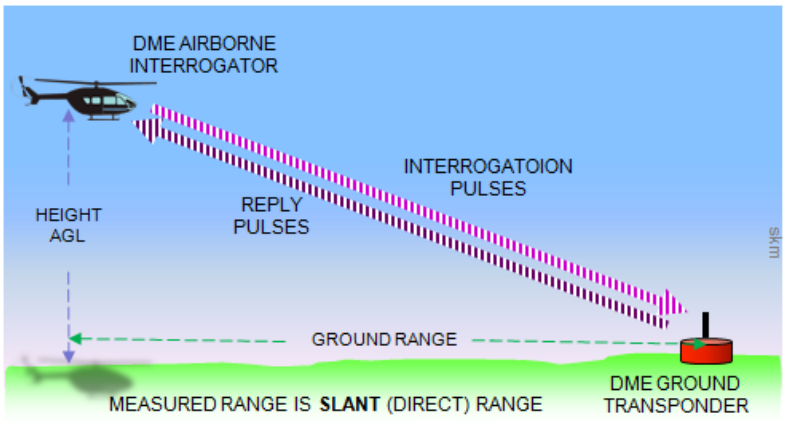
DME

Distance Measuring Equipment operates on principle of secondary radar. A ground beacon continuously responds to trigger pulses received from airborne interrogators. Airborne equipment receives all responses, determines the ones related to its transmissions and finds time duration between firing of interrogation pulses and corresponding reply pulses. This duration is displayed as slant (direct) range at the airborne equipment as distance from the ground station.

PRINCIPLE OF OPERATION. Basic principle of operation of DME is **Range by pulse** technique. An airborne equipment transmits pulse pairs in all directions on the receiver frequency of the ground transponder station. Ground station, activated by the interrogation pulses, transmits pulse pairs in all directions on the receiver frequency of the airborne equipment.



At the airborne equipment, time interval between transmission of interrogation pulses and reception of reply pulses is determined. It is converted to range in nautical miles and displayed on the indicator.

EQUIPMENT

Ground transmitter beacons of DME are co-located with VOR and ILS equipment at all major aerodromes and enroute reporting points. The system operates on frequencies between 960 MHz and 1215 MHz on the UHF band. Therefore, it can provide line of sight range as in the case of VOR. Each ground station transmits its unique aural Morse code identification signal comprising three letters.

Single DME ground station can respond to a maximum of 100 airplanes at one time before reaching saturation. Jittering (randomly changing) the airborne equipment's pulse repetition rate, ensures that it rejects the responses meant for other airplanes.

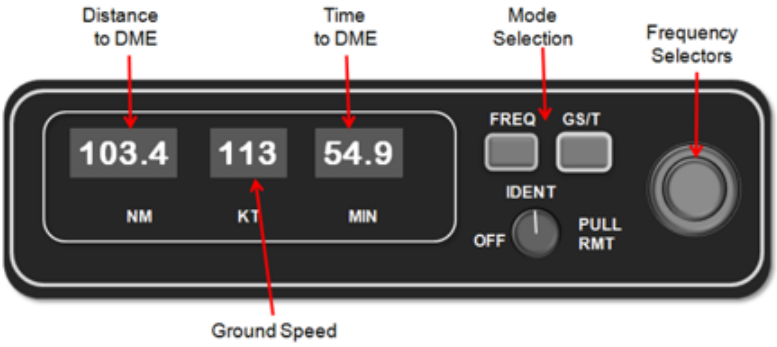
There are 126 channels available for civil use. Each channel using a unique paired set of airborne and ground beacon frequencies. The pairing has been formulated by ICAO and used as such throughout the world. Pilots need not know the exact frequency details, since the combination is automatically selected by his selection of a VHF frequency associated with either a VOR or ILS localizer transmitter. DME airborne equipment can also be used with military TACAN (tactical air navigation) system for range information. This system is not available in India.

