Piper Seminole
Multi-engine Guide

MIDDLE GEORGIA STATE UNIVERSITY

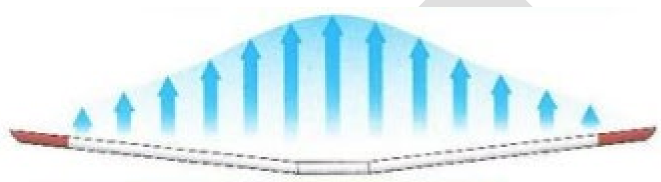
Table of Contents

Multi-engine Aerodynamics

Benefits of Induced Flow

Induced flow refers to the generation of additional lift due to the acceleration of a large parcel of air propelled rearwards by the engine's propeller. Induced flow is generally greater in a multi-engine airplane due to propellers positioned directly in front of the wing compared to a single engine where the propeller is placed in front of a fuselage.

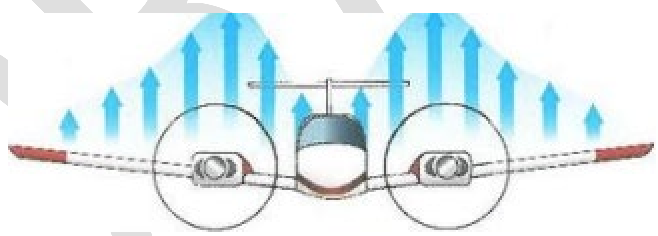
Visualization of life created by a wing without fuselage, empennage, or engine would look like below.



Source- Jeppesen Multi-Engine Manual

The propeller accelerates a large parcel of air rearwards towards the wing, creating an accelerated slipstream creating more lift behind the propeller as visualized below

Source- Jeppesen Multi-Engine Manual



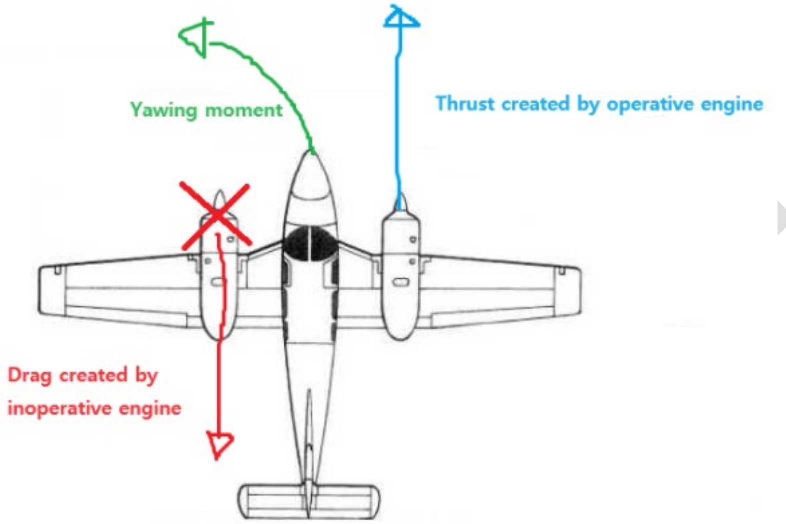
Effects of Engine Failure in Multi-engine

When an engine failure occurs in a multi-engine airplane, asymmetric thrust and drag, cause the following effects on the aircraft's axes of rotation:

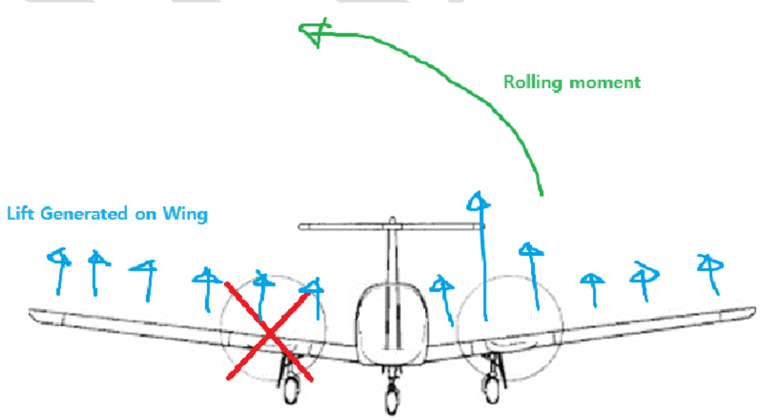
Loss of thrust and increase drag from the windmilling propeller cause the aircraft to yaw toward the inoperative engine. This requires additional rudder pressure on the side of the operating engine

Yawing moment visualized from the rear

The airplane rolls toward the inoperative engine due to the loss of accelerated slipstream on the side of the inoperative engine and requires additional aileron deflection into the operating engine.



Rolling moment visualized from the rear



Finally, loss of accelerated slipstream over the horizontal stabilizer causes it to produce less negative lift, causing the aircraft to pitch down. To compensate, additional back pressure is required. The Seminole has a lesser pitch-down effect than most light twins because the T-tail configuration removes the horizontal stabilator from the accelerated slipstream.

Engine Inoperative Climb Performance

Climb performance depends on the excess power needed to overcome drag. When a multi-engine airplane loses an engine, the airplane loses 50% of its available power. This power loss results in a loss of approximately 80% of the aircraft's excess power and climb performance. Drag is a major factor relative to the amount of excess power available. An increase in drag must be offset by additional power. This additional power is now taken from the excess power, making it unavailable to aid the aircraft in climb. When an engine is lost, maximize thrust and minimize drag in order to achieve optimum single-engine climb performance.

Approximate Drag Factors per the Piper Seminole POH

1. Flaps 25°	-240 FPM
2. Flaps 40°	-275 FPM
3. Windmilling Prop	-200 FPM
4. Gear Extended	-250 FPM

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 Ibs., or less and a Vso 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 1.2Vso
    - 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 Ibs. or less, and/or Vso 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 Vso^2 (Vso 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 Vs

Single-Engine Service Ceiling

Single-engine service ceiling is the maximum density altitude at which the single-engine best rate of climb airspeed (V_{YSE}) will produce a 50 FPM rate of climb with the critical engine inoperative.

Single-Engine Absolute Ceiling

Single-engine absolute ceiling is the maximum density altitude that an aircraft can attain or maintain with the critical engine inoperative. V_{YSE} and V_{XSE} are equal at this altitude. The aircraft drifts down to this altitude when an engine fails.

Airspeeds for Max Single-Engine Performance

V_{XSE}: The airspeed for the steepest angle of climb on a single-engine.

V_{YSE}: The airspeed for the best rate of climb on single-engine, or the slowest loss of altitude on drift-down. Blueline is the marking on the airspeed indicator corresponding to V_{YSE} at max weight.

Sideslip vs Zero Sideslip

During flight with one engine inoperative, proper pilot technique is required to maximize aircraft performance. An important technique is to establish a Zero Sideslip Condition.

Sideslip Condition

When an engine failure occurs, thrust from the operating engine yaws the aircraft. In order to maintain aircraft heading with the wings level, rudder must be applied toward the operating engine. This rudder force results in the sideslip condition by moving the nose of the aircraft in a direction resulting in the misalignment of the fuselage and the relative wind. This condition usually allows the pilot to maintain aircraft heading; it produces a high drag condition that significantly reduces aircraft performance.

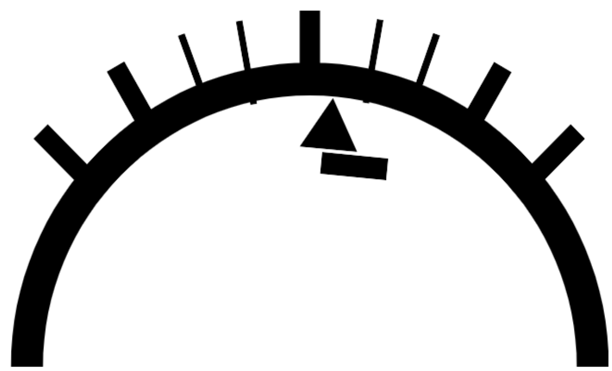
Zero Sideslip Condition

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

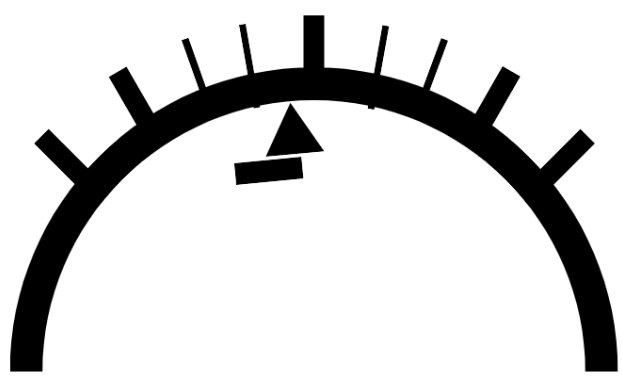
Maintaining Zero sideslip

Zero sideslip should always be maintained in a one-engine inoperative to ensure the best performance of the airplane and low Vmc speed even when turning, climbing, and descending.

The rule of thumb for zero sideslip is to bank 2-3 deg into the operative engine and "brick" (slip and skid indicator) half deflection into the operative engine. The below attitude should be maintained at all times.



Left engine INOP zero sideslip attitude visualized



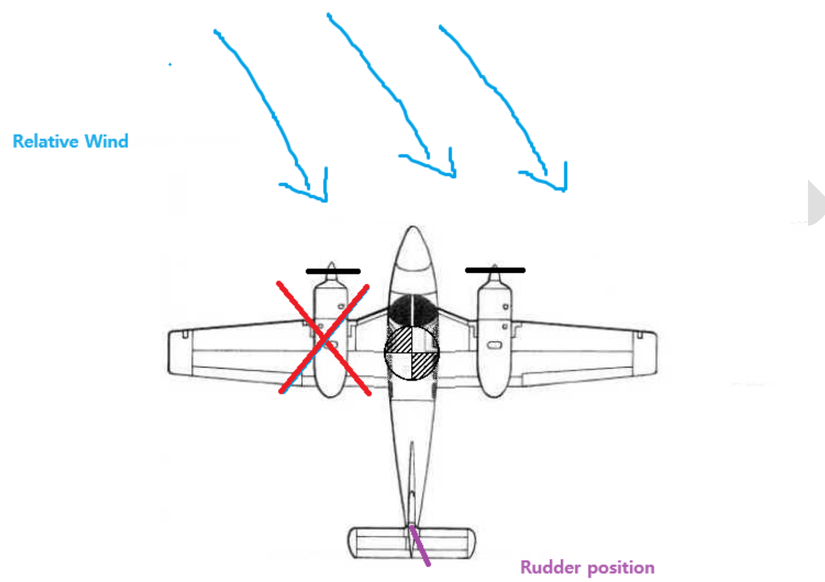
Right engine INOP zero sideslip attitude visualized

0° bank

When 0° bank is maintained, the relative wind comes from the inoperative engine side of the airplane. This creates a fuselage lift toward the operating engine. Rudder force towards the operating engine combined with the fuselage lift helps us counteract the yaw towards the inoperative engine.

Since the airplane is not banked, it creates no horizontal component of lift. The yaw towards the inoperative engine is countered purely by the rudder when 0° bank is maintained. This results in a moderate Vmc.

The fuselage lift created by the relative wind results in more induced drag, which results in a moderate drag.



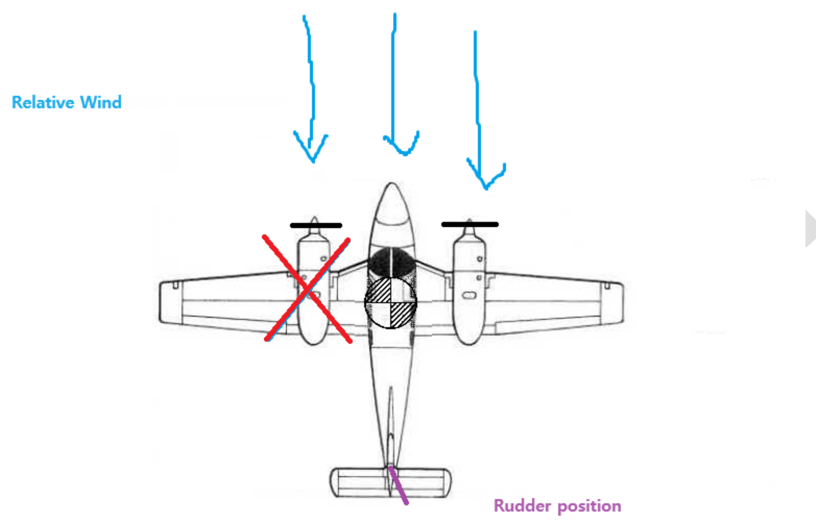
0° bank visualized

2-3° bank towards the Operating Engine (ZERO SIDESLIP)

When 2-3° bank is maintained towards the inoperative engine, the relative wind is aligned with the longitudinal axis of the airplane, which creates no fuselage lift. To counteract the yaw towards the inoperative engine, horizontal component of lift (from banking 2-3° towards the operating engine), and rudder force are used.

The horizontal component of lift helps counteract the yaw towards the inoperative engine, which helps us acquire low Vmc speed, but not as much as 8° bank into the operating engine.

The lack of fuselage lift in a zero sideslip minimizes the induced drag created which gives us minimum drag.



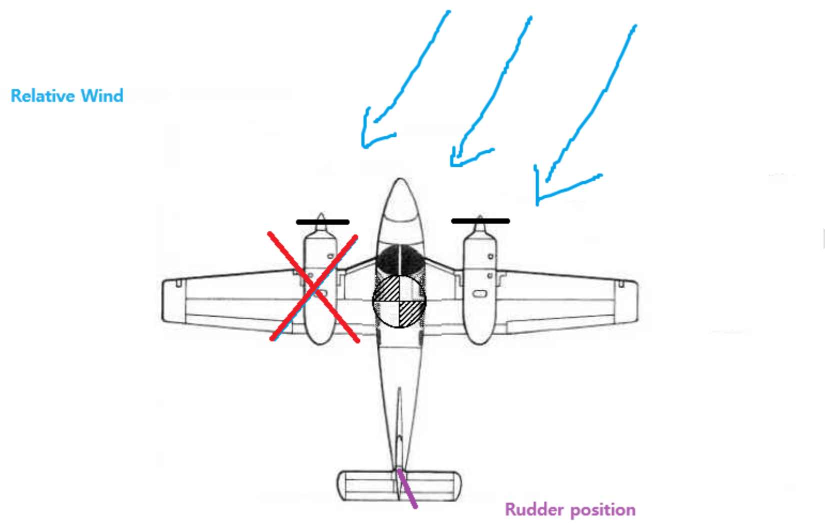
Zero sideslip visualized

8° bank towards the Operating Engine

When 8° bank is maintained towards the inoperative engine, the relative wind comes toward the operative engine side. This creates a fuselage lift towards the inoperative engine which is added onto the yaw towards the inoperative engine. This force needs to be counteracted by the Horizontal component of lift and rudder force to maintain the aircraft's heading.

The increased horizontal component of lift towards the operating engine helps to counteract the yaw towards the inoperative engine a lot which helps to acquire the lowest Vmc speed.

However, the induced drag created by fuselage lift, rudder force, and horizontal component of lift is also increased, which gives you moderate drag.



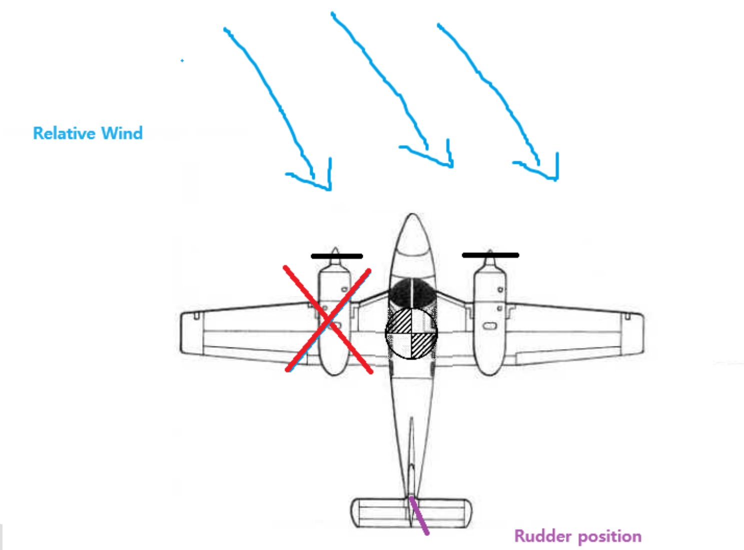
8° bank towards operating engine visualized

5° bank towards the INOPERATIVE Engine

When 5° bank is maintained towards the inoperative engine, the relative wind comes from the inoperative engine side. Because the airplane is banked towards the inoperative engine, the horizontal component of lift is created towards the inoperative engine side. The combination of yaw from the inoperative engine and the horizontal component of lift (towards INOP. engine) are countered by the rudder force and the fuselage lift towards the operative engine.

Since there is an addition of yaw towards the inoperative engine and the horizontal component of lift (towards INOP. engine), more rudder force is required to maintain the heading. This results in the highest Vmc**.**

The induced drag created by the fuselage lift and rudder force creates moderate drag**.**

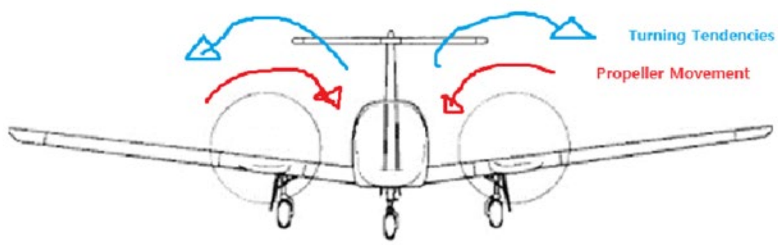


5° bank towards inop. engine visualized

Counter Rotating Engine vs Conventional Engine

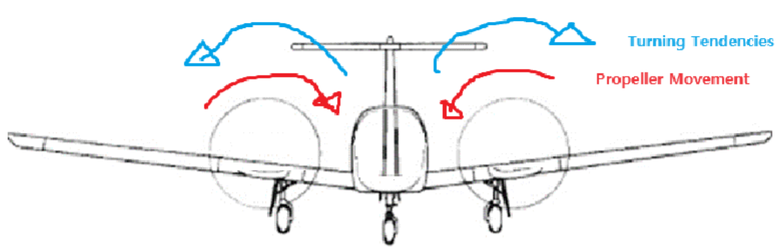
Counter Rotating Engines

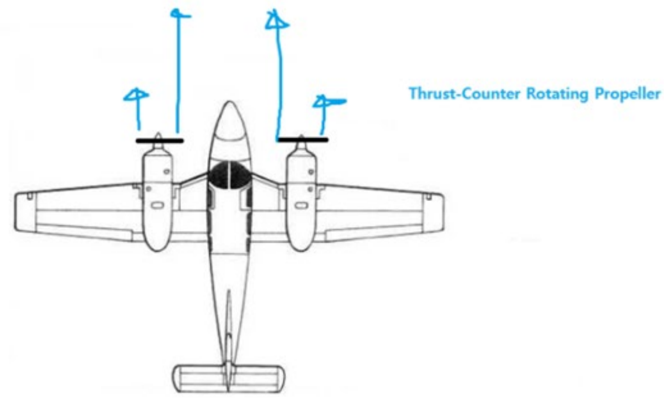
Counter rotating engines refers to a kind of engine used by a twin airplane where the left engine rotates clockwise and the right engine rotates counterclockwise. The advantages and disadvantages of using a counter-rotating engine are as below. Piper Seminole (PA-44-180) used by the MGA Flight Department is equipped with Counter Rotating Engines.



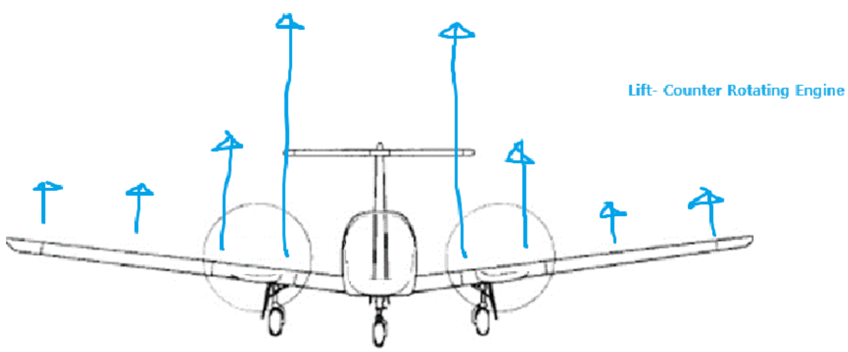
Counter rotating engines refers

Counter Rotating Engine visualized from the rear





Counter Rotating Engine thrust visualized from a bird's eye view

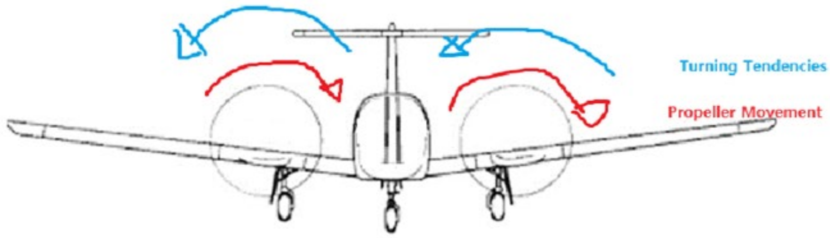


The single greatest advantage of counter rotating engines is that it eliminates turning tendencies. The left engine creates a left-turning tendency, and the right engine creates a right-turning tendency. Both turning tendencies counteract each other thus eliminating a Critical Engine.

