ADF and VOR

What is the ADF

-The Non- Directional Beacon [NDB] is a simple radio transmitter designed to produce a stable radio wave which follows the curvature of the earth's surface [a ground wave]. The wave is transmitted with equal strength in all directions i.e. non-directional. NDBs operate in the low to medium frequency bands at around 200 to 400 khz. The airborne component which receives this ground wave is called Automatic Direction Finding[ADF] equipment. Because the ground wave follows the earth's surface, the range of the equipment is not limited to line of sight, but varies with the power of the transmitter and the nature of the surface. Ground wave range is best over water and least over dry sandy country. The rated coverages of NDBs vary from as little as 30 nm for low power transmitters, up to a few hundred nm for major airports.

- Commercial broadcast stations may be used to obtain ADF bearings, however care should be exercised in identification since some broadcast stations are merely relay stations for a signal that originates elsewhere. CASA exercises no control over the management of commercial broadcasting stations, and therefore offers no NOTAM service on them. Though they do regard them as possibly helpful for navigation. Details on BROADCAST STATIONS are found in ERSA NAV/COM (around page 3).

-several factors degrade the performance of the ADF system

-Night Effect: Direct [sky] wave interference with the ground wave, especially at night.

-Thunderstorm Effect: Radio signals generated by thunderstorms affecting the net signal received by the ADF receiver.

-Co-channel Interference: Caused by other transmitters in the vicinity transmitting on the same or adjacent frequencies. Efforts are made to prevent this when frequencies are allocated.

-Mountain Effect: Caused by reflections of the NDB signal from mountains. This error decreases with increased height.

-Coastal Refraction: Distortion of the signal as the ground wave passes from one type of surface to another such as land to sea.

-Quadrantal Error: Interference cause by the structure of the aircraft interacting with the incoming signal.

-as usual with radio navigation aids, you must work to build up a “situational awareness” using the information supplied by the aid.

What does the ADF do?

-The ADF points a needle on a relative bearing to the tuned station

-A “**fixed card**” ADF display has a compass rose fixed in place with 000 aligned with aircraft axis. So all bearings shown are relative to the axis of the aircraft.

-A "**moving card**" ADF display allows the compass rose below the needle to be rotated by the user. When the heading is set as the bearing reference, the ADF needle shows bearing to the aid directly without any need for mental arithmetic.

-there are several variations but a popular one is a slaved DG which keeps the compass rose of the ADF indicator aligned with aircraft heading, allowing it to show bearing to station without any manual setting. This arrangement is referred to as a **Radio Magnetic Indicator** (RMI).

-No matter what system is used the **ADF needle ALWAYS shows the relative bearing** of the station to the aircraft axis.

A few scenarios, try these..

HDG (M)	ADF (fixed card)	BRG (M)
000	135	
180	325	
270	090	
090	090	

What is the VOR?

-A VHF navaid which gives specific track guidance. These selectable tracks are called radials.

-several factors degrade the performance of the VOR system

GROUND STATION ERROR: A systematic error, usually less than 2°, associated with the actual installation of the ground station, i.e. the transmitter, aerial earth systems and the power supply. I don't know what a pilot is supposed to do about it.

SITE EFFECT ERROR: An error due to the topographical features surrounding the ground station and affecting the signal. At the time of commissioning the VOR, the combined ground station error and site effect error must be less than 3°.

TERRAIN EFFECT: This error is caused by the radial being reflected or 'rippled' as it passes over rough terrain between the station and the aircraft. It appears in the cockpit as oscillations of the CDI or RMI needle. These are referred to as 'bending' when the oscillations are slow and 'scalloping' when the oscillations are rapid. The magnitude of these oscillations normally does not exceed 2°

AIRBORNE EQUIPMENT ERROR: Caused by the various components of the VOR installation in the aircraft, this error is less than2° in a well designed system.

