XIII.C. Engine Failure after Lift-Off

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to handling an engine failure while airborne.
Key Elements	1. Fly First 2. Zero Side Slip 3. Don't approach V_{MC}
Elements	1. Controlling the Aircraft 2. Engine Failure Procedures 3. Engine Failure After Lift-Off
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can safely maintain control of the aircraft and properly handle the checklists in the event of an engine failure while airborne.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

This lesson will cover the elements involved with safely handling an engine failure while airborne, whether that includes landing on the remaining runway, returning to land, or enroute.

Why

In the case of an engine failure it is essential that a pilot understands the elements involved and can maintain control of the airplane.

How:

1. **Controlling the Aircraft**
   - A. Recognize the Engine Failure and Maintain Directional Control
     - i. The easiest way to recognize an engine failure is visually (if in V_{MC})
       - a. The pilot will recognize an uncommanded yaw in the direction of the dead engine
       - b. Visual recognition allows for better control, don't stare at the engine instruments, fly the plane
       - c. If in IMC, the engine failure will be recognized on the instruments, the aircraft will yaw toward the dead engine, the nose will drop, engine gauges will indicate a failure
       - d. Common Error – Failure to recognize an inoperative engine
     - ii. When an engine fails use rudder and aileron to maintain directional control
       - a. Establish a zero-sideslip configuration by adding approximately 2-3° of bank to counteract the roll and maintaining heading visually with rudder pressure (the aircraft will almost fall into a sideslip)
         - After a couple degrees of bank are established and rudder pressure is set to maintain heading double check the zero sideslip on the instruments and make changes needed
           - a A zero sideslip will vary based on the aircraft flown, but 1-3° bank toward the operating engine and ½ ball deflection (on the turn coordinator) toward the operating engine should be close
       - b. Common Error – Failure to establish and maintain proper bank for best performance
         - Additional bank or too little bank will create excess drag on the airframe (since it is no longer coordinated), thus reducing performance
2. **Engine Failure Procedures**
   - A. Set the Controls (Full Power)
     - i. Initially this means add full power on both engines
       - a. Increasing power means increasing rudder
       - b. The more power, the more yaw created, don't increase the power and lose control of heading

   c. Smoothly increase the power and rudder pressure (fast movements are hard to control)

B. Reduce Drag
   i. Verify Gear and Flaps are UP
   ii. Common Error – Failure to properly adjust engine controls and reduce drag
      a. Full power is necessary due to the loss of an engine
      b. Reducing drag is necessary to prevent altitude loss
      c. In an engine failure always add full power and reduce drag immediately
         - Unless landing straight ahead
         - Maintain control of the aircraft, add right rudder with the increase in power

C. Identify
   i. Dead Foot, Dead Engine
      a. Whichever foot is not being used on the rudder correlates to the engine that has failed
         - If the right foot is “dead” on the ground, the right engine is the failed engine

D. Verify
   i. To verify, reduce the throttle for the dead engine to idle
      a. There should be no change
         - You’ll know if you got the wrong throttle when the aircraft yaws rapidly in the wrong direction
      b. Reduce the throttle gently, if you accidentally got the wrong engine it will be easier to maintain control (again, fast movements are hard to control)
   ii. Common Error – Hazards of improperly identifying and verifying the inoperative engine
      a. Choosing the wrong engine can be very dangerous
      b. One engine is already failed, if you feather the incorrect engine (because you skipped or didn’t properly identify/verify the failed engine) you will be in a situation with zero engines operating

E. Fix or Feather
   i. If there is time and altitude, attempt to fix the failed engine
      a. Follow manufacturer procedures
         - Common Error - Failure to follow prescribed emergency checklist
      b. Take a break from the checklist every step or two to check airspeed, altitude, heading, zero sideslip and engine instruments
         - Assuming the aircraft has the power and ability to continue flying/climbing there’s no rush to getting the checklist done, flying is most important
   ii. If it cannot be fixed (or if time does not allow it) then feather the engine
      a. Follow manufacturer procedures
         - Common Error - Failure to follow prescribed emergency checklist
      b. Take a break from the checklist every step or two to check airspeed, altitude, heading, zero sideslip and engine instruments
         - There’s no rush to getting the checklist done, flying is most important
   iii. Before feathering the engine ALWAYS verify you have the correct engine
   iv. When feathered rudder can be reduced
      a. Yaw toward the dead engine is reduced since the drag on the inoperative propeller is reduced
      b. Adjust the controls to maintain the zero sideslip

F. Restart the Inoperative Engine
   i. Follow manufacturer Procedures
      a. Common Error - Failure to follow prescribed emergency checklist

ii. Maintain control during the process
    a. When the engine restarts rudder will have to be increased as yaw and drag will increase
iii. As you increase the power, adjust rudder
    a. Maintain directional control with the rudder/aileron visually

G. Overview: Maintain control, full power, gear up, flaps up, identify, verify, fix or feather

3. Engine Failure After Lift-Off

A. Engine failures after lift-off can be summarized into four scenarios
    i. Landing Gear Down
    ii. Landing Gear Up, single engine climb inadequate
    iii. Landing Gear Up, single engine climb adequate
    iv. Enroute (at a safe altitude)

