VOR Navigation

Introduction to VOR

VOR

(PHAK C16) (AIM 1-1-3)

- **VOR stands for (Very High Frequency (VHF) Omnidirectional Range)**
- Ground based radio navigation system used by pilots in flight.
- The ground stations (below) send out radio signals that can be utilized to determine location of the aircraft

VOR Ground Station - KONA HI

VOR BASICS

- **For civilian flight operations (non-military) there are 3 types of VORs:**

- **Very High Frequency** means that VORs operate on a frequency range between 108.0 and 117.9 MHZ.
- **Omni-direction Range** means that VORs provide pilots with 360 degrees of Navigational Coverage.
- Operates works based on timing between **2 radio signals**.
  - One of the radio signals a VOR sends out is a **Uni-Directional** (sweeping) signal.
- The other signal is **Omnidirectional** (all-directions).
  - Every time the sweeping, uni-directional signal points due North, the omnidirectional signal flashes.

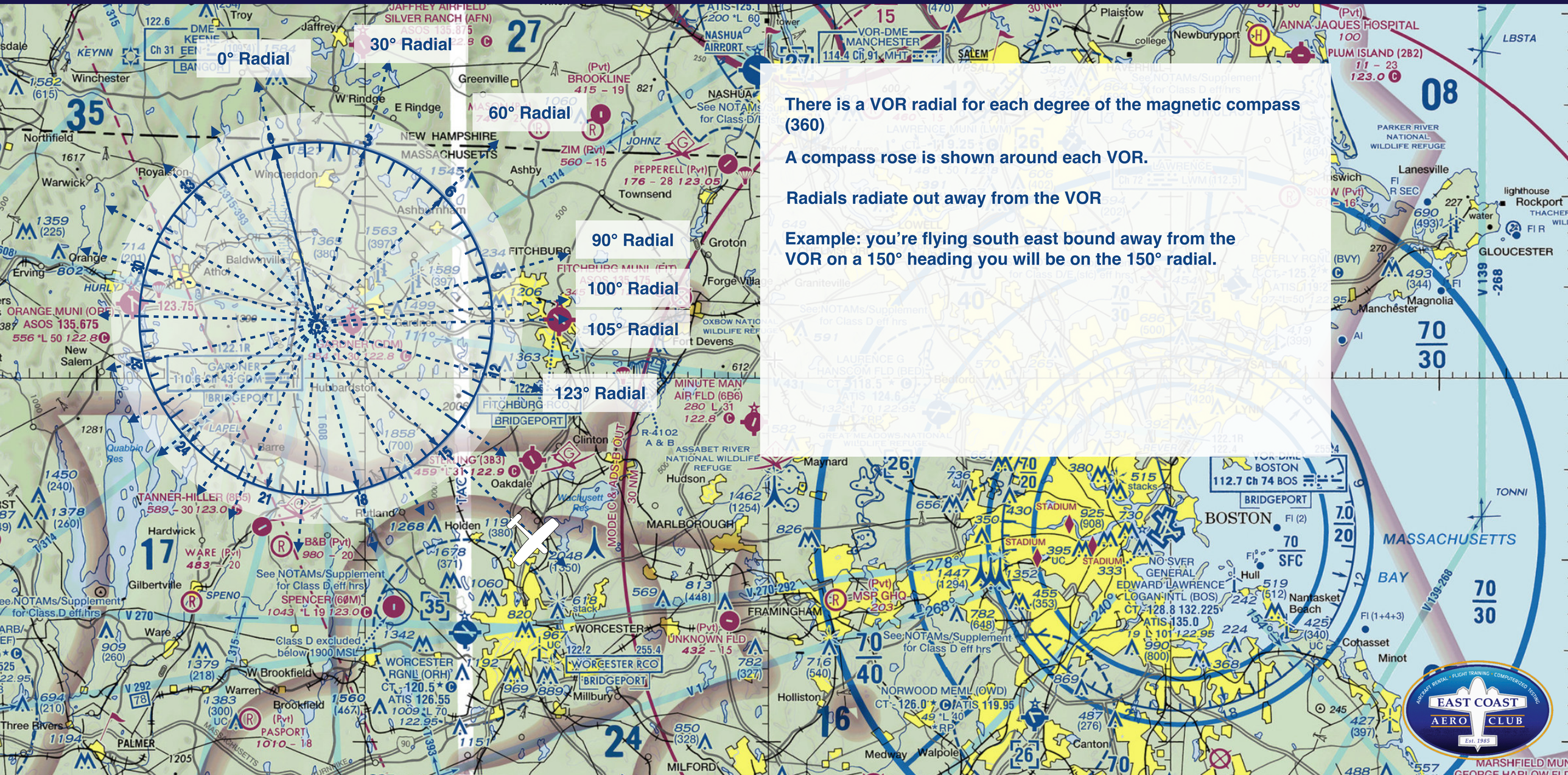
WHAT IS A VOR / VORTAC

- VORs are VHF radio stations that transmit radio signals for the purpose of navigation.
- The radio signal project **radials** in all directions (360°) from the station, like spokes from the hub of a wheel.
- Each of these radials is denoted by its outbound magnetic direction.
- Almost all VOR stations will also be VORTACs. A VORTAC (VOR-Tactical Air Navigation), provides the standard bearing information of a VOR plus distance information to pilots of airplanes which have distance measuring equipment (DME).”
- Transmitting frequencies of VOR stations are in the VHF (very high frequency) band between **108 and 117.95 MHz**, which are immediately below aviation communication frequencies.”

WHAT IS A VOR RADIAL

- A radial is defined as a line of magnetic bearing extending from an omnidirectional range (VOR).
- A VOR projects 360 radials from the station.
- These radials are always identified by their direction “from” the station.
  - Regardless of heading, an aircraft on the 360° radial will always be located north of the station.

