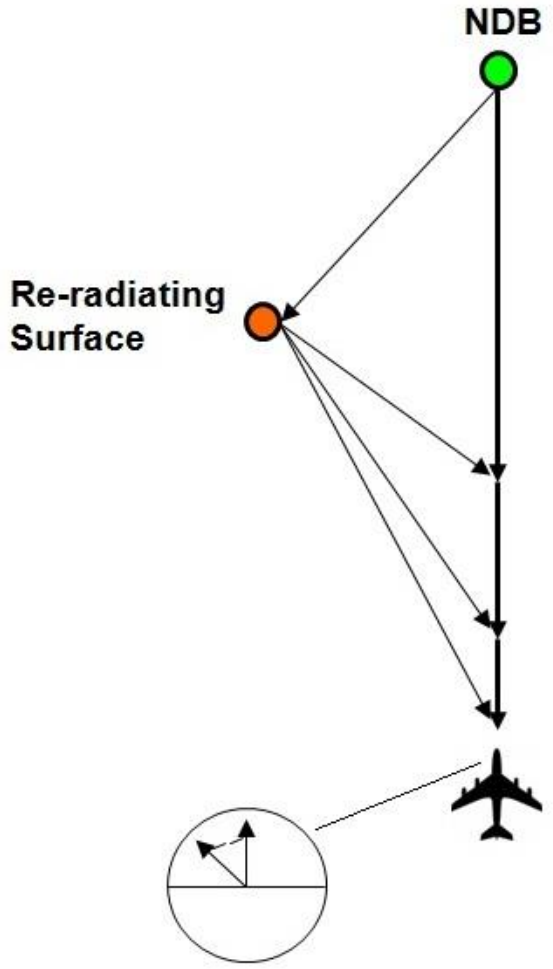
NDB Bearing Errors

The horizontal radiation pattern of an NDB antenna is always completely omnidirectional (a perfect circle) because the antenna has an electrical length that is very short compared to the wavelength of the radiated signal. This is where the name “Non Directional Beacon” originates. As the NDB signal propagates by ground wave, away from the transmitting antenna, the circular pattern can become distorted as transitions across boundaries of different ground conductivities occur. For this reason, NDB signals are not commonly used to navigate by taking bearing readings. Despite these bearing errors, the approach to an NDB will always guide the user to the exact location of its antenna although not necessarily following a straight flight path.

A second reason for bearing uncertainty can result from an inadequate signal to noise ratio at the receiver. At a given radius from the NDB, the signal field strength may vary at different bearings due to differences in propagation conditions.

A third abnormality of bearings taken on NDB installations can be caused by multipath. This is a situation whereby the direction finding receiver encounters signals from two or more directions. One is the direct path between the NDB and the receiver. Other paths can occur caused by re-radiation of the NDB signal from conducting surfaces on either side of the direct propagation path. These re-radiated signals can be from tall metal structures such as high voltage electrical distribution towers, tall antenna towers or even metallic mineral deposits in mountainous areas that lie on either or both sides of the direct propagation path. This process is illustrated in Figure 1. The radio compass responds to the vector sum of the direct and re-radiated signals. Rapid radio compass deviations occur as the aircraft moves. The error signal can be seen to get more severe as the approach continues. An increase in the power of the NDB has no effect because the strength of both the direct and the re-radiated signals increase.



ADF Compass indicator oscillates between NDB signal source and signal received from re-radiating surface.

When excessive bearing errors occur, it is not difficult to determine which effect is causing the problem. Inadequate signal to noise ratio can cause random radio compass fluctuations, even at a fixed location. Predictions of annual radio noise level variations throughout the world are published in ITU-R p.372-10. Improvement can be made by increasing the radiated power of the NDB.

Wavefront bending caused by transitions across ground conductivity boundaries causes stable bearing errors at specific locations.

The effects of multipath are quite different. Very small changes of the receiver position result in rapid bearing fluctuations as the vector sum of the signals from the two or more paths changes. This is because the signals have travelled different distances and hence are not phase coherent.

Investigation and Resolution

Remedial measures may be possible in multipath conditions. Single tower re-radiators can sometimes be detuned at the operating carrier frequency by the installation of radio-frequency chokes. This would not of course be possible where re-radiation results from natural topographic features such as metallic ore deposits in mountainous terrain. Because the efficiency of a re-radiator often varies with frequency, the problem can sometimes be resolved by changing the operating carrier frequency. Where a commonly used approach direction is involved, it is sometimes possible to improve system performance by re-locating the NDB. A low power, portable NDB and antenna can be used to seek a more suitable location or operating frequency. Moving the NDB closer to the re-radiating structure such that the re-radiated signal emanates from the same location may be a possible solution.