

RECOMMENDATION ITU-R S.580-6

**Radiation diagrams for use as design objectives for antennas
of earth stations operating with geostationary satellites**

(Question ITU-R 42/4)

(1982-1986-1990-1992-1993-1994-2003)

The ITU Radiocommunication Assembly,

considering

- a) that efficient utilization of the radio spectrum is a primary factor in the management of the geostationary-satellite orbit (GSO);
- b) that the side-lobe characteristic of earth-station antennas is one of the main factors in determining the minimum spacing between satellites and therefore the extent to which the radio spectrum can be efficiently employed;
- c) that the radiation diagram of antennas directly affects both the e.i.r.p. outside the main radiation axis and the power received by the side lobes;
- d) that the construction of antennas with improved side-lobe characteristics may be envisaged using current design techniques but that their practical applications may involve increase in cost;
- e) that the Radiocommunication Study Groups are studying the potential advantages of using antennas with improved side-lobe characteristics for a better utilization of the GSO,

recommends

- 1** that new antennas of an earth station operating with a geostationary satellite should have a design objective such that the gain, G , of at least 90% of the side-lobe peaks does not exceed:

$$G = 29 - 25 \log \varphi \quad \text{dBi}$$

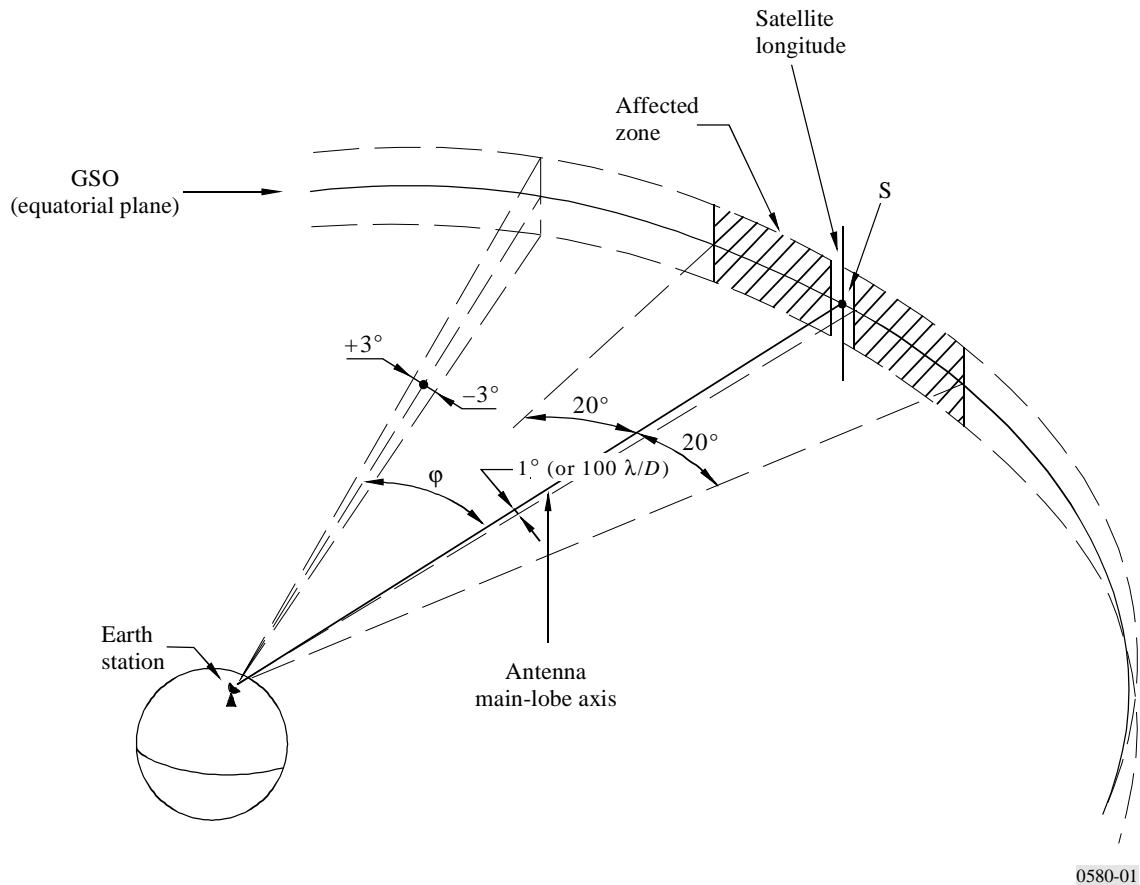
(G being the gain relative to an isotropic antenna and φ being the off-axis angle in the direction of the GSO referred to the main-lobe axis).

