Piper Arrow

Single-engine Guide

MIDDLE GEORGIA STATE UNIVERSITY

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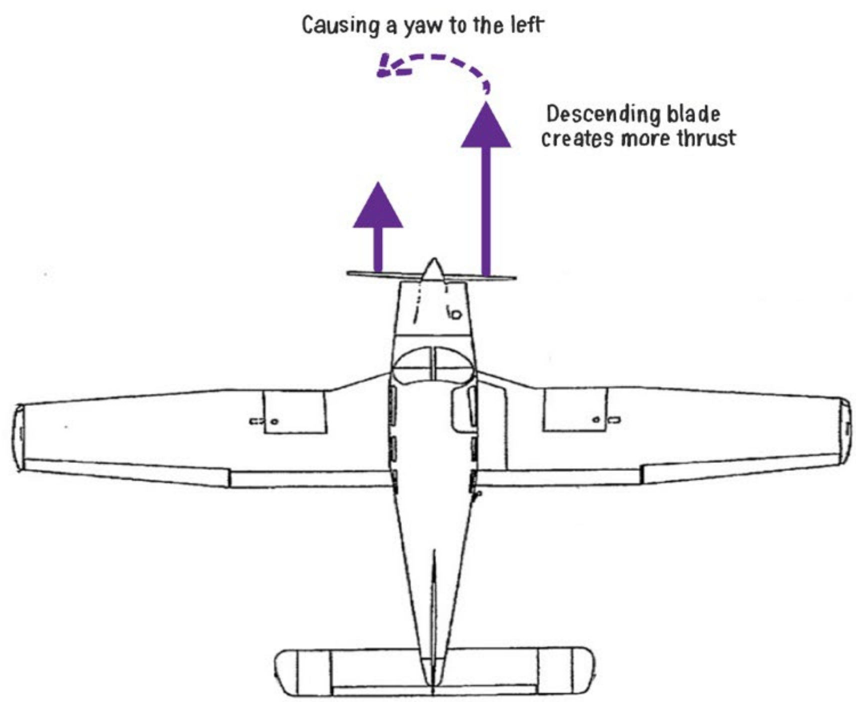
Section I: Single-engine Aerodynamics

Left-Turning Tendencies

Each blade of a propeller is fundamentally a rotating airfoil. The propeller produces a force called thrust, which pushes or pulls the aircraft through the air. Due to this force, there are four left-turning tendencies that you might experience during flight.

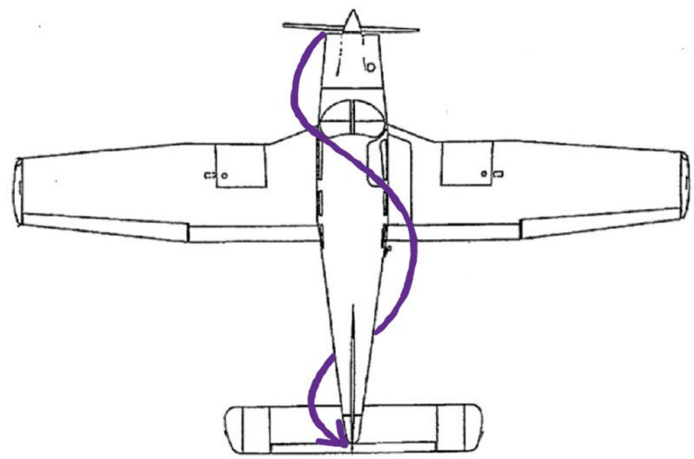
P-Factor

- P-factor, also known as asymmetric propeller loading, occurs when the descending blade of the propeller takes a bigger "bite" of air than the ascending blade. When the aircraft is flying at a greater angle of attack, the descending blade moves at a higher velocity. When the velocity of the airfoil increases, lift increases. Therefore, the descending blade produces more lift, or thrust, causing the aircraft to yaw to the left.



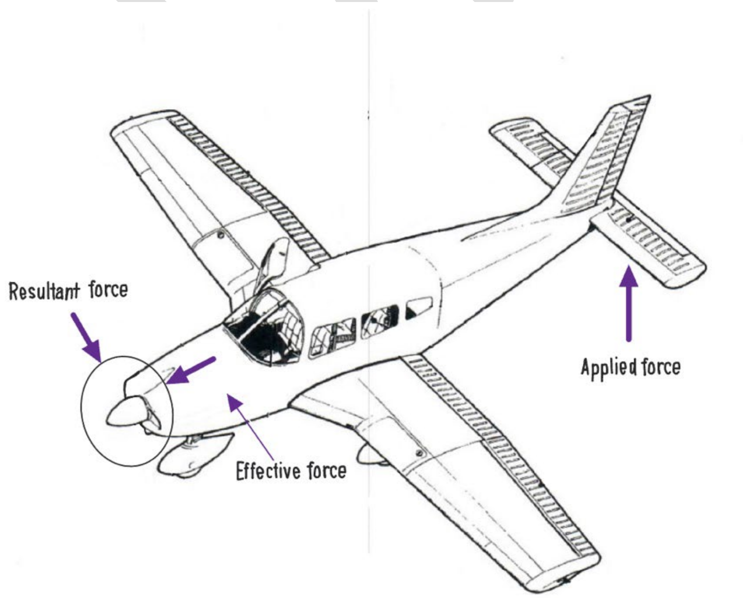
Spiraling Slipstream

- Spiraling slipstream occurs due to the high-speed rotation of the aircraft's propeller. The airflow coming from the propeller wraps around the fuselage of the aircraft, like a corkscrew. This normally occurs then the speed of the propeller is high, and the speed of the aircraft is slow (such as in takeoff configuration). When the airflow wraps around the plane, it strikes the tail of the aircraft, causing a yawing motion to the left.



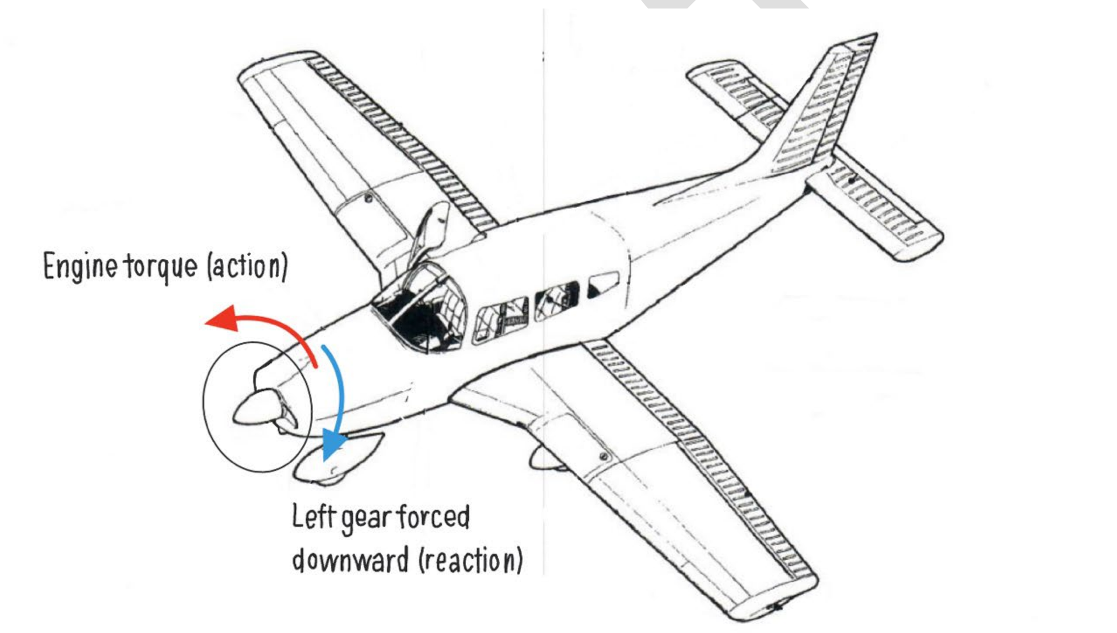
Gyroscopic Precession

- A gyroscope is a mounted wheel or disk that rapidly spins around an axis. On the airplane, the propeller acts as a gyroscope. There are two principles of gyroscopes: precession and rigidity in space. For this turning tendency, precession is the principle being considered. Precession is the resultant action when a force is applied to the spinning disk. When this force is applied, the resultant action (force) occurs 90 degrees later in the direction of rotation. This can cause a pitching motion, yawing motion, or both depending on where the force was first applied.



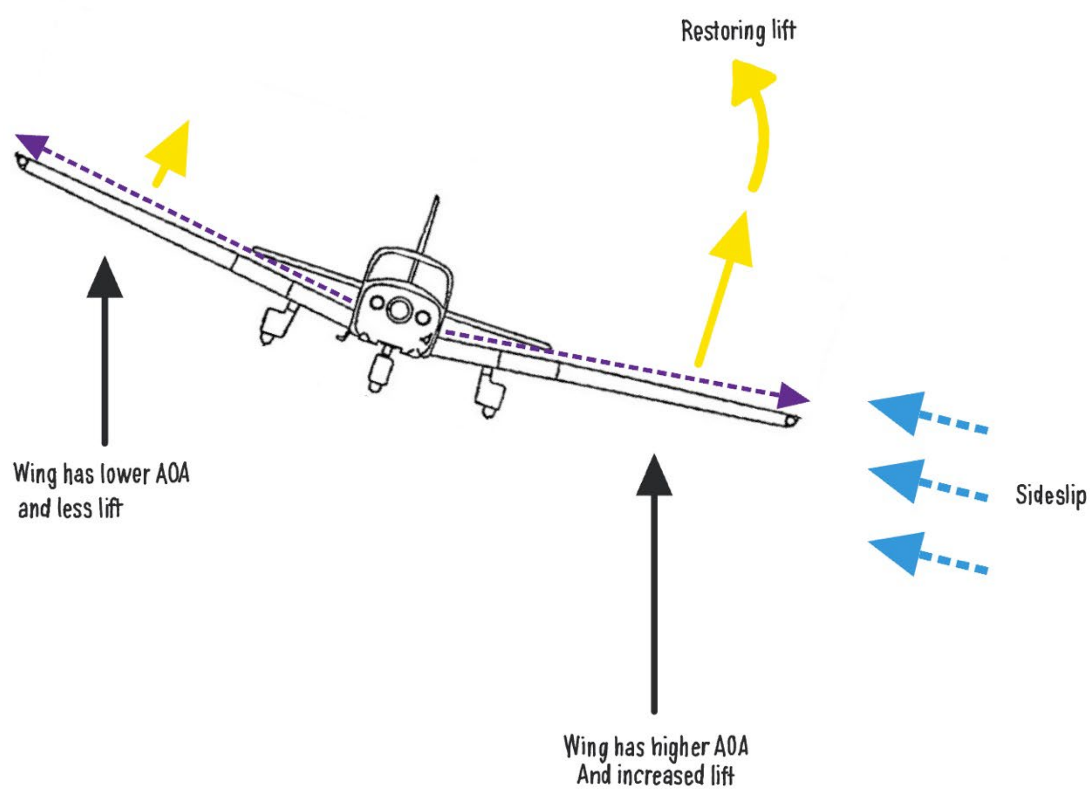
Torque

- The principle of torque is based on Newton's Third Law that states "every action has an equal and opposite reaction". The clockwise rotation of the engine and propeller to the right (the action) forces the left landing gear of the aircraft to push down on the ground (the reaction).