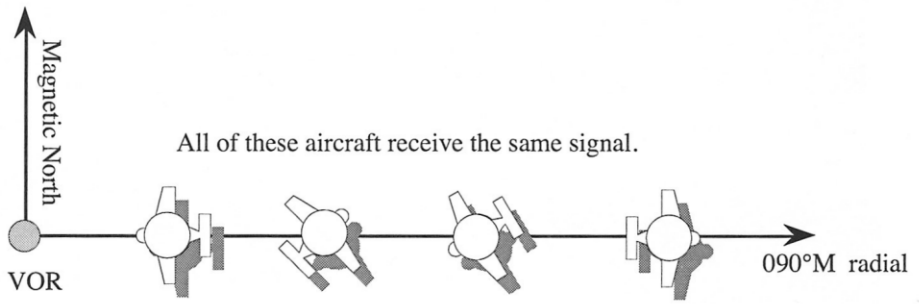
VERTICAL POLARISATION EFFECT: VOR transmissions are horizontally polarised, however signals reflected from terrain can become vertically polarised. When the aircraft is banked, this can cause some abnormal movement of the CDI or RMI needle.

AGGREGATE ERROR: This is the algebraic sum of all the above errors. It is almost always less than 5°. Remember the VOR does not pretend to be a precision aid, however it's general accuracy is good and aggregate errors of more than 2° are rare.

THE VHF OMNIDIRECTIONAL RANGE [VOR]

The VOR provides magnetic bearings from the ground station by transmitting VHF radio signals in such a way that the characteristics of the signal change through 360° around the transmitter. This produces 360 'radials' each with its own unique characteristics. The signal transmitted to the east of the station i.e. along the 090 °M outbound track, or radial, cannot be received from any other direction. Whenever the aircraft's equipment receives that particular signal it fixes its position as being somewhere on the 090 radial i.e. somewhere east of the station. Note that the actual heading of the aircraft will have nothing to do with the signal that is received [Fig 5.7].

Fig 5.7



Once it has identified the signal being received, the instrument compares it with the direction the pilot has set on the Omni-Bearing Selector [OBS].

