# VOR and NDB Approaches

Alan Bugos, ATP CFII



Updated FEB2025

# Overview

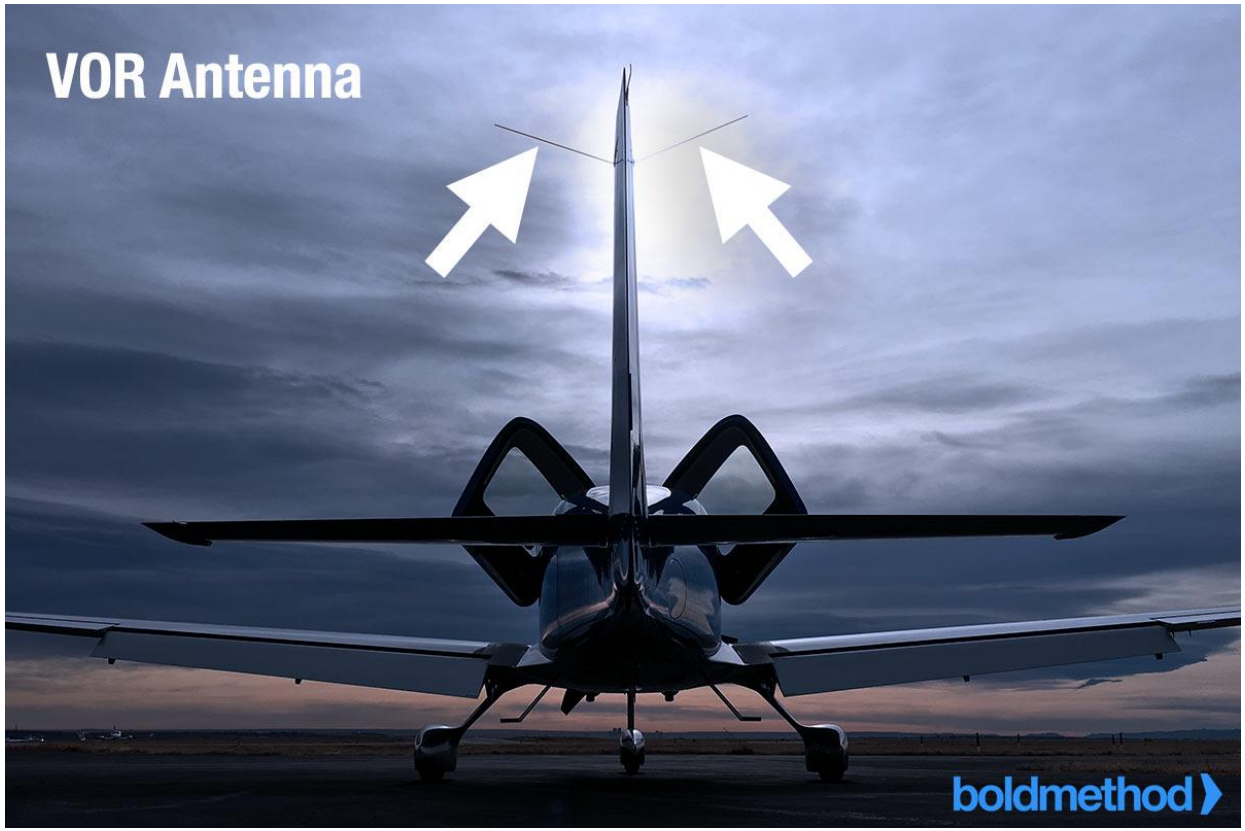
- VOR Approach Procedures
- Off-Airport Facility
- On-Airport Facility
- VOR/DME Approach Procedures
- NDB Approach Procedures
- Radar Vectors to the Approach

# VOR Approach Procedures

- VOR approaches divided into two basic categories
  - VOR facility located off of airfield
  - VOR facility on the airfield
- Setting CDI to final approach course is really important!
  - This problem doesn't exist with ILS, LOC, LDA, SDA, NDB, and RNAV approaches.
  - Use GPS as an aid to situational awareness if so equipped – final approach course to VOR can be programmed.
  - Other gotcha's:
    - VOR receiver not tested for IFR flight
    - VLOC vs GPS setting (CDI button - Garmin)
    - VLOC vs GPS setting (CDI Knob – IFD440)

# VOR Ground Station

# Airborne Antennas



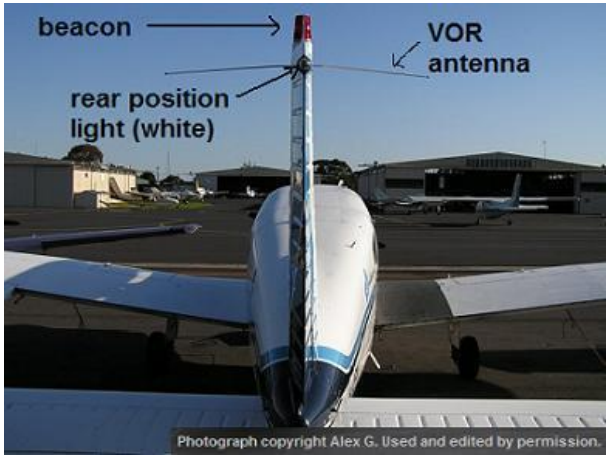
# NAV Radio


MKR
A
M
SPEAKER
TEL
1 COM 2
1 NAV 2
DME
MKR
ADF
AUTO
COM 1 COM 2
MIC
PHONE
124.400
Boston App
118.500
Hanscom Twr
Land
Nav
Wx Overlay
GS 127 Kts
Dst ETE 9:45
GPS
KBED
078
N933HD
Rgnl Rdr 10 Min
SVS
MAP
AVIDYNE
FMS
MAP
AUX
PROC
ENTR
CLR
COM / VLOC
USE
STBY
COMM
NAV
KX 155 TSO
BENDIX/KING

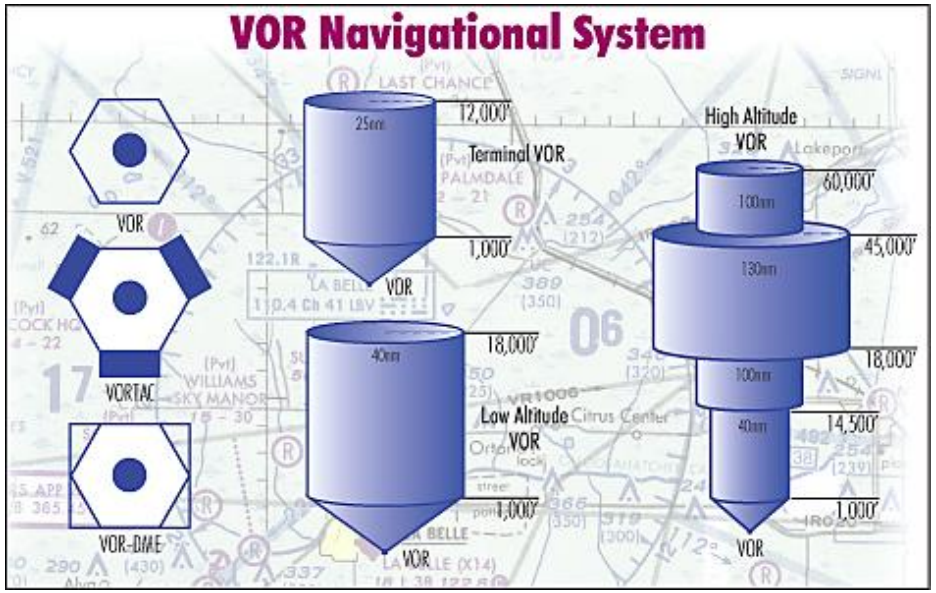
# VOR (VHF Omnidirectional Range) components







