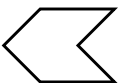


Flight Principles – Engine Inoperative

THE BACKSEAT PILOT



Overview

- **What**
 - Critical engine, or which engine has the most adverse effect on control & performance
 - Minimum controllable airspeeds
 - Managing an engine failure
- **Why**
 - Essential to understand the elements involved in an engine failure in order to maintain control and safety

Content

- **Critical Engine**
- V_{MC}
- V_{MC} and the Loss of Control
- V_{MC} and Stall Speed
- **Engine Failure during / after Lift-off**

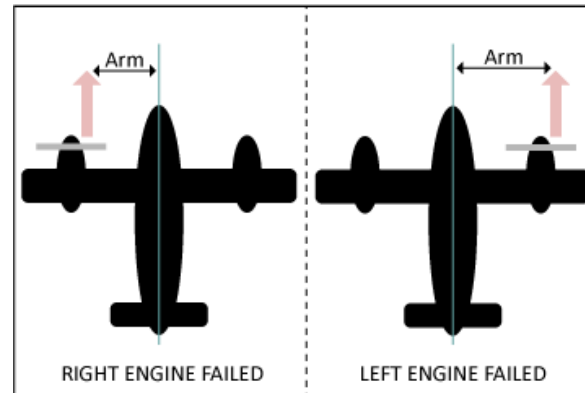
Critical Engine

- Engine whose failure most adversely affects control & performance

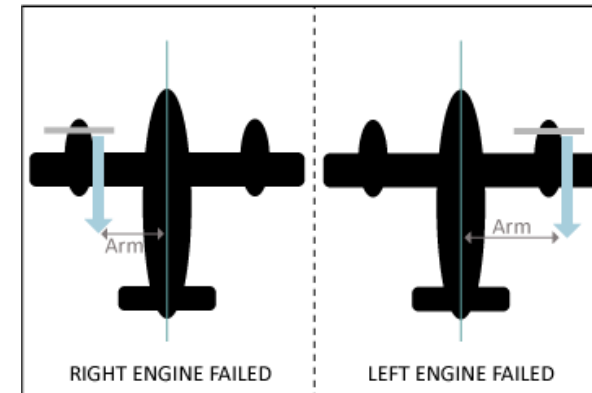
- LEFT ENGINE

- 4 Factors (PAST)

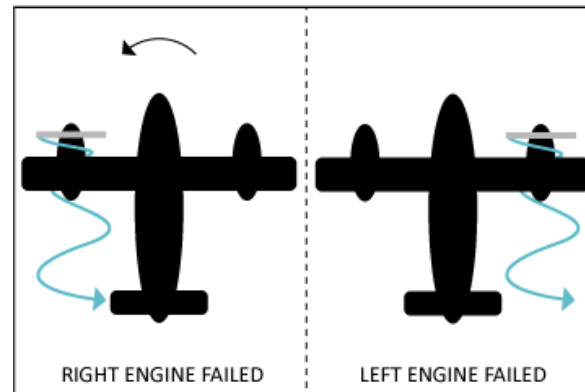
- P-Factor
- Accelerated Slipstream
- Spiraling Slipstream
- Torque



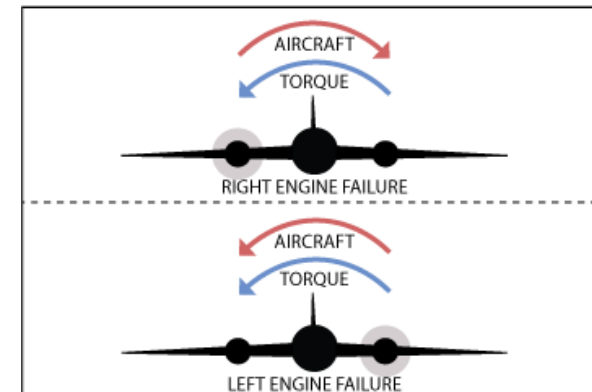
P-Factor



Accelerated Slipstream



Spiraling Slipstream



Torque

Minimum Controllable Airspeed – V_{MC}

- Minimum controllable airspeed with the critical engine inoperative
- V_{MC} Factors
 - Critical Engine Windmilling
 - Maximum Takeoff Power
 - Sea Level Conditions
 - Most Unfavorable Weight
 - Most Unfavorable CG
 - Landing Gear Retracted
 - Flaps in Takeoff Position
 - Cowl Flaps in Takeoff Position
 - Trimmed for Takeoff
 - Out of Ground Effect
 - Maximum 5° of bank