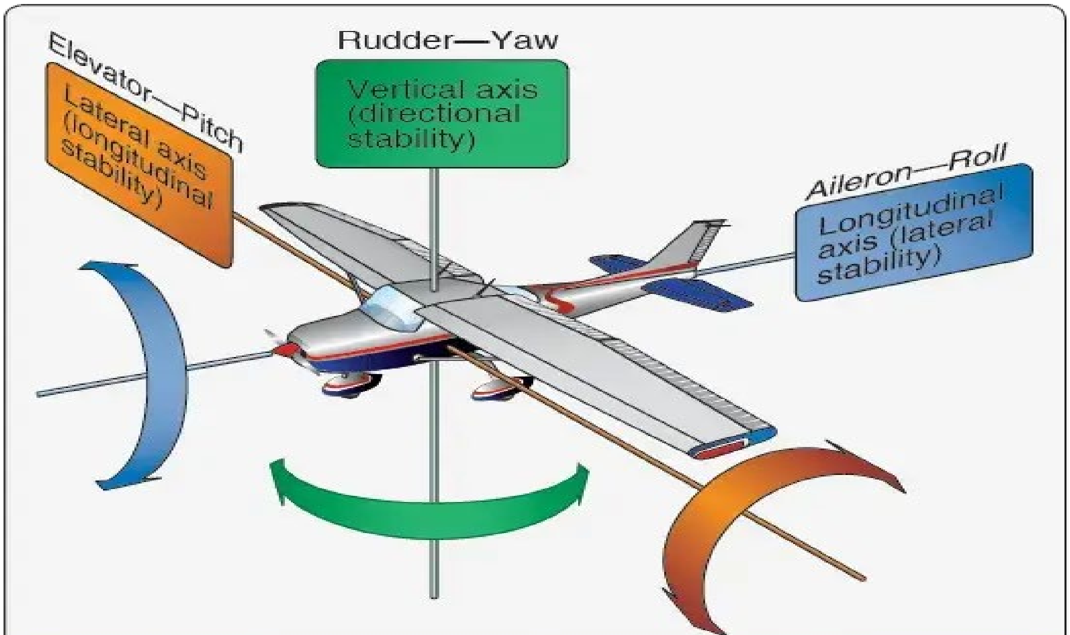
Dihedral Wings

Dihedral wings are when the aircraft's wing tip is at a higher angle than the wing's root. Dihedral wings make the aircraft more laterally stable, meaning the aircraft is more stable in a bank. in certain conditions, wind can cause the aircraft to roll into a sideslip. The sideslip changes where the relative wind is coming from, therefore changing the AOA and lift of the wing. With the lower wing having a higher AOA, it also has increased lift. The relative wind strikes under the wing that is lowered, which pushes it back up towards the level position.



Stability

Stability is the inherent quality of an airplane to correct for conditions that disturb equilibrium and return to its original state or flight path. There are 3 different types of stability around each of the axes of rotation:

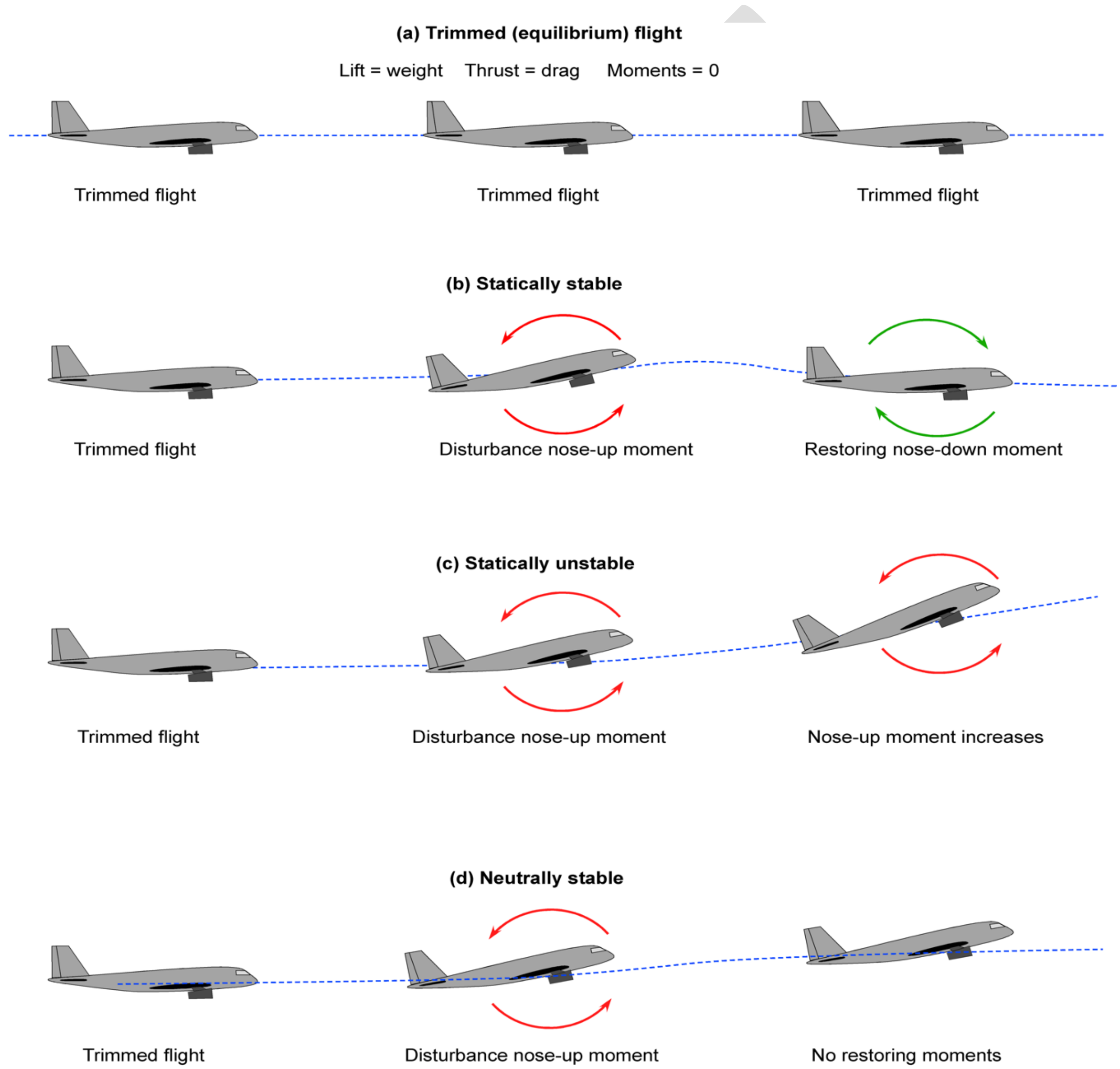


Primary Control Surface	Airplane Movement	Axes of Rotation	Type of Stability
Aileron	Roll	Longitudinal	Lateral
Elevator/ Stabilator	Pitch	Lateral	Longitudinal
Rudder	Yaw	Vertical	Directional

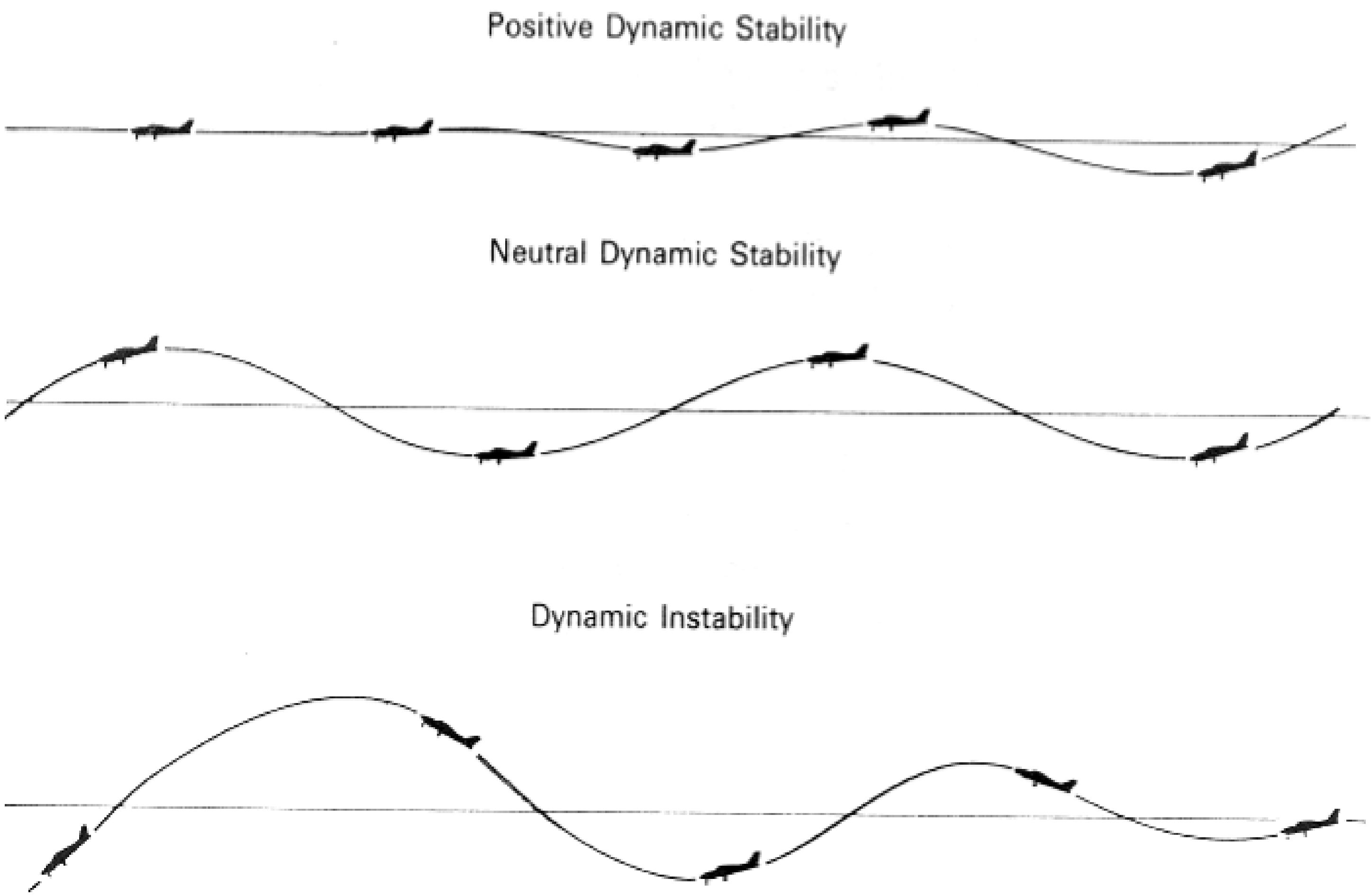
Static and Dynamic Stability

Aside from longitudinal, lateral, and directional stability, there is also static and dynamic stability.

Static stability is the initial tendency that airplane displays after its equilibrium is disturbed, or how it initially moves relative to the trimmed position. The aircraft will either experience positive, neutral, or negative static stability. Positive stability means the aircraft initially reverts to the trimmed position. Neutral stability means the aircraft stays in the position the disturbance caused. Negative stability means the aircraft continues further in the direction of the disturbance.