# Types of VORs and VOR checks




**VORs must be checked within the past 30 days to use them under IFR. There are 3 ways to do this:**

a) **VOR Test Facility (VOT): Broadcasts only the 360° radial. May be used only on the ground or within designated airborne areas as the AFD notes. Tolerance is +/- 4° when OBS is set to 360 (FROM) or 180 (TO).**

b) **VOR checkpoints: Can be ground or airborne – check AFD to find the locations. Tolerance is +/- 4° for ground and +/- 6° for air.**

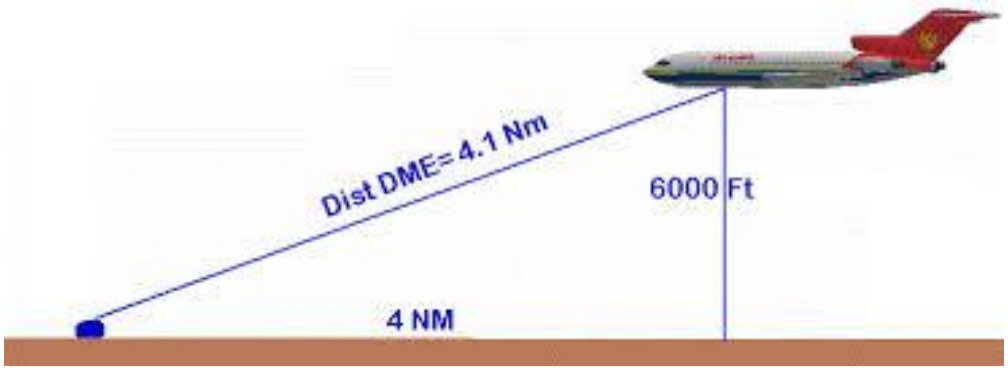
c) **Dual system check: Can be used anywhere where a VOR can be received as long as the two units are independent from each other except for the antennae. Tolerance is a maximum difference of 4°.**

**The pilot must keep a written or electronic log of VOR or VOT checks performed for the specific aircraft flown using VOR/LOC/ILS systems**

# VOR identification

1. **VORs:**
   a) **Tune nav receiver to appropriate frequency**
   b) **Select appropriate button on intercom panel so that you can hear transmissions on the VOR frequency**
   c) **Turn up volume and select "ident" feature on the nav radio to remove audio filter and permit hearing of the morse code identifier (1020 Hz).**

# Distance measuring equipment (DME)




1. **Slant range will be very close to horizontal range if horizontal range is at least 1 NM for every 1000 ft of altitude above the station.**


**Distance and frequency readout**


**Distance, groundspeed, and estimated time enroute to station readout**

# DME identification

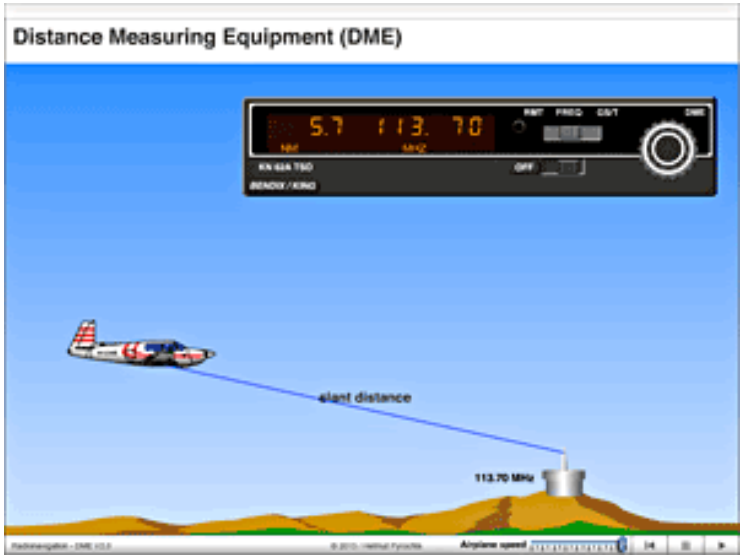
## DME Radio

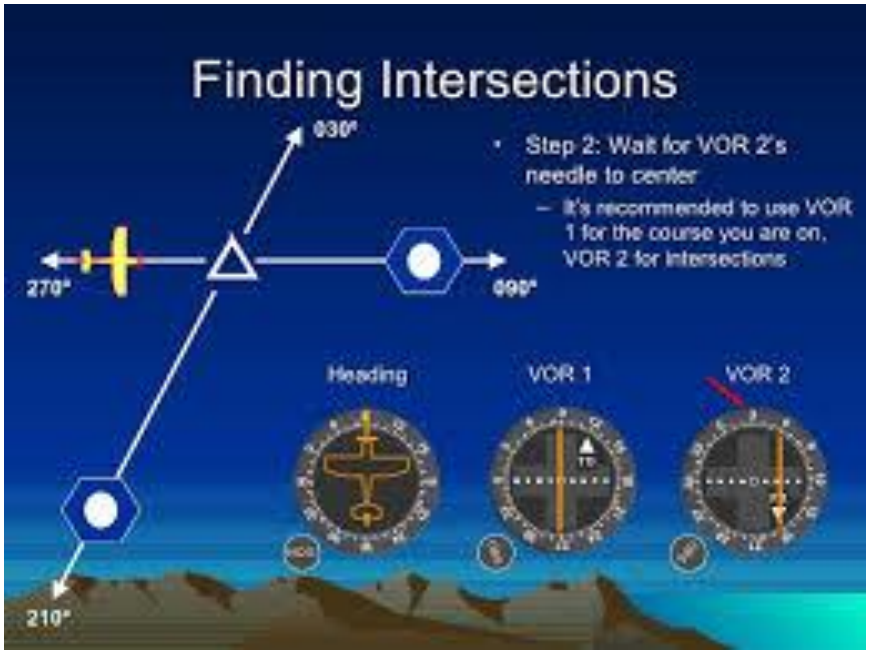
a) Tune DME receiver to appropriate frequency

b) Select appropriate button on intercom panel so that you can hear transmissions on the frequency

