

Learning Goals Sector intercept

So far we have been using several navigation instruments for tracking a bearing or intercepting a radial. Let's go over them once more and have a look at all the different types before we start with the real deal.

ADF (Automatic Direction Finder)

On the automatic direction finder you will find 1 needle always pointing directly to the NDB station

Rotatable compass card



fixed compass card



CDI (Course Deviation Indicator)

The CDI works with a VOR and indicates if an aircraft is established on a certain radial. The desired radial can be selected with the OBS knob.

CDI1 / NAV 1 / Locator and GS



CDI1 / NAV 1 / Locator



CDI1 / NAV 1 / floating needle
Locator



RMI (Radio Magnetic Indicator)

The RMI has 2 needles.
1 for the NDB and 1 for the VOR.
The compass card rotates automatically with the heading of the aircraft.



HSI (Horizontal Situation Indicator)

Like the CDI, the HSI displays if you are established on the desired radial of a VOR. The HSI is capable of receiving and displaying an ILS signal. The Locator radial can be set with the COURSE knob.

HSI / NAV 1 / Locator and GS



HSI / NAV 1 / Locator and GS



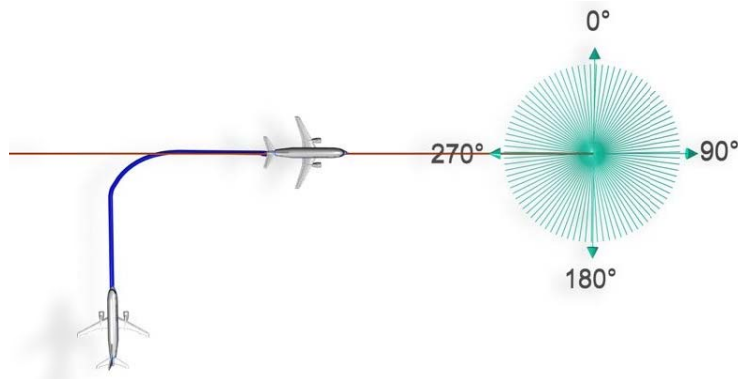
Oki we have gone over the various instruments. Now let's see how to use them properly.

Intercept a RADIAL

To fly a radial in a Boeing 737 or other aircraft, you must forget about your FMC. You cannot program a radial into a FMC.

Let's assume we are flying on a heading 360 to the North and we receive the instruction:

“From present heading, intercept the 270 inbound radial of CVO VOR”.



First, we must set the NAV1 to the correct frequency of CVO, which is 115.20

Then we use the Course selector to indicate what radial we want to fly. As we know now, you must fly R-270 inbound but that is not your ultimate heading.

We do the math for the inbound course: $270 - 180 = 090$ degrees

So you have to adjust the course selector to 090 degrees.

Switch on the LOC and your aircraft will then track the correct radial

You see that this is not too difficult. You only need to think carefully and have everything set correctly.

- ✓ NAV1 radio tuned to VOR
- ✓ COURSE set correctly
- ✓ LOC activated

Just always remember the following rules for setting your COURSE:

**An inbound radial is always flown with the course set to the opposite heading.
An outbound radial is always flown with the course set to the given heading**



