UNIT 7 - AIR NAVIGATION

GENERAL NAVIGATION

TYPES OF DIRECTIONS AND REFERENCE DATUMS

Below is a table of the types of directions and their respective reference datums:

Type of Direction	Suffix	Short Form	Reference Datum
TRUE	(T)	045T	True North - the direction of the meridian running towards the North Pole
MAGNETIC	(M)	090M	The magnetic lines of force from the Earth's magnetic field. The North Magnetic Pole is located in Northern Canada and is where the magnetic lines of force point vertically downwards.
COMPASS	(C)	180C	Is the horizontal reference of a magnetic compass needle. This is a combination of compass error and the magnetic field of the aircraft. All aircraft must have a calibrated compass correction card.
GRID	(G)	280G	Referenced to a meridian on a map.
RELATIVE	(R)	010R	The horizontal direction of the longitudinal axis of the aircraft in relation to another object or aircraft.

Abbreviated forms are used when calculating directions, for example if we were to write 045° True North, this can be abbreviated to "045T" or 280° from Grid North, this would be "280G".

RELATIONSHIP BETWEEN TRUE AND MAGNETIC REFERENCES

The difference between the True and Magnetic North is called Variation (V), expressed in degrees. Variation is easterly if the Magnetic North is east of True North, and the opposite for westerly variations. Variation also changes with time due to the fact that the magnetic fields move slowly and irregularly; luckily, this change is small. Charts are updated if there are significant magnetic variations.

We can show this relationship in Figure 3 below, where we can find our magnetic direction based on the datum of true direction plus (or minus) the variation. In order to remember whether to add or subtract variation for east or west, we can use the rhyme:

"East is Least – West is Best"

The following formula can be used to determine true heading from compass and vice versa:

TVMDC (True – Variation – Magnetic – Deviation – Compass) or

CDMVT (Compass - Deviation– Magnetic - Variation – True)

Remember that when determining compass from true (TVMDC), we apply the correction "east is least (-)/west is best (+)" for variation and deviation and the reverse signs when calculating true from compass (CDMVT):

TVMDC (Compass from True)				
True	Variation -E / +W	Magnetic	Deviation -E / +W	Compass
350°	(+) 5°W	355°	(-)1°E	354°
CDMVT (True from Compass)				
Compass	Deviation +E / -W	Magnetic	Variation +E / -W	True
354°	(+)1°E	355°	(-) 5°W	350°

For example, we are required to find the compass heading of a route between two airports. With our navigation chart, we plot a line on a chart between the airports, which give us a True Track of 350° relative to True North.

Next, we need to determine the magnetic variation. we find that the variation closest to our route of flight shows "5°W" (these lines are usually shown as dashed lines in blue or purple on navigation charts) and are called *isogonals*[1].

As we are required to determine Compass from True (TVMDC), we apply the formula as in the table above to determine magnetic track:

350° TH + 5°W VAR = 355° MH

Let's assume that there is no wind correction needed so therefore, from our magnetic track (heading), we need to determine the actual compass heading by applying a deviation correction. The next step is determining the compass heading the crew will need, in order to steer by consulting the compass card which shows 1°E Deviation:

355° MH - 1°E DEV = 354° C

Therefore, we will need to maintain a compass heading of 354° to maintain our track on the map.

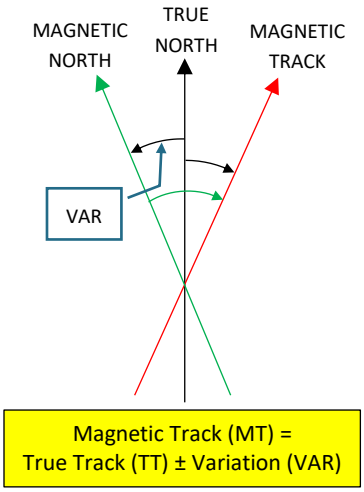

Figure 1 - True and Magnetic North

Heading and Track

See the example on the right. The aircraft is supposed to fly from point **A** to **B** on a True Heading of North. The wind is from the west at 30 knots. If we were to keep the same heading, without compensating for any wind correction, the aircraft would drift to the right as shown, on a true track of approximately 020° to point **C**. The difference between the true track and true heading is called drift angle, and the distance between B and C is called drift.

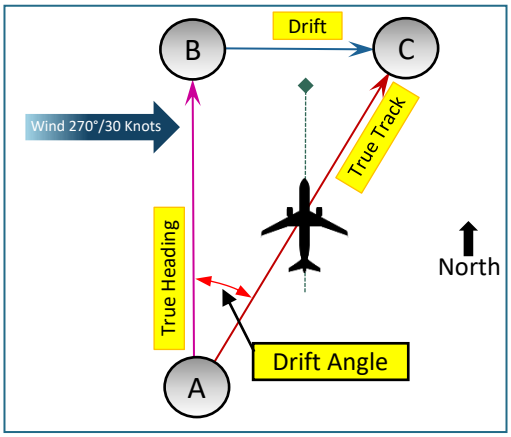

Figure 2 - Heading and Track

Therefore, in order to fly from A to B, we would need to either double our drift angle to the left until we intercept the desired track or course[2], then halve the correction to maintain that course. Frequent heading corrections must be made in order to maintain a set track or course in the presence of wind. The angle to correct for wind is called Wind Correction Angle or WCA and is expressed in degrees left or right.

