ARTICLE 22

Space services[1]

Section I − Cessation of emissions

22.1   § 1   Space stations shall be fitted with devices to ensure immediate cessation of their radio emissions by telecommand, whenever such cessation is required under the provisions of these Regulations.

Section II − Control of interference to geostationary-satellite systems

22.2   § 2   1)   Non-geostationary-satellite systems shall not cause unacceptable interference to and, unless otherwise specified in these Regulations, shall not claim protection from geostationary-satellite networks in the fixed-satellite service and the broadcasting-satellite service operating in accordance with these Regulations. No. **5.43A** does not apply in this case.   (WRC-07)

22.3   2)   Whenever the emissions from geostationary satellites in the inter-satellite service are directed towards space stations at distances from Earth greater than that of the geostationary-satellite orbit, the boresight of the antenna mainbeam of the geostationary satellite shall not be pointed within 15° of any point on the geostationary-satellite orbit.

22.4   § 3   In the frequency band 29.95-30 GHz space stations in the Earth exploration-satellite service on board geostationary satellites and operating with space stations in the same service on board non-geostationary satellites shall have the following restriction:

                    Whenever the emissions from the geostationary satellites are directed towards the geostationary-satellite orbit and cause unacceptable interference to any geostationary-satellite space system in the fixed-satellite service, these emissions shall be reduced to a level at or less than accepted interference.

22.5   § 4   In the frequency band 8 025-8 400 MHz, which the Earth exploration-satellite service using non-geostationary satellites shares with the fixed-satellite service (Earth-to-space) or the meteorological-satellite service (Earth-to-space), the maximum power flux-density produced at the geostationary-satellite orbit by any Earth exploration-satellite service space station shall not exceed −174 dB(W/m^2) in any 4 kHz band.

22.5A   § 5   In the frequency band 6 700-7 075 MHz, the maximum aggregate power flux-density produced at the geostationary-satellite orbit and within ±5° of inclination around the geostationary-satellite orbit by a non-geostationary-satellite system in the fixed-satellite service shall not exceed −168 dB(W/m^2) in any 4 kHz band. The maximum aggregate power flux-density shall be calculated in accordance with Recommendation ITU-R S.1256-0.   (WRC-15)

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[1]   **A.22.1**   In applying the provisions of this Article, the level of accepted interference (see No. **1.168**) shall be fixed by agreement between the administrations concerned, using the relevant ITU-R Recommendations as a guide.

22.5B   (SUP - WRC-2000)

22.5C   § 6   1)   The equivalent power flux-density[2], epfd↓, at any point on the Earth's surface visible from the geostationary-satellite orbit, produced by emissions from all the space stations of a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Tables **22-1A** to **22-1E**, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Tables **22-1A** to **22-1E** for the given percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Tables **22-1A** to **22-1E**, for all pointing directions towards the geostationary-satellite orbit.   (WRC-03)

22.5CA   2)   The limits given in Tables **22-1A** to **22-1E** may be exceeded on the territory of any country whose administration has so agreed (see also Resolution **140 (WRC-03)**[*]).   (WRC-03)

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[2] **22.5C.1**   The equivalent power flux-density is defined as the sum of the power flux-densities produced at a geostationary-satellite system receive station on the Earth's surface or in the geostationary orbit, as appropriate, by all the transmit stations within a non-geostationary-satellite system, taking into account the off-axis discrimination of a reference receiving antenna assumed to be pointing in its nominal direction. The equivalent power flux-density is calculated using the following formula:

$$epfd = 10 \log_{10} \left[\sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4 \pi d_i^2} \cdot \frac{G_r(\varphi_i)}{G_{r,max}} \right]$$

where:

N_a: number of transmit stations in the non-geostationary-satellite system that are visible from the geostationary-satellite system receive station considered on the Earth's surface or in the geostationary orbit, as appropriate

i: index of the transmit station considered in the non-geostationary-satellite system

P_i: RF power at the input of the antenna of the transmit station, considered in the non-geostationary-satellite system (dBW) in the reference bandwidth

θ_i: off-axis angle between the boresight of the transmit station considered in the non-geostationary-satellite system and the direction of the geostationary-satellite system receive station