WHAT IS A VOR RADIAL



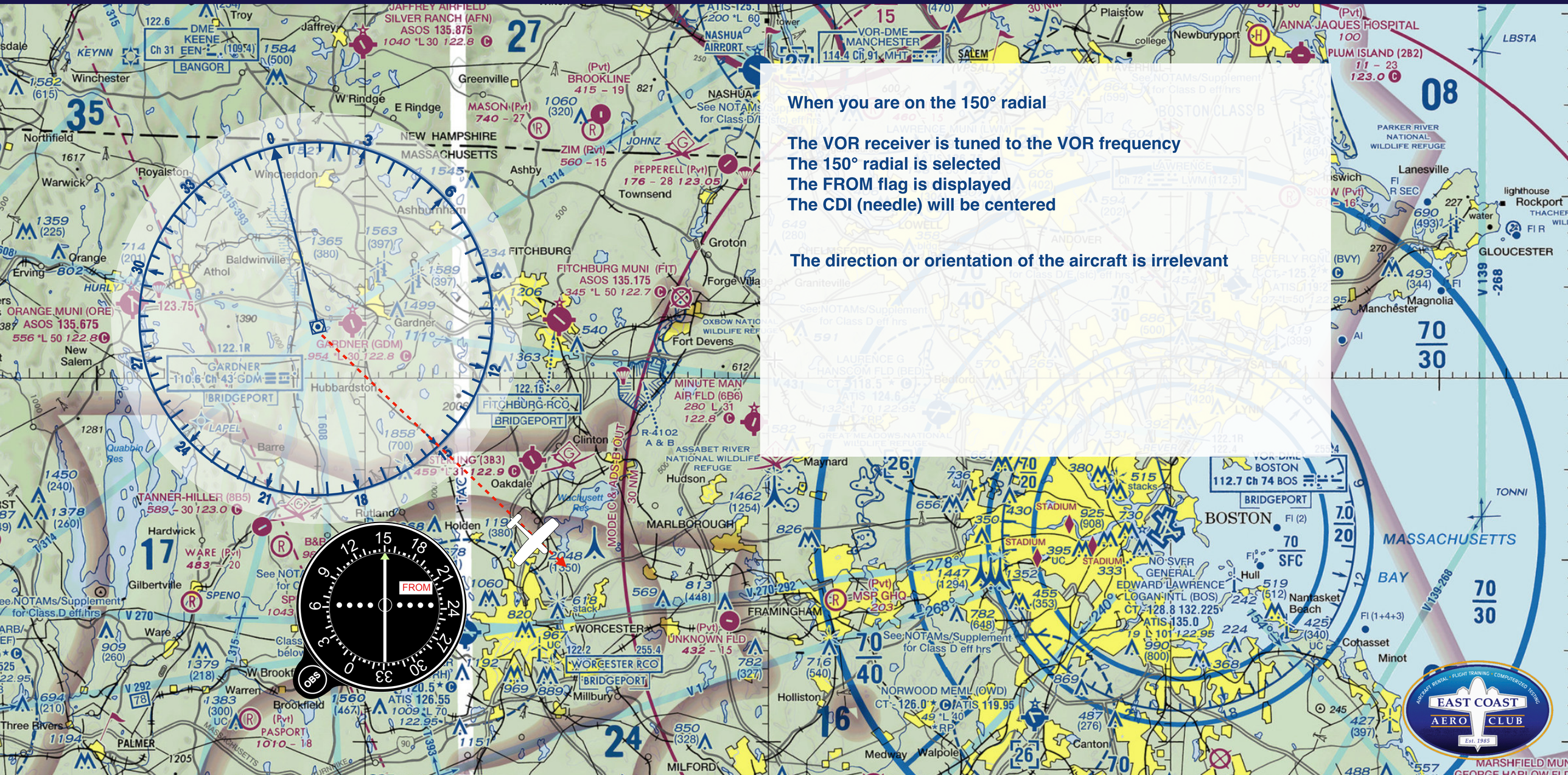
There is a VOR radial for each degree of the magnetic compass (360)

A compass rose is shown around each VOR.

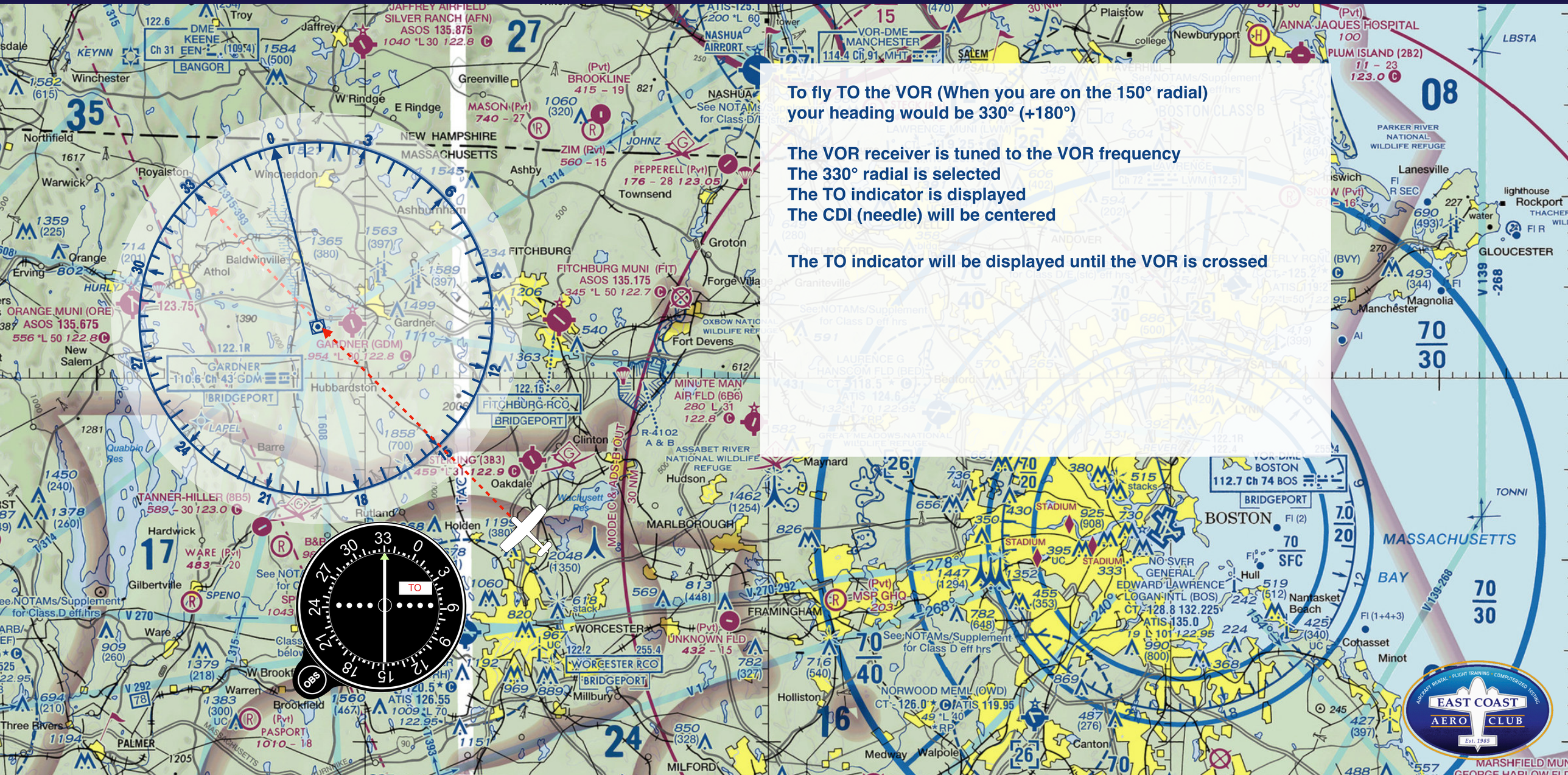
Radials radiate out away from the VOR

Example: you're flying south east bound away from the VOR on a 150° heading you will be on the 150° radial.