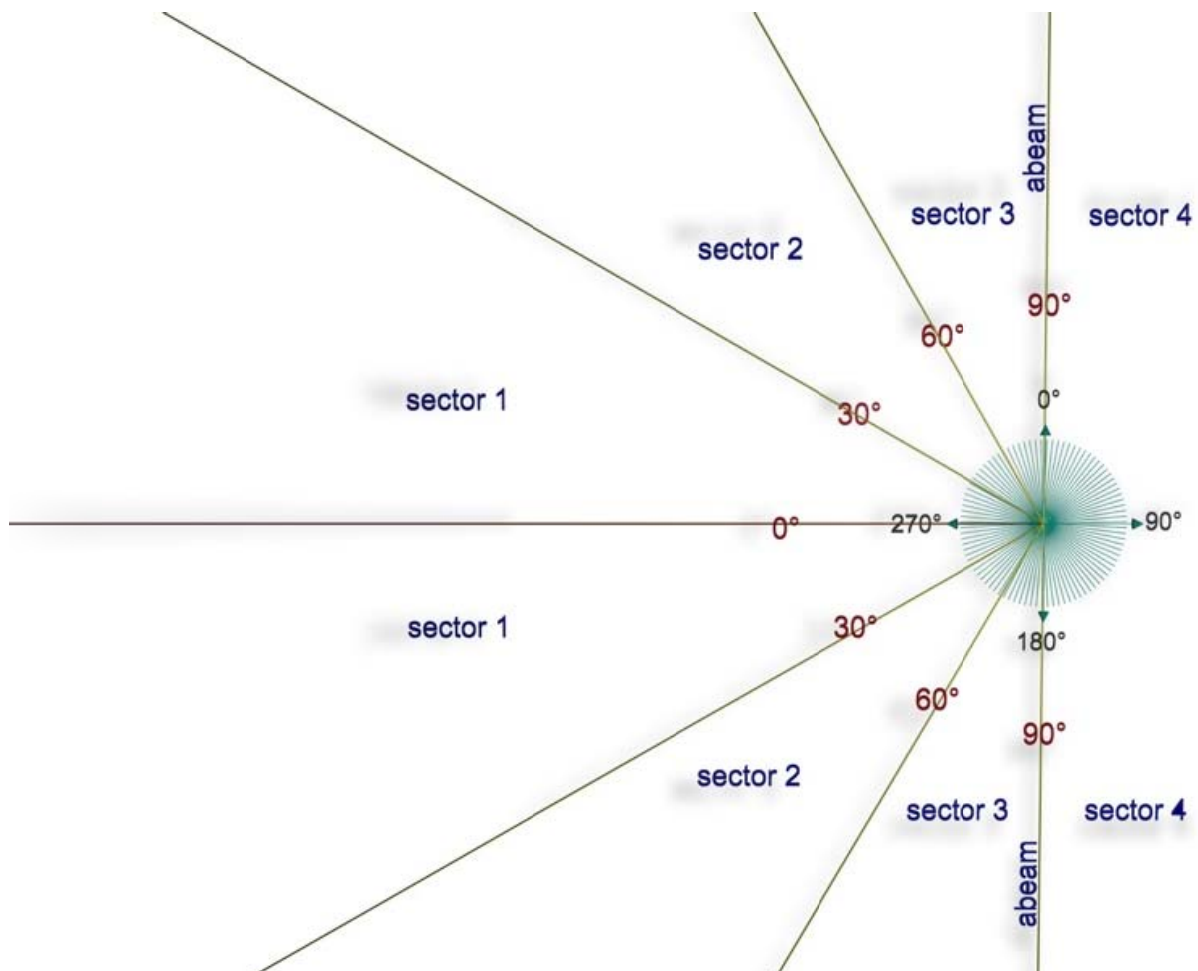
INTERCEPTING RADIALS INBOUND

Now we delve a little deeper into the correct way to intercept a radial. The way we have just flown it, is not really the correct way of a (good) intercept. We went from 360 degrees and then made the turn to 90 degrees (to CVO VOR).

The proper way is to start a short turn before intercepting depending on the amount of degrees that you should rotate your plane.

In the above example, we should have turned first 45 degrees to the right and then activate the LOC to intercept CVO. All this is done in order NOT to overshoot the radial

There are in total 4 sectors from which you have to decide how to make the proper INBOUND radial intercept. This means that you have to look very closely to your position in relation to the station.

