Wing Flaps - FULL DOWN
6. Further deceleration to stall speed by pitching up gradually (nose up about 5°)
7. Recognize and recover from stall at the first indication of buffeting and decay of control effectiveness by immediately reducing angle of attack, increasing power and leveling the wings
8. Recovery Procedure:
Full Power
Pitch level, wings level
Wing Flaps to 15°, with flap retraction pitch up to approx. 10° and initiate climb (airspeed at $V_x = 85$ KIAS)
When positive climb, gear up, lower pitch to 5° and gradually accelerate to $V_y = 107$ KIAS
With airspeed above 90 KIAS Wing Flaps UP
9. Return to entry airspeed, altitude and configuration

PTS heading $\pm 10^\circ$ or in turning flight 30° bank $+0/-10^\circ$

Maneuvering during Slow Flight

1. Trim Airplane for straight and level at a power setting of 19" MAP/2200 RPM
2. Reduce Throttles to 15" MAP
3. As airspeed bleeds off, trim nose up to hold altitude
4. At 90 KIAS - Throttles to about 17" MAP, to hold this airspeed and specified altitude
5. If Flaps have been deployed some more throttle is necessary
6. Turns, climbs and descents can be practiced in this configuration
7. Recovery: Add Throttle to 22" MAP, Pitch to maintain altitude
8. Retract Flaps if deployed and resume Cruise Flight

PTS altitude ± 100 ft (Private), ± 50 ft (Commercial); heading $\pm 10^\circ$; airspeed ± 5 KIAS
on turns: specified bank $\pm 10^\circ$; roll out on specified heading $\pm 10^\circ$

Steep Turns

NOTE: Steep Turns for Private Pilot Rating: 45° Bank; for Commercial Pilot Rating 50° Bank

1. Adjust Power to about 21" MAP/2300 RPM to obtain approximately 148 KIAS
2. Enter a 360° turn using either 45° or 50° bank
G-load is rapidly increasing above 25° bank. Roll to final bank angle with increasing pitch to compensate for G-load and to hold altitude.
3. Increase Throttles 1-3" MAP to hold airspeed constant.
4. Complete first 360° turn and roll out second 360° turn in other direction.
With roll out release back pressure as bank approaches level and apply more back pressure with again increasing bank.
5. Roll out on desired heading.
6. Throttles back to 21" MAP

PTS altitude ± 100 ft; bank $\pm 5^\circ$; airspeed ± 10 KIAS; roll out on specified Heading $\pm 10^\circ$

Minimum Control Speed Demonstration

1. Reduce Throttles to 19" MAP and trim to hold altitude
2. Audibly call out parameters:
 - a. Aft Center of Gravity
 - b. Flaps Up
 - c. Gear Up
 - d. Throttle Left Engine (critical) Idle
 - e. Props full forward - High RPM
 - f. Throttle Right Engine - Full Power
3. Establish Vyse 106 KIAS and 5° bank into good engine, 1/2 ball out - then gently slow airspeed by pitching up
Do not remove hand from right throttle. Gradually increase aileron and rudder as airspeed decreases.
4. At first sign of loss of directional control or stall simultaneously reduce angle of attack and partially reduce power on right engine to maintain control with a minimum loss of altitude (Pitch to about -5°).
5. At more than 80 KIAS smoothly apply full throttle on right engine (left remains simulated dead) and accelerate to 106 (Vyse).
6. Match Throttles at 18-19" MAP; Propellers back to 2200 RPM
7. Resume Cruise Flight

PTS heading within 20° of entry heading; airspeed during recovery at ± 5 KIAS of Vyse

Single Engine Maneuvering (normally zero thrust engine)

1. Power to 19" MAP/2400 RPM and trim to hold altitude
2. Zero Thrust one engine (Propeller full forward, as much throttle to hold RPM on about 1950; see Fig. 3-3)
3. Adjust pitch trim for 106 KIAS and use rudder trim.
4. Demonstrate different phases of flight with different power on "good engine"
Turns into and away from "good engine"; Climbs and descents
5. Warm up inoperative engine beginning with 15" MAP for several minutes.
6. Resume Cruise Flight

During the Flight Test the examiner will fail one Engine (simulated) in different phases of flight or on takeoff.

The procedures to be followed are described in the emergency checklist.