Dynamic stability is the aircraft's response over time to the disturbance that has been created to the aircraft's pitch, yaw, or roll. Like static stability, the aircraft will either experience positive, neutral, or negative dynamic stability. Positive stability means that over time, the aircraft will deviate back toward the original state. Neutral stability means the aircraft will stay displaced, not returning to the original state nor trending further away. Negative stability means oscillations getting bigger or going further and further from the original state as time goes on.

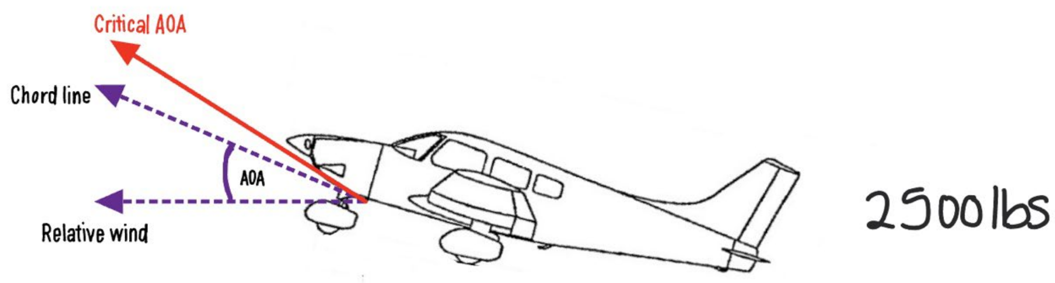


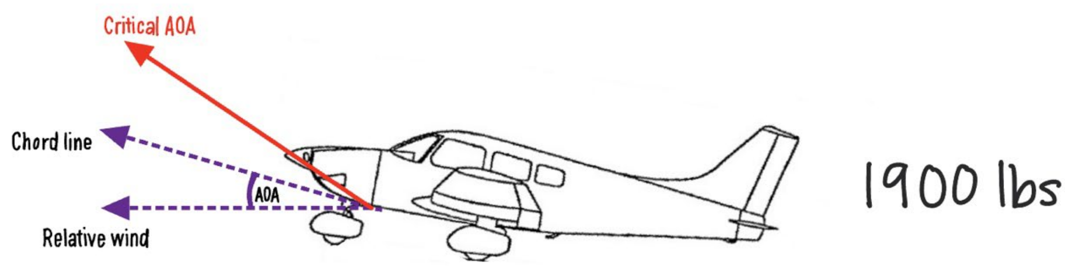
Stall speed and Maneuvering Speed

A stall is a reduction in lift as the airfoil exceeds the critical angle of attack. The speed at which a stall occurs can vary based on the weight of the aircraft.

When the aircraft is at a higher weight, it must maintain a higher angle of attack, to create enough lift to support the weight of the plane. Maintaining this higher AOA means that the aircraft is closer to the critical angle of attack, therefore, causing the airplane to stall at a higher speed.

When the aircraft is at a lower weight, enough lift can be generated to support the plane at a lower angle of attack. Therefore, you will be further from the critical angle of attack, and your stall speed will be decreased.





Maneuvering speed is the speed at which a full-scale deflection of the flight controls about one axis is guaranteed to stall the plane before causing structural damage. However, it is important to remember that the maneuvering speed is everchanging based on weight. The same rule applies with maneuvering speed as it does with stall speed. When the aircraft's weight is greater, you must fly at a higher angle of attack to maintain enough lift to support the aircraft. Therefore, when you are at a higher AOA with a higher stall speed, the speed at which the full-scale deflection can be safely done also increases.

When you increase the angle of attack to create more lift, you are increasing the load factor. The load factor is measured in G's (acceleration of gravity) and is the ratio of lift to the weight of the aircraft. For example, when an aircraft is experiencing 2 G's, the load being placed on the aircraft is twice its weight. When you increase the load factor, maneuvering speed is increased

Section II: Speeds, Weights, and Performance

Piper Arrow PA28R-201 Speeds

Speed	KIAS	Description	Airspeed Indicator Marking
V_{SO}	55	Stall speed in landing configuration	Bottom of white arc
V_S	60	Stall speed with no flaps	Bottom of green arc
V_R	60-71	Rotation speed	
V_X	72	Best angle of climb with gear down, flaps up	
V_X	78	Best angle of climb with gear up and flaps up	
V_Y	78	Best angle of climb with gear down, flaps up	
V_Y	90	Best rate of climb, gear up, flaps up	
V_G	79	Best glide speed at max weight	
V_{FE}	103	Maximum flap extension speed	Top of white arc
V_{LO}	107	Maximum Landing Gear Retraction Speed	
V_{LE}	129	Maximum Landing Gear Extension Speed	
V_{NO}	146	Max structural cruising speed	Top of green arc
V_{NE}	183	Never exceed speed	Red line
V_A	118	Maneuvering speed at 2,750 lbs.	
V_A	96	Maneuvering speed at 1,865 lbs.	

The maximum demonstrated crosswind is 17 knots

Piper Arrow PA28R-201 Weight and Balance

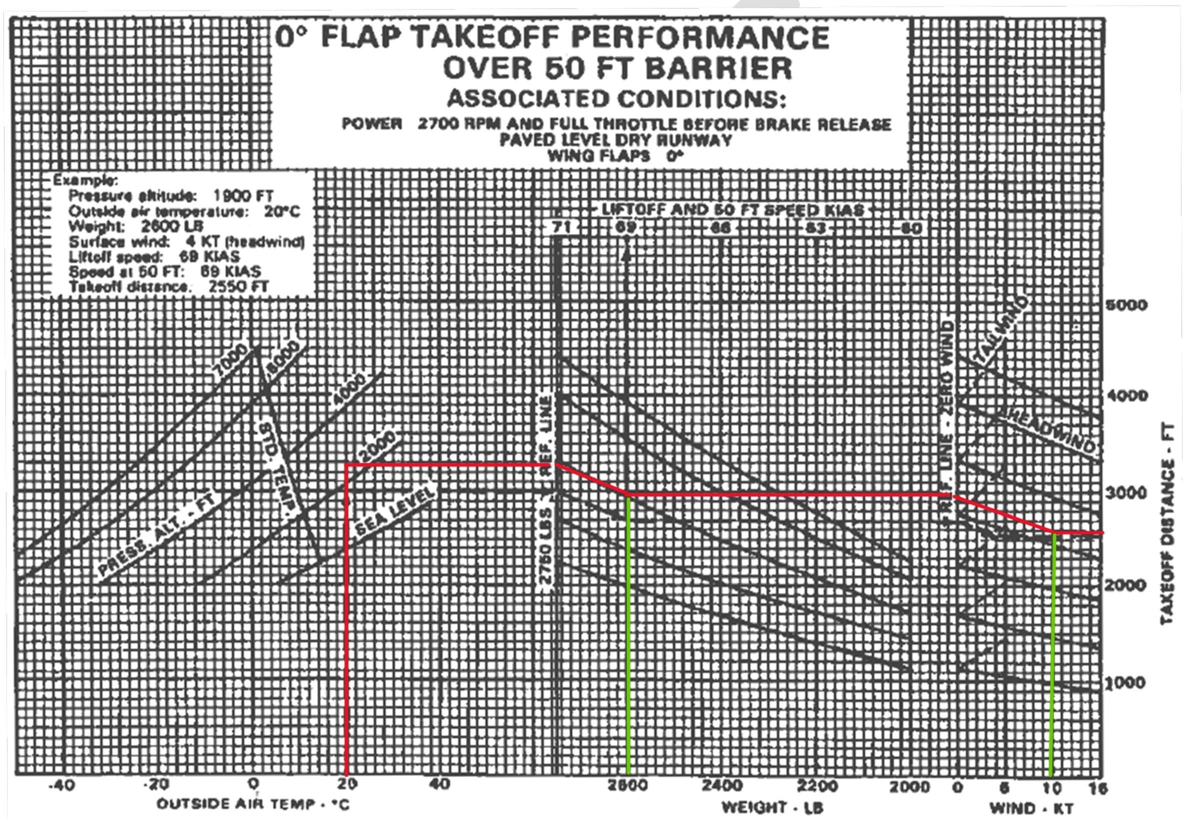
Maximum Ramp Weight (lbs.)	2,758
Maximum Takeoff Weight (lbs.)	2,750
Maximum Landing Weight (lbs.)	2,750
Maximum Weight in Baggage compartments (lbs.)	200

	Weight (Lbs)	Arm Aft Datum (Inches)	Moment (In-Lbs)
Basic Empty Weight	1890	84.8	160272
Pilot and Front Passenger	340.0	80.5	27370
Passengers (Rear Seats)	170.0	118.1	20077
Fuel (72 Gallons Maximum)	294	95.0	27930
Baggage (200 Lbs. Maximum)	64	142.8	9139
Ramp Weight (2758 Lbs. Maximum)	2758	88.76	244788
Fuel Allowance For Engine Start, Taxi, and Run-Up	-8	95.0	-760
Moment due to Retraction of Landing Gear			819
Takeoff Weight (2750 Lbs. Maximum)	2750	89.04	244847

Takeoff and Landing Distances

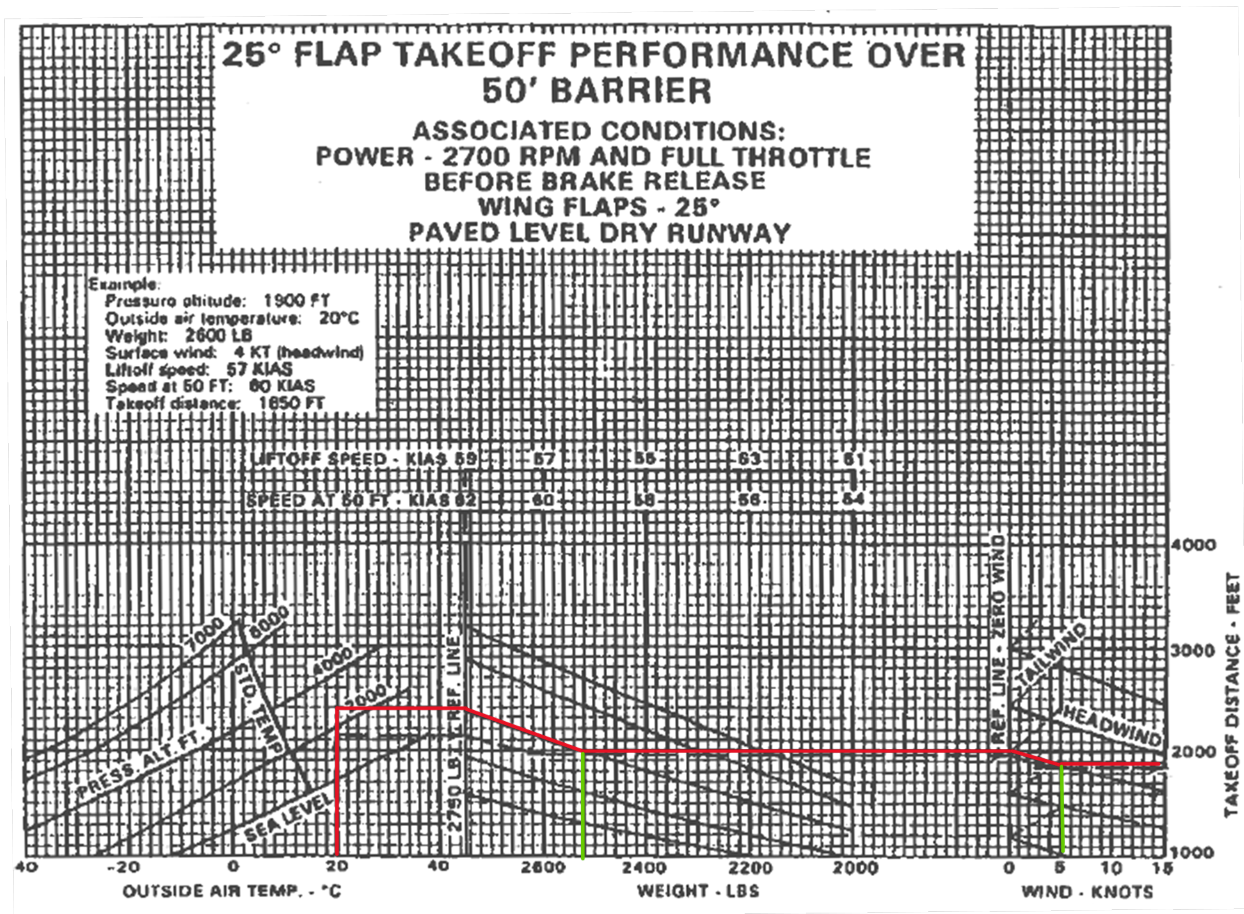
Normal Takeoff Distance

Example:
Temperature – 20 degrees
Pressure altitude – 2,500 ft.
T/O weight – 2,600 lbs.
Wind component – 10 kts Headwind