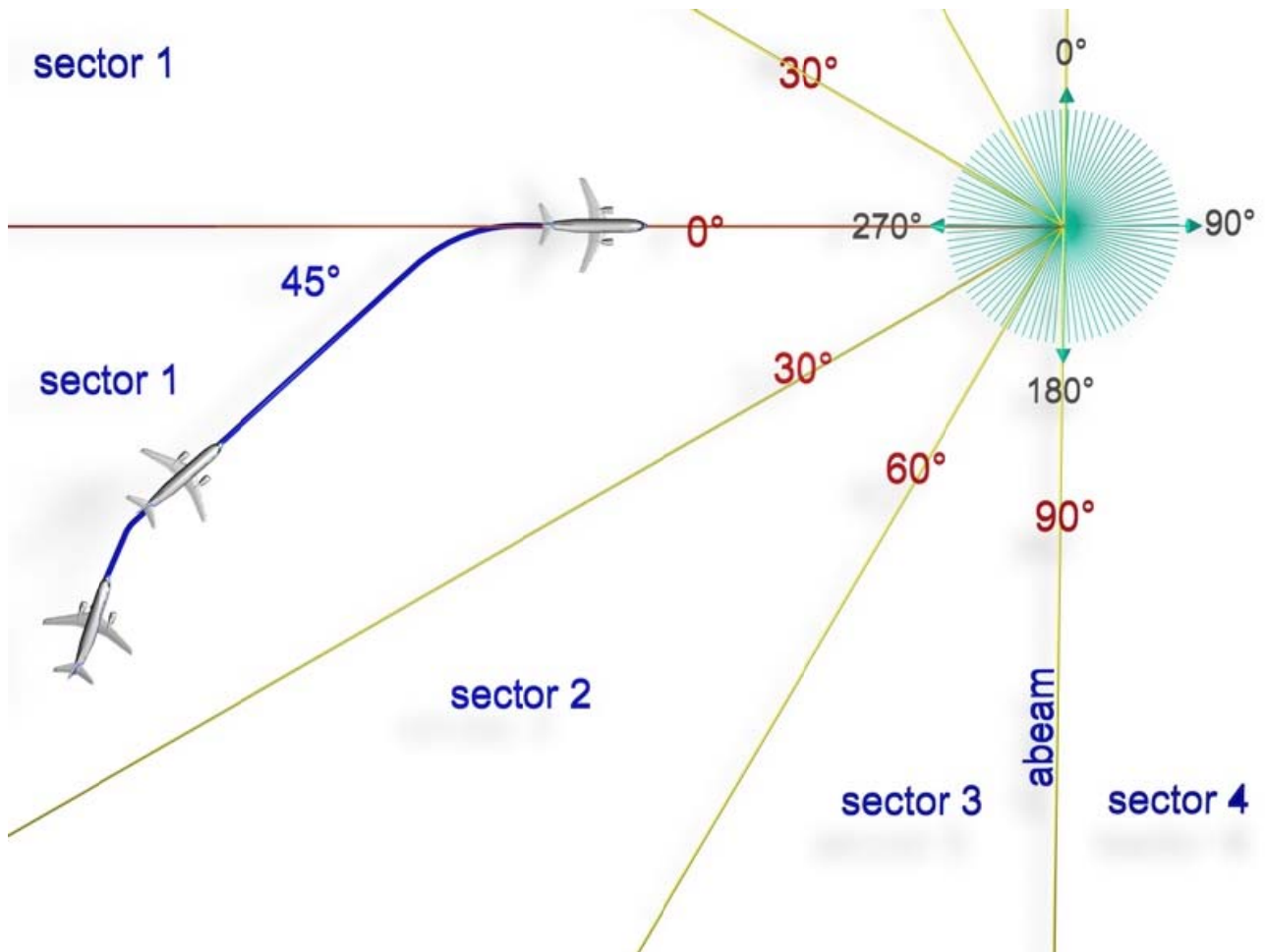


Lets go over the sectors step by step and see how to approach this



- **Sector 1 intercept**

Less than 30 degrees : 45 degrees intercept



In this example we are flying somewhere in sector 1

Make sure your course is set to $270-180=090$

step 1: position your aircraft in such way that you are intercepting the radial with an angle of 45°

NOTE:

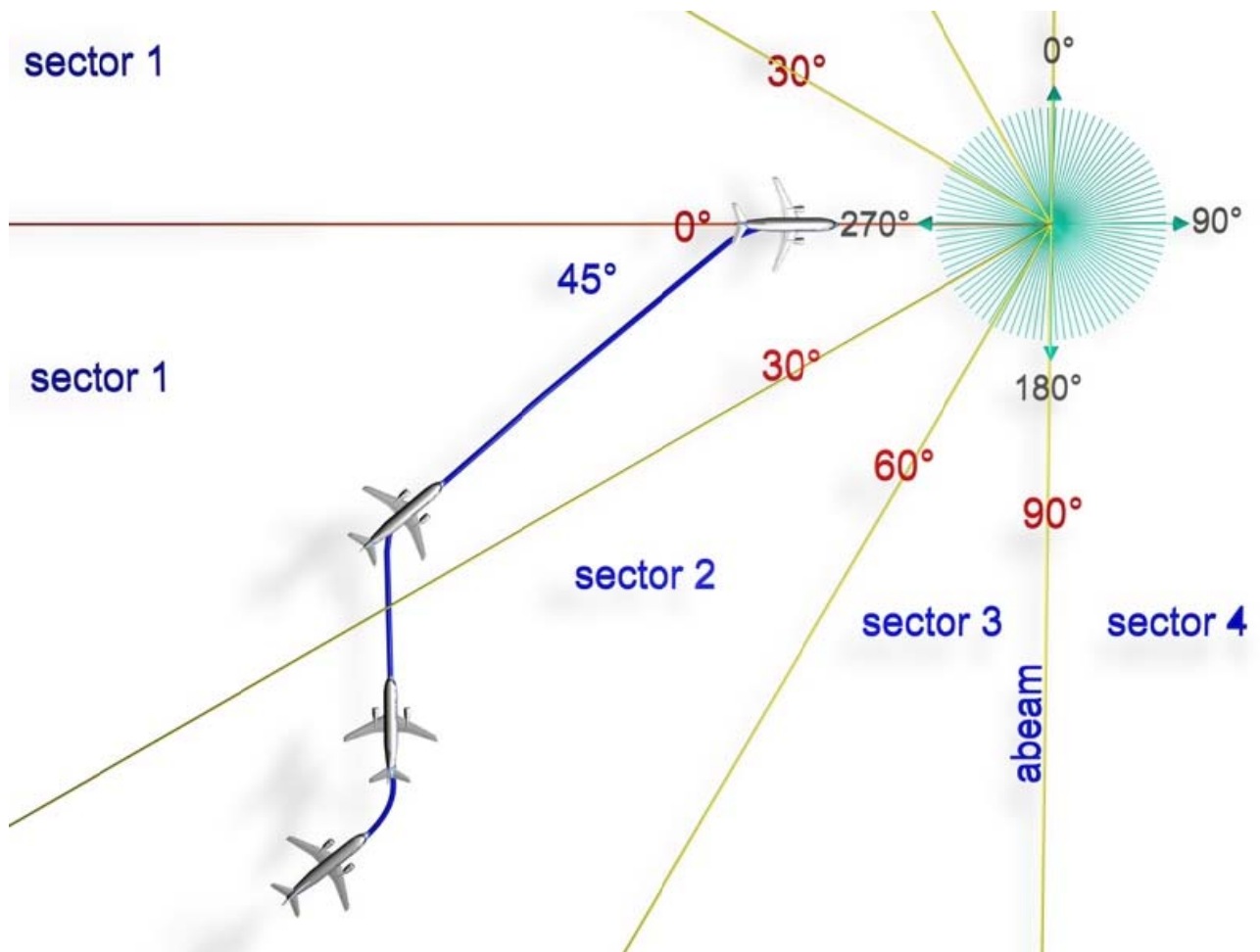
How do you know in which sector you are?

Set your NAV2 to CVO and monitor your QDR !!



- **Sector 2 intercept**

Within 30 and 60 degrees: 90 degrees until you reach Sector 1 and then 45 degrees to intercept.