$G_t(\theta_i)$:   transmit antenna gain (as a ratio) of the station considered in the non-geostationary-satellite system in the direction of the geostationary-satellite system receive station

d_i: distance (m) between the transmit station considered in the non-geostationary-satellite system and the geostationary-satellite system receive station

φ_i: off-axis angle between the boresight of the antenna of the geostationary-satellite system receive station and the direction of the i-th transmit station considered in the non-geostationary-satellite system

$G_r(\varphi_i)$:   receive antenna gain (as a ratio) of the geostationary-satellite system receive station in the direction of the i-th transmit station considered in the non-geostationary-satellite system

$G_{r,max}$:   maximum gain (as a ratio) of the antenna of the geostationary-satellite system receive station

$epfd$:   computed equivalent power flux-density (dB(W/m^2)) in the reference bandwidth.   (WRC-2000)

[*]   *Note by the Secretariat*: This Resolution was revised by WRC-15.

TABLE **22-1A** (WRC-03)

Limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service systems in certain frequency bands[3, 4, 5, 6]

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern[7]
10.7-11.7 in all Regions; 11.7-12.2 in Region 2; 12.2-12.5 in Region 3 and 12.5-12.75 in Regions 1 and 3	−175.4	0	40	60 cm Recommendation ITU-R S.1428-1
	−174	90		
	−170.8	99		
	−165.3	99.73		
	−160.4	99.991		
	−160	99.997		
	−160	100		
	−181.9	0	40	1.2 m Recommendation ITU-R S.1428-1
	−178.4	99.5		
	−173.4	99.74		
	−173	99.857		
	−164	99.954		
	−161.6	99.984		
	−161.4	99.991		
	−160.8	99.997		
	−160.5	99.997		
	−160	99.9993		
	−160	100		

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[3] **22.5C.2**   For certain geostationary fixed-satellite service system receive earth stations, see also Nos. **9.7A** and **9.7B**.   (WRC-2000)

[4] **22.5C.3**   In meeting these limits, the administrations intending to develop such systems shall ensure that the assignments appearing in the Plan of Appendix **30B** will be fully protected.   (WRC-2000)

[5] **22.5C.4**   In addition to the limits shown in Table **22-1A**, the following single-entry epfd↓ limits apply to all antenna sizes greater than 60 cm in the frequency bands listed in Table **22-1A**:

100% of the time epfd↓ (dB(W/(m² · 40 kHz)))	Latitude (North or South) (degrees)	
−160	0	< |Latitude| ≤ 57.5
−160 + 3.4 (57.5 − |Latitude|)/4	57.5	< |Latitude| ≤ 63.75
−165.3	63.75	< |Latitude|

(WRC-2000)

[6] **22.5C.5**   For each reference antenna diameter, the limit consists of the complete curve on a plot which is linear (dB) for the epfd↓ levels and logarithmic for the time percentages, with straight lines joining the data points.   (WRC-2000)

[7] **22.5C.6**   For this Table, reference patterns of Recommendation ITU-R S.1428-1 shall be used only for the calculation of interference from non-geostationary-satellite systems in the fixed-satellite service systems into geostationary-satellite systems in the fixed-satellite service.   (WRC-03)

TABLE **22-1A** (*end*)   (WRC-03)

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern[7]
	−190.45	0	40	3 m Recommendation ITU-R S.1428-1
	−189.45	90		
	−187.45	99.5		
	−182.4	99.7		
	−182	99.855		
	−168	99.971		
	−164	99.988		
	−162	99.995		
	−160	99.999		
	−160	100		
	−195.45	0	40	10 m Recommendation ITU-R S.1428-1
	−195.45	99		
	−190	99.65		
	−190	99.71		
	−172.5	99.99		
	−160	99.998		
	−160	100		

TABLE **22-1B**   (WRC-03)

**Limits to the epfd↓ radiated by non-geostationary-satellite systems
in the fixed-satellite service in certain frequency bands[3, 6, 8]**

