

RECOMMENDATION ITU-R S.1068

**FIXED-SATELLITE AND RADIOLOCATION/RADIONAVIGATION SERVICES
SHARING IN THE BAND 13.75-14 GHz**

(Question ITU-R 79/4)

(1994)

The ITU Radiocommunication Assembly,

considering

- a) that the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992) (WARC-92) allocated the frequency band 13.75-14 GHz to the fixed-satellite service (FSS) on a primary basis;
- b) that this band is also allocated to the radiolocation and radionavigation services on a primary basis;
- c) that the Footnote No. 855A of the Radio Regulations (RR) restrictions were placed on the FSS and radiolocation and radionavigation services in order to allow these services to share this band;
- d) that the WARC-92 in Resolution No. 112 invited the ex-CCIR to conduct the necessary studies with respect to the values given in RR No. 855A and report its outcome;
- e) that digital and analogue TV-FM carriers in the FSS are sensitive to interference from radars;
- f) that studies have been performed to ascertain the effects of radar interference to these carrier types;
- g) that the highest average e.i.r.p.s of known existing radars operating in the band 13.75-14 GHz is 59 dBW,

recommends

- 1. that the minimum value of any emission from an earth station of 68 dBW e.i.r.p. is appropriate for the protection of carriers in the FSS from existing radars with a maximum average e.i.r.p. of 59 dBW;
- 2. that the minimum earth station antenna diameter of 4.5 m is consistent with the minimum e.i.r.p. requirement of 68 dBW for FSS networks and also minimizes the possibilities of unacceptable interference to the radionavigation and radiolocation services;
- 3. that the maximum value of any emission from an earth station of 85 dBW e.i.r.p. is consistent with the maximum values employed in FSS networks;
- 4. that the methods and criteria given in Annex 1 be used to compute and assess the interference from radars to FSS networks;
- 5. that the design of new transmitters in the radiolocation/radionavigation services should be consistent with the sharing criteria in Annex 1.

ANNEX 1

Sharing criteria between radiolocation/radionavigation services and the fixed-satellite service**1. Interference from radar into FSS**

Measurements reflecting very severe interference from radars in the band were conducted in order to assess its impact on some FSS digital carriers as well as to analogue TV carriers.

1.1 Measurements of interference into digital FSS carriers

The interference was measured into Intelsat intermediate data rate (IDR) digital carriers operating at 2 Mbit/s, 8 Mbit/s and 45 Mbit/s and using FEC rate 3/4. The interfering radars were assumed to operate in a range of the pulse repetition frequencies (PRF) of 1 kHz to 100 kHz. It was also assumed that the interference occurs during the “clear sky” conditions, i.e. that the noise level on the link is very low compared to the interference, and consequently, its impact is insignificant. The results of the measurements of the BER versus the duty cycle δ are shown in Fig. 1 for all the three digital carriers measured and for $PRF = 1$ kHz. The results for other PRFs show similar behaviour.

Having in mind that radar interference is a short time event, a degradation up to $BER = 10^{-6}$ is acceptable. Using the results of the measurements, the C/I values corresponding to $BER = 10^{-6}$ were determined and converted into the permissible peak radar e.i.r.ps. (e.i.r.ps of the FSS carrier of 68 dBW, 74 dBW and 81.5 dBW for 2 Mbit/s, 8 Mbit/s and 45 Mbit/s carriers, respectively). A composite envelope of the results is shown in Fig. 2 together with the $(59 - \log \delta)$ (dBW) limit imposed by the RR.

1.2 Measurements of interference into analogue TV carriers

The C/I ratios for “just perceptible interference” into a NTSC, 20 MHz TV carrier were recorded for PRFs of 1 kHz, 10 kHz and 100 kHz, and for duty cycles up to about 3%. The carrier-to-noise ratio of the TV carrier was set at 18 dB. The results are presented in Fig. 3. Following the same procedure as above for IDR carriers, a composite envelope of the maximum permissible peak radar e.i.r.ps was then derived for a TV carrier e.i.r.p. of 77 dBW and presented in Fig. 4.

2. Sharing criteria

The following criteria are based on the analysis in § 3 and 4 and are consistent with the expected radar emissions from the radars described in § 3.

