

RECOMMENDATION ITU-R BO.1697

Power flux-density values in the band 11.7-12.7 GHz and associated calculation methodology which may be used for bilateral coordination when the power flux-density values in § 3 of Annex 1 to Appendix 30 or Annex 4 to Appendix 30 of the Radio Regulations are exceeded

(Question ITU-R 84/6)

(2005)

Scope

The Recommendation addresses power flux-density values in the band 11.7-12.7 GHz and associated calculation methodology which may be used for bilateral coordination between Administrations when the power flux-density values in § 3 of Annex 1 to Appendix 30 or Annex 4 to Appendix 30 are exceeded.

In particular, this Recommendation identifies pfd levels for particular antenna sizes, the envelope of which constitutes the pfd values in Annex 4 or § 3 of Annex 1 to Appendix 30.

It is to be noted that § 3 of Annex 1 to Appendix 30 and Annex 4 to Appendix 30 provide pfd masks corresponding to the envelope of the permissible interfering pfd into the range of BSS GSO earth station antenna sizes used in the 11.7-12.7 GHz band. These masks are used by BR to determine when coordination of proposed FSS or BSS assignments is required with previously filed BSS assignments and BSS Plan/List assignments.

The ITU Radiocommunication Assembly,

considering

- a) that systems in the fixed-satellite service (FSS) and the broadcasting-satellite service (BSS) have allocations in the band 11.7-12.7 GHz;
- b) that the use of this band by the FSS or BSS where this service is not subject to a Plan is subject to the procedure of Article 7 of Appendix 30 of the Radio Regulations (RR);
- c) that Annex 4 to Appendix 30 provides threshold values to determine if there is a need to coordinate FSS networks or BSS networks where this service is not subject to a Plan in one Region with respect to BSS networks in another Region in the band 11.7-12.7 GHz;
- d) that the use of this band by BSS where this service is subject to a Plan is subject to the procedure of Article 4 of Appendix 30;
- e) that § 3 of Annex 1 to Appendix 30 provides threshold values to determine if BSS in another Region may be affected by proposed new or modified BSS assignments,

further considering

- a) that the power flux-density (pfd) values in § 3 of Annex 1 to Appendix 30 and Annex 4 to Appendix 30 are thresholds to determine if the BSS assignment in one Region may be affected by a proposed BSS or FSS assignment in another Region;
- b) that such threshold values should necessarily be protective of BSS links with a wide range of technical characteristics;
- c) that § 3 of Annex 1 to Appendix 30 and Annex 4 to Appendix 30 also provide pfd masks which correspond to the envelope of the permissible interfering pfd into the range of BSS GSO earth station antenna sizes used in the 11.7-12.7 GHz band;
- d) that technical information is needed to address instances when the pfd values in § 3 of Annex 1 to Appendix 30 or Annex 4 to Appendix 30 are exceeded and coordination of the corresponding FSS or BSS assignments with BSS assignments is necessary,

recommends

1 that in cases where, as a result of the application of Article 7 of Appendix 30, the Annex 4 pfd values are exceeded, or as a result of the application of § 4.1.1c), 4.2.3a), 4.2.3b), or 4.2.3f) of Appendix 30, the § 3 of Annex 1 threshold values are exceeded, the pfd values given in Table 1 may be used by Administrations in their bilateral or multilateral coordination of their FSS or BSS assignments with BSS assignments, to identify levels equivalent to those in Annex 4 or § 3 of Annex 1 to Appendix 30 for particular antenna sizes (see also Notes 1 to 9 and 11);

2 that, notwithstanding *recommends* 1, the pfd value produced at the surface of the Earth within the service area of the affected BSS assignment by a FSS or a BSS network operating in another Region should, for the purposes of facilitating coordination, not exceed $-103.6 \text{ dB(W/(m}^2 \cdot 27 \text{ MHz))}$ (see Note 10).

TABLE 1

**Applicable pfd values (dB(W/(m² · 27 MHz)))
corresponding to various BSS antenna sizes**

Orbital separation between wanted and interfering space stations	45 cm⁽¹⁾	60 cm	80 cm	120 cm	240 cm	Other size
$\theta = 0^\circ$	-134.2	-136.7	-138.7	-141.4	-147.4	See Note 4
$\theta > 0^\circ$	See Table 2 and Note 3.					

⁽¹⁾ See Note 8.

