IX.F. EIGHTS ON PYLONS

OBJECTIVE & COMPLETION STANDARDS

To develop an understanding of the eights on pylon maneuver and the skills necessary for the task. The learner can apply these concepts in the plane.

The lesson is complete when the learner understands Pivotal Altitude and the accompanying concepts to Eights on Pylons. The learner applies these concepts in the airplane meeting ACS standards.

KEY POINTS

- Point Moves Forward: Forward Pressure
- Point Moves Back: Back Pressure
- Small Coordinated Control Inputs

ELEMENTS

1. What is Pivotal Altitude?
2. The Basics
3. Calculating Pivotal Altitude
4. Performing Eights on Pylons
5. Common Errors
6. Hazards

REFERENCES

- Airplane Flying Handbook
- POH

SCHEDULE

- Introduction
- Development
- Conclusion

EQUIPMENT

- Board & Markers
- References
- Model airplane

INSTRUCTOR

- Present Content
- Ask/Answer Questions
- Assign Homework

STUDENT

- Participate in learning
- Take notes
- Ask/Answer Questions

LEGEND & ABBREVIATIONS

SECTION HEADER FOR EACH LESSON ELEMENT

*Light blue for **Main points and/or brief section summary***

- **Orange** text is used for mnemonics or things to remember
- **RM**: Teal RM denotes an ACS Risk Management concept
- **CE**: Red CE shows an Airplane Flying Handbook listed Common Error

IA: Instructor Action (ex. hop out of the lesson & review a checklist) – Coming soon!

Light gray for notes, examples, extra details & explanations, etc.

INTRODUCTION

ATTENTION

Interesting fact or attention-grabbing story

The eights on pylons maneuver started in WWI. This maneuver was developed to maintain a constant view of a target, allowing the gunner to destroy it. A more practical application now is keeping the wing out of the way for aerial photography.

OVERVIEW

Review Objectives, Elements, and Key Points

Every single Knowledge & Risk Management task is annotated! Find whatever info you need.

WHAT

Eights on Pylons involves flying the plane in a figure eight path around two selected points on the ground. The goal is to have an imaginary line extending from the pilot's eyes to the pylon. The line must be imagined to be parallel to the lateral axis. Along this line, the airplane appears to pivot as it turns around the pylon. No attempt is made to maintain a uniform distance from the pylon.

In other words, if a string extended from the plane to the pylon, the string would remain parallel to the lateral axis as the plane turned around the pylon.

WHY

AI.IX.F.K1

The objective of this maneuver is to develop the ability to maneuver the airplane accurately while dividing one's attention between the flight path and the selected points on the ground. Eights on Pylons are extremely helpful in teaching, developing, and testing subconscious control of the airplane.

HOW

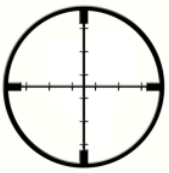
1. WHAT IS PIVOTAL ALTITUDE (PA)

AI.IX.F.K3

A. Altitude which keeps a pylon in the same position relative to the aircraft as the plane turns around it

i. Varies with groundspeed

ii. The reference line is parallel with the lateral axis (off wingtip or position on the window)



B. When turning at PA, the reference line appears to be fixed to a point on the landscape

i. Above the pivotal altitude, the wingtip appears to move backward

ii. Below the pivotal altitude, the wingtip appears to move forward

2. THE BASICS

AI.IX.F.K2, AI.IX.F.K3

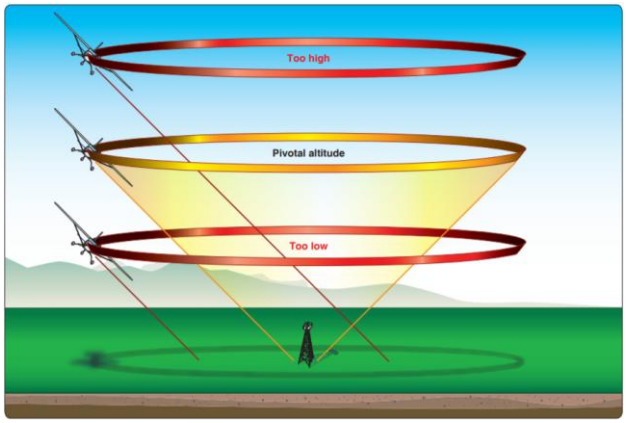
A. Pivotal Altitude is Based on Groundspeed

