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Federal Aviation Agency

ADVISORY CIRCULAR

AC NO: AC 170-3A

AIR NAVIGATION FACILITIES

EFFECTIVE: 6/17/65

SUBJECT: DISTANCE MEASURING EQUIPMENT (DME)

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1. PURPOSE. This circular presents information concerning Distance Measuring Equipment (DME) and some of its uses to pilots who may be unfamiliar with this advanced but easily utilized navigational aid.

2. CANCELLATION. Advisory Circular No. AC 170-3, dated May 23, 1963, is cancelled.

3. BACKGROUND. As of February 28, 1965, 381 VORTACs and 8 VOR/DMEs were in commission. Present plans call for a total of 753 VORTAC installations. Many pilots are familiar with the use of VORTAC facilities in providing course information to aircraft equipped with VOR receivers. However, less familiar is the range (distance) data available from all VORTAC stations by use of airborne DME. Federal Aviation Regulations require the installation of DME in U.S. registered civil aircraft using VOR navigation at 24,000 feet mean sea level or above when operating within the 48 contiguous states or in the District of Columbia. DME is also presently required, regardless of the altitude flown, on all air carrier and commercial operator turbojet, turboprop, and pressurized reciprocating engine airplanes. It will also be required on other large air carrier airplanes by February 28, 1966. Although this regulation does not affect the great majority of general aviation aircraft, many aircraft owners have enjoyed the benefits afforded by DME and have installed this aid on a voluntary basis.

4. EXPLANATION. The Agency has received many inquiries relative to operational use of DME. It is our hope that the information contained in attachment 1 will answer some of your questions and stimulate further interest in this important navigational aid.

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DISTANCE MEASURING EQUIPMENT

1. WHAT IS DME? DME is an electronic system which measures distance from an aircraft to a station on the ground. Basically, it operates by transmitting a signal to the ground station which, in turn, replies. The time taken to exchange these signals is measured accurately, and from this and the known speed of the radio wave, the distance is automatically computed. This is then indicated to the pilot in nautical miles on a circular dial-needle pointer instrument or an odometer presentation.

2. DOES DME MEASURE GROUND DISTANCE? DME measures the distance directly from the airplane to the ground DME facility. This measurement is commonly referred to as slant range distance. The difference between a measured distance on the surface and the DME slant range distance is smallest at low altitude and long range. It increases as the range decreases and altitude increases. The difference is greatest when an aircraft is directly over the ground facility, at which time the DME receiver actually will display altitude in nautical miles above the station. Generally the difference between slant range and surface distance is negligible if the aircraft is one mile or more from the navaid (ground station) for each 1,000 feet of altitude above the elevation of the navaid.

3. HOW ACCURATE IS DME? Lightweight equipment designed for the general aviation market is reported by the manufacturers to be accurate within plus or minus one-half mile or three percent (3%) of the distance, whichever is greater.

4. WHAT IS VORTAC? VORTAC consists of a VOR plus a TACAN facility. It provides course and distance information to military aircraft equipped with TACAN receivers and the same information to civil aircraft using VOR and DME receivers.

5. WHAT IS VOR/DME? VOR/DME is a VOR station with the distance measuring equipment of TACAN installed with it. It provides distance and course information to a VOR/DME equipped aircraft and distance information only to one equipped with a TACAN receiver.

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6. WHAT IS ILS/DME? ILS/DME is an ILS and associated DME. The addition of DME to an ILS provides distance information to aircraft equipped to receive ILS and DME. It thus furnishes continuous three dimensional position information to aircraft equipped to receive ILS localizer and glide slope and DME information. This program is still in the evaluation stage. *

7. DOES DME OPERATE ON THE SAME FREQUENCY AS VOR? No. DME operates on the ultrahigh frequencies of 960 to 1215 megacycles. VOR stations utilize very high frequency transmitters operating in the 108 to 118 megacycle band.

8. IS A DME RECEIVER TUNED TO THE VOR FREQUENCY OR THE DME FREQUENCY? VOR and DME transmitting frequencies are paired; that is, one DME channel is assigned to a particular VOR frequency. Some aircraft installations provide automatic tuning of the DME receiver through the VOR tuning selector. In most DME receivers on which separate tuning is provided, tuning to the published VOR frequency with the DME tuning selector will place the DME receiver on the proper channel.

9. CAN A DME EQUIPPED CIVIL AIRCRAFT OBTAIN INFORMATION FROM A MILITARY TACAN STATION? Yes. Distance information may be obtained from a TACAN facility by tuning the DME receiver to the paired frequency (VOR) shown * in the Airman's Information Manual for the particular TACAN channel. * Any course indications obtained under these conditions should be ignored.