This requirement should be met for φ between 1° or $(100 \lambda/D)$ whichever is the greater and 20° for any off-axis direction which is within 3° of the GSO;

- 2** for an off-axis angle, φ , greater than the limits specified above, Recommendation ITU-R S.465 should be used as a reference (see Note 5);

FIGURE 1

Example of a zone around the GSO to which the design objective for earth-station antennas applies



3 that the following Notes should be considered part of this Recommendation.

NOTE 1 – This Recommendation primarily addresses the GSO sharing criteria. However, it must be emphasized that the application of this Recommendation should not prejudice the antenna characteristics concerned with frequency coordination between the FSS and terrestrial services (see Recommendation ITU-R S.465).

NOTE 2 – When asymmetric beam or asymmetric aperture antennas are used, the side-lobe radiation in the direction of the GSO can be reduced if the minor axis of the beam (major axis of the antenna aperture) is oriented so that it is parallel to the GSO arc. In this case, the alignment of the antenna aperture axes relative to the GSO arc would facilitate the compliance with *recommends* 1 in the affected zone around the GSO arc as indicated in Fig. 1:

- for the aperture minor axis plane, Recommendation ITU-R S.465 should be complied with for any off-axis angle ϕ beyond 1° or $(100 \lambda/D_e)$, whichever is the greater but not exceeding 3°, where D_e is provisionally defined as the circular equivalent diameter using the aperture area of the asymmetric aperture antenna as given below:

$$D_e = \sqrt{4A/\pi}$$

where A is the aperture area of the asymmetrical antenna;

- for the aperture major axis plane, *recommends* 1 should be complied with for any off-axis angle φ beyond 1° or $(100 \lambda/D_e)$, whichever is the greater but not exceeding 2° , where D_e is provisionally defined above.

NOTE 3 – This Recommendation applies to antennas with D/λ greater than or equal to 50. Further studies are required to determine a design objective for circular aperture antennas having a D/λ less than 50, and also to confirm the definition of D_e for the asymmetric aperture antennas.

NOTE 4 – The method of statistical processing of side-lobe peaks is dealt with in Recommendation ITU-R S.732.

NOTE 5 – In those cases where there is discontinuity between this design objective Recommendation and the reference radiation patterns of Recommendation ITU-R S.465, the gain, G , of at least 90% of the side-lobe peak is defined as follows:

$$G = -3.5 \quad \text{dBi} \quad \text{for } 20^\circ < \varphi \leq 26.3^\circ$$

NOTE 6 – For the analysis of an antenna pattern for angles φ not specified in this Recommendation, additional mathematical expressions from Appendix 7 of the Radio Regulations may be used as a reference to represent the radiation pattern limits for φ less than 1° or $(100 \lambda/D)$, whichever is the greater. Further study is required to define the most adequate expressions for this purpose.

NOTE 7 – Small earth-station antennas with improved main beam and side-lobe characteristics are being developed. It is indicated that the efficient use of the GSO may necessitate reflecting these improved characteristics in the ITU Radiocommunication Assembly texts and Recommendations.

NOTE 8 – The performance objectives in § 1 have been met by off-set-fed type antennas operating in the 10-14 GHz with $D/\lambda \geq 35$ and by off-set-fed type receive only antennas operating in the 10.7-11.7 GHz band with $D/\lambda \geq 22$.

NOTE 9 – Theoretical calculations supported by preliminary test results of the side-lobe radiation pattern, in the diagonal plane, for square microstrip array antennas with $D/\lambda \cong 26$ meet the current design objective of § 1. These tests were performed on an active array in the 14 GHz band. Further studies are required to confirm that this design objective can be applied to square microstrip phased array antennas.