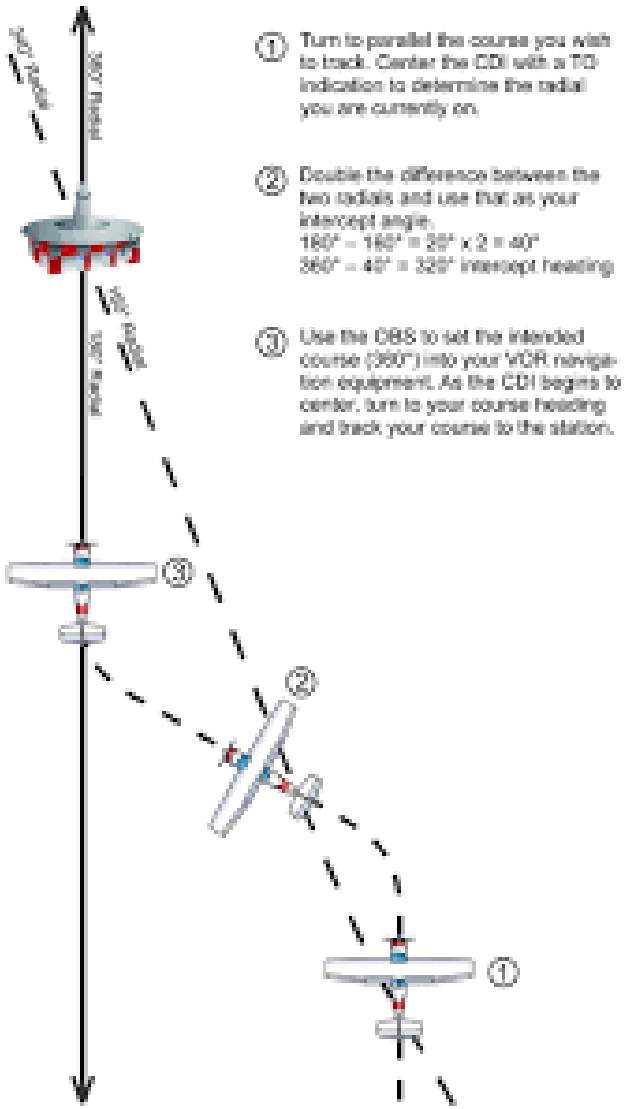
c) Listen to the Morse code identifier (1350 Hz). The identifier is at a slightly higher pitch than the VOR identifier and is transmitted at approximately 30 second intervals.