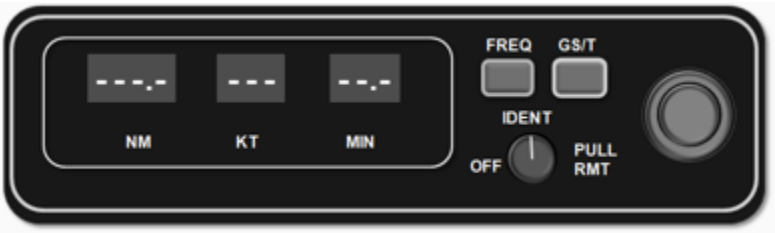
VOR/ DME PAIRING. When co-located, although operating on the different frequencies – VOR on VHF and DME on UHF, both navigational aids have same Morse code identification. However, the higher pitched one and with longer inter-spread is for

the DME, which is heard twice in a minute. Between the DME identifications, two or three identifications of VOR may be received. In case only one of them is heard, the pilot can discern from the pitch and number of times the identification is heard in a minute, which of the transmitters is operating.

ILS/ DME PAIRING. Now most localizers (track guidance component of ILS system) are paired with a DME located very close to landing threshold of the runway. This provides accurate and continuous distance information during an instrument approach to land. The identification Morse code in such cases generally consists of four letters – usual there, prefixed by an 'I'. Examples for Delhi and Mumbai are: IPLM, IDLH, IDGM, IDMR, IDEL, ISCZ, IBBY, IBOM. Many ILS instrument approach procedures commence with flying a constant distance arc based on DME.

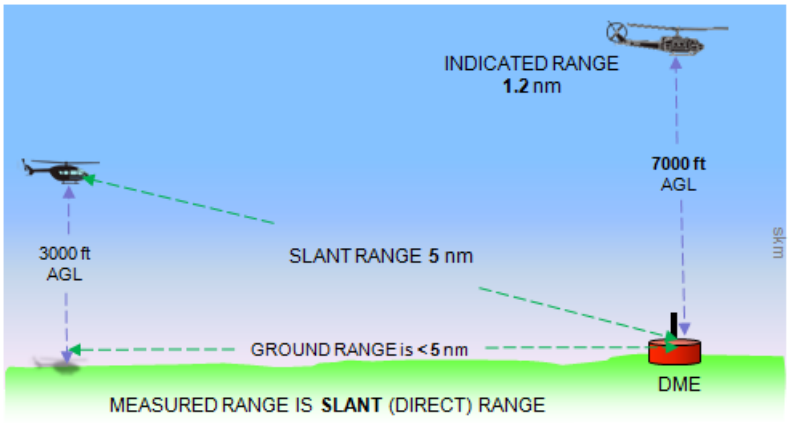
DME CONTROLS AND INDICATORS. Typical equipment consists of a combined control unit and an indicator. The indicator displays distance in nm along with speed and time to fly to the beacon. The DME frequencies on this control unit can be locally selected by combination of two concentric knobs and associated buttons. Selection of paired VOR or ILS frequency by the pilot on the control unit automatically selects the paired UHF frequencies of the DME. Remote selection at VHF-Nav set also is provided, which makes quick changeover possible between two stations. When a steady distance value is obtained and displayed, DME is said to have a **lock on**. Initially, while the interrogator is searching for the range and if the signal is reduced below acceptable level, the indicator displays dashes in place of the readings as shown in the figure. If signals are lost for a short duration of few seconds, with memory circuit equipment continues to display changes in the respective values based on the latest rate of change computed and stored.





The indicator displays the groundspeed as rate of closure of the helicopter with the ground station based on rate of change in the DME range. If the helicopter is either tracking in or out of the beacon this would be same as the ground speed – very useful information for pilot navigation. Some indicators also display time to station in minutes considering the closure rate as ground speed. It must be remembered that indications, both the ground speed and the time to the station will be in error if helicopter is not tracking in or out of DME station.

