

## Understanding VOR's

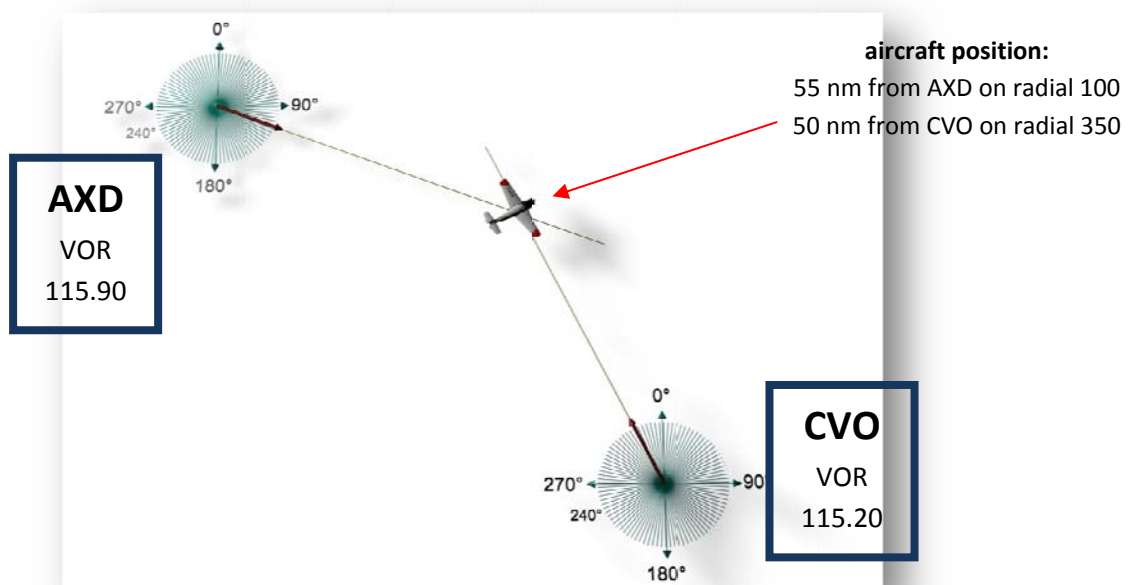
**VOR** stands for **V**ery high frequency **O**mnidirectional **R**ange

The VOR is a type of radio navigation system for aircraft. Unlike an NDB which transmits 1 frequency all around. The VOR transmits 2 signals. 1 steady frequency and 1 rotating frequency. The VOR therefore can transmit 360 signals all around. 1 signal per degree !

A VOR ground station broadcasts a VHF radio composite signal including the station's identifier, voice (if equipped), and navigation signal. The identifier is typically a two- or three-letter string in Morse code



This allows the receiving equipment to determine a magnetic bearing from the station to the aircraft or the line of position (LOP ) or RADIAL from the VOR.



*The intersection of two radials from different VOR stations on a chart provides the position of the aircraft*

The VOR transmits between 108.0 MHz and 117.95MHz with 50 kHz interspacing

The 100kHz even digits are used for the VOR

108.00 , 108.05, 108.20 , 108.25, 108.40, 108.45 etc...115. 20 (CVO)

The 100kHz odd digits are reserved for the ILS ( Instrument Landing System)

108.10 , 108.15, 108.30 , 108.35, 108.50, 108.55 etc...109. 90 (ils rwy 05C)

### **VOR range**

The volume of airspace covered by the VOR station is called its Standard Service Volume (SSV)

T-VORs have the lowest range to protect them from interference by other stations on the same frequency

<b>SSV</b>	<b>from</b>	<b>Up to</b>	<b>range</b>
T (terminal)	1000 ft AGL	12000 ft	25 nm
L (Low Altitude)	1000 ft AGL	18000 ft	40 nm
H (High Altitude)	1000 ft AGL	14500 ft	40 nm
	14500 ft AGL	60000 ft	100 nm
	18000 ft AGL	45000 ft	130 nm

VOR stations rely on "line of sight" because they operate in the VHF band—if the transmitting antenna cannot be seen on a perfectly clear day from the receiving antenna, a useful signal cannot be received. This limits VOR (and DME) range to the horizon—or closer if mountains intervene.