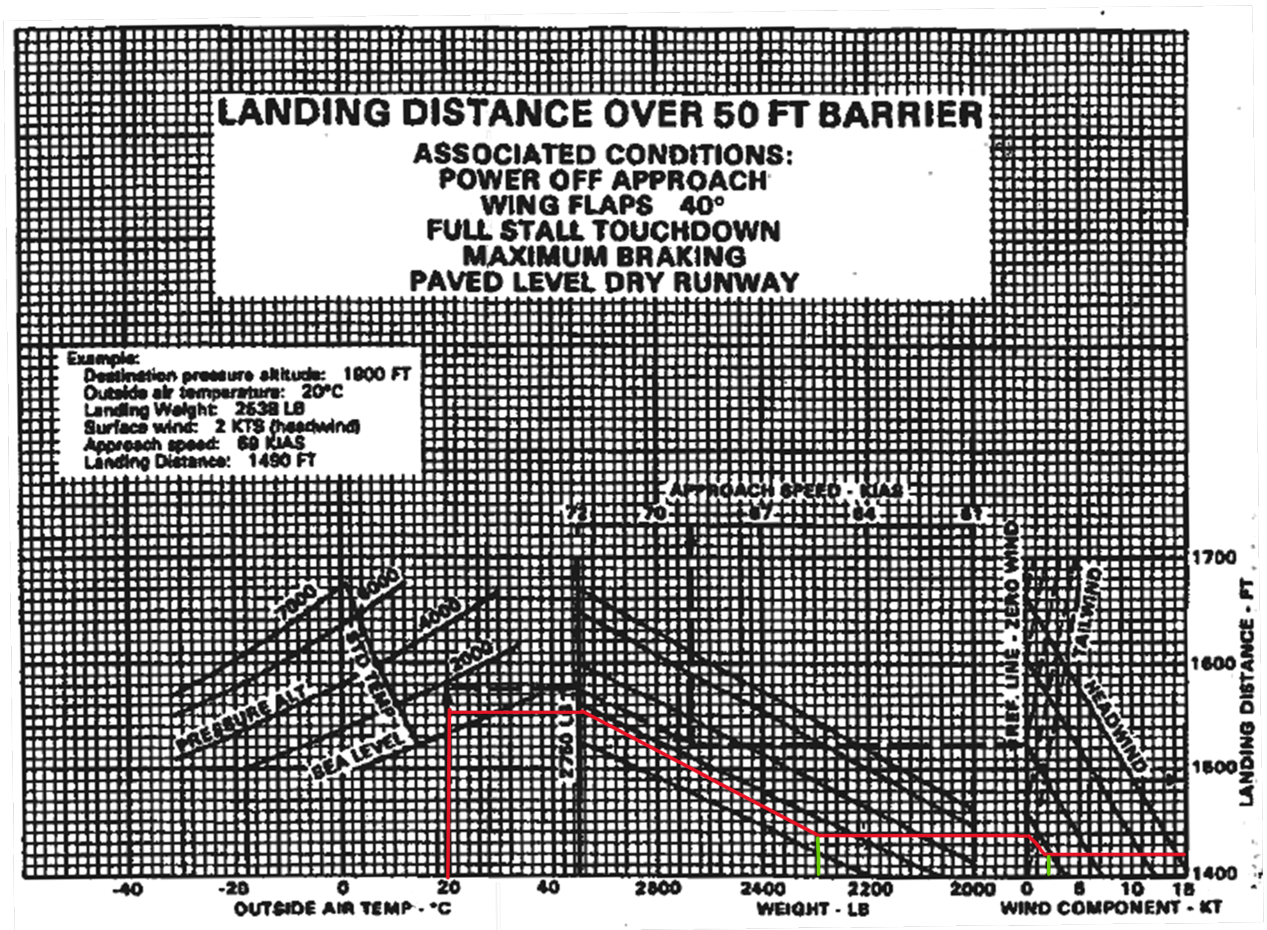
Flaps 25 degrees Takeoff Distance

Example:
Temperature – 20 degrees
Pressure altitude – 2,500 ft.
T/O weight – 2,500 lbs.
Wind component – 5 kts Headwind



Landing Distance

Example:
Temperature – 20 degrees
Pressure Altitude – 1,000 ft.
LDG weight – 2,300 lbs.
Wind component – 3 kts Headwind

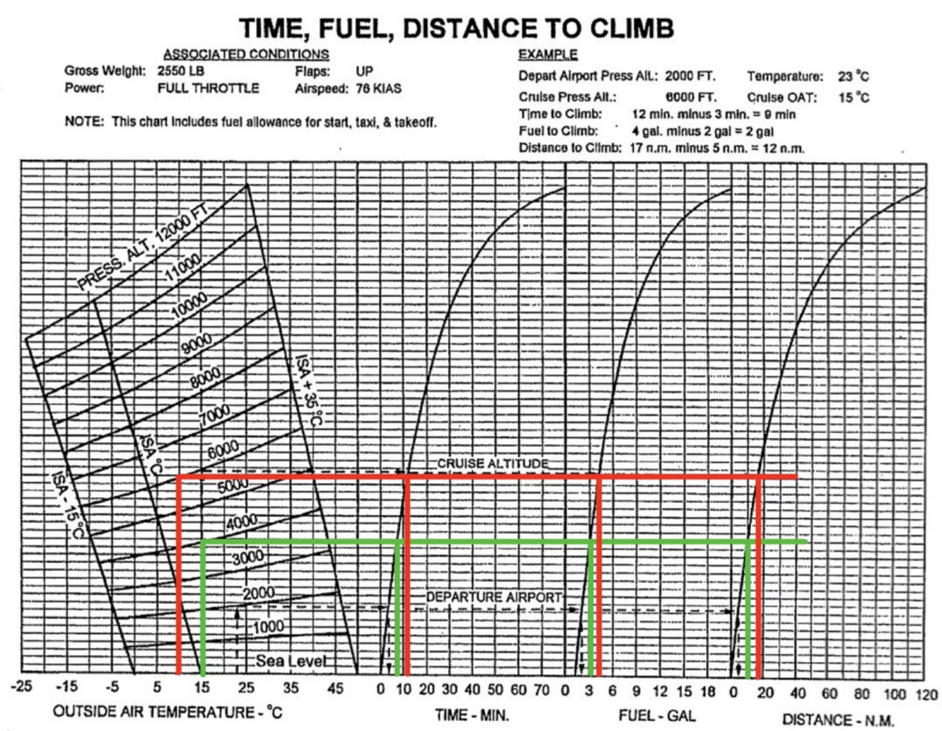


Time, Fuel, and distance calculations

Example:

Departure airport:
Temperature – 10 degrees
Pressure altitude – 6,000 ft
Time – 10 minutes
Fuel – 4 gallons
Distance – 18 nm

Cruise altitude:
Temperature – 15 degrees
Pressure altitude – 4,000 ft
Time – 8 minutes
Fuel – 3 gallons
Distance – 10 nm



Answer
Time: 10 min – 8 min = 2 min
Fuel: 4 gal – 3 gal = 1 gal
Distance: 18 nm -10 nm = 8 nm

Cruise Calculations

Based on desired fuel burn and percent power, we can use the following charts to find the recommended RPM for that specific condition.

Example:
Power – 55%
Fuel burn – 8.2 GPH
Pressure altitude – 2,000 ft
Temperature – ISA + 20
Desired RPM – 2305

Engine / Cruise Performance for Non-ISA OAT*
RPM for Constant 55% Power
Fuel Flow: Best Economy Mixture, 8.2 GPH

Pressure Altitude Feet	Indicated Outside Air Temperature °C	°C	°F	Engine Speed RPM	True Air Speed Knots **
Sea Level	ISA-15	0	32	2245	105
	ISA	15	59	2265	
	ISA +10	25	77	2275	
	ISA +20	35	95	2285	
	ISA +30	45	113	2295	106
2000	ISA -15	-4	25	2265	106
	ISA	11	52	2280	
	ISA +10	21	70	2295	
	ISA +20	31	88	2305	
	ISA +30	41	106	2315	107
4000	ISA -15	-8	18	2285	106
	ISA	7	45	2300	
	ISA +10	17	63	2315	
	ISA +20	27	81	2325	
	ISA +30	37	99	2335	108
6000	ISA -15	-12	10	2305	107
	ISA	3	37	2320	
	ISA +10	13	55	2330	
	ISA +20	23	73	2345	
	ISA +30	33	91	2355	108
8000	ISA -15	-16	3	2320	107
	ISA	-1	30	2340	
	ISA +10	9	48	2350	
	ISA +17.5	16.5	62	2360	108
9000	ISA -15	-18	0	2330	107
	ISA	-3	27	2350	
	ISA +8.5	5.5	42	2360	108
10000	ISA - 15	-20	-4	2340	107
	ISA	-5	23	2360	108

NOTE: * Aircraft weight 2550 Lbs., Wheel pants and strut fairings installed
** Subtract 3 KTAS if wheel pants are removed.

ENGINE/CRUISE PERFORMANCE (55%)

Example:
Power – 65%
Fuel burn – 9.5 GPH
Pressure altitude – 4,000 ft
Temperature – ISA
Desired RPM – 2450

Engine / Cruise Performance for Non-ISA OAT*
RPM for Constant 65% Power
Fuel Flow: Best Economy Mixture, 9.5 GPH

Pressure Altitude Feet	Indicated Outside Air Temperature °C	°C	°F	Engine Speed RPM	True Air Speed Knots **
Sea Level	ISA-15	0	32	2385	113
	ISA	15	59	2405	
	ISA +10	25	77	2415	
	ISA +20	35	95	2430	
	ISA +30	45	113	2440	116
2000	ISA -15	-4	25	2405	114
	ISA	11	52	2425	
	ISA +10	21	70	2440	
	ISA +20	31	88	2450	
	ISA +30	41	106	2465	117
4000	ISA -15	-8	18	2430	115
	ISA	7	45	2450	
	ISA +10	17	63	2460	
	ISA +20	27	81	2475	
	ISA +30	37	99	2485	118
6000	ISA -15	-12	10	2450	116
	ISA	3	37	2470	
	ISA +10	13	55	2485	
	ISA +20	23	73	2495	
	ISA +30	33	91	2510	119
8000	ISA -15	-16	3	2475	117
	ISA	-1	30	2495	
	ISA +10	9	48	2505	
	ISA +17.5	16.5	62	2515	119
9000	ISA -15	-18	0	2485	117
	ISA	-3	27	2505	
	ISA +8.5	5.5	42	2515	119
10000	ISA -15	-20	-4	2495	118
	ISA	-5	23	2515	119

NOTE: * Aircraft weight 2550 Lbs., Wheel pants and strut fairings installed
** Subtract 3 KTAS if wheel pants are removed.

