RECOMMENDATION 631-1

USE OF HYPERBOLIC MARITIME RADIONAVIGATION SYSTEMS IN THE BAND 283.5-315 kHz

(Question 58/8)

(1986-1992)

The CCIR,

considering

a) that there could be operational advantages in radionavigation systems operating in the band 283.5-315 kHz providing automatic determination of position;

b) that Recommendation No. 2 of the Regional Administrative Conference for the Planning of the Maritime Radionavigation Service (Radio beacons) in the European Maritime Area (Geneva, 1985) considered that a requirement for a phase measurement multi-frequency radionavigation system in the band 283.5-315 kHz had arisen and had invited the CCIR to continue to study the possibility of using radio beacons in the hyperbolic mode,

recommends

that the protection ratio for a hyperbolic phase measurement multi-frequency radionavigation system with characteristics such as those described in Annex 1, should be 20 dB within ± 110 Hz of the centre frequency of the system.

Note 1 – The technical characteristics of an existing phase measurement multi-frequency radionavigation system working in the hyperbolic mode are given in Annex 1.

ANNEX 1

Technical characteristics for a hyperbolic maritime radionavigation system in the band 283.5-315 kHz

1. Emissions

1.1 A hyperbolic system operating in the frequency band used by existing maritime radio beacons has a narrow spectrum and, for reasons of accuracy, is multi-frequency.

It operates by phase comparison between different unmodulated carriers emitted sequentially by at least three synchronous transmitters. These frequencies allow total resolution of ambiguity given a position known to within 700 km. Moreover, each station constantly emits a characteristic unmodulated carrier, on a frequency peculiar to it, for purposes of identification and constant updating of bearings during intervals of the sequential rhythm.

1.2 A chain may include as many transmitters as are necessary to cover the whole area, within the limit of 20 transmitters. Transmitters are spaced 100 to 200 km apart on average.

1.3 On each frequency, the transmission has a narrow spectrum (± 10 Hz) with a transmitter frequency stability of 10^{-6}.

All the continuously transmitted characteristic frequencies of a 20-station chain are grouped around a single central frequency which is not transmitted and occupy a band of B_p of bandwidth 22 × 6.25 = 137.5 Hz.

Eight sequential ambiguity resolution frequencies are dispersed throughout the band 283.5-315 kHz, with two others in the 405-415 kHz band.

The first two frequencies are 100 Hz to either side of the central frequency of the continuously transmitted frequency band B_p.

The system thus occupies one continuous band from 285.4-285.6 kHz, six very narrow-band frequencies between 285.6 and 315 kHz and two very narrow-band frequencies between 405 and 415 kHz (see No. 466A of the Radio Regulations).

1.4 The effective radiated power is low, under 1 W. This power provides coverage of 400 nautical miles for a minimum signal of 3 μV/m by day (night-time coverage 200 nautical miles).

2. Protection ratios and distances

2.1 The protection ratio against an interference signal locked on to an operating frequency of the system is 20 dB, which corresponds to a phase error of 1.7×10^{-2} of a cycle.

The interference distance for an interfering radio beacon as a function of its radiated power derives from this ratio and the minimum wanted field-strength value at the limit of service range (3 μV/m).

2.2 The protection ratio against a frequency offset interference source is a function of the selectivity curve of the hyperbolic multi-frequency receiver.

The main values to be taken into consideration are shown in Table 1.

TABLE 1

Protection ratios

Frequency separation of the interfering signal from the 285.4-285.6 band edges, or separation relative to one of the six sequential frequencies (Hz)	Interfering signal attenuation at the receiver input (dB)	Protection ratio interfering signal/wanted signal (dB)
0	0	–20
8.5	0	–20
10	57	+33
100	102	+78

2.3 The protection distance between interference source and hyperbolic multi-frequency transmitter can vary between 770 and 2 500 km, according to the power of the interference source, as shown below:

The hyperbolic system radiates 0.7 W isotropic power, and produces a field strength of:

– 34 dB(μV/m) at 130 km from the transmitter (70 nautical miles);

– 9 dB(μV/m) at 740 km from the transmitter (400 nautical miles), daytime range limit;

– 23 dB(μV/m) at 370 km from the transmitter (200 nautical miles), night-time range limit.

Correct signal processing requires a minimum signal-to-noise ratio of 20 dB (1.7×10^{-2} phase error).

The maximum interference signal level is thus:

– daytime: 9 – 20 = –11 dB(μV/m);

– night-time: 23 – 20 = +3 dB(μV/m).

This represents an attenuation, relative to the field of an interfering radio beacon at the edge of its service range, of 45 dB by day and 31 dB by night. The field strengths corresponding to this attenuation are obtained at distance, Δ, from the radio beacon as shown in Table 2 which is based on CCIR propagation curves plotted for 1 kW of radiated power.

TABLE 2

Oversea path

Radio beacon range (km)	Field strength at edge of service area for a 1 kW transmitter (dB(μV/m))	Field strength at the interference distance limit for a 1 kW transmitter (dB(μV/m))		Interference distance, Δ, from radio beacon (km)	
		Day	Night	Day	Night
18	85	40	54	800	400
36	79	34	48	1 000	550
54	75	30	44	1 100	700
90	70	25	39	1 300	800
130	67	22	36	1 450	900 (1)
180	65	20	34	1 550	1 100 (1)
216	62	17	31	1 600	1 300 (1)
270	60	15	29	1 650	1 500 (1)
370	56	11	25	1 750	1 600 (1)

(1) Including sky-wave signal.

The minimum separation distance for a hyperbolic transmitter and a radio beacon locked on the same frequency is the sum of the distance, Δ, in Table 2 and the range of the hyperbolic transmitter, i.e. 370 km by night and 740 km by day.

As the lowest value is 770 km and the highest value is 2 500 km, it is impossible to operate radio beacons and the hyperbolic system on the same frequencies.