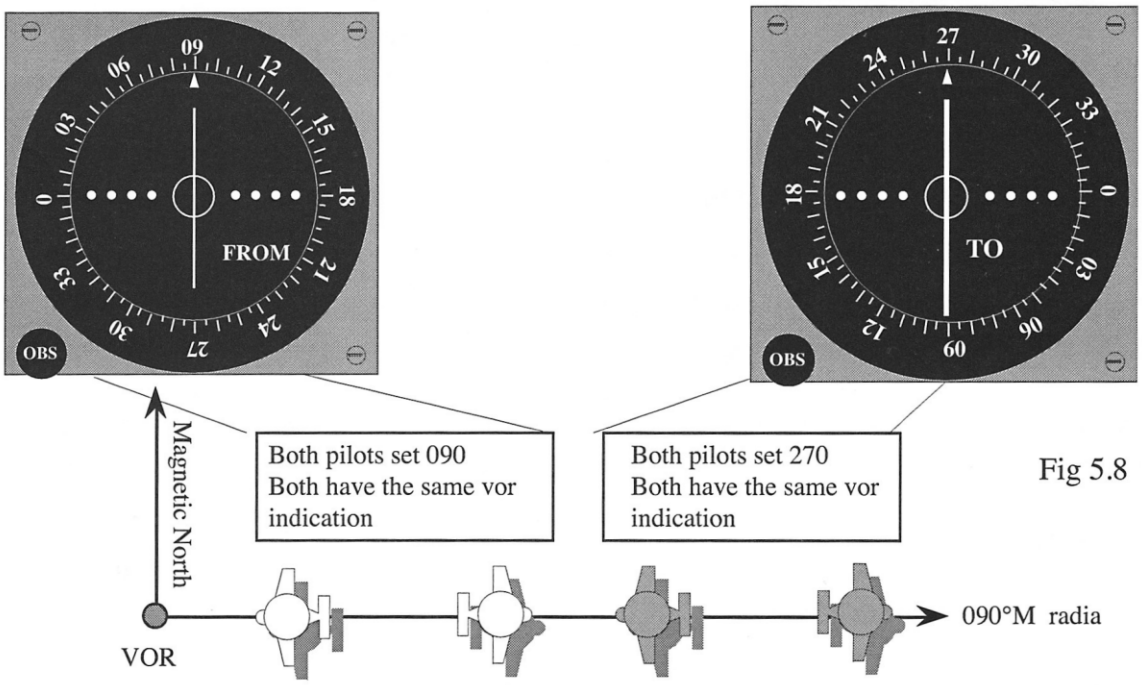


Fig 5.8

If the OBS setting is the same as the signal being received, the Course Deviation Indicator [CDI] will centre to indicate that the aircraft is on the selected track and the flag will show FROM to indicate that flying that OBS setting will take the aircraft away from the station. If the OBS setting is the reciprocal of the signal being received, the CDI will centre and the flag will show TO to indicate that flying that OBS setting will take the aircraft towards the station. Once again, the indications are independent of the aircraft's heading [Fig 5.8].

The radials are defined by the characteristics of the radio signal received in each direction. Each radial is named by its *outbound* direction. The aircraft tracking 270 °M towards the station in Fig 5.7, are still said to be on the 090 radial. The pilot is not interested in radials during normal navigation, he/she simply sets the *magnetic track* he/she wants to fly and the instrument automatically indicates whether that track will take the aircraft TO or FROM the station. It is only when communicating with ATC or other pilots that the radial is considered. For example, the aircraft tracking 270 °M to the VOR in Fig 5.7 would report its position as 'inbound on the 090 radial'.

If the OBS setting is to one side of the signal being received, the CDI will be displaced from the centre. The edge of the centre circle, and each white dot represents 2° of displacement from the selected track. To intercept the selected track, the pilot simply turns towards the needle. These are said to be 'command indications'.