WHAT IS A VOR RADIAL



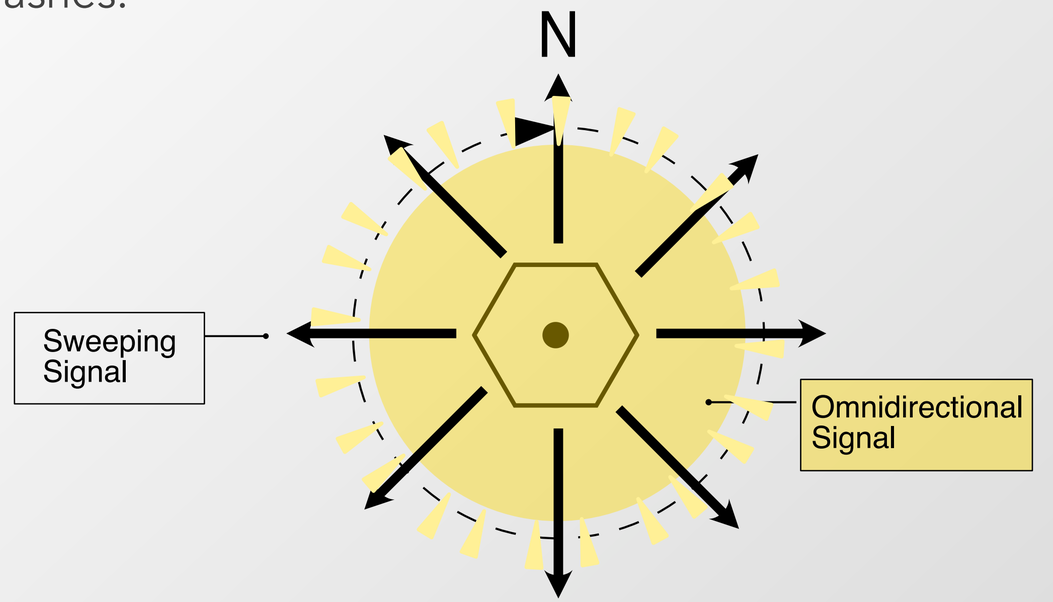
FLYING TO A VOR ON A RADIAL



VOR BASICS

THE LIGHTHOUSE EXAMPLE

- A VOR works based on timing between 2 different radio signals.
- An omnidirectional signal. (all directions at once)
- A unidirectional, sweeping signal (signal is focused in one direction at z time
- Each time the sweeping signal passes North, the omnidirectional signal flashes.



- The airborne equipment receives both signals, looks (electronically) at the difference between the two signals, and interprets the result as a radial from the station.

TYPES OF VOR

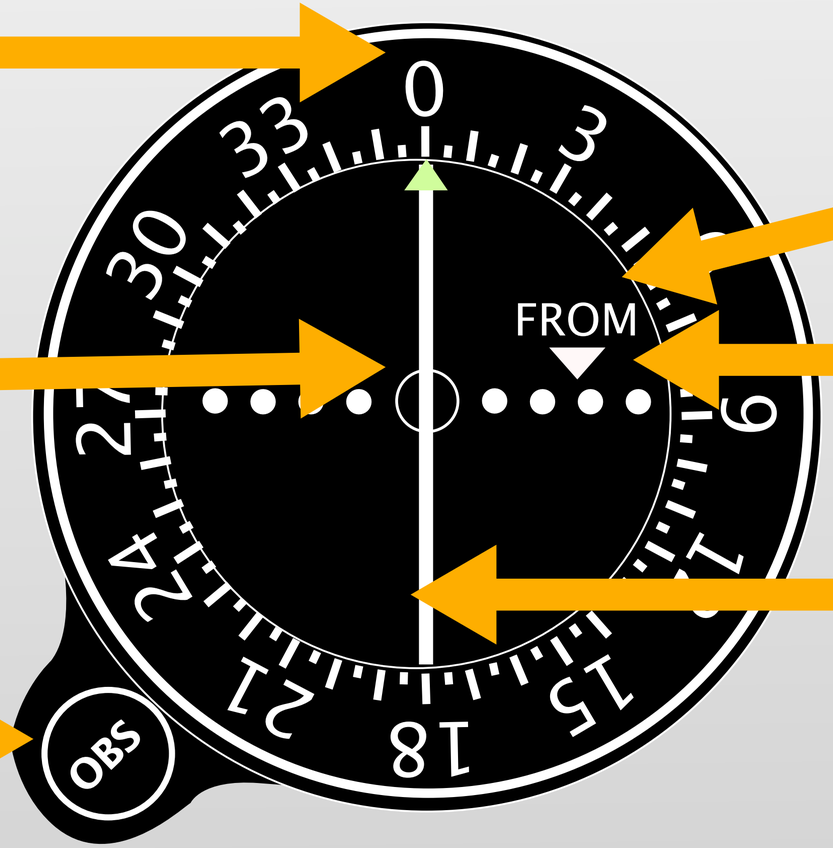
- **For civilian flight operations (non-military) there are 3 types of VORs:**
- **VOR**
- **VOR/DME** - A VOR co-located with DME (Distance Measuring Equipment)
- **VORTAC** - TAC stands for TACAN and is for military use only.
  - To civilian pilots, VORTAC and VOR/DME mean the same thing.