Frequency band (GHz)	epfd↓ (dB(W/m^2))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern[7]
17.8-18.6	−175.4	0	40	1 m Recommendation ITU-R S.1428-1
	−175.4	90		
	−172.5	99		
	−167	99.714		
	−164	99.971		
	−164	100		
	−161.4	0	1 000	
	−161.4	90		
	−158.5	99		
	−153	99.714		
	−150	99.971		
	−150	100		
	−178.4	0	40	2 m Recommendation ITU-R S.1428-1
	−178.4	99.4		
	−171.4	99.9		
	−170.5	99.913		
	−166	99.971		
	−164	99.977		
	−164	100		
	−164.4	0	1 000	
	−164.4	99.4		
	−157.4	99.9		
	−156.5	99.913		
	−152	99.971		
	−150	99.977		
	−150	100		
	−185.4	0	40	5 m Recommendation ITU-R S.1428-1
	−185.4	99.8		
	−180	99.8		
	−180	99.943		
	−172	99.943		
	−164	99.998		
	−164	100		
	−171.4	0	1 000	
	−171.4	99.8		
	−166	99.8		
	−166	99.943		
	−158	99.943		
	−150	99.998		
	−150	100		

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[8]   **22.5C.7**   A non-geostationary-satellite system shall meet the limits of this Table in both the 40 kHz and the 1 MHz reference bandwidths.   (WRC-2000)

TABLE **22-1C** (WRC-03)

**Limits to the epfd↓ radiated by non-geostationary-satelllite systems in
the fixed-satellite service in certain frequency bands[3, 6, 8]**

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern[7]
19.7-20.2	−187.4 −182 −172 −154 −154	0 71.429 97.143 99.983 100	40	70 cm Recommendation ITU-R S.1428-1
	−173.4 −168 −158 −140 −140	0 71.429 97.143 99.983 100	1 000	
	−190.4 −181.4 −170.4 −168.6 −165 −160 −154 −154	0 91 99.8 99.8 99.943 99.943 99.997 100	40	90 cm Recommendation ITU-R S.1428-1
	−176.4 −167.4 −156.4 −154.6 −151 −146 −140 −140	0 91 99.8 99.8 99.943 99.943 99.997 100	1 000	
	−196.4 −162 −154 −154	0 99.98 99.99943 100	40	2.5 m Recommendation ITU-R S.1428-1
	−182.4 −148 −140 −140	0 99.98 99.99943 100	1 000	
	−200.4 −189.4 −187.8 −184 −175 −164.2 −154.6 −154 −154	0 90 94 97.143 99.886 99.99 99.999 99.9992 100	40	5 m Recommendation ITU-R S.1428-1
	−186.4 −175.4 −173.8 −170 −161 −150.2 −140.6 −140 −140	0 90 94 97.143 99.886 99.99 99.999 99.9992 100	1 000	

TABLE **22-1D** (Rev.WRC-15)

Limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands into 30 cm, 45 cm, 60 cm, 90 cm, 120 cm, 180 cm, 240 cm and 300 cm broadcasting-satellite service antennas[6, 9, 10, 11]

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern[12]
11.7-12.5 in Region 1; 11.7-12.2 and 12.5-12.75 in Region 3; 12.2-12.7 in Region 2	−165.841 −165.541 −164.041 −158.6 −158.6 −158.33 −158.33	0 25 96 98.857 99.429 99.429 100	40	30 cm Recommendation ITU-R BO.1443-3, Annex 1
	−175.441 −172.441 −169.441 −164 −160.75 −160 −160	0 66 97.75 99.357 99.809 99.986 100	40	45 cm Recommendation ITU-R BO.1443-3, Annex 1
	−176.441 −173.191 −167.75 −162 −161 −160.2 −160 −160	0 97.8 99.371 99.886 99.943 99.971 99.997 100	40	60 cm Recommendation ITU-R BO.1443-3, Annex 1

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[9] **22.5C.8**   For broadcasting-satellite service antenna diameters 180 cm, 240 cm and 300 cm, in addition to the single-entry limits shown in Table **22-1D**, the following single-entry 100% of the time epfd↓ limits also apply in the frequency bands listed in Table **22-1D**:

100% of the time epfd↓ (dB(W/(m² · 40 kHz)))	Latitude (North or South) (degrees)	
−160	0	< |Latitude| ≤ 57.5
−160 + 3.4 (57.5 − |Latitude|)/4	57.5	< |Latitude| ≤ 63.75
−165.3	63.75	< |Latitude|

