
ENGINE FAILURE AFTER LIFTOFF
THE BACKSEAT PILOT

OVERVIEW

WHAT

- Safely handling engine failures after liftoff
  - Performance factors
  - Procedures based on where the engine fails

WHY

- Controlling the airplane & managing an engine failure is essential to safety in a multiengine airplane, especially when close to the ground and with significant drag

CONTENT

- OEI Airspeeds & Performance
- Managing an Engine Failure
- Engine Failure after Liftoff Procedures
- Takeoff Briefing
- Simulated Feathering
- Hazards

OEI AIRSPEEDS & PERFORMANCE

VMC: RED LINE

- Speed at which the rudder no longer has the authority to overcome the yaw caused by the critical engine being inoperative
  - Under specific FAA criteria
- Lower V_{MC} is safer
- V_{MC} is strictly concerned with directional control
  - Irrespective of performance

OEI AIRSPEEDS & PERFORMANCE

VMC: RED LINE

- Published versus Actual V_{MC}
  - Published: Based on specific FAA mandated criteria
  - Actual: Varies based on conditions, configuration, & pilot technique during an engine failure
- Takeoff Engine Failures & V_{MC}
  - Slowing below V_{MC} while close to the ground may not allow the time or altitude to recover
  - Critical to maintain safe speeds

OEI AIRSPEEDS & PERFORMANCE

VMC: RED LINE

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

OEI AIRSPEEDS & PERFORMANCE

VYSE: BLUE LINE

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

OEI AIRSPEEDS & PERFORMANCE

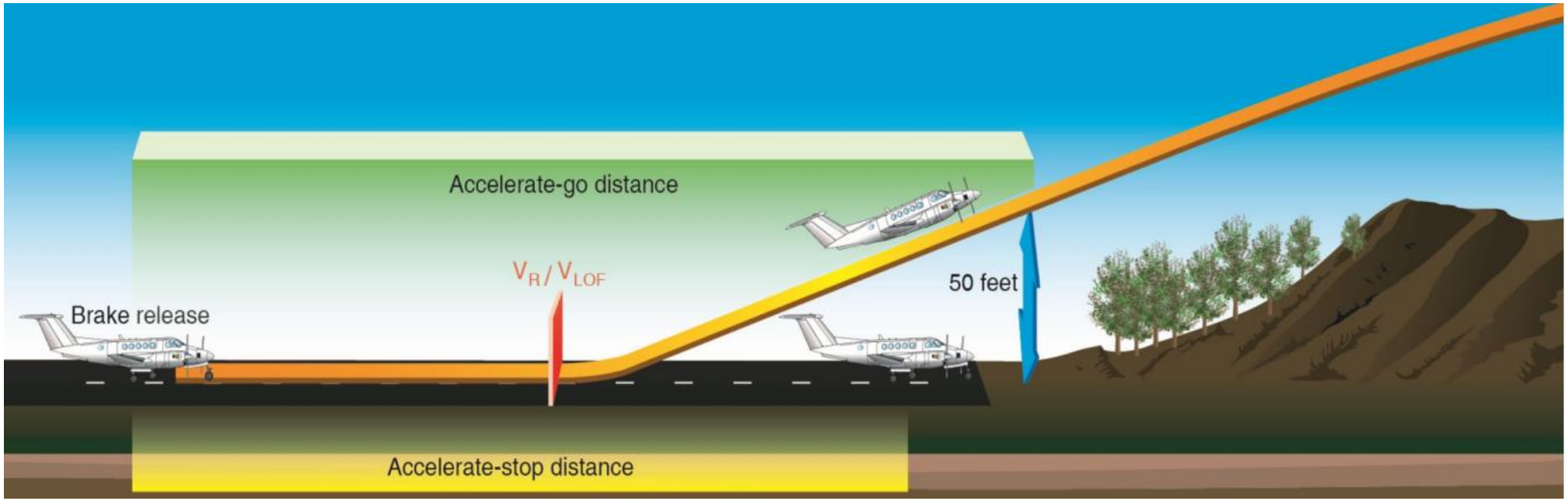
VSSE: SAFE SINGLE ENGINE SPEED

- Safe, intentional OEI speed
- Minimum speed to intentionally render an engine inoperative
- Not shown on the airspeed indicator
- Use V_{YSE} if V_{SSE} is not published

OEI AIRSPEEDS & PERFORMANCE

ACCELERATE STOP DISTANCE

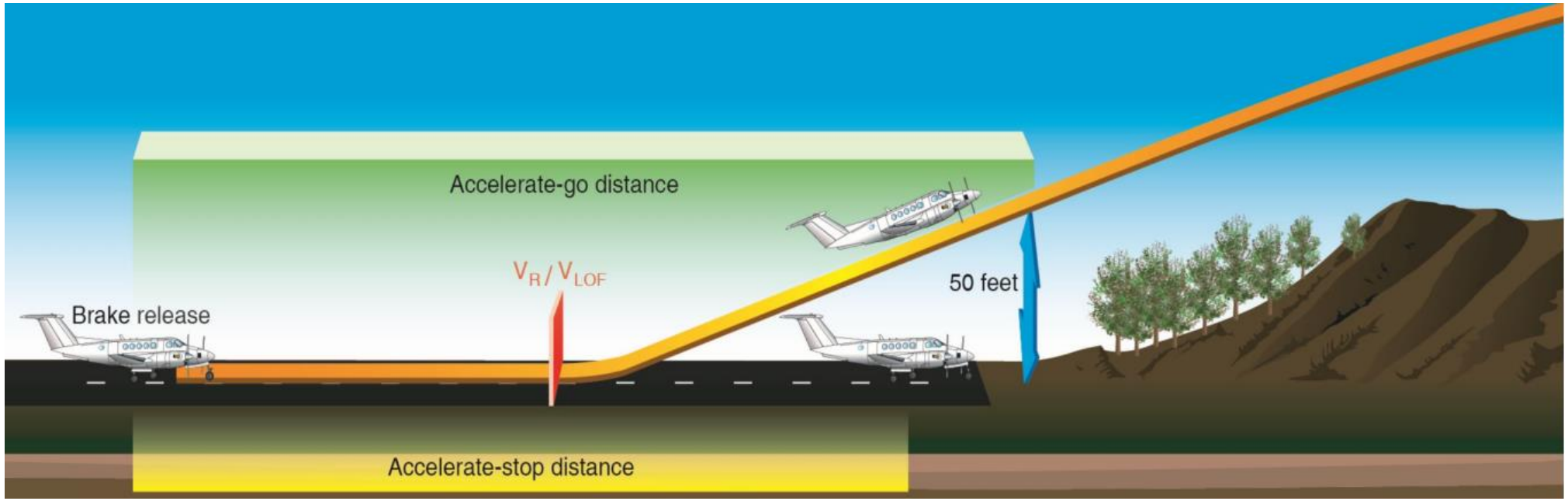
- Distance to accelerate to V_R, experience an engine failure & come to a complete stop
  - Can we stop on the runway if we lose an engine at the latest point in the takeoff roll?
- Prior to every flight, ensure this distance is less than the runway available



OEI AIRSPEEDS & PERFORMANCE

ACCELERATE GO DISTANCE

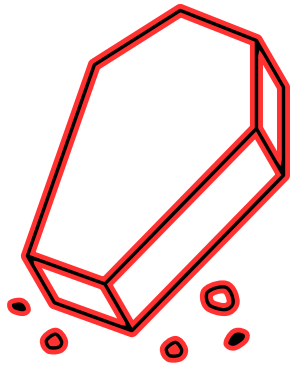
- Distance required to accelerate to V_R, experience an engine failure & climb to 50’
  - If we lose an engine at rotation speed, can we clear a 50’ obstacle?
- Verify Accelerate-Go Distance performance prior to every flight
  - Compare the distance to the location of obstacles off the departure end of the runway



MANAGING AN ENGINE FAILURE

RECOGNITION & CONTROL

- Recognize the Engine Failure
  - Visual: Easiest way to recognize an engine failure
  - Instrument: Use the instruments
    - Yaw toward the dead engine, nose drop, engine gauges indicate a failure
- Maintain Control
  - Use rudder & aileron to establish a zero sideslip
  - Pitch for V_{YSE}
- Zero Sideslip
  - 1-3^{o} of bank & ½ ball deflection into the operating engine
  - Anything other than a zero sideslip reduces performance
  - “Raise the Dead”