i. As groundspeed increases, pivotal altitude increases, and vice versa

- Does not change with bank angle
- Distance from pylon affects bank angle

ii. Circling the reference point, groundspeed, & therefore pivotal altitude, will change with wind

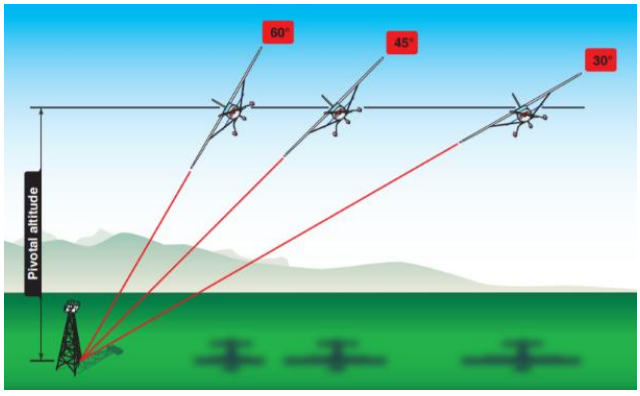
iii. To adjust, the pilot climbs or descends to maintain the visual reference with the pylon
- The change in altitude will depend on how much the wind affects groundspeed



B. Maintaining the Pivotal Altitude References

i. **Pitch**

- **As Groundspeed Decreases, Pivotal Altitude Decreases**
  - The wing moves backward over the ground & the point moves forward in relation to the wing
  - Descend to maintain the reference line to the pylon
    - We descend to lower pivotal altitude, increase in airspeed moves pivotal altitude up
  - Rule: If the point moves FORWARD, apply FORWARD pressure
- **As Groundspeed Increases, Pivotal Altitude Increases**
  - Wing moves forward over the ground / point moves backward in relation to the wing
  - Climb to maintain the reference line to the pylon
    - We climb to higher pivotal altitude, decrease in airspeed moves pivotal altitude down
  - Rule: If the point moves BACKWARD, apply BACK pressure
- **Corrections & Wind Speed**
  - Corrections are like tracking a VOR
    - Once the correction is made (intercept angle is established), remove the correction when the pylon is back on the line-of-sight reference (intercepting the radial)
  - Changes in pitch & altitude are based on wind speed
    - The stronger the wind, the greater the variation in max/min pivotal altitudes
  - Too strong of winds becomes unsafe
    - PA gets closer and closer to the ground and can require very high bank angles
- **RM: Coordination** AI.IX.F.R5
  - Always maintain coordinated flight
  - Use altitude changes, not rudder pressure, to hold the reference point on the pylon



ii. **Bank**

Performed at bank angles ranging from shallow to steep (no more than 40° per the ACS)

- **Distance from the pylon affects bank**
  - As wind pushes you to or from the pylons, bank is used to maintain the reference line

- If the pylon moves above the reference point, (i.e., above the wing tip) decrease bank
- If the pylon moves below the reference point (i.e., below the wing tip), increase bank

iii. **RM: Energy Management & Power** AI.IX.F.R6

- Pivotal altitude is based on groundspeed
- Set power prior to entering the maneuver to keep the desired indicated airspeed consistent
  - Changes in power lead to changes in airspeed which change pivotal altitude
  - The more consistent the power setting, the more consistent the airspeed

Reference Appendix A. Energy Management as needed for more detailed energy management concepts – Corresponding slides can be found in the slide's appendix