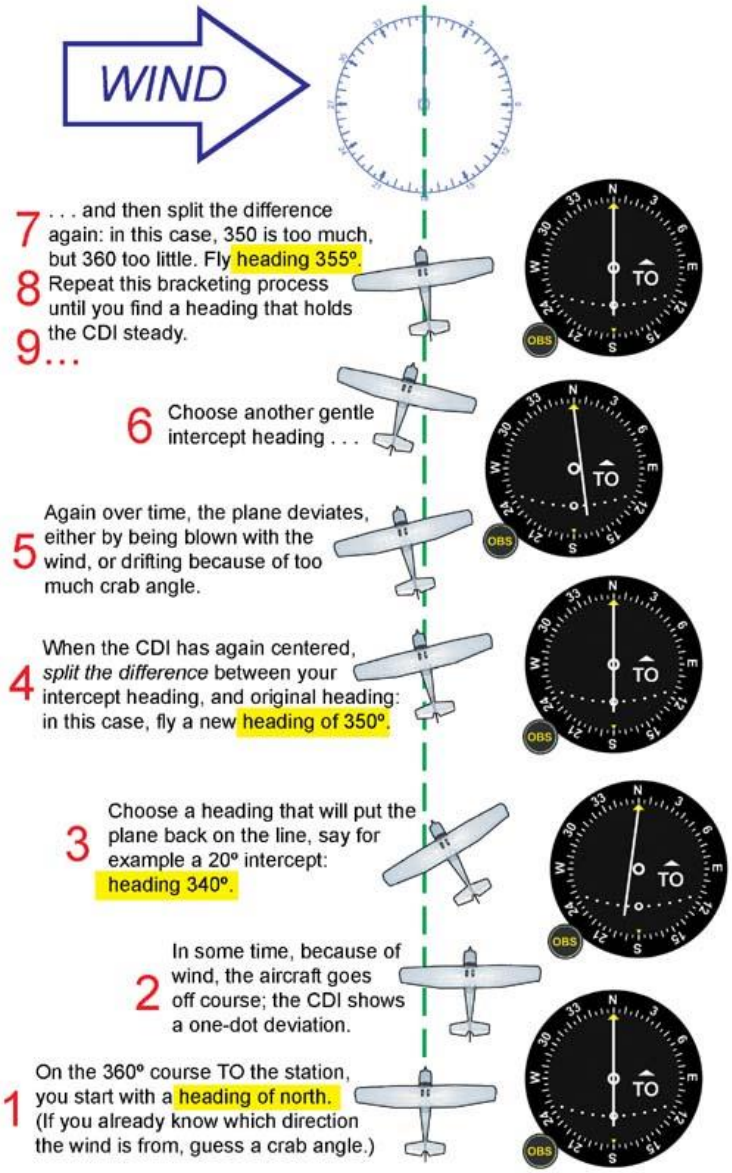
# Determining progress using VORs



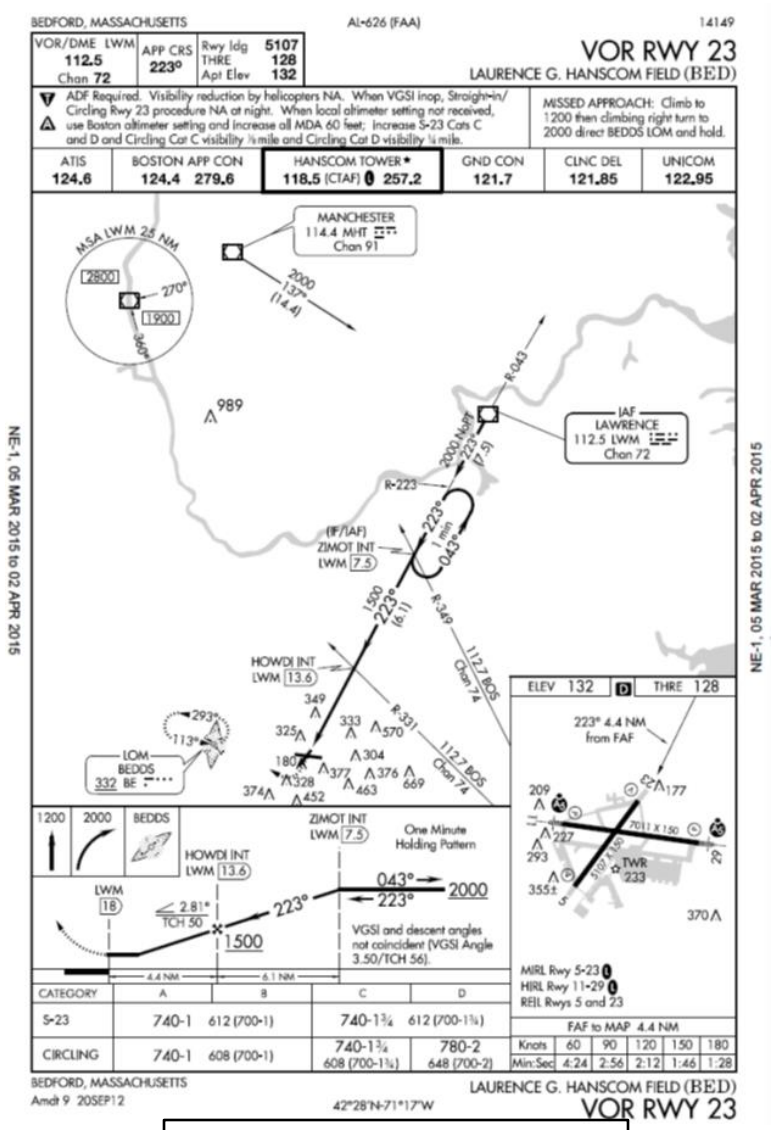




# Intercepting and tracking radials

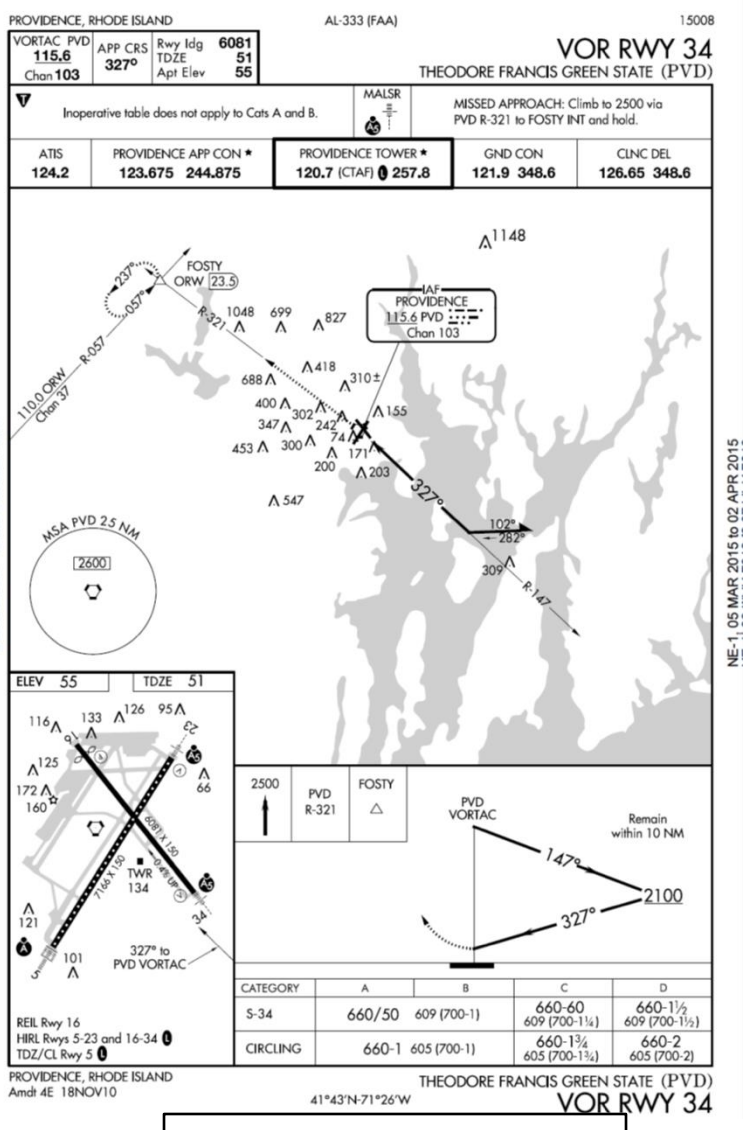


# VOR Approach Procedures

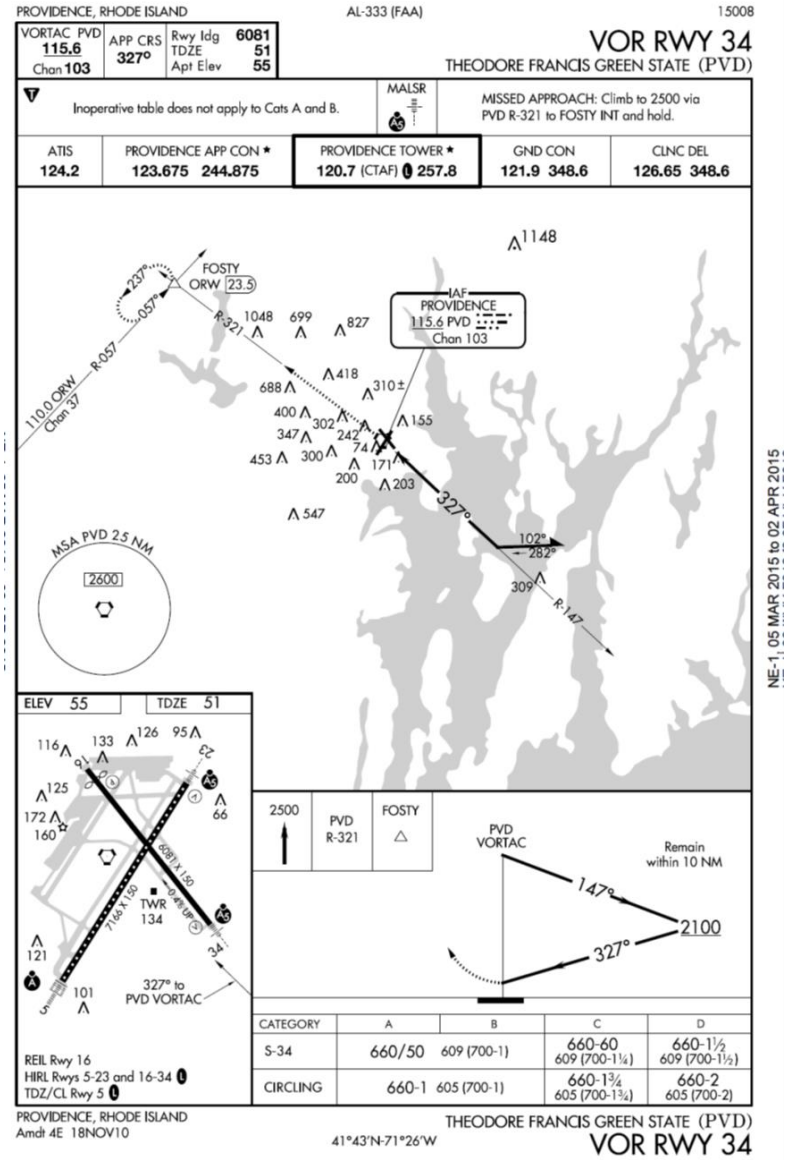



VOR off of airfield



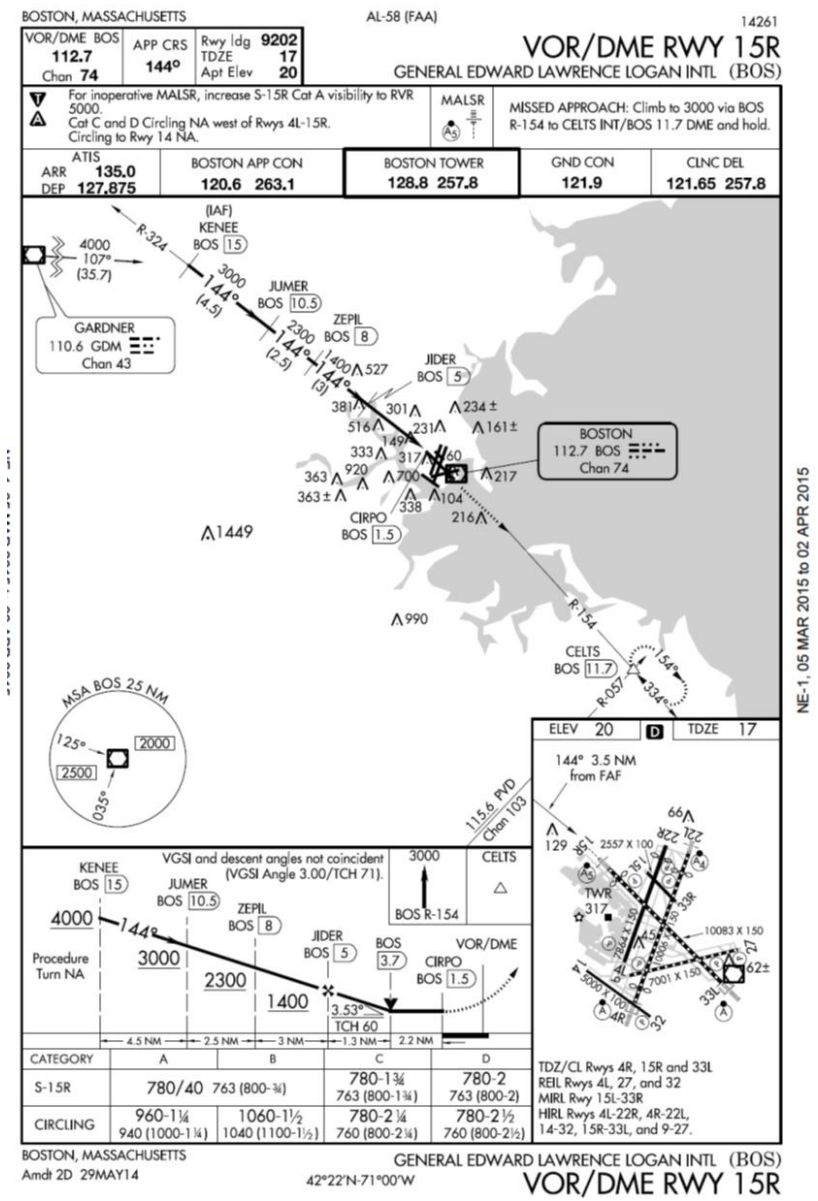

VOR on airfield