MANAGING AN ENGINE FAILURE

RECOGNITION & CONTROL

- Maintain Control (as discussed)
  - Zero side-slip, pitch for V_{YSE}
- Max Power
  - Throttles, Prop, Mixture
- Reduce Drag
  - Gear up, flaps up
- Identify
  - Dead foot, dead engine
- Verify
  - Slowly & smoothly reduce the throttle on the dead engine
- Fix or Feather
  - Generally, feather the propeller & secure the engine in these situations

MANAGING AN ENGINE FAILURE

CHECKLISTS

- Take a break from the checklist every step or two to verify aircraft performance
  - Flying safely is the primary concern
- There's rarely a rush to get the checklist done
  - The aircraft is under control & memory items are complete

Securing Failed Engine	
Mixture	IDLE CUT OFF
Magnetos	OFF
Alternator	OFF
Cowl flap	CLOSE
Boost pump	OFF
Fuel selector	OFF
Prop sync	OFF
Electrical load	Reduce
Crossfeed	Consider

ENGINE FAILURE AFTER LIFTOFF

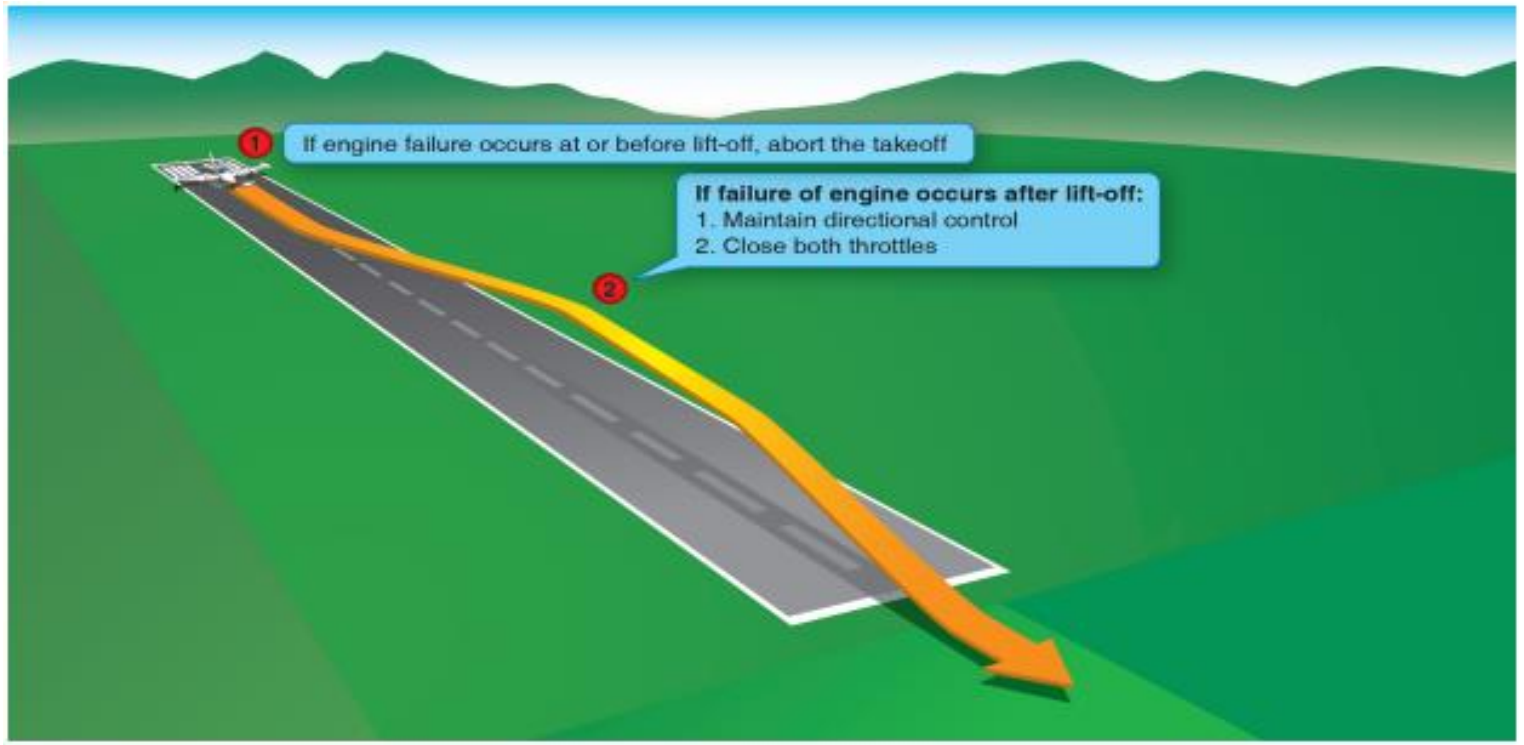
BIG PICTURE

- Takeoff is the most critical time to suffer an engine loss
- Preflight Planning & Performance are Crucial
- Engine Failures after Liftoff can be summarized in 3 Scenarios:
  - Gear Down
  - Gear Up, Single Engine Climb Inadequate
  - Gear Up, Single Engine Climb Adequate
- DO NOT attempt to continue flight when it’s not within the performance capabilities

ENGINE FAILURE AFTER LIFTOFF

GEAR DOWN

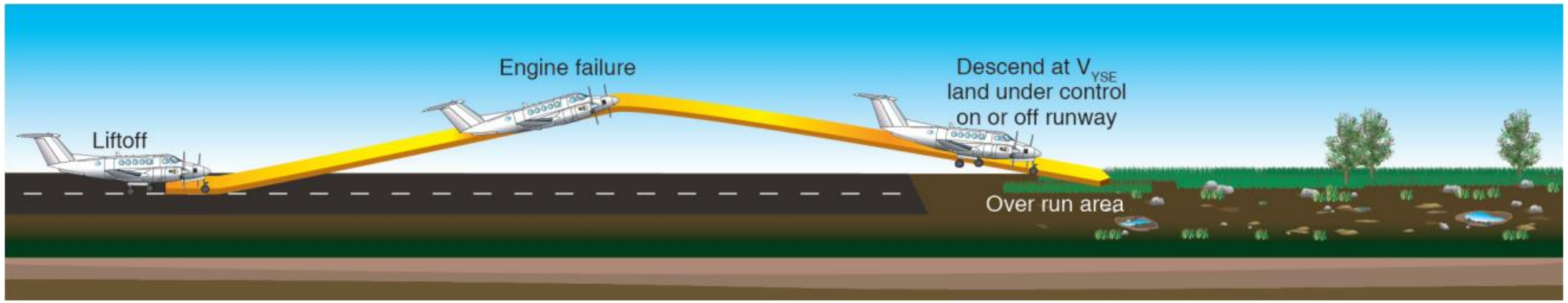
- Keep the nose as straight as possible
- Close both throttles
- Pitch to maintain adequate airspeed
- Descend & land on the remaining runway