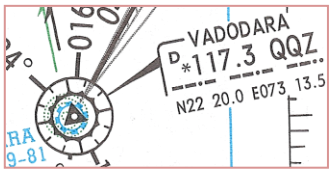
SLANT vs GROUND RANGE. It is pertinent to note, flying overhead DME station will not indicate zero range, but the height above ground as the distance to beacon. As a thumb rule, the error is insignificant, if slant range is 1nm/ 1000 feet of height above ground. That is to say at 5000 feet agl beyond 5 nm, the difference in he two ranges is negligible.



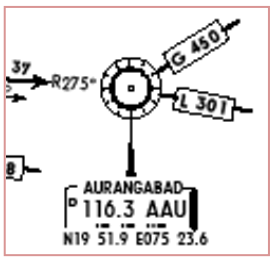
An ILS paired DME is designed to provides precise **ground ranges along the runway centre line** from the touchdown. It means that distances provided in other directions from such a DME are in slight error.

CHART DEPICTION OF DME STATION. Some examples of different ways the DME is portrayed on Jeppesen charts are illustrated here.

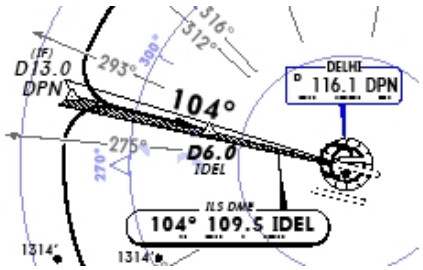
Enroute Chart
Co-located VOR and DME



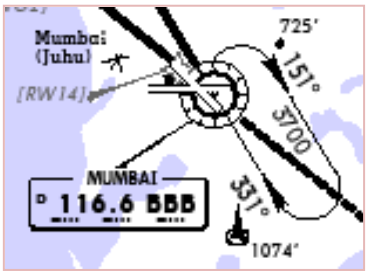
SID / STAR



ILS Instrument Approach



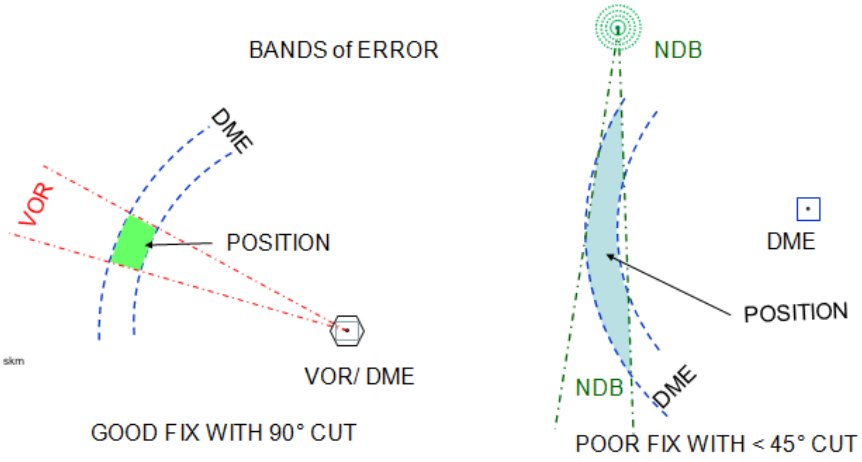
VOR Instrument Approach



Notice small ‘D’ in navaid facility boxes prefix to frequency and identification indicates co-located DME. On ILS Instrument Approach Chart four letter identification of paired ILS DME can be noticed.

USE of DME RANGE

FIXING POSITION WITH DME. The DME range is a circular position line with the station as its centre and the range as the radius. Combining it with another suitable position line a radio fix can be obtained. Co-located VOR/ DME always provide the best angle of cut of 90° and therefore a good fix. Accuracy of fix may be degraded if another VOR or NDB is used for the second position line. Angle of cut less than 45° or using two DME, either side of track, would result in a radio fix with doubtful accuracy.