### **RNAV ( Area navigation)**

Traditionally, VOR and older NDB stations were used as intersections along airways. An aircraft will hop from station to station in straight lines occasionally broken by a turn to a new course.

Navigational reference points can also be defined by the point at which two radials from different VOR stations intersect, or by a VOR radial and a DME distance. This is the basic form of RNAV which allows navigation to points located away from VOR stations without overflying them.

In future, expensive VOR station will be become obsolete and fully replaced by GPS ( Global Positioning Systems)

### **Station types**

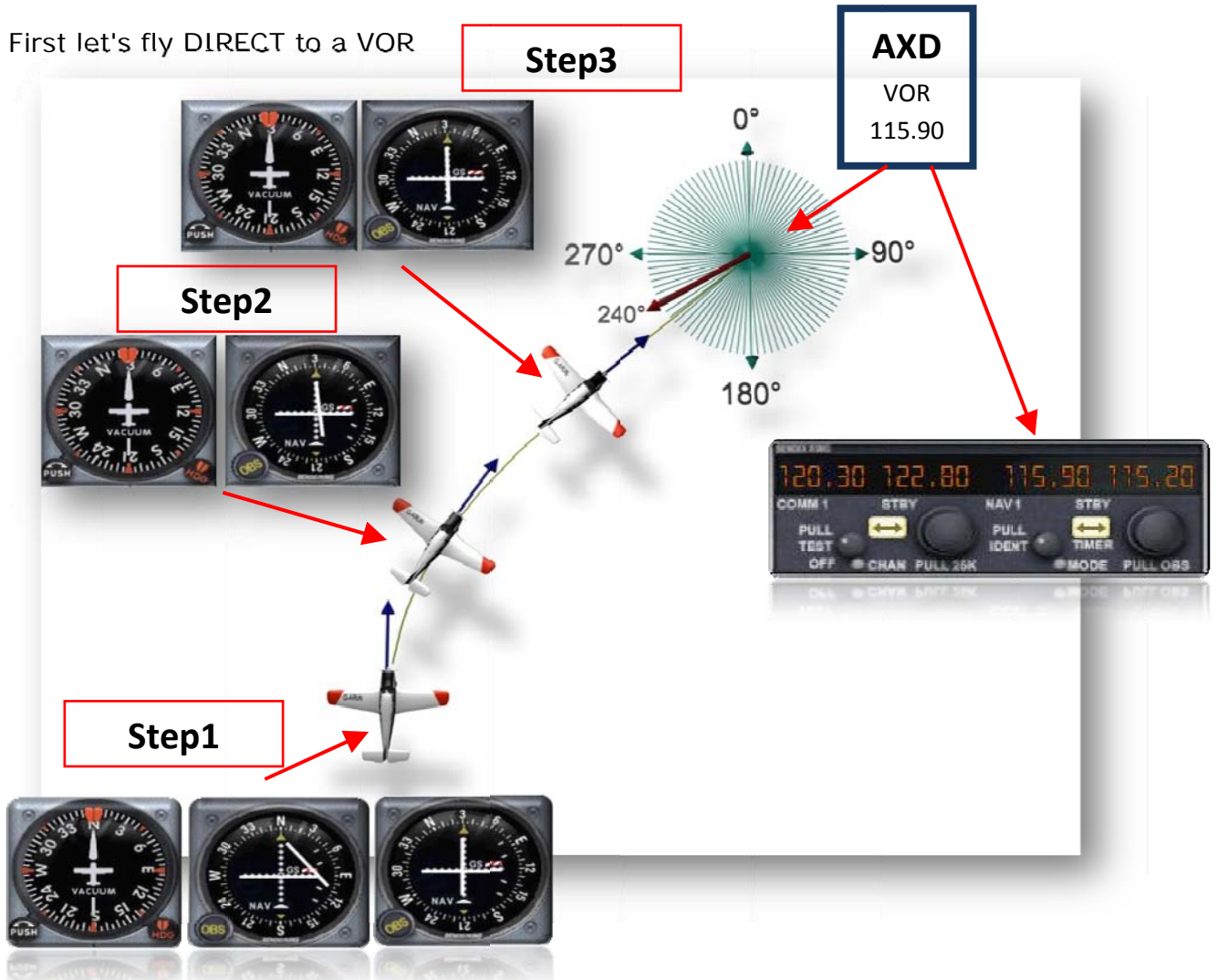
VOR	Localizer
VOR-DME	Localizer + distance
TACAN	Tactical Air navigation for military purposes
VORTAC	Localizer + Tactical Air navigation