3. CALCULATING PIVOTAL ALTITUDE AI.IX.F.K3

A. Equation to estimate pivotal altitude

i. For Knots – $(Groundspeed^2 \div 11.3)$ + MSL

ii. For MPH – $(Groundspeed^2 \div 15)$ + MSL

B. Calculate the highest and lowest pivotal altitudes

i. Highest = TAS + tailwind; Lowest = TAS - headwind

ii. If altitudes are unsafe, do not perform the maneuver

Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
100	115	885
104	120	960
109	125	1050
113	130	1130

4. PERFORMING EIGHTS ON PYLONS AI.IX.F.K1, AI.IX.F.K5

A. Selecting the Pylons

i. Two ground points along a line perpendicular to the wind

- Sufficiently prominent & easy to see in an open area away from hills/obstructions

  Smaller pylons are easier to notice changes in movement
- About ½ mile apart (3-5 second flight between pylons)

  Allows time for planning, but not unnecessary drone between the pylons
- At the same elevation

ii. RM: Ensure a suitable emergency landing area within gliding distance AI.IX.F.R7

B. Pre-Maneuver

i. Pre-maneuver checklist; Clear the area of traffic

ii. Trimmed for straight and level flight, at or below V_A

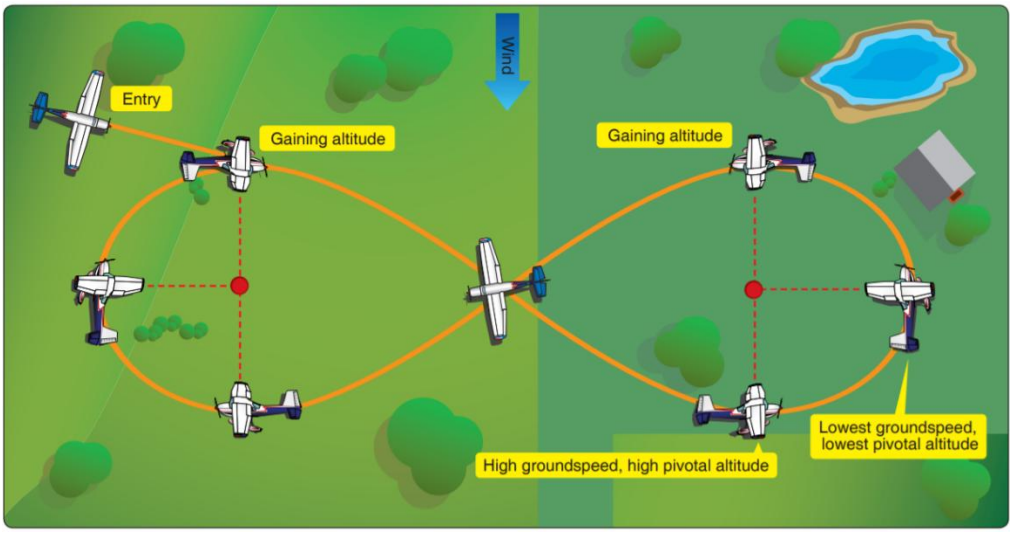
C. Entry

i. Fly to the midpoint of the pylons at a 45° angle to the downwind (note the entry heading)

- **Technique**: Make the first turn to the left around the left pylon (out your window)
- Downwind entry starts at the highest groundspeed & therefore the highest pivotal altitude

ii. Lower the upwind wing to roll into a 30-40° bank when the pylon is just ahead of the reference

iii. Place wingtip (or other reference) at the base of the pylon



D. First Turn

i. **Entry is at the Highest Groundspeed & Highest Pivotal Altitude**

- As the groundspeed decreases through the turn, pivotal altitude decreases
- With no corrections, the pylon will move forward
- Forward movement = forward pressure – Descend to maintain reference point
- Decrease bank to maintain reference as wind pushes the airplane away from the point

ii. **Continuing the Turn**

- Continuing around, groundspeed and therefore pivotal altitude will begin to increase again
- Climb to maintain pivotal altitude & the visual reference – Backward movement = back pressure
- Relative wind will push the airplane toward the pylon AI.IX.F.K4
  - Increase bank angle to maintain the visual reference