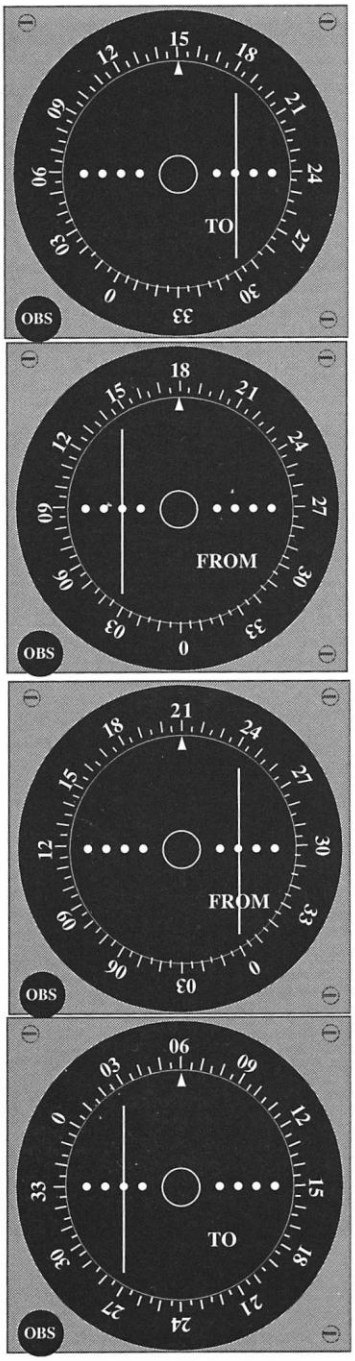
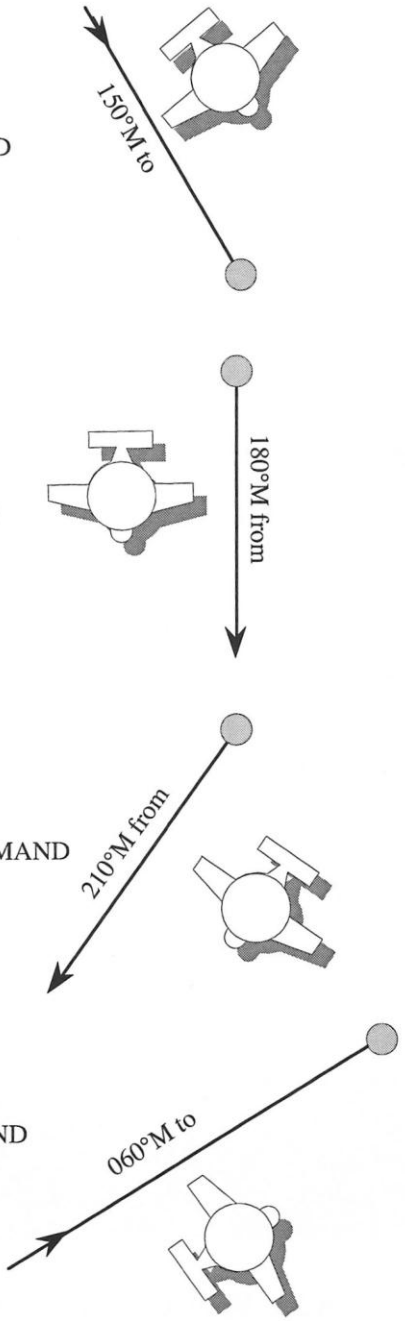
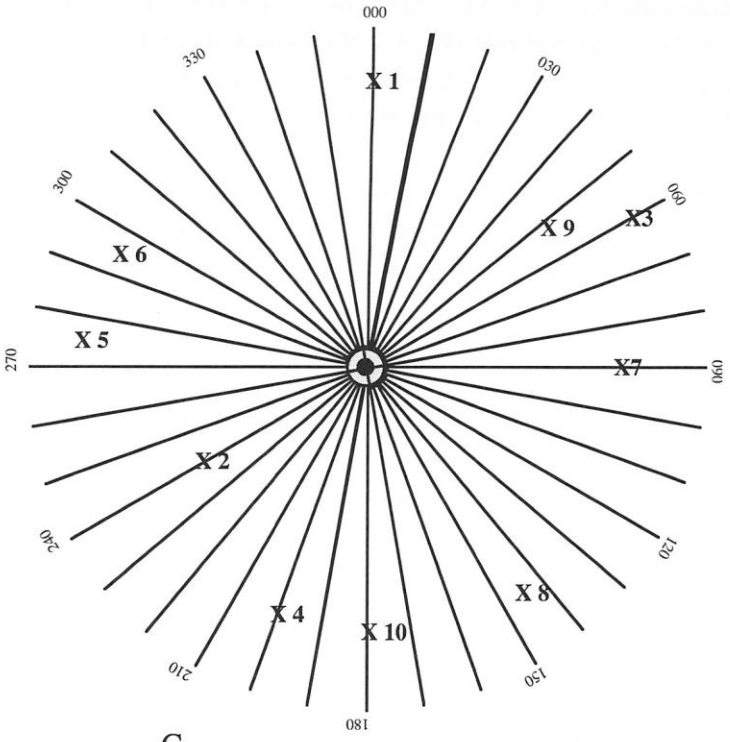


Fig 5.9

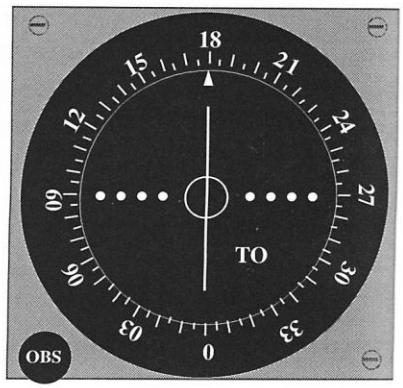


EXERCISE

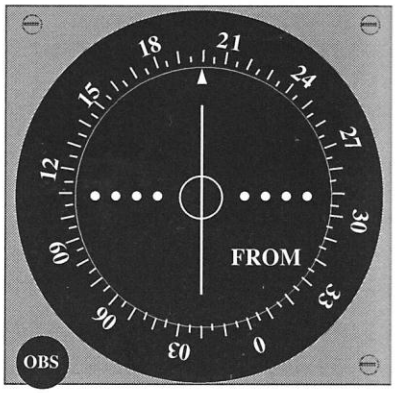
Match the instruments with the locations shown below.



