

REPORT 910-1

**SHARING BETWEEN THE MARITIME MOBILE SERVICE
AND THE AERONAUTICAL RADIONAVIGATION SERVICE
IN THE BAND 415-526.5 kHz**

(Question 53/8)

(1982-1986)

1. Introduction

Parts of the frequency band 415-526.5 kHz are allocated to both the maritime mobile service and the aeronautical radionavigation service.

In the maritime mobile service, the frequency 518 kHz is used exclusively for the transmission by coast stations of navigational warnings and urgent information to ships, by means of narrow-band direct-printing telegraphy (also called NAVTEX).

Because of differences in operational use, frequency planning, radiated power, etc., coexistence of these two radio services in the same bands may present problems. Particular attention is required with respect to the problems which have their origin in the difference in the power levels used.

The aeronautical radio navigation service, operating at power levels which are 20-30 dB lower than those of the maritime mobile service, has a more difficult problem in the protection against interference.

It is essential that suitable criteria, which will permit coexistence of the two services in the same band, be developed as soon as possible.

The following examination is restricted to:

- (a) geographical separation (co-channel);
- (b) frequency separation (co-location);
- (c) combination of (a) and (b) with variable geographical distance and frequency separation.

Also certain variations in the power level radiated by stations in the maritime mobile service and the effect of a more selective automatic direction finding (ADF) receiver are examined.

2. Factors involved**2.1 Differences in radiated power levels**

2.1.1 The maritime mobile service provides communications between coast stations and ship stations or between ship stations. There are no protection criteria in the Radio Regulations governing the maritime mobile service in the bands between 435 kHz and 526.5 kHz.

Normally the output power of coast station transmitters is of the order of 1-2 kW. With an antenna efficiency of 30% the e.r.p. is then 300-600 W. However, an antenna efficiency of 1-30% may be found in some cases.

The typical e.r.p. of NAVTEX transmitting stations is of the order of 10-50 W.

Technical characteristics of NAVTEX stations should be in accordance with Recommendation 540, (100 Bd F1B, with a necessary bandwidth of 304 Hz).

Ship stations normally use 400 W transmitters. If the antenna efficiency is 10%, the e.r.p. is 40 W.

2.1.2 In the aeronautical radionavigation service in some cases transmitters of about 50 W are used, but the e.r.p. is of the order of 0.5 W. A typical aeronautical beacon in the European area has a range of 50 NM with an e.r.p. of less than 1 W. In other areas, beacons with a range of about 200 NM are quite common.

The ICAO standard on radiated power states that, "The power radiated from a NDB shall not exceed by more than 2 dB that necessary to achieve the agreed rated coverage..." (Annex 10 to the Convention on International Civil Aviation, Vol. I, Part I, § 3.4.3.) Other characteristics of the beacon, both as prescribed by ICAO (Annex 10) and the operational use of the beacon, need also to be taken into consideration.

2.2 Protection ratio desired/undesired signal in the aeronautical radionavigation service

The protection figure of 15 dB quoted in the Radio Regulations No. 2854 applies to bands below those concerned in this Report. The Radio Regulations make no statement on the protection figure to be applied to aeronautical NDBs between 435 and 526.5 kHz. However, the figure of 15 dB has been taken as applicable for the purposes of this Report.

2.3 Automatic direction finding (ADF) receiver selectivity

The extent to which the ADF receiver is capable of suppressing undesired frequencies is governed by the ADF receiver selectivity curves (see Fig. 1).

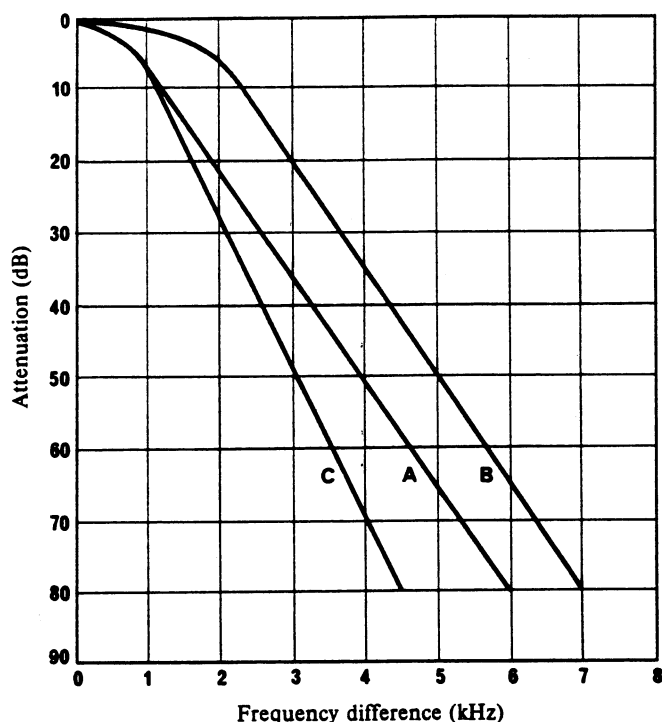


FIGURE 1 – ADF receiver selectivity curves

Curves A: Annex 10 Vol. I, Att. B to Part II, para 3
 B: Annex 10 Vol. I, Att. B to Part II, para 2
 C: arbitrary curve, better than A