ENGINE/CRUISE PERFORMANCE (65%)

Example:
Power – 75%
Fuel burn – 11 GPH
Pressure altitude – 3,000 ft
Temperature – ISA + 10
Desired RPM – 2580

Engine / Cruise Performance for Non-ISA OAT*
RPM for Constant 75% Power
Fuel Flow: Best Economy Mixture, 11.0 GPH

Pressure Altitude Feet	Indicated Outside Air Temperature °C	°C	°F	Engine Speed RPM	True Air Speed Knots **
Sea Level	ISA-15	0	32	2485	119
	ISA	15	59	2515	
	ISA +10	25	77	2535	
	ISA +20	35	95	2550	
	ISA +30	45	113	2565	124
2000	ISA -15	-4	25	2520	121
	ISA	11	52	2545	
	ISA +10	21	70	2565	
	ISA +20	31	88	2580	
	ISA +30	41	106	2600	126
3000	ISA -15	-6	21	2535	122
	ISA	9	48	2560	
	ISA +10	19	66	2580	
	ISA +20	29	84	2595	
	ISA +30	39	102	2615	127
4000	ISA -15	-8	18	2550	123
	ISA	7	45	2575	
	ISA +10	17	63	2595	
	ISA +20	27	81	2610	
	ISA +30	37	99	2630	128
5000	ISA -15	-10	14	2565	124
	ISA	5	41	2590	
	ISA +10	15	59	2610	
	ISA +20	25	77	2625	
	ISA +25	30	86	2635	128
6000	ISA -15	-12	10	2580	125
	ISA	3	37	2605	
	ISA +10	13	55	2625	
	ISA +15	18	64	2635	128
7000	ISA -15	-14	6.8	2595	126
	ISA	1	34	2625	
	ISA +7.5	8.5	47	2635	128

NOTE: * Aircraft weight 2550 Lbs., Wheel pants and strut fairings installed
** Subtract 3 KTAS if wheel pants are removed.

ENGINE/CRUISE PERFORMANCE (75%)

Section III: Systems

Airframe

- Low-wing monoplane of all metal construction
- Four seats, with a maximum baggage weight of 200 pounds
- The majority of the aircraft is constructed with aluminum alloy except the following components:
    - Engine mount. (tubular steel)
    - Other misc. parts
    - Semi-tapered wings
- Tapered wings decrease the length of the chord from the root to the wing tip. This causes a decrease in drag, and an increase in lift.

Flight Controls

<u>Primary Flight Controls</u>

- Ailerons
    - Controls roll about the longitudinal axis. They are located at the outboard trailing edge of the wing.
    - Connected by cables, bell cranks, pulleys, and/or push-pull tubes
    - Moving the yoke to the right causes the right aileron to deflect up and the left aileron to deflect downward. Moving the yoke to the left causes the left aileron to deflect upward and the right aileron to deflect downward.
    - Differential ailerons
1. One aileron is raised significantly more, and the other aileron is lowered, which produces an increase in drag on the descending wing. The aileron deflected up is going a further distance than the aileron deflected down, which creates more drag and counteracts adverse yaw.

- Stabilator
    - A one-piece horizontal stabilizer that moves around a central hinge point.
    - Stabilators are very sensitive to control inputs, so antiservo tabs are often placed on the trailing edge of the surface. These tabs deflect in the same direction as the stabilator, making it to where the pilot must increase force on the controls. This aids with overcontrolling the airplane.
    - Connected by cables, bell cranks, pulleys, and pushrods

- Rudder
    - Controlled by the left and right rudder pedals
    - Connected by cables, pulleys, and push/pull tubes.
    - Rudder effectiveness increases with speed. Deflecting the rudder to either direction, alters the airflow and creates a side component of lift. This lift will push the tail in one direction and yaw the nose in the opposite direction.

<u>Secondary Flight Controls</u>

- Flaps
    - Manually operated and spring loaded
    - Three extended positions: 10 degrees, 25 degrees, and 40 degrees
    - Slotted flaps

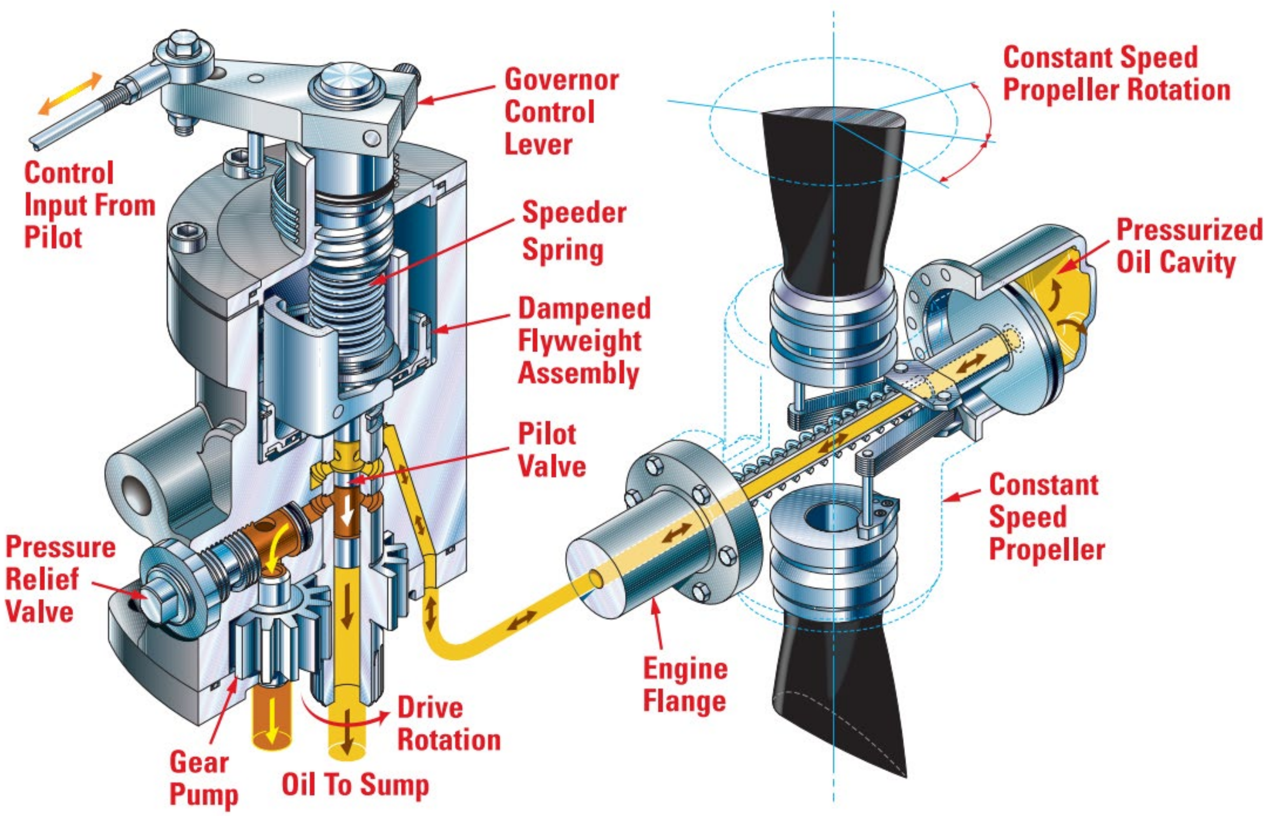
1. Increases lift coefficient without excessive drag
2. When the flap is lowered, a duct forms between the flap and the wing allowing airflow and delaying airflow separation.

Power Plant and Propeller

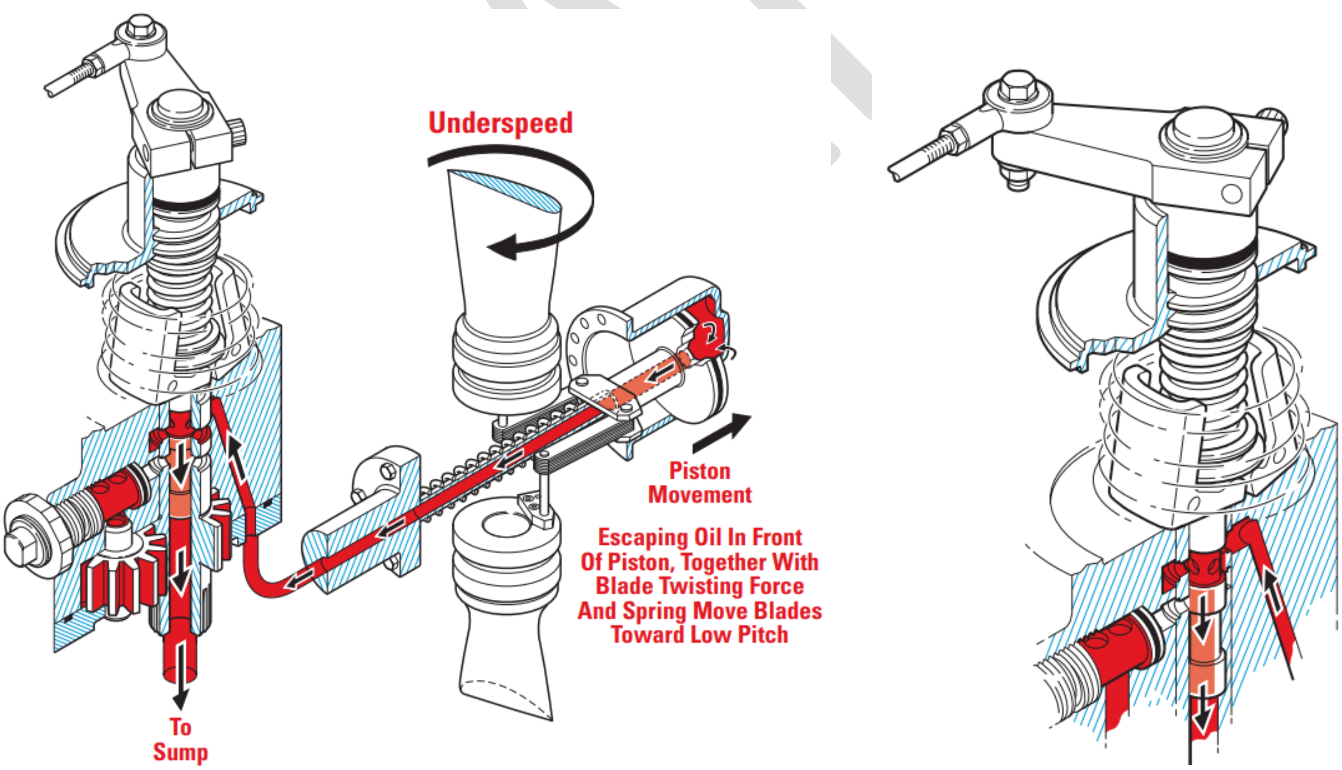
- **Power plant**
    - Lycoming IO-360-C1C6
    - 200 horsepower, 360 cubic inches of displacement, 2700 RPM
    - Horizontally opposed
    - Pistons face away from each other
    - 4 cylinders, 2 spark plugs a piece for increased reliability (8 total)
    - Air-cooled
    - Not liquid-cooled
    - Cooling fins aid in heat dissipation allowing the engine to cool faster
    - Naturally aspirated
    - Takes in air under normal atmospheric pressure
    - Not supercharged or turbocharged
    - Direct drive
    - Propeller is directly connected to crankshaft, so it turns at the same speed as the crankshaft.
    - Fuel injected vs. carbureted
    - Fuel injected engines are more fuel efficient due to the air-to-fuel mixture being more precise. In these engines, the fuel and air mixture is mixed directly in the cylinder.
    - Although fuel injected engines have many pros, they are harder to maintain and more expensive. They are also susceptible to vapor lock. This is when the fuel in the lines evaporates and turns to a gas.
- **Propeller**