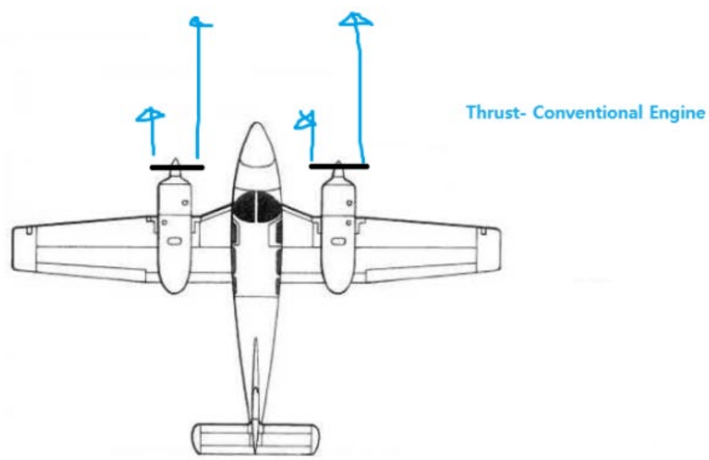
Disadvantages of counter rotating engines include greater expense to maintain and each engine (left and right) are mirrored and are considered two different models of engines. This makes it harder to replace the engine as the parts for the two engines are different.

Conventional Engine

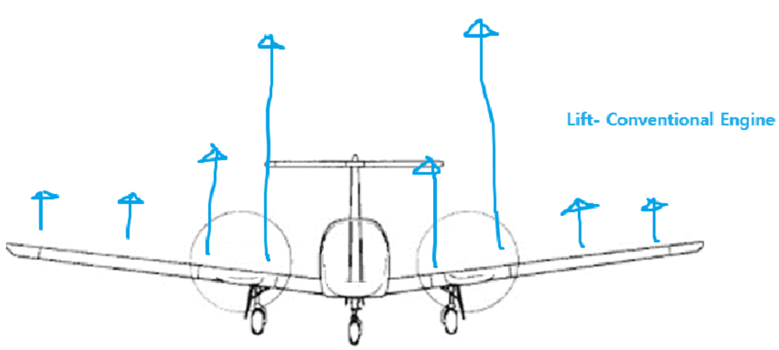
Conventional engine refers to a kind of engine used by a twin airplane where both left and right engines rotate clockwise. The advantages and disadvantages of using a conventional engine are as below.



Conventional Engine visualized from the rear



Conventional Engine thrust visualized from a bird's eye view



Conventional Engine lift visualized from the rear

Advantages of conventional engine twin aircraft include typically a lower cost of maintenance since both engines (left and right) are identical, thus parts can be shared.

The greatest disadvantage of a conventional engine twin is that the turning tendencies are twice as strong. Both left and right engines create left-turning tendencies, thus the aircraft has a critical engine.

Determining Critical Engine

Critical Engine refers to an engine if failed, would most adversely affect the performance and handling characteristics. Only conventional twin airplanes have a critical engine. Piper Seminole (PA-44-180) does not have a critical engine as it is equipped with counter-rotating engines.

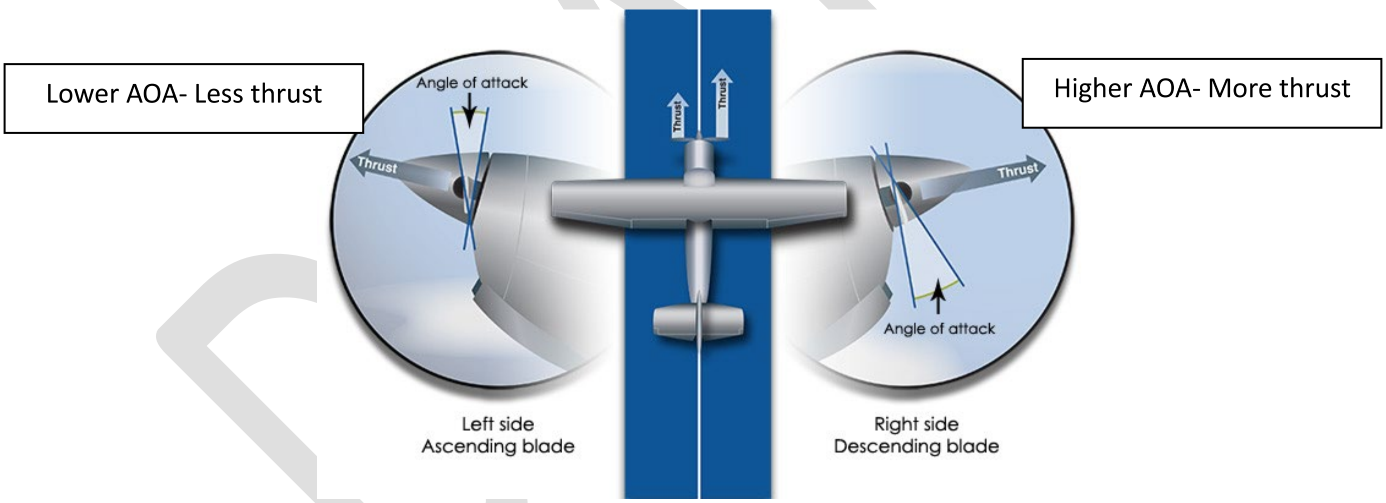
There are four factors that determine the critical engine (Acronym PAST)

- P-Factor
- Accelerated Slip Stream
- Spiraling Slip Stream
- Torque Effect

ALL SCENARIOS BELOW ARE BASED ON CONVENTIONAL ENGINE

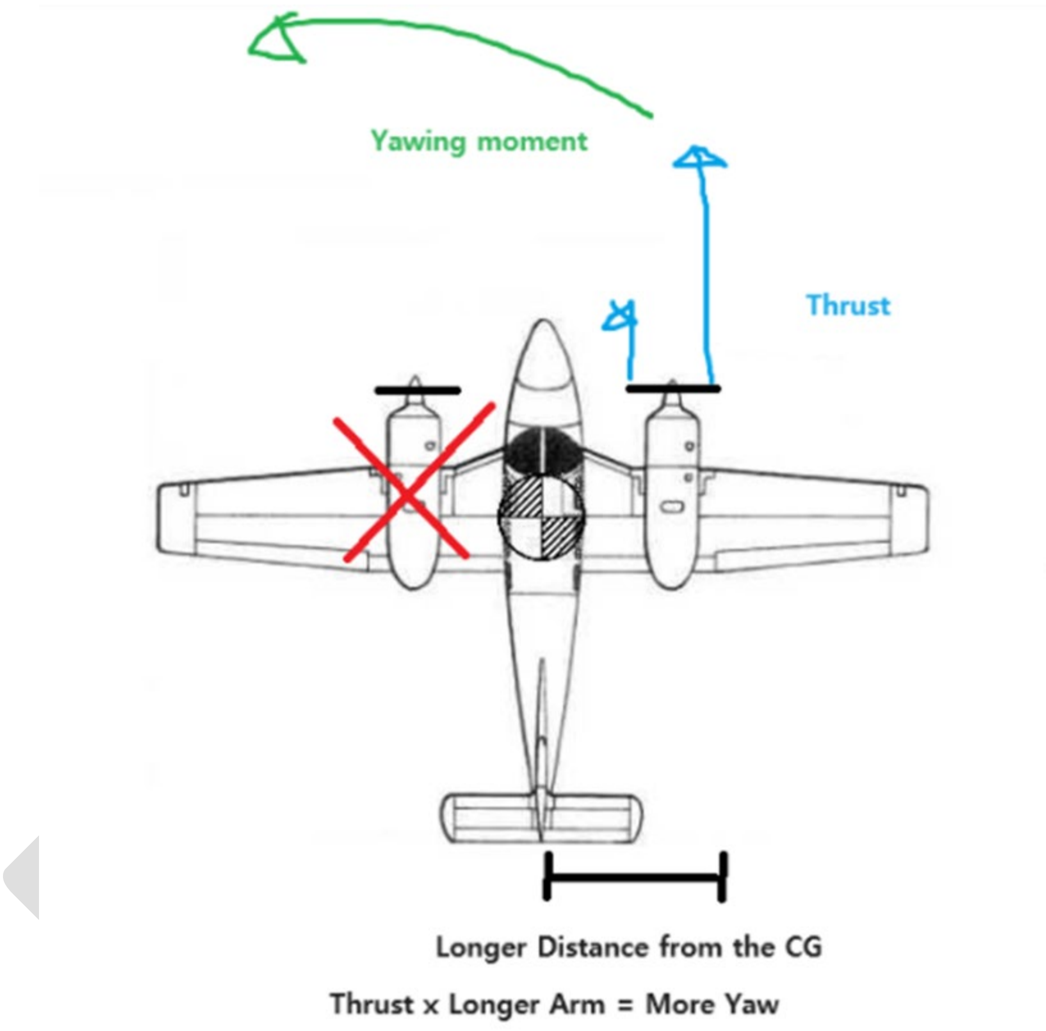
P- Factor

P- Factor refers to a phenomenon where the downward moving blade (right side of propeller) receives a higher AOA than the upward moving blade (left side of propeller). The downward-moving blade creates more thrust than the upward-moving blade. The differential thrust of the two blades creates a yawing moment to the left.



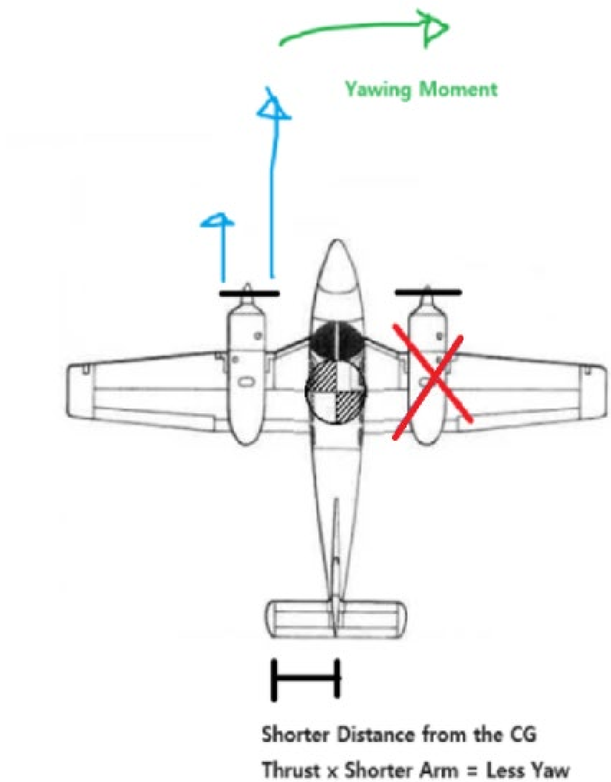
Source- AOPA Pilot's Magazine, December 2011

In a Conventional Twin, when the **left engine is inoperative** and the **right engine is operative** the descending blade (the blade that makes the most thrust) is **farther from the Center of Gravity**. A longer distance between the point of most thrust and the CG **creates more yawing moments toward the inoperative engine**. Ex- Arm (distance between the point of most thrust) x force (amount of thrust) = Moment (Yawing moment towards the inoperative engine)



Left engine failure visualized

When the **right engine is inoperative** and the **left engine is operative** the descending blade (the blade that makes the most thrust) is **closer to the Center of Gravity**. Less distance between the point of most thrust and the CG **creates less yawing moment towards the inoperative engine**. Ex- Arm (distance between the point of most thrust) x force (amount of thrust) = Moment (Yawing moment towards the inoperative engine)

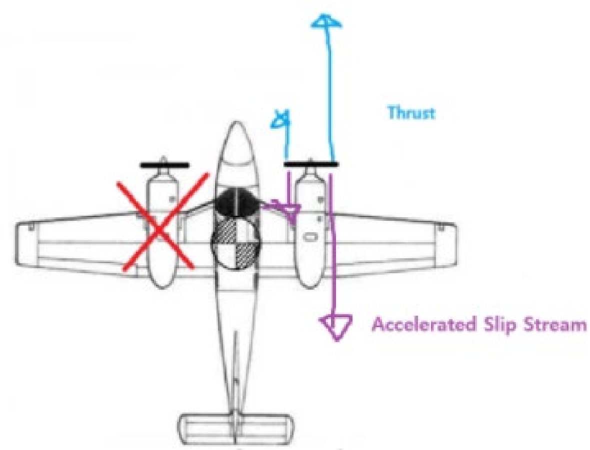


Right engine failure visualized

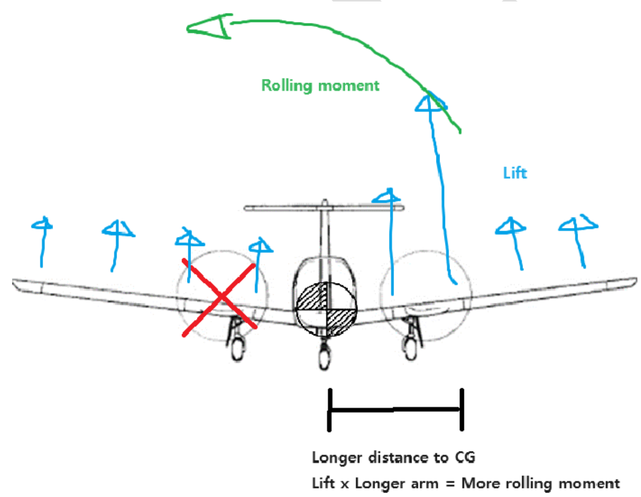
Accelerated Slip Stream

Much like the P-Factor, the accelerated parcel of air pushed rearward by the propeller creates more lift on the part of the wing directly behind the propeller. The descending blade of the propeller creates more thrust, meaning it accelerates air rearward faster behind the descending blade (Newton's third law), creating more lift due to faster airflow hitting the wing.

When **the left engine is inoperative and the right engine is operative**, the wing directly behind the descending blade of the right-wing receives a faster-accelerated slipstream. Faster airflow hitting the wing creates more lift. The point of most lifts is **farther away from the CG**, creating **more rolling moment towards the inoperative engine**.

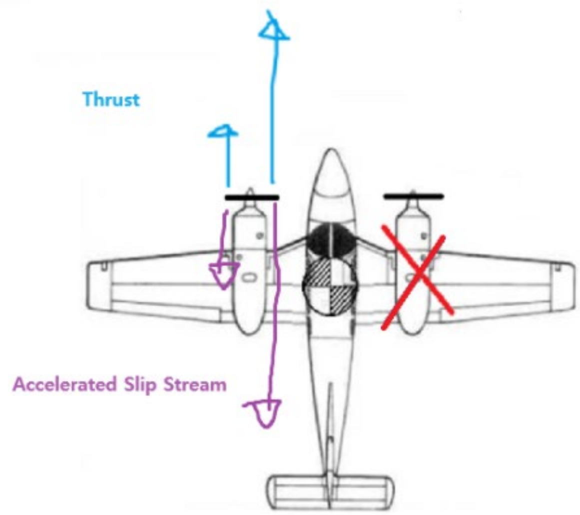


Left engine inoperative accelerated slip stream visualized

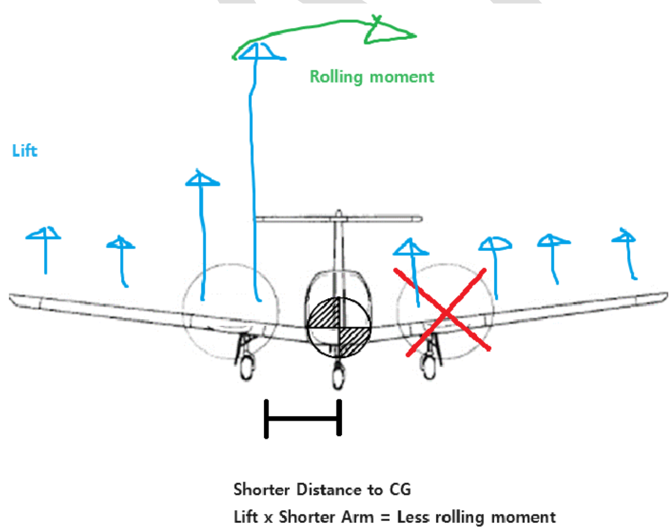


Left engine inoperative lift visualized

When **the right engine is inoperative and the left engine is operative**, the wing directly behind the descending blade of the left-wing receives a faster-accelerated slipstream. Faster airflow hitting the wing creates more lift. The point of most lifts is **closer to the CG**, creating **less rolling moment towards the inoperative engine**.



Right engine inoperative thrust visualized

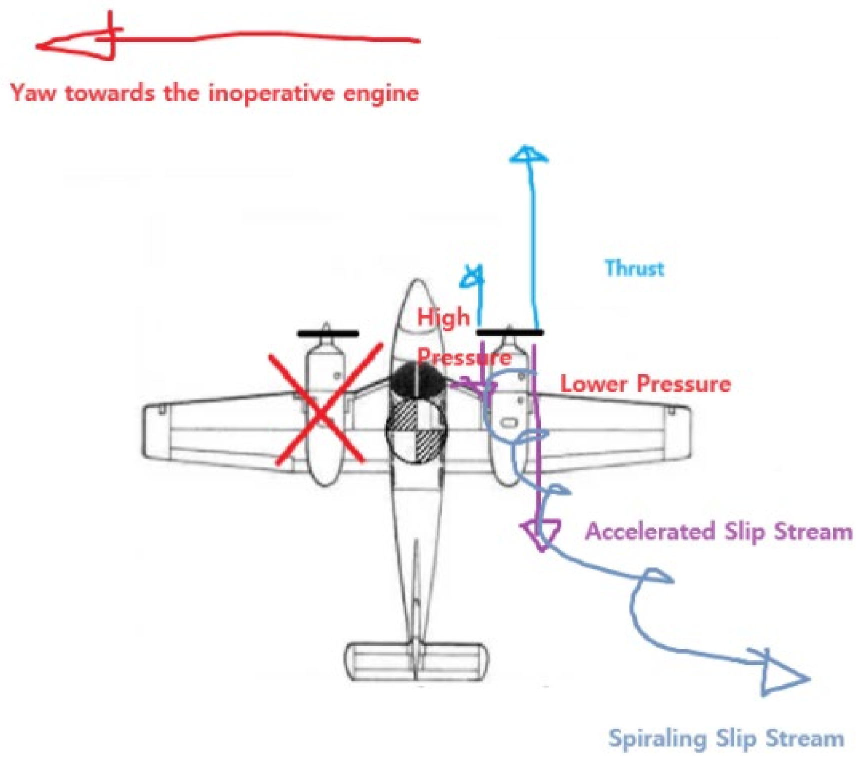


Right engine inoperative lift visualized

Spiraling Slipstream

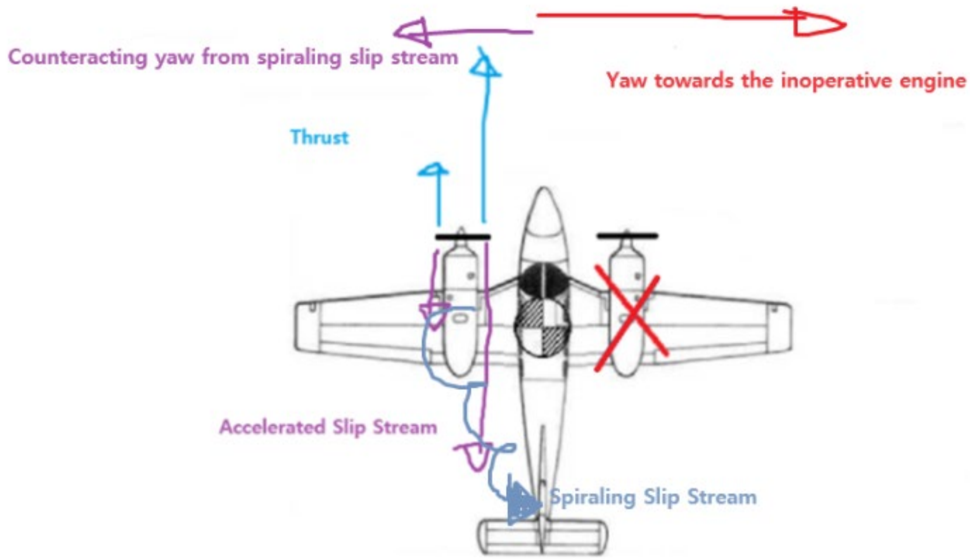
The corkscrew movement of the rearward-pushed air behind the propeller moves **rearwards and rightward**. The spiraling slipstream moves towards the right due to the left side (upward moving side of the propeller) of the propeller creating less thrust, therefore creating a slower accelerated slipstream than the right side (descending side) of the propeller. Slower airflow creates higher pressure and faster airflow creates lower pressure, creating left side higher pressure airflow to move towards the right side lower pressure airflow.