PARTS OF THE VOR RECEIVER

Selected radial

Center dot represents the aircraft; CDI line is the desired course

OBS: allows selection of a radial

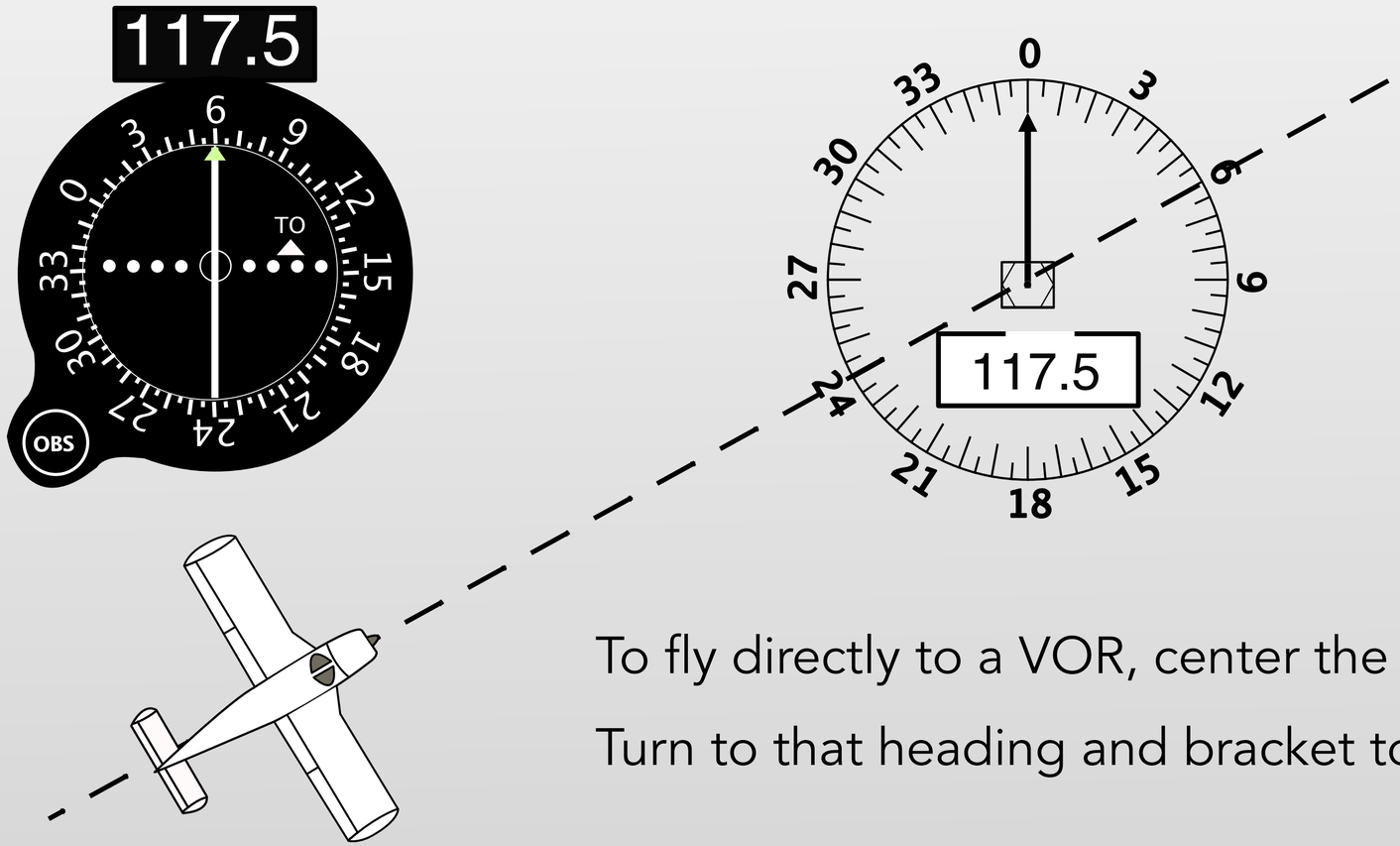


To/From indicator: orients the VOR position

Dots denote degrees off centered

CDI: needle shows angular deviation from selected radial

DIRECT TO VOR RECEIVER



To fly directly to a VOR, center the needle with a TO indication.

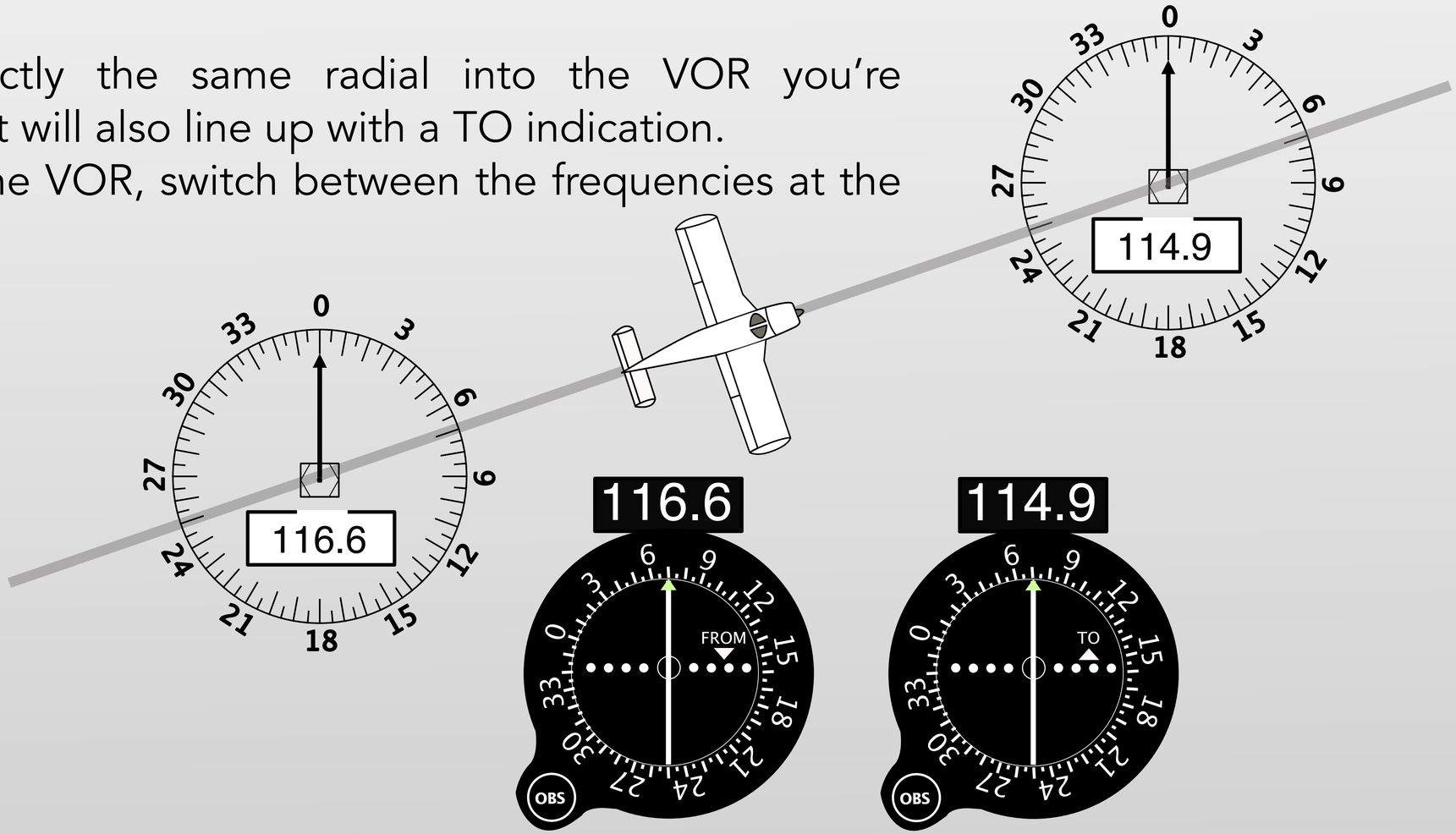
Turn to that heading and bracket to stay on the line

FLYING FROM ONE VOR RECEIVER TO ANOTHER

To fly from one VOR to another, fly away from one VOR with the needle centered on the appropriate radial and a FROM indication.

You can put exactly the same radial into the VOR you're approaching, and it will also line up with a TO indication.