- Equipped with a 2 blade, 74-inch, constant speed, hydraulically actuated McCauley Propeller.
- The propeller is constant speed, meaning the propeller governor can change the blade angle during flight to maintain a constant RPM that is set by the pilot.
- Constant Speed Propeller
    - Propeller provides constant RPM regardless of power setting
    - Propeller RPM is adjusted by the propeller control lever

- Components of Constant Speed Propeller
    - Propeller control lever in cockpit is used to set propeller RPM
    - Governor control lever applies pressure to speeder spring based on propeller setting
    - Speeder spring is connected to pilot valve
    - Pilot valve has openings which align with different lines depending on whether oil must go into or out of the hub
    - Flyweights are spinning within the governor at an RPM paired with the propeller
    - Movement of flyweights moves speeder spring and pilot valve which allows oil to move into or out of propeller hub
    - Propeller piston is attached to a spring which pushes it forward in the propeller hub cylinder when there is no oil pressure in the hub
    - When oil pressure enters the hub, propeller piston is moved and the propeller blade angle is adjusted

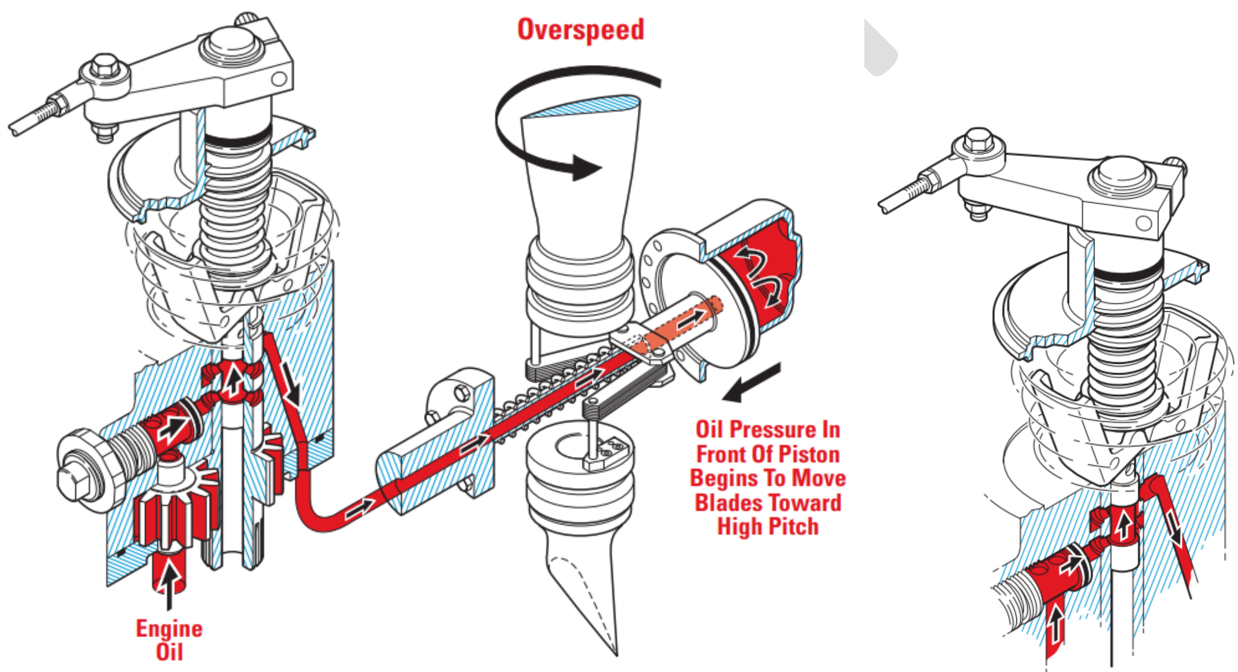


- **Moving Propeller Control Forward (**low pitch/high RPM**)**
  1. Allows smaller bites of air, allowing the propeller to push air faster (higher RPM) allowing more torque
  2. Used for Takeoff and Landing
     - It is like climbing a hill on a bicycle with a low gear (low pitch) with faster pedal movement (high RPM) to allow a more efficient climb.
- **Operations**
  1. Pilot moves propeller control forward in cockpit which moves cables connected to the governor control lever.
  2. Governor control lever applies downward force to the speeder spring and flyweights and moves the pilot valve
  3. Movement of pilot valve allows oil to flow out of propeller hub into the oil sump
  4. As oil leaves the propeller hub, a spring pushes propeller piston forward
  5. Propeller piston is connected to propeller with metal linkages and moves blade angle to a fine or low angle of attack pitch
  6. As propeller RPM increases, the flyweights will begin to return to a neutral position as the speed of the propeller and flyweights begin to sync.
  7. As flyweights move into the neutral position, pressure is applied to the speeder spring and the pilot valve is raised to prevent oil from leaving the hub
  8. The propeller is now in an on-speed condition



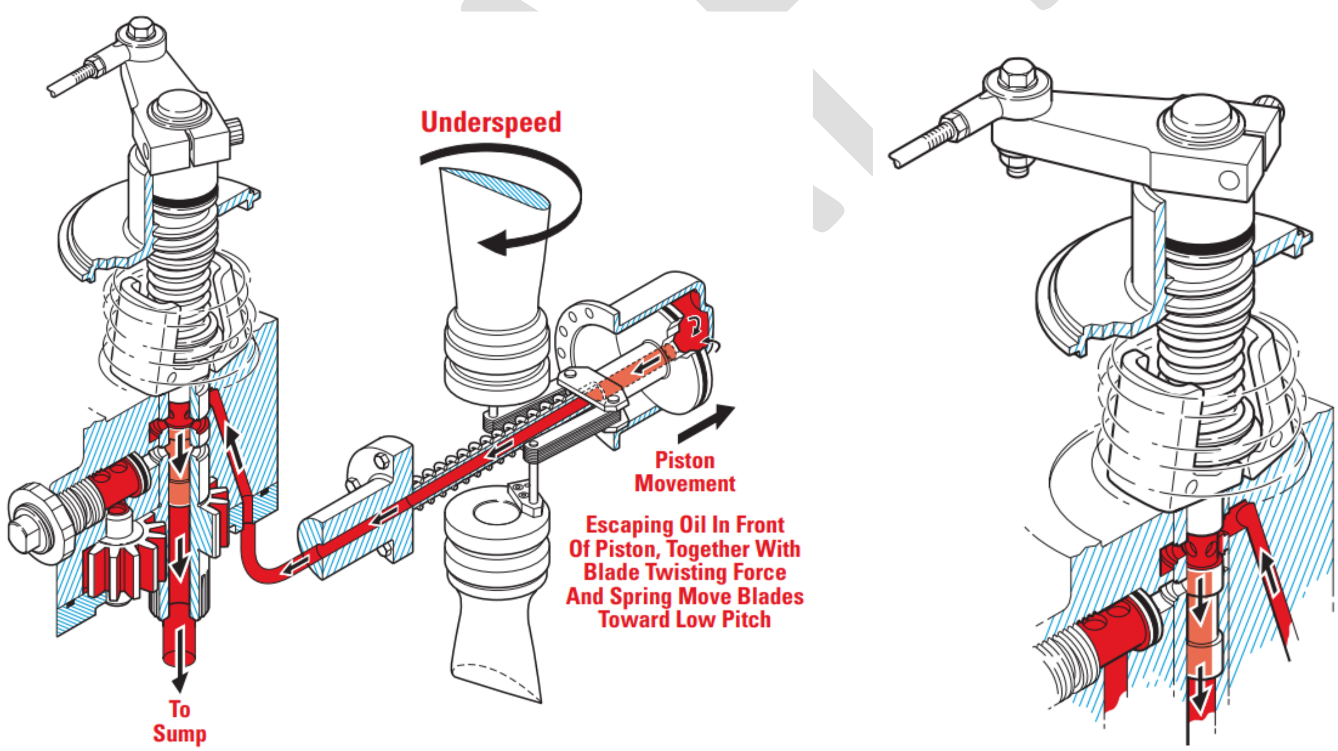
Source: McCauley

- **Moving Propeller Control Backward (**high pitch/low RPM**)**
    - Allows bigger bites of air, allowing the airplane to accelerate to a higher speed more efficiently
    - Used for Cruise
  1. 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
- **Operations**
  1. The pilot moves propeller control aft in cockpit, which moves cables connected to the governor control lever.
  2. The governor control lever applies an upward force to the speeder spring, flyweights, and moves the pilot valve
  3. Movement of the pilot valve allows openings to line up with a line from the engine-driven gear pump which provides oil pressure
  4. Oil is pumped into the propeller hub and moves the propeller hub aft.
  5. Propeller piston is connected to propeller with metal linkages and moves blade angle to a coarse or a high angle of attack pitch
  6. As propeller RPM decreases, the flyweights will begin to move to a neutral position as the speed of the propeller and the flyweights begin to sync
  7. As flyweights move into a neutral position, pressure is applied to the speeder spring and the pilot valve is lowered to prevent oil from leaving the hub
  8. The propeller is now in an on-speed condition

