X.D. Eights on Pylons

References: FAA-H-8083-3

Objectives	The student should develop knowledge of the elements behind the Eights on Pylons maneuver and have the ability to perform the maneuver to PTS standards.
Key Elements	1. Points moves forward: Forward Pressure 2. Point moves backward: Backward Pressure 3. Small, coordinated corrections
Elements	1. Pivotal Altitude 2. Before the Maneuver 3. Performing Eights on Pylons
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 lesson is complete when the student understands Pivotal Altitude and the accompanying concepts to Eights on Pylons. The student also will have the ability to properly fly the maneuver.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

The eights on pylons maneuver started in WWI. In order to have a constant view of a target and have the ability to destroy it, this maneuver was developed. It allowed aircraft to point the wing at a point and maintain the same site picture, allowing the gunner to destroy a target. A more practical application, for us, would be keeping the wing out of the way for some sort of aerial photography.

Overview

Review Objectives and Elements/Key ideas

What

Eights on Pylons is an advanced maneuver in which the pilot's attention is directed at maintaining a pivotal position on a selected pylon, with minimum attention inside the cockpit.

The maneuver itself involves flying the airplane in a figure eight path around two selected points or pylons on the ground. However, no attempt is made to maintain a uniform distance from the pylon. Instead, the airplane is flown at such a precise altitude and airspeed that a line parallel to the airplane's lateral axis, and extending from the pilot's eye, appears to pivot on each of the pylons.

Why

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.

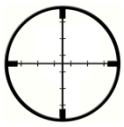
How:

1. Pivotal Altitude

A. General Description

i. A specific altitude at which, when the airplane turns at a given groundspeed, a projection of the sighting reference line to the selected point on the ground will appear to pivot on the point

a. The sighting reference: Keeping the pylon in the same spot on the window



- Parallel with the lateral axis
  - a Off the wingtip in our case
  - b In a swept wing aircraft, there will be no wing reference so the point has to be kept in the same position on the window
    1. In the center of an imaginary target

b. CE - Use of an improper "line-of-sight" reference

- In the case of the DA20 (and most non-swept, low wing aircraft) place the wingtip on the reference point and adjust to keep it there

c. When an aircraft is turning at pivotal height the wingtip appears to be fixed to a single point in the landscape, but when at any height other than the pivotal altitude, the wing tip will appear to move across the landscape.

- When an aircraft is turning at a height greater than the pivotal altitude, which is the normal situation in flight, the wingtip appears to move backwards over the landscape

- When an aircraft is turning at a height less than pivotal altitude (close to the ground) the wingtip appears to move forward over the landscape
- Thus when a turning and descending aircraft descends below pivotal altitude there is an apparent reversal of the wingtip movement from backward to forward, which is the reason pivotal altitude is sometimes termed **reversal height**

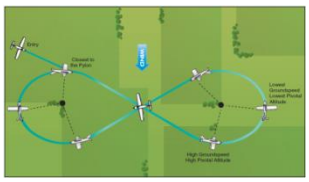
B. Pivotal altitude is based on groundspeed
   i. Estimating the pivotal altitude
      a. KNOTS Formula: Pivotal Altitude = $TAS^2/11.3$ (TAS = True Airspeed)
         - TAS can be found using a flight computer
      b. MPH Formula: Pivotal Altitude = $TAS^2/15$
   ii. The pivotal altitude does not change with bank
      a. Distance from the pylon affects the angle of bank
   iii. Since the headings throughout the turns continually vary from directly downwind to directly upwind, the groundspeed will constantly change
      a. This will result in the pivotal altitude varying throughout the maneuver
         - Adjustment is made for this by climbing or descending, as necessary, to hold the reference line or point on the pylons
            a Elevators are the primary control for maintaining the pylons
         - The change in altitude will be dependent on how much the wind affects groundspeed
      b. How the corrections work
         - As our groundspeed decreases (headwind), our pivotal altitude does as well
            a We will be above the pivotal altitude
               1. The wing appears to move backwards across the landscape
            b Descend to the new pivotal altitude and maintain the reference line to the pylons
               1. When we descend, we increase airspeed slightly, therefore, increasing pivotal altitude
                  a. We descend to it and the pivotal altitude comes to us
            c BASIC: If the point moves FORWARD, apply FORWARD pressure
         - As our groundspeed increases (tailwind), our pivotal altitude does as well
            a We will be below the pivotal altitude
               1. The wing appears to move forward across the landscape
            b Climb to reach the new pivotal altitude and maintain the reference line to the pylons
               1. When we climb, we are decreasing our airspeed slightly, therefore, slightly decreasing our pivotal altitude (moving it toward us)
            c BASIC: If the point moves BACKWARD, apply BACK pressure
         - Pitch controls the site picture we are trying to maintain Horizontally
         - Bank, on the other hand, controls the site picture Vertically
            a If the site picture begins to move up the window bank will have to be decreased to maintain the line of sight reference
               1. The aircraft is banked too steeply
            b If the site picture moves down the window, bank will have to be increased to maintain the line of sight reference
               1. The aircraft is banked too shallow
         - Corrections are like tracking a VOR
            a Once the correction is made (an intercept angle is established), remove that correction when the pylon is back into the line of sight reference (Upon intercepting the radial)
               1. Don't make the correction (i.e. descend) and hold it