(WRC-2000)

[10] **22.5C.9**   For a broadcasting-satellite service earth station antenna diameter of 240 cm, in addition to the single-entry 100% of the time epfd↓ limit specified in No. **22.5C.8** to this Table, a single-entry 100% of the time operational epfd↓ limit is specified in Table **22-4C**.   (WRC-2000)

[11] **22.5C.10**   In meeting these limits, the administrations intending to develop such systems shall ensure that the assignments appearing in the Plans of Appendix **30** will be fully protected.   (WRC-2000)

[12] **22.5C.11**   For this Table, reference patterns of Annex 1 to Recommendation ITU-R BO.1443-3 shall be used only for the calculation of interference from non-geostationary satellite systems in the fixed-satellite service into geostationary-satellite systems in the broadcasting-satellite service.   (WRC-15)

TABLE **22-1D** (*end*)   (Rev.WRC-15)

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern[12]
11.7-12.5 in Region 1; 11.7-12.2 and 12.5-12.75 in Region 3; 12.2-12.7 in Region 2	−178.94 −178.44 −176.44 −171 −165.5 −163 −161 −160 −160	0 33 98 99.429 99.714 99.857 99.943 99.991 100	40	90 cm Recommendation ITU-R BO.1443-3, Annex 1
	−182.44 −180.69 −179.19 −178.44 −174.94 −173.75 −173 −169.5 −167.8 −164 −161.9 −161 −160.4 −160	0 90 98.9 98.9 99.5 99.68 99.68 99.85 99.915 99.94 99.97 99.99 99.998 100	40	120 cm Recommendation ITU-R BO.1443-3, Annex 1
	−184.941 −184.101 −181.691 −176.25 −163.25 −161.5 −160.35 −160 −160	0 33 98.5 99.571 99.946 99.974 99.993 99.999 100	40	180 cm Recommendation ITU-R BO.1443-3, Annex 1
	−187.441 −186.341 −183.441 −178 −164.4 −161.9 −160.5 −160 −160	0 33 99.25 99.786 99.957 99.983 99.994 99.999 100	40	240 cm Recommendation ITU-R BO.1443-3, Annex 1
	−191.941 −189.441 −185.941 −180.5 −173 −167 −162 −160 −160	0 33 99.5 99.857 99.914 99.951 99.983 99.991 100	40	300 cm Recommendation ITU-R BO.1443-3, Annex 1

TABLE **22-1E** (WRC-03)

Limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands

Frequency band (MHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern (m)
3 700-4 200	−195.4	100	4	1.8 [13]
	−197.9	100	4	2.4 [13]
	−201.6	100	4	3.7 [13]
	−203.3	100	4	4.5 [13]
	−204.5	100	4	5.5 [13]
	−207.5	100	4	8 [13]
	−208.5	100	4	10 [13]
	−212.0	100	4	15 [13]

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[13] **22.5C.12** The associated reference radiation pattern is defined as follows:

a)   for values of $\left(\dfrac{D}{\lambda}\right) \geq 100$:

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

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

$$G(\varphi) = 29 - 25 \log \varphi \qquad \text{for} \quad \varphi_r \quad \leq \varphi < 20°$$

$$G(\varphi) = -3.5 \qquad \text{for} \quad 20° \quad \leq \varphi < 26.3°$$

$$G(\varphi) = 32 - 25 \log \varphi \qquad \text{for} \quad 26.3° \leq \varphi < 48°$$

$$G(\varphi) = -10 \qquad \text{for} \quad 48° \quad \leq \varphi \leq 180°$$

b)   for values of $42 \leq \left(\dfrac{D}{\lambda}\right) < 100$:

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

$$G(\varphi) = G_1 \qquad \text{for} \quad \varphi_m \quad \leq \varphi < 100\left(\frac{\lambda}{D}\right)$$

$$G(\varphi) = 29 - 25 \log \varphi \qquad \text{for} \quad 100\left(\frac{\lambda}{D}\right) \leq \varphi < 20°$$

$$G(\varphi) = -3.5 \qquad \text{for} \quad 20° \quad \leq \varphi < 26.3°$$

$$G(\varphi) = 32 - 25 \log \varphi \qquad \text{for} \quad 26.3° \leq \varphi < 48°$$

$$G(\varphi) = -10 \qquad \text{for} \quad 48° \quad \leq \varphi \leq 180°$$

22.5D   3) The equivalent power flux-density[14], epfd↑, produced at any point in the geostationary-satellite orbit by emissions from all the earth stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table **22-2**, for all conditions and for all methods of modulation, shall not exceed the limits given in Table **22-2** for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Table **22-2**, for all pointing directions towards the Earth's surface visible from any given location in the geostationary-satellite orbit.   (WRC-2000)

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[13] **22.5C.12** (*continued*)

c)   for values of $\left(\dfrac{D}{\lambda}\right) < 42$:

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

$$G(\varphi) = G_1 \qquad \text{for} \qquad \varphi_m \ \leq \varphi < 100 \left(\frac{\lambda}{D}\right)$$

$$G(\varphi) = 32 - 25 \log \varphi \qquad \text{for} \qquad 100 \left(\frac{\lambda}{D}\right) \leq \varphi < 48°$$

$$G(\varphi) = -10 \qquad \text{for} \qquad 48° \ \leq \varphi \leq 180°$$

where:

D: antenna diameter

λ: wavelength $\qquad\Big\}$ expressed in the same units

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

G_1:   gain of the first side lobe $= 2 + 15 \log \left(\dfrac{D}{\lambda}\right)$ dBi

$\varphi_m = \dfrac{20\lambda}{D} \sqrt{G_{max} - G_1}$ degrees

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

$G_{max} = 7.7 + 20 \log \left(\dfrac{D}{\lambda}\right)$ dBi   (WRC-03)

[14] **22.5D.1**   See No. **22.5C.1**.   (WRC-2000)

TABLE **22-2**   (WRC-03)

Limits to the epfd↑ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[15]

Frequency band	epfd↑ (dB(W/m²))	Percentage of time epfd↑ level may not be exceeded	Reference bandwidth (kHz)	Reference antenna beamwidth and reference radiation pattern[16]
5 925-6 725 MHz	−183.0	100	4	1.5° Recommendation ITU-R S.672-4, $Ls = -20$
12.5-12.75 GHz 12.75-13.25 GHz 13.75-14.5 GHz	−160	100	40	4° Recommendation ITU-R S.672-4, $Ls = -20$
17.3-18.1 GHz (Regions 1 and 3) 17.8-18.1 GHz (Region 2) [17]	−160	100	40	4° Recommendation ITU-R S.672-4, $Ls = -20$
27.5-28.6 GHz	−162	100	40	1.55° Recommendation ITU-R S.672-4, $Ls = -10$
29.5-30 GHz	−162	100	40	1.55° Recommendation ITU-R S.672-4, $Ls = -10$

22.5E   (SUP - WRC-2000)

22.5F   4)   The equivalent power flux-density[18], $epfd_{is}$, produced at any point in the geostationary-satellite orbit by emissions from all the space stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table **22-3**, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Table **22-3** for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions into a reference antenna and in the reference bandwidth specified in Table **22-3**, for all pointing directions towards the Earth's surface visible from any given location in the geostationary-satellite orbit.   (WRC-2000)

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[15] **22.5D.2**   In meeting these limits, the administrations intending to develop such systems shall ensure that the assignments appearing in the Plans of Appendices **30A** and **30B** will be fully protected.   (WRC-2000)

[16] **22.5D.3**   For this Table, reference patterns of Recommendation ITU-R S.672-4 shall be used only for the calculation of interference from non-geostationary-satellite systems in the fixed-satellite service into geostationary-satellite systems in the fixed-satellite service. For the case of $Ls = -10$, the values $a = 1.83$ and $b = 6.32$ shall be used in the equations in Annex 1 to Recommendation ITU-R S.672-4 for single-feed circular beams. In all cases of Ls, the parabolic main beam equation shall start at zero.   (WRC-2000)

[17] **22.5D.4**   This epfd↑ level also applies to the frequency band 17.3-17.8 GHz to protect broadcasting-satellite service feeder links in Region 2 from non-geostationary fixed-satellite service Earth-to-space transmissions in Regions 1 and 3.   (WRC-2000)