B. Engine Failure After Lift-Off with the Gear Down
    i. A takeoff or go around is the most critical time to suffer an engine loss
        a. The airplane will be slow, close to the ground and flaps and gear may be extended
        b. Altitude and time will be minimal
    ii. If failure occurs before selecting the gear up, close both throttles and land on the remaining runway
        a. Landing gear should be retracted when a positive rate of climb is established AND no remaining runway is available to land on
            • Therefore, if the landing gear is up the decision has been made to continue the flight if an engine fails

C. Landing gear up, single engine climb inadequate
    i. A landing must be accomplished on whatever lies ahead
        a. Maintain control, clean up excess drag, establish zero side slip, pitch for V_{YSE}
    ii. A descent at V_{YSE} can increase the distance the aircraft can fly before reaching the ground
    iii. If necessary (and better than landing gear up), lower the gear for landing

D. Landing Gear Up, single engine climb adequate
    i. The procedures for continued flight should be followed
        a. Control
            • Use rudder and aileron as necessary in order to maintain control/zero side slip
                a Common Error - Failure to establish and maintain proper bank for best performance
            • Fly the plane first, checklists second
        b. Configuration - Full Power, Gear, Flaps, Identify (dead foot, dead engine), Verify (reduce throttle), Fix or Feather
            • Common Error – Failure to properly identify and verify the inoperative engine
            • Common Error – Failure to properly adjust engine controls and reduce drag
        c. Perform the appropriate checklist
            • Common Error – failure to follow prescribed emergency checklist
            • Do not attempt to fix the failed engine unless time and altitude allow
        d. Maintain V_{YSE}
            • Common Error – Failure to establish and maintain a pitch attitude that will result in best engine inoperative airspeed, considering the height of obstructions
        e. Return to land

E. Enroute
    i. The procedures for continued flight should be followed
        a. Control

- Use rudder and aileron as necessary in order to maintain control/zero side slip
- Maintain altitude (if necessary, climb at V_{YSE})
  - a Pitch will have to increase in order to maintain altitude due to the lost engine
- Fly the plane first, checklists second

b. Configuration - Full Power, Gear, Flaps, Identify (dead foot, dead engine), Verify (reduce throttle), Fix
- Follow the checklists to attempt to fix the engine
  - a After every step or two return to flying the aircraft
    1. Check altitude, airspeed, heading, zero sideslip, and engine indications
    2. There's no rush to finish the checklist, controlling the aircraft is the #1 priority

c. If the engine cannot be fixed proceed to feather the engine as described in the POH/emergency procedures and land as necessary

Common Errors:

- 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

Conclusion:

Brief review of the main points

Control is the most important aspect of any engine failure. No matter where the engine failure occurs, maintain control before, during and after any checklists are completed.

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements related to engine failure after lift-off by describing:
   a. Use of prescribed emergency checklist to verify accomplishment of procedures for securing the inoperative engine.
   b. Proper adjustment of engine controls, reduction of drag, and identification and verification of the inoperative engine.
   c. How to establish and maintain a pitch attitude that will result in the best engine inoperative airspeed, considering the height of obstructions.
   d. How to establish and maintain a bank as required for best performance.
   e. How to maintain directional control.
   f. Methods to be used for determining reason for malfunction.
   g. Monitoring and proper use of the operating engine.
   h. An emergency approach and landing, if a climb or level flight is not within the airplane's performance capability.
   i. Positive airplane control.
   j. How to obtain assistance from the appropriate facility.

2. Exhibits instructional knowledge of common errors related to engine failure after lift-off by describing:
   a. Failure to follow prescribed emergency checklist.
   b. Failure to properly identify and verify the inoperative engine.
   c. Failure to properly adjust engine controls and reduce drag.
   d. Failure to maintain directional control.
   e. Failure to establish and maintain a pitch attitude that will result in best engine inoperative airspeed, considering the height of obstructions.
   f. Failure to establish and maintain proper bank for best performance.
3. Demonstrates and simultaneously explains a simulated engine failure after lift-off from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to engine failure after lift-off.

Private & Commercial Pilot ACS Skills Standards

1. Promptly recognize an engine failure, maintain control and utilize appropriate emergency procedures.
2. Establish V_{YSE}; if obstructions are present, establish V_{XSE} or V_{MC} +5 knots, whichever is greater, until obstructions are cleared, then transition to V_{YSE}.
3. Reduce drag by retracting landing gear and flaps in accordance with the manufacturer's guidance.
4. Simulate feathering the propeller on the inoperative engine. (Evaluator should then establish a zero-thrust on the inoperative engine).
5. Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required.
6. Monitor the operating engine and make adjustments as necessary.
7. Recognize the airplane's performance capabilities. If a climb is not possible at V_{YSE}, maintain V_{YSE} and return to the departure airport for landing, or initiate an approach to the most suitable landing area available.
8. Simulate securing the inoperative engine.
9. Maintain heading ±10°, and airspeed ±5 knots.
10. Complete the appropriate checklist.