Note. – In congested areas curve A is used when planning LF/MF beacons in the aeronautical radionavigation service. It is to be noted that there are ADF equipments currently being used, which have selectivity characteristics that are not as stringent as specified in Curve A.

For a given frequency separation between stations, a selectivity curve with steeper slopes will reduce the minimum geographical distance required between stations in the maritime mobile service and the aeronautical radionavigation service. However, because the ADF receiver is required to receive signals with a bandwidth of about 2 kHz, steeper slopes will have a negligible effect for frequency separations less than 1 kHz.

2.4 The separation distance required between a NDB and a coast station once established will remain fixed provided their respective frequencies and powers do not change. The required separation between a NDB and a ship station will vary depending on the position of the ship, its transmitter power and its frequency. To allow for these variable parameters an area extending inland from the coast will require particular consideration.

2.5 NAVTEX considerations

2.5.1 Protection to NAVTEX receivers

Annex I describes signal-to-interference and off-frequency rejection protection required for NAVTEX receivers, and provides an example of separation distances necessary to prevent interference to NAVTEX.

2.6 Protection to ADF receivers from NAVTEX transmissions

Because of the relatively small NAVTEX emission bandwidth, ADF selectivity curves of Fig. 1 can be used to describe the off-frequency rejection protection required for ADF receivers from NAVTEX transmissions. Annex II provides an example of separation distances necessary to prevent interference to the aeronautical radionavigation service.

2.7 Propagation of NAVTEX or aeronautical radiobeacon signals by sky wave could cause interference to either service. For that reason, aeronautical radiobeacon stations operating on or near 518 kHz in Regions 2 and 3 and NAVTEX stations operating on 518 kHz should take necessary precautions such as using the minimum power necessary to enable the coverage of the service area. This would reduce the risk of interference to other stations due to sky-wave propagation especially after dusk.

3. Examples of planning calculations for ground-wave propagation

3.1 For the examples of calculations given below the following assumptions are used:

3.1.1 General

Frequency:	500 kHz
Propagation conditions:	CCIR curve (see Recommendation 368-3) (Kyoto, 1978), Fig. 3 ($\sigma = 10^{-2}$ S/m; $\epsilon = 4$) (only ground wave propagation has been taken into account).

3.1.2 Maritime mobile service

Coast stations:	e.r.p. 500 W
Ship stations:	e.r.p. 50 W.

3.1.3 Aeronautical radionavigation service

Field strength at limits of coverage:	70 μ V/m (36.9 dB (μ V/m)) (see Radio Regulations No. 2857)
Protection ratio:	15 dB
ADF receiver selectivity:	Convention on International Civil Aviation, Annex 10, Volume I, Att. B to Part II, § 3 (see Fig. 1, curve A).

3.2 The curves in Fig. 2 represent the minimum frequency separation between a station in the maritime mobile service and a station in the aeronautical radionavigation service as a function of the geographical separation between these stations.

The various curves refer to different service ranges of the aeronautical radio beacon.

If the coast station lies within the operational range of the aeronautical beacon, the minimum frequency separation is a function of the difference in field strength of each service at the location of the coast station. If the coast station lies outside the operational range of the aeronautical beacon then the frequency separation is determined by the difference in field strength of each service at the limit of the coverage of the aeronautical beacon.

The maximum frequency separation is required when the operational range of the aeronautical radio-beacon is equal to the geographical separation of the two stations involved. This frequency separation is 6.4 kHz in the case of a coast station with an e.r.p. of 500 W. It can also be concluded that with a distance of 650-700 km between the two stations the minimum frequency separation is 0 kHz.

Note 1. — For frequencies lower than 500 kHz this distance will increase; for a frequency of 400 kHz this distance is about 950 km.

Note 2. — For sea-path propagation conditions ($\sigma = 5$ S/m; $\epsilon = 80$) the minimum distance in the co-frequency case is 1400 km (at 500 kHz).