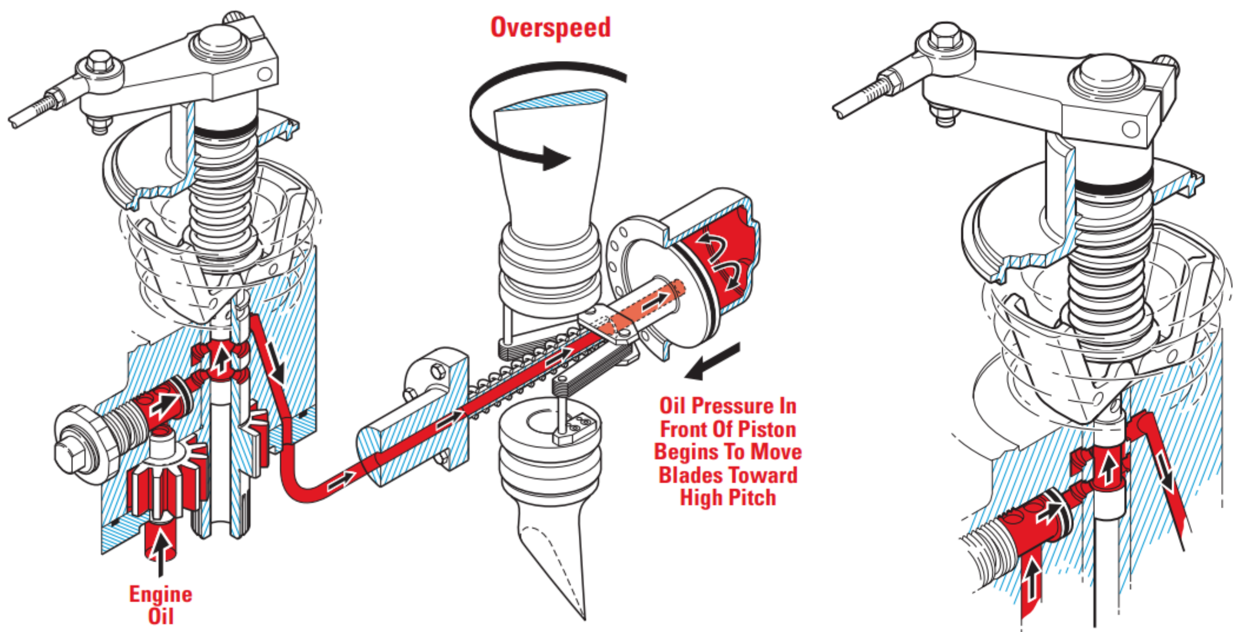


Source: McCauley

- **Propeller in Underspeed Condition**
  1. Propeller RPM is too low for the given condition
     - Ex. Reducing the throttle without adjusting the prop lever
     - Ex. Initiating a climb without adjusting throttle lever
     - Ex. Initial 45 degrees of lazy eight maneuver with increase in pitch
- **Operations**
  1. Decrease in propeller RPM results in a decrease in RPM of the flyweights
  2. Centrifugal force acts on flyweights and causes them to fall inwards and lower speeder spring
  3. Movement of pilot valve allows oil to flow out of propeller hub into the oil sump
  4. As oil leaves the propeller hub, a spring pushes propeller piston forward
  5. Propeller piston is connected to the propeller with metal linkages and moves blade angle to a fine or low angle of attack pitch
  6. As propeller RPM increases, the flyweights will begin to return to a neutral position as the speed of the propeller and flyweights begin to sync.
  7. As flyweights move into the neutral position, pressure is applied to the speeder spring and the pilot valve is raised to prevent oil from leaving the propeller hub
  8. The propeller is now in an on-speed condition



- **Propeller in Overspeed Condition**
  1. Propeller RPM is too fast for the given condition
     - Ex. Increasing the throttle without adjusting the prop lever
     - Ex. Initiating a descent without adjusting throttle lever
     - Ex. 90-135 degrees of lazy eight maneuver with decrease in pitch
- **Operations**
  1. Increase in propeller RPM results in an increase in RPM of flyweights
  2. Centrifugal force acts on flyweights and causes them to fall outwards and lift speeder spring
  3. Upward force from the speeder spring moves the pilot valve
  4. Movement of the pilot valve allows openings to line up with a line from the engine-driven gear pump which provides oil pressure
  5. Oil is pumped into the propeller hub and moves the propeller hub aft.
  6. Propeller piston is connected to the propeller with metal linkages and moves blade angle to a coarse or a high angle of attack pitch
  7. As propeller RPM decreases, the flyweights will begin to move to a neutral position as the speed of the propeller and the flyweights begin to sync
  8. As flyweights move into a neutral position, pressure is applied to the speeder spring and the pilot valve is lowered to prevent oil from leaving the propeller hub
  9. The propeller is now in an on-speed condition



Landing Gear System

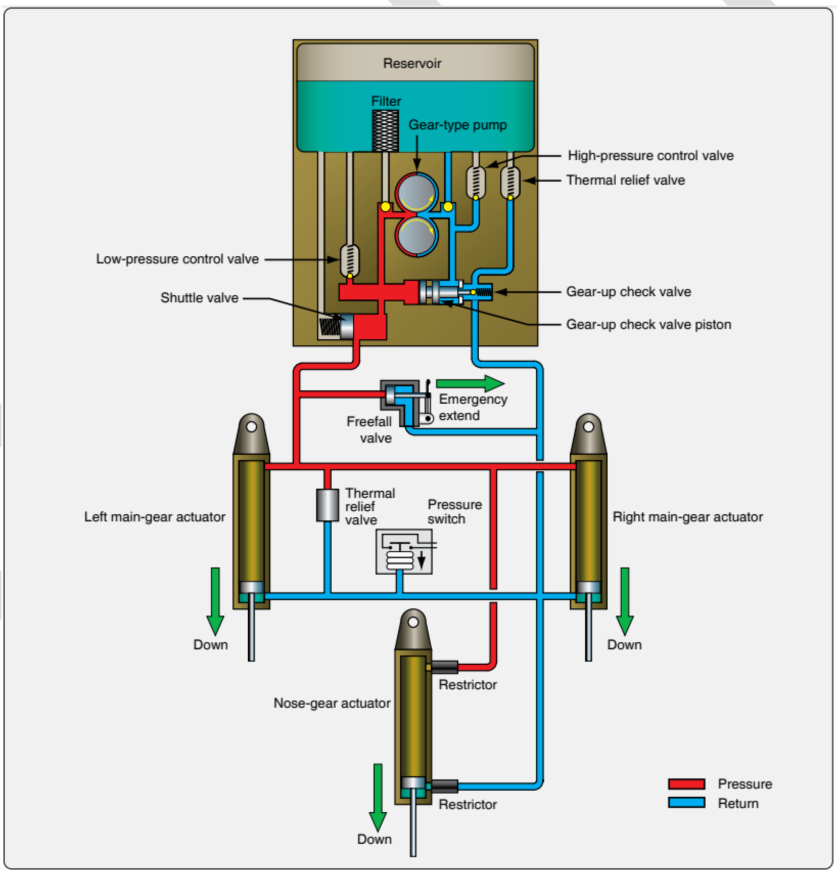
- Landing Gear
    - Equipped with retractable tricycle landing gear
    - Hydraulically actuated by an electrically powered reversible pump
    - Landing gear retraction and extension takes approximately seven seconds
    - When the gear is fully extended and in the down and locked position, three green lights will illuminate in the cockpit when contact is made with the down-lock switches on each gear
    - The brightness of the gear indication lights is affected by the navigation lights; if the navigation lights are on, the gear indication lights will be dimmed.
    - When the landing gear is in transition or has not fully extended or retracted, a red gear unsafe light will illuminate.
    - The red gear unsafe light and a gear warning horn will annunciate if:

1. Gear is retracted and power is reduced below approximately 14 inches of manifold pressure
2. Gear selector switch is up while on the ground and the throttle is idle
3. Whenever flaps are extended beyond 10 degrees and the landing gear is not down and locked

    - The gear warning horn emits a beeping sound in contrast to the stall warning horn which is continuous
    - When the landing gear is retracted and contact is made with the up-limit switch, the red gear unsafe will be extinguished
    - To prevent retraction of the gear when on the ground, a weight-on-wheels switch or "squat switch" is active as long as there is sufficient weight on the landing gear
    - The nose wheel is equipped with a hydraulic shimmy damper to reduce nose wheel shimmy
    - During normal operation, the emergency landing gear extension lever must be in the up position
    - During emergency operations, the emergency gear extension lever must be in the down position.
    - Lowering the emergency gear extension lever results in the release hydraulic pressure and permits the main gear to free fall, while the nose gear extension is spring assisted.

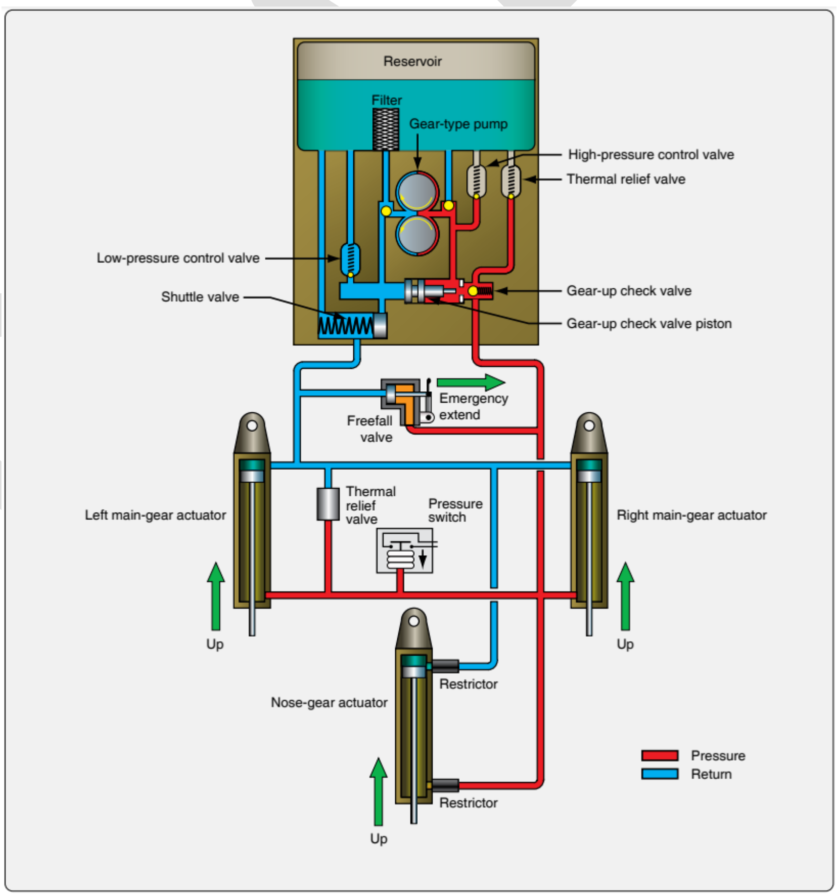
Landing Gear Extension

- Extending Landing Gear
  - To extend the landing gear, the gear selector is placed in the down position
  - This action results in the hydraulic pump pumping hydraulic fluid out of the gear actuator pistons and back to the reservoir
  - When the gear is full extended and contact is made with the down-lock switch, the three green lights will illuminate in the cockpit and the gear unsafe light will be extinguished
  - If the hydraulic pressure in the low-pressure lines decreases below 600 PSI, the low-pressure relief valve will open to allow fluid to return to the hydraulic reservoir
  - The extension process is aided by gravity.
  - In the event of an emergency, the emergency gear extension lever can be operated to permit the high-pressure fluid in the cylinders to flow back to the reservoir and permit the landing gear to free fall



