

## RECOMMENDATION ITU-R SA.1022-1

**METHODOLOGY FOR DETERMINING INTERFERENCE CRITERIA FOR  
SYSTEMS IN THE EARTH EXPLORATION-SATELLITE AND  
METEOROLOGICAL-SATELLITE SERVICES**

(Question ITU-R 138/7)

(1994-1999)

The ITU Radiocommunication Assembly,

*considering*

- a) that system designers require guidance on the levels of radio-frequency interference that their systems should tolerate;
- b) that permissible total levels of interference for systems operating in the Earth exploration-satellite and meteorological-satellite services should be based on performance objectives for those services;
- c) that, although specific systems may have performance objectives that differ from those recommended for the service, all systems operating in the Earth exploration-satellite and meteorological-satellite services should accommodate interference thresholds greater than or equal to the permissible levels of interference that are recommended for the service;
- d) that the methodology used to develop interference criteria for the Earth exploration-satellite and meteorological-satellite services may be applied to a specific system in order to determine the extent to which the permissible total levels of interference may be exceeded while meeting performance specifications for the system,

*recommends*

- 1** that the methodology of Annex 1 be used for the development of interference criteria for the Earth exploration-satellite and meteorological-satellite services;
- 2** that the methodology of Annex 1 be used for the determination of interference thresholds for specific systems, with the provision that these thresholds must be greater than or equal to the permissible levels established for the services according to § 1 above and specified in the relevant Recommendations.

## Methodology for determining interference criteria

The interference-free margin for the victim system can be defined as:

$$M = \frac{C/N_0}{(C/N_0)_{required}}$$

where  $C/N_0$  is the carrier-to-noise density ratio at the victim receiver, and  $(C/N_0)_{required}$  is the minimum carrier-to-noise density ratio needed to achieve the required system performance.  $M$  is conventionally expressed in dB, but in the equations that follow it is convenient not to do so.

Defining  $I_0$  as the interference spectral density at the victim receiver, the system margin in the presence of interference can be written:

$$M' = \frac{C/(N_0 + I_0)}{(C/N_0)_{required}}$$

If the interference is allowed to consume a fraction  $q$  of the interference-free margin expressed in dB (i.e.  $qM_{dB} = [C/(N_0 + I_0)]_{dB} - (C/N_0)_{dB}$ ), then  $\frac{M'}{M} = M^{-q} = \frac{C/(N_0 + I_0)}{C/N_0}$  and the permissible interference

spectral density becomes  $I_0 = N_0 (M^q - 1)$ . This expression for the permissible interference spectral density is not helpful when the victim system has little margin ( $M \cong 1$ ) because  $I_0$  becomes unrealistically small. Furthermore, it has no meaning when  $M < 1$ . A system having little or no margin should be expected to accept a reasonable amount of interference. Let  $M_{min}$  denote the smallest interference-free margin for which the victim system must be fully protected, i.e. for which only a fraction  $q$  of the interference-free margin expressed in dB is consumed by the interference. Then the victim must accept an interference spectral density at least equal to  $N_0 (M_{min}^q - 1)$ . In summary, then, the permissible interference is determined from:

$$I_0 = N_0 (M^q - 1) \quad \text{for } M > M_{min}$$

$$I_0 = N_0 (M_{min}^q - 1) \quad \text{for } M \leq M_{min}$$

Interference criteria for specific systems can be calculated from this equation after selecting suitable values for the parameters  $q$  and  $M_{min}$ .

### a) *Single-link communication systems*

Application of the above methodology to single-link systems (e.g. earth stations receiving sensor data from meteorological satellites) is straightforward.  $N_0$  represents the system noise density of the destination receiver, and  $I_0$  represents the interference density entering that receiver.

### b) *Two-link communication systems*

Application of the above methodology to two-link systems (e.g. earth stations receiving processed data from another earth station via a meteorological satellite transponder) is somewhat more complicated.  $N_0$  and  $I_0$  now represent the composite noise and interference densities at the destination receiver. Therefore they include not only the receive system noise and the interference that enters the receiver directly, but also the noise and interference received via the satellite. Determination of interference criteria must include an allocation for sharing the composite permissible interference by each link of the system. Typically it may be assumed that half of the interference is received via the satellite, and half enters the receiver directly, though this allocation may change in some situations.