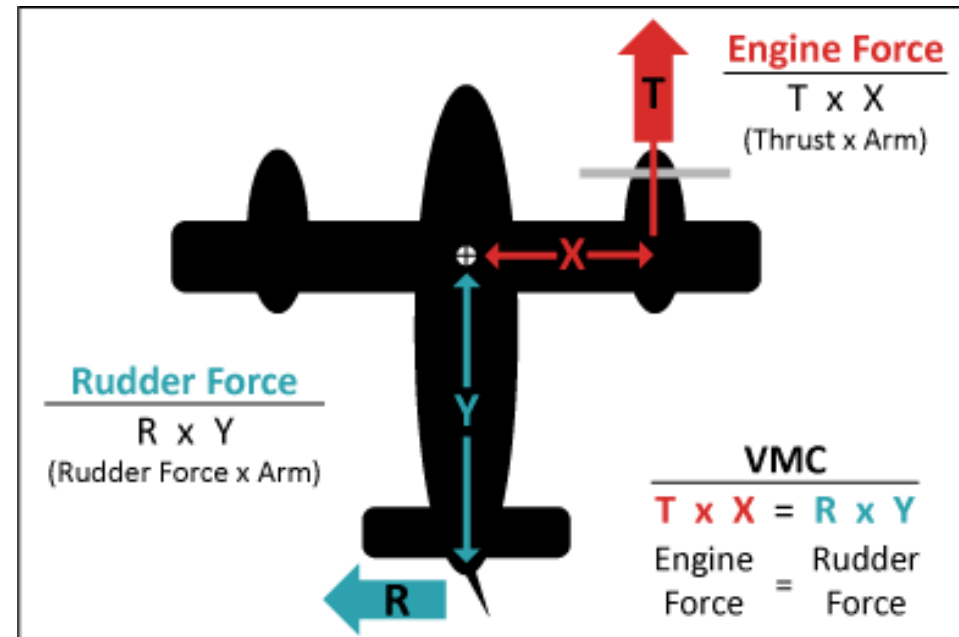
Source: Airplane Flying Handbook, FAA

Aircraft Control, V_{MC} and Performance

Factor	Control	V_{MC}	Performance
Windmilling Propeller	↓	↑	↓
Max Takeoff Power	↓	↑	↑
Sea Level (Low DA)	↓	↑	↑
Light Weight	↓	↑	↑
Aft CG	↓	↑	↑
Gear Up	↓	↑	↑
T/O Flaps (Up)	↓	↑	↑
T/O Cowl Flaps (Open)	↑	↓	↓
Trimmed for Takeoff	?	?	?
Out of Ground Effect	↓	↑	↓
Bank Angle (Max 5°)	↑	↓	↑