2.1 Short-term criterion for FSS digital IDR carriers

The necessary short-term criterion for sharing between the FSS digital carriers and radars was obtained as an envelope of the maximum permissible peak radar e.i.r.ps towards FSS geostationary satellites determined for various FSS carriers as indicated in § 1. The following expression provides a good approximation of the envelope:

$$e.i.r.p.p \text{ (dBW)} = 59 + 15 \log [1 + 0.5 PRF \text{ (kHz)} / \delta \text{ (\%)}] \quad (1)$$

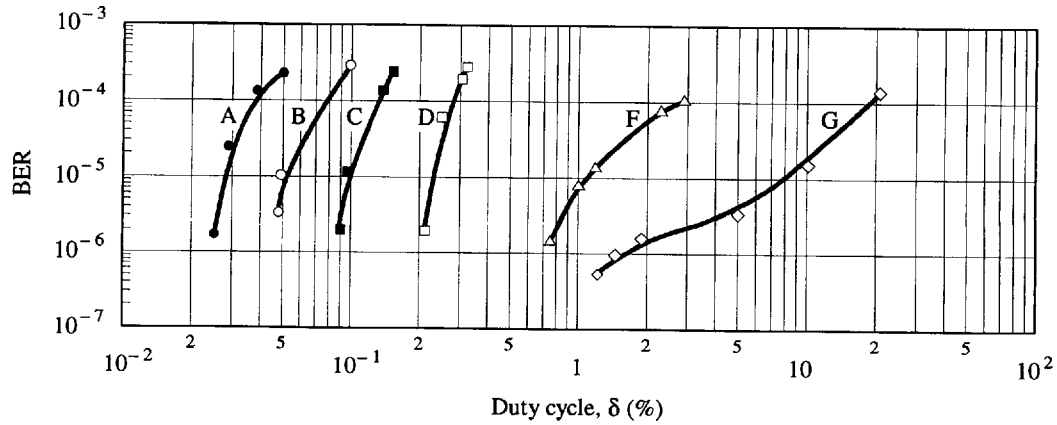
Taking into account the peak radar e.i.r.p. limit defined by the RR and the above developed criterion, the short-term sharing criteria can be defined as:

$$e.i.r.p.p \text{ (dBW)} \leq \begin{cases} 59 - 10 \log [\delta \text{ (\%)} / 100] \\ \text{or} \\ \left(\begin{array}{l} 59 + 15 \log [1 + 0.5 PRF \text{ (kHz)} / \delta \text{ (\%)}] \\ \text{for more than 99.98\% of any month} \\ \text{and 99.996\% of any year} \end{array} \right) \end{cases} \quad (2)$$

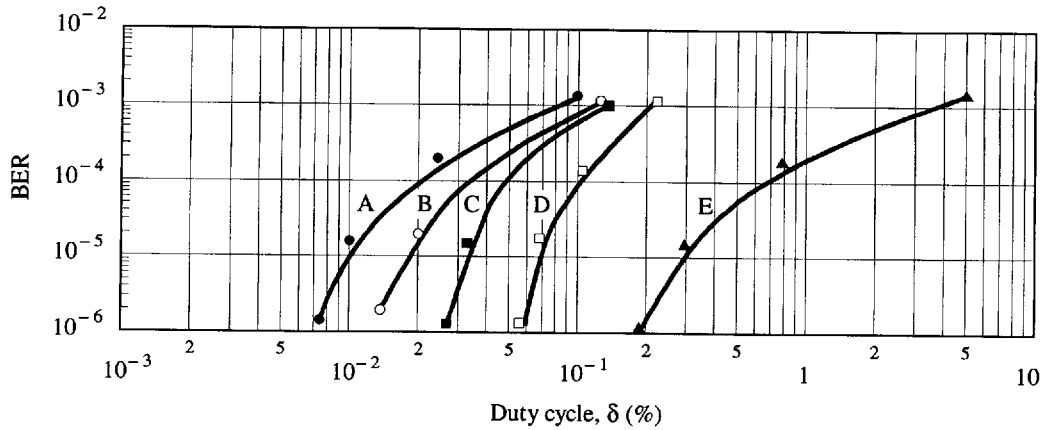
whichever is less. The criteria are shown in Fig. 2.