[18] **22.5F.1**   See No. **22.5C.1**.   (WRC-2000)

TABLE **22-3**   (WRC-2000)

Limits to the epfd$_{is}$ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[19]

Frequency band (GHz)	epfd$_{is}$ (dB(W/m²))	Percentage of time during which epfd$_{is}$ level may not be exceeded	Reference bandwidth (kHz)	Reference antenna beamwidth and reference radiation pattern[20]
10.7-11.7 (Region 1) 12.5-12.75 (Region 1) 12.7-12.75 (Region 2)	−160	100	40	4° Recommendation ITU-R S.672-4, $Ls = -20$
17.8-18.4	−160	100	40	4° Recommendation ITU-R S.672-4, $Ls = -20$

22.5G   (SUP - WRC-2000)

22.5H   5)   The limits specified in Nos. **22.5C** (except for Table **22-1E**) to **22.5D** (except for Table **22-2** for the frequency band 5 925-6 725 MHz) and **22.5F** apply to non-geostationary-satellite systems in the fixed-satellite service for which complete coordination or notification information, as appropriate, has been received by the Bureau after 22 November 1997. The limits specified in Table **22-1E** and those specified in Table **22-2** for the frequency band 5 925-6 725 MHz apply to non-geostationary-satellite systems in the fixed-satellite service for which complete notification information has been received by the Bureau after 5 July 2003. The limits in Tables **22-4A**, **22-4A1**, **22-4B** and **22-4C** do not apply to non-geostationary-satellite systems in the fixed-satellite service for which complete coordination or notification information, as appropriate, has been received by the Bureau before 22 November 1997.   (WRC-03)

22.5I   6)   An administration operating a non-geostationary-satellite system in the fixed-satellite service which is in compliance with the limits in Nos. **22.5C**, **22.5D** and **22.5F** shall be considered as having fulfilled its obligations under No. **22.2** with respect to any geostationary-satellite network, irrespective of the dates of receipt by the Bureau of the complete coordination or notification information, as appropriate, for the non-geostationary-satellite system and the geostationary-satellite network, provided that the epfd↓ radiated by the non-geostationary-satellite system in the fixed-satellite service into any operating geostationary fixed-satellite service earth station does not exceed the operational and additional operational limits given in Tables **22-4A**, **22-4A1**, **22-4B** and **22-4C**, when the diameter of the earth station antenna is equal to the values given in Table **22-4A**, **22-4A1** or **22-4C**, or the gain of the earth station is equal to or greater than the values given in Table **22-4B** for the corresponding orbital inclination of the geostationary fixed-satellite service satellite. Except as otherwise agreed between concerned administrations, an administration operating a non-geostationary-satellite system in the fixed-satellite service that is subject to the limits in Nos. **22.5C**, **22.5D** and **22.5F** and which radiates epfd↓ into any operating geostationary fixed-satellite service earth station at levels in excess of the operational or additional operational limits

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[19] **22.5F.2**   In meeting these limits, the administrations intending to develop such systems shall ensure that the assignments appearing in the feeder-link Plans of Appendix **30A** will be fully protected.   (WRC-2000)

[20] **22.5F.3**   In this Table, the reference pattern of Recommendation ITU-R S.672-4 shall be used only for the calculation of interference from non-geostationary-satellite systems in the fixed-satellite service into geostationary-satellite systems in the fixed-satellite service. In applying the equations of Annex 1 to Recommendation ITU-R S.672-4, the parabolic main beam equation shall start at zero.   (WRC-2000)

given in Tables **22-4A**, **22-4A1**, **22-4B** and **22-4C**, when the diameter of the earth station antenna is equal to the values given in Tables **22-4A**, **22-4A1** or **22-4C**, or the gain of the earth station is equal to or greater than the values given in Table **22-4B** for the corresponding orbital inclination of the geostationary fixed-satellite service satellite, shall be considered to be in violation of its obligations under No. **22.2**, and the provisions of Article **15** (Section V) apply. In addition, administrations are encouraged to use the relevant ITU-R Recommendations to determine whether such a violation has occurred.   (WRC-03)

TABLE **22-4A**   (REV.WRC-07)

Operational limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[21, 22, 23]

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Geostationary-satellite