When the **left engine is failed** the rearward and rightward moving spiraling slipstream created by the right engine does not reach anywhere, and has **NO EFFECTS**.



Left engine inoperative spiraling slip stream visualized

When the **right engine is failed the spiraling slipstream created by the left engine hits the vertical stabilizer of the airplane** and creates a slight **yawing moment towards the left**, which helps to counteract some of the yaw towards the inoperative engine. **HOWEVER, THE EFFECTS ARE SO SMALL, IT IS NEGLIGIBLE**.

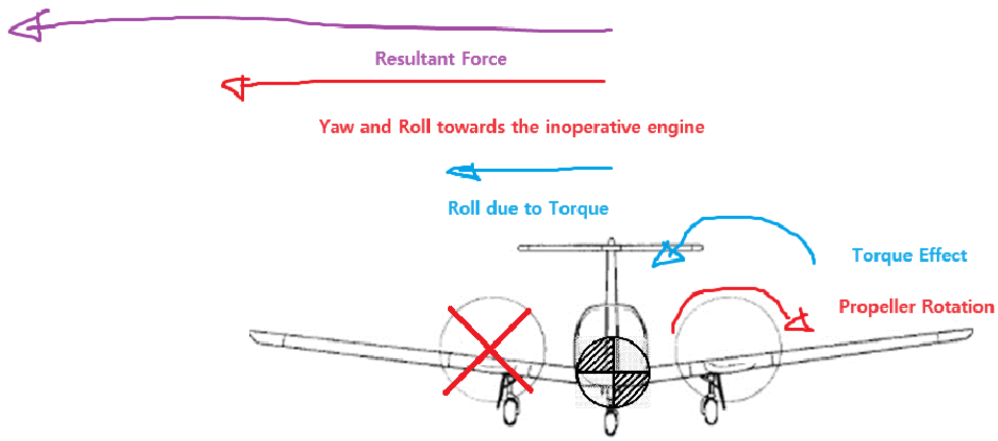


Right engine inoperative spiraling slip stream visualized

Torque Effect

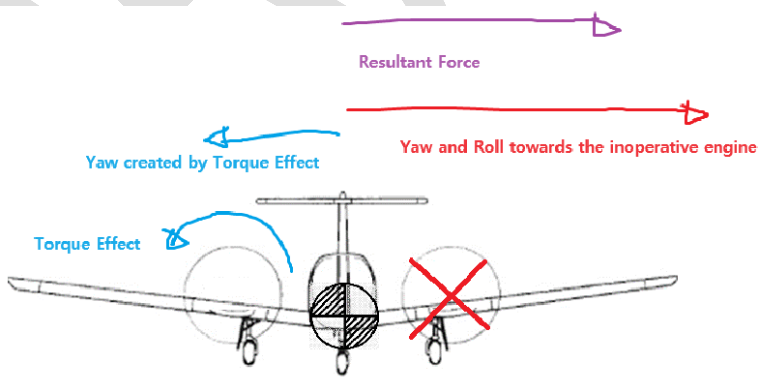
The torque effect refers to the counter-clockwise rolling tendency of the airplane due to the propeller's rotation towards clockwise. According to Newton's third law, there are equal and opposite reactions to the force, thus creating a left-rolling tendency.

When the **left engine fails**, the **left rolling tendency of the torque effect created by the right engine** is **added** on to the left yawing and rolling tendency created by the left inoperative engine. Creating a **larger yawing and rolling moment towards the inoperative engine**.



Left engine inoperative torque effect visualized

When the **right engine fails**, the **left rolling tendency of the torque effect created by the left engine counteracts** the left yawing and rolling tendency created by the right inoperative engine. Creating a **weaker yawing and rolling moment towards the inoperative engine**.



Right engine inoperative torque effect visualized

Determining Critical Engine

Looking at the effects of the P-Factor, Accelerated Slip Stream, Spiraling Slip Stream, and Torque Effect when a left engine failure occurs, it **creates more yaw and rolls towards the inoperative engine**. So we can determine that the **left engine** is the critical engine in a **conventional twin-engine airplane**.

Vmc

Vmc refers to a **speed below which aircraft control cannot be maintained if the critical engine fails (14 CFR part 23).** If you maintain the aircraft at or above Vmc, it guarantees you **directional control** of the airplane. VMC DOES NOT GUARANTEE PERFORMANCE OF THE AIRPLANE.

When a twin-engine airplane loses an engine, it experiences yaw and rolls towards the inoperative engine. Rudder towards the operative engine is required to maintain **directional control** of the airplane. When the airspeed of the airplane is decreased, the effectiveness of the rudder is also decreased due to less airflow around the control, however, the yaw and roll towards the inoperative engine remains the same. More rudder is required to maintain directional control. As airspeed decreases even more, there is going to be a point where **the full rudder is deflected** and the heading of the airplane **cannot** be maintained anymore, this is the point where the **airplane loses directional control.**

Vmc of the airplane is based on the following condition

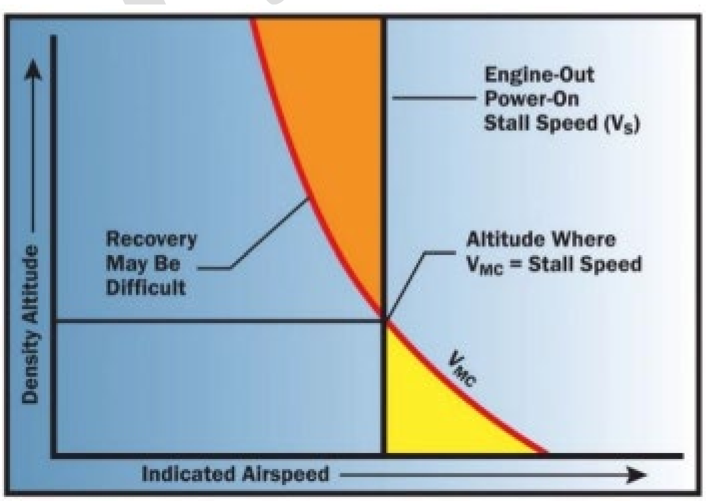
- **15 CFR 25.149 - Old Regulation (not in effect anymore)**
    - Vmc must be determined under these conditions
        - Most unfavorable weight (lightweight)
        - Most unfavorable CG (rear CG)
        - In the air and out-of-ground effect
        - Flaps takeoff position
        - Gear Up
        - Maximum takeoff power
        - Propeller in takeoff position
        - Trimmed for takeoff
    - Vmc must be recovered within
        - 20 deg of heading
        - Without any dangerous attitudes
        - Requiring less than 150 lbs of force on the rudder
        - Without needing a decrease of power (on the operating engine)
- **14 CFR 23.2135 – New Regulation (Regulation in effect)**
    - Airplane must be Controllable under these conditions
        - The airplane must be controllable and maneuverable without requiring exceptional piloting skill, alertness, or strength, within the operating envelope
            - At all loading condition for certification is requested
            - During all phases of flight
            - With likely reversible flight control or propulsion system failure
            - During configuration changes

- **Key Differences in Context: Part 23 vs. Part 25**
  - 14 CFR 23.2135 is aimed at smaller, often reciprocating-engine or light turbine-engine aircraft, focusing on pilot controllability in general aviation contexts.
  - 14 CFR 25.149 is more prescriptive and designed for transport-category aircraft, ensuring stringent safety in commercial operations.
- **Piper Seminole and Certification Basis**
  - The Piper Seminole was certified under the legacy 14 CFR 23.149 standard.
  - Even newly manufactured Seminoles are held to this certification basis unless the manufacturer opts for recertification under the modern Part 23 framework, which is uncommon.
  - Pilots and operators must reference the aircraft's certification basis in the AFM/POH for accurate VMC determination and comply with the associated limitations.

Recognizing and Recovering from Vmc

- You can **recognize you are below Vmc** under any of these conditions, **RECOVER IMMEDIATELY**
  - Loss of directional control (full rudder deflected and heading is lost towards inoperative engine)
  - Stall warning horn
  - Stall buffet
  - Rapid decay of control effectiveness (flight control suddenly requires significantly more input to maintain positive control)
- **Recovery Procedure**
  - Decrease asymmetrical thrust by reducing the operative engine’s power
  - Pitch down to regain the airspeed of the airplane above Vyse
  - Increase power on the operative engine as required to maintain positive flight controls

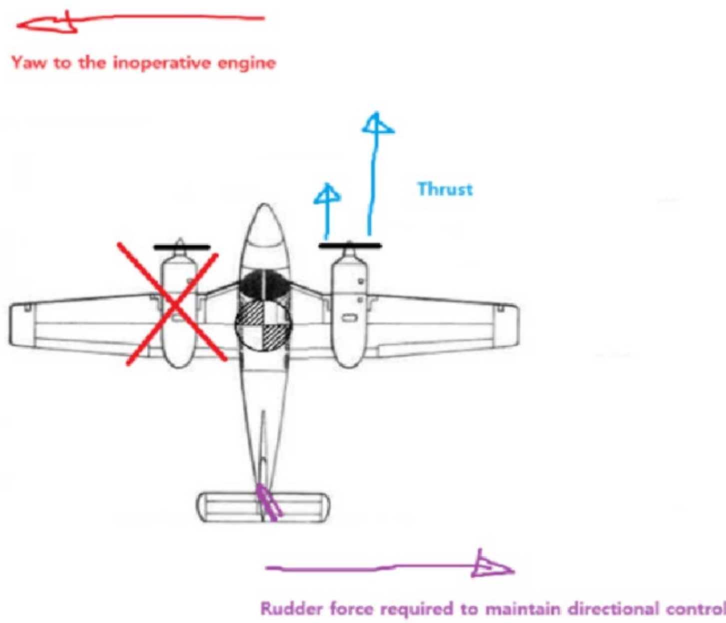
Vmc vs Stall Speed



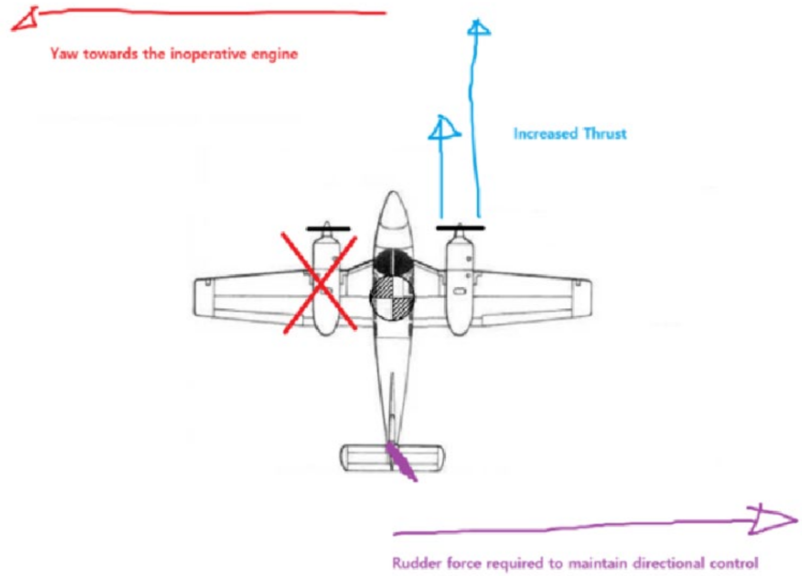
Source- Jeppesen Multi-Engine Manual

As density altitude increases, the thrust produced by the propeller decreases and the engine power decreases due to decreased O2. In a situation where an engine has failed, the increased density altitude decreases Vmc because less asymmetrical thrust is created by the operative engine which results in less rudder required to maintain directional control. Vmc decreases with increasing altitude.

However, the Indicated Stall Speed remains the same regardless of the altitude. At a certain altitude, the Vmc is going to be less than the Vs. If you go below Vmc above that specific altitude, recovery may be difficult as the airplane stalls and loses directional control.



Higher density altitude visualized



Lower-density altitude visualized

Factors affecting Vmc

A general rule of factors affecting Vmc is if more rudder is required to maintain directional control, the Vmc increases. If less rudder is required to maintain directional control, the Vmc decreases.

BELOW CONDITIONS ARE BASED ON ONE ENGINE INOPERATIVE

Effect On	Vmc	Performance
Power Increase	**UP** More asymmetrical thrust, more yaw towards inop. engine. More rudder is required.	**UP** More power and thrust
Temperature Increase, Density Altitude Increase, Pressure Decrease	**DOWN** Less asymmetrical thrust, and less yaw towards inop. engine. Less rudder is required.	**DOWN** Less power and thrust
Feathered Propeller (Least amount of drag) (Coarse/highest pitch)	**DOWN** Less asymmetrical drag, and less yaw towards inop. engine. Less rudder is required.	**UP** Less parasitic drag (compared to windmilling)
Windmilling Propeller	**UP** More asymmetrical drag, and more yaw towards inop. engine. More rudder is required.	**DOWN** More parasitic drag
Flaps Down	**DOWN** More induced drag is created behind the operating engine due to accelerated slip stream behind the propeller. Less yaw towards inop. engine. Less rudder is required.	**DOWN** More induced drag due to flap.
AFT CG	**UP** There is less arm between the CG and the rudder. The rudder is less effective, requiring more rudder.	**UP** Less induced drag is created as less downward lift is produced by the stabilator/horizontal stabilizer.
Gear Down	**DOWN** Nose gear extends downward and forward, moving CG to forward- Vmc DOWN Gear down creates a keel effect, increasing the stability of the airplane- Vmc DOWN	**DOWN** More parasitic drag

Gear Up	**UP** Nose gear retracts upward and rearward, moving CG to AFT-Vmc UP Keel effect is no longer produced by the gear – Vmc UP	**UP** Less parasitic drag
Heavier Weight	**DOWN** More lift is required to maintain level flight in heavy airplanes. When the airplane is banked towards the operative engine, there is more horizontal component of lift produced. The HCL counteracts some of yaw to the inop. engine. Less rudder is required	**DOWN** More lift is required, more induced drag is created
Critical Engine Failure (When compared to non-critical engine failure)	**UP** P.A.S.T (Factors determining critical engine) creates more yaw to the inop. engine when critical engine is failed. More rudder is required	**DOWN** More rudder is required to maintain zero sideslip. More rudder deflection creates more induced drag on the horizontal stabilizer
In Ground Effect	**UP** Less induced drag causes reduction in thrust required (meaning an airplane has extra thrust). Creates more yaw to the inop. engine. More rudder is required.	**UP** Less induced drag is created due to ground preventing wingtip vortices traveling to the top of the wing. Which prevents lift vectoring backwards.
Cowl Flap Open	**DOWN** More induced drag is created behind the operating engine due to the accelerated slip stream behind the propeller. Less yaw towards inop. engine. Less rudder is required	**DOWN** More induced drag due to flap.

Speeds, Weight, and Performance Seminole PA-44-180

Speeds

Vso (stall speed landing config.)	55 KIAS (bottom white arc)
Vmc (min. control speed)	56 KIAS (red radial line)
Vs (stall speed zero flaps)	57 KIAS (bottom green arc)
Vr (short TO)	70 KIAS
Vx	82 KIAS
Vy	88 KIAS
Vxse (single-engine best angle of climb)	82 KIAS
Vyse (single-engine best rate of climb)	88 KIAS (blue radial line)
Vsse (min. intentional OEI speed) (SIMULATED ENGINE FAILURE MAY NOT BE ATTEMPTED BELOW THIS SPEED)	82 KIAS
Enroute climb	105 KIAS
Vno (max. structural cruising speed)	169 KIAS (top green arc)
Vne (never exceed speed)	202 KIAS (top red radial)
Va (design maneuvering speed)	2700 lb 112 KIAS 3800 lb 133 KIAS
Vfe (max flap ext. speed)	111 KIAS
Vle (max landing gear extended speed)	140 KIAS
Vlo Down (max landing gear extension)	140 KIAS
Vlo Up (max landing gear retraction)	109 KIAS
Max door open speed	82 KIAS
Approach for Normal Landing	Aprox. 80 KIAS (when runway is made)
Approach for Short Field Landing	Aprox. 75 KIAS (when runway is made)

Seminole PA-44-180 Weights

Max Ramp Weight	**3816 lbs**
Max Takeoff Weight	**3800 lbs**
Max Landing Weight	**3800 lbs**
Max Baggage Weight	**200 lbs**

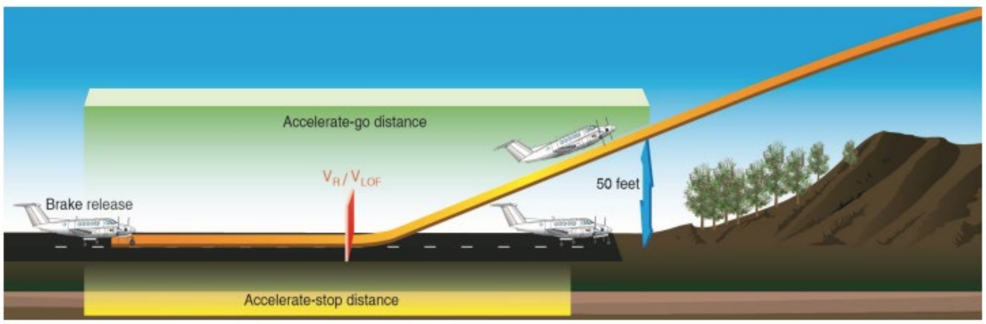
Takeoff and Landing

Accelerate Stop Distance

Accelerate stop distance must be calculated before taking off. Accelerate stop distance guarantees that the airplane will accelerate to Vr or Vlof or manufacture specified speed and experience an engine failure, and bring the airplane to a complete stop.

Accelerate go distance is the distance required to continue the takeoff and climb to 50 feet assuming that an engine failure has occurred at Vr or Vlof or manufacture specified speed.

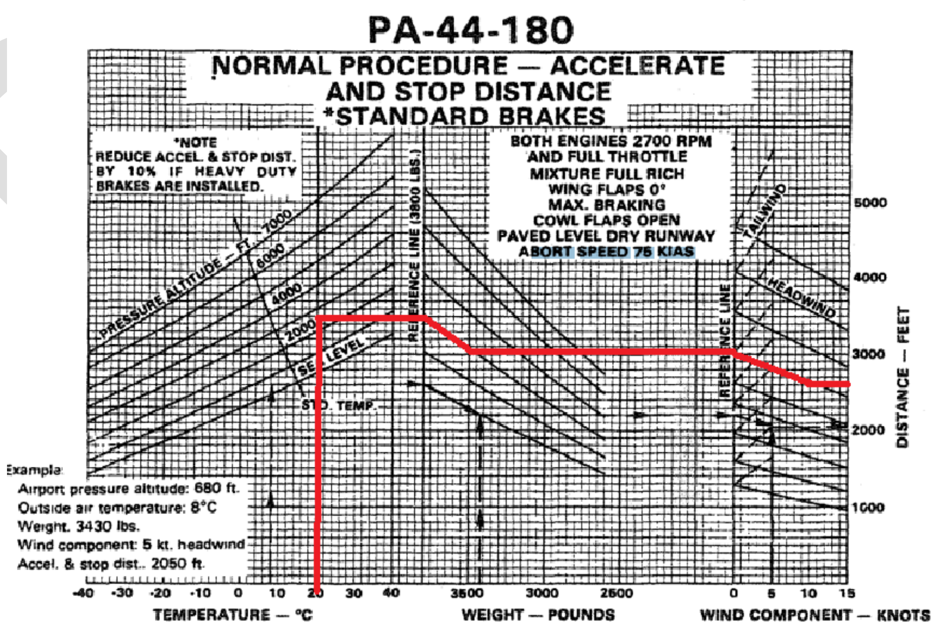
MGA DOES NOT PERMIT SINGLE-ENGINE TAKEOFF.



Source- Airplane Flying Handbook Chapter 13

To calculate the accelerate stop distance, refer to the example below.