NOTE 1 – The applicable pfd value should be derived from Table 1 using a BSS earth station antenna diameter as specified in § 3.7.1 of Annex 5 to Appendix 30, i.e. 1 m for Region 2 and 60 cm for Regions 1 and 3, unless otherwise specified in the Appendix 4 information/former Annex 2 to Appendix S30 information, as appropriate, provided to the Radiocommunication Bureau under Article 4 of Appendix 30 for the affected BSS assignment.

NOTE 2 – In calculating the compliance of the pfd levels produced by the interfering FSS or BSS network with those given in Table 1, the affected BSS receive earth station antenna should be assumed to be compliant with the antenna pattern specified in Recommendation ITU-R BO.1213, noting the relevant frequency within the 11.7-12.7 GHz band, and the corresponding maximum gain as defined under Step 2 of Annex 2 of this Recommendation.

NOTE 3 – In calculating the compliance of the pfd levels produced by the interfering FSS or BSS network with those given in Table 1, the minimum orbital separation between the wanted and interfering networks should be assumed, including the station-keeping accuracies. For any value of the orbital separation θ between the wanted and interfering space stations, the applicable pfd should be relaxed from the value corresponding to 0° orbital separation by adding the off-axis antenna discrimination, as calculated in accordance with Note 2.

NOTE 4 – For BSS earth station antenna diameters different from those in Table 1, the method given in Annex 2 of this Recommendation is an example of a possible way to interpolate.

NOTE 5 – The values in Table 1 may be exceeded by mutual agreement between the concerned Administrations.

NOTE 6 – This Recommendation and the associated methodology do not release Administrations from their coordination obligation under Articles 4 and 7 of Appendix 30.

NOTE 7 – The pfd values in Table 1 were derived using the methodology contained in Annex 1 and assuming a 6% noise increase interference allowance, a frequency of 11.7 GHz, an antenna efficiency of 65%, and total noise temperature values of 174 K for antennas with up to 60 cm diameter, 198 K for 80 cm diameter, 238 K for 120 cm or more. During coordination between concerned Administrations, other values for noise temperature increase and noise temperature may be considered.

NOTE 8 – The values for less than 60 cm antenna diameter are only applicable to (taking into account Note 1):

- Region 2 BSS networks;
- those Region 3 BSS networks that were notified and brought into use before 9 June 2003 whose notified assignments have been recorded in the Master Register with a favourable finding and for which the date of bringing into use has been confirmed to the Radiocommunication Bureau by that date.

NOTE 9 – This Recommendation is not intended to be used by the Bureau in its analysis of networks to determine whether or not the criteria in Annex 4 or § 3 of Annex 1 to Appendix 30 are exceeded.

NOTE 10 – The threshold value of $-103.6 \text{ dB(W(m}^2 \cdot 27 \text{ MHz))}$ referred to in *recommends 2* should not be confused with the similar value of $-103.6 \text{ dB(W(m}^2 \cdot 27 \text{ MHz))}$ contained in § 1 of Annex 1 of Appendix 30. The latter value is intended to be used as a hard limit to protect Regions 1 and 3 BSS from proposed new or modified BSS assignments in the Regions 1 and 3 List.

NOTE 11 – In the particular case of some steerable FSS spot beams deployed with small geographic separation between Regions, the values in Table 1 might not necessarily be the decisive factor. Additionally, specific agreements between the concerned Administrations may be needed.

Annex 1

Methodology to calculate pfd levels for BSS networks using particular earth station antenna sizes for use when the threshold values in § 3 of Annex 1 or Annex 4 to Appendix 30 are exceeded

1 Description of the methodology

The pfd required to protect an interfered-with BSS network is related to the receive earth station antenna gain and noise temperature of the interfered-with BSS network by the following formula:

$$\text{pfd}(\theta) = 10 \log (\Delta T/T) + 10 \log (k T b_{ref}) + 10 \log (4\pi/(0.3/f)^2) - G_a(\varphi)$$

where:

- θ : orbital separation between interfered-with and interfering satellites (see Note 3)
- φ : topocentric angle between the interfered-with and interfering satellites at the wanted receiving antenna
- $\Delta T/T$: allowable relative increase in receiver link noise
- k : Boltzmann's constant (1.38×10^{-23}) (J/K)
- T : total receive link noise temperature (K)
- b_{ref} : reference bandwidth (27 MHz in Regions 1 and 3; 24 MHz in Region 2)
- f : frequency of the interfered-with and interfering signals (GHz)
- $G_a(\varphi)$: receive antenna gain for topocentric angle of φ .

