



VMC Demonstration

Overview

WHAT

- An explanation of V_{MC} and how it affects multiengine flying
- Demonstration of the procedure used to regain control of the aircraft in the case it slows below the minimum controllable airspeed

WHY

- Safety!
- Without an understanding of V_{MC} and the proper recovery techniques, decelerating below V_{MC} can lead to a loss of control

CONTENT

- One Engine Inoperative Airspeeds
- V_{MC} : Minimum Controllable Airspeed
- V_{MC} in the Airplane
- V_{MC} Demonstration
- Hazards



One Engine Inoperative Airspeeds

VSSE

- Safe Single Engine Speed
- Minimum speed to intentionally render an engine inoperative
 - Failing an engine below V_{SSE} creates a high likelihood for loss of control & an accident
- Not depicted on the airspeed indicator
 - Used for training purposes
- ACS
 - Evaluator must not simulate engine failure until attaining at least 400' AGL & V_{SSE} (or V_{XSE} or V_{YSE})
 - Apply this during training



One Engine Inoperative Airspeeds

VYSE: Blue Line

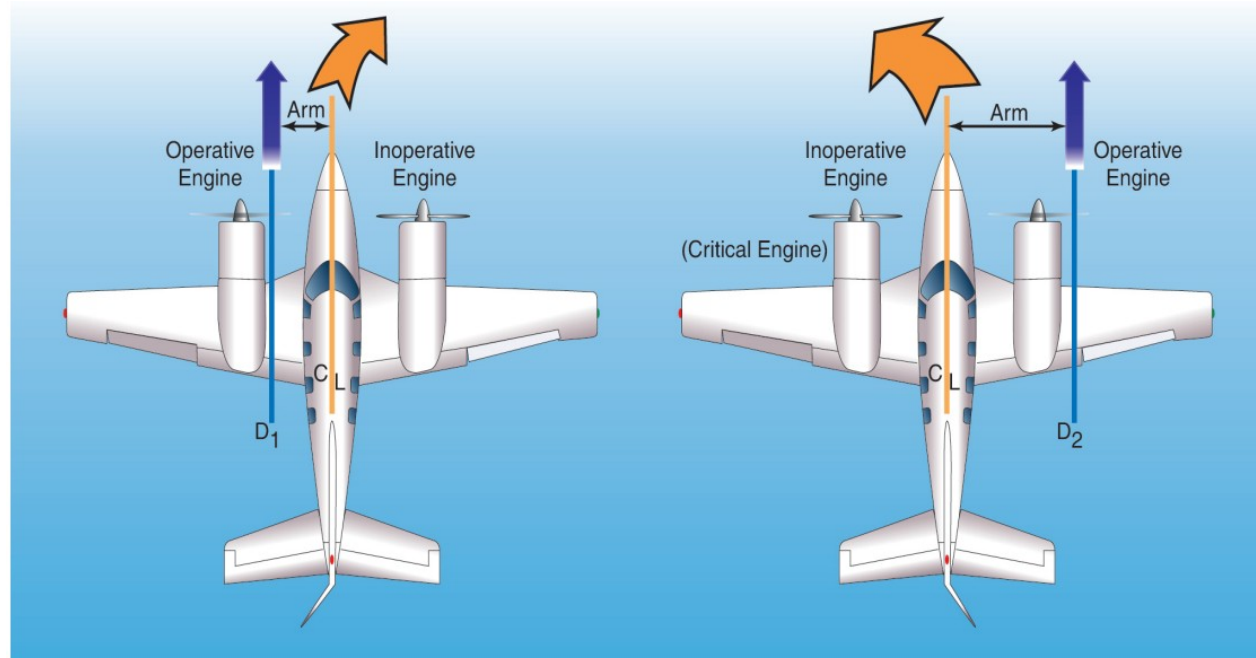
- Best rate of climb speed with OEI
- Blue line on the airspeed indicator
- Used for max performance during OEI operations
 - Or minimize descent, if above the single engine service ceiling



One Engine Inoperative Airspeeds

VMC: RED Line

- Min speed that the plane can be controlled when an engine suddenly becomes inoperative
- Not a fixed speed
 - Only fixed for the very specific set of circumstances under which it was tested during certification
 - VMC varies with a variety of factors



VMC: Minimum Controllable Airspeed

What is VMC?