If you have only one VOR, switch between the frequencies at the half way point.



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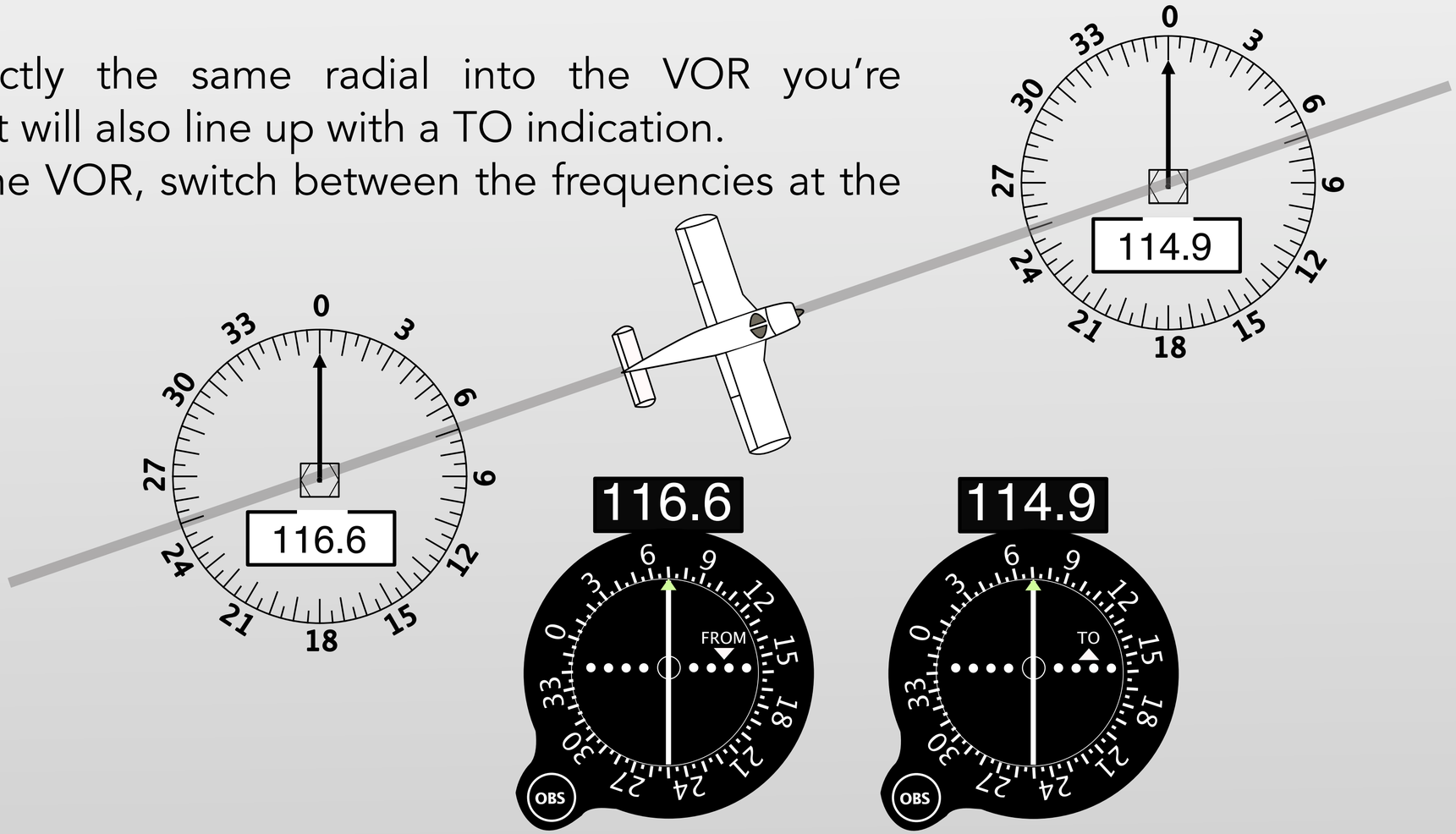
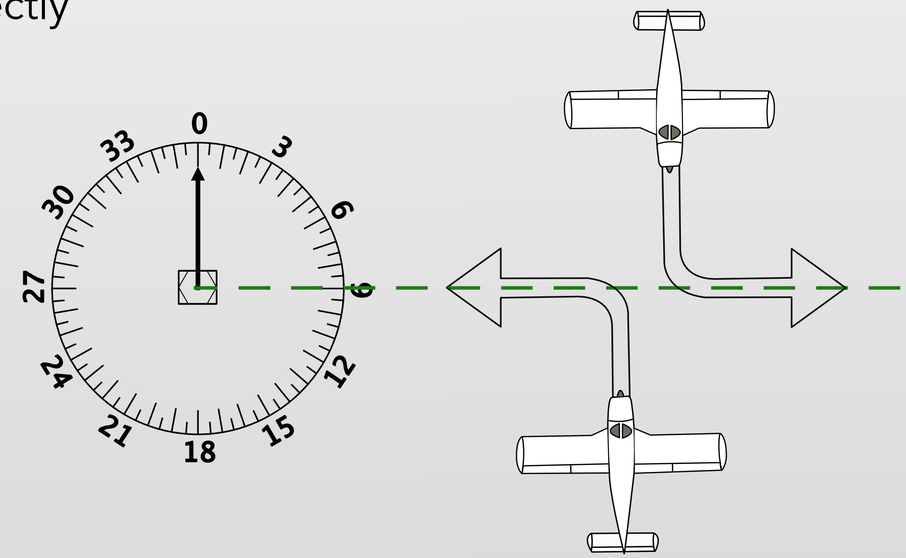


INTERCEPTING A RADIAL

INTERCEPTING A RADIAL is a matter of choosing the angle at which you wish to get on the line, and then doing some simple math.

The most rapid way to get on to a distant radial would be to fly perpendicular, straight it: a 90° intercept. To intercept a 270° TO course from the south, fly direct north until the needle centers. To intercept that same line (which would also be the 90° FROM radial) from the north, fly directly south.



Usually, though, you'll want to intercept a course at a shallower angle, because that cuts down the

total distance and time to your destination. 30° or 45° are good intercept angles, but any angle will do and the math is always the same: Take the magnetic course of the line that you want to be on.

