RECOMMENDATION 589-2*

INTERFERENCE TO RADIONAVIGATION SERVICES FROM OTHER SERVICES IN THE FREQUENCY BANDS BETWEEN 70 AND 130 kHz

(Question 33/8)

(1982-1986-1992)

The CCIR,

considering

a) that radionavigation systems exist or are being implemented in the three Regions of the ITU;

b) that various services, including radionavigation systems, operate in frequency bands between 70 and 130 kHz;

c) that radionavigation being a safety service, all practical means consistent with the Radio Regulations (RR) should be taken to prevent harmful interference to any radionavigation system;

d) that users of phased pulsed radionavigation systems in the band 90-110 kHz receive no protection outside that band, yet may receive benefit from their signals outside the occupied bandwidth;

e) that in the band 90-110 kHz, different phased pulsed radionavigation systems may operate in adjacent areas, on the same assigned frequency and within the same occupied bandwidth,

recommends

1. that for CW-radionavigation systems in the frequency bands 70-90 kHz and 110-130 kHz the parameter to be used in planning, to avoid harmful interference, should be the protection ratio in terms of wanted to unwanted signals;

2. that the protection ratio, for CW-radionavigation systems with interference characteristics such as that of an existing system (described in Annex 1) that presently operates in the same bands, should be 15 dB within the receiver passband of ± 7 Hz at 3 dB;

3. that information be exchanged between the authorities operating radionavigation systems in the band 90-110 kHz with those operating other systems in the band 70-130 kHz employing stable transmissions;

4. that administrations operating radionavigation systems in the band 90-110 kHz in adjacent areas coordinate the technical characteristics of their individual systems in accordance with the RR;

5. that within the allocated band 90-110 kHz, the protection criteria for pulsed radionavigation systems (e.g. Loran-C and Chayka) should be in terms of unwanted to wanted emissions and in accordance with Annex 2;

6. determination of Loran-C signal levels should be in accordance with the guidelines given in Annex 2.

* The Director, CCIR, is requested to bring this Recommendation to the attention of the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the International Association of Lighthouse Authorities (IALA) and Study Group 7.

ANNEX 1

Decca Navigator (DN) system

1. Interference characteristics

1.1 Co-channel interference[*]

Co-channel interference is that experienced in a Decca Navigator (DN) receiver channel from another transmission whose carrier or line frequencies fall with ± 5 Hz (but more than ± 1 Hz, see § 3) of a DN transmission frequency. Interference arises because the DN receiver offers little or no rejection to the interfering signal, which if it is strong enough and is sufficiently phase stable will beat with the wanted DN transmission, and will at a level of the order of +12 dB (wanted/unwanted signal strengths), show considerable distortion in the accuracy of the phase output of the affected channel. Further at +15 dB (wanted/unwanted), triggering of the lane identification signal will be affected if the interference is on the 6*f* or 8.2*f* channels.

*1.2 Adjacent channel interference**

Adjacent channel interference is that experienced in a DN receiver from another transmission near to but differing by more than ± 5 Hz from a DN transmission frequency. The interference created by the unwanted signal, being incoherent with respect to the wanted signal, is treated by the DN receiver as if it were noise. The accepted level of interference to the 5*f*, 8*f* and 9*f* channels at the input to the DN receiver is +8 dB (wanted/unwanted) while the 6*f* and 8.2*f* triggering remains as in § 1 at +15 dB (wanted/unwanted). Typical DN receiver selectivity characteristics are as follows:

± 10 Hz separation: – 6 dB

± 20 Hz separation: –10 dB

± 50 Hz separation: –25 dB

± 100 Hz separation: –37 dB

± 200 Hz separation: –48 dB

± 500 Hz and greater separation: better than – 60 dB

In practice the true degree of DN receiver rejection to an interfering signal does depend on the bandwidth of that signal, especially as the wanted DN frequency is closely approached. Signals that are, by their nature (intentionally or otherwise), wideband may not be subject to the degree of rejection expected. Transmission spectrum analysis and local geographical knowledge of the interfering transmitter are therefore all-important for an accurate assessment of the degree of interference to a particular DN chain.

*1.3 Synchronous interference**

Synchronous interference will be experienced in a DN receiver from another transmission on a frequency very close (less than +1 Hz) to the DN frequency, especially when the interfering transmission frequency and the DN frequency are each separately stabilised by their own high stability standards.

This is clearly a special, and very serious, case of "co-channel" interference. It can arise if the interfering signal is CW in nature with an effect similar to that caused by co-channel interference with the difference that the DN phase information will in general tend to drift possibly in a slow oscillating manner or at worst (and most dangerous) could be nearly static over long periods of time with large phase errors and/or poor signal/noise characteristic.

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[*] The expression "wanted-to-unwanted signal ratio" when used in conjunction with an interfering pulsed transmission must be interpreted as "wanted CW to unwanted peak-signal-ratio".

The effects very much depend on the wanted-to-unwanted ratio of signal strengths but a +15 dB (wanted/unwanted) figure would keep the phase excursions within acceptable limits.

As regards the lane identification triggering requirement, the (wanted/unwanted) figure for CW interference and sideband interference would be similar to § 1 but if the interference was due to pulse energy (which would not be in existence long enough to cause persistent phase errors but could blank out triggering information for long periods) then this would be “time interference” which is covered in the next paragraph.

The side band or pulse spectral line energy although not in existence long enough as previously stated, to cause persistent phase errors, can upset the channel, causing hunting of the oscillators. A factor of 12 dB (wanted/unwanted) is required.