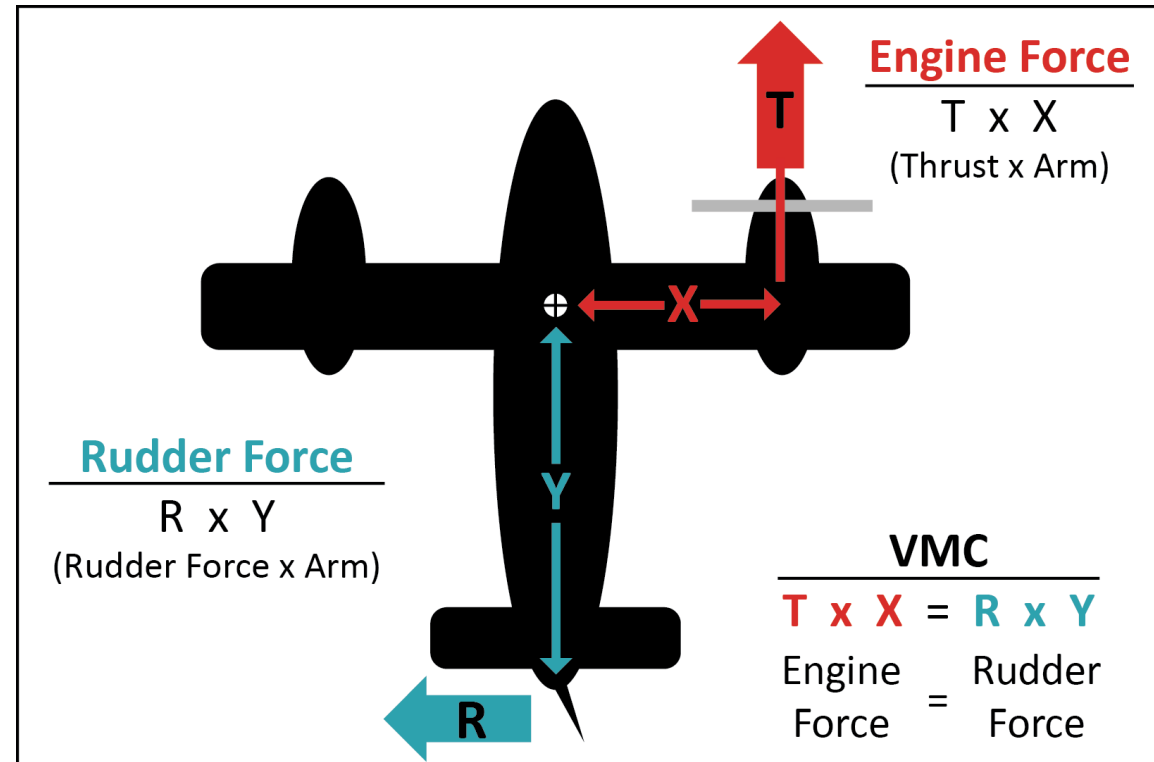
- The speed at which the rudder no longer has the authority to overcome the yaw caused by the critical engine being inoperative, under specific criteria mandated by the FAA
- A lower V_{MC} is good
- V_{MC} deals strictly with maintaining directional control, irrespective of climb performance
- Published versus Actual V_{MC}
 - Published V_{MC} is based on specific FAA mandated criteria
 - Actual V_{MC} varies based on the conditions, configuration, and technique



VMC: Minimum Controllable Airspeed

What Causes VMC?

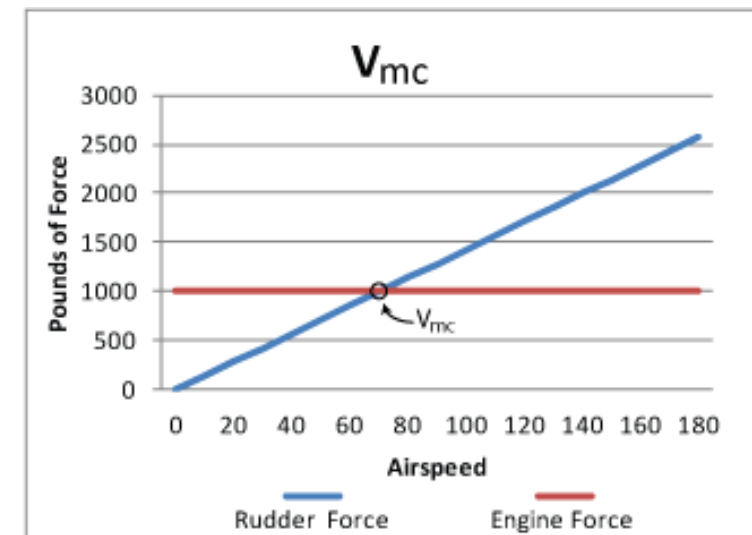
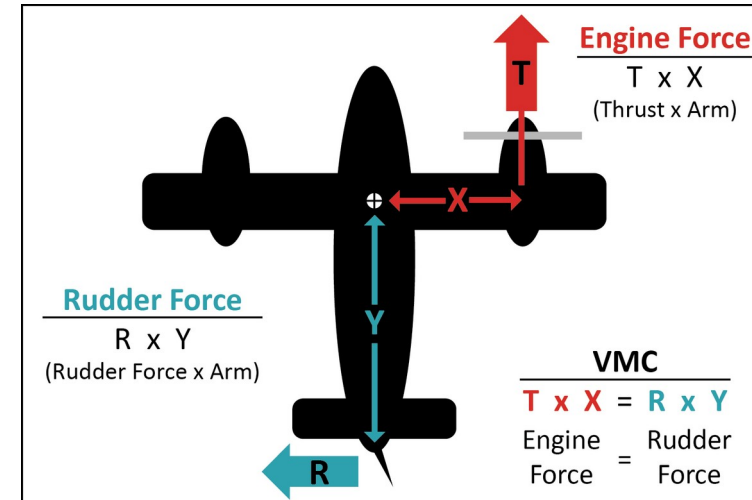
- With an engine failed, the operating engine produces a yawing force toward the dead engine
 - $T \times X$
- Rudder is used to counter the yaw and keep the plane straight
- The rudder's force is based on airspeed
 - $R \times Y$
 - The slower the plane, the less airflow over the rudder, and therefore the less force