ENGINE FAILURE AFTER LIFTOFF

GEAR UP, CLIMB INADEQUATE

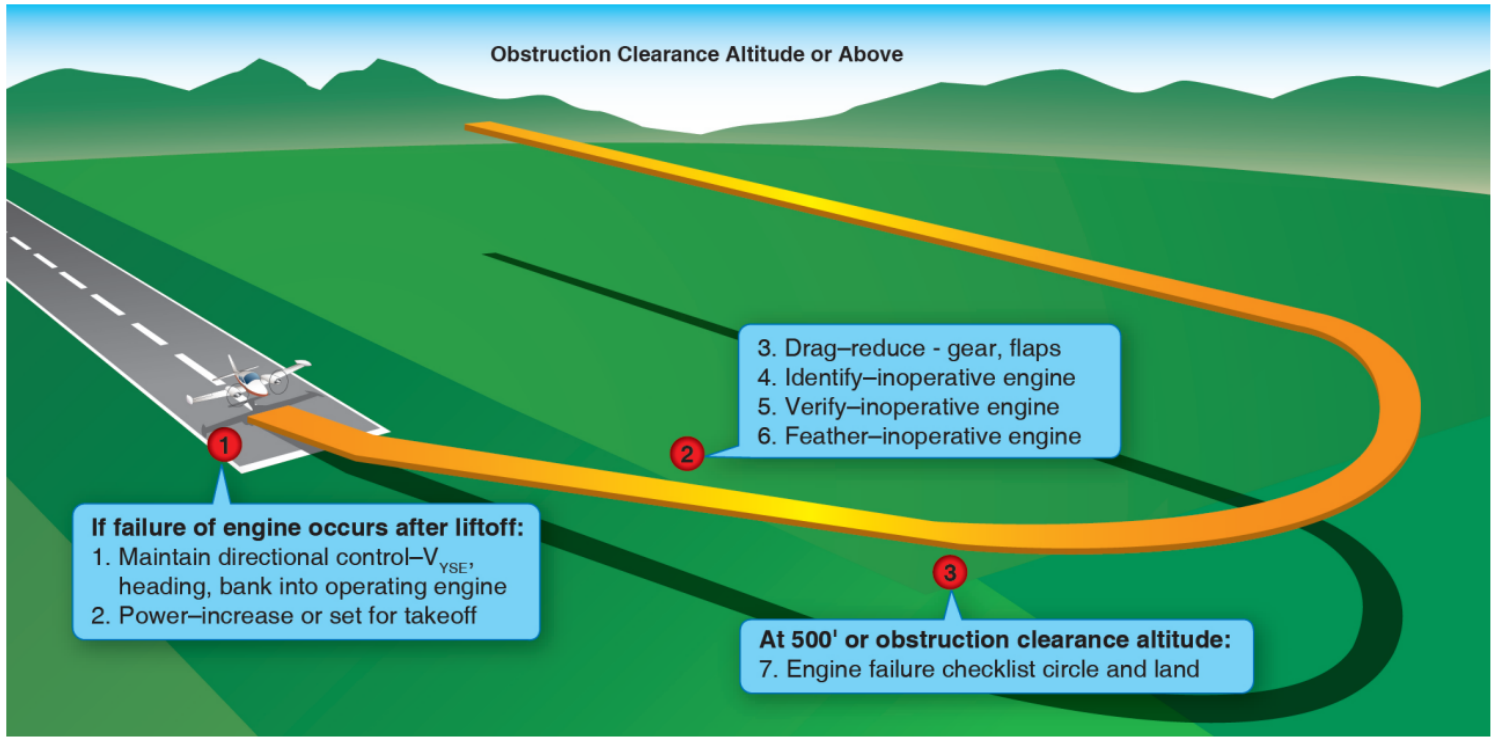
- Landing must be accomplished on whatever lies ahead
- Maintain control, reduce drag, establish a zero sideslip, maintain adequate airspeed
- Landing under control is paramount
  - A descent at V_{YSE} can increase the distance before reaching the ground
  - Bleeding speed in a futile attempt to maintain altitude will likely be fatal



ENGINE FAILURE AFTER LIFTOFF

GEAR UP, CLIMB ADEQUATE

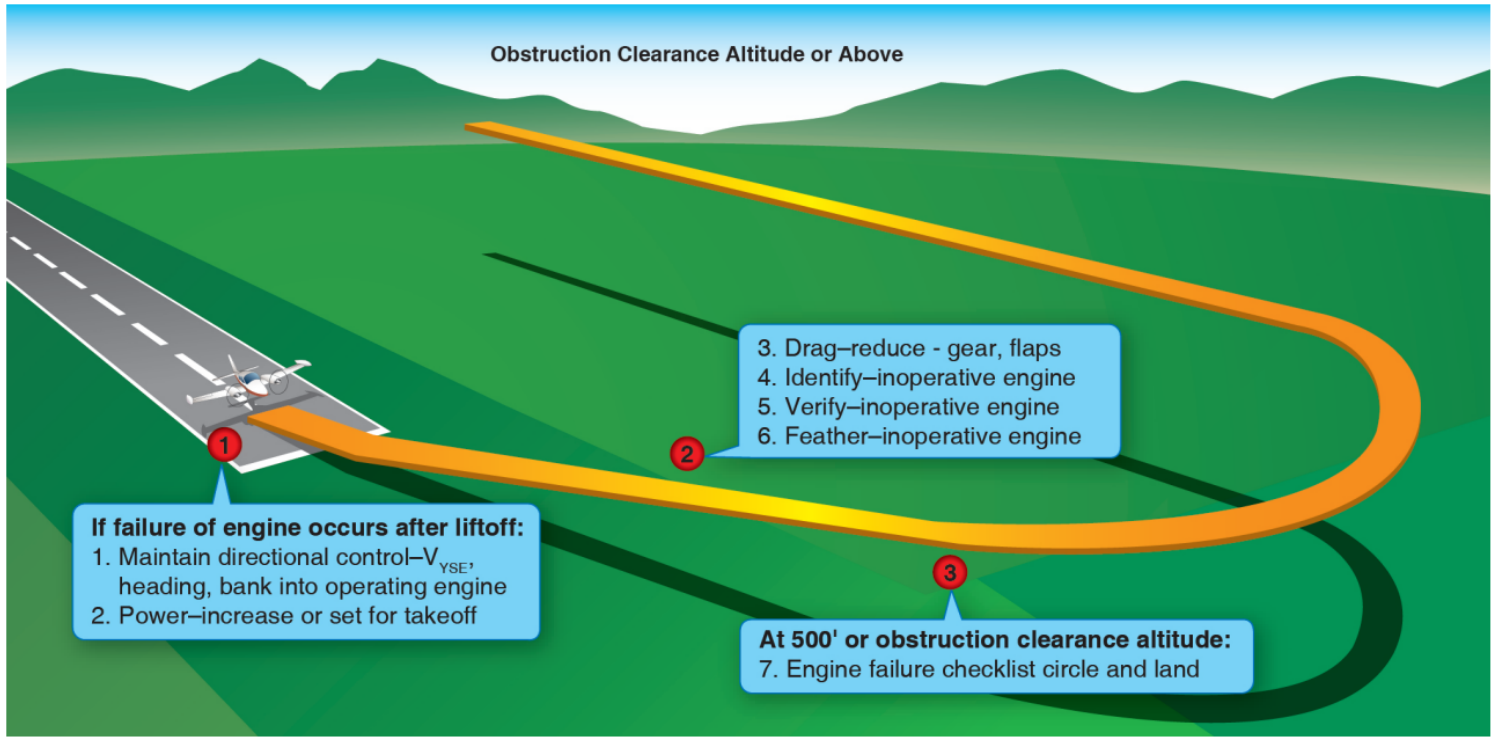
- Control
  - Rudder & aileron
  - Establish zero sideslip
  - Pitch for V_{YSE}
- Configuration
  - Full Power
  - Gear Up
  - Flaps Up
  - Identify
  - Verify
  - Feather