# KPVD VOR RWY 34



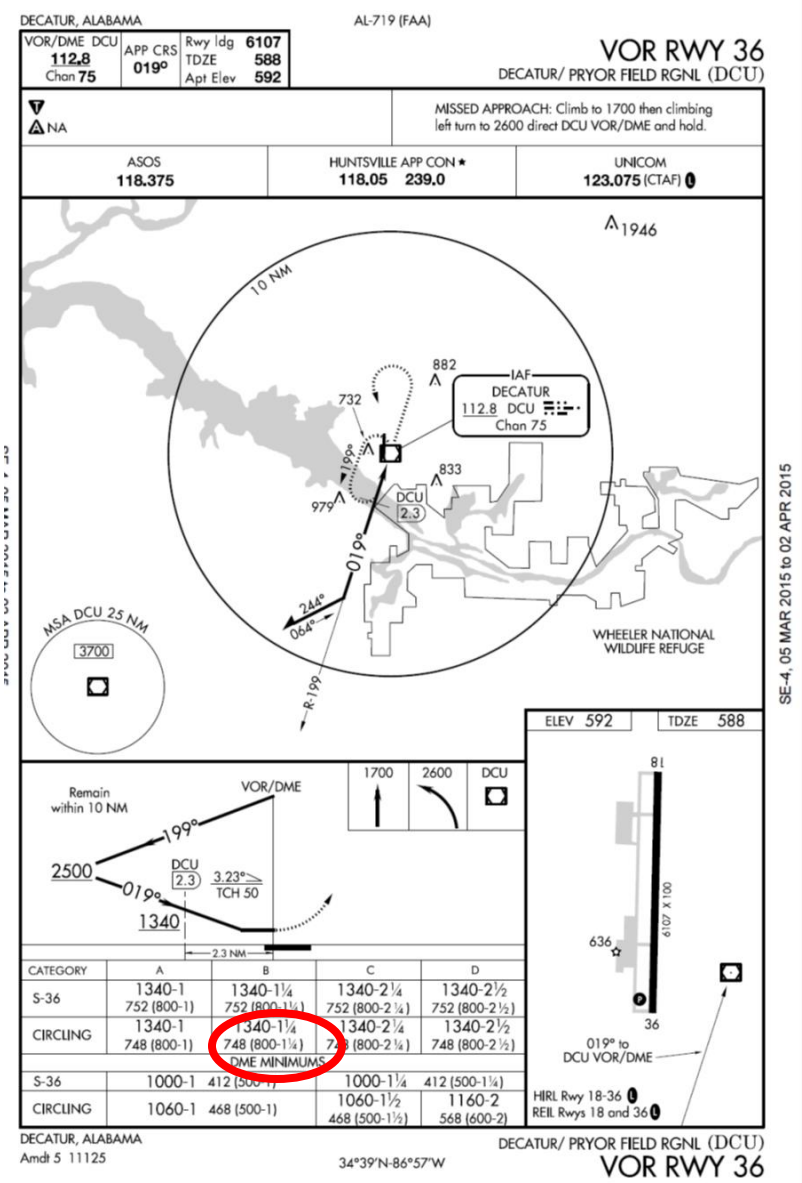

1. **Assume that you are approaching the airport from the northwest. You ask for the full approach.**
2. **Is there a FAF?**
3. **How is the final approach *point* defined?**
4. **How do you determine how far outbound to fly on the PVD 147 radial before starting the procedure turn?**
5. **How do you know where the MAP is?**