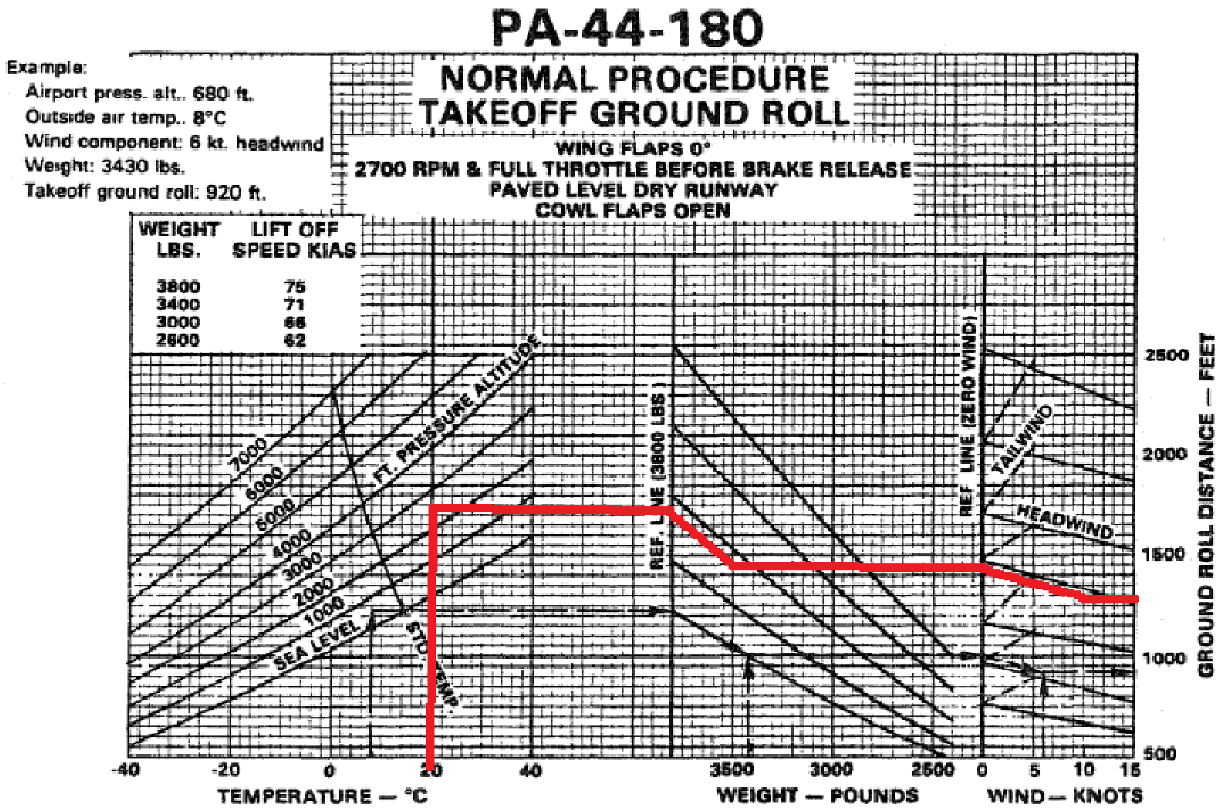
Sample Question- Temp 20 deg, Pressure Altitude 2500’, 3500 lb TO weight, 10 KIAS headwind



Answer- approximately 2650’

Normal Takeoff Distance

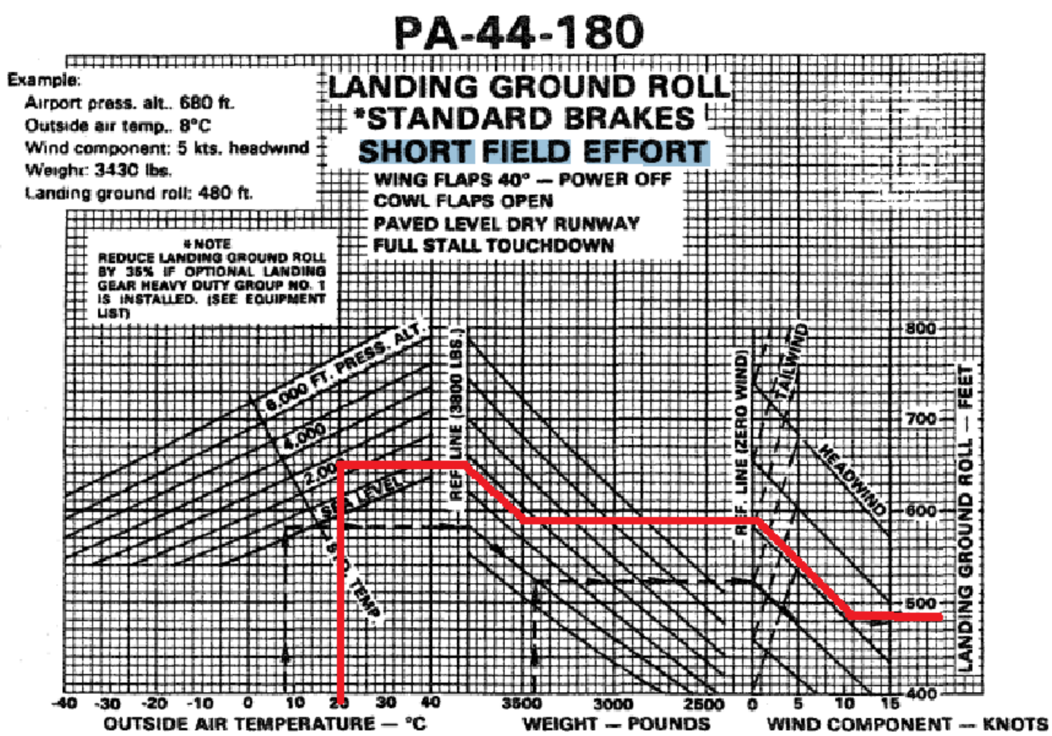
Sample Question- Temp 20 deg, Pressure Altitude 2500', 3500 lb TO weight, 10 KIAS headwind



Answer- approximately 1300'

Short Field Landing Distance

Sample Question- Temp 20 deg, Pressure Altitude 2500’, 3500 lb TO weight, 10 KIAS headwind



Answer- Approximately 490’

Time Fuel and Distance to Climb

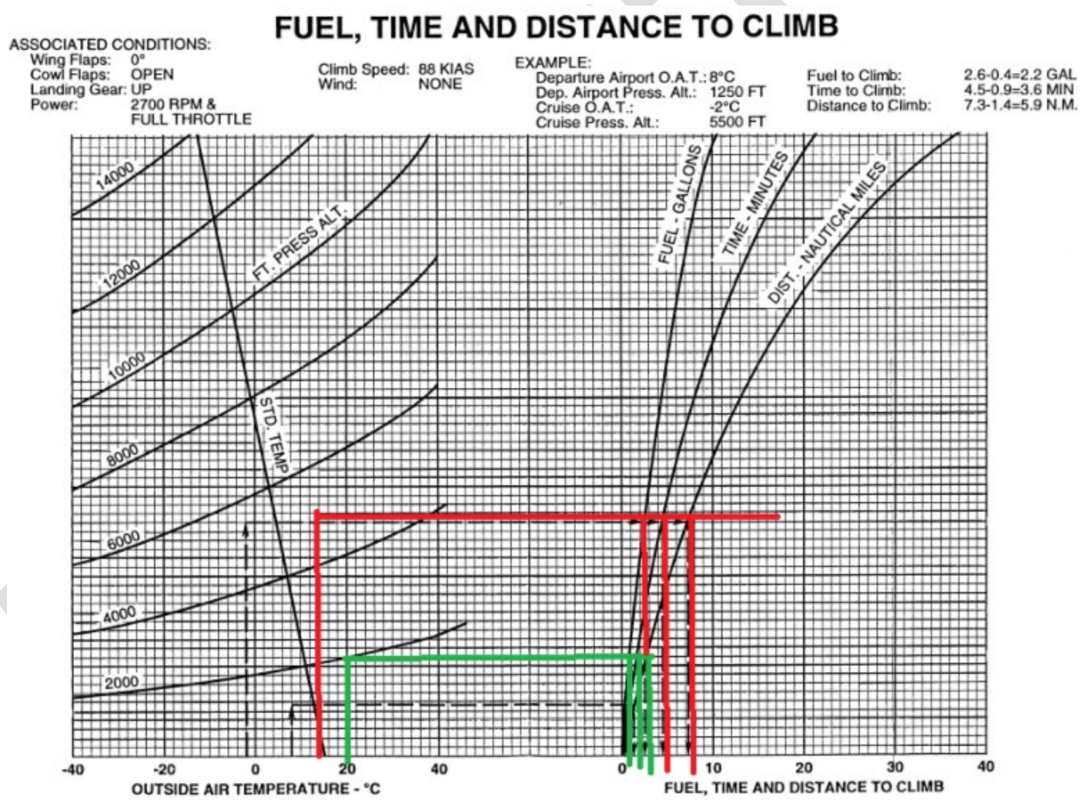
Sample Question- Departure airport temp 20 deg, Cruise altitude temp 15 deg, Climb from 2000' Press. Alt. to 5000' Press. Alt., Cowl flap Open, Flaps Up, Full throttle at 2700 RPM.

Step 1- Find time, fuel, and distance to climb at the departure airport using the departure airport temp and press. alt.

Time – 2 min, Fuel – 1 gal., Distance – 3 nm

Step 2- Find time, fuel, and distance to climb at cruising altitude using the cruising altitude temp and press. alt.

Time – 5 min, Fuel – 3 gal, Distance – 8 nm



Answer-

Time 5 – 2 = 3 min.

Fuel 3 – 1 = 2 gal (add 2.6 gal if you are adding start, taxi, and runup fuel)

Distance 8 – 3= 5 nm (not accounted for any winds)

Cruise Performance

Fuel and Power Setting Table PER ENGINE

Sample Question- 5000' Press. Alt., 15 deg, 75% power, 2400 RPM, 23 MP

FUEL AND POWER SETTING TABLE

LYCOMING (L) O–360–A1H6 (PER ENGINE)

Press. Alt. Feet	Std. Alt. Temp. °C	99 BHP– 55% Rated Power Approx. Fuel Flow 8.7 G.P.H.* RPM AND MAN. PRESS.				117 BHP– 65% Rated Power Approx. Fuel Flow 10.2 G.P.H.* RPM AND MAN. PRESS.				135 BHP– 75% Rated Power Approx. Fuel Flow 11.7 G.P.H.* RPM AND MAN. PRESS.				Press. Alt. Feet
		2100	2200	2300	2400	2100	2200	2300	2400	2200	2300	2400	2500	
SL	15	22.3	21.7	21.1	20.6	24.9	24.2	23.5	22.9	26.7	26.0	25.2	24.6	SL
1000	13	22.0	21.3	20.8	20.3	24.6	23.8	23.2	22.6	26.3	25.6	24.9	24.3	1000
2000	11	21.7	21.0	20.5	20.0	24.2	23.5	22.9	22.3	25.9	25.3	24.6	24.0	2000
3000	9	21.3	20.7	20.2	19.8	23.9	23.2	22.6	22.0	25.6	25.0	24.4	23.7	3000
4000	7	21.1	20.5	20.0	19.5	23.5	22.8	22.3	21.8	FT	24.7	24.1	23.5	4000
5000	5	20.8	20.2	19.7	19.2	23.2	22.5	22.0	21.5	—	FT	23.8	23.2	5000
6000	3	20.5	19.9	19.4	19.0	22.9	22.2	21.7	21.3	—	—	FT	22.9	6000
7000	1	20.2	19.7	19.2	18.7	FT	21.9	21.5	21.0	—	—	—	FT	7000
8000	-1	20.0	19.4	18.9	18.5	—	FT	21.2	20.8					8000
9000	-3	19.7	19.1	18.7	18.2	—	—	FT	20.6					9000
10,000	-5	19.5	18.9	18.4	18.0	—	—	—	FT					10,000
11,000	-7	19.2	18.7	18.2	17.8									11,000
12,000	-9	FT	18.4	18.0	17.6									12,000
13,000	-11	—	FT	FT	17.4									13,000
14,000	-13	—	—	—	FT									14,000

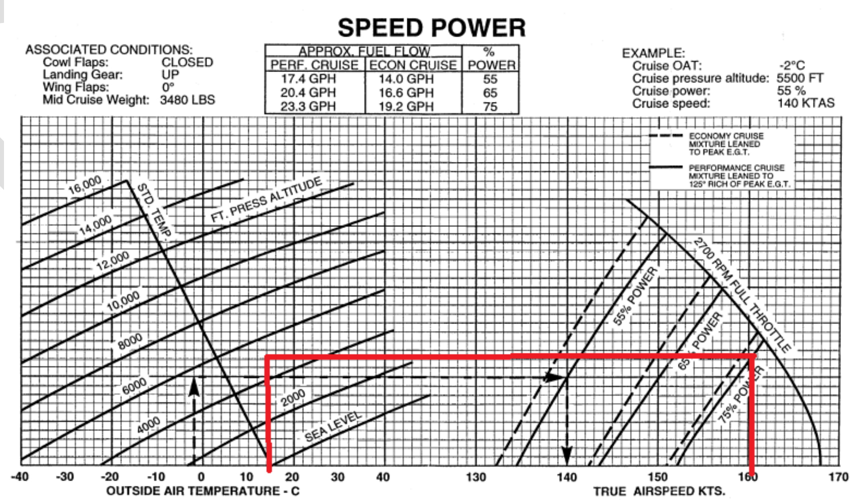
NOTE: To maintain constant power, add approximately 1% Manifold Pressure for each 8°C above standard. Subtract approximately 1% for each 8°C below standard.

*PERFORMANCE CRUISE POWER

Answer- Fuel flow 23.4 GPH (11.7 x 2 accounted for two engines), Recommended 24.8 MP (accounted from the NOTE and nonstandard temp)

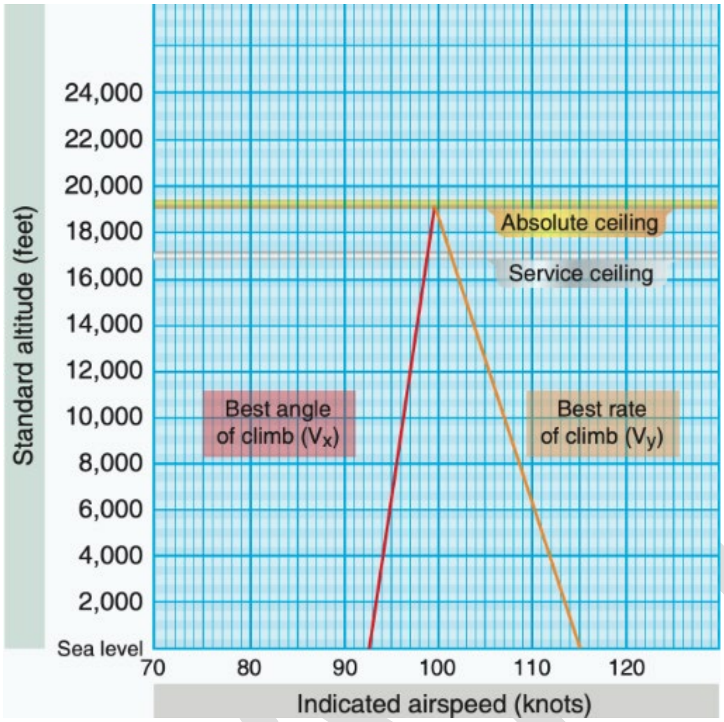
Speed Power

Conditions- 5000' Press. Alt., 15 deg, 75% power, Cowl Flap Closed, Gear and Flaps UP



Answer- 162 KIAS at 75% power, 23.3 GPH.

Ceiling



Source- Pilot's Handbook of Aeronautical Knowledge Chapter 11

- **Absolute Ceiling**
  - Altitude where the airplane produces zero Rate of Climb (the point where Vy meets Vx)
- **Service Ceiling**
  - Altitude where the airplane produces 100 feet per minute climb
- **Single-engine Absolute Ceiling**
  - Altitude where a multi-engine airplane with one engine operative produces zero Rate of Climb
- **Single-engine Service Ceiling**
  - Altitude where a multi-engine airplane with one engine operative produces 50 feet per minute climb

When an airplane is flying at an absolute ceiling and experiences an engine failure, the airplane will drift down to the single-engine absolute ceiling even when it maintains Vyse.

Calculating Absolute Ceiling

Step 1- Use the climb performance chart based on the configuration of the airplane

Step 2- Draw a straight line up from 0 FPM to the aircraft's weight

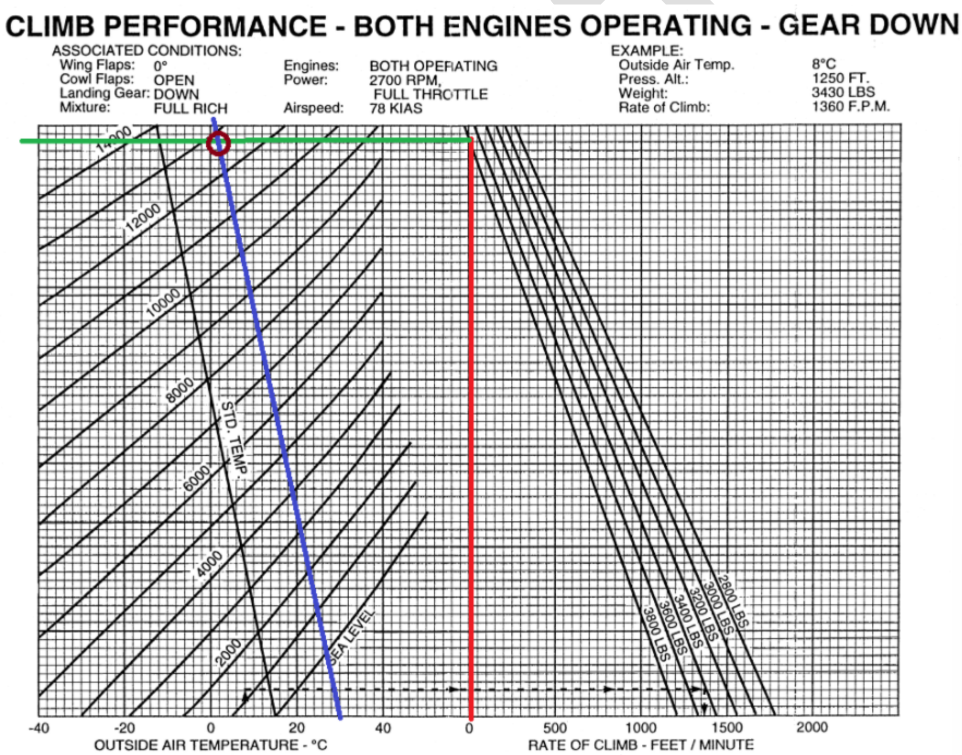
Step 3- Draw a straight line horizontally across from the intersection point to the left

Step 4- Find how much the winds aloft is above STD temperature

Step 5- Draw a line parallel to the STD TEMP reference line.

Step 6- The intersection point is the Absolute Ceiling

Sample Question- 3800 lbs, the temperature at 12,000 is 15 deg above STD temp



Answer- Approximately 12500' (rounded down for safety)

Calculating Single-engine Absolute Ceiling

Step 1- Use the climb performance chart based on the configuration of the airplane

Step 2- Draw a straight line up from 0 FPM to the aircraft's weight

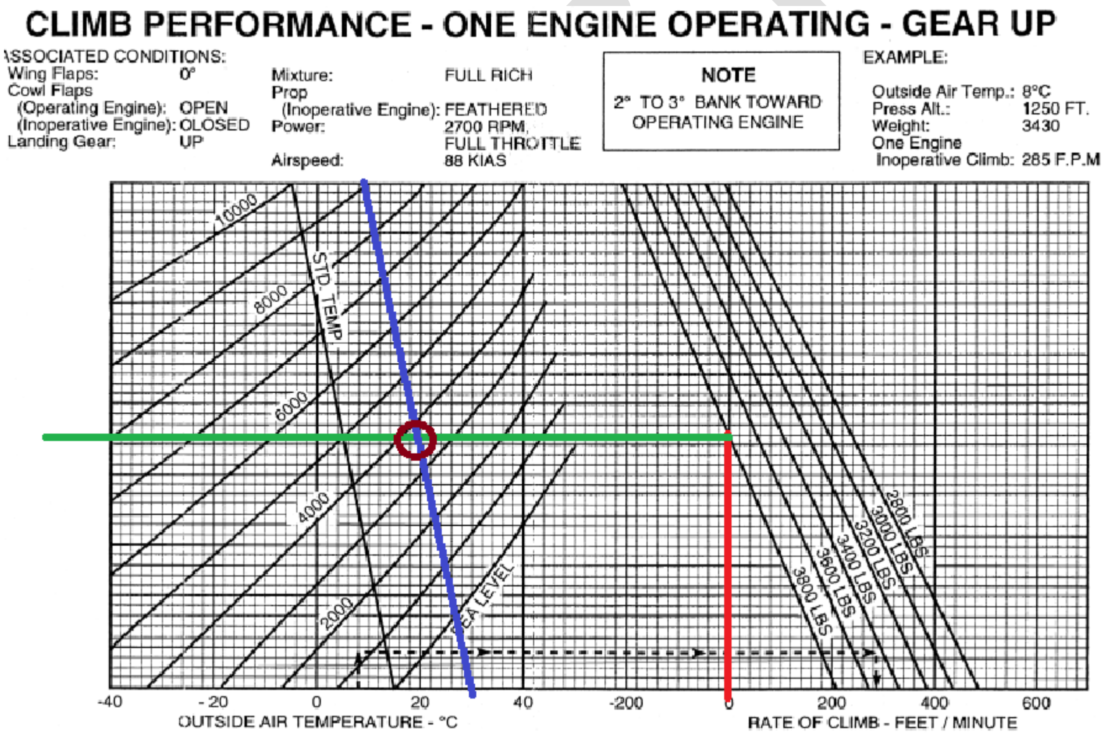
Step 3- Draw a straight line horizontally across from the intersection point to the left

Step 4- Find how much the winds aloft is above STD temperature

Step 5- Draw a line parallel to the STD TEMP reference line.

