

## VII.A. Intercepting and Tracking Navigational Systems and DME Arcs

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**References:** 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM

Objectives	The student should develop knowledge of the elements related to operation and use of VORs.
Key Elements	<ol style="list-style-type: none"><li>1. Always check the VOR ID</li><li>2. Never fly the tail of the CDI (avoid reverse sensing)</li><li>3. VORs are Line-of-sight</li></ol>
Elements	<ol style="list-style-type: none"><li>1. <a href="#">Components</a></li><li>2. <a href="#">Tracking with the VOR</a></li><li>3. <a href="#">VOR Tips</a></li><li>4. <a href="#">Intercepting and Maintaining a Selected Course</a></li><li>5. <a href="#">Intercepting and Maintaining a DME Arc</a></li></ol>
Schedule	<ol style="list-style-type: none"><li>1. Discuss Objectives</li><li>2. Review material</li><li>3. Development</li><li>4. Conclusion</li></ol>
Equipment	<ol style="list-style-type: none"><li>1. White board and markers</li><li>2. References</li></ol>
IP's Actions	<ol style="list-style-type: none"><li>1. Discuss lesson objectives</li><li>2. Present Lecture</li><li>3. Ask and Answer Questions</li><li>4. Assign homework</li></ol>
SP's Actions	<ol style="list-style-type: none"><li>1. Participate in discussion</li><li>2. Take notes</li><li>3. Ask and respond to questions</li></ol>
Completion Standards	The student understands the VOR, and has the ability to VORs for navigation as well as approach procedures

**Instructors Notes:**

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**Introduction:**

**Attention**

Interesting fact or attention-grabbing story

**Overview**

Review Objectives and Elements/Key ideas

**What**

The VOR (or very high frequency omni-directional range) is an instrument used for navigation and approach procedures in the IFR system. Since the student is already familiar on a basic level with VORs from the PPL, this lesson will provide a more in-depth overview of using the VOR, and tracking and intercepting radials.

**Why**

A very important part of the IFR system, VORs are the backbone of the federal airway system, and many approaches are based off VOR navigation.

**How:**

**1. Components - Ground Transmitter and Receiver**

- A. Ground Transmitter: At a specific position on the ground; transmits on an assigned frequency
  - i. Oriented to magnetic North, provides 360 courses To or From the station
  - ii. Various strengths and operating ranges; Line of sight
- B. Receiver: Consists of an antenna, the tuning device, and the VOR instrument
  - i. Antenna receives the signals from the ground transmitter
  - ii. Tuning device is used to select and identify the desired VOR frequency
  - iii. VOR instrument consists of:
    - a. Course Selector, or OBS (Omni Bearing Selector)
      - Dial that is rotated to select a radial or determine the radial the airplane is currently on
    - b. CDI (Course Deviation Indicator) Needle
      - As the OBS is rotated, the CDI shows the radial in relation to the plane
      - Centering the CDI indicates the radial the airplane is on, or the radial To / From the station
    - c. To / From Indicator
      - Shows whether the selected course, if flown, will take the aircraft To or From the station
      - Does not indicate whether the aircraft is heading to or from the station

**2. Tracking with the VOR**

- A. TIM: Tune, Identify, Monitor
  - i. Tune the VOR frequency and check the identifiers to verify the desired VOR is being received
  - ii. Station can be identified by its Morse code identification, a voice stating the name and VOR, or the 3 letter identifier on electronic flight displays
  - iii. If out of service, the coded identification is removed and not transmitted
    - a. Do not use for navigation
  - iv. VOR receivers have an alarm flag to indicate when signal strength is inadequate

