

RECOMMENDATION ITU-R S.1428

**REFERENCE FSS EARTH-STATION RADIATION PATTERNS FOR USE IN
INTERFERENCE ASSESSMENT INVOLVING NON-GSO SATELLITE
IN FREQUENCY BANDS BETWEEN 10.7 GHz AND 30 GHz**

(Question ITU-R 42/4)

(2000)

The ITU Radiocommunication Assembly,

considering

- a) that for earth station antennas in the FSS Recommendation ITU-R S.465 prescribes a reference 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 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 gain pattern of the victim or source, respectively, and that the occurrence of such circumstances is rapidly increasing in the FSS;
- d) that for FSS earth stations a suitable reference 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 pattern should cover all off-axis angles from 0° to $\pm 180^\circ$ in all planes which include the principal axis;
- f) that the reference 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 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 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 calculations involving moving sources or receivers of FSS interference, the following reference earth station radiation pattern should be employed:

For $20 \leq \frac{D}{\lambda} \leq 25$ (for GSO earth stations only):

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

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

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

$$G(\varphi) = -9 \quad \text{dBi} \quad \text{for} \quad 33.1^\circ < \varphi \leq 80^\circ$$

$$G(\varphi) = -5 \quad \text{dBi} \quad \text{for} \quad 80^\circ < \varphi \leq 180^\circ$$

For $25 \leq \frac{D}{\lambda} \leq 100$ (for GSO earth stations only):

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

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

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

$$G(\varphi) = -9 \quad \text{dBi} \quad \text{for} \quad 33.1^\circ < \varphi \leq 80^\circ$$

$$G(\varphi) = -4 \quad \text{dBi} \quad \text{for} \quad 80^\circ < \varphi \leq 120^\circ$$

$$G(\varphi) = -9 \quad \text{dBi} \quad \text{for} \quad 120^\circ < \varphi \leq 180^\circ$$

where:

$D = \text{antenna diameter}$
 $\lambda = \text{wavelength}$ } expressed in the same unit (D is the equivalent diameter for non-symmetric antennas)

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

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

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

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

For $\frac{D}{\lambda} > 100$ (for GSO and non-GSO earth stations):

$$\begin{aligned}
 G(\varphi) &= G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda} \varphi \right)^2 & \text{dBi} & \quad \text{for} \quad 0 < \varphi < \varphi_m \\
 G(\varphi) &= G_1 & & \quad \text{for} \quad \varphi_m \leq \varphi < \varphi_r \\
 G(\varphi) &= 29 - 25 \log \varphi & \text{dBi} & \quad \text{for} \quad \varphi_r \leq \varphi < 10^\circ \\
 G(\varphi) &= 34 - 30 \log \varphi & \text{dBi} & \quad \text{for} \quad 10^\circ \leq \varphi < 34.1^\circ \\
 G(\varphi) &= -12 & \text{dBi} & \quad \text{for} \quad 34.1^\circ \leq \varphi < 80^\circ \\
 G(\varphi) &= -7 & \text{dBi} & \quad \text{for} \quad 80^\circ \leq \varphi < 120^\circ \\
 G(\varphi) &= -12 & \text{dBi} & \quad \text{for} \quad 120^\circ \leq \varphi \leq 180^\circ
 \end{aligned}$$

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. This assumption may be reviewed in the light of further studies on the manner in which multiple signals at varied polarizations contribute to the total power received in the far-side lobe and back lobe regions.

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.