## NOW LET'S FLY

With our OBS (Omni Bearing Selector) we can select a **COURSE** and listen to 1 of these 360 radials signals from the VOR. This is called TRACKING a **RADIAL** and **very useful for accurate navigation**

First let's fly DIRECT to a VOR



How do we do that? First make sure you entered the correct frequency of the VOR in your NAV1 (active)

If you are not sure you receive the VOR signals correctly ..you can listen to it !!

Don't forget to set NAV mode



Press NAV 1 in your audiopanel to listen to the morse code of the VOR

OR

Pull ident NAV 1 in your radiostack to listen to the VOR



### Step 1:

We are flying NORTH on a heading 360°.

FIRST make sure that you set the OBS of your VOR1 indicator on the same bearing as your current heading...so.... 360° / North



Now where is the VOR????

The vertical needle of your VOR1 indicator says it is somewhere on the right of us.

is it at 005? 010? 015?

Just turn your OBS and wait until the Vertical needle starts moving. Keep turning your OBS until the vertical needle is perfectly straight. There is the VOR....29 degrees to the right !

So to fly directly to the VOR we need to change our heading to 029



### Step 2:

We have changed our heading and are now flying heading 029.



### Step 3:

What happened here? the needle is no longer straight upwards.



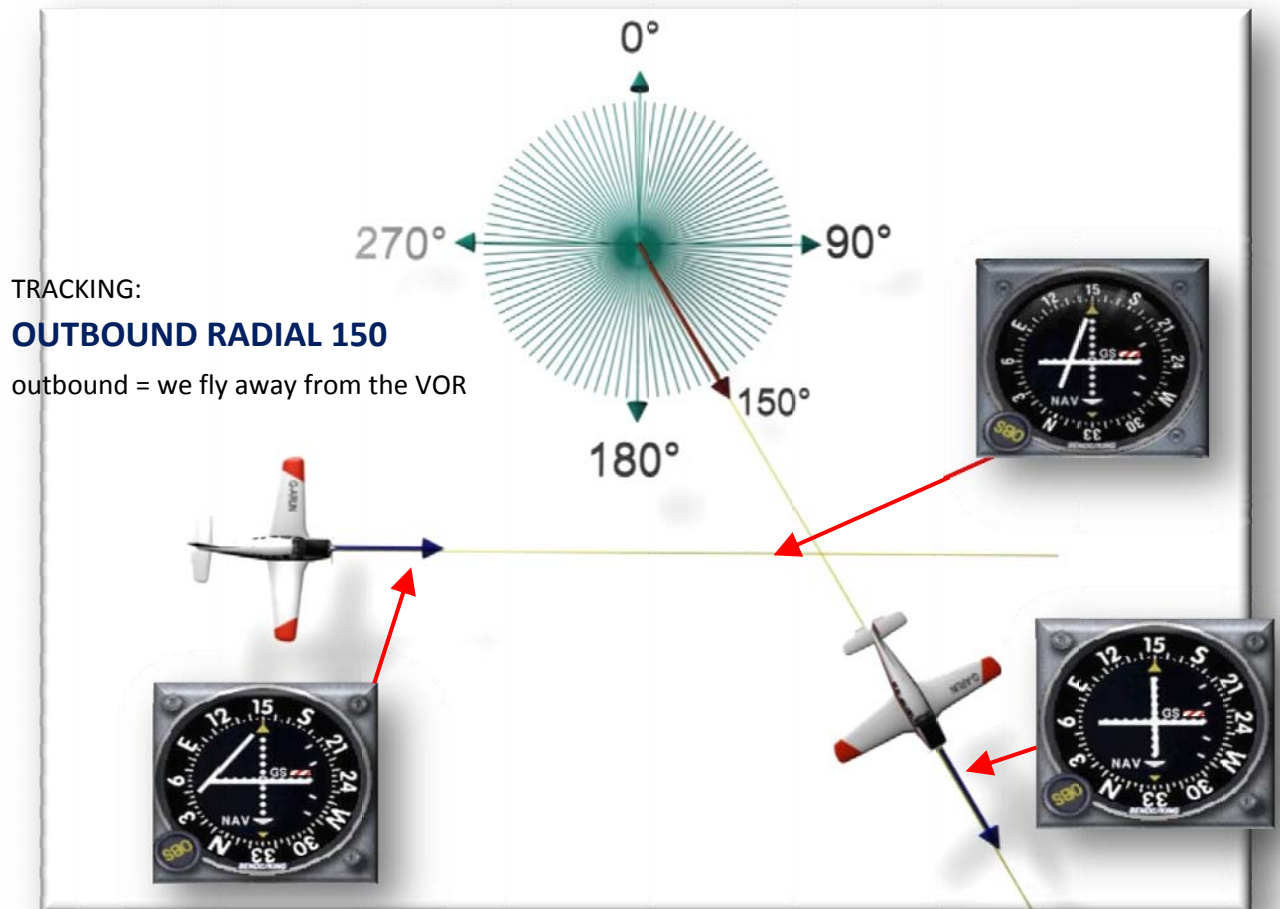
So we do the procedure again....turn the OBS and find the VOR. Now it says 031...we fly heading 031...and keep the needle in the middle.

as you see...it takes time to set the instruments...while we keep on flying and turning. Sometimes we need to make a few adjustments.



## Intercepting OUTBOUND RADIALS

Without overflying the VOR we can use 1 of the 360 radials to get us on a specific course.



We are flying on a heading 090. ....if you set your OBS on 090 you will see that the vertical needle will swing to the left...indicating that the VOR is on our left side

Step 1: We set our OBS to 150 and we wait until the needle starts moving.

Step 2: Once its moving, we slowly start our turn to get on the outbound radial 150 until the needle is perfectly straight. Our heading will then be 150 . Try not to overshoot !

Try to pick up the radial manually !

