RECOMMENDATION ITU-R S.1428-1

Reference FSS earth-station radiation patterns for use in interference assessment involving non-GSO satellites in frequency bands between 10.7 GHz and 30 GHz

(Question ITU-R 42/4)

(2000-2001)

The ITU Radiocommunication Assembly,

considering

a) that for earth station antennas in the fixed-satellite service (FSS), Recommendation ITU-R S.465 prescribes a reference antenna radiation pattern which represents an envelope of the side-lobe peaks;

b) that peak envelope antenna reference patterns are necessary for interference calculations involving a non-mobile receiver and a single non-mobile interference source to ensure that the worst case is covered, and that in the FSS such circumstances predominated in the past;

c) that in circumstances where there are multiple interfering sources or receivers whose positions vary substantially with time, the level of interference received inevitably depends on the troughs as well as the peaks in the antenna side lobe gain pattern of the victim or source of interference, respectively, and that the occurrence of such circumstances is rapidly increasing in the FSS;

d) that for FSS earth stations a suitable reference antenna radiation pattern is needed for use in calculations of interference from moving sources or receivers;

e) that to facilitate its use in computer simulations of interference, the reference antenna pattern should cover all off-axis angles from 0° to ±180° in all planes which include the principal axis;

f) that the reference antenna pattern should be consistent both with antenna theory and with the results of measurements on as wide a range of FSS earth station antennas as practicable;

g) that it might be appropriate to establish different reference antenna patterns for different ranges of D/λ and for different FSS frequency bands;

h) that for the purpose of specifying antenna performance, the peak envelope reference patterns in Recommendation ITU-R S.580 are appropriate;

j) that the use of the reference antenna pattern should lead to interference levels that would be representative of those received by antennas meeting relevant ITU-R antenna pattern Recommendations,

recommends

1 that for interference calculations involving moving interfering sources and/or victim receivers of FSS interference, the following reference earth station radiation antenna pattern should be employed:

for $20 \le \frac{D}{\lambda} \le 25$:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 \quad \text{dBi} \quad \text{for } 0 < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \quad \text{for } \varphi_m \le \varphi < \left(95 \frac{\lambda}{D} \right)$$

$$G(\varphi) = 29 - 25 \log \varphi \quad \text{dBi} \quad \text{for } 95 \frac{\lambda}{D} \le \varphi < 33.1°$$

$$G(\varphi) = -9 \quad \text{dBi} \quad \text{for } 33.1° < \varphi \le 80°$$

$$G(\varphi) = -5 \quad \text{dBi} \quad \text{for } 80° < \varphi \le 180°$$

for $25 < \frac{D}{\lambda} \le 100$:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 \quad \text{dBi} \quad \text{for } 0 < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \quad \text{for } \varphi_m \le \varphi < \left(95 \frac{\lambda}{D} \right)$$

$$G(\varphi) = 29 - 25 \log \varphi \quad \text{dBi} \quad \text{for } 95 \frac{\lambda}{D} \le \varphi \le 33.1°$$

$$G(\varphi) = -9 \quad \text{dBi} \quad \text{for } 33.1° < \varphi \le 80°$$

$$G(\varphi) = -4 \quad \text{dBi} \quad \text{for } 80° < \varphi \le 120°$$

$$G(\varphi) = -9 \quad \text{dBi} \quad \text{for } 120° < \varphi \le 180°$$

where:

D: antenna

λ: wavelength expressed in the same unit*

φ: off-axis angle of the antenna (degrees)

$$G_{max} = 20 \log \left(\frac{D}{\lambda} \right) + 7.7 \quad \text{dBi}$$

$$G_1 = 29 - 25 \log \left(95 \frac{\lambda}{D} \right)$$

$$\varphi_m = \frac{20 \lambda}{D} \sqrt{G_{max} - G_1} \quad \text{degrees}$$

---

* D is the equivalent diameter for non-symmetric antennas.

for $\frac{D}{\lambda} > 100$:

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 \quad \text{dBi} \quad \text{for } 0 < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \quad \text{for } \varphi_m \leq \varphi < \varphi_r$$

$$G(\varphi) = 29 - 25 \log \varphi \quad \text{dBi} \quad \text{for } \varphi_r \leq \varphi < 10°$$

$$G(\varphi) = 34 - 30 \log \varphi \quad \text{dBi} \quad \text{for } 10° \leq \varphi < 34.1°$$

$$G(\varphi) = -12 \quad \text{dBi} \quad \text{for } 34.1° \leq \varphi < 80°$$

$$G(\varphi) = -7 \quad \text{dBi} \quad \text{for } 80° \leq \varphi < 120°$$

$$G(\varphi) = -12 \quad \text{dBi} \quad \text{for } 120° \leq \varphi \leq 180°$$

where:

$$G_{max} = 20 \log \left(\frac{D}{\lambda} \right) + 8.4 \quad \text{dBi}$$

$$G_1 = -1 + 15 \log \frac{D}{\lambda} \quad \text{dBi}$$

$$\varphi_m = \frac{20 \lambda}{D} \sqrt{G_{max} - G_1} \quad \text{degrees}$$

$$\varphi_r = 15.85 \left(\frac{D}{\lambda} \right)^{-0.6} \quad \text{degrees}$$

NOTE 1 – For the purposes of calculation or computer simulation of the total power at the antenna output due to multiple interfering sources at varied polarizations, it should be assumed that the contribution of the cross-polar components at off-axis angles up to 30° and in the spill-over regions up to 120° is negligible. Outside these angular regions, even though a paraboloid antenna exhibits very little polarization discrimination, for the purpose of non-GSO/GSO interference calculations the contribution of cross-polar components can be ignored.

NOTE 2 – This Recommendation is based on studies of a range of paraboloid antennas. Further study is required of the applicability of the recommended reference patterns to planar array antennas.

NOTE 3 – This Recommendation may require revisions in the future when data on measured performance of antennas in the 20/30 GHz range becomes available.

NOTE 4 - Within this Recommendation, the use of the term moving when applied to an FSS earth station denotes a tracking earth station in the FSS and not a mobile earth station.