FIGURE 1
BER versus duty cycle for PRF of 1 kHz

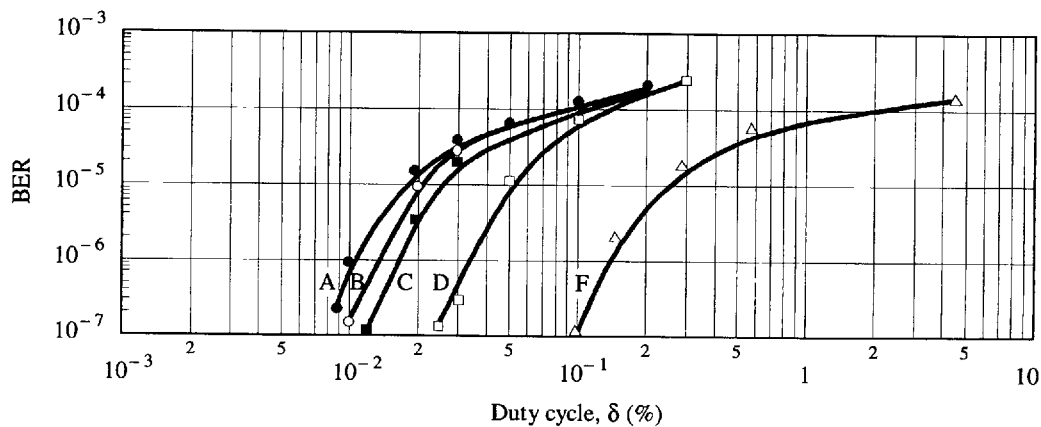
a) 2 Mbit/s IDR carrier



b) 8 Mbit/s IDR carrier



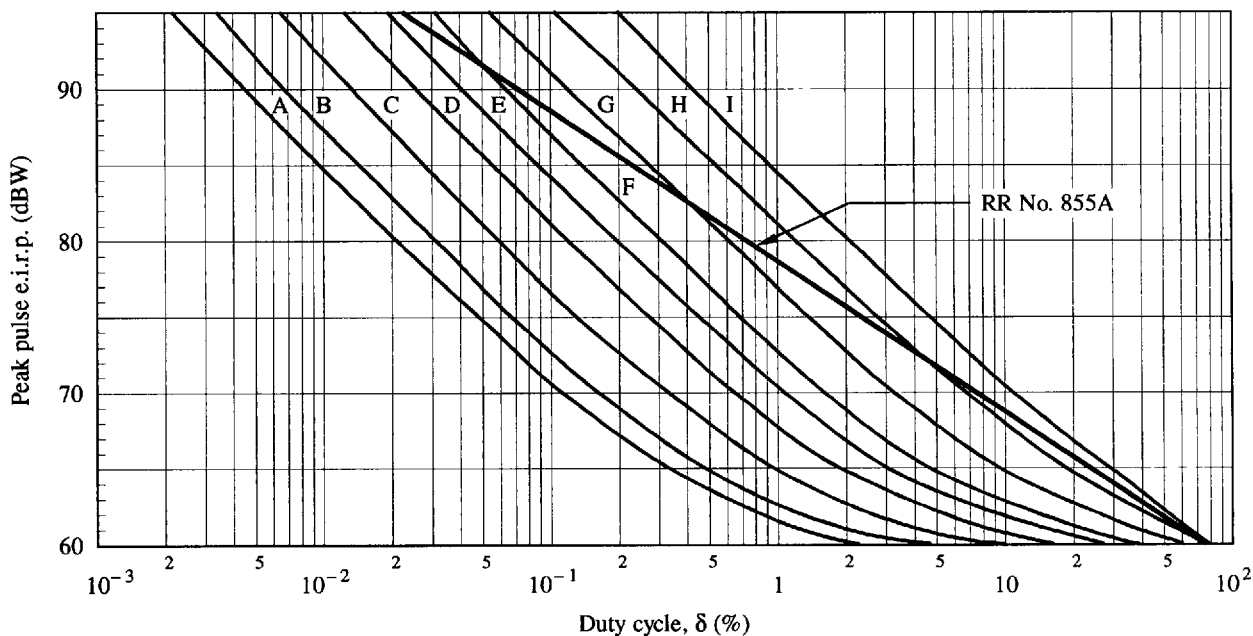
c) 45 Mbit/s IDR carrier



- | | |
|---------------------|-------------------|
| • A: $C/I = -15$ dB | ▲ E: $C/I = 4$ dB |
| ◊ B: $C/I = -10$ dB | △ F: $C/I = 5$ dB |
| ■ C: $C/I = -5$ dB | ◇ G: $C/I = 6$ dB |
| □ D: $C/I = 0$ dB | |



FIGURE 2
Interference criteria for IDR carriers



- | | |
|----------------|----------------|
| A: PRF = 1 K | F: PRF = 115 K |
| B: PRF = 1.5 K | G: PRF = 130 K |
| C: PRF = 3 K | H: PRF = 160 K |
| D: PRF = 6 K | I: PRF = 100 K |
| E: PRF = 10 K | |

$$e.i.r.p. \leq 59 + 15 \log [1 + 0.5 PRF \text{ (kHz)} / \delta \text{ (\%)}] \quad \text{dBW}$$

For IDR carriers, 2 Mbit/s to 45 Mbit/s,
QPSK, rate 3/4 FEC, BER = 1×10^6

$$e.i.r.p. \leq 59 - 10 \log [\delta \text{ (\%)} / 100] \quad \text{dBW (RR No. 855A)}$$

Doc

2.2 Long-term criterion for FSS digital IDR carriers

The mask in Fig. 5 provides the long-term criterion for FSS digital IDR carriers for radar duty cycles up to about 10%.

The peak radar e.i.r.p. at point A should be computed using equation (2). The percentage of time at point A is:

$$t(\%) = \frac{36 T(\%)}{BW(\text{MHz})} \quad (\text{For } BW = 36 \text{ MHz, } t\% = T\%)$$

$T = 0.004\%$ is the overall annual allowance. However, in the case of non-uniform distribution of radar emissions over the year, the worst month percentage should not exceed 0.02% provided that the overall annual allowance is maintained.