

Operation of Navigational Aids

Early Navigation

The first navigational aid consisted of flashing beacons that rotated along specified routes. Most lights were red, but every third beacon was green. The green signified that there was a suitable landing field. This was the predecessor of today's green and white airport beacons.

On the Beam

The flashing beacon system did not work well at night or in low-visibility conditions, so a LF navigation system was developed. These radio beacons were placed 200 miles apart and transmitted two Morse-code signals: the letter "A," • – , and its opposite, the letter "N," – • . When the aircraft was centered on the airway, these two opposite Morse-code signals would merge and sound like a single tone.

_____ (NDB) / _____ (ADF)

- A. Operate on the LF/MF frequencies 190 - 535 kHz (540 to 1620 kHz is AM radio)
- B. Travel _____ distances, not subject to line-of-sight.
- C. Reception errors
 - 1. _____ (points to lightening – a “poor man’s stormscope”)
 - 2. _____ (static)
 - 3. _____ (interference from distant stations)
 - 4. _____ (bent signal)
 - 5. _____ (reflection)
 - 6. _____ (ionosphere reflection)
- D. The _____ antenna determines the direction of the station but cannot determine whether the bearing is TO or FROM the station.
- E. The _____ antenna (traditionally a long wire) determines the bearing.
- F. Service Volumes
 - Compass Locator _____ NM.
 - MH _____ NM.
 - H _____ NM.
 - HH _____ NM.
- G. Since ADF receivers do not have a _____ to warn the pilot when erroneous bearing information is being displayed, the pilot should continuously monitor the NDB's identification.

_____ (VOR)

- A. 108.00 - 117.95 MHz – Below aviation radio and above FM radio.
- B. Reception is limited to line of _____.
- C. Accuracy is +/- _____ degrees.
- D. Two signals
 - 1. _____ signal - rotates around the VOR at 1800 RPM.
 - 2. _____ signal - emulates in all directions.
- E. Measures the _____ wave phase difference between the two signals.
- F. Each dot represents _____ degrees off course.

G. Service Volumes

- T - Terminal: 1,000' - 12,000' AGL: _____ NM.
- L - Low Altitude: 1,000' - 18,000' AGL: _____ NM.
- H - High Altitude: 1,000' - 14,500' AGL: _____ NM.
14,500' - 60,000' AGL: _____ NM.
18,000' - 45,000' AGL: _____ NM.

- H. The only positive method of identifying a VOR is by its Morse Code identification or by recorded automatic voice identification: the station's name followed by "VOR."
- I. During periods of maintenance, the facility may radiate a _____ code (– •••• –) or the code may be removed.

Distance Measuring Equipment (DME)

- A. Provides _____ range distance. (Beware of high altitudes close to the station.)
- B. The DME unit on the airplane transmits a pair of _____ to the antenna on the ground & the ground unit sends a pair back with similar timing.
- C. Radio waves travel at the speed of _____, therefore time = distance.
- D. Reliable up to _____ NM
- E. Accuracy: _____ mile or _____ % of the distance, whichever is greater.
- F. Answers up to _____ interrogations at once

VHF Omni-Directional Range/Tactical Air Navigation (_____)

- A. Combines a VOR and TACAN. (Tactical Air Navigation – used by the military with UHF frequencies providing bearing and distance.)
- B. It provides three individual services: VOR azimuth, TACAN azimuth and TACAN distance (DME) at one site.
- C. The UHF DME frequency is _____ to the VOR, so the pilot only has to tune in the VOR frequency.
- D. All components are considered part of a single unit, or _____.

Identification

- A. The VOR is identified by a Morse Code tone modulated at 1020 Hz.
- B. (The NDB Morse Code is also transmitted at 1020 Hz.)
- C. The TACAN or DME is identified by a _____ tone modulated at 1350 Hz.
- D. The DME or TACAN coded identification is transmitted one time for each three or four times that the VOR identification is transmitted.
- E. A single coded identification with a repetition interval of approximately _____ seconds indicates that only the DME is operative.

(RNAV)

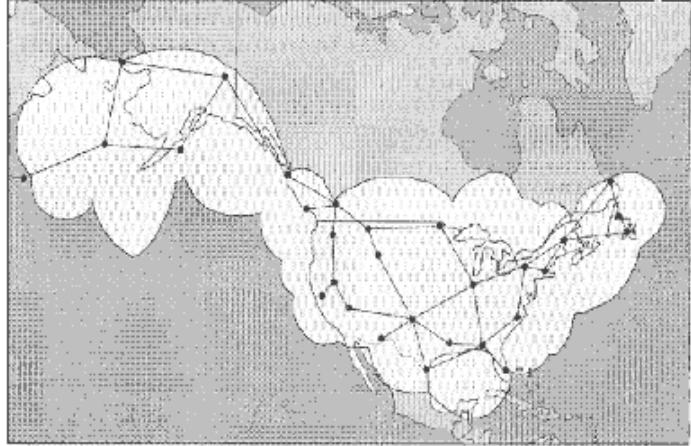
- A. RNAV provides direct point-to-point off-airway navigation.
- B. It enables aircraft to “fly as the _____ flies.”
- C. The first RNAV consisted of an on-board computer that created phantom VOR/DME stations called _____.

D. Later versions of RNAV include LORAN C, INS/IRS, and _____.

(LORAN C)

- A. 27 ground-based stations send out low frequency signals centered at 100 kHz.
- B. Range is about 1,200 NM during the day to 2,300 NM at night.
- C. Operated by the United States

- _____.
- D. Information based on time variance in signal reception from a master station that sends out an initial signal and at least two secondary, or slave, stations that send out a response upon reception of the first signal.
 - E. LORAN will eventually be discontinued due to high costs and the popularity of GPS.



(GPS)

- A. Needs at least _____ satellites in orbit.
- B. At least _____ satellites are needed for accurate position.
- C. At least _____ are needed for error detection (RAIM.)

For more information, see Chapter 1 of the Aeronautical Information Manual.