ENGINE FAILURE AFTER LIFTOFF

GEAR UP, CLIMB ADEQUATE

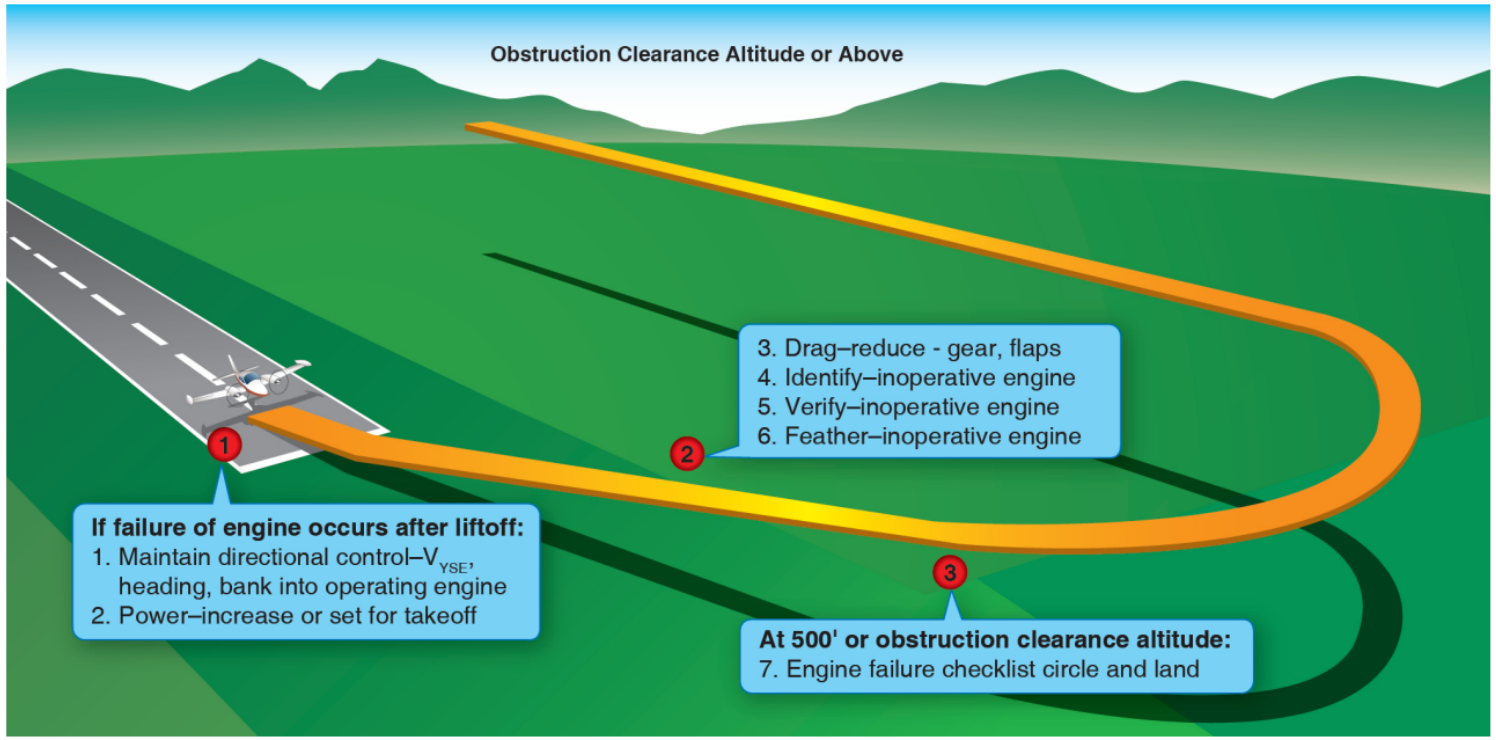
- Climb
  - V_{YSE} & zero sideslip
  - Climb to at least 400’ AGL before attempting to return to land
- Checklist
  - Accomplish the remainder of the engine securing, or applicable checklist
  - Do not sacrifice aircraft control to execute checklist items



ENGINE FAILURE AFTER LIFTOFF

GEAR UP, CLIMB ADEQUATE

- Communicate
  - Inform ATC & declare an emergency
- Circle & Land



TAKEOFF BRIEFING

HAVE A PLAN

- Airspeeds
  - V_R, V_Y, V_{YSE}
- Runway & Performance
  - Takeoff on Runway XX, we have X,XXX' of runway, performance shows we need X,XXX' for takeoff
  - Accelerate-stop distance is X,XXX' & Accelerate-go distance is X,XXX'
- Emergency Procedures
  - If we lose an engine on the roll, I will close the throttle, maintain control with the rudder & brakes, and stop straight ahead
  - If we lose an engine after rotation with the gear down & runway available, I will maintain directional control, close the throttles and pitch to land on the remaining runway
  - If we lose an engine after rotation with the gear up, I will maintain control, set max power, pitch for V_{YSE}, verify gear & flaps are up, identify & verify the dead engine, feather the propeller, and continue the climb to 400' before returning to land

SIMULATED FEATHERING

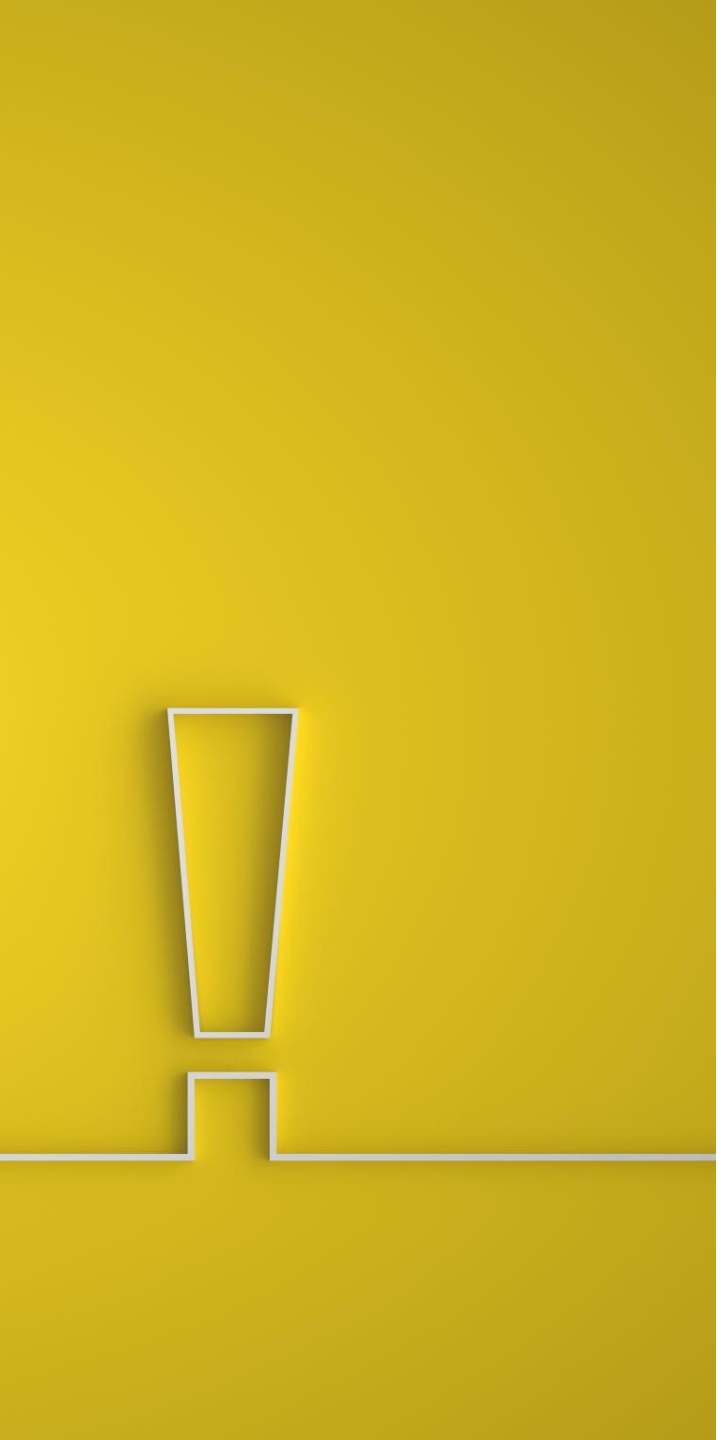
ZERO THRUST

- ACS Appendix 3 - XII.F. Engine Failure After Liftoff
  - The evaluator must not simulate feathering of an engine until attaining an altitude of at least 400’ AGL and at least V_{SSE}, V_{XSE}, or V_{YSE}
- To simulate feathering, the evaluator should establish zero thrust on the inoperative engine
- Zero Thrust
  - Set power on the engine such that drag from its propeller equals that of a feathered propeller
  - Basically, the same performance as a feathered propeller without shutting down the engine