VMC: Minimum Controllable Airspeed

What Causes VMC?

- As an aircraft slows, and the rudder's force decreases, the yawing force remains constant
- Therefore, there is a speed where the rudder's force = the yawing force
 - $T \times X = R \times Y$
- Slower than this speed, the aircraft yaws uncontrollably to the dead engine
 - Rudder produces less force than the engine



VMC: Minimum Controllable Airspeed

How is VMC Certified?

- The FAA sets forth criteria for manufacturers to follow when establishing V_{MC}
 - Critical Engine Inoperative
 - Inoperative Engine Propeller Windmilling
 - Maximum Available Takeoff Power
 - Sea Level Conditions
 - Most Adverse Legal Weight
 - Most Adverse Legal CG
 - Landing Gear Retracted
 - Airborne & Out of Ground Effect
 - Cowl Flaps in the Takeoff Position
 - Maximum 5-degrees of Bank
 - Flaps in the Takeoff Position
 - Airplane Trimmed for Takeoff

VMC: Minimum Controllable Airspeed

How Does Certification Criteria Affect VMC?

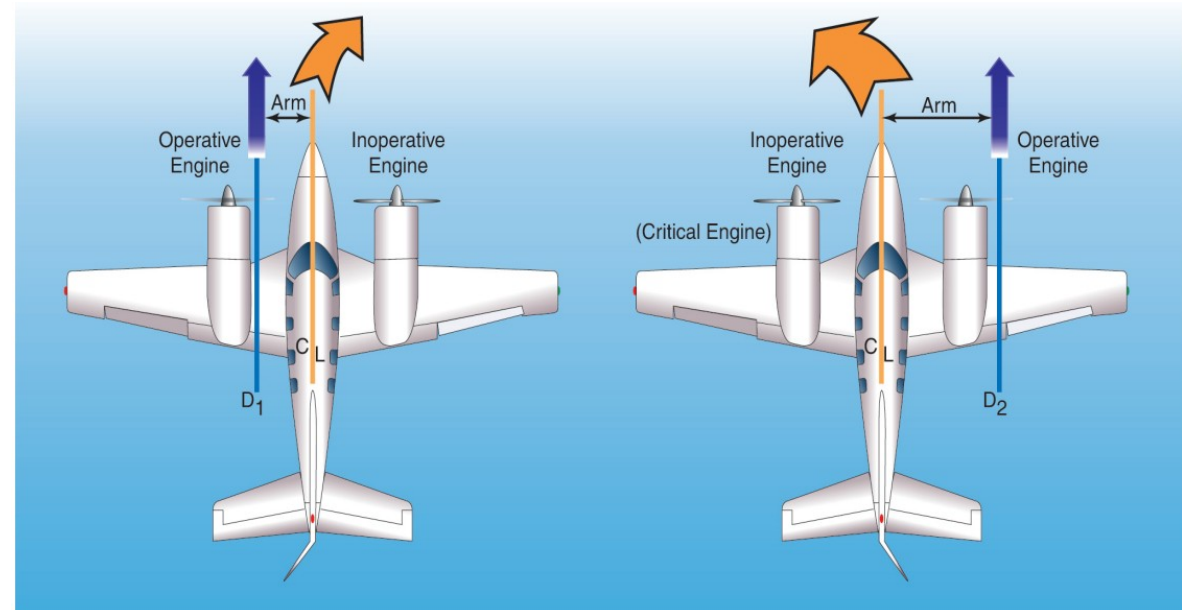
FACTOR	CONTROL	VMC
Critical Engine Inoperative	Decreases	Increases
Windmilling Propeller	Decreases	Increases
Max Takeoff Power	Decreases	Increases
Sea Level Conditions	Decreases	Increases
Most Adverse Legal Weight (Light)	Decreases	Increases
Most Adverse Legal CG (Aft)	Decreases	Increases
Gear Up	Decreases	Increases
Out of Ground Effect	Decreases	Increases
Cowl Flaps set for Takeoff (Open)	Increases	Decreases
Max of 5-degrees of Bank	Increases	Decreases
Flaps Set for Takeoff	Could go either way	Could go either way
Trimmed for Takeoff	Could go either way	Could go either way