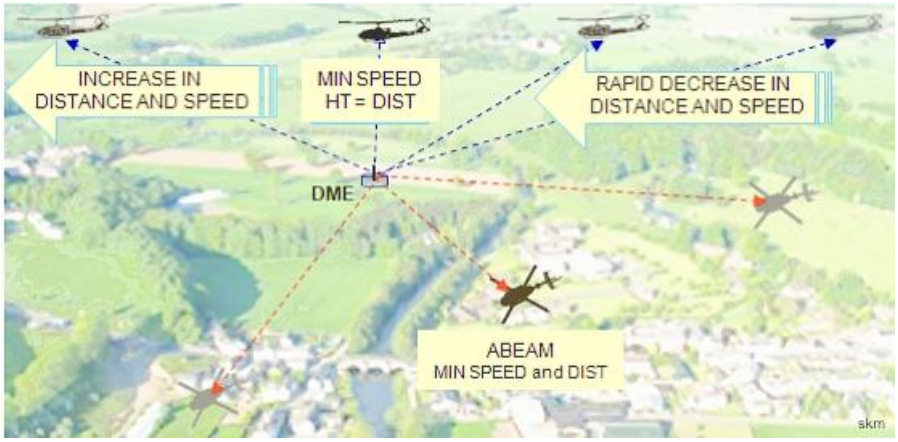


DME GROUND SPEED. As stated, some indicators show closure rate to the station. In event of the helicopter tracking in or out of the station, this rate is the ground speed itself. In absence of a ground speed read out, while tracking in or out of DME station, the ground speed can be found by a simple calculation using distance and time.

Example. At 1007 DME range is 27.0 nm. At 1013 it increases to 36.5 nm and helicopter is tracking out.

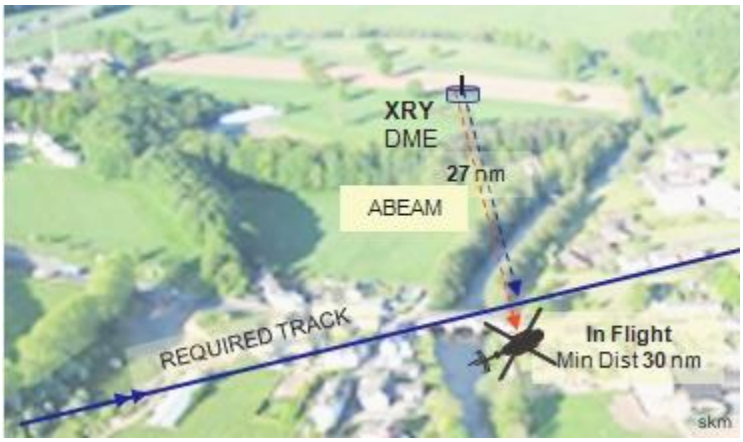
Ground speed = (9.5 nm / 6 min) x 60 min = 95 kts.

INDICATIONS OVER DME. In case helicopter is flying directly to DME, its position overhead DME is indicated by rapid decrease in distance up to its height in nm or by a dropout of the indications. If not tracking to or away from a DME station, the closure rate will decrease gradually and read zero, when helicopter reaches an abeam position. At this point the distance indicated will be minimum. If continued, closure rate would increase with increasing distance.



DME HOMING. As a last option for homing and in absence of bearing information, once at abeam position the pilot can turn 90° towards station, and notice the distance readings reducing. In case, after turn the distance starts increasing the turn has been made on to the wrong side.

TRACK KEEPING. If DME is located to one side of the track, abeam position thus determined can be gainfully used to establish helicopter's ground position with respect to required track. Distance found to be less than the planned one indicates the position off track and towards the side the station is located and vice versa.



Example: On a planned route, DME beacon XRY is 27 nm port of track. In flight DME observations of XRY decreased up to 30 nm and then increased. What is the helicopter's position with respect to track?

Abeam position is at 30 nm, that 3 nm off track.

DME is to the felt, hence helicopters is 3 nm starboard of track.

DME RANGE AND RATED COVERAGE. Operating at UHF, maximum range expected are optical range that can be calculated by the formula given in notes for VOR. However rated coverage specified in aeronautical publication may be less than the calculated values. These may have taken terrain shielding and other preparation factors in consideration.

ACCURACY. DME is most accurate navaid amongst the ones providing bearing or distance for route navigation. Its accuracy is ± 0.5 nm, or 3% of the indicated distance if greater. That means up to 17 nm the error is within half a nm and beyond ±3% of the distance.