# VOR/DME approach procedures



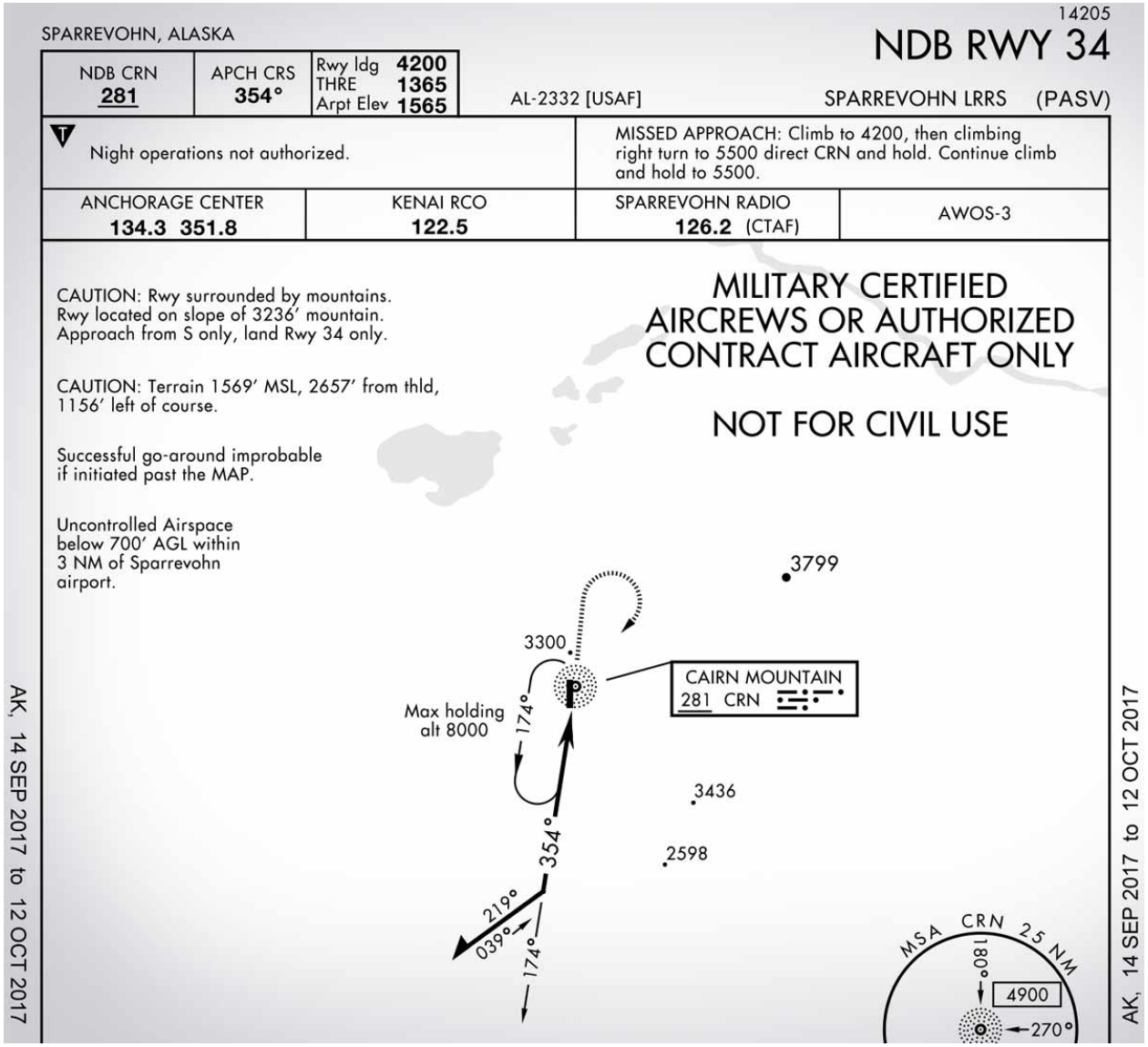

1. **The "DME" in approach title means DME is "required" (not just convenient)**
   a. **Approved substitutes for a DME?**
   b. **What are the caveats/restrictions?**
2. **DME (or approved substitute) is only way to identify stepdown fixes and MAP**
3. ***Some VOR approaches that do not require DME offer lower minimums if you are equipped with a DME or substitute. . .***