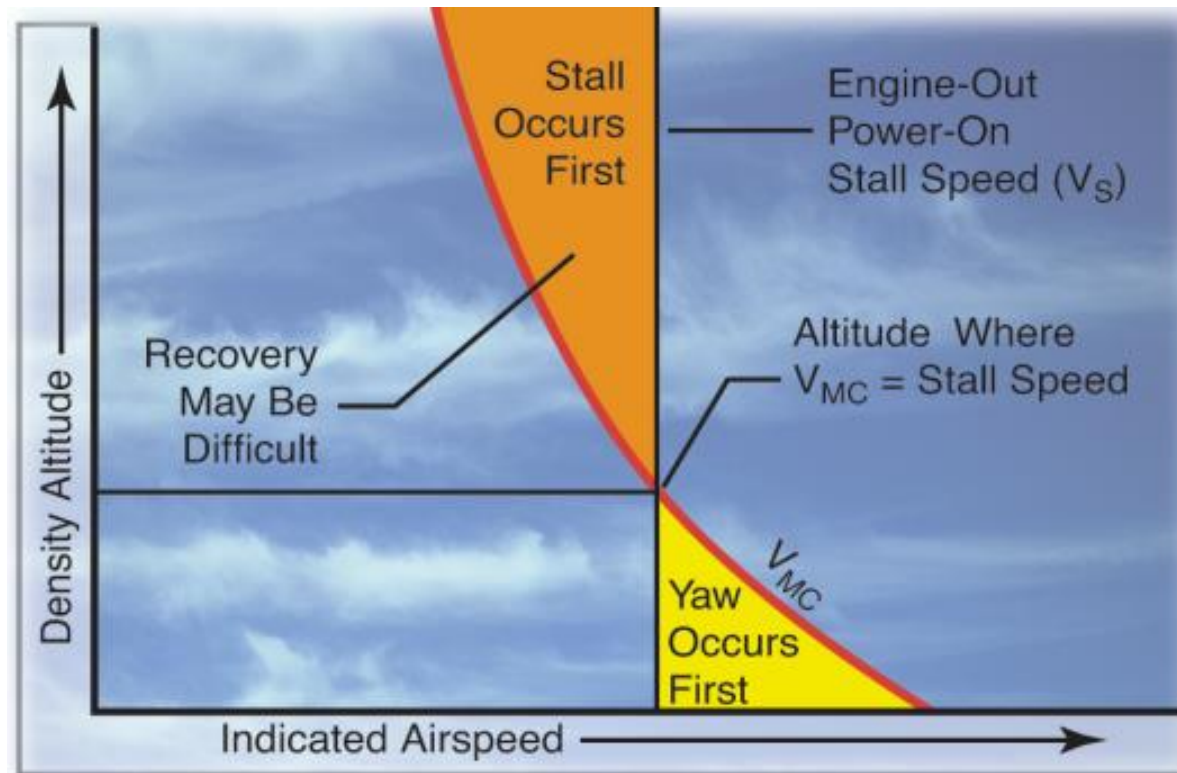
V_{MC} and the Loss of Control

- Control is lost when
 - Thrust arm moment ($T \times X$) > Rudder arm moment ($R \times Y$)
- Recovery
 - Reduce operating engine power
 - Decrease pitch attitude



V_{MC} and Stall Speed

- V_{MC} decreases with altitude, while stall speed remains the same
- Altitude where $V_{MC} = V_S$ and above is extremely dangerous



Source: Airplane Flying Handbook, FAA

V_{YSE}

- Single engine best rate of climb speed
 - Blue line
- $\geq V_{YSE}$ at all times when single engine
 - Exception: V_{XSE}