Landing Gear Retraction

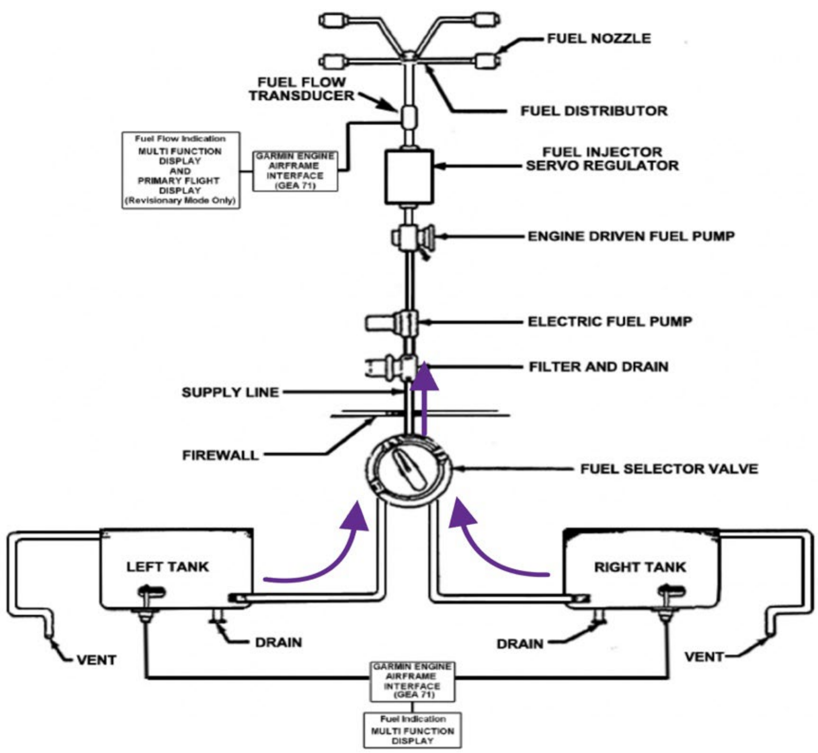
- Retracting the Landing Gear
    - To retract the landing gear, the gear selector is placed in the up position
    - This action results in the hydraulic pump pumping hydraulic fluid into the gear actuator pistons
    - When the fluid pressure in the cylinders reaches 1800 psi, the pressure switch deactivates the hydraulic pump and the high pressure remaining in the cylinders is what keeps the gear in the retracted position
    - When the gear is retracted and contact is made with the up limit switch, the gear unsafe light is extinguished, and the warning horn will shut off if active.
    - If the pressure in the cylinder falls below 1500 PSI, the pressure switch will activate the hydraulic pump to pump more fluid into the cylinder
    - If the pressure in the hydraulic lines exceeds, 2400 PSI, the high-pressure relief valve will open to release hydraulic fluid back to the reservoir and relieve pressure.
    - If the pressure in the hydraulic lines exceeds 3000 PSI due to thermal expansion, the thermal relief valve will open to release hydraulic fluid back to the reservoir and relieve pressure.



Oil and Fuel

Fuel System

- 2 tanks, one in the left wing and one in the right wing
- 38.5 gallons a piece (77), however 2.5 gallons per side is unusable. Therefore, we have 72 usable gallons.
- A fuel injected engine has a slightly different flow than carbureted.



Fuel flows from the tanks to the fuel selector, through the strainer, then the electric fuel pump. It then goes through the engine driven pump, to the regulator, then the distributor that injects the fuel into all cylinders.

Oil

- The range for the oil on the PA28R-201 is 6-8 quarts. Ensure the oil level is always above 6 quarts before departing.

Pitot Static and Stall Warning device

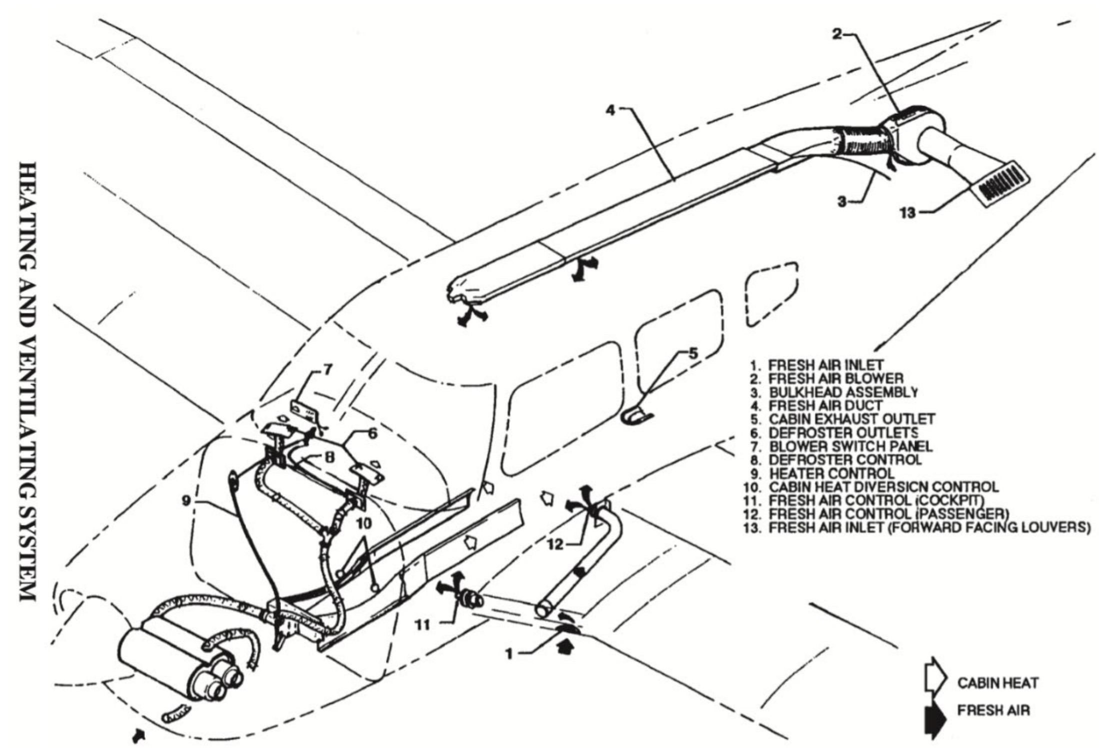
- The ram air pitot is located on the front side of the pitot mast. The drain hole is on the bottom, and the static port is located on the backside of the mast.
- Alternate static is located in the cockpit, under the panel that the PFD is on.

- The stall warning alert is activated five to ten knots above stall speed. Aside from the stall warning, you may encounter a buffet of the airplane. To test the stall warning alert, turn on the battery master and lift the detector on the wing.

- Pitot heat
    - Heat is directed into the pitot tube and is able to melt any ice forming inside of the instrument.
- Defrost
    - Air goes over the exhaust shroud and is heated. Then it travels through a heater muff into the cockpit over the dash and under the center floor panel. The heat on the windshield prevents ice from forming.
- Carburetor Heat
    - Directs heat to the carburetor and melts any ice that may be present due to the high velocity of the fuel/air mixture through the venturi.

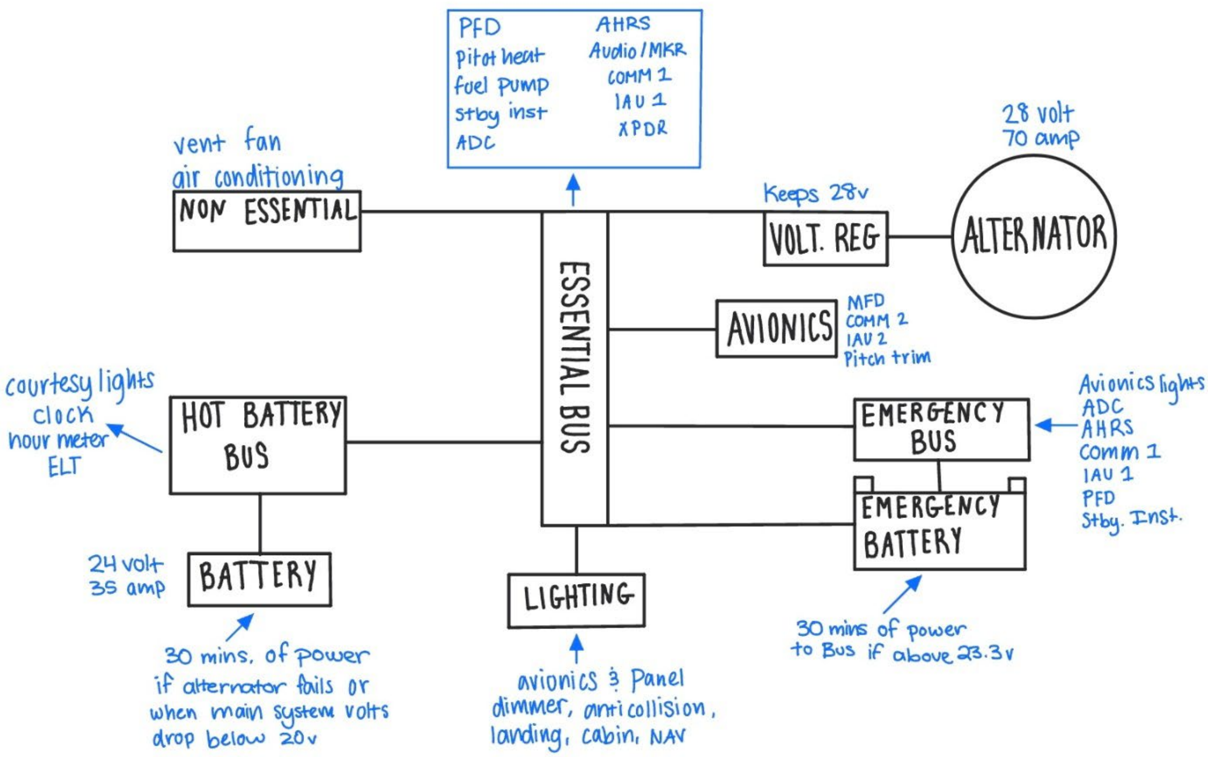
Environmental

- Fresh air inlets can be found in the onboard portion of the leading edge near the wing and near the aft portion of the fuselage. The vents in the ceiling and the floor of the aircraft are adjustable to each seat location. There is also a cabin air blower that is in the cockpit and is operated by a fan.
- Cabin heat can be regulated by controls on the right side of the cockpit. This heat is provided by the same heater muff attached to the exhaust.



Electrical System and Avionics

PA28R-201 Electrical System



G5

Contains internal backup batteries that can power the device up to 4 hours if aircraft electrical power is lost. It uses an external magnetometer under the right wing.

Aspen

Additional 30 minutes of power. It uses the internal magnetometer.

PA28R-201 Avionics

In the Piper Arrow, we have a G500 NXI, which provides us with all our pitot static and gyroscopic instruments, as well as our engine instruments. We also have a GTN 650 and a GTN 750, which provide us with our radio, GPS, and VHF navigation.

G500 NXI

G750 & G650

Figure 1 - GTN 750 Control and Display Layout

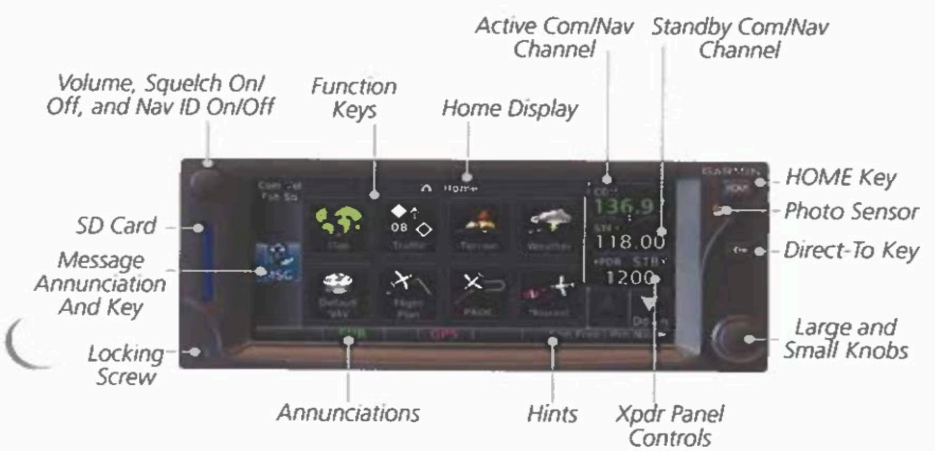


Figure 2 - GTN 635/650 Control and Display Layout

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