E. Transitioning between Pylons

i. Start the rollout to proceed diagonally to a point on the downwind side of the 2nd pylon

ii. Maintain straight and level flight for 3 to 5 seconds

iii. Crab into the wind to correct for wind drift AI.IX.F.K4

iv. Initiate a turn in the opposite direction as the pylon aligns with the reference point

- Roll into 30-40° bank and place the same reference on the other side of the plane on the pylon

F. Second Turn

i. **Same procedures as the first turn, but in the opposite direction**

ii. Entry is at the highest ground speed – As groundspeed decreases, descend to maintain PA

iii. Continuing through the turn, groundspeed increases again – climb to maintain PA

G. Exit

i. Roll wings level after completing one rotation around each pylon and exit on the entry heading

5. COMMON ERRORS AI.IX.F.K6

A. Failure to adequately clear the surrounding area for safety hazards, initially and throughout the maneuver

B. Skidding or slipping in turns (whether trying to hold the pylon with rudder or not)

C. Excessive gain or loss of altitude

D. Poor choice of pylons

E. Not entering the pylon turns into the wind

F. Failure to compensate for drift when flying between pylons

G. Failure to time the bank so that the turn entry is completed with the pylon in position

H. Abrupt control usage

I. Inability to select pivotal altitude

6. RM: HAZARDS

A. Division of Attention AI.IX.F.R1

i. Crosscheck focuses primarily on outside references with glances inside for airspeed, altitude, etc.
- Over concentration inside or outside will result in the other being neglected and a poor maneuver
- Allows the pilot to divide attention between aircraft control and orientation
  - Orientation is not just airplane attitude, but also where you are & what/who is around you

ii. In the case of an unsafe situation or orientation stop the maneuver and fix the problem. Safety first

iii. Don't fixate, divide attention between the turn, wind, flying the aircraft, and your surroundings

iv. Be proactive in making corrections

B. Distractions, SA & Disorientation, Task Prioritization AI.IX.F.R4

i. Distractions
- They're dangerous - Remove them from view or, if a person, explain the situation & ask them to stop
- Focus on aircraft performance and clear for traffic - If distracted, recognize it and fix it – Safety first

ii. Situational awareness (SA) & Disorientation
- Extremely important, lost SA has led to unsafe situations, mishaps, and incursions
- Maintain SA
  - Starts with preflight planning
  - Know what's coming next and stay ahead of the airplane
  - Divide attention between inside and outside references
  - If SA is lost, admit it and fix the problem
- If disoriented, stop what you're doing and get to a safe attitude, airspeed, and altitude
  - Disorientation can be caused by, or lead to an upset

- **Push**: Apply forward pressure to unload the plane
- **Roll**: Roll aggressively to the nearest horizon
- **Thrust**: Adjust as required
- **Stabilize**: Return to a safe flight condition

iii. Task Management

- Divide attention between the aircraft, scanning, and communicating (ATC or CTAF)
- Understand what tasks need to be accomplished and when
- Recognize when you are getting behind and find a way to catch up
- Proper task management can help prevent distractions, loss of SA, and disorientation
- Safety is the number one priority – Aviate, Navigate, Communicate

C. Low Altitude Maneuvering AI.IX.F.R3

i. A small problem at high altitude can quickly become a big problem at a low altitude

ii. Be aware of, and avoid, obstructions, towers, etc.

- Quick, panicked maneuvers, especially if slow, can result in a stall/loss of control near the ground

iii. Low Altitude Stall/Spin

- A low altitude stall or spin can leave little to no recovery time
  - ALWAYS maintain coordination, and airspeed at low altitudes
  - If you get any indication of a stall at low level, recover, and climb to a safe altitude
- Spin - A result of a stall + yaw
  - Prevention
    - Maintain coordination
    - Do not use abrupt, excessive pressure inputs (especially back elevator pressure)
    - Stop whatever you're doing and recover at the first sign of a stall
  - Recovery (PARE)
    - **P**ower - Idle
    - **A**ilerons - Neutral
    - **R**udder - Full rudder opposite the spin direction
    - **E**levator - Brisk, positive forward pressure (nose down)
    - When the spin stops, neutralize the rudder & raise the nose, being careful not to stall again
  - Different aircraft respond differently to spins and spin recoveries, follow the POH procedures

iv. CFIT (Controlled Flight into Terrain) - *AC 61-134: General Aviation CFIT Awareness*

- The solution to combating CFIT accidents starts on the ground
  - Common themes include proper planning, good decision making, and being able to safely operate the aircraft throughout its entire operating range
- Recommendations:
  - Non-instrument rated VFR pilots should not attempt to fly in IMC
  - Know and fly above minimum published safe altitudes

- If IFR, fly published procedures
- Verify proper altitude, especially at night or overwater, through use of a correctly set altimeter
- Verify all ATC clearances. Question potentially hazardous clearances
- Maintain situational awareness both vertically and horizontally
- Comply with appropriate regulations for your specific operation
- Don't operate below minimum safe altitudes if uncertain of position or ATC clearance
- Be extra careful when operating in an area which you are not familiar
- Use current charts, appropriate checklists, and know your aircraft and its equipment

D. Collision Hazards AI.IX.F.R2

i. **Collision Avoidance**

- Scanning
  - Short, regularly spaced eye movements bringing successive areas into the central visual field
  - Each movement should not exceed 10°, each area should be observed for at least one second
- Clearing Procedures
  - Climb/Descent: Use gentle banks to scan above/below the wings as well as other blind spots
  - Prior to any turn: Clear in the direction of the turn
  - Maneuvers: Clearing turns – Clear above/below/in front/behind and during maneuvers
- Operation Lights On - Voluntary FAA safety program
  - Turn on landing lights during takeoff and when operating below 10,000', day or night
- Right-of-Way Rules (FAR 91.113)
  - An aircraft in distress has the right-of-way over all other traffic
  - Converging Aircraft
    - Same Category Aircraft: The aircraft to the right has the right-of-way
    - Different Categories: Basically, the less maneuverable aircraft has the right-of-way
      - Balloons, gliders, and airships have the right of way over airplanes
      - An aircraft towing or refueling an aircraft has the right-of-way over engine driven aircraft
  - Approaching Head-on: Each pilot shall alter course to the right
  - Overtaking: Aircraft being overtaken has the right-of-way; when overtaking, pass on the right
  - Landing
    - Aircraft landing/on final to land have the right-of-way over those in flight or on the surface
    - When 2 or more aircraft are approaching for landing, the lower aircraft has the right-of-way
    - Don't take advantage of either of these rules

ii. **Terrain**

- Study terminal charts and IFR/VFR chart altitudes, use Max Elevation Figures (MEFs)
- Day vs Night flying over terrain
  - Be extra vigilant at night, when terrain may be impossible to see until it is too late
- Minimum Safe Altitudes (FAR 91.119)

- Anywhere: Altitude allowing an emergency landing without undue hazard to persons or property
- Congested Areas: 1,000’ above the highest obstacle within 2,000’
- Other than Congested Areas: 500’ above the surface, except when over open water/sparsely populated areas, then no closer than 500’ to any person, vessel, vehicle, or structure

iii. **Obstacles & Wire Strike**

- Research obstacles near airports (Terminal Procedures, NOTAMs, etc.)
- Antenna Towers can reach > 1,000-2,000’ AGL with supporting guys wires 1,500’ horizontally
- Overhead Wires (may not be lit) and often span departures & landmarks pilots often follow
    - Lakes, highways, railroad tracks, etc.

Conclusion: Brief review of the main point