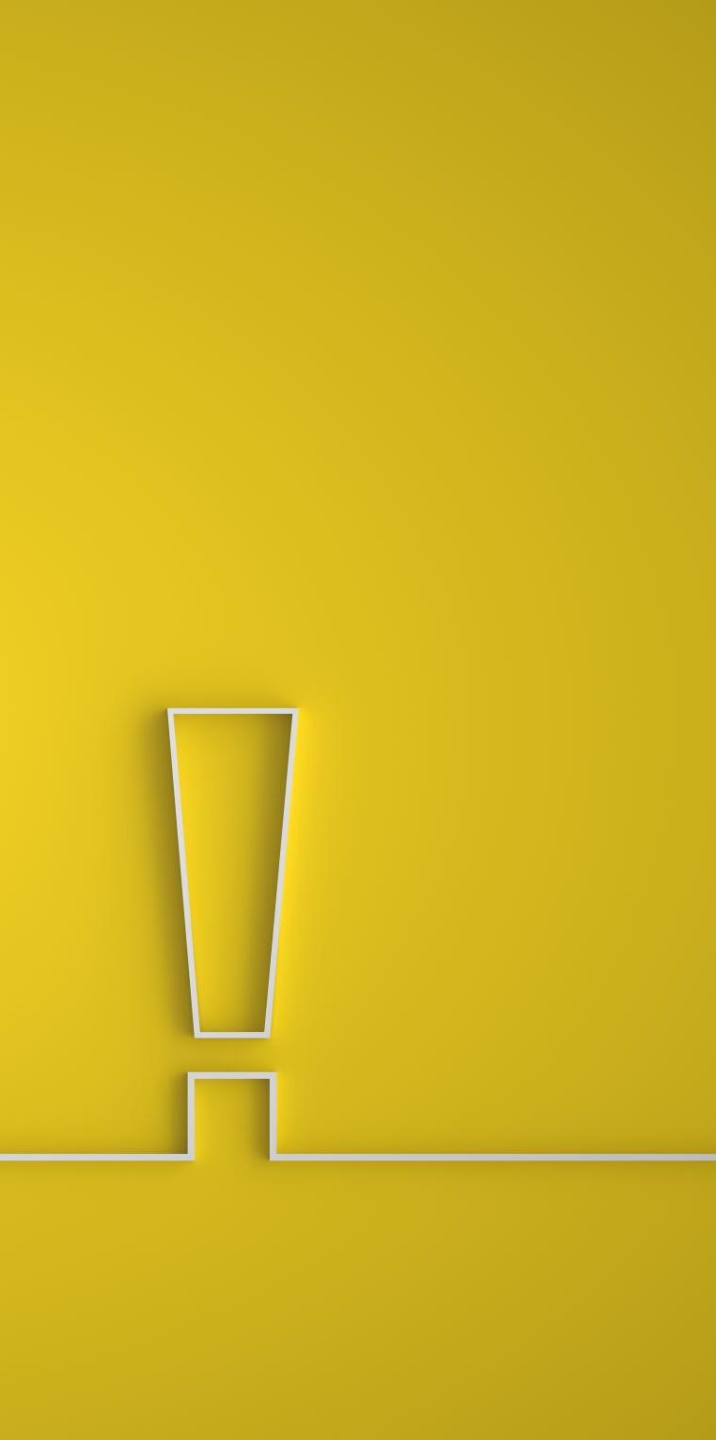
COMMON ERRORS

ENGINE FAILURE AFTER LIFTOFF

- Failure to follow prescribed emergency checklist
- Failure to properly identify and verify the inoperative engine
- Failure to properly adjust engine controls and reduce drag
- Failure to maintain directional control
- Failure to establish and maintain a pitch attitude that will result in best engine inoperative airspeed, considering the height of obstructions
- Failure to establish and maintain proper bank for best performance



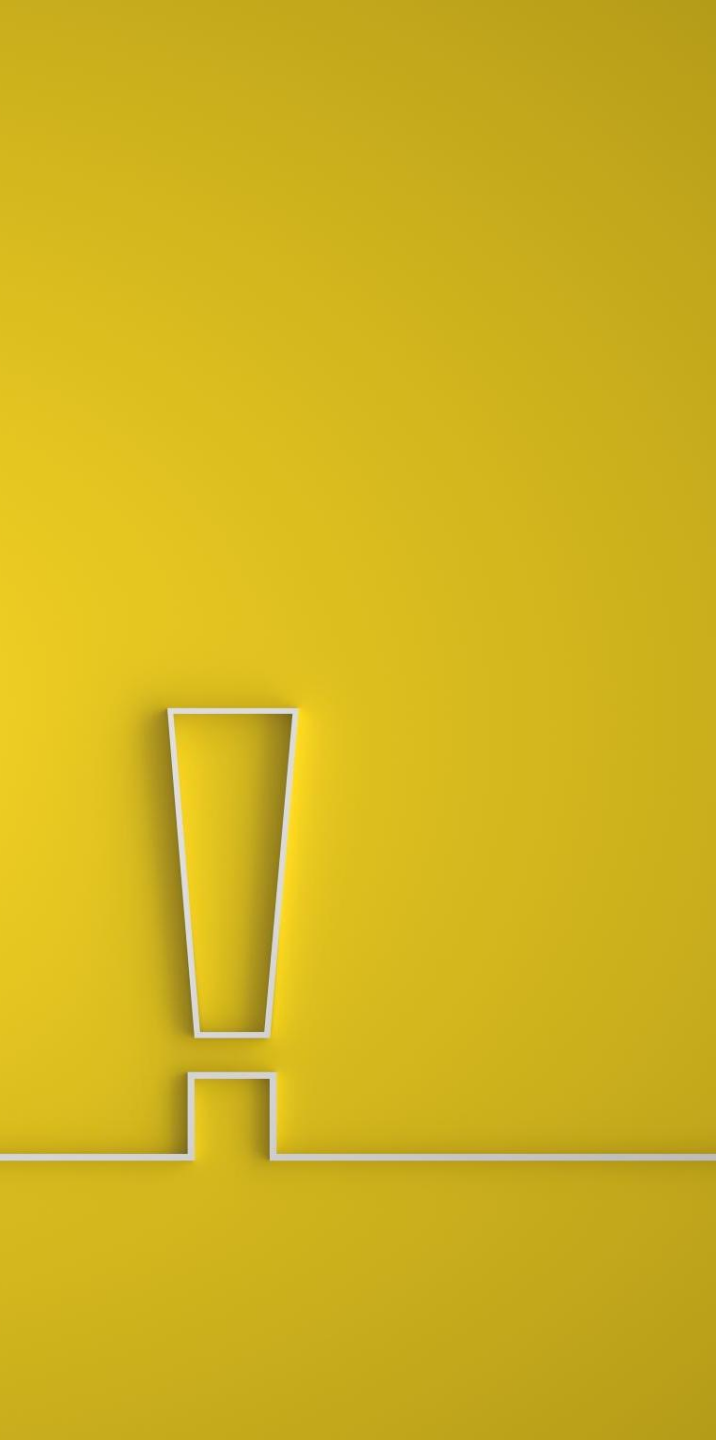
HAZARDS



HAZARDS

CONFIGURING THE AIRPLANE

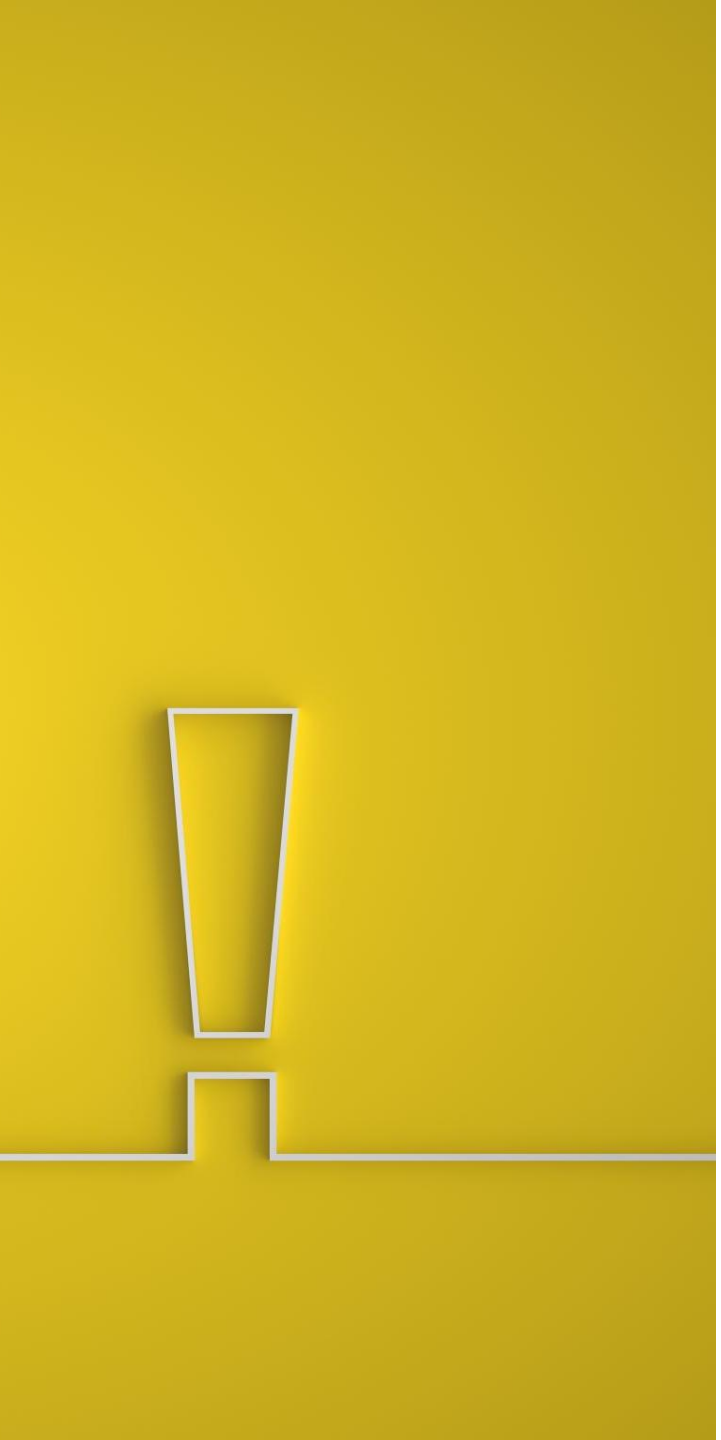
- The airplane likely will not be able to hold altitude OEI with excess drag
  - Critical the gear and flaps are retracted, and the propeller is feathered
- Follow POH procedures
  - Perform memory items to configure for the climb
  - Zero sideslip, VYSE, Max power, gear & flaps up, identify, verify, feather
  - Continue with the checklist when safe
- Reduced drag & the proper configuration reduces the odds of reaching V_{MC} and a loss of control