Source: Airplane Flying Handbook, FAA

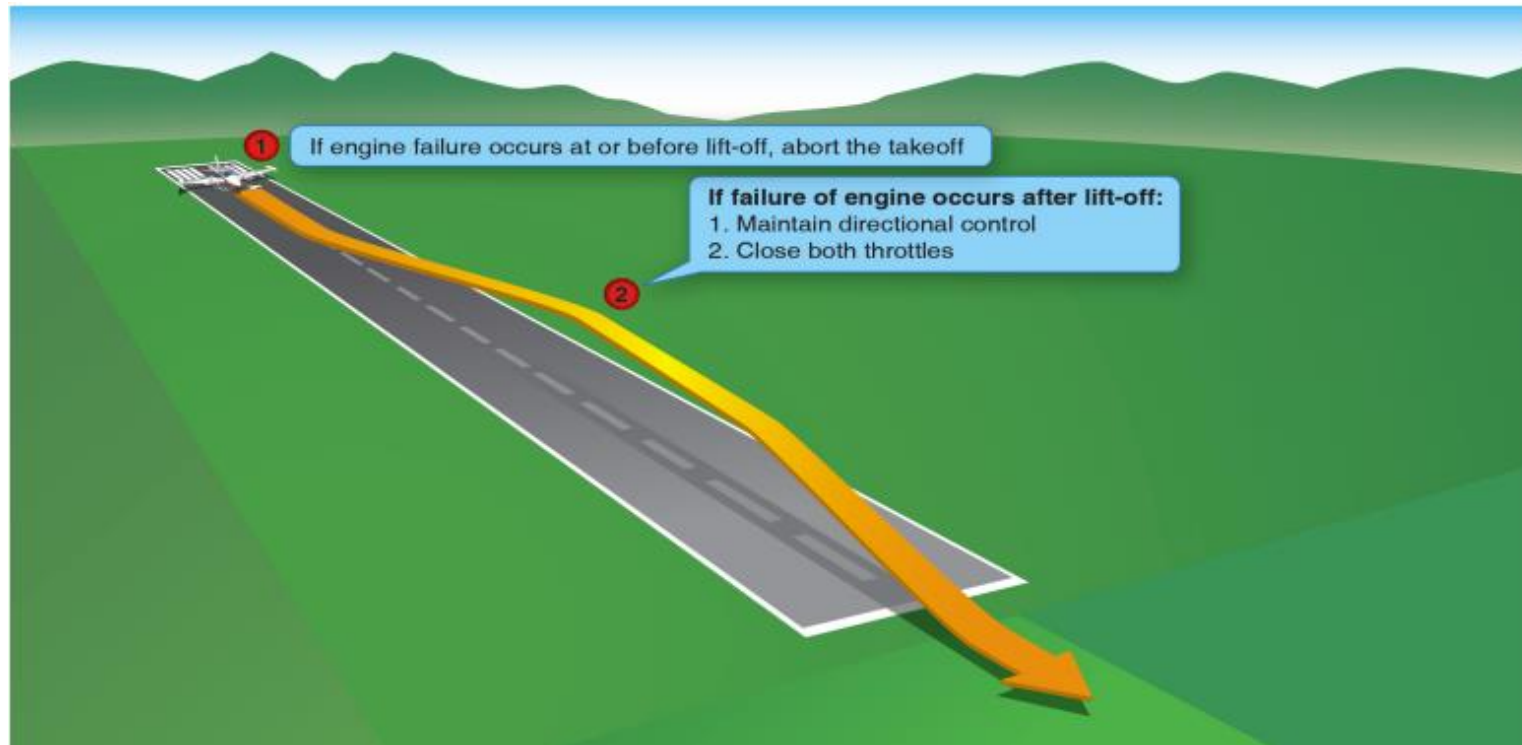
Engine Failure During / After Lift-Off

- Most critical time to suffer engine loss: Takeoff and Go-Around
 - Maintain Control
 - Pitch for V_{YSE}
 - Engine Failure Procedures
- Engine Failure Scenarios
 - Gear Down
 - Gear Up, Inadequate Climb
 - Gear Up, Adequate Climb