Step 6- The intersection point is the Single-engine Absolute Ceiling

Sample Question- **ONE ENGINE INOP.**, 3800 lbs, the temperature at 12,000 is 15 deg above STD temp



Answer- Approximately 3500' (rounded down for safety)

Piper Seminole Systems

General Description of the Airplane

The Seminole is a twin-engine, all-metal, retractable landing gear, fully feathering, normally aspirated, complex airplane. It has seating for up to four occupants and has a two-hundred-pound capacity luggage compartment.

Airframe

- Majority of the airframe is constructed of an aluminum alloy
- Nose cone
  - Constructed with fiberglass
- Fuselage
  - Semi-monocoque design
- T-Tail Design
  - Horizontal stabilizer or stabilator is installed on top of the vertical stabilizer
  - Deep stall characteristics
    - At high AOA, passing critical AOA, the disturbed airflow from the wing travels to the stabilator. The stabilator is less effective due to receiving the disturbed airflow, preventing the airplane from pitching down to break the stall.

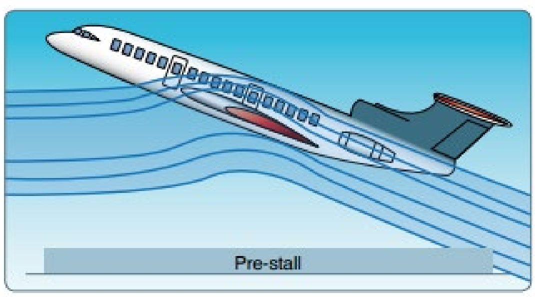
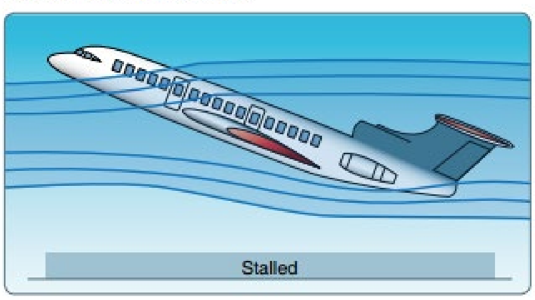


Figure 5-69. *Wingtip pre-stall.*



Source- Pilot's Handbook of Aeronautical Knowledge Chapter 5

Flight Controls

- Ailerons
    - Controlled by yoke via cables, pulleys, bellcranks, and pushrod
    - Equipped with a counterweight to prevent fluttering of the aileron
    - Types of aileron
        - Frise Type Aileron
            - The aileron being raised creates parasitic drag on the lower part of the aileron to counteract adverse yaw
        - Differential Aileron
            - The aileron going up travels more up than the aileron going down. Aileron going up deflects more into the wind, creating parasitic drag to counteract adverse yaw
- Stabilator
    - Controlled by yoke via cables, pulleys, bellcranks, and pushrod
    - Equipped with a counterweight to prevent fluttering of the aileron
    - Anti-servo trim tab
        - Controlled by trim wheel via cables, pulleys, pushrods, and trim screws
        - Moves in the direction of the stabilator
            - Increases AOA of the stabilator creating more effective control
            - Increases the pilot's control feedback
            - Increases stability as the stabilator returns to a neutral position due to the increased AOA
- Rudder
    - Controlled by yoke via cables, pulleys, bellcranks, and pushrod
    - Equipped with a counterweight to prevent fluttering of the aileron
    - Anti-servo trim tab
        - Moves in the direction of the stabilator
            - Increases AOA of the stabilator creating more effective control
            - Increases the pilot's control feedback
            - Increases stability as the stabilator returns to a neutral position due to the increased AOA
- Flaps
    - Controlled by flap handle via cables, pulley, chain, tube, and pushrod
    - Slotted Type Flap
        - Allows airflow from below the wing to travel to the top of the wing, delaying airflow separation
    - Equipped with return spring to return to 0 deg position
    - Positions
        - 0°
        - 10°
        - 25°
        - 40°

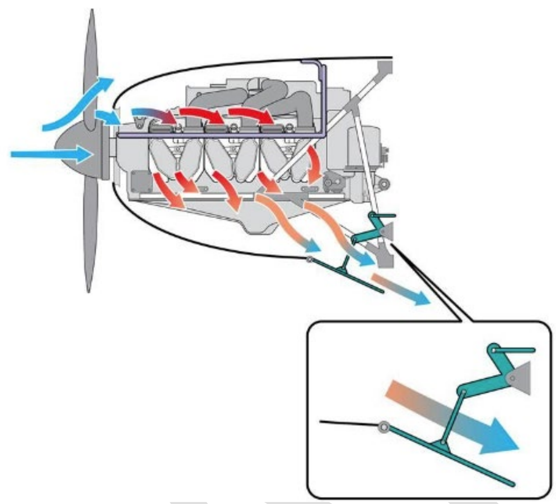
▪

Slotted Flap Visualized

Power plant and Propeller

- Power plant
  - Equipped with two O-360-E1A6D or A1H6 engine
    - Mounted by steel tubing and dynafocal engine mount to reduce vibration
    - The left engine has an additional code of L for "left"- ex LO-360-E1A6D which means it turns counterclockwise
  - Creates 180 BHP at 2700 RPM
  - Horizontally opposed 4 cylinders
    - Has displacement of 360 cubic inches in all 4 cylinders combined
    - 8 total spark plugs
  - Air cooled
    - Uses cooling fins and oil to cool the engine
  - Normally Aspirated
    - Intakes ambient air around the air intake
  - Direct drive
    - Propeller RPM is equal to the crankshaft RPM as there is no gearbox
  - Fuel Injected/Carbureted
    - Fuel Injected
      - Pro
        - Has better fuel flow
        - Better throttle response
        - Not susceptible to carb icing
        - Precise fuel control
      - Con
        - Expensive
    - Carbureted
      - Pro
        - Cheaper to replace and maintain
      - Con
        - Hard to precisely control fuel
        - Susceptible to carb icing
        - Throttle response may be delayed
  - Two magnetos per engine
    - Generates electricity for 8 sparkplugs
    - Two magnetos for efficiency and redundancy
    - Left magneto is equipped with impulse coupling
      - Impulse coupling
        - Provides ignition at engine crank speed

- Cowl Flaps
    - Manually operated by cowl flap lever
    - Changes the amount of airflow coming inside the engine cowling for cooling the engine
        - Open- Cools the engine more efficiently, but creates induced drag
        - Closed- Engine may overheat in certain conditions, but creates less induced drag (faster cruise speed)

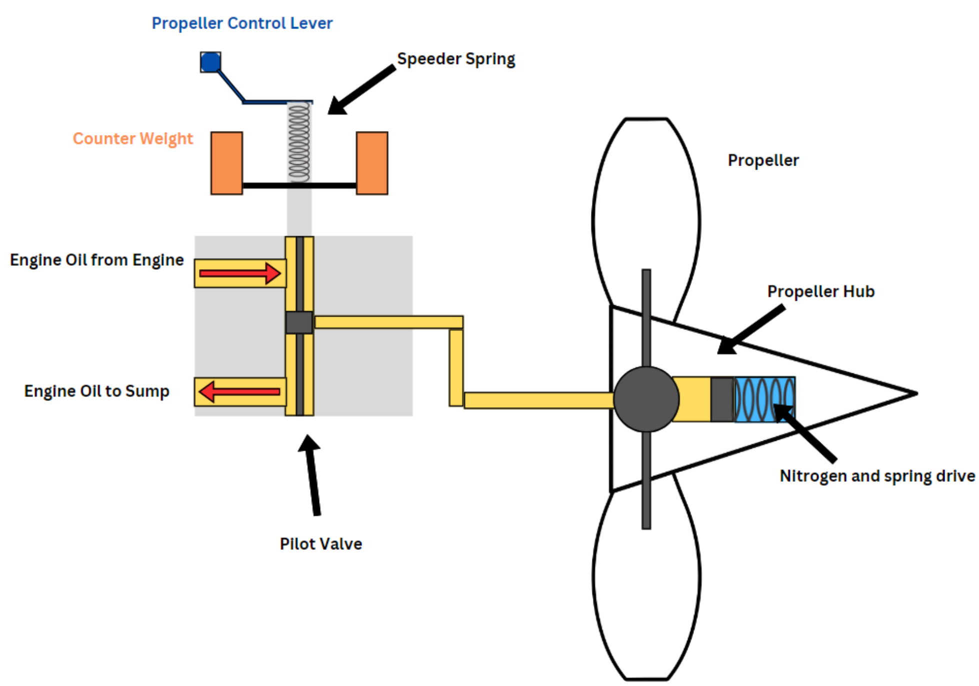


Cowl Flaps Visualized, Source- Cowl Flaps - AOPA

- Air Induction Systems
    - Two-way valve allowing air to flow to…..
        - Air filter →Induction air box →carburetor
        - Or
        - Heated air (from exhaust shroud)(has no air filter) →Induction air box →carburetor
            - Carburetor heat provides the following
                - Alternate source of air (if the air filter is clogged)
                - Melts carburetor icing
            - Carburetor heat should not be used on the ground because it is not filtered and it may damage the engine

- Propellers
    - Two-blade, constant speed, counter-rotating, controllable pitch, and feathering propeller
        - Constant Speed
            - Propeller provides constant RPM regardless of power setting
            - Propeller RPM is adjusted by the propeller control lever
        - Counter-rotating propeller
            - The left engine rotates clockwise, and the right engine rotates counter-clockwise

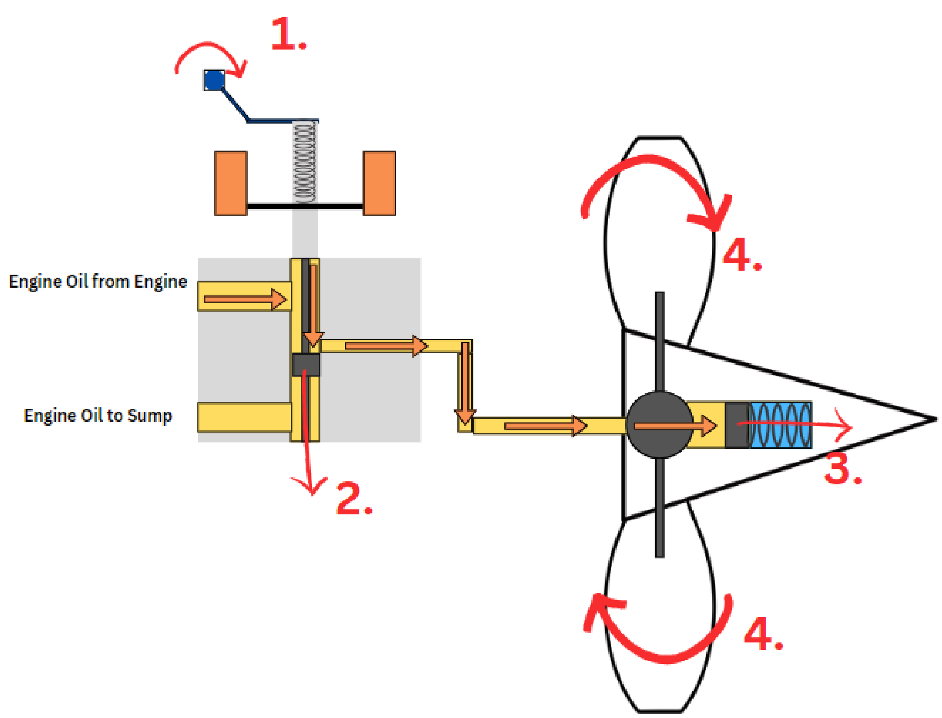
        - Eliminates critical engine
    - Feathering is only possible above 950 RPM
        - Centrifugal locking mechanism, when RPM is above 950 RPM, the centrifugal force caused by the propeller's rotation unlocks the **feathering lock**, allowing the piston to move and change the propeller angle
        - Feather is still possible even when there is no oil pressure in the engine
        - Feathering is not possible below 950 RPM because there is not enough centrifugal force to unlock the **feathering lock**
- Propeller pitch is controlled by oil and nitrogen pressure by the prop governor



Propeller System Visualized

- **Moving Propeller Control Forward (**low pitch (windmilling)/high RPM**)**
    - Allows smaller bites of air, allowing the propeller to push air faster (higher RPM) allowing more torque
    - Used for Takeoff and Landing

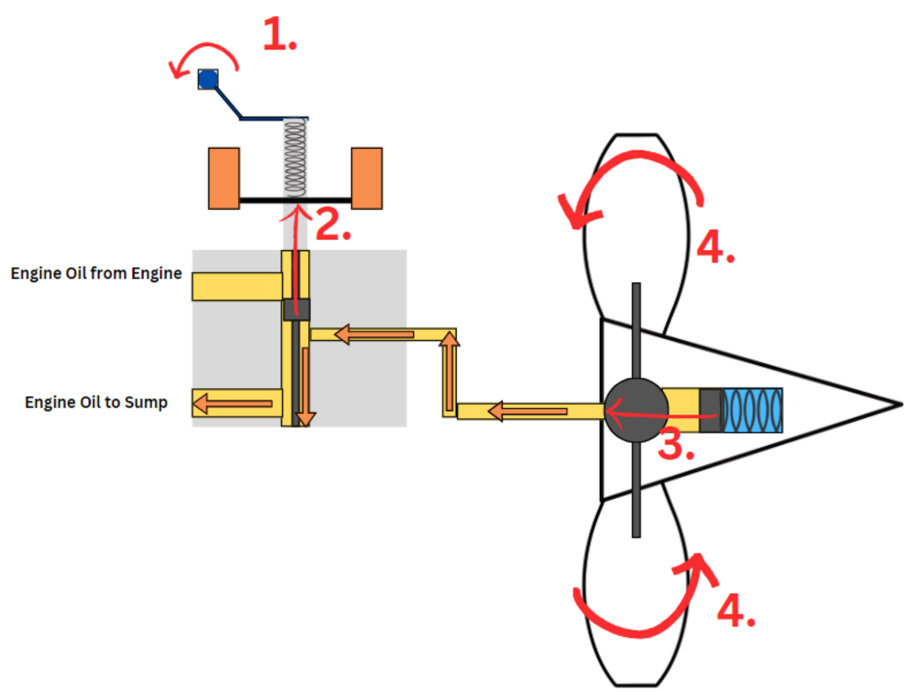
        - It is like climbing a hill on a bicycle with a low gear (low pitch) with faster pedal movement (high RPM) to allow a more efficient climb.
    - Windmilling the propeller (lowest pitch) causes the most amount of parasitic drag
    - Operations
        - 1. Propeller control moves forward
        - 2. The pilot valve is adjusted so that oil from the engine can enter the propeller hub
        - 3. The oil pressure from the engine overpowers the nitrogen and spring drive and pushes the prop hub piston forward
        - 4. The propeller angle is adjusted to a low pitch/windmilling position causing a high RPM



Prop Control Forward Visualized

- **Moving Propeller Control Backward (**high pitch (feathering)/low RPM**)**
    - Allows bigger bites of air, allowing the airplane to accelerate to a higher speed more efficiently
    - Used for Cruise

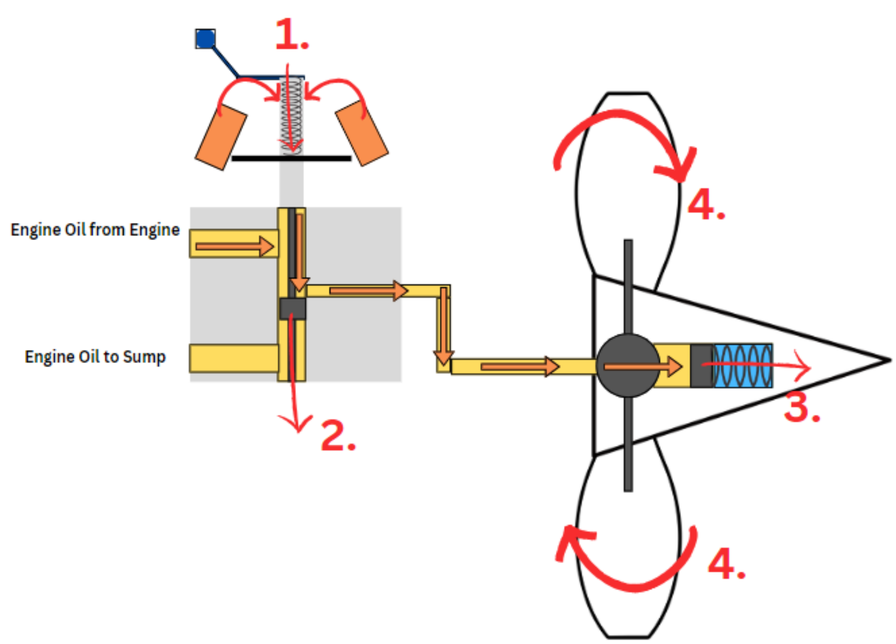
        - It is like riding a bicycle with a higher gear (high pitch) with lower pedal movement (low RPM) when you are on a flat surface, trying to gain more speed
    - Feathering the propeller (highest pitch) causes the least amount of parasitic drag
    - Operations
        - 1. Propeller control moves rearward
        - 2. The pilot valve is adjusted so that the oil is removed from the propeller hub to the sump
        - 3. The nitrogen and spring drive pushes oil back into the sump
        - 4. The propeller angle is adjusted to a high pitch/feathering position causing a low RPM



Prop Control Backward Visualized

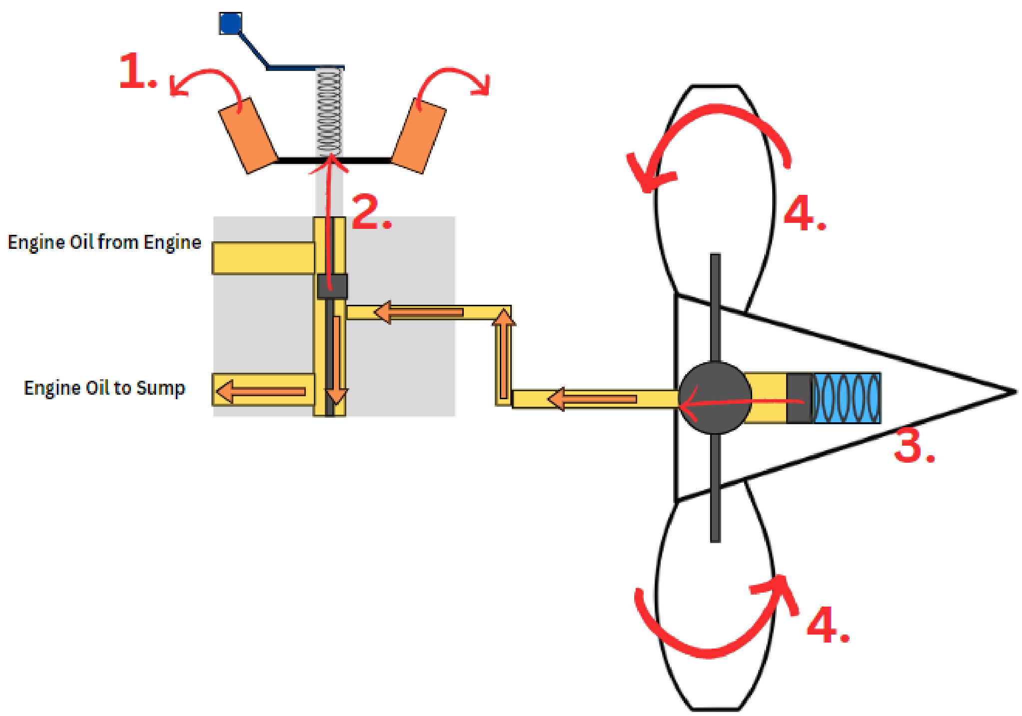
- **Propeller in Underspeed Condition**
    - Propeller RPM is too low for the given condition
        - Ex. Reducing the throttle without adjusting the prop lever
    - Operations

- 1. Speeder spring force is greater than the centrifugal force, and the counterweight tilts inwards
- 2. The pilot valve is adjusted so that oil from the engine can enter the propeller hub
- 3. The oil pressure from the engine overpowers the nitrogen and spring drive and pushes the prop hub piston forward
- 4. The propeller angle is adjusted to a low pitch/windmilling position producing a higher RPM to match the current propeller condition