HAZARDS

LOW ALTITUDE MANEUVERING

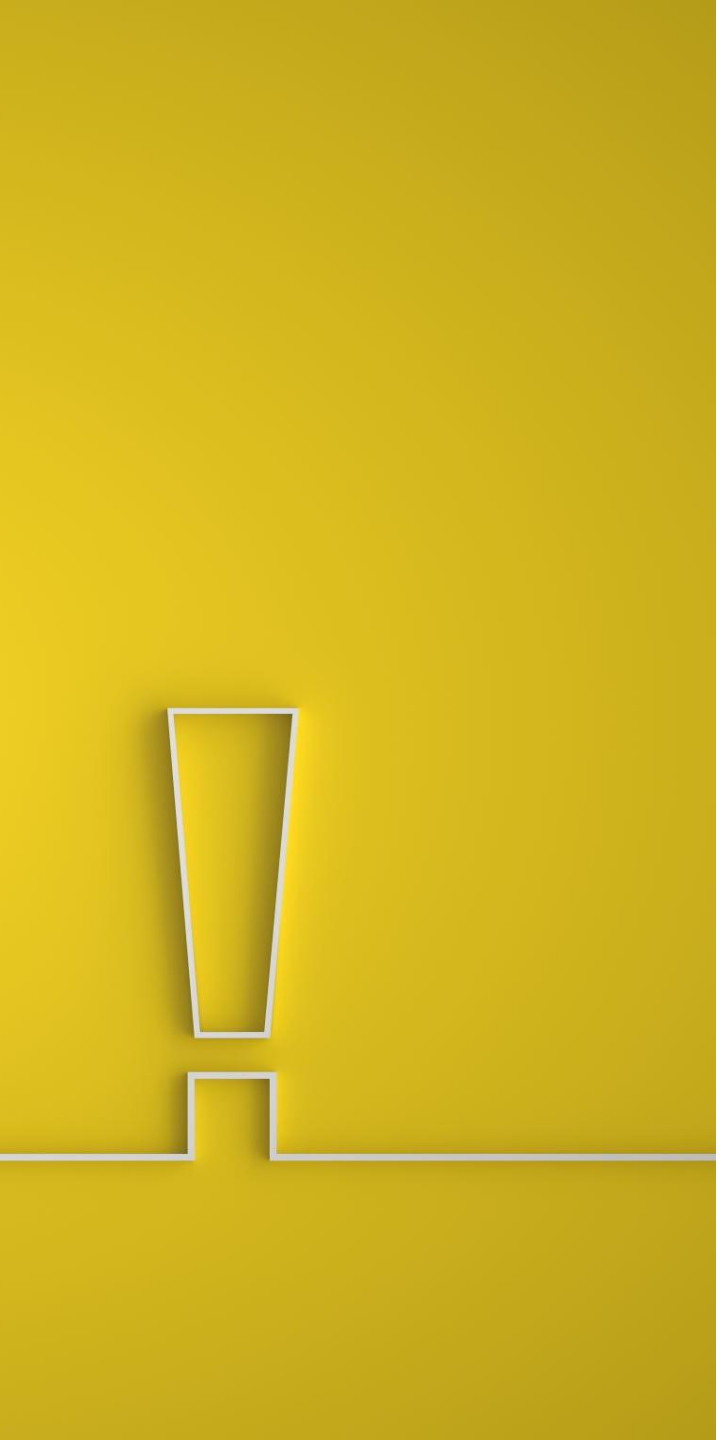
- A small problem at high altitude can be a big problem at low altitude
- Be aware of, and avoid obstructions near the airfield
- Low Altitude Stall
  - Little to no recovery time – recover at the first sign of a stall
- Low Altitude & OEI Maneuvering
  - Maintain a zero-sideslip & stay at or above V_{YSE}
  - In the case of a loss of control, recover promptly
    - Reduce power, Lower the nose, Establish V_{YSE}
- Turning with an Engine Failed
  - All turns reduce climb performance
  - If possible, climb to at least 400’ AGL before turning



HAZARDS

LOW ALTITUDE MANEUVERING

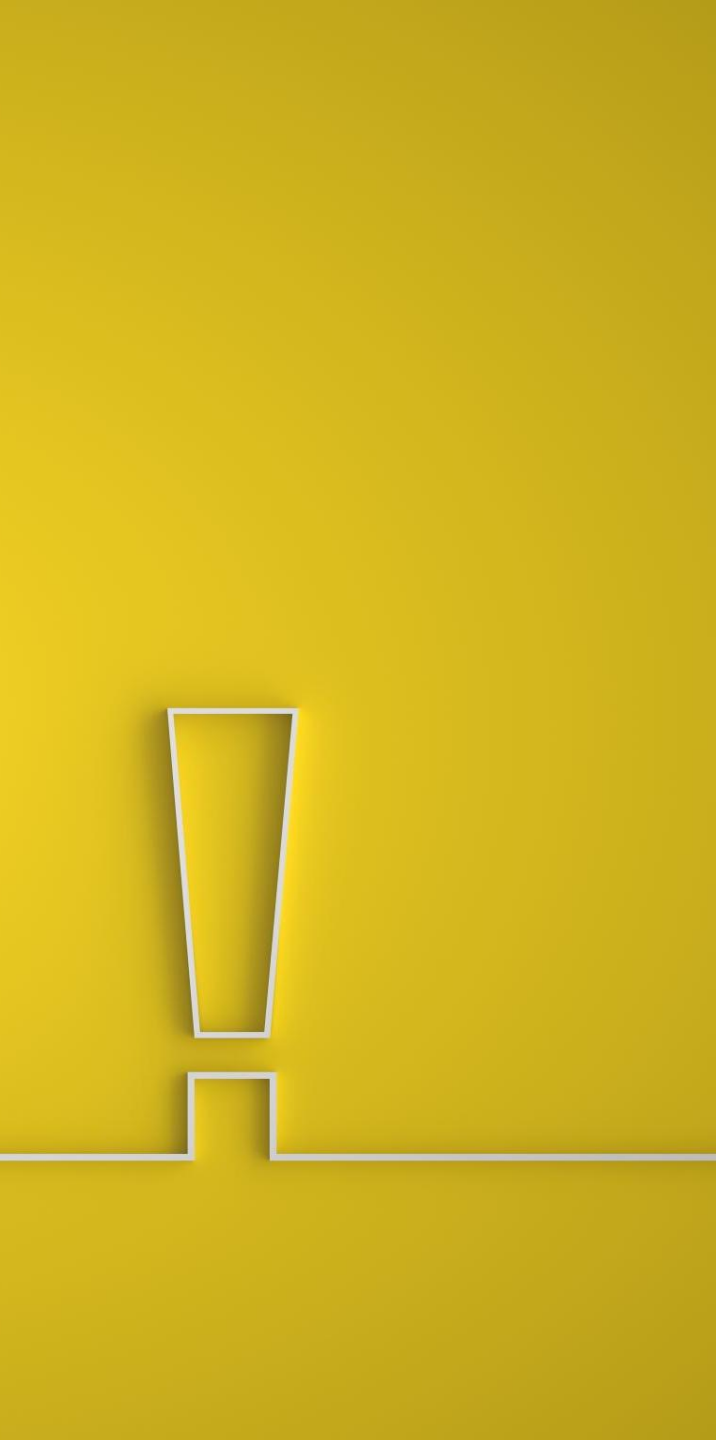
- Controlled Flight Into Terrain (CFIT)
  - Avoidance starts on the ground with proper planning & decision making
- Recommendations
  - Don’t attempt to fly into IMC
  - Fly above minimum safe altitudes
  - Verify ATC clearances & proper altitude
  - Maintain SA vertically and horizontally
  - Comply with appropriate regulations
  - Be extra cautious in unfamiliar areas
  - Use current charts & reference all available information
  - Use appropriate checklists
  - Know your aircraft & its equipment
  - Verify single engine performance is compatible with airfield terrain & obstructions