SAMPLE QUESTIONS: DME

1. DME primarily provides range using
   (a) echo principle.
   (b) secondary radar to determine time interval.
   (c) pulse jittering technique to find distance.
   (d) continuous transmission and reception at airborne equipment.

2. Frequencies used in DME operation are from the …… (i) band and selection is made on control unit for …… (ii) band.

	(i)	(ii)
(a)	UHF	VHF
(b)	VHF	UHF
(c)	HF	UHF
(d)	SHF	UHF

3. DME ground beacons are identified by their unique
   (a) transmission/ reception frequencies which are paired universally .
   (b) two letter Morse code transmitted by ground beacon.
   (c) three letter Morse code only.
   (d) three or four letter Morse code.

4. For a co-located VOR/ DME identification Morse code is heard
   (a) two time in a minute.
   (b) five to six times in a minute.
   (c) alternately for VOR and DME every ten seconds.
   (d) only for the VOR.

5. Co-located ILS/ DME equipment has the DME transmitter installed
   (a) close to or at the glide slope transmitter.
   (b) near or at the localizer transmitter.
   (c) at the inner marker transmitter of ILS.
   (d) half way off the centre line to one side of the instrument runway.

6. Indicated display of ground speed at DME indicator is
   (a) always correct, if the distance from beacon is more than three times the height.
   (b) in error if helicopter is tracking away fro the station.
   (c) rate of closure to beacon rather than the ground speed.
   (d) Only correct if helicopter is tracking to the station on steady heading.

7. Position overhead a DME may be checked by indication of distance
   (a) being zero.
   (b) reducing to minimum value and then increasing.
   (c) and speed reducing to minimum and farmer being equal to height of helicopter.
   (d) disappearing to show dashes.

8. Expected abeam distance of ABC, VOR for the helicopter to be positioned on track is 17nm to the port. Pilot notices least distance indicated is 21nm at 0223 UTC. The position of the helicopter at 0223 is;
    (a) 4 nm left of track.
    (b) 4 nm right of track.
    (c) on parallel track at 4 nm.
    (d) 12° off the required track.

9. As DME operates in UHF and VOR in VHF band, its operational range with all other factors being same will be;
    (a) less than the VOR.
    (b) more than the VOR.
    (c) same as the VOR.
    (d) more by 10% than the VOR.

10. DME, working on secondary radar principle has an airborne;
    (a) directional interrogator with non–directional transponder on ground.
    (b) directional interrogator with directional transponder on ground
    (c) non-directional interrogator with directional transponder on ground.
    (d) non-directional interrogator with non-directional transponder on ground.

11. Ground speed and time to station information displayed on DME indicator is
    (a) correct, if helicopter is flying out of the station.
    (b) actually based on relative speed.
    (c) calculated taking ground range into consideration.
    (d) corrected for the height above ground.

12. Flying to a DME station at 0957 pilot observes the distance to be 21.4 nm. Then at 1003 the reading is 30.0 nm. Ground speed of the helicopter is;
    (a) 96 kts
    (b) 104 kts
    (c) 74 kts
    (d) 86 kts

13. Maximum number of air planes that a DME ground station can handle at one time,
    before it gets saturated is;
    (a) 126
    (b) 30
    (c) 54
    (d) 100

14. Difference in the indicated distance of 2.6 nm and correct ground distance will be insignificant if helicopter is flying at;
    (a) altitude of 2600 feet.
    (b) 3000 feet agl.
    (c) 1300 feet.
    (d) Flight Level 30.

15. Distance information obtained from a Co located ILS/ DME is;
    (a) accurate in all directions.
    (b) limited only to the localizer sector.
    (c) the precise ground range in localizer coverage area.
    (d) the slant range continuously available in localizer area.

ANSWERS: DME

Question	Option
1	b
2	b
3	d
4	b
5	a
6	c
7	c
8	b
9	c
10	d
11	a
12	d
13	d
14	b
15	c