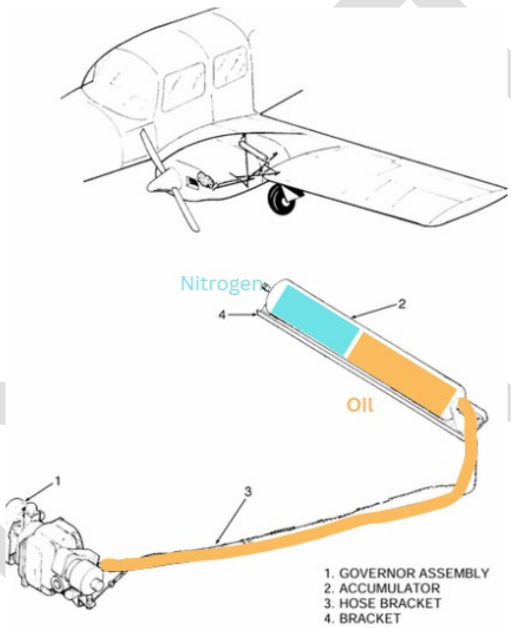
Underspeed Condition Visualized

- **Propeller in Overspeed Condition**
  - Propeller RPM is too fast for the given condition
    - Ex. Increasing the throttle without adjusting the prop lever
  - Operations
    - 1. Centrifugal force acting on the counterweight is greater than the speeder spring force, the counterweight tilts outwards
    - 2. The pilot valve is adjusted so that the oil is removed from the propeller hub to the sump
    - 3. The nitrogen and spring drive pushes oil back into the sump
    - 4. The propeller angle is adjusted to a high pitch/feathering position producing a lower RPM to match the current propeller conditions

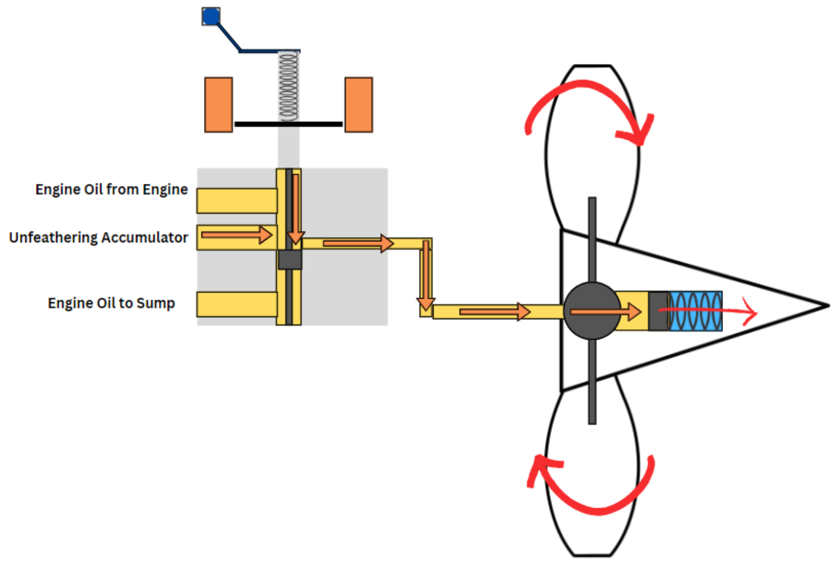


Overspeed Condition Visualized

- **Unfeathering**
  - The unfeathering procedure turns the propeller into a windmilling position which causes the most amount of parasitic drag
    - The propeller must be unfeathered before reattempting to start the engine either by windmilling start or starter motor start
  - Unfeathering accumulator holds nitrogen/oil pressure and releases it to the prop governor when the prop control lever is in the forward position
  - Feathering time
    - 10-17 seconds
  - Unfeathering time
    - 8-12 seconds



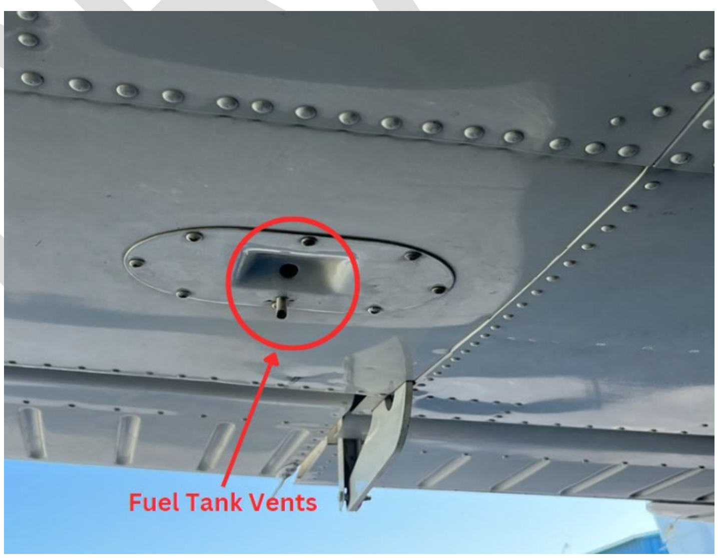
Unfeathering Accumulator Diagram, Source- Seminole PA-44-180 Maintenance Manual



Unfeathering Accumulator Operations Visualized

Oil and Fuel

- Oil
  - Wet sump system
    - Oil reservoir is built inside the engine instead of a separate compartment
  - Cooled by air using cooling fins
  - Limitations
    - Max 8 qts
    - Min 2 qts
    - Have at least 6 qts for operation at MGA
  - Has two different dipsticks reading
    - "LEFT ENGINE"
    - "RIGHT ENGINE"
    - Make sure the dipsticks are placed at the right engine
  - Shares oil with the propeller governor
- Fuel
  - Holds 110 gallons of fuel total
    - 54 gallons of usable fuel per wing
    - 1 gallon of unusable fuel per wing
  - Minimum Fuel Grade
    - 100 octane
  - Fuel Tank Vents
    - 1 per underneath the wing
    - Provides anti-icing to prevent ice formation from blocking the fuel tank vent lines



Fuel Tank Vents Visualized

  - Scupper Drain
    - 1 per underneath the engine cowling

        - Removes excess fuel in case of a spill or overfill of the wing tank

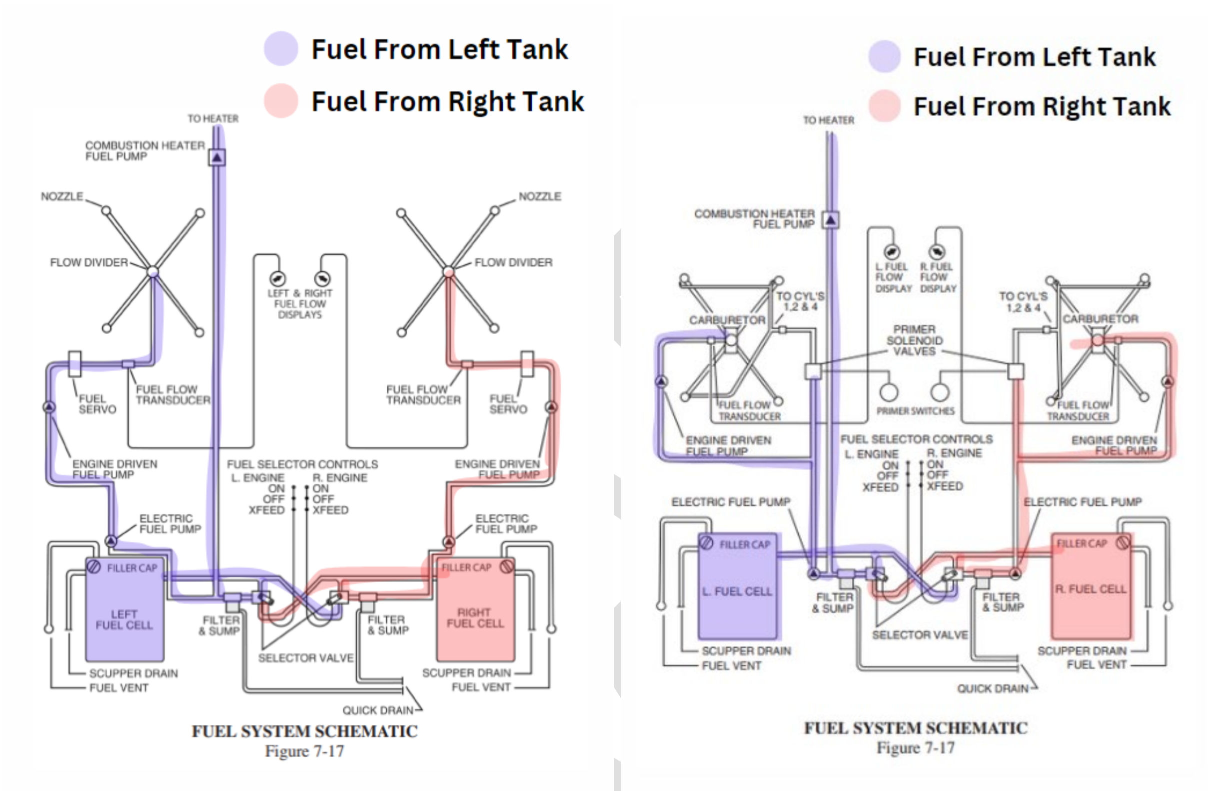
Scupper Drain Visualized

- Fuel Drain
    - 2 Drains located on the right side of the fuselage
    - Drains fuel from the lowest point of the fuel system so any contaminations can be removed from the system

Fuel Drain Visualized

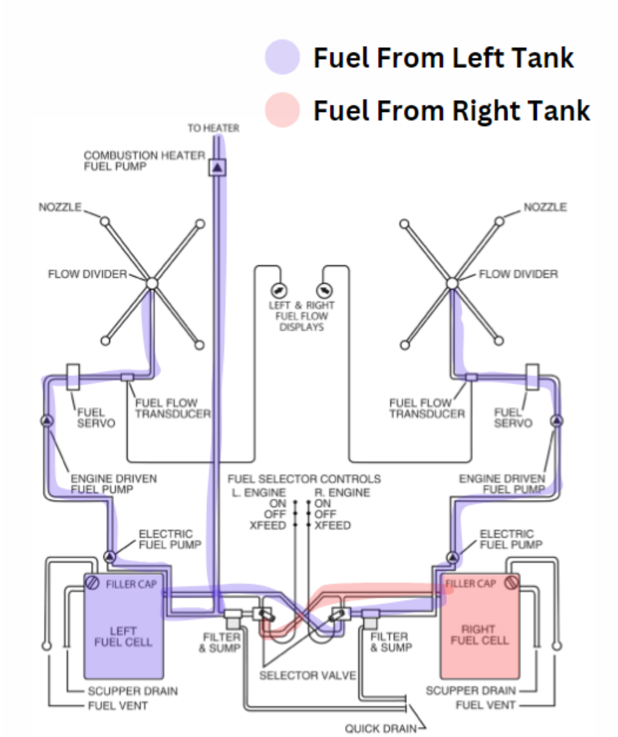
- Fuel Pumps
    - 1 engine-driven fuel pump per engine
    - 1 electrical fuel pump per engine
        - Electrical fuel pump must be on for Takeoff and Landing
- Fuel Gauges
    - Displayed on the MFD EIS window or Engine page
    - A calibrated fuel dipstick must be used for accurate reading for the fuel level

- Operations
  - General rule of Cross Feeding
    - "Hungry Tank gets the Cross Feed"
  - Fuel selectors Left and Right in the "ON" position
    - Left engine receives fuel from the Left tank
      - Left engine provides fuel for the Combustion Heater
    - Right engine receives fuel from the Right tank

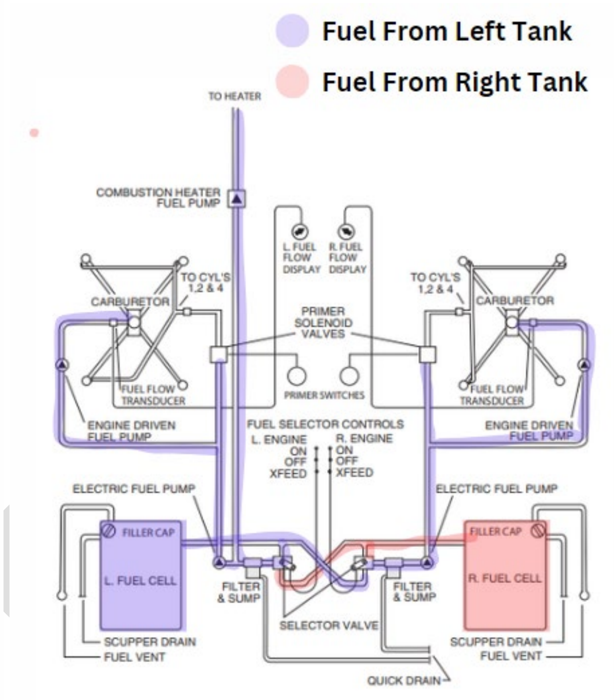


Fuel Selector L and R in ON Position Visualized

- Fuel selectors Left in the "ON" position, fuel selector Right in the "Cross-feed" position
  - Left engine receives fuel from the Left tank
  - Right engine receives fuel from the Left tank
  - Reasons to cross-feed fuel
    - Cross-feed should be used to burn excess fuel on either wing to match the fuel levels on both tanks in normal operation
    - Cross-feed is also used if there is a fuel delivery issue from the tank to the engine



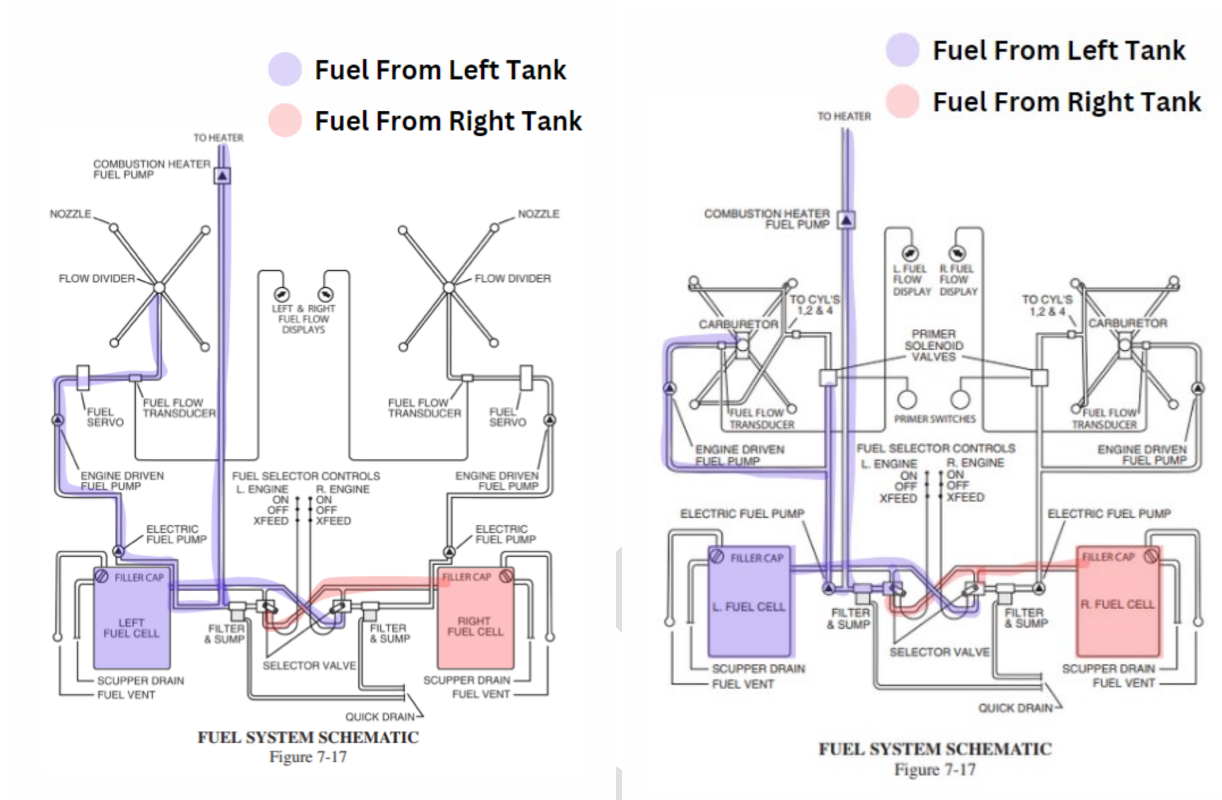
FUEL SYSTEM SCHEMATIC
Figure 7-17



FUEL SYSTEM SCHEMATIC
Figure 7-17

Fuel Selector L ON and R X-feed position visualized

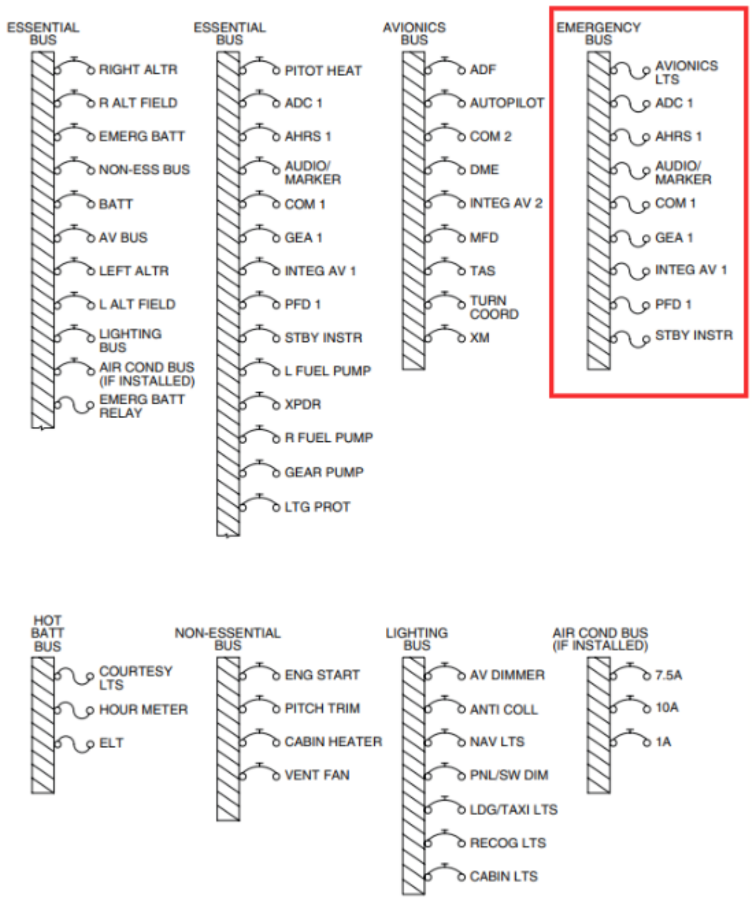
- Fuel selector Left in “ON” position, Right in “OFF” position



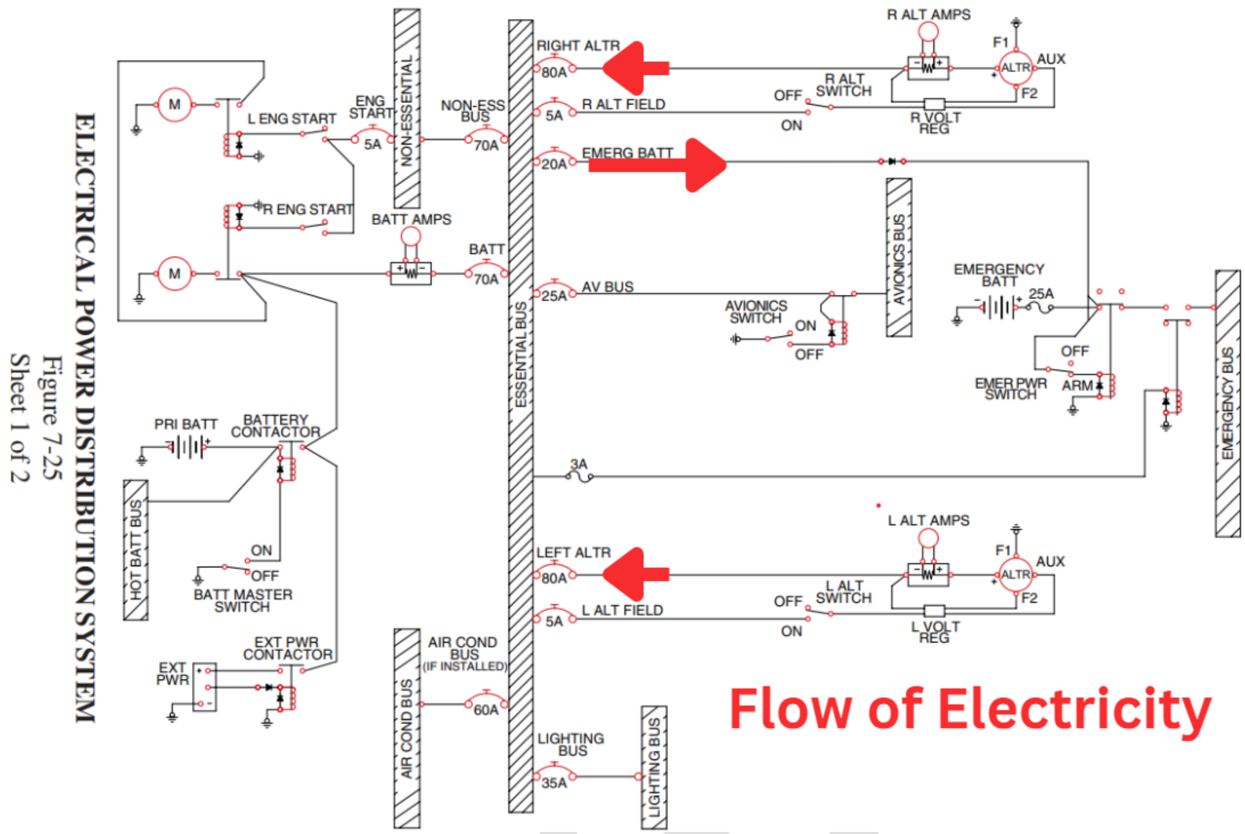
Fuel Selector L ON R OFF visualized

Electrical and Avionics

- Two belt driven Alternators
  - Provides and charges the system with 28 volt 65 amps
  - Equipped with Voltage Regulator on each alternator
    - Maintains voltage at 28 volts
      - Prevents overvoltage by taking the alternator off the line if more than 32 volts
    - Shares load between two alternators evenly
- Main Battery
  - Provides battery power with 24 volt 13.6 amps
  - Electrical power is still provided even with the Battery Master switch OFF
- Buses