# VOR/DME Approach Procedures




**Some VOR approaches that do not require DME offer lower minimums if you are equipped with DME or substitute. . .**

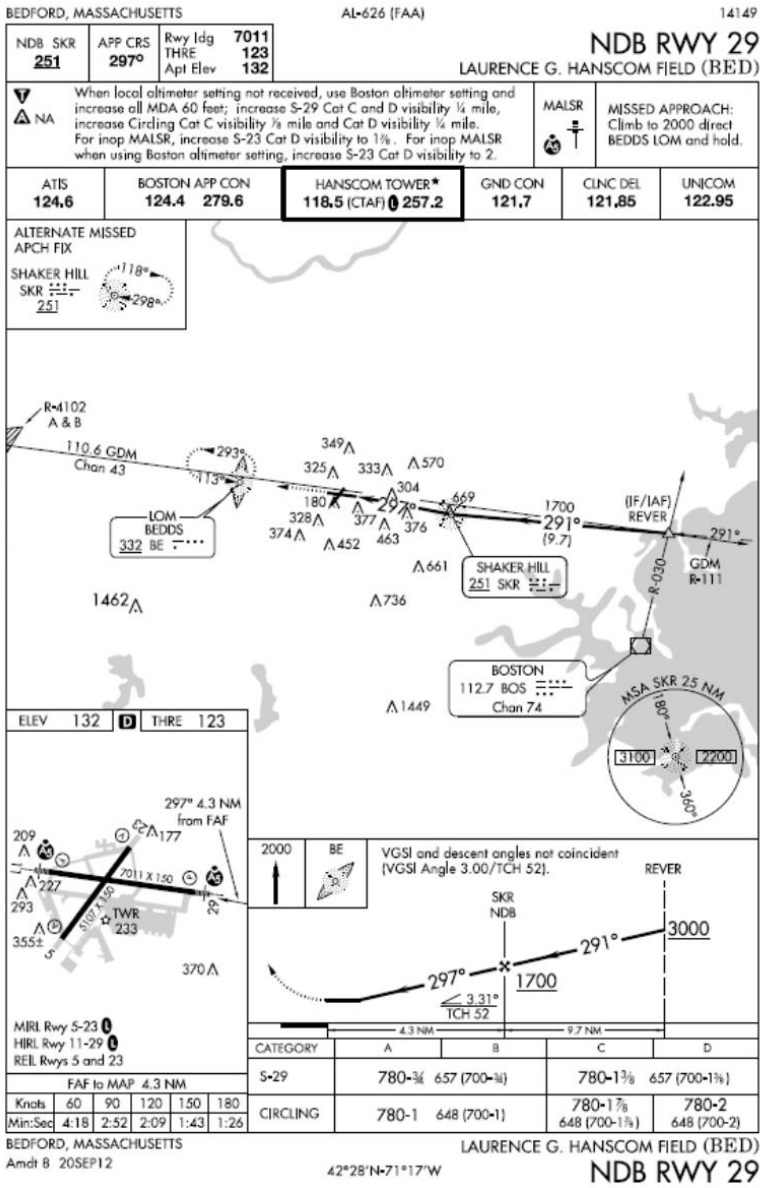
# NDB Approaches - still in use




**As NDBs are decommissioned, their use during instrument approach procedures is becoming more and more uncommon.**

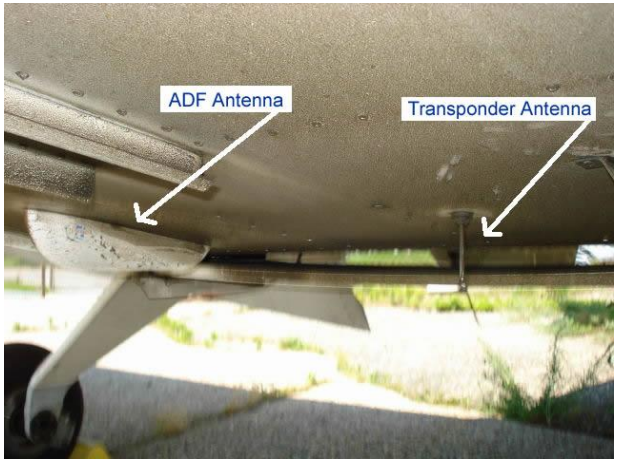
**However, states like Alaska still have a lot of them.**

# NDB Approach Procedures




1. **Any approved substitutes for ADF *in this case*?**
2. **Why leave the volume turned up on ADF receiver during entire approach?**
   a. **CDI vs. ADF needle. . .what does the CDI have that ADF display lacks?**
3. **Why is it very important that the HI be set correctly, perhaps more so than on VOR approaches?**
   a. **Remember that the goal is to *track* inbound or outbound from an NDB on a particular course, not *home* on it.**


# ADF navigation - components



# Automatic Direction Finder (ADF) Concepts

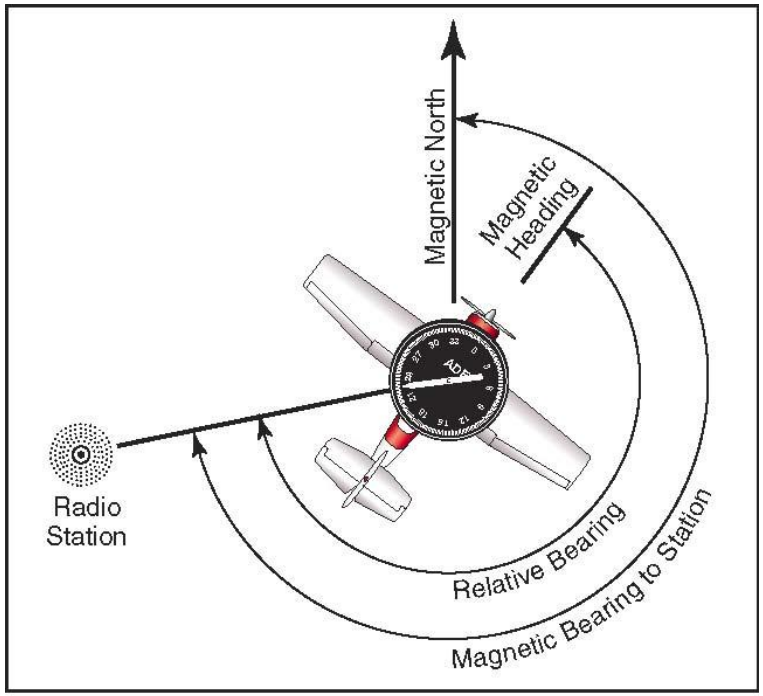



Figure 14-32. ADF terms.

1. **Needle indication is a function of aircraft heading (unlike VOR)**
2. **Thunderstorms and other electrical phenomena can interfere with NDB reception (unlike VOR)**
3. **MB = MH + RB**
4. **Some ADF indicators have fixed cards and others have movable cards. If the movable card is set to the current magnetic heading, then magnetic bearing to the station can be read directly from the display.**
5. **There is no "off" flag on the face of the ADF display (unlike VOR).**

# NDB identification

## NDB

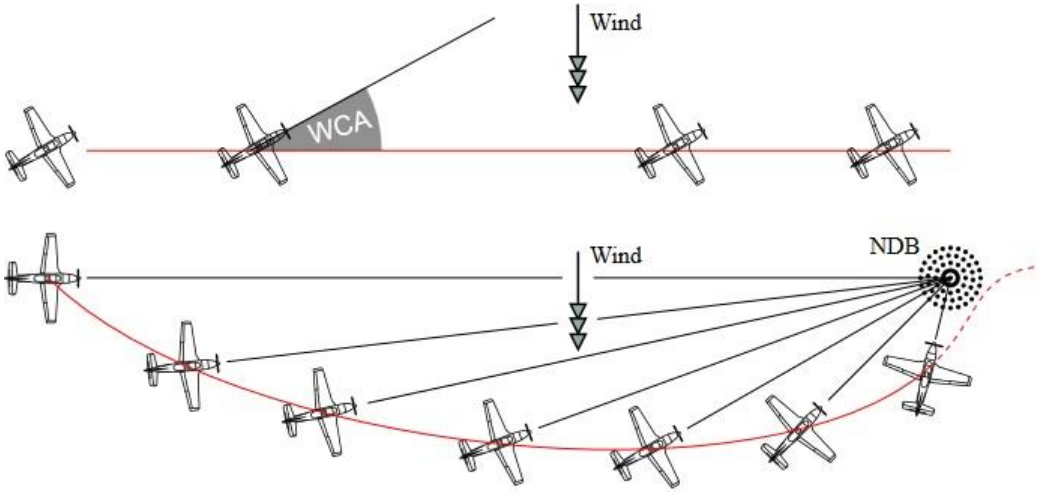
a) Tune NDB receiver to appropriate frequency and turn up volume.

b) Select appropriate button on intercom panel so that you can hear transmissions on the frequency

c) Listen to the Morse code identifier. Note that there is no “flag” on the indicator to visually alert the pilot of a failure.



# Tracking an NDB




## NDB Navigation Techniques

- Tracking:
  - Establishing a wind correction angle that negates the drift caused by the crosswind
  - Principle: WHEN THE ANGLE OF DEFLECTION = THE ANGLE OF INTERCEPTION YOU'RE ON COURSE
  - Or: when the angle formed by the aircraft heading and the desired course is the same as the angle between either the 0 or 180 mark on the indicator and the pointer, the aircraft is on course.

