

## The VOR

VOR stands for **VHF Omni-Range**. It works by transmitting two radio signals.

1. The reference phase, and
2. The Variable Phase.

When due magnetic north of the station, the two are in phase

When due magnetic east of the station, the two are out of phase by +90°

When due magnetic south of the station, the two are out of phase by 180°

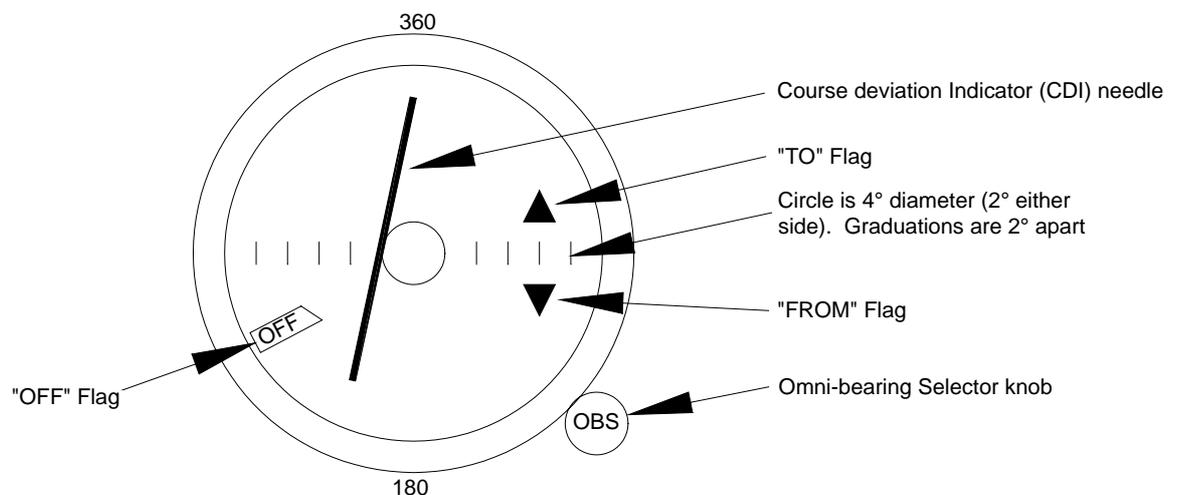
When due magnetic west of the station, the two are out of phase by -90°

Every 10 seconds the station transmits a 3 character Morse ident.

The range of a VOR depends on line of sight, and is a function of the height of the aircraft above the station.

$$\sqrt{1.5 \times \text{height\_in\_feet}}$$

The cockpit display is the **Omni-Bearing Indicator (OBI)**. Although all the indicators are shown in the drawing below, the "TO" and "FROM" flags do not display at the same time, and when a valid signal is being received, the "OFF" flag does not display.



**Figure 1 The Omni-bearing Indicator (OBI)**

When tracking a VOR, your heading must be within 180° of the track required. Although possible, it is difficult to fly "TO" a VOR on a "FROM" heading as the CDI needle indication is reversed, which can quickly lead to disorientation. The "OFF" flag is displayed when the instrument is unable to receive signals on the selected frequency. This may be because the aircraft is out of range of the VOR transmitter, or, as quite commonly occurs, it is out of service due to a fault, or for maintenance.

### ***Preparing the VOR for Use***

Before take off: -

- a) Switch on

- b) Select desired frequency
- c) Identify - listen to the Morse ident at least twice
- d) Check that the "OFF" flag is not showing.

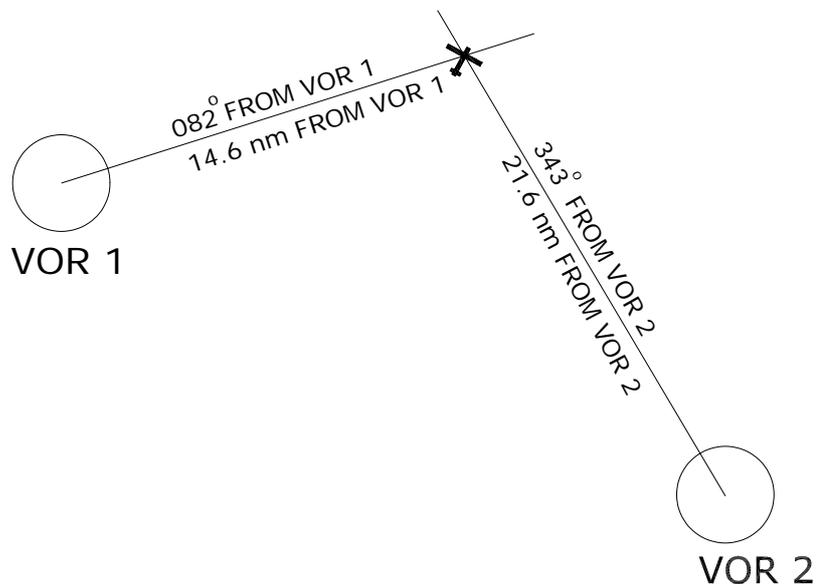
This check may be called the "SID" rule (Select, Identify, Display).