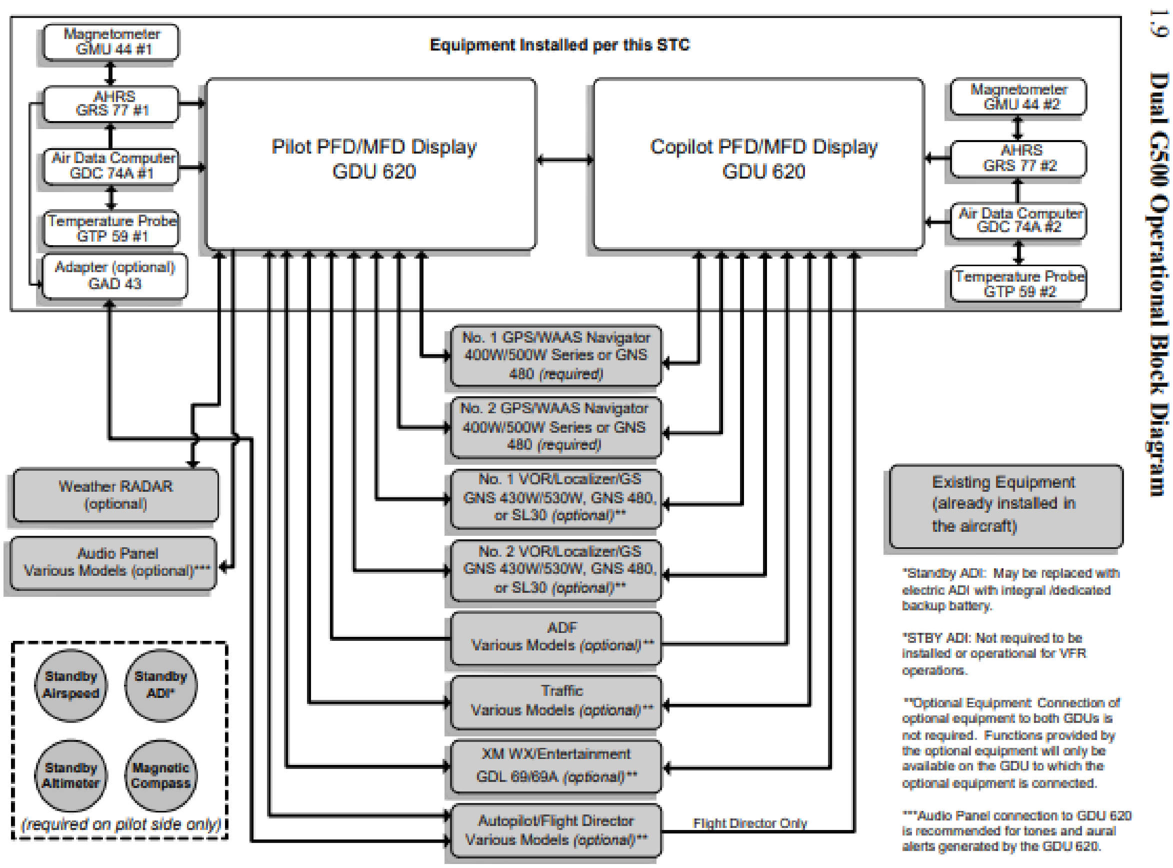


Electrical Buses, Source- Seminole PA-44-180 Information Manual



PA-44-180 Electrical Power Distribution System, Source- PA-44-180 Information Manual

- Avionics
  - Garmin system is used
    - Line replaceable unit, meaning if one component is inoperative, just that unit can be replaced instead of the entire system
  - G500 diagram



G500 Diagram, Source- Garmin G500 Manual

- G1000 diagram

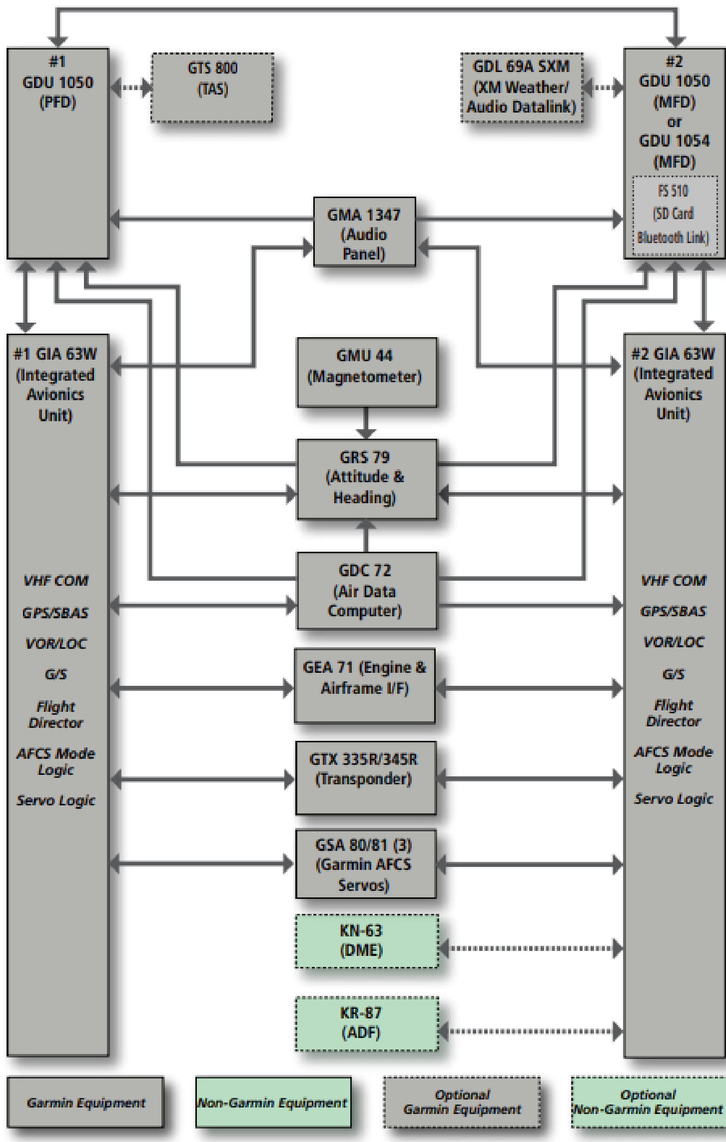
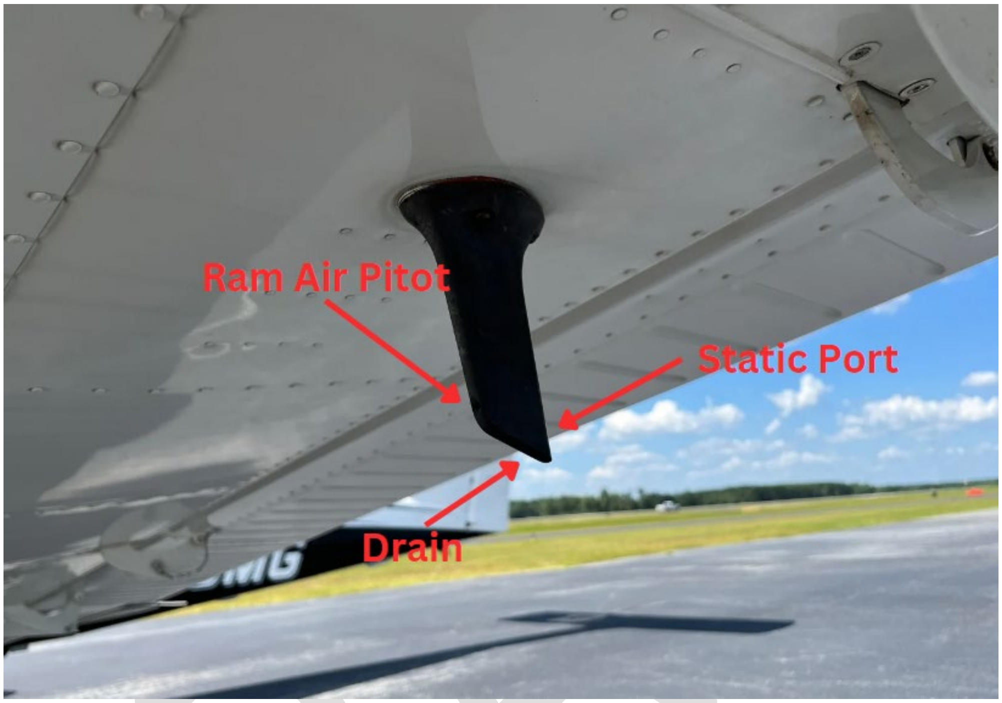


Figure 1-1 System (LRU Configuration)

G1000 Diagram, Source- Garmin G1000 Manual

Pitot-static/Stall Warning Device

- Equipped with Pitot Mast
  - Located on the bottom of the left-wing
  - Static Port, Ram Air Pitot, and Drain are located in the Pitot Mast



Pitot-static visualized

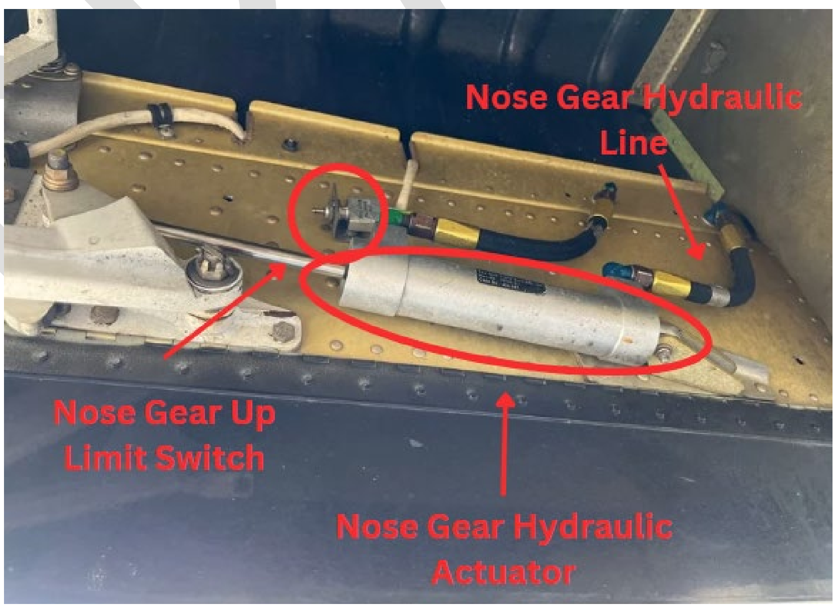
- Pitot & Static Drain
  - Located on the lower pilot side wall
  - Drains any liquids within the Pitot-static system by releasing pressure
- Alternate Static Source
  - Located on the bottom of PFD on the pilot's side
    - The alternate static port measures static pressure inside the cabin when used
- Stall Warning Vanes
  - Squat switch prevents activation of stall warning system to be activated on the ground
  - Activated 5-10 knots above stall speed
  - Located on the leading edge of the left wing
  - Inboard stall warning vane (nearest to the fuselage)
    - Activates when Flaps are 25 deg and 40 deg
  - Outboard stall warning vane (farthest from the fuselage)
    - Activates when Flaps are 10 deg or less

Stall Warning Vane Visualized

Landing Gear

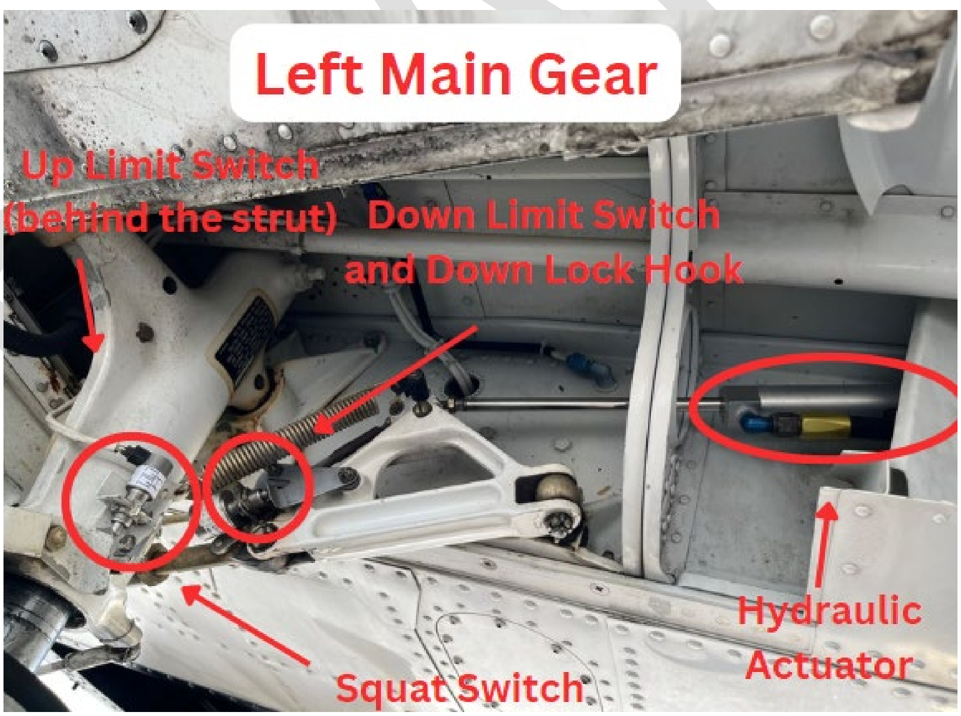
- Equipped with fully retractable tricycle landing gear
  - Equipped with gear centering spring
    - Prevents shimmy tendencies
  - Equipped with bungee assembly
    - Reduces ground steering effort and dampens shocks and bumps during taxi
  - As the gear is being retracted, the nose wheel centers itself before going inside the wheel well by disconnecting the steering linkage once the nose wheel is lifted from the ground
- Limitation
  - Max Gear Retraction speed – 109 KIAS
    - Callout
      - "Below 109 gear up"
      - "Gear up no lights"
  - Max Gear Extension/Extended speed – 140 KIAS
    - Callout
      - "Below 140 gear down"
      - "3 green, no red, 1 in the mirror gear down"
  - Max Manual Gear Extension speed- 100 KIAS
  - Max 30 degree arc nose gear steering
- Gear is operated by a 12-volt reversible hydraulic pump powered electrically controlled by two position gear selector switch
  - Hydraulic fluid is RED in color if **RED FLUID IS LEAKING, DO NOT FLY**
- Landing Gear Switches
  - Nose Gear
    - 1 Up limit switch
      - Indicates gear-up
      - Turns landing gear position indicator to hollow white circle
    - 1 Down limit switch
      - Indicates gear down
      - Turns landing gear position indicator to green circle

Nose Gear Switch Visualized 1

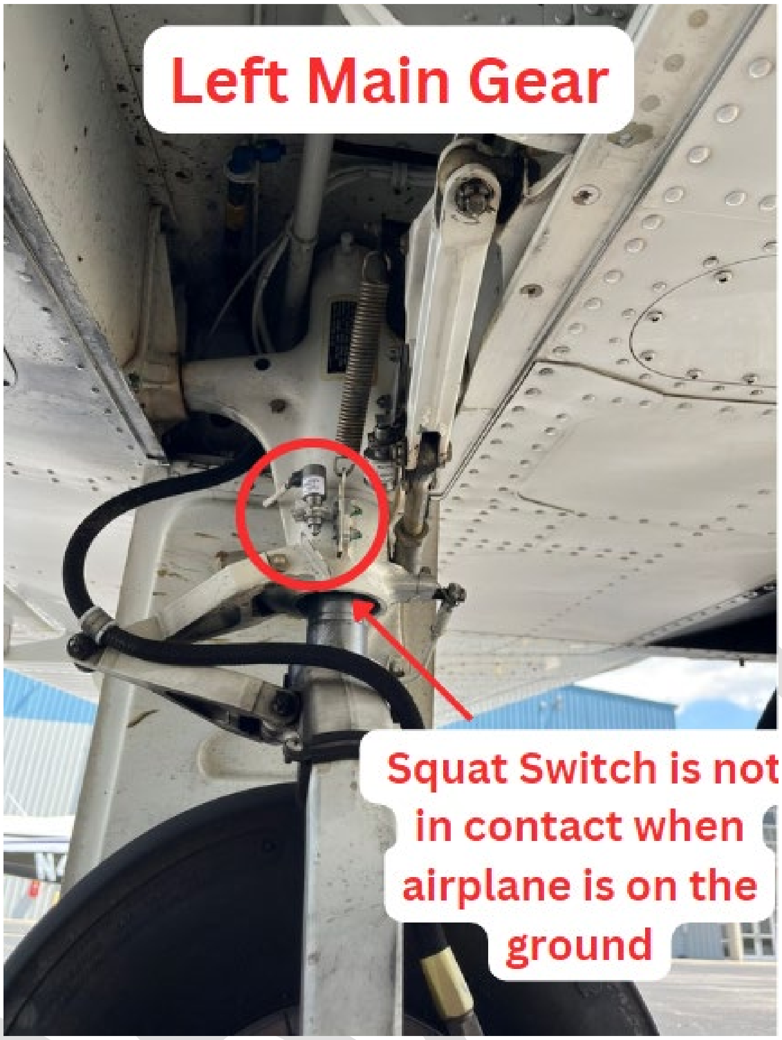


Nose Gear Switch Visualized 2

- Left Main Gear
  - 1 Up limit switch
  - 1 Down limit switch
  - 1 Squat switch
    - General function of the squat switch
      - Indicates weight on the wheel, sensing if the airplane is on the ground or airborne
    - Squat switch is not in contact when the airplane is on the ground
      - Squat switch only makes contact when weight on wheel is released (airborne)
    - Left Main Gear Squat switch specific function
      - Prevents gear retraction on the ground by preventing the hydraulic pump from actuating when the battery master switch is on
- Right Main Gear
  - 1 Up limit switch
  - 1 Down limit switch
  - 1 Squat switch
    - Activates stall warning horn and tach time upon the release of weight on the wheel

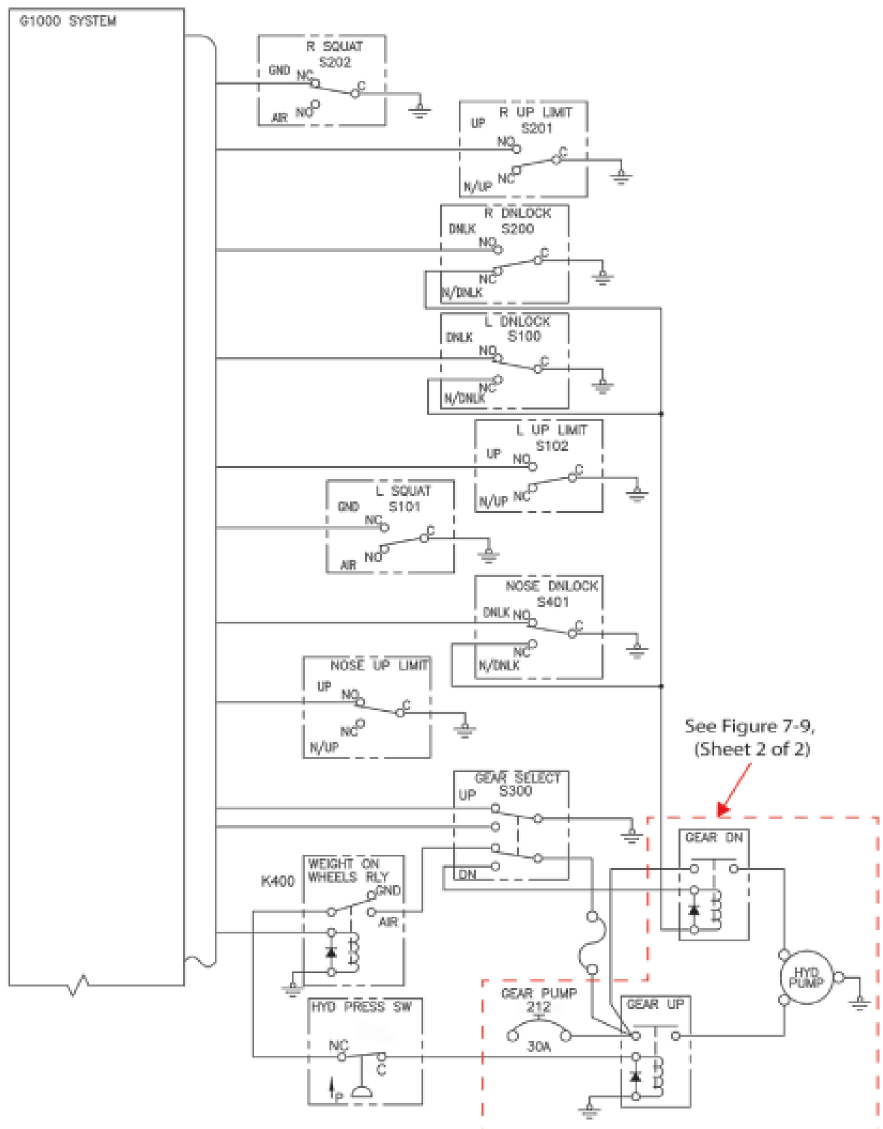


Left Main Gear Switch Visualized 1



Left Main Gear Switch Visualized 2

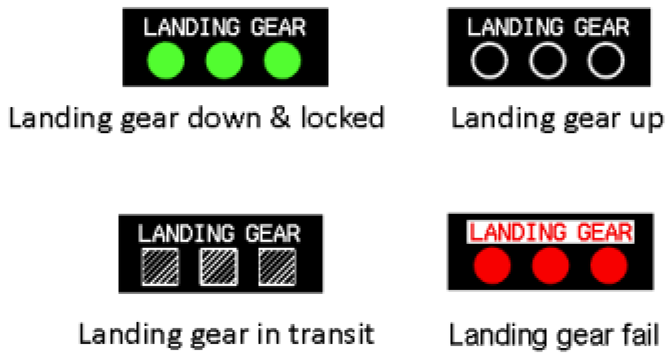
- Pressure Switch
  - De-activates gear pump once the hydraulic pressure reaches 1800 PSI, activates gear pump once hydraulic pressure decreases to 200-400 PSI