VMC in the Airplane

Loss of Control

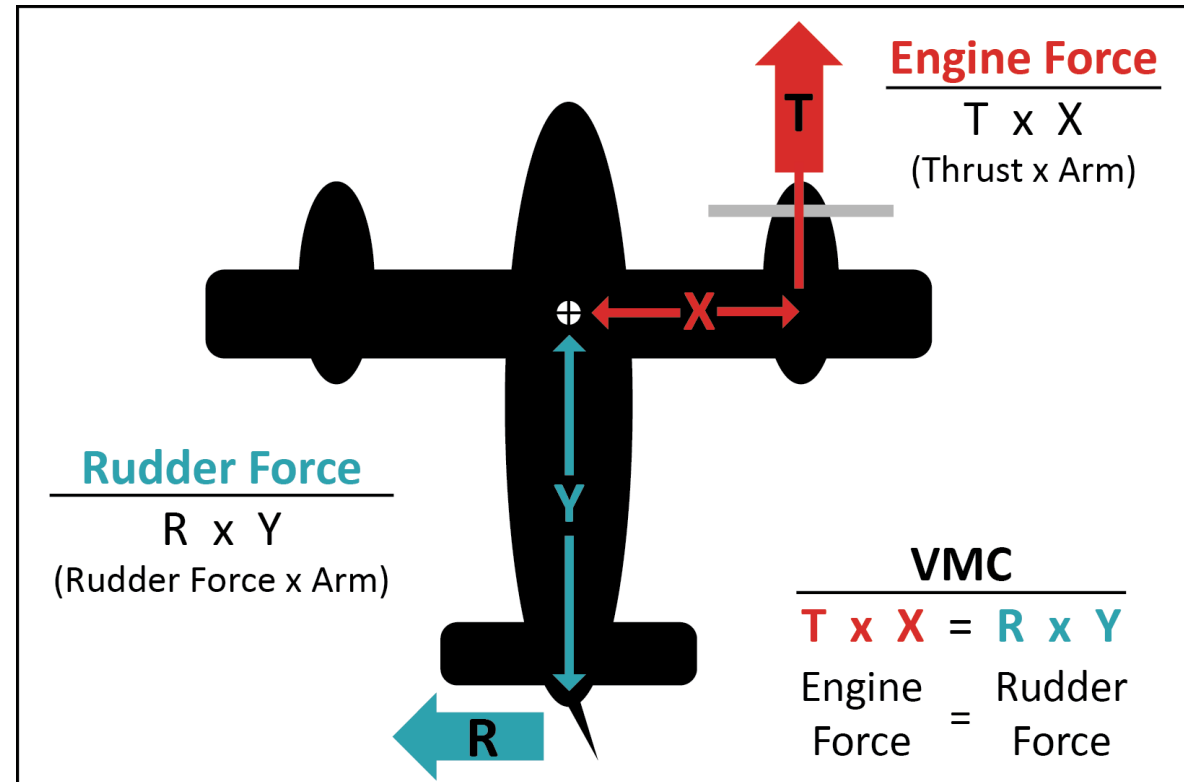
- Control is lost when the moment of the thrust arm of the operating engine exceeds that of the rudder
- Indication
 - Full rudder is applied into the operating engine and the airplane continues to yaw toward the dead engine
 - Visual reference point is the easiest way to recognize
- Maintain a zero-sideslip to obtain an accurate VMC