C



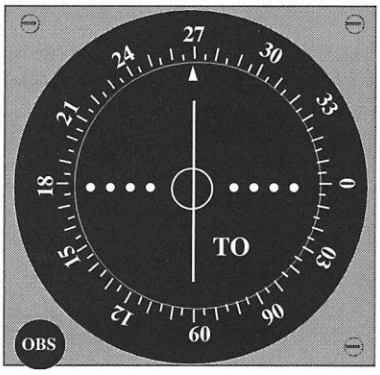
A



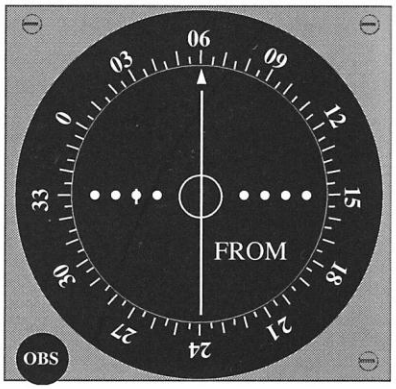
B

D

F

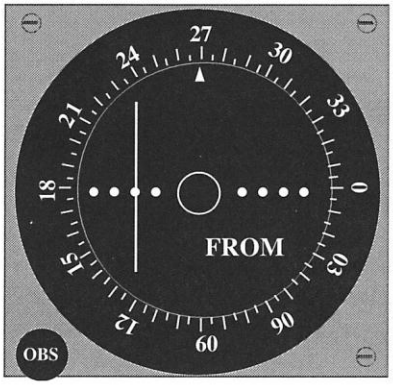


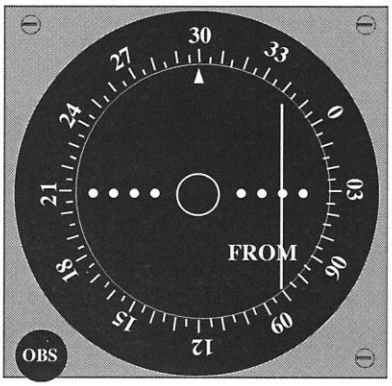
G

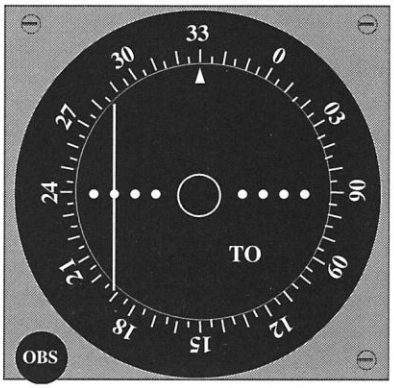


H

E







Solution A,X1 B,X4 C,X2 D,X7 E,X3 F,X5 G,X6 H,X8,

INTERCEPTS WITH THE VOR.

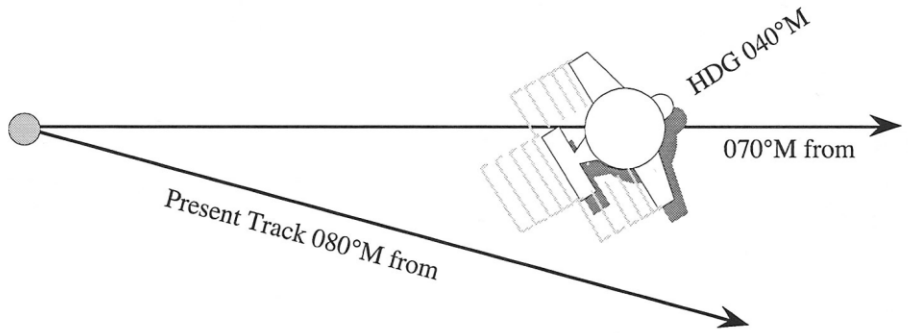
Once you have mastered the art of orientation, the mental processes involved in intercepting a given track to or from the station are the same no matter which type of navigation aid is used. Here are some examples using the VOR, but remember the same questions could be put with the Fixed-Card ADF or the RMI.

EXAMPLE 1

The indications of a VOR are:

OBS	080
CDI	centred
FLAG	FROM

What HDG is required to make a 30° intercept of the 070 °M outbound track from the VOR?



EXAMPLE 2

The indications of a VOR are:

OBS	240
CDI	centered
FLAG	TO

What HDG is required to make a 30° intercept of the 250 °M inbound track to the VOR?