a. That will result in going below the pivotal altitude

iv. Corrections and Wind Speed
   a. Corrections are based on the wind speed
      - The greater the wind speed, the greater the variation in our maximum and minimum pivotal altitudes
         a Increased wind speed = Increased rate of climb
   b. Too strong of winds becomes unsafe
      - We get closer and closer to the ground
      - Also, the airplane can be blown very close to the pylon, requiring large increases in bank angle

C. Calculating the Pivotal Altitude
   i. Never going to be exact
   ii. Calculate the highest pivotal altitude - TAS + tailwind (highest groundspeed)
      a. Using a flight computer
         - Take into account, wind direction, speed, and true airspeed to get groundspeed
   iii. Calculate the lowest pivotal altitude
      a. True airspeed minus headwind (lowest groundspeed)
         - Remember that when in a headwind, we will be descending
            a groundspeed will be slightly faster than expected (since we're not level in the headwind)
               1. Therefore, we won't get as low as expected
   iv. Calculating the highest and lowest pivotal altitude will provide an expected window during the maneuver
      a. If the altitudes are not safe, do not perform the maneuver

2. Before the Maneuver
   i. Pre-maneuver checklist
   ii. Ensure the area is clear of traffic
      a. Below, at, and above your altitude
   iii. Selecting two Pylons
      a. Select two points on the ground along a line which lies 90° (perpendicular to the wind)
         - The pylons should be
            a In an open area and are not near hills or obstructions
            b Sufficiently prominent to be readily seen when coming back for the maneuver and also when completing the turn around one pylon and heading for the next
            c Adequately spaced to provide time for planning the turns and yet not cause unnecessary straight-and-level flight between pylons
               1. About ½ mile apart
                  a. The length of a small runway
               2. Approximately 10-15 seconds straight-and-level flight between the pylons
            d The smaller the pylon, the easier to notice changes in movement
      b. CE - Selection of pylons where there is no suitable emergency landing area within gliding distance
   iv. The airplane should be in straight and level flight at cruise power
      a. Not above V_A



3. Performing Eights on Pylons

A. Entering the Maneuver
   i. Adjust power to the recommended entry speed
      a. Close to V_A

ii. Enter trimmed on airspeed and at pivotal altitude
iii. Enter at a 45° angle to the (right of the) downwind in order to make the first turn to the left around the left pylon
    a. The left turn is to put the point out the left window (easiest to see), rather than looking over the right seat passenger and through the right window
    b. Fly to the midpoint between the pylons
    c. Make note of the entry heading as it will be the exit heading as well
        - Bug the heading
iv. With a downwind entry, you will have the highest groundspeed and the highest pivotal altitude.
v. Maintain straight and level flight until the pylon is just ahead of the reference line, then roll into a 30° to 40° bank
    a. Not to exceed 40°
vi. Place wingtip at the base of the pylon
vii. CE - Faulty entry procedure
    a. Plan ahead, orient yourself with the wind and enter at 45° to the downwind