10. WHAT IS THE MAXIMUM EFFECTIVE RANGE OF DME? DME receiving equipment is usually considered reliable up to 100 miles from the station. The more sophisticated (and expensive) equipment may be accurate over greater distances. In any case, effective range depends greatly on altitude. The higher the altitude, the greater the effective range. The term "service volume" is used to express the distances over which the received DME signals are considered accurate. The class of ground VOR facility must also be considered. The Air Navigation Radio Aids Section of the * Airman's Information Manual shows the various frequency protected areas* of VOR, VORTAC, and TACAN facilities. These are considered to be the normal service volumes of the facilities.

Class of Facility	Operational Service Volume
* T (Terminal)	25 nmi. up to 12,000 ft. m.s.l.
L (Low Altitude)	40 nmi. up to 18,000 ft. m.s.l.
H (High Altitude)	40 nmi. up to 18,000 ft. m.s.l.
	130 nmi. from 18,000 ft. m.s.l.
	45,000 ft. m.s.l.
	100 nmi. above 45,000 ft. m.s.l. *

The class of facility, as indicated in the Airman's Information Manual, thus indicates the maximum reliable range of both VOR and DME indications from a given facility. An attempt to utilize a reading obtained beyond the interference-free distance may result in an erroneous indication because of the interference of other stations operating on the same channel.

11. WHAT IS THE INDICATION IF A DME RECEIVER IS TUNED TO A STATION TOO DISTANT FOR ADEQUATE SIGNALS? The DME receiver will go into "search operation"; that is, the receiver will scan the DME spectrum looking for a signal on the channel to which it is tuned. This searching will evidence itself in a traveling of the indicator from minimum to maximum range and back again. "Search operation" occurs when the receiver is

first turned on, when the receiver's tuning is altered (as in changing from one station to another) or when insufficient signal strength is available. It then becomes a warning that something is amiss and that the DME indication is unreliable.

12. WHAT IS MEANT BY "MEMORY OPERATION"? Memory operation is the ability of the DME receiver to maintain its distance indication for short periods of time when the signal is blanked out momentarily. If the signal interruption is short enough, the pilot will be unaware that such an outage has occurred. However, if the signal disappears for any considerable length of time, the DME receiver will go into search operation.

13. HOW IS DME IDENTIFIED? Like the VOR ground station, the DME station transmits an identification signal. It is transmitted twice a minute and timed for proper inclusion with the VOR identification. The DME audible signal is recognizably higher in pitch than that of the VOR. Sequence of a VORTAC identification signal with coded identification only is:

VOR (code), VOR (code), VOR (code), VOR (code), TACAN (code)

Sequence of a VORTAC identification with code and voice identification is:

VOR (code), VOR (voice), VOR (code), TACAN (code)

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14. NON-COLLOCATED VOR AND TACAN FACILITIES. Some military VOR and TACAN facilities are not designated as VORTACs because of excessive distance between the two facility sites. However, some of these facilities are frequency paired and, when tuned on a VOR receiver with automatic DME tuning, both azimuth and distance information will be received. While the distance indications received may be nearly correct, they, in other instances, may be incorrect by a number of miles. Thus, when a VOR receiver is tuned to other than a VORTAC or ILS/DME facility and a DME distance indication is received, that distance should not be used for other than information purposes and then only after verification of the DME facility identification and location. The pilot must remember that he is receiving course information from one location and distance information from another. *

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15. HOW MAY NON-COLLOCATED FACILITIES BE IDENTIFIED? The facilities are shown as different separated facilities on charts and are not identified* as VORTACs. Their identification signals are not timed in accordance with procedures detailed in par. 13 above and will intermix rather than appear in proper sequence.

16. <u>WHAT ADVANTAGES ARE OFFERED TO THE PILOT BY DME</u>? The pilot of an aircraft equipped with a properly operating DME receiver has several advantages, including:

a. He has a running fix along a line of position at all times.

b. His position over the ground is presented to him more accurately than is the case with dual VOR and/or ADF installations, so long as he is in range of a VOR/DME station.

c. He can quickly and accurately estimate his ground speed because he knows his position at all times while using DME. Some available
* equipment presents direct read-out ground speed and "time to station" information. *

* d. The more readily available position reports gained through pilot use of DME may permit reduction of inflight delays not avoidable when * time separation is employed by Air Traffic Control. Also, DME can be very useful in assisting a controller to radar identify a flight without requiring identifying turns.

e. Many instrument approach procedures either permit or require use of DME. These procedures sometimes eliminate the need for procedure turns and/or other time-consuming maneuvers. Also, lower approach minimums are sometimes possible because of the added position accuracy afforded by DME.

f. Separation between flights with DME and operating under Instrument Flight Rules (IFR) can be safely reduced from that required by non-radar time separation standards.