True and Relative Bearing

Remember that for navigational purposes, it is best to use True North as your primary working datum using the CDMVT/TVMDC formula above. The following figure reflects this concept.

For example, if we have an aircraft flying a true heading (TH) of 125°, and we want to find the true bearing (TB) to fly to a beacon that has a Relative Bearing (RB) of 30 degrees to the right of the aircraft.

The formula for determining TB, RH or RB is given by the following relationship:

TB = TH + RB

And can be solved for TH or RB by simple re-arrangement of the formula:

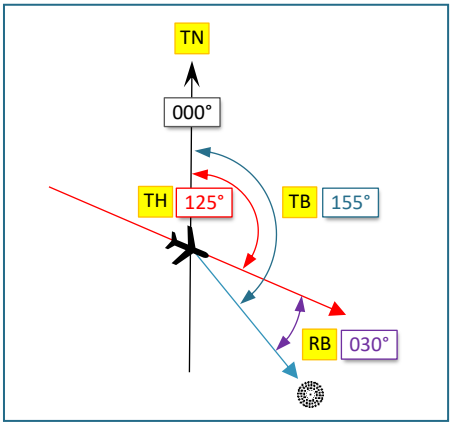

Figure 3 - Relationship between TH, TB and RB

[1] Isogonals are lines joining points of equal magnetic declination (variation).
[2] The expression "Course" is the same as intended track in certain environments.

RB = TB – TH *or* TH = TB - RB

By using the formula above, we find the True Bearing (TB) of the beacon to be TB = 125T + 30 = **155T**.

Radial and heading

Radials are used when navigating using ground-based radio aids such as VORs, NDBs or TACANs. The directions of radials are always in magnetic referenced from the radio aid. The radial is always a fixed reference and is not related to the heading. An aircraft can be on a particular radial from the station and can be on a completely different heading.

It must be mentioned that an aircraft tracks either TO (inbound) or FROM (outbound) on a radial from a particular navaid. Instructions from ATC can be of the type:

"Airline 123, from present heading, intercept the track inbound to the 109° radial FROM Torino VOR".

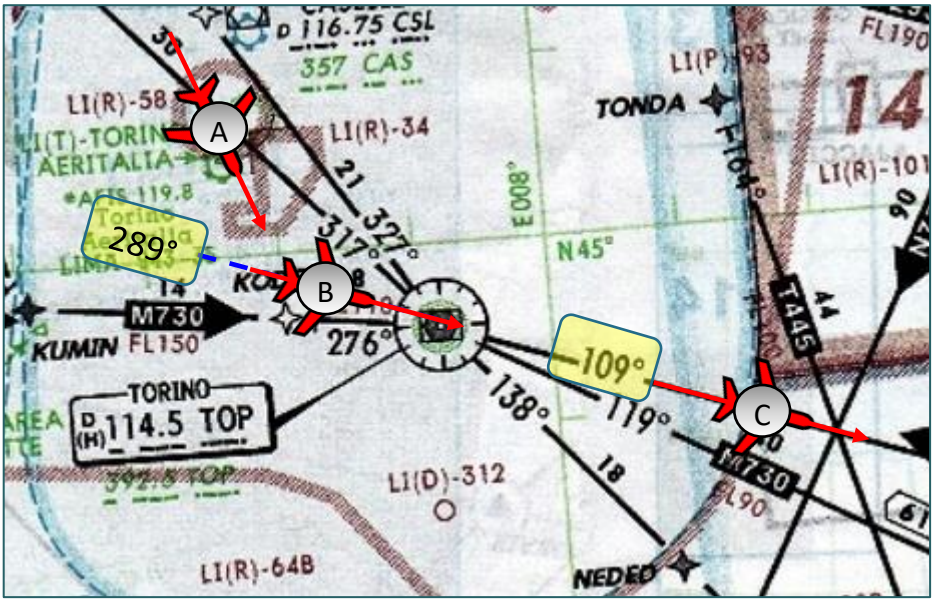

Figure 4 - Radial interception

In this case, the radial that needs to be intercepted is the 109° radial FROM the VOR. If the aircraft is located NW of the station (Position A), the 180-degree reciprocal of the 109 radial is 289°. The aircraft then flies an initial heading of say 145° for intercepting. Once the reciprocal radial is intercepted (Position B), the aircraft turns to a heading of 109° inbound to the station. Once the aircraft overflies the station, the aircraft will then fly along the 109° radial outbound or FROM the station (Position C).