B. During the Maneuver
i. General
    a. The elevator is the primary control for holding the pylons
        - Use altitude changes, rather than rudder pressure, to hold the reference point on the pylon
        - CE - Uncoordinated use of flight controls
        - CE - Application of rudder alone to maintain "line-of-sight" on the pylon
            a Do not use the rudder to yaw the wing forward or backward to maintain the "line-of-sight" reference
ii. First Turn
    a. Entry is at the highest groundspeed
        - Continuing through the turn, into an increasing headwind, groundspeed will get progressively slower
            a The pivotal altitude will decrease
                1. If no corrections are made the wing tip will move back in reference to the pylon
        - Descend to maintain correct pivotal altitude/reference point
            a Do not wait for the pylon to get significantly out of position, make consistent small corrections
            b Descending increases pivotal altitude and corrects the visual reference
    b. Continuing the turn
        - Groundspeed will begin to increase and, therefore, our pivotal altitude will increase
            a Climb in order to maintain pivotal altitude and maintain/correct the visual reference
                1. If no corrections are made the wing tip will move forward in reference to the pylon
                2. Climbing decreases pivotal altitude and corrects the visual reference
        - The relative wind will push the airplane towards the pylon
            a Bank angle will increase in order to maintain the visual reference
                1. Remember, bank angle has no effect on pivotal altitude
iii. Transitioning between Pylons
    a. As the airplane turns toward a downwind heading, the rollout of the turn should be started
        - The airplane should proceed diagonally to a point on the downwind side of the 2nd pylon
    b. Maintain straight and level flight for 3 to 5 seconds
    c. Crab into the wind to correct for wind drift
        - Since in straight and level flight

d. Initiate a turn in the opposite direction when the pylon is aligned with the wing reference point
e. CE - Improper planning for turn entries and rollouts
f. CE - Improper correction for wind drift between pylons

iv. Second Turn
a. Entry, again, is fastest groundspeed
- Therefore, the highest pivotal altitude
- Continuing through the turn results in an increasing headwind, decreasing the groundspeed
  a Pivotal altitude, again, decreases
    1. Descend to correct for changing groundspeed
    2. The wingtip will be moving backward in reference to the pylon

b. Coming back into more of a tailwind will result in an increasing groundspeed
- Increasing groundspeed = Increasing pivotal altitude
  a Climb
    1. Reduces groundspeed and brings airplane up to pivotal altitude
- Relative wind pushes the airplane closer to the pylon
  a Bank must increase to maintain visual reference

v. CE - Poor planning, orientation, and division of attention
a. The entire maneuver is based on planning ahead (pivotal altitude), orienting yourself in relation to the wind and dividing attention between the aircraft, the reference points and what is coming next
b. Solid planning, starting with the pivotal altitude calculations on the ground, wind direction and reference point selection in the air and adjustments in the aircraft will make the maneuver much easier to perform
- Poor planning results in a sloppy maneuver