3.3 Figure 3 shows how the minimum frequency separation is affected by the power of the coast station transmitter in the case of the aeronautical beacon operational range of 75 km.

3.4 Figure 4 shows the effect on sharing possibilities of different selectivity curves for the ADF receivers.

Details of the selectivity curves used are given in Fig. 1.

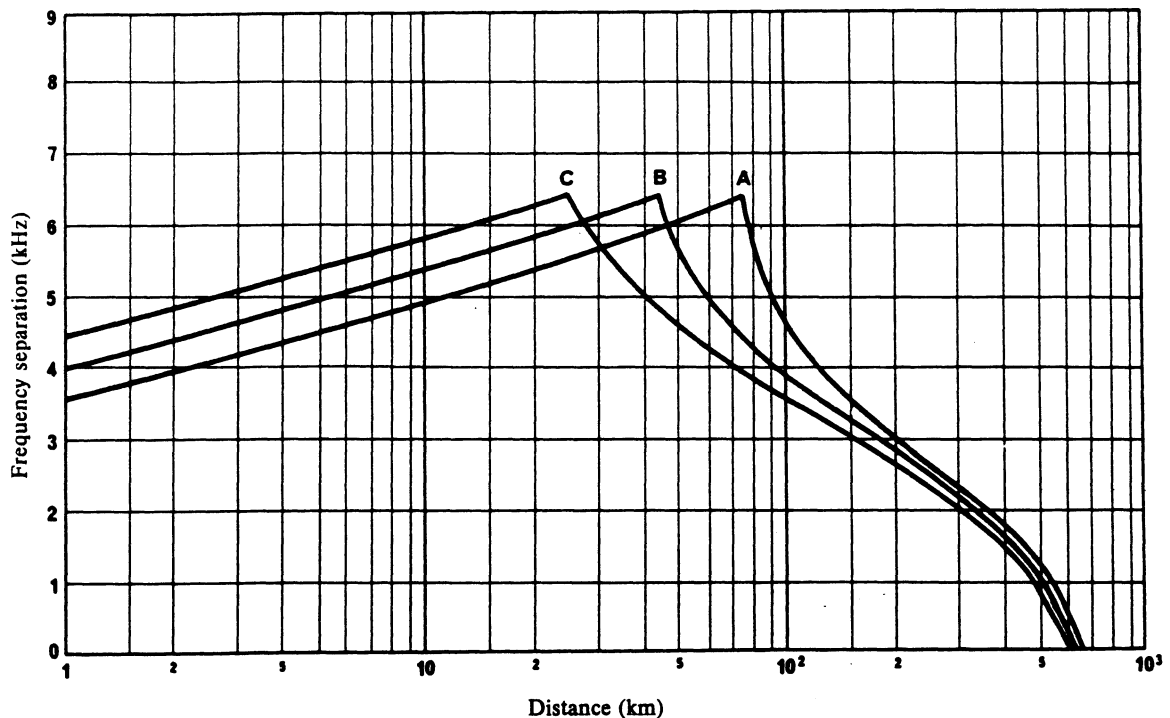


FIGURE 2 – Minimum frequency separation between transmitters in the maritime mobile service and the aeronautical radionavigation service versus interference distance

- Curves A: – coast station: 500 W e.r.p.
 – aeronautical beacon: range 75 km (40 NM)
 B: – coast station: 500 W e.r.p.
 – aeronautical beacon: range 45 km (25 NM)
 C: – coast station: 500 W e.r.p.
 – aeronautical beacon: range 25 km (15 NM)

4. Example of planning calculations for the more general case (see Note)

Examples of planning calculations for the more general case are contained in Annexes I and II.

Note. – Takes into account propagation by ground wave, sky wave and the case when the receiving antenna is located well above the surface of the Earth.

5. Test results

Tests [EELAB, 1983] were performed in Region 2 between a temporarily installed 100 W, 1020 Hz A2A aeronautical radiobeacon on 522 kHz and a 1 kW NAVTEX station (20 W e.r.p.) at a distance of 35 km, on 518 kHz. Because of the radiobeacon antenna characteristics, the NAVTEX transmitting facility was near the edge of the radiobeacon service area. Results indicated that a NAVTEX receiver installed 15 m from the radiobeacon (unwanted to wanted signal strength 60 dB) showed no reception error, while an ADF installed on a helicopter showed interference (indicator deflection) when within 2.2-2.5 NM (4-4.6 km) of the NAVTEX station.

6. Conclusions

6.1 Coexistence of the aeronautical radionavigation service and the maritime mobile service is possible when account is taken of protection requirements, e.r.p. and propagation loss for individual cases.