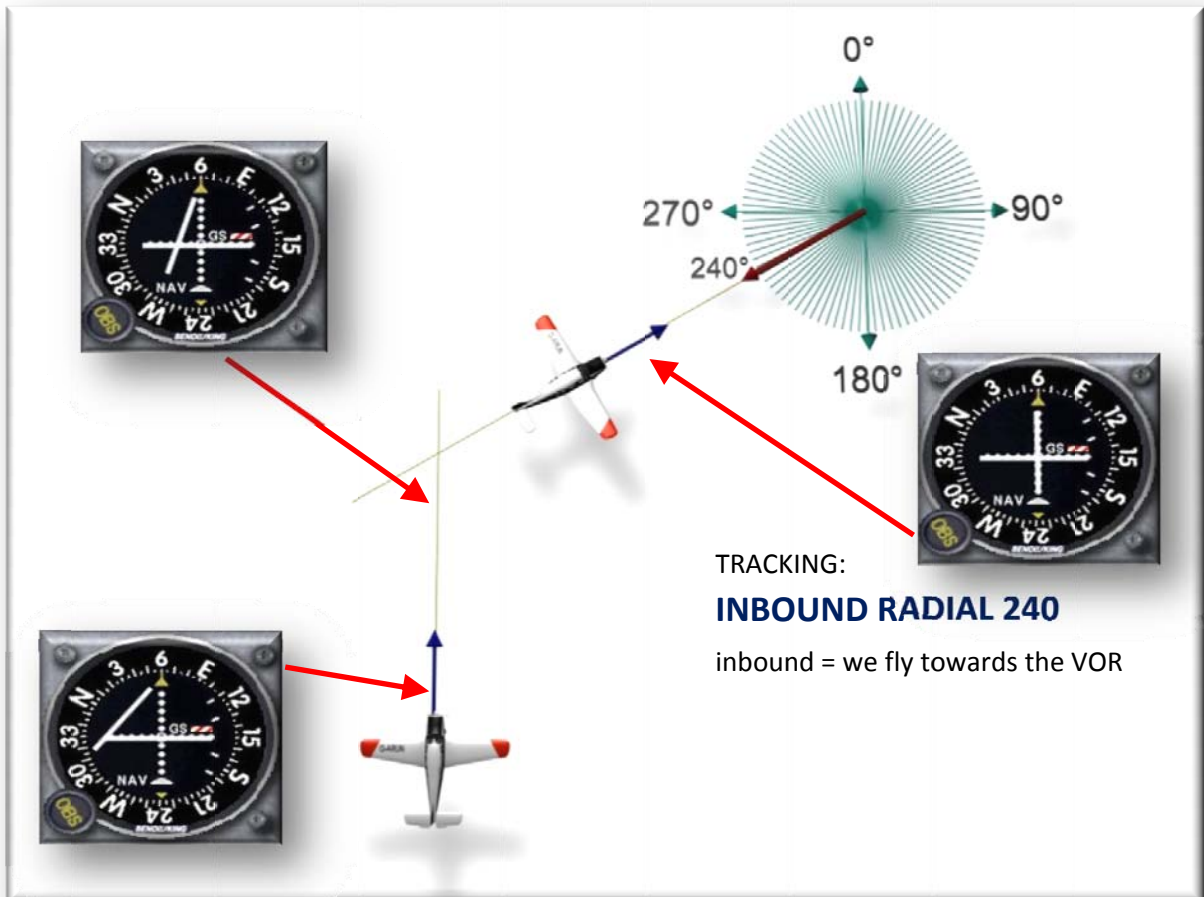
When you have HDG and NAV switched on in your autopilot. The aircraft will automatically intercept and turn onto the radial.



## Intercepting INBOUND RADIALS

The VOR station is always sending 360 signals OUTWARDS... so how can we fly INBOUND then??

Now this is the trick ...if we want to fly **INBOUND radial 240** we **add or subtract 180 degrees on our OBS setting**. So instead of setting COURSE 240 we set COURSE **060** ( $240-180=060$ )



Try to pick up the radial manually !

When you have HDG and NAV switched on in your autopilot. The aircraft will automatically intercept and turn onto the radial.



Therefore ...listen very closely to the instruction of the ATC...does he say:

intercept **OUTBOUND** radial 240?? we set our OBS on 240

intercept **INBOUND** radial 240?? we set our OBS on  $240-180 = 060$



## ***Intercepting RADIALS***

In the example above we have shown you the basic principles of how to use your instruments to intercept an inbound or an outbound radial. There are however more rules for intercepting a radial depending on your position in relation to the VOR. For instance...what to do if you are South East of the VOR and you need to intercept an outbound radial 360 which is all the way on the other side of the VOR in the North.

This is a topic we will discuss in the document : **SECTOR INTERCEPT**

### ***VOR approach***

Not all airports in the world have an ILS (instrument Landing System)  
But how can we land there then?

Alexandria airport (HEAX) doesn't have an ILS for runway 04.  
What we do know.....Alexandria has a VOR which is positioned almost exactly in line with the runway. We KNOW the runway heading is 037° so if we intercept the INBOUND radial 217 and set our course to  $217 \pm 180 = 037$  we will get pretty good aligned with runway 04 .

Note: we have to perform the descend ourselves !!! and the last minute corrections when we have a visual on the runway