Note that for a specified ($\Delta T/T$), b_{ref} , and T the allowable interfering pfd is only a function of the receive antenna gain which is a function of satellite orbital separation. The term $10 \log (4\pi/(0.3/f)^2)$ in the above equation corresponds to the isotropic gain of a 1 m^2 effective aperture.

2 Application of the methodology to obtain the values specified in Table 2

The methodology in § 1 has been used for calculating the pfd values required for the protection of BSS networks with antenna sizes ranging from 45 cm to 2.4 m from interfering FSS or BSS networks with given orbital separation angles, with the assumptions given in Notes 2 and 7 of the Recommendation and assuming $\phi = 1.1 \theta$. The corresponding values for these cases are given in Table 2, which correspond to the pfd values given in Table 1 for $\theta = 0$. The noise temperature values are also given in Table 2 (see Note 11).

TABLE 2

Applicable pfd (pfd (θ)) values (dB(W/(m² · 27 MHz))) corresponding to various BSS earth station antenna sizes and orbital separations

Orbital separation angles (θ) (degrees)	45 cm antenna $T = 174$ K	60 cm antenna $T = 174$ K	80 cm antenna $T = 198$ K	120 cm antenna $T = 238$ K	240 cm antenna $T = 238$ K
0.01	-134.2	-136.7	-138.7	-141.4	-147.4
0.10	-134.2	-136.7	-138.7	-141.3	-147.2
0.50	-134.0	-136.3	-137.9	-139.7	-140.8
1.00	-133.3	-135.1	-135.7	-134.8	-127.9
1.50	-132.1	-133.0	-132.1	-126.5	-123.5
2.00	-130.5	-130.1	-126.9	-120.4	-120.4
2.50	-128.4	-126.4	-120.3	-117.9	-117.9
3.00	-125.9	-121.8	-116.8	-116.0	-116.0
3.50	-122.8	-116.5	-115.1	-114.3	-114.3
4.00	-119.3	-114.2	-113.6	-112.8	-112.8
5.00	-111.8	-111.8	-111.2	-110.4	-110.4
6.00	-109.8	-109.8	-109.2	-108.4	-108.4
7.00	-108.1	-108.1	-107.6	-106.8	-106.8
8.00	-106.7	-106.7	-106.1	-105.3	-105.3
9.00	-105.4	-105.4	-104.8	-104.0	-104.0
10.00	-104.3	-104.3	-103.7	-102.9 ⁽¹⁾	-102.9 ⁽¹⁾
11.00	-103.2 ⁽¹⁾	-103.2 ⁽¹⁾	-102.7 ⁽¹⁾	-101.9 ⁽¹⁾	-101.9 ⁽¹⁾
12.00	-102.3 ⁽¹⁾	-102.3 ⁽¹⁾	-101.7 ⁽¹⁾	-100.9 ⁽¹⁾	-100.9 ⁽¹⁾

⁽¹⁾ As a result of *recommends 2*, the value of -103.6 dB(W/(m² · 27 MHz)) is applicable in this case.

Annex 2

Methodology for determining the pfd ($\theta = 0$) values for an antenna size not included in Table 1

Step 1: Determination of closest parameters x_A , y_A , x_B , y_B from Table 1 and the applicable total noise value, T

If $45 \leq d \leq 60$ (cm) then: $T = 174$ K

If $60 < d \leq 80$ (cm) then: T is derived using the equation below with $x_A = 60$, $y_A = 174$, $x_B = 80$, $y_B = 198$

If $80 < d < 120$ (cm) then: T is derived using the equation below with $x_A = 80$, $y_A = 198$, $x_B = 120$, $y_B = 238$

If $120 \leq d \leq 240$ (cm) then: $T = 238$ K

$$T = y_A + (y_B - y_A)(d - x_A)/(x_B - x_A)$$

Step 2: Determination of the applicable maximum gain, G_{max}

$$G_{max} = 10 \log (0.65 (0.01\pi d/(0.3/f))^2)$$

Step 3: Determination of the applicable pfd ($\theta = 0$)

$$\text{pfd}(\theta = 0) = 10 \log (6/100) - 228.6 + 10 \log (T) + 74.3 + 10 \log (4\pi/(0.3/f)^2) - G_{max}$$

where:

T : total BSS system noise temperature (K)

d : diameter of the interfered-with receiving antenna (cm)

G_{max} : maximum gain of the interfered-with receiving antenna (dBi)

f : frequency of the interfered-with and interfering signals (GHz).