In this example we are flying somewhere in sector 2

Make sure your course is set to $270 - 180 = 090$

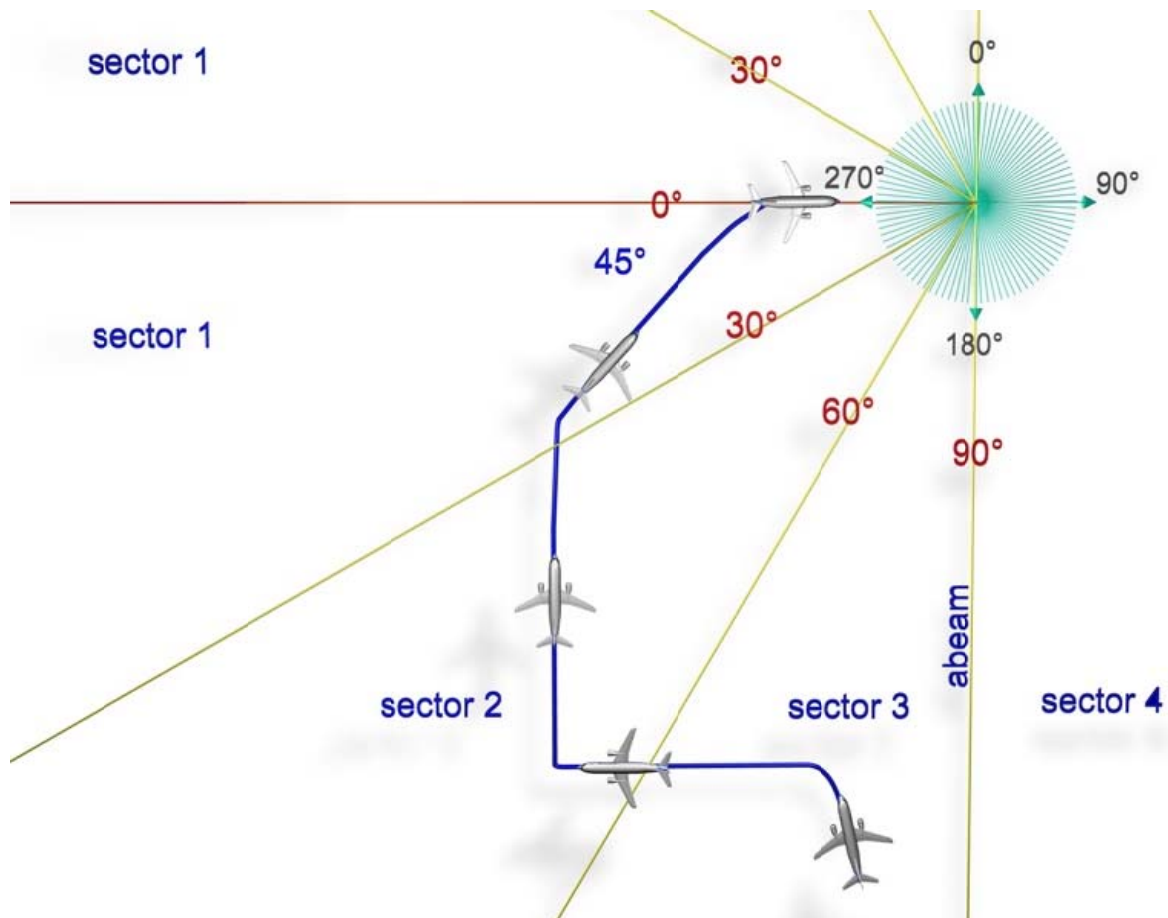
step 1: position your aircraft in such way that you are flying perpendicular to the radial. This means in our example you need to fly heading 360 until you reach sector 1

step 2: Once you reached sector 1 follow the rules for the sector 1 intercept. which means: turn right with 45° for the intercept.



- **Sector 3 intercept**

Between 60 and 90 degrees: fly reciprocal / parallel for 2 minutes .. then you look to see if you are in Sector 1 or 2 is .. and act accordingly.



In this example we are flying somewhere in sector 3