HAZARDS

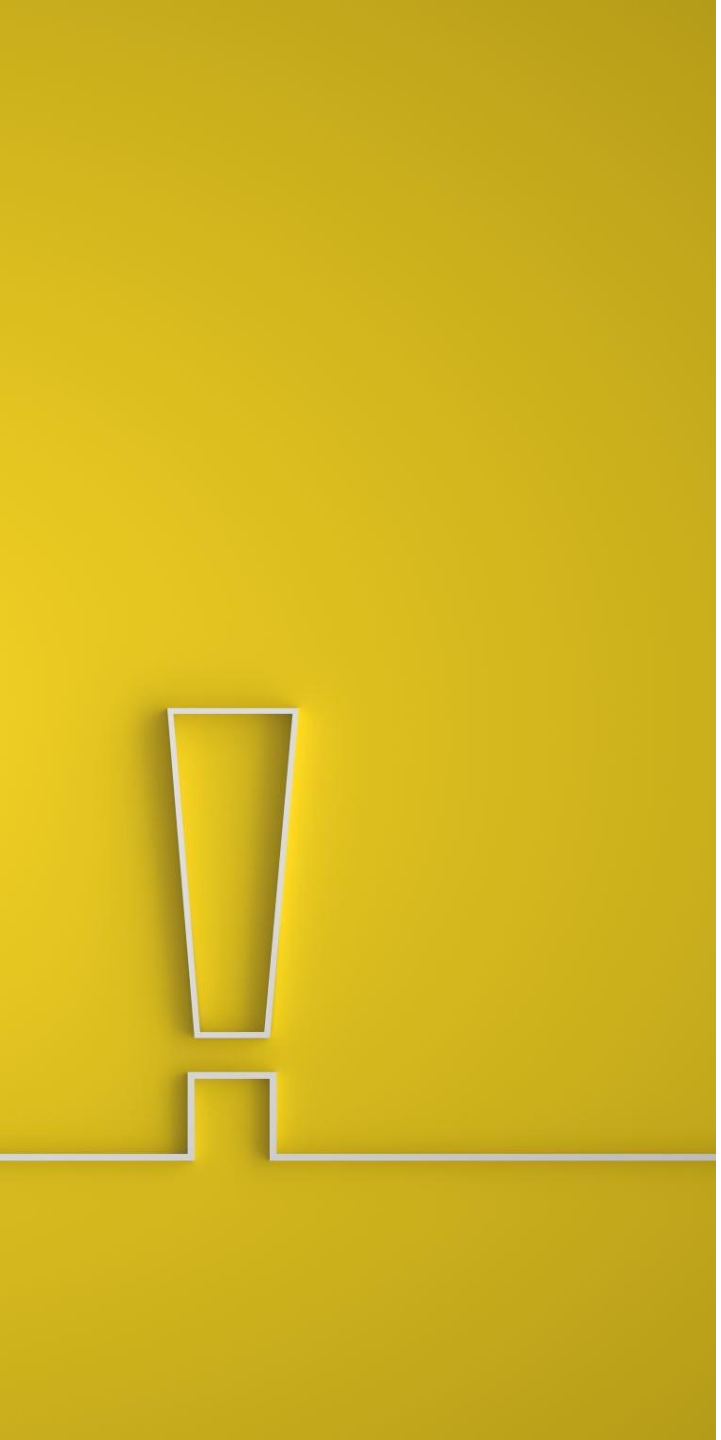
COLLISION AVOIDANCE

- Scanning
  - Series of short regularly spaced eye movements
  - Continue to scan with OEI
- Communication
  - Tower: Inform tower of the emergency & intentions
  - Uncontrolled Field: Clearly communicate intentions & location
- Operation Lights On
  - Turn on landing lights below 10,000’ MSL
- Right-of-way rules
  - Aircraft in distress has the right-of-way
  - Be cautious



HAZARDS
TERRAIN

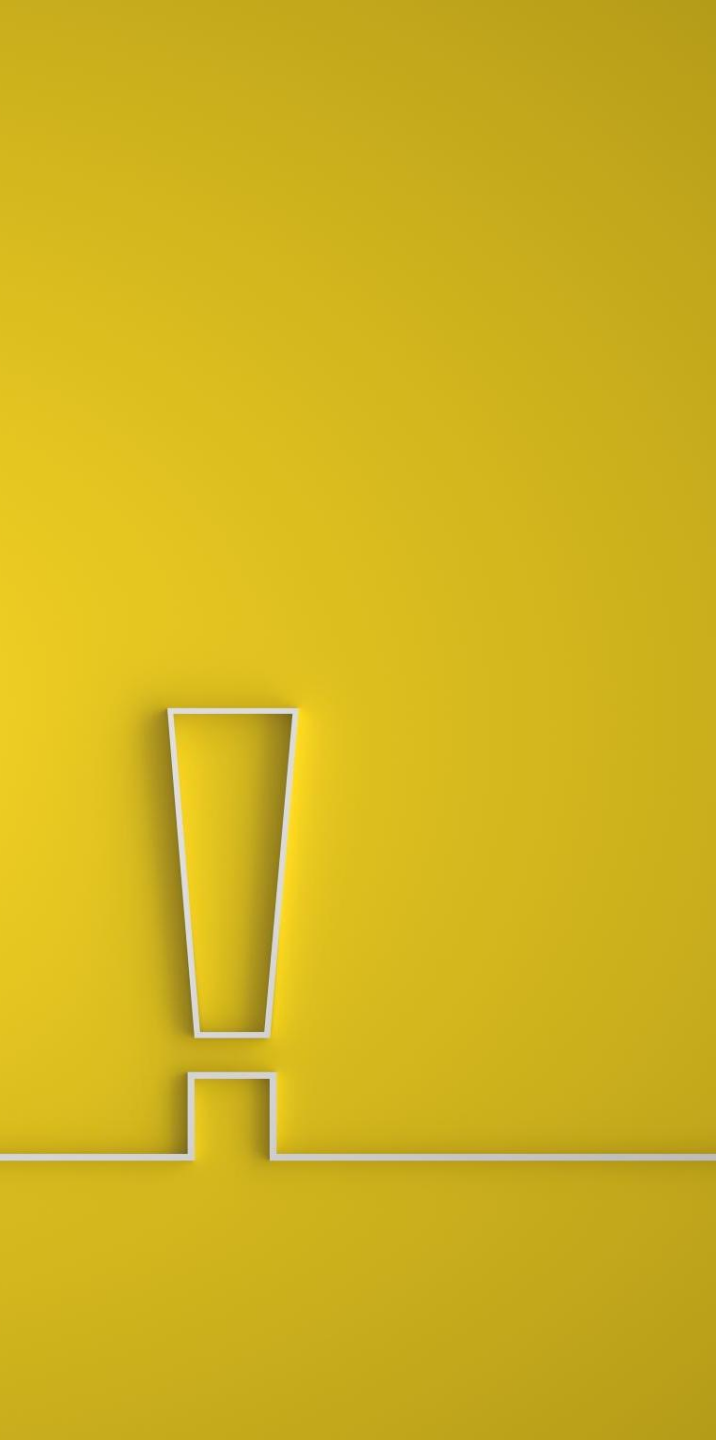
- Be aware of & plan for hazardous terrain along your route
- Study the Charts
  - Terminal charts & chart supplement, IFR/VFR chart altitudes
  - Use Maximum Elevation Figures and other data
- Performance Data
  - Ensure single engine performance can clear all terrain & obstacles
  - Do not put yourself in a situation where climb performance is inadequate
  - Use current conditions, weight & balance, etc. for the most accurate information
- Minimum Safe Altitudes
  - Anywhere: Altitude allowing emergency landing without undue hazard
  - Congested: 1,000’ above the highest obstacle within 2,000’
  - Uncongested: 500’ from the surface (500’ from people/property)