1. **Select a heading that you think will give you the desired course.**
2. **If the ADF needing remains stationary, then you are tracking a course directly to or from the station.**
3. **If the needle moves left or right, then turn toward the needle double the amount of the relative bearing.**
4. **Hold the new heading until the relative bearing equals the course correction.**
5. **Turn back toward the station and establish a wind correction angle that gives a constant relative bearing to the station.**
6. **Station passage occurs when needle points to a wingtip or rotates near the 180 relative bearing position.**

# Radar vectors to the approach

- When in a radar environment (usual in non-mountainous areas), you rarely have to fly a “full” approach
- ATC radar vectors onto the final approach course
  - If vectored, course reversal is not expected nor authorized
  - Vectors to final is more convenient and expedient than flying the full procedure
- So, when might you have to fly the full procedure?
  - Equipment failures (approach radar, or perhaps your transponder)
  - Geographic limitations – inadequate radar coverage for that area due to distance from the radar facility and/or nearby mountainous terrain
    - More relevant in places other than eastern Massachusetts
  - For training purposes

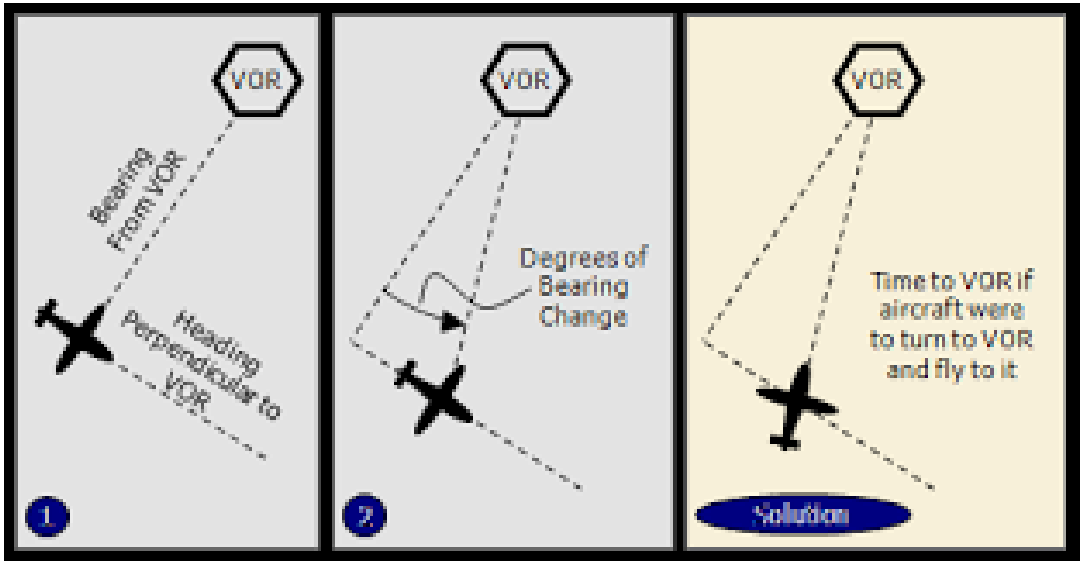
# Horizontal Situation Indicator


1. **HSI can not "reverse sense" except when tuned to a localizer**
2. **Selected course and how it's oriented to the airplane is graphically obvious – it's no longer necessary to "mentally rotate" the airplane to a heading that agrees with the selected course to get the "sensing" correct.**
3. **Functions of heading indicator and conventional VOR indicator are combined into one display**
4. **Each dot represents a 2-degree angular displacement from the radial – for localizers, each dot is one half of a degree of displacement.**
5. **Actual displacement from radial is approximately 200 feet per NM range from VOR per dot of CDI deflection**

# Radio Magnetic Indicator (RMI)


1. **Combines functions of heading indicator and bearing information from two navigational sources.**
2. **Magnetic heading is obtained from a magnetic flux detector - it does not have to be set to the magnetic compass manually (unlike the HSI).**
3. **Toggle switches can select which navigation source to use.**

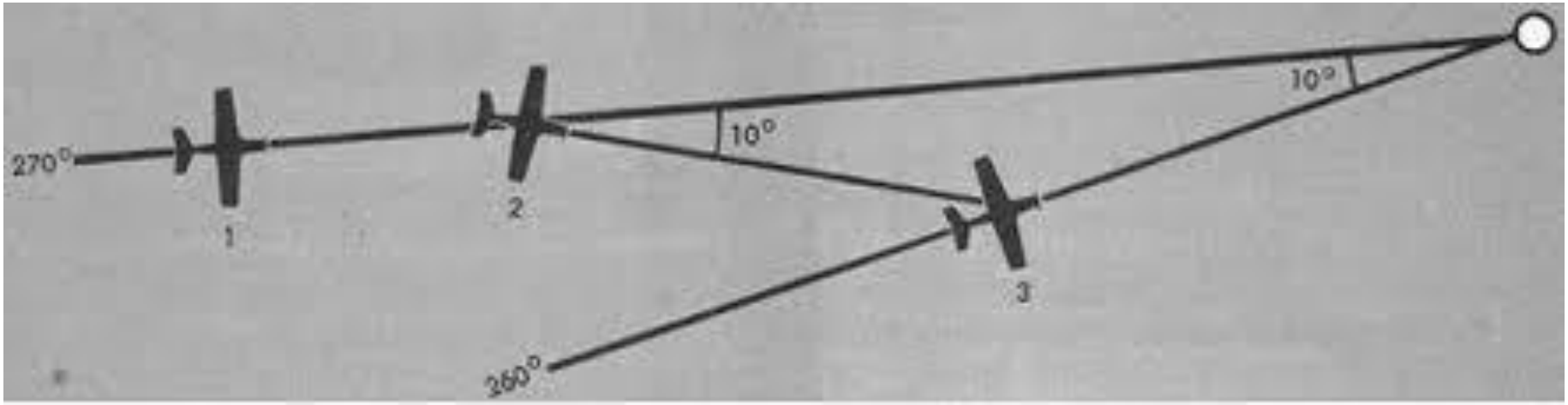
# Time and distance to station




$$\text{Time to station} = \frac{\text{60 x minutes flown between bearing change}}{\text{Degrees between bearings}}$$

$$\text{Distance to station} = \frac{\text{TAS x minutes flown}}{\text{Degrees between bearings}}$$

# Isosceles triangle method




1. **Turn away from the course 10 degrees (or any known angle).**
2. **Twist course selector on HSI or VOR the same amount in the opposite direction.**
3. **Note the time it takes for the CDI to center on the new course.**
4. **Time to station is the same time as it took for the CDI to center.**

# Youtube videos

- VOR approaches
  - https://www.youtube.com/watch?v=nbWbMVrVrUs
  - https://www.youtube.com/watch?v=c5WSGh3qztM
- NDB approaches
  - https://www.youtube.com/watch?v=vv58A5rIZGA
  - https://www.youtube.com/watch?v=f41aBdTYj9I