VMC in the Airplane

Recovery

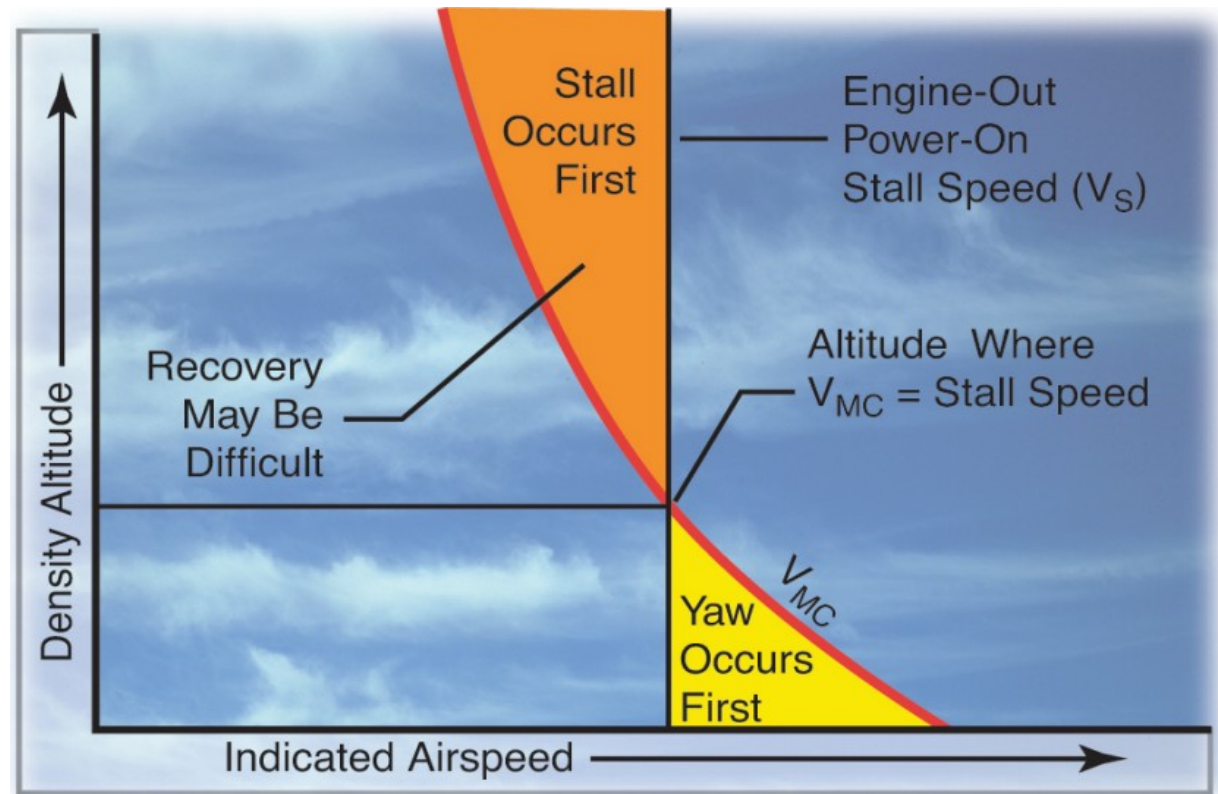
- Recover the moment uncontrollable yaw or any stall symptom is recognized
- Simultaneously reduce power & pitch
 - Reduces the yawing moment
 - Makes the rudder more effective
- Recover to straight flight at V_{YSE}



VMC in the Airplane

VMC & Stall Speed

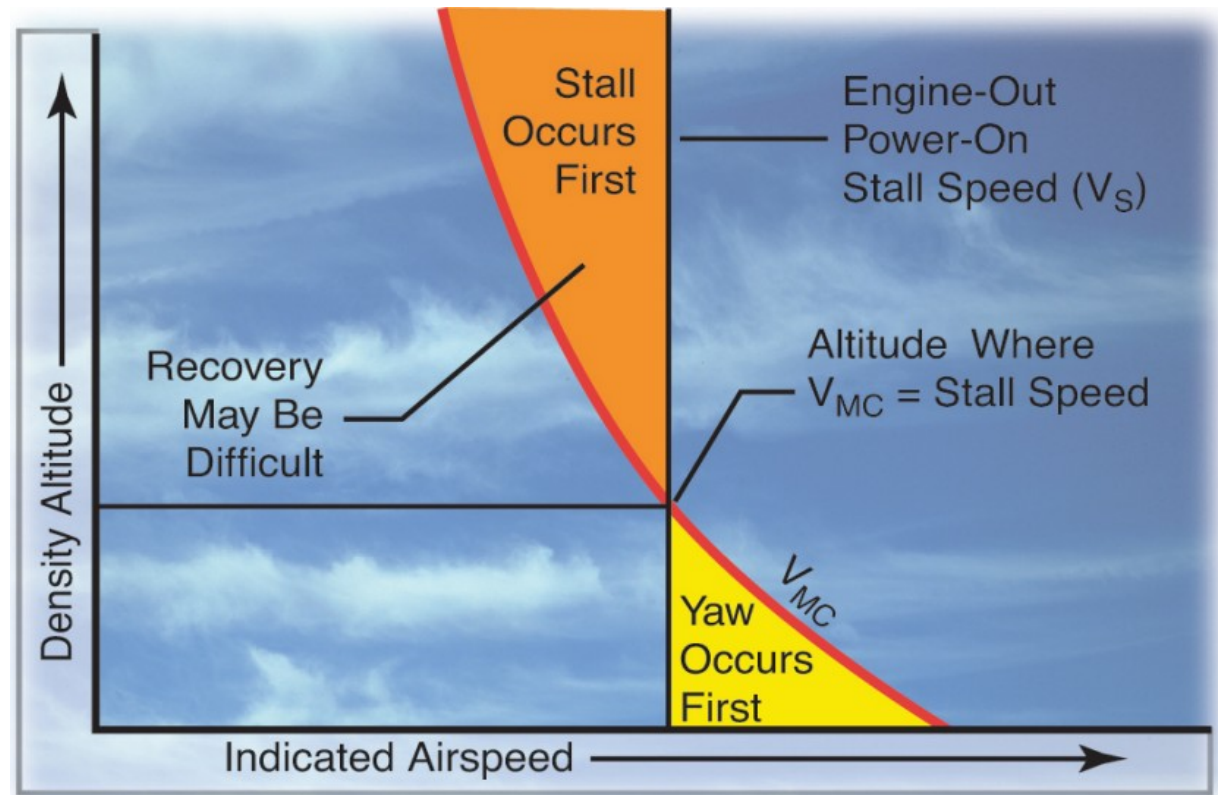
- V_{MC} decreases with altitude while stall speed remains the same
- The altitude where $V_S = V_{MC}$ and above is extremely dangerous
 - A stall with one inoperative engine will likely enter a spin
 - Departure from controlled flight can be sudden
 - Twins are not required to demonstrate spin recovery