Make sure your course is set to $270-180=090$

Now this is a bit more tricky cause we are so close to the VOR. We need to create some distance for the final intercept.

step 1: Turn your aircraft to the opposite direction of the inbound course. Fly Parallel (away from the station) . Once you completed this turn, start timing for 2 minutes and check if you have reached sector 2. If not? continue your heading until you do reach sector 2.

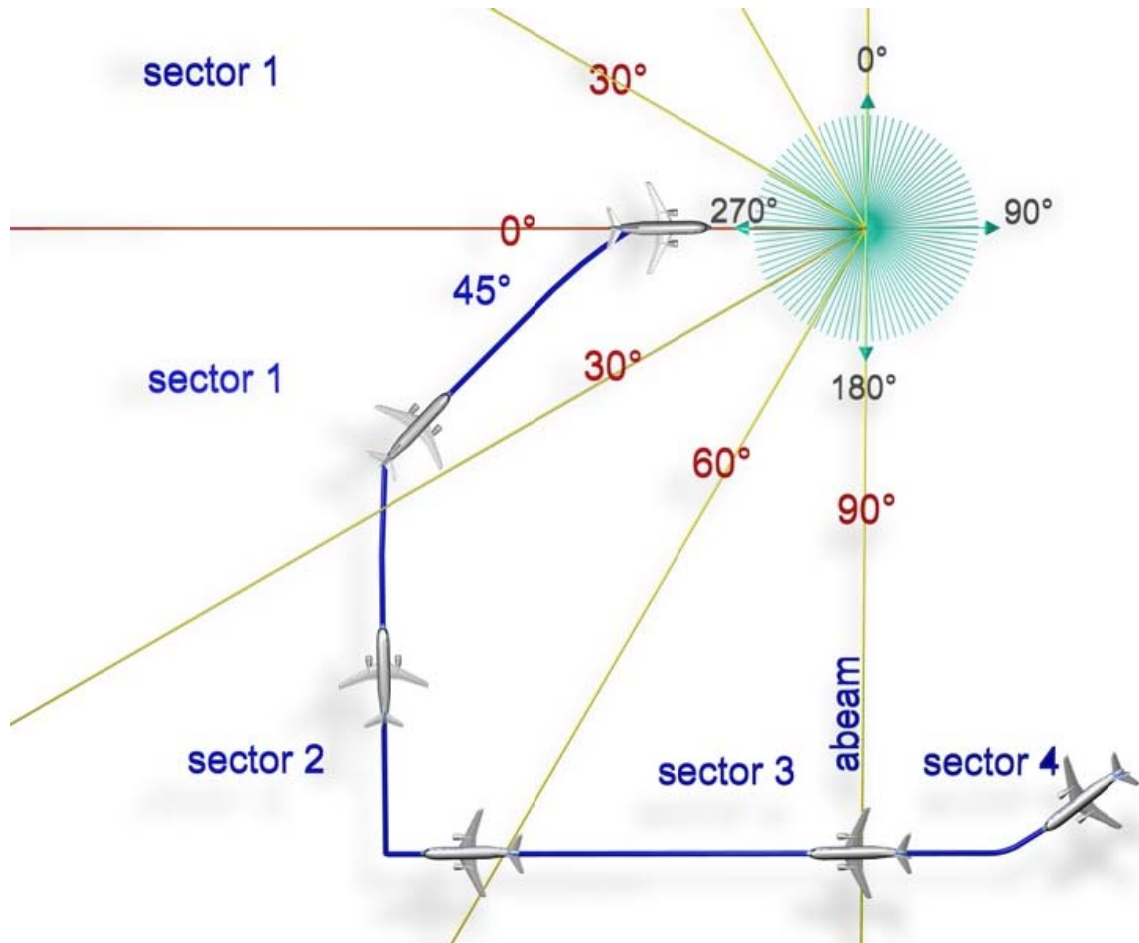
step 2: Once you reached sector 2 follow the rules for the sector 2 and make the turn perpendicular to the radial. This means in our example you need to fly heading 360 until you reach sector 1