LANDING GEAR ELECTRICAL SYSTEM SCHEMATIC
Figure 7-9
(Sheet 1 of 2)

Landing Gear Electrical System Schematic, Source- Seminole PA-44-180 PIM

- Landing Gear Position Indications
    - The microswitches in landing gear systems send signals to the Advanced Flight Display system to show the current landing gear position as below

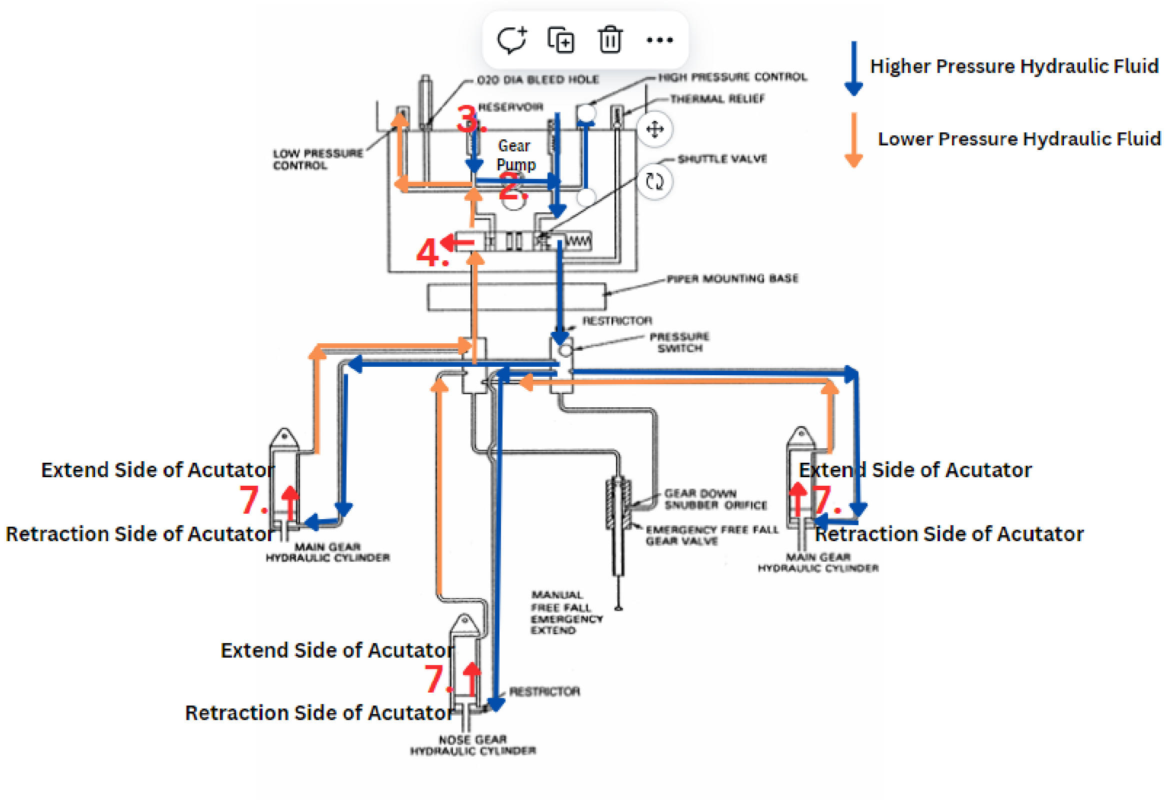


LANDING GEAR INDICATIONS
Figure 7-13

Landing Gear Indications, Source- Seminole PA-44-180 PIM

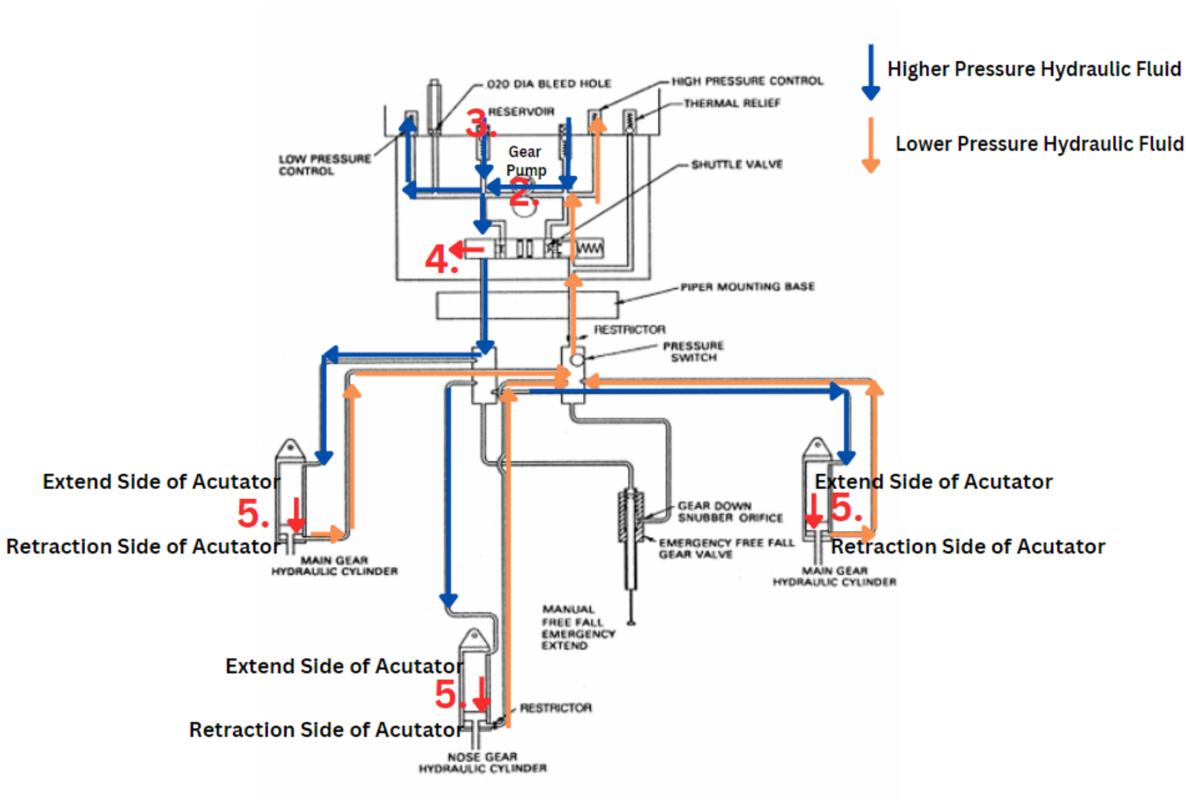
- Gear Position Unsafe
    - When the below conditions are met, Check Gear Warning and the Gear Warning/Caution Annunciator will engage during the flight
        - Gear is not down and locked and……
            - Either engine's manifold pressure is below 14 inches
            - Flaps are extended to 2nd and 3rd notch position
        - Gear selector is in the UP position but on the ground
    - Check Gear Warning can only be muted if it was triggered by low manifold pressure

- Gear Retraction
    - Operation
        - 1. Gear selector switch comes up
        - 2. Gear pump activates
        - 3. Hydraulic fluids are drawn from the reservoir
        - 4. Shuttle valve moves to a position that allows higher-pressure hydraulic fluids to travel to the retraction side of the actuator
        - 5. Down lock hook (j-hook) is disengaged
        - 6. Down limit switch is disengaged
            - Turns off the green light and turns into dashed square light
        - 7. Gear comes up by hydraulic pressure only
        - 8. Gear is fully up and Up limit switch is engaged
            - Turns off the dashed square light and turns on hollow white circle
        - 9. The pressure switch in the gear system turns off the gear pump



Gear Retraction Visualized

- Gear Extension
  - Operation
    - 1. Gear selector switch comes down
    - 2. Gear pump activates
    - 3. Hydraulic fluids are drawn from the reservoir
    - 4. Shuttle valve moves to a position that allows higher-pressure hydraulic fluids to travel to the extension side of the actuator
    - 5. Gear comes down by tension spring, gravity, and hydraulic pressure
    - 6. Up limit switch is disengaged
      - Turns off hollow white circle, turns on dashed square light
    - 7. Once the gear is fully down, it is locked by the Down lock hook (J-hook)
    - 8. Down limit switch is engaged
      - Turns off dashed square light and turns on green light



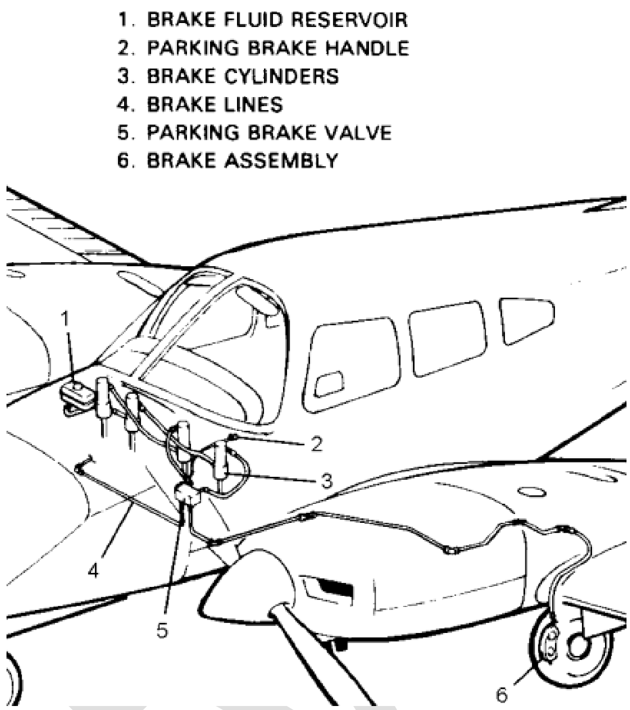
Gear Extension Visualized

- Emergency Gear Extension
    - When one or more gear appears to be in transit or not down and locked with the gear selector lever in the down position…..
    - Troubleshoot
        - Check Nav Light (On/Off)- If equipped with physical bulbs for landing gear position indicator
        - Check Circuit Breakers- Reset landing gear circuit breakers
        - Check Battery Master Switch ON
        - Check Alternator ON
    - If the gear does not come down even after troubleshooting….
        - Airspeed reduce below 100 KIAS
        - Gear selector lever to Down position
        - Pull Emergency Gear Extend Knob
            - Yaw and roll the airplane if the gear does not come down and locked fully
        - Check gear position indicator lights
    - If the gear does not come down even after pulling the Emergency Gear Extend Knob prepare for gear up landing
        - Touchdown at the lowest speed

- Emergency Gear Extension Operation
    - 1. Gear selector switch comes down
    - 2. Reduce airspeed below 100 KIAS
    - 3. Pull the emergency gear extend knob
    - 4. The Emergency Free Fall Gear Valve opens and equalizes pressure between retraction and extension hydraulic lines
    - 5. Gear comes down by Gravity and Tension Spring
    - 6. Gear comes down fully and Down Limit Switch is engaged
        - Turns off red light and turns on green light
    - 7. Down lock hook (j-hook) is engaged

Brake

- Operated by two pedals on the pilot and front passenger seat
  - Brake Fluid Reservoir is directly connected to the front passenger pedals
- Parking brake
  - Operated by holding hydraulic pressure within the brake system by pulling the parking brake knob



Brake System, Source- PA-44-180 Information Manual

Anti-ice/De-ice

- Pitot heat
  - Prevents ice formation on the pitot mast
- Carburetor heat/alternate air
  - De-ices any carburetor icing present in the system
  - Provides alternate air in case the air filter is clogged due to icing formation
- Heater/Defroster
  - Prevents ice formation on the front windshield
- Fuel tank vent
  - Provides anti-icing to prevent ice formation from blocking the fuel tank vent lines
- Fuel additives
  - Adds alcohol to lower the freezing point of the fuel

Environmental

- Heater/Defroster
  - Provided by Janitrol combustion heater located in the forward fuselage
    - Fuel is drawn from the left fuel tank by an electrical fuel pump to be ignited in the heater
    - Uses ½ gallons per hour
  - Fresh cold air from Fresh Air Inlet is heated up from the heater (heated by fuel and air combustion) and then enters the cabin
    - Potential risk for Carbon Monoxide poisoning if there is a leak in the heating system

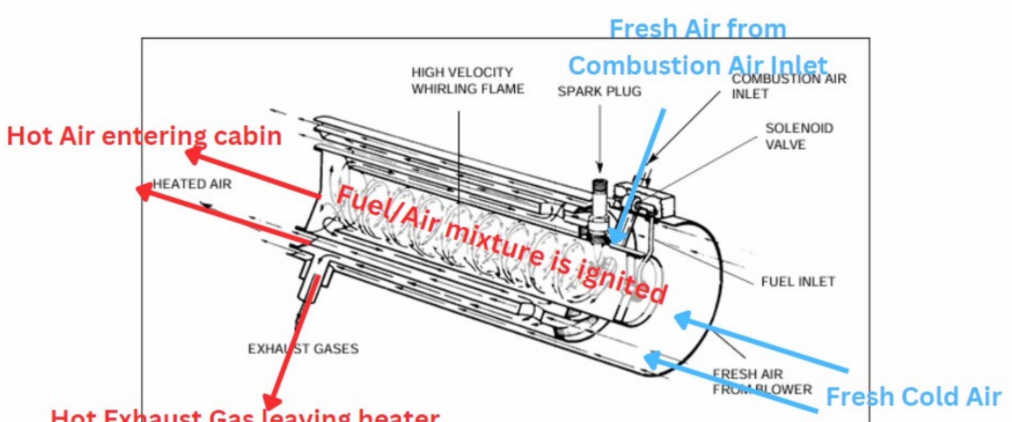
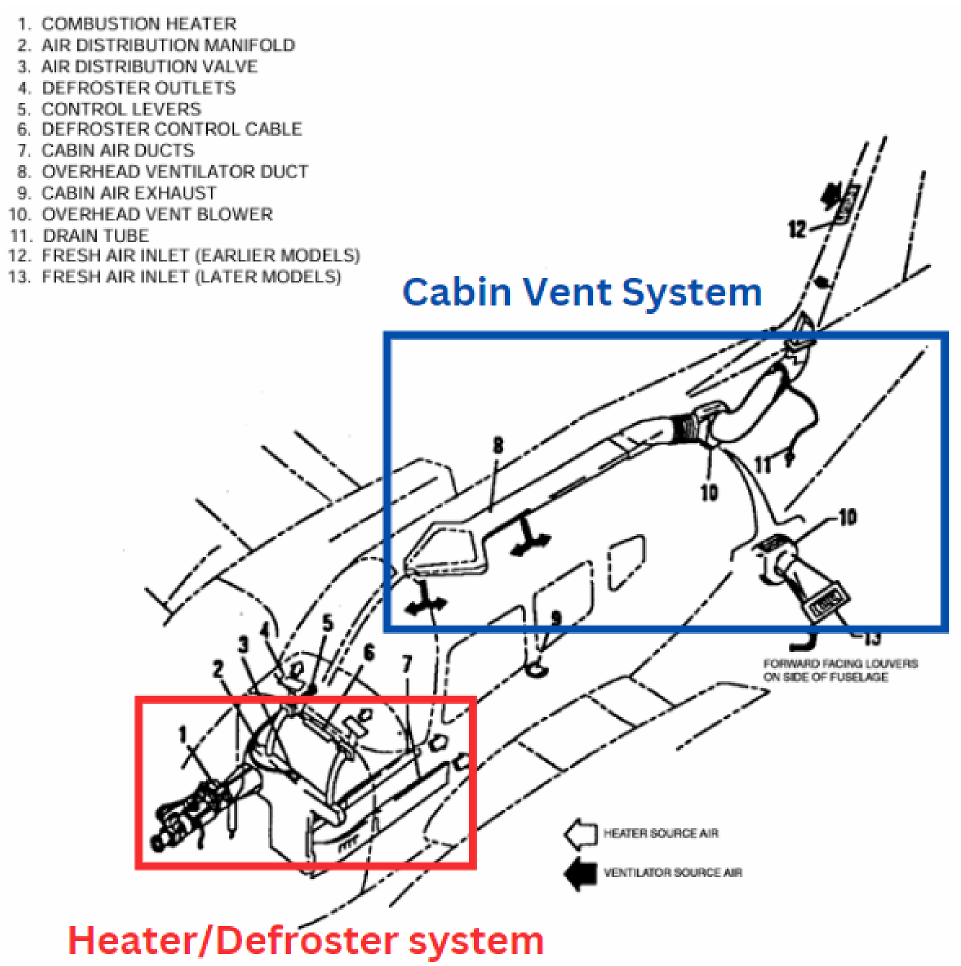


Figure 21-3. Diagramatic Cutaway of Heater to Show Whirling Flame Action

Heating System Visualized, Source- Seminole PA-44-180 Maintenance Manual

- Ventilation
    - Ventilation is provided by a ventilation fan positioned in the rear empennage of the airplane
        - Provides fresh unheated air to enter the cabin



Environmental System, Source- Seminole PA-44-180 Maintenance Manual

Glossary of Terms

VR —rotation speed—speed at which back pressure is applied to rotate the airplane to a takeoff attitude.

VLOF —lift-off speed—speed at which the airplane leaves the surface. (Note: Some manufacturers reference takeoff performance data to VR, others to VLOF.)

VX —best angle of climb speed—speed at which the airplane gains the greatest altitude for a given distance of forward travel.

VXSE —best angle-of-climb speed with OEI.

VY —best rate of climb speed—speed at which the airplane gains the most altitude for a given unit of time.

VYSE —best rate of climb speed with OEI. Marked with a blue radial line on most airspeed indicators. Above the single-engine absolute ceiling, VYSE yields the minimum rate of sink.

VSSE —safe, intentional OEI speed—originally known as safe single-engine speed. It is the minimum speed to intentionally render the critical engine inoperative.

VREF —reference landing speed—an airspeed used for final approach, which is normally 1.3 times VSO, the stall speed in the landing configuration. The pilot may adjust the approach speed for winds and gusty conditions by using VREF plus an additional number of units (e.g.,VREF+5).

VMC —currently defined in 14 CFR part 23, section 23.2135(c) as the calibrated airspeed at which, following the sudden critical loss of thrust, it is possible to maintain control of the airplane. VMC is typically marked with a red radial line on most airspeed indicators [Figure 13-1]. VMC was previously defined in 14 CFR part 23, section 23.149 as the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane with that engine still inoperative, and thereafter maintain straight flight at the same speed with an angle of bank of not more than 5 degrees. This definition still applies to airplanes certified under that regulation. There is no requirement under either determination that the airplane be capable of climbing at this airspeed. VMC only addresses directional control. Further discussion of VMC as determined during airplane certification and demonstrated in pilot training follows later in this chapter

Accelerate-stop distance— is the runway length required to accelerate to a specified speed, 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 Vr or as specified by the manufacturer.

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

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

Single-Engine 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.

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

References

1. Jeppesen Multi-Engine Manual
2. Airplane Flying Handbook (FAA-H-8083-3C) Chapter 13
3. Pilot’s Handbook of Aeronautical Knowledge (FAA-H-8023-25C) Chapter 4, 5 and 11
4. Flying Light Twins Safely (FAA-P-8740-66)
5. Seminole PA-44-180 Information Manual
6. Seminole PA-44-180 Maintenance Manual
7. Operator’s Manual Lycoming O-360 Series, Garmin G500 Manual, Garmin G1000