VMC in the Airplane

Exceeding Critical AOA

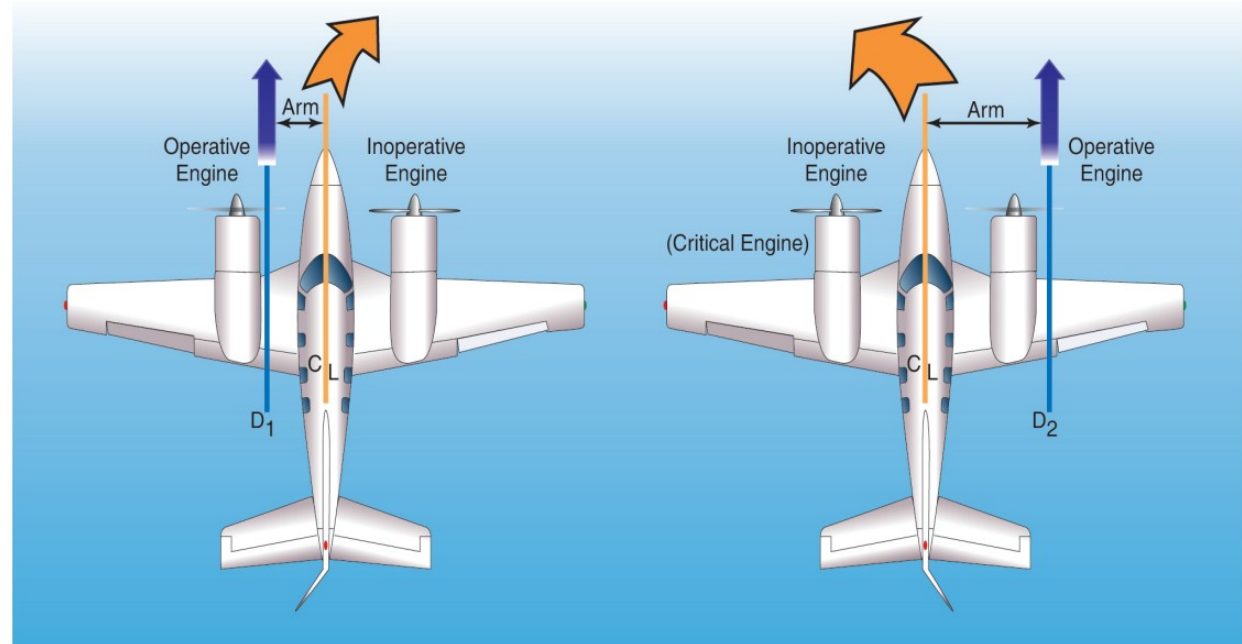
recover at any
symptom of an
impending stall



VMC Demonstration

Setup

- Choose a visual reference point
- Configuration
 - Gear up, flaps & trim set for takeoff
 - High rpm on both prop controls
 - Cowl flaps open (as applicable)
- Get stable about 10 knots above V_{SSE}/V_{YSE}