step 3: Once you reached sector 1 follow the rules for the sector 1 intercept. which means in our example: turn right with 45° for the intercept.



- **Sector 4 intercept**

more than 90 degrees: reciprocal / parallel till abeam station .. timing than for 3 minutes .. look at situation to see whether you are in Sector 1 or 2... and act accordingly.



step 1: Turn your aircraft to the opposite direction of the inbound course. Fly Parallel (away from the station) heading 270 .

step 2: Start timing for 3 minutes once you are ABEAM of the station (you reached the very edge of sector 3). After 3 minutes, check if you have reached sector 2. If not? (you are still in sector 3) continue your present heading until you do reach sector 2.

step 3: Once you reached sector 2 follow the rules for the sector 2 and make the turn perpendicular to the radial. This means in our example you need to fly heading 360 until you reach sector 1

step 4: Once you reached sector 1 follow the rules for the sector 1 intercept. which means in our example: turn right with 45° for the intercept.

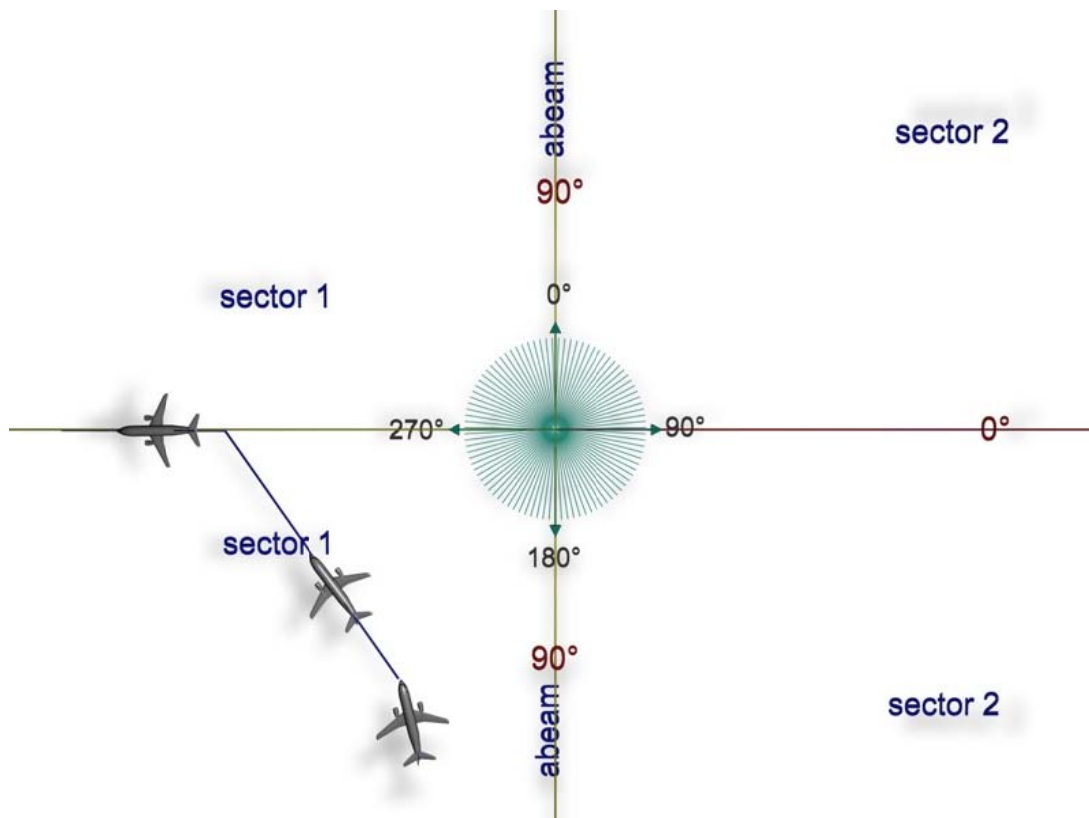


INTERCEPTING RADIALS OUTBOUND

There are in total 2 sectors from which you have to decide how to make the proper OUTBOUND radial intercept. This means that you have to look very closely to your position in relation to the station.

Sector 1 intercept

You are on the outbound side of the VOR.

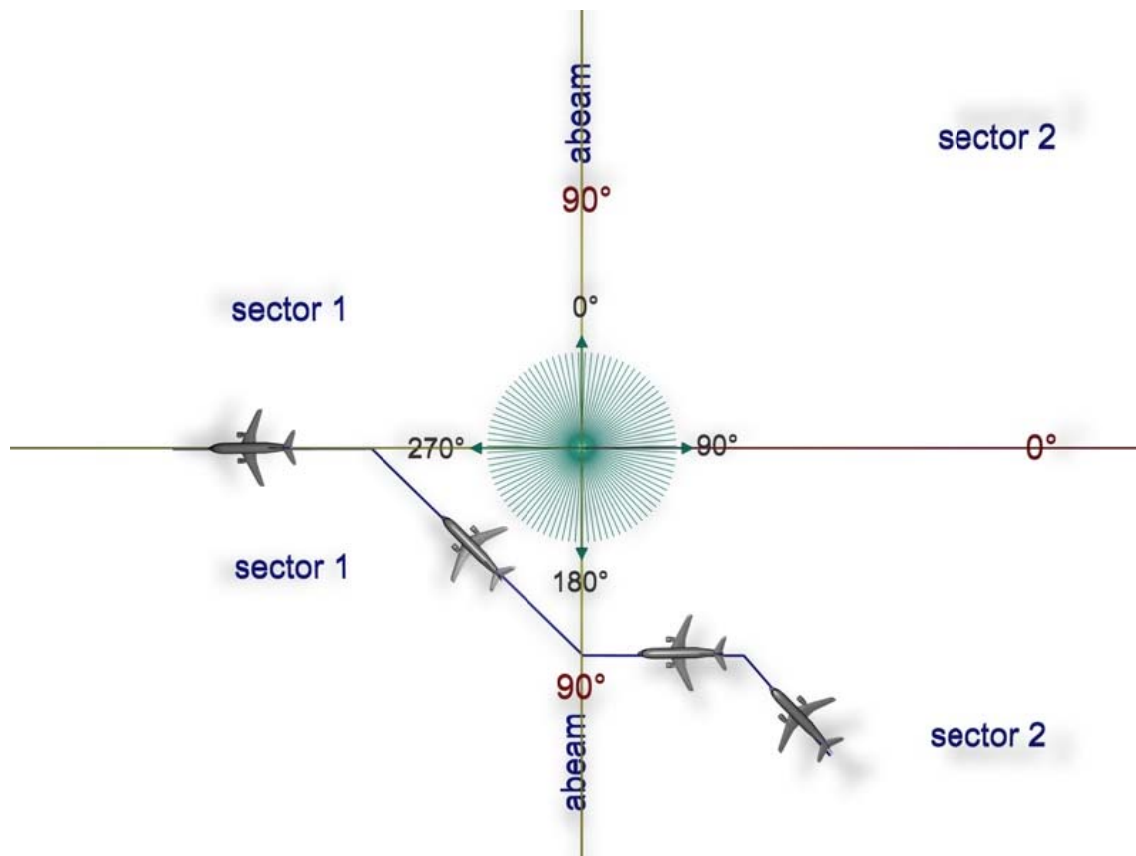


step 1: position your aircraft in such way that you are intercepting the radial with an angle of 45°



Sector 2 intercept

You are on the inbound side of the VOR.



step 1: Turn your aircraft in such a way that you will fly parallel to the outbound course

step 2: Once passed the abeam point of the VOR intercept the radial with an angle of 45°

RADIO COMMUNICATION, no misunderstanding

The last thing I would like to deal with is the communication within IVAO.