HAZARDS

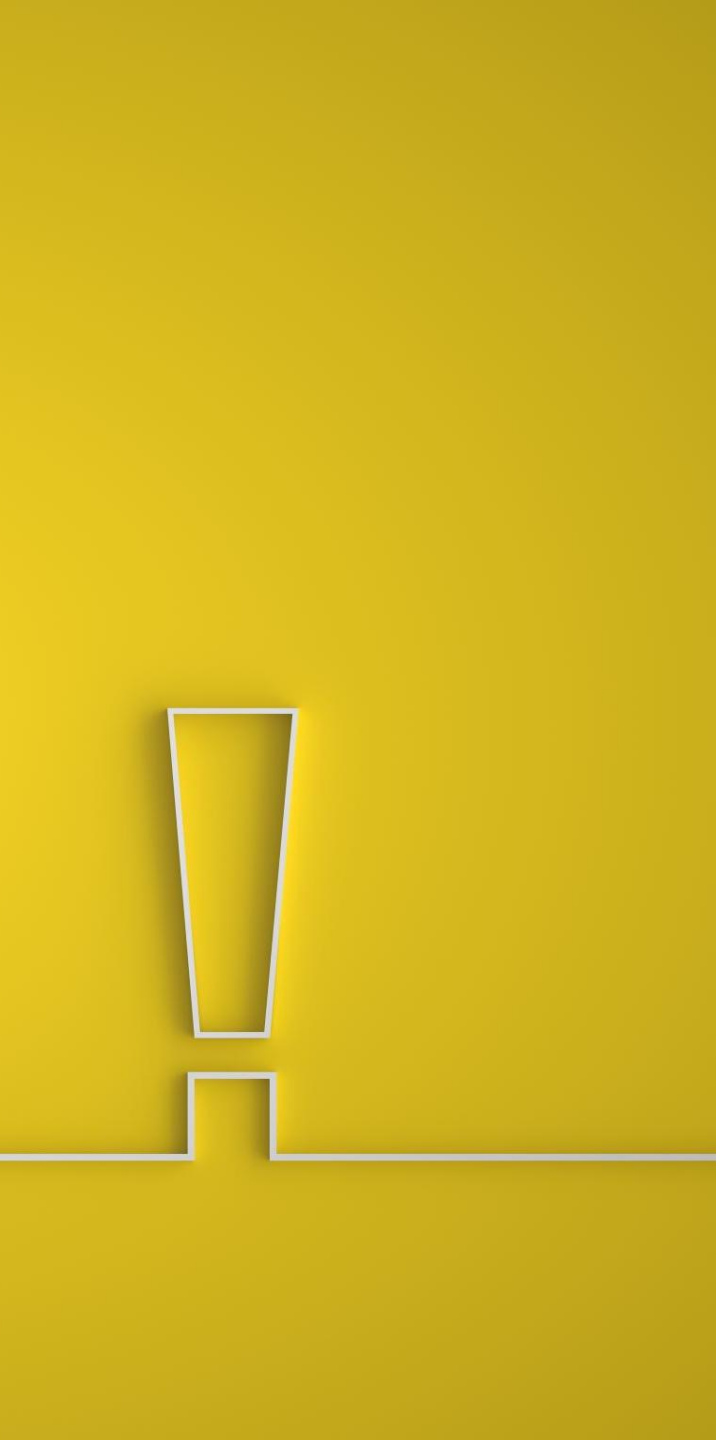
OBSTACLES & WIRE STRIKES

- Be familiar with any obstacles nearby airports
  - NOTAMs & Terminal Procedures
- Antenna Towers
  - Can extend over 1,000’ to 2,000’ AGL
  - Supporting guy wires can extend 1,500’ horizontally
- Overhead Wires
  - Transmission lines often span runway departures and landmarks pilots follow
    - Lakes, highways, railroad tracks, etc.



HAZARDS
DISTRACTIONS

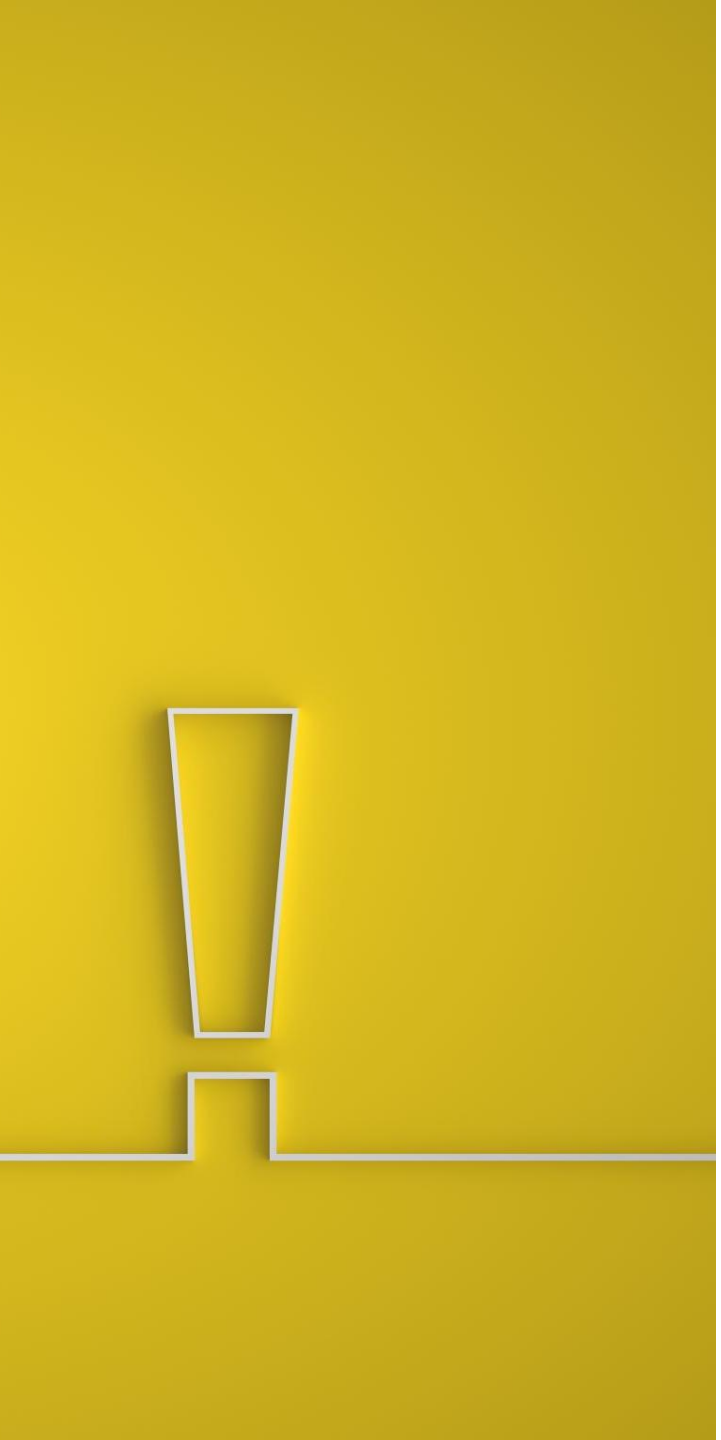
- They’re dangerous
  - Remove them from view
  - If a person, explain the situation & ask them to stop
- Maintain a sterile flight deck during takeoff
- Don’t fixate on the problem at the detriment of flying
  - Airplanes have been lost for this reason
- Aviate, Navigate, Communicate
  - Focus on flying, 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
- High task loads during an emergency can lead to a loss of SA
- 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 flying, scanning, checklists & communicating
  - No one responsibility should take full attention for more than a short period
  - Don’t sacrifice aircraft control to accomplish checklists
- Understand what needs to be accomplished and when
  - Use standard operating procedures & checklists
- Don’t be overcome by surprise or startle response
  - Take a deep breathe, follow the training & manage the engine failure
- Recognize when you’re behind and find a way to catch up
  - “Attack the closest alligator”

QUESTIONS?