Engine Failure: Gear Down

- Land on the remaining runway

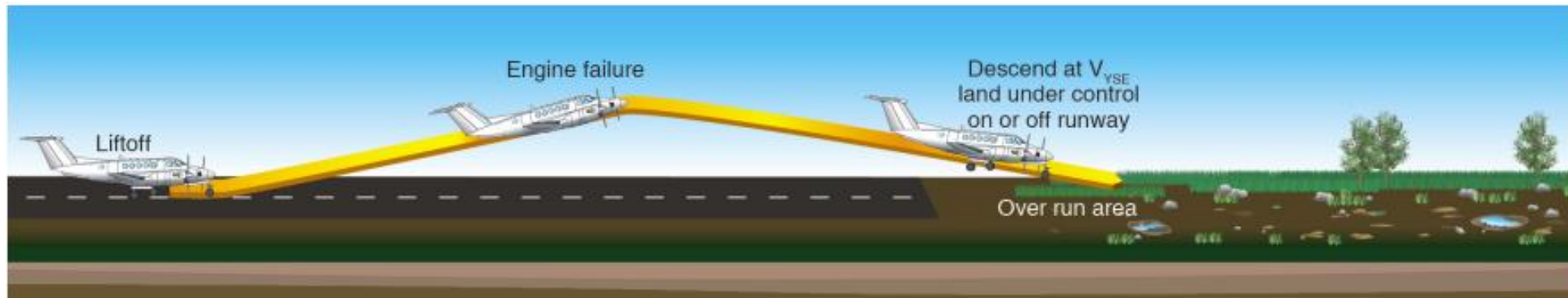


Source: Airplane Flying Handbook, FAA



Engine Failure: Gear Up, Inadequate Climb

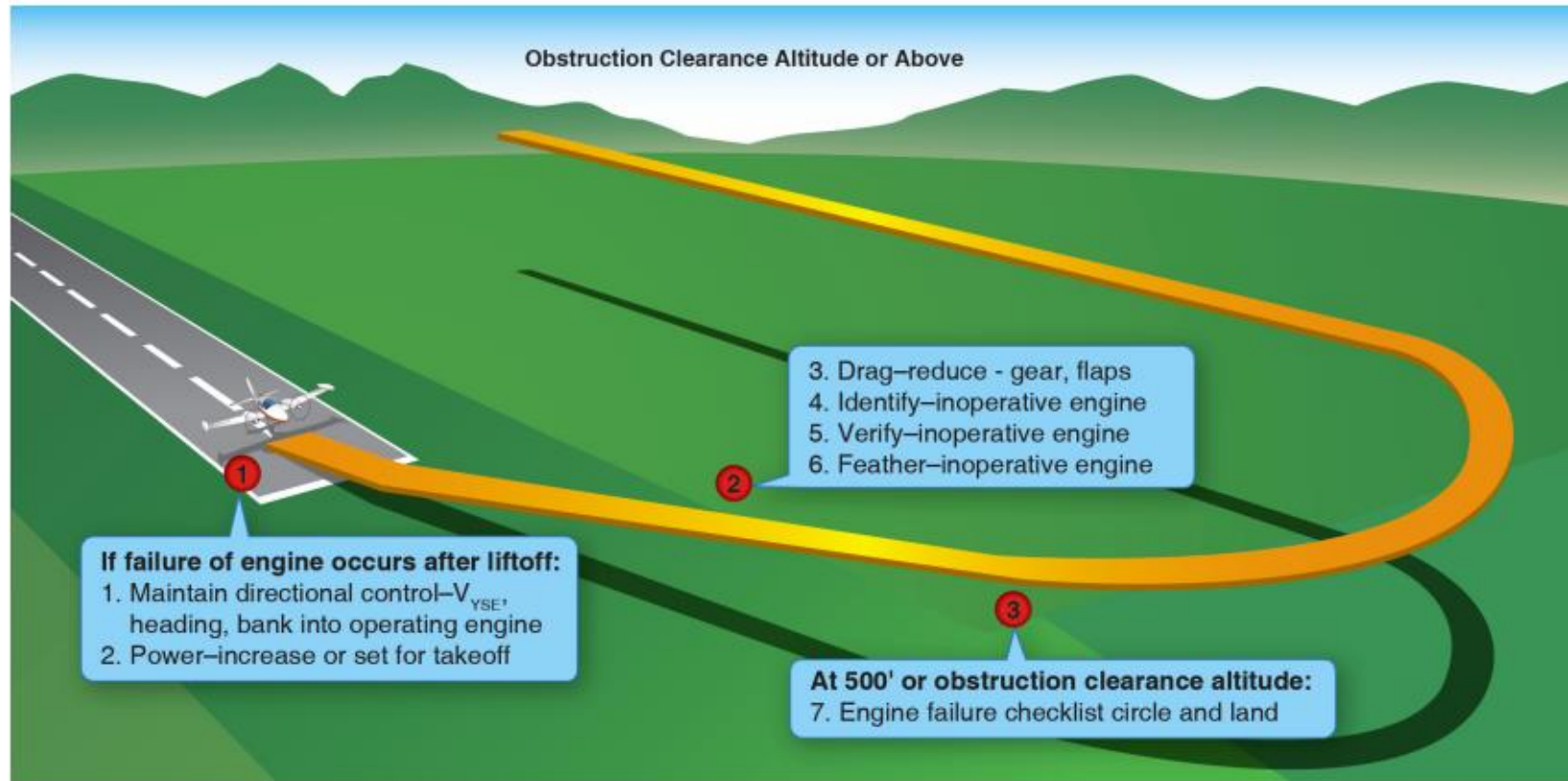
- Landing must be accomplished



Source: Airplane Flying Handbook, FAA

Engine Failure: Gear Up, Adequate Climb

- Return to land



Source: Airplane Flying Handbook, FAA



Engine Failure During / After Lift-Off

- Plan Ahead
 - Engine Failure on the Roll: Reduce power, maintain directional control
 - Engine Failure Airborne, Gear Down: Maintain directional control, land straight ahead
 - Engine Failure Airborne, Gear Up: Maintain directional control, configure to return for landing



Questions?