Then, if you're intercepting from the right side of the line, add the intercept angle

If you're intercepting from the left of the line, subtract the intercept angle

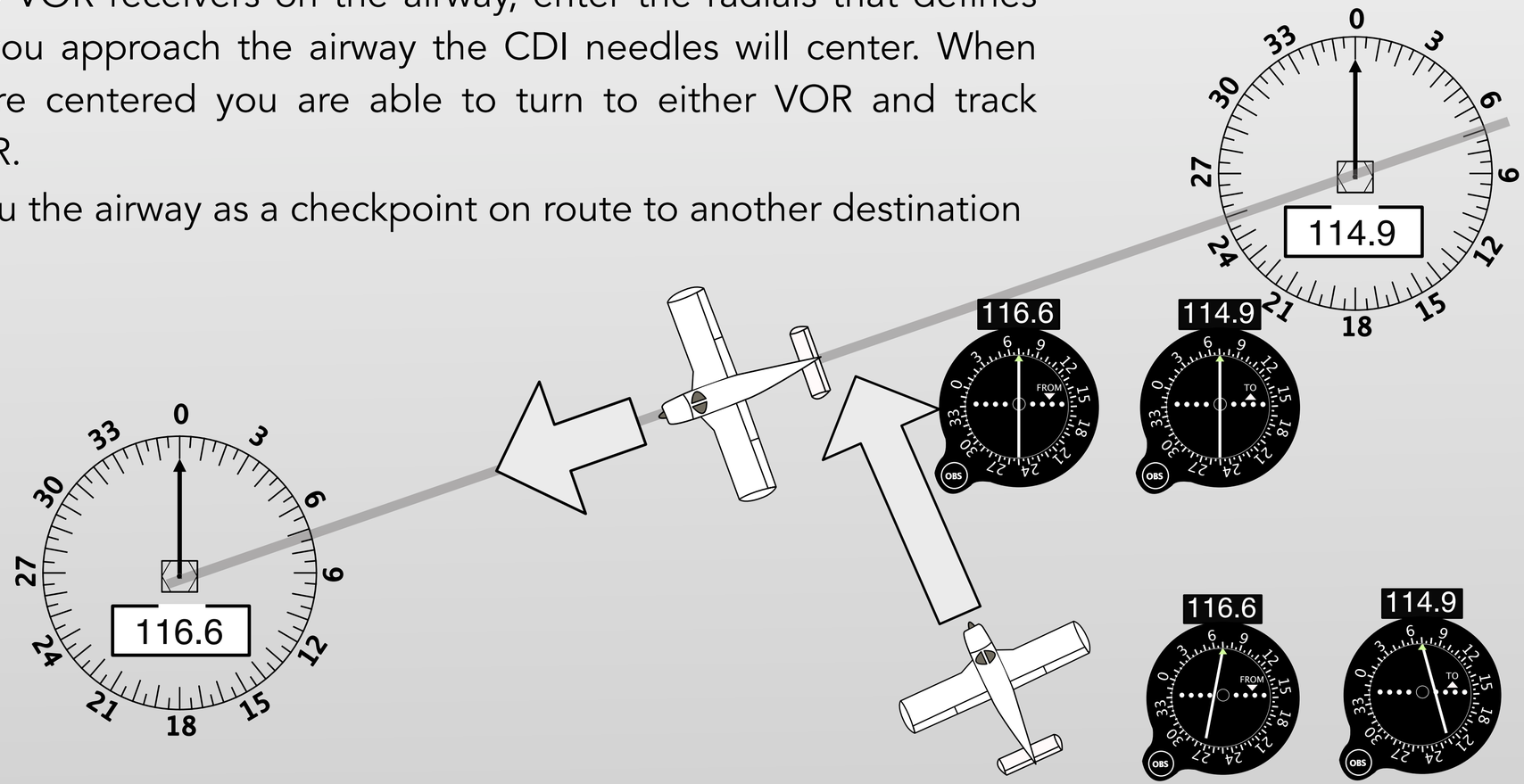
PAUL ROBERTS

INTERCEPTING A VICTOR HIGHWAY

Victor airways are low-altitude airways. They are defined in straight-line segments, each of which is based on a straight line between either two VHF omnidirectional range (VOR) stations, or a VOR and a VOR intersection.Fly a course that will intercept the airway.

Tune to the two VOR receivers on the airway, enter the radials that defines the airway. As you approach the airway the CDI needles will center. When both needles are centered you are able to turn to either VOR and track towards the VOR.

You may also you the airway as a checkpoint on route to another destination



INTERCEPTING RADIALS

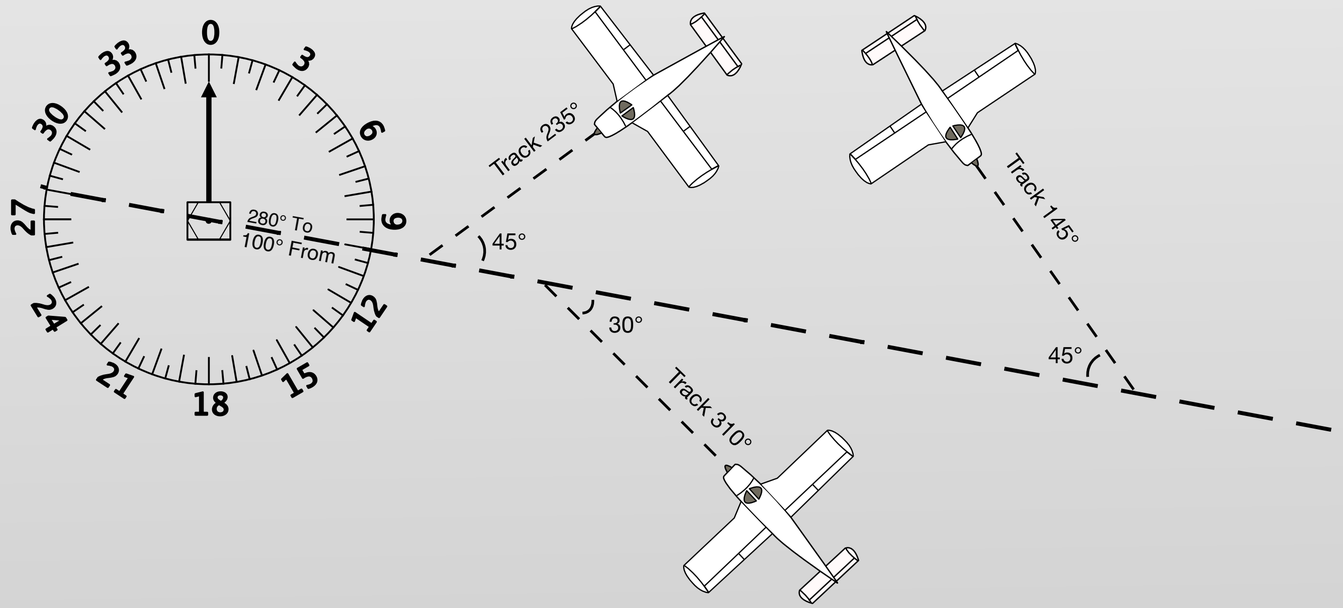
You're trying to **intercept the 280° course** (TO the station) from **south** of that line.

- You choose a 30° intercept. Fly a track of (280°+30°) = 310°

If you're trying to **intercept the 280° course** from the **north** on a 45° intercept, fly a track of (280°- 45°) = **235°**

- If you were going to fly **FROM** on that same line, it's the **100° radial**.
- To intercept at a 45° angle from the north, you 're now on the left side of the line, so fly (100° + 45°) = 145°

Note that the track is not necessarily the heading: you'll have to crab for wind in order to intercept correctly.