1.4 Time interference (Type I)

Time interference will in general only be experienced in the 6*f* or 8.2*f* channels of a DN receiver in the presence of a pulsed interfering transmission. A persistent effect will only be experienced:

– if the interfering transmission is of significantly long duration with respect to the shortest switching period of the DN system (i.e. lane identification triggering – 0.05 s);
– if the pulsed transmission is time coincident with the DN lane identification switching period;
– if the peak spectral line power of the pulsed transmission is strong enough; and
– if it is stable enough.

The effect on the DN receiver is a loss of triggering and a +15 dB (wanted/unwanted) protection factor is required.

1.5 Time interference (Type II)[*]

A pulsed transmission can, in specific conditions, cause different interference effects in a DN receiver. If the peak spectral line power of the pulse transmission at a particular location is very much greater than the power of the DN 6*f* or 8.2*f* transmission then the pulsed transmission will shock excite the DN lane identification 6*f* or 8.2*f* triggering. The effect is that the DN receiver will be made to produce false triggers with associated false phase indications. The degree of effect depends on the closeness of the spectral line frequency of the interference transmission to the DN frequency and the pulse repetition rate.

ANNEX 2

Loran-C protection criteria and signal level determination guidelines

1. Protection criteria

1.1 The protection criteria for Loran-C/CW interference as a function of frequency offset are given in Fig 1.

1.2 Near-synchronous interference at frequency, *f*, should satisfy the following relationship:

$$\left| f - \frac{n}{2\,GRI} \right| < f_b$$

[*] The expression “wanted-to-unwanted signal ratio” when used in conjunction with an interfering pulsed transmission must be interpreted as “wanted CW to unwanted peak-signal-ratio”.

where:

GRI : group reception intervals

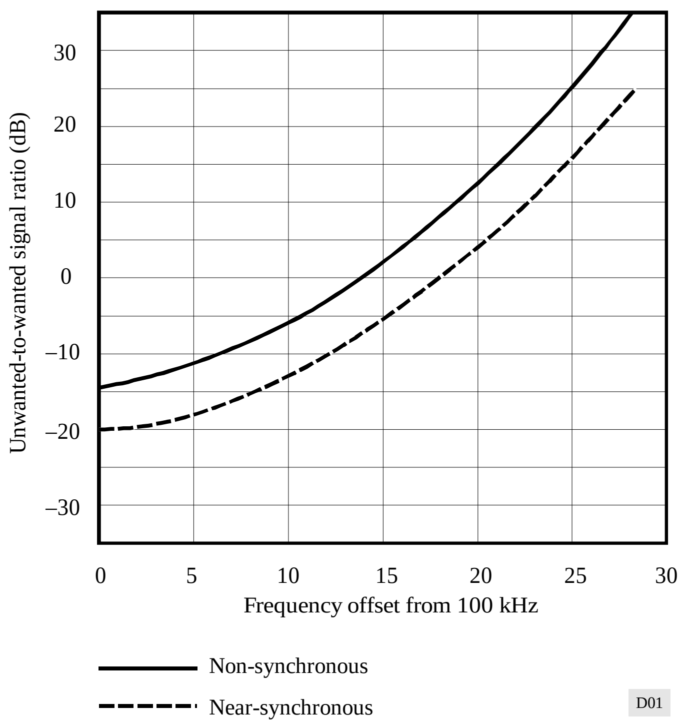
n : any integer, and

f_b : response bandwidth of the receiver (related to response time).

In the track-mode, typical Loran-C receivers have a –3 dB tracking response of 0.01 Hz for marine receivers and 0.1 Hz for aeronautical receivers. However, in the signal acquisition, or search mode, the response may be of considerably higher frequency. The value of f_b = 1.0 Hz is therefore recommended to be used.

FIGURE 1

Loran-C/CWI protection criteria



1.3 The protection criteria for Loran-C/FSK interference as a function of frequency offset are given in Fig. 2.

2. Signal level determination guidelines

The application of Figs. 1 and 2 to determine a maximum acceptable field strength of a specific unwanted signal to a known frequency requires knowledge of the expected Loran-C signal strength. This expected signal strength varies widely within the coverage area of a specific Loran-C chain. However, a minimum level may be determined at the coverage boundary.

The area of Loran-C coverage is specified by the administration operating the stations within a chain. This chain coverage area is determined on the basis of the Loran-C signal strength with respect to expected ambient noise levels. The signal-to-noise ratio at the boundary of the coverage area is typically –10 dB. Therefore, the signal-to-noise ratio within the defined coverage area is greater than that value. The ambient noise levels used to calculate the boundaries are derived from Recommendation 372, characteristics and applications of atmospheric radio noise data. The Loran-C field strength, measured at the boundary of that coverage area, then represents the minimum expected. For example, if the expected noise level is 55 dB(μV/m), a Loran-C signal level of 45 dB(μV/m) or higher would likely be found throughout the coverage area. 45 dB(μV/m) could then be used as the value of the wanted signal in conjunction with Figs. 1 and 2.

A study relative to chains operated within the United States of America reported that Loran-C signal levels within defined coverage areas may be as low as 43 dB(µV/m). Using this value, and considering a near-synchronous CWI signal between 90 and 110 kHz, the maximum unwanted to wanted signal level, determined from Fig. 1 is –20 dB. In this case, the unwanted field strength at the Loran-C receiver may have to be below 23 dB(µV/m) to prevent interference.

FIGURE 2

Loran-C/FSK protection criteria