### ***Position Fixing using the VOR***

The VOR can be used to determine the aircraft's position

By turning the Omni-bearing selector (OBS) until the CDI needle is centred and the "FROM" flag is displayed, and observing the DME instrument, the pilot is able to obtain a "position fix", which will be, for example 120° FROM the VOR (i.e. to the south east of it) and 21.5 miles from it along the 120° radial.

By selecting a second VOR within range and carrying out the same exercise, the position fix may be confirmed, or the accuracy of the pilot's rough plot on the chart improved (remember he/she is flying the aircraft at the same time! Ideally the radials from the two VORs should intersect as nearly at right angles as possible).



**Figure 2 Position fix from two VORs**

### ***Tracking TO a VOR***

The VOR can be used to fly a particular track along a radial to a destination by keeping the CDI needle centred. The first requirement is to have a fairly good idea of where you are in relation to the beacon. In Figure 2 above, you have ascertained that you are within the area to the north east of the VOR 1 transmitter. As you turn the OBS knob, the needle will not move until the dial indicates within 10° of the radial you are currently positioned along, then it will move very quickly, possibly needing a little backward and forward adjustment until the needle settles. Note that you may not be flying *along* this radial, and if this is the case, the needle may continue to move.

When the needle is centred, however momentarily, check the indicated bearing, then turn the OBS knob until the TO flag is showing and the needle is again centred. This will be when the opposite bearing – 262° – is at the top of the dial. To fly to the VOR, all you now need to do is to turn onto the heading shown and fly a heading to keep the needle centred. The heading flown may not be precisely that indicated, but may need to be adjusted to allow for wind drift. Keeping the needle centred is the aim.

Corrections need to be made carefully, so as not to wander from side to side of the intended track. If the needle is 2 divisions (4°) off centre and you are 20 miles from the VOR as shown on the couple DME instrument, then you are off track by 4°. Turn in the direction the needle is “pointing” (in Figure 1, for example, you would turn left) onto a heading which is **twice** the track error. If the error is 4° and your required track is 262° then (using figure 1 as an example again) turn left 8° onto a heading of 254°. As the needle centres, turn back onto your original heading, with perhaps a degree or 2 more left to correct the wind drift which is pushing you to the right of track.

As you get nearer the VOR beacon, the needle becomes more sensitive, needing more frequent adjustments. However, once you are within about 2 miles of the station, stop trying to make adjustments and fly a steady heading until you have crossed over it. You will know when you have crossed the VOR station because

- a) The TO flag will quickly change to FROM
- b) The DME readout will change from decreasing values, through zero and start increasing
- c) The needle will probably move quickly to full scale deflection and remain there for some minutes although you have not changed course.

### ***Tracking FROM a VOR***

If you have a course change planned at the VOR, turn the OBS knob to the new course, and check that the FROM flag is showing. Turn onto the planned course and maintain that course for about a minute, then check, using the technique described above, fix your position – find out which radial you are on. Now select the radial you intend to fly along, and turn in the direction of the needle. Make the turn twice the track error, up to a maximum of 60 correction.

For example, if you find you are on the 180° radial, and you intend to be flying along the 204 radial turn right (204°-180°) x 2 = 48°. Then turn onto track as the needle centres. To continue to follow the intended radial ‘outbound’ (FROM) the VOR, simply keep the needle centred; fly right if the needle moves to the right; fly left if the needle moves to the left.

NEVER, as a relatively inexperienced simulator instrument pilot, attempt to fly towards a VOR if the FROM flag is showing, or away from a VOR if the TO flag is showing. Although perfectly feasible, it quickly leads to confusion and disorientation trying to remember to turn right if the needle indicates turn left and vice versa.