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This following circular is hereby promulgated for information**,** guidance and necessary action**.**

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Director General

LIMITATIONS OF NON-DIRECTIONAL BEACONS AND AUTOMATIC DIRECTION FINDING EQUIPMENT.

The following circular has been extracted from UK Civil Aviation Authority, Aeronautical Information Circular.

1. In recent years, VHF Omni Range Facilities (VOR) have increasingly replaced or supplemented Medium Frequency Non-Directional Beacons (NDBs) in many parts of the world . NDBs are however still in use as navigation and instrument approach aids and in particular, as a lead-in to instrument approach system (ILS or radar) and are likely to be utilised in these roles for several years to come.

2. The increasing use of the VOR may result in pilots losing sight of the inherent limitations of the NDB and its associated air-borne Automatic Direction-Finding (ADF) equipment which if used under certain conditions, is capable of producing large and potentially dangerous errors.

3. The principle factors liable to affect NDB/ADF performance and produce or contribute to error are:

Static interference;
Station interference;
Night effect;
Mountain effect;
Coastal refraction;
Absence of failure warning system.

3.1 **Static interference-**

All kinds of precipitation (including falling snow) and thunderstorms can cause static interference of varying intensity to ADF systems. Precipitation static reduces the effective range and accuracy of bearing information and thunderstorms can give rise to bearing errors of considerable magnitude and even to false indications of “station passage”. Indeed, it is often said that in an area affected by thunderstorms activity, the ADF bearing pointer is useful only as an indication of the direction of the most active storm cell.

3.2 Station interference.

Most countries adopt measures to minimise the possibility of interference between transmission from different stations by spacing frequencies and limiting the power outputs of those which might conflict. However, the LF and MF frequency bands remain inevitably congested and there is a risk that some interference will occasionally occur. When interference is experienced, bearing errors of varying degrees will result. By day, the use of an NDB within the promulgated service range (based on daylight conditions) will normally afford protection against interference. Providing the beacon is correctly tuned and identified, reliable performance can usually be expected **.** By night , however , it is possible for sky-wave signal from other (more distant) transmitters to penetrate those areas considered protected during the day, thus giving rise to the possibility of two signal being received and resulting in unreliable bearing indications. Extreme care should therefore be exercised by day when making use of NDBs close to the limit of their promulgated service range at all times and all areas during the period between evening and morning twilight. Positive identification of the call sign of the required beacon is essential and is just as important with modern incrementally- tuned crystal controlled ADF sets as with the earlier designs since frequency reference alone cannot guarantee that the required station is being unambiguously received. Following initial identification and when ADF indications are being followed, further checks on reception of the correct call-sign and on the accuracy of tuning should also be made at frequent intervals.

3.3 Night effect

At night, in addition to the interference which can occur between transmission from different stations (already described in para 5 above) it is possible for the reception of ground wave signal from an individual NDB to be contaminated by a sky wave signal from the same transmission source. This will give rise to bearing errors of varying magnitude depending on the heights of the ionise layers and the polarisation of the signal on arrival at the receiver. Night effect is usually most marked during the twilight hours when sky wave contamination can cause “fading” of signal strength with resultant wandering of the ADF bearing needle. Caution should therefore be exercised whenever fluctuations in bearing indications are observed in the circumstances described.

3.4 Mountain effect

ADF facilities may be subject to errors caused by the reflection and refraction of the transmitted radio waves in mountainous areas. High ground between the aircraft and the beacon may increase the errors especially at low altitude.

3.5 Coastal refraction

In coastal areas, the differing radio energy absorption properties of land and water result in refraction of NDB transmissions. This error, known as “Coastal Refraction”, is most marked when the transmission cross the coastline at an oblique angle and when the transmitting station is located away from the coast. Such bearings should. therefore be used with caution.

3.6 Lack of failure warning system

Because of the absence of failure warning device on ADF instruments, failure in any part of the system may produce false identification which are not readily detectable. Having selected and identified the NDB constant monitoring of the identification signal is the only

way to ensure that the beacon and the aircraft equipment are functioning satisfactorily. This should prevent a false indication being followed and applied, particularly when making approaches towards the station as, in the event of failure the ADF needle will seemingly indicate correctly (i.e. ahead), even though the beacon has been passed**.**

3.7 Beacon Tuning and Identification

Two systems are commonly used to enable NDBs to transmit their Morse identification signal. The AOAI system which required the use of a Beat Frequency Oscillator (BFO), transmits an identification signal usually between two and four times per minute; on the other hand, the AOA2 system, with modulated carrier, transmits its signal at least eight times per minute. Moreover, during the keying of this signal, the AOA2 system continues to provide an uninterrupted bearing indication whereas the AOA1 system has to interrupt this whilst transmitting its identification and this can result in the bearing pointer wandering due to these gaps in transmission. Although an ICAO standard requires NDBs in use as landing aids to be operated on the AOA 2 system of emission (provided their rated coverage does not exceed 50 NM), AOA1 or even a mixture of beacons using either system may be encountered in this role. When tuning and identifying the transmissions from any NDB, an operator must therefore be clear about the system of emission to expect and pre-select the ADF receiver controls to the appropriate mode of operation for this.

4. In conclusion,

It has to be stressed that at comparatively short distances i.e. less that 50 nautical miles over which NDBs are most commonly used, the most potentially dangerous errors are those resulting from all types of precipitation, static, thunderstorms and station interference (particularly at night). When these are experienced, the ADF system should be used only when necessary and then with extreme caution; VHF aids are much less affected and these should be used in preference wherever possible. Cross-checking on the accuracy of ADF indications by reference to other available navigational aids is not only a matter of good airmanship but also a most necessary safeguard wherever any difficulty is experienced in the reception or identification of the intended NDB.

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