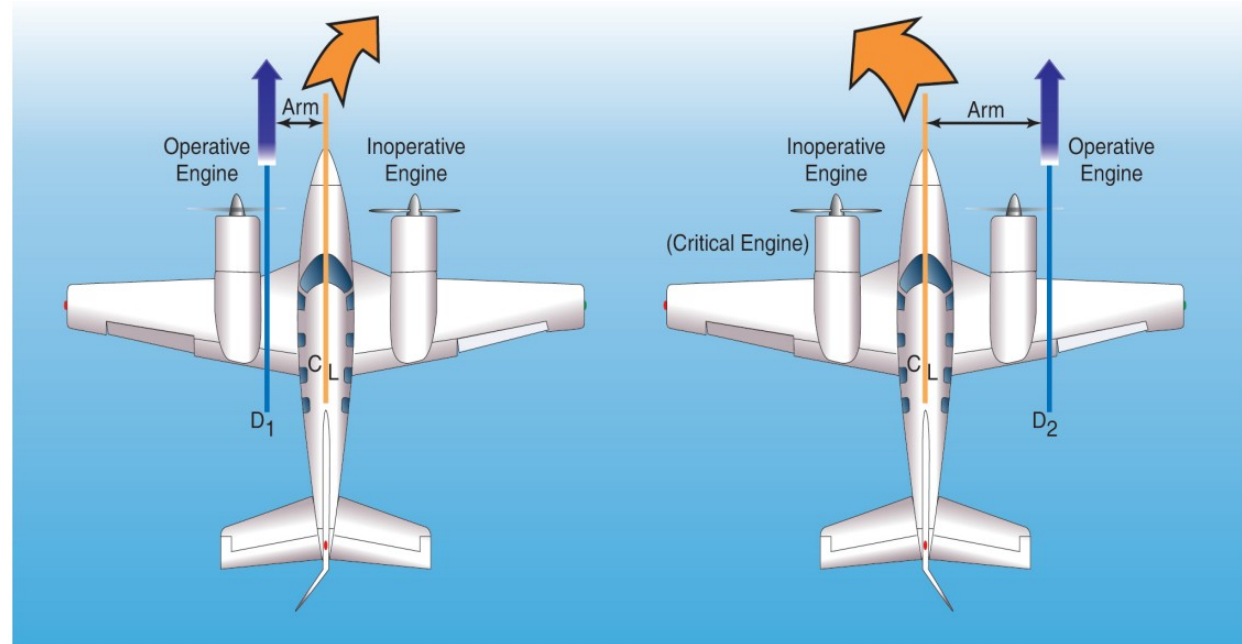


VMC Demonstration

Setup

- Power
 - Left engine to idle power
 - Right engine to takeoff power
- Establish a zero sideslip
- Brief the Maneuver

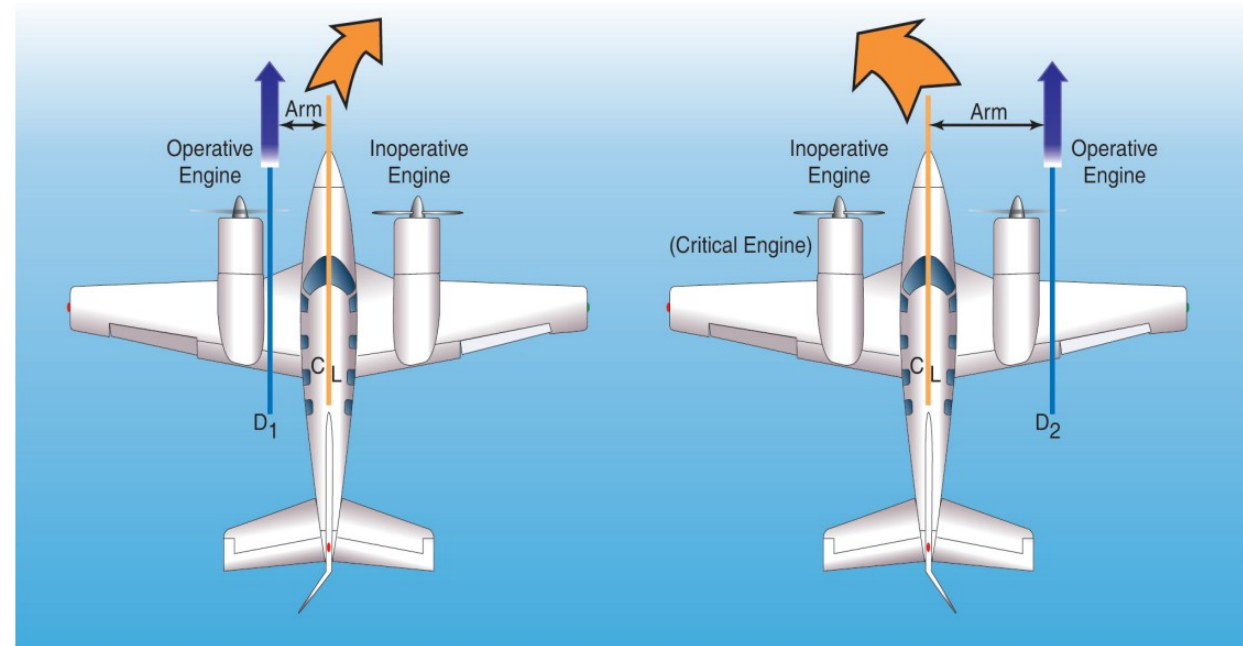
“I will pitch up at a rate to realize a decrease of 1 knot per second. At the first indication of a loss of directional control or a stall, I will reduce power on the operating engine and lower the nose.”