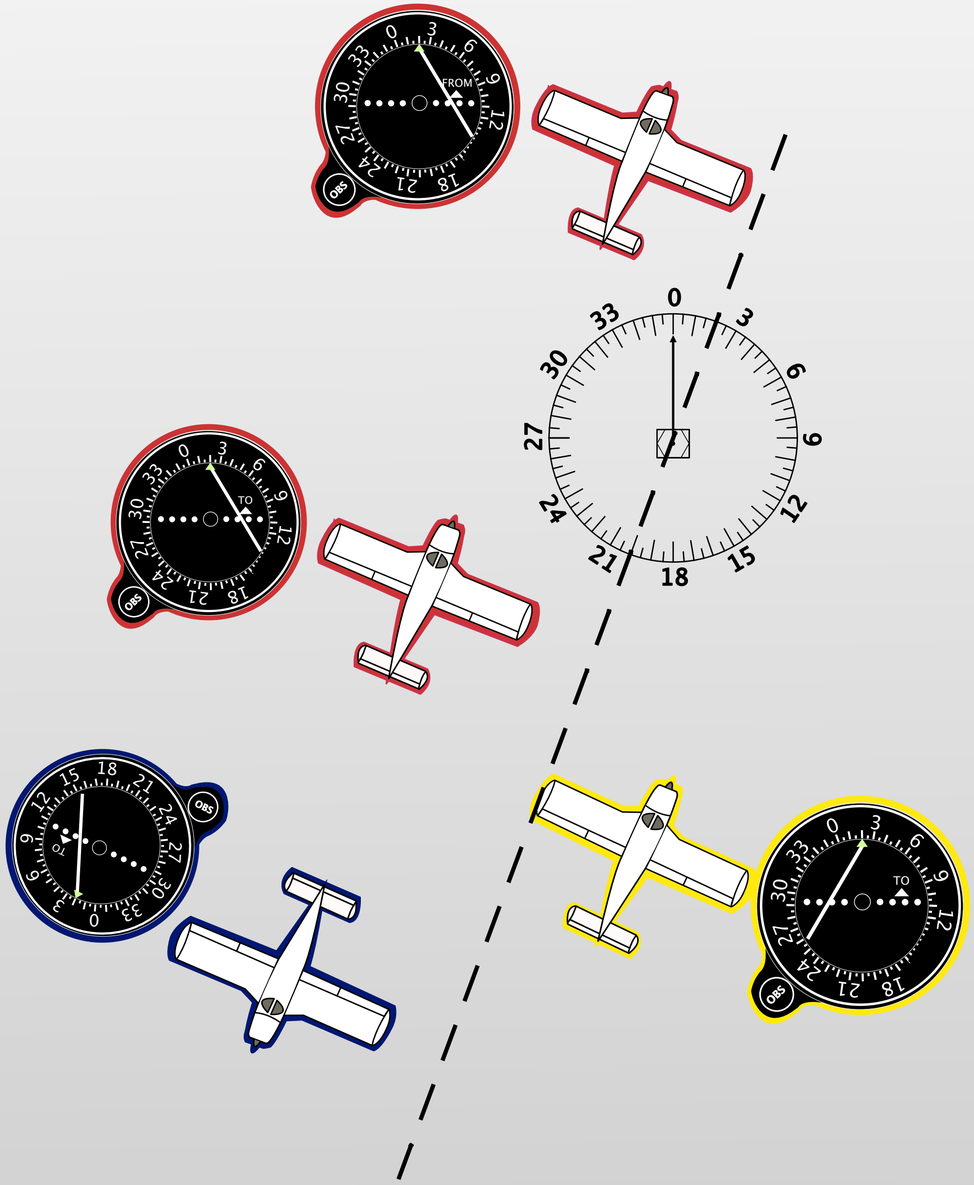
COURSE DEVIATION

If the aircraft is not on the line, the CDI shows a deviation of **one dot for every two degrees**.

Think of the center dot as being the aircraft, and the CDI as being the line you want to be on.

If the line is to the right of the dot, get back on it by turning right (red aircraft).

If the line is to the left, go left (yellow aircraft).



IMPORTANT: if you are flying away from the VOR station, and the indicator says TO, you will get **reverse sensing**: the line will be on the wrong side.

This is the situation with the blue aircraft. If the blue plane goes right, toward the CDI needle, it will get farther away.

The same is true if you are flying toward the station, and the indicator says FROM.

BRACKETING

Bracketing is the craft of getting and staying on a direct track to a navigation facility, by making adjustments for wind drift, and establishing a crab.

The principle is:

- Get on the line and hold a heading.
- The wind pushes you off the track.
- Pick a heading to back to the line, and then split the difference.
- Repeat until you find the heading that holds the CDI steady, straight up and down.

  Example on next slide

COURSE DEVIATION

7 and then split the difference again: in this case, 350° is too much, but 360° too little. Fly heading 355° Repeat this bracketing process until you find a heading that holds the CDI steady.

6 Choose another gentle intercept heading . .

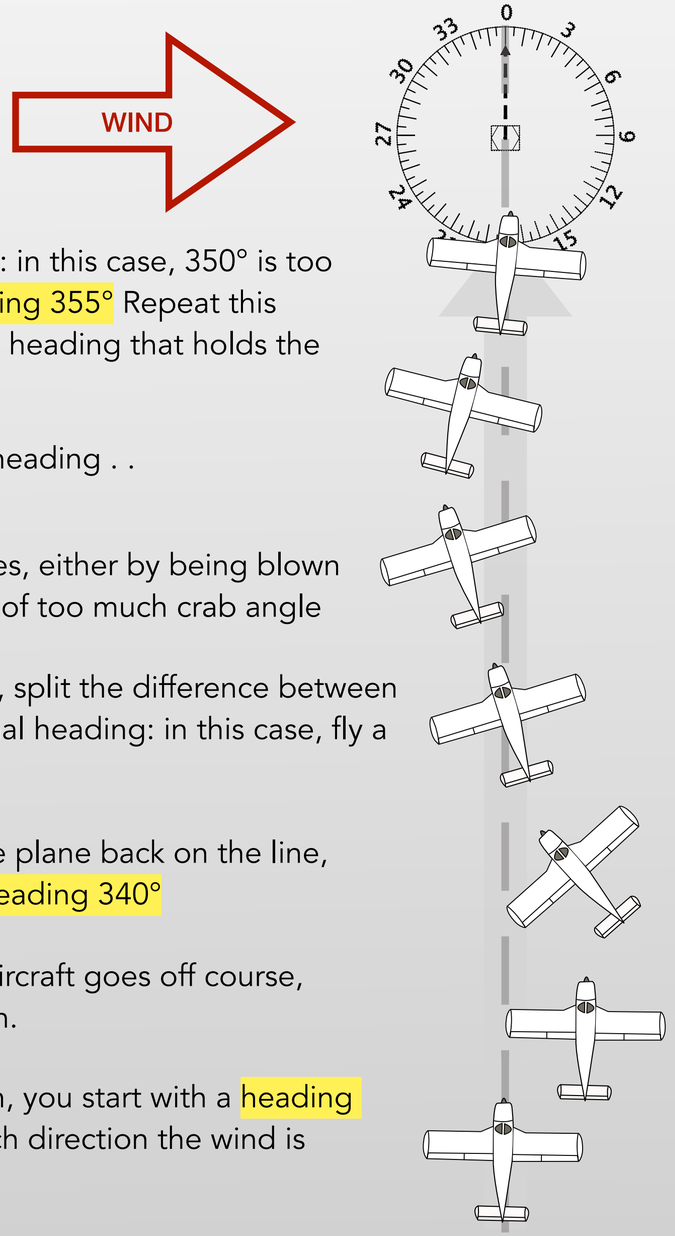
5 Again over time, the plane deviates, either by being blown with the wind, or drifting because of too much crab angle