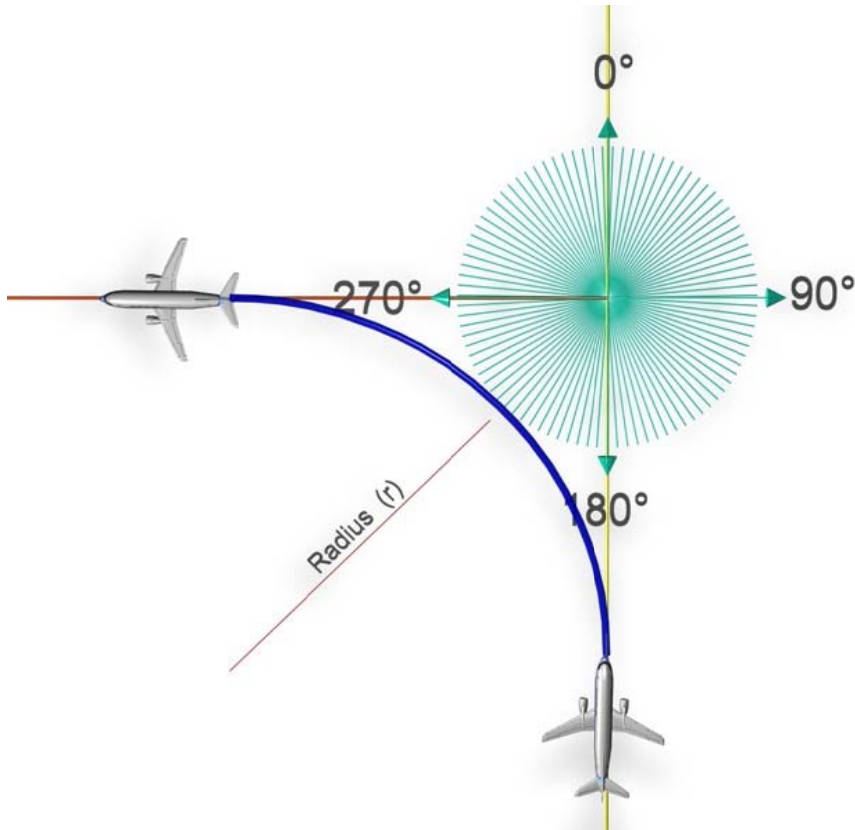
MSR606, left heading 270 and intercept radial 316 CVO.

Now we have a problem because is it Inbound or Outbound?

In the real world, there is an unwritten rule that says when there is no Inbound or Outbound mentioned by the ATC, then it is always the Outbound course. Again it is not a law and so it is good practice to ask the ATC whether the radial should be flown Inbound or Outbound.



Intercept from INBOUND to OUTBOUND



$$r = \frac{v^2}{g * \tan(\varphi)}$$

with:

r = radius [m]
 v = speed [m/s]
 g = 9.81 [m/s²]
 φ = angle of bank [°]

example:

our groundspeed v = 250 knots
 with 1nm/h = 1.852 km/h v = 463 km/h
 v = 128.6 m/s

gravity constant g = 9.81 m/s²

Angle of bank φ = 25 °

will result in a radius of: r = 3.6 km
 r = 1.9 nm

so....in this case we would need to start our turn 2 nm from the VOR



How to do this in practice?

In midflight you don't have the time or the means to quickly calculate your radius, so...as long as the VOR is not a mandatory overfly point you can do exactly the same as your FMS would do..anticipate the turn.

The moment of starting the turn depends on your speed and bank angle.
A higher speed or a smaller angle of bank requires you to start the turn earlier.

Anticipate on the turn by looking at: How sharp is the angle I have to fly. The sharper the turn, the earlier you need to start.

Did you start too early? just roll out on an intercept heading to intercept the new outbound radial with 45 degrees like you would normally do.