VMC Demonstration

Demo

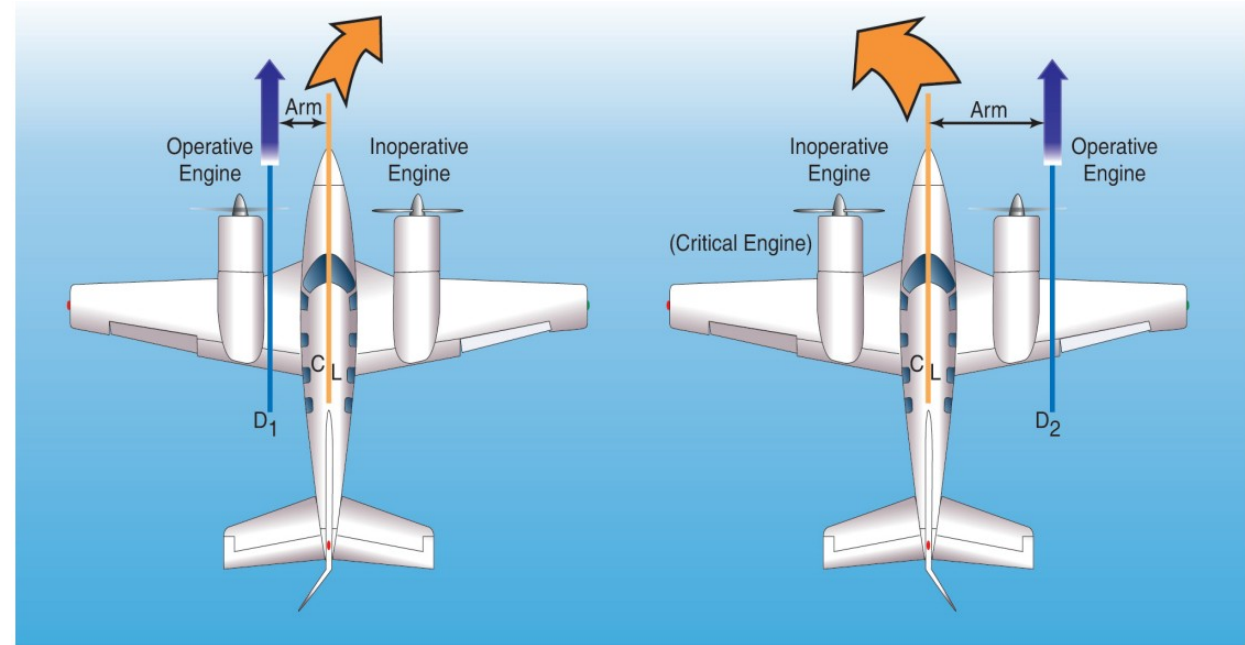
- Gently pitch up
- Airspeed decreases and control effectiveness decays
 - Increase rudder to counter yaw
 - Increase aileron to maintain bank
- Full rudder deflection = V_{MC}
 - Any slower results in a loss of directional control



VMC Demonstration

Recovery

- Reduce power on the operating engine and lower the nose
 - Smooth inputs/adjustments
- Reducing Power
 - Reduce rudder to prevent yaw
 - Maintain the reference point
- Reestablish heading & V_{YSE}
- Return to normal flight
 - Increase power on the idle engine
 - Adjust rudder to maintain the reference point/heading



Common Errors

VMC Demo

- Inadequate knowledge of the causes of loss of directional control at airspeeds less than V_{MC} , factors affecting V_{MC} , and safe recovery procedures
- Improper entry procedures, including pitch attitude, bank attitude, and airspeed
- Failure to recognize imminent loss of directional control
- Failure to use proper recovery procedure





Hazards

Hazards

Configuring the Airplane

- In relation to V_{MC} , configure as specified for the demonstration
 - Understand the effects of different configurations on V_{MC} & controllability
- Real-Life Engine Failures
 - Airplane will likely not be able to hold altitude OEI with excess drag
 - Retract gear & flaps (and any other drag devices), & feather the propeller
 - Reduced drag lowers the odds of reaching V_{MC} or slower airspeeds



Hazards

Distractions

- They're dangerous
 - Remove them from view
 - If a person, explain the situation & ask them to stop
- Don't fixate on the problem at the expense of flying the airplane
 - Maintain airspeed & zero sideslip
- Aviate, Navigate, Communicate
 - Focus on flying, especially with an inoperative engine



Hazards

SA & Disorientation

- Maintain Situational Awareness & Orientation
 - Starts with preflight planning – Know your options & have a plan
 - Know where you are, what's coming next, & stay ahead of the airplane
 - If SA or orientation is lost, admit it, and fix it
- Disoriented: Get the aircraft to a safe attitude, airspeed, and altitude
 - Zero side-slip at V_{YSE} , never below V_{MC}
 - Recover if below V_{MC}
- Ask for Help when it's Needed
 - ATC, Guard, other pilot/passengers, etc.



Hazards

Task Prioritization

- #1 Task: Safely flying the airplane
- Divide attention between the aircraft, scanning, & communicating
 - No responsibility should take full attention for more than a short period
 - Verify aircraft performance often & consistently during any checklists
- Understand what needs to be accomplished and when
 - Use standard operating procedures & checklists
- Recognize when you're behind and find a way to catch up
 - “Attack the closest alligator”



Hazards

VMC & Density Altitude

- ACS Appendix 3 - XIII. Multiengine Operations
 - Airplanes with normally aspirated engines will lose power as altitude increases because of the reduced density of the air entering the induction system of the engine. This loss of power will result in a V_{MC} lower than the stall speed at higher altitudes. Therefore, recovery should be made at the first indication of loss of directional control, stall warning, or buffet.
 - Do not perform this maneuver by increasing the pitch attitude to a high angle with both engines operating and then reducing power on the critical engine. This technique is hazardous and may result in loss of airplane control.





Questions?