4 When the CDI has again centered, split the difference between your intercept heading, and original heading: in this case, fly a new heading of 350°

3 Choose a heading that will put the plane back on the line, say for example a 20° intercept: heading 340°

2 Over time, because of wind, the aircraft goes off course, the CDI shows a one-dot deviation.

1 On the 360° course TO the station, you start with a heading of north. (If you already know which direction the wind is from, guess a crab angle.)



IDENTIFYING THE CORRECT VOR

VORs should always be identified.

1. When you're in range of the VOR - tune to the station frequency
2. (Garmin 430) Select OBS (omni bearing selector)
3. Push the V button "push to ID" (Garmin 430) to receive the ID info - Morse Code.
4. Push in the "Nav" button on the audio panel

IDENTIFYING THE CORRECT VOR

- VORs that are out of operation may transmit nothing at all, or may transmit TEST (_ . … _)
- The closer to the VOR you get, the more your angle to the chosen course changes.
  - This means that the needle gets more sensitive and deflects much easily and may also get amore “squirrelly” near the VOR itself.
- The closer you fly, the smaller your course-correction heading changes should be
- When very close to passing over the VOR, just hold the drift correction you’ve already determined.
- The CDI may go full deflection for a short time, but should come back in after passing over the VOR and the TO/FROM flip.

TESTING A VOR

Before flight, you should test the VOR's reliability. The best way is to use a VOR test facility (a.k.a. VOT). VOTs transmit only on a 360° radial.

- When on the ground at an airport, tune in the VOT on the appropriate frequency (listed in the Chart Supplement). When you center the needle, it should be within 4 degrees of 360°, with a FROM indication, and within 4 degrees of 180° with a TO indication.
- Airports sometimes have ground checkpoints (Chart Supplement)
- Get to the proper location and tune the VOR to the listed frequency.
- Turn the OBS to center the CDI, and be sure it's within 4 degrees.
- Airborne checkpoints are less accurate, but be sure that the CDI centers 6 within 6 degrees of the published radial.
- When checking one VOR against another, they should line up within 4° of each other.
- After checking the VOR, in the airplane's VOR logbook, write the facility, date, the amount of bearing error, and your signature.

DME

DME (distance measuring equipment) gives the distance to a VOR station in nautical miles.

The distance is the actual, slant-range distance from the aircraft to the VOR tower.

This means that as the aircraft gets close to the station, its altitude needs to be considered.

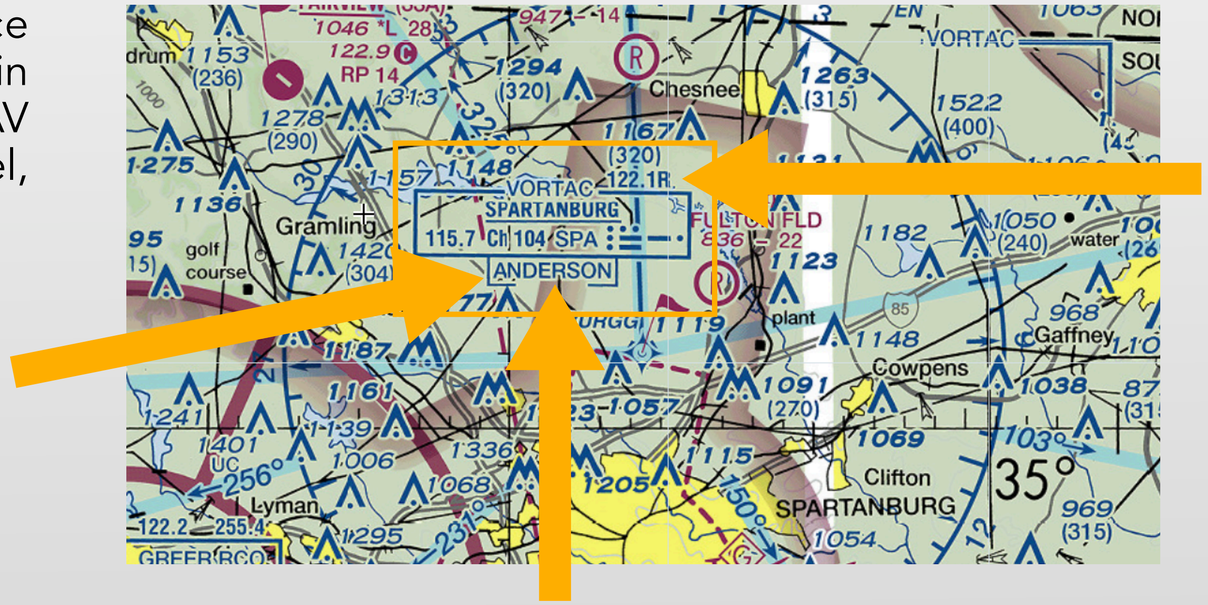
If the aircraft is flying at 6,000 feet, it will show 1 n.m. distance away when it's directly overhead the VOR station, but from more than a few miles away, the DME slant problem is negligible: the DME will show the real ground distance to the VOR.

VOR AS A RADIO COMMUNICATIONS RECEIVER

A VOR can receive voice transmissions. Sometimes weather information is given over a VOR frequency, or even communications with FSS can be conducted over VORs in areas where normal where normal comm frequencies are unavailable.

To listen to the voice channel of a VOR, tune in the VOR, push the NAV button on the radio panel, and turn up the volume.

All FSS's monitor 122.2
You can reach Anderson FSS on 122.2



If a FSS can reach you via a VOR, a frequency is noted above the communications box, followed by an R. The "R" means, "Receive only.'

In the case of this VOR, you could talk to Anderson FSS by tuning your communications radio to 122.1, and listening to 115.7 over the VOR radio's voice channel. Yes, you will be talking to them over one machine (the comm radio), and they will be responding and you listening over another (the VOR).