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- a. The plane is either too far or too low and is out of the line-of-sight of the transmitting signal
  - B. Rotate the OBS to center the CDI with a "TO" indication
    - i. If centered with a "FROM" indication, rotate 180°
      - a. From indicates the radial we are on, TO indicates TO the station
      - b. When centered with a "TO" indication, the tail of the needle indicates the radial you are on
  - C. Turn to the heading indicated on the OBS
    - i. This will track directly to the station in a no wind situation
  - D. If there is a crosswind, and heading is maintained, you will drift off course
    - i. If the crosswind is from the right, the plane will drift left, and the CDI will gradually move right
    - ii. To return to the desired radial, the heading must be altered to the right
    - iii. When centered, the airplane is on the radial, and must be crabbed into the wind (right in this case)
      - a. Amount of crab, or wind correction, will vary based on the strength of the crosswind
  - E. Upon arriving, and passing the VOR, the "TO" indication will change to "FROM"
    - i. Generally, the same procedures apply for tracking outbound as inbound
      - a. If the intent is to continue on the same course the course selector shouldn't be changed
      - b. If tracking outbound on a different course, the new course must be set into the selector
        - Turn to intercept this course and track as previously discussed
  - F. Reverse Sensing
    - i. If flying To a VOR with a FROM indication, or vice versa, the CDI will indicate opposite
      - a. Following the needle leads away from the desired course
      - b. For example, if right of course, the CDI indicates a right correction is required
- 3. VOR Tips**
- A. Always identify the station
  - B. Remember, VOR signals are line-of-sight
  - C. Correct for wind drift, don't reset the radial (avoid homing)
  - D. When flying TO a station always fly the selected course with a TO indication
  - E. When flying FROM a station always fly the selected course with a FROM indication
- 4. Intercepting and Maintaining a Selected Course**
- A. Where are we? What radial is the aircraft on?
  - B. Where do we want to go? Which direction is the course and do we want to fly inbound or outbound?
  - C. How do we get there?
    - i. Determine the difference between the radial the airplane is on and the radial to be intercepted
    - ii. Intercept Angle: Double the difference and apply it in the direction we want to fly
      - a. Apply it to the radial to be intercepted
      - b. Intercept angle will not be less than 20° or more than 90°
  - D. Does it make sense? Will the bearing we have chosen get us to the course we want to fly?
  - E. Ex: SE of the VOR on the 160° radial, and want to intercept the 205° radial
    - i. Difference between radial on and radial to intercept = 45°; Double it = 90°
    - ii. Turn to 295° (205° + 90°)
- 5. Intercepting and Maintaining a DME arc**
- A. DME Arc: A track (arc) that is a constant radius from the VOR
    - i. Used in many instrument approach procedures

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- B. Intercept the lead-in radial designated in the approach
- C. Approximately ½ mile before reaching the arc distance, make a 90° turn to intercept the arc
  - i. Turn the OBS needle 10° in the direction you will be flying
  - ii. Distance for the turn varies based on groundspeed
- D. When the needle centers, turn the OBS 10° further and make a 3 second standard rate turn
  - i. Repeat until approximately 10° prior to the inbound course
- E. Turn to intercept the final approach course
- F. If the DME distance is getting too big or too small, adjust the turns to maintain DME
  - i. Too small: Reduce or eliminate the turn (ex. rotate the CDI 10° but don't turn)
  - ii. Too big: Increase the turn (ex. Rotate the CDI 10° and turn 15°)
- G. Amount of adjustment will vary with the amount of error
- H. OR, load the DME arc approach in the GPS and follow the needle!

### Common Errors:

- Incorrect tuning and identification procedures
- Failure to properly set the navigation selector on the course to be intercepted
- Failure to use the proper procedures for course DME arc interception and tracking
- Improper procedures for intercepting a course or localizer from a DME arc

### Conclusion:

Brief review of the main points

### PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of intercepting and tracking navigational systems and DME arcs by describing-
  - A. tuning and identification of a navigational facility.
  - B. setting of a selected course on the navigation selector or the correct identification of a selected bearing on the RMI.
  - C. method for determining aircraft position relative to a facility.
  - D. procedure for intercepting and maintaining a selected course.
  - E. procedure for intercepting and maintaining a DME arc.
  - F. procedure for intercepting a course or localizer from a DME arc.
  - G. recognition of navigation facility or waypoint passage.
  - H. recognition of navigation receiver or facility failure.
2. Exhibits instructional knowledge of common errors related to intercepting and tracking navigational systems and DME arcs by describing-
  - A. incorrect tuning and identification procedures.
  - B. failure to properly set the navigation selector on the course to be intercepted.
  - C. failure to use proper procedures for course or DME arc interception and tracking.
  - D. improper procedures for intercepting a course or localizer from a DME arc.
3. Demonstrates and simultaneously explains intercepting and tracking navigational systems and DME arcs from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to intercepting and tracking navigational systems and DME arcs.
5. Exhibits instructional knowledge on the uses of the MFD and other graphical navigational displays, if installed, to monitor position in relation to the desired flightpath during holding.

**ACS Skills Standards**

1. Tune and correctly identify the navigation facility/program the navigation system and verify system accuracy as appropriate for the equipment installed in the aircraft.
2. Determine aircraft position relative to the navigational facility or waypoint.
3. Set and correctly orient to the course to be intercepted.
4. Intercept the specified course at appropriate angle, inbound to or outbound from a navigational facility or waypoint.
5. Maintain airspeed  $\pm 10$  knots, altitude  $\pm 100$  feet, and selected headings  $\pm 5^\circ$ .
6. Apply proper correction to maintain a course, allowing no more than  $\frac{3}{4}$ -scale deflection of the CDI. If a DME arc is selected, maintain that arc  $\pm 1$  nautical mile.
7. Recognize navigational system or facility failure, and when required, report the failure to ATC.
8. Use an MFD and other graphical navigation displays, if installed, to monitor position, track wind drift, and to maintain situational awareness.
9. Properly use the autopilot, if installed, to intercept courses.