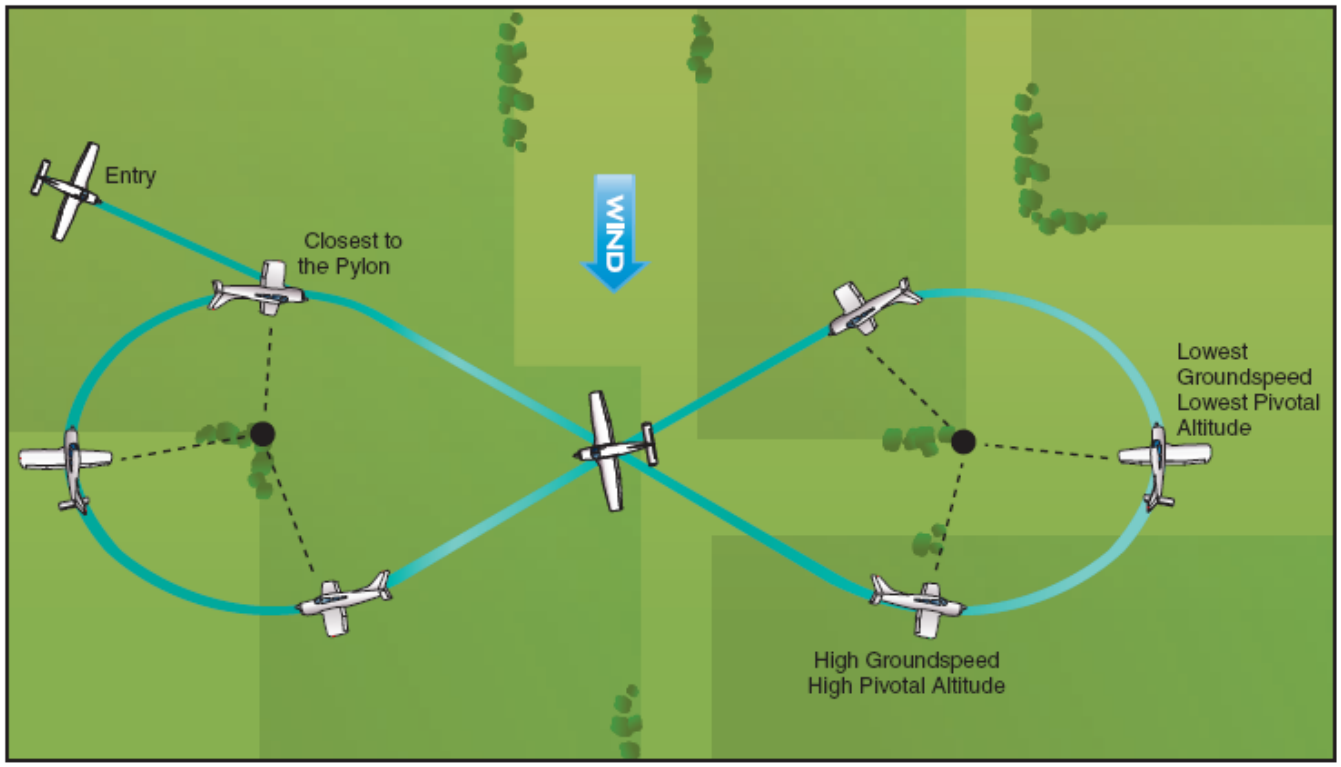
vi. Exit
a. After completing one rotation around each pylon, roll wings level, and exit on the entry heading

Common Errors:
- Faulty entry procedure
- Poor planning, orientation, and division of attention
- Uncoordinated use of flight controls
- Use of an improper “line-of-sight” reference
- Application of rudder alone to maintain “line-of-sight” on the pylon
- Improper planning for turn entries and rollouts
- Improper correction for wind drift between pylons
- Selection of pylons where there is no suitable emergency landing area within gliding distance

Conclusion:
Brief review of the main points
If the point moves forward, apply forward pressure
If the point moves backward, apply back pressure
Eights on Pylons is the most advanced and most difficult of the low altitude flight training maneuvers. Because of the various techniques involved, this maneuver is unsurpassed for teaching, developing, and testing subconscious control of the airplane.

PTS Requirements:
To determine that the applicant:

1. Exhibits instructional knowledge of the elements of eights on pylons by describing:
    a. The purpose of eights on pylons and their relationship to basic/advanced airmanship skills.
    b. How to determine the approximate pivotal altitude.
    c. How to select suitable pylons with consideration given to emergency landing areas.
    d. Orientation, division of attention, and planning.
    e. Configuration and airspeed prior to entry.
    f. Relationship of groundspeed change to the performance of the maneuver.
    g. Pilot's "line-of-sight" reference to the pylon.
    h. Entry procedure.
    i. Procedure for maintaining "line-of-sight" on the pylon.
    j. Proper planning for turn entries and rollouts.
    k. How to correct for wind drift between pylons.
    l. Coordination of flight controls.
2. Exhibits instructional knowledge of common errors related to eights on pylons by describing:
    a. Faulty entry procedure
    b. Poor planning, orientation, and division of attention.
    c. Uncoordinated use of flight controls.
    d. Use of an improper "line-of-sight" reference.
    e. Application of rudder alone to maintain "line-of-sight" on the pylon.
    f. Improper planning for turn entries and rollouts.
    g. Improper correction for wind drift between pylons.
    h. Selection of pylons where there is no suitable emergency landing area within gliding distance.
3. Demonstrates and simultaneously explains eights on pylons from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to eights on pylons.


Entry
Closest to
the Pylon
WIND
Lowest
Groundspeed
Lowest Pivotal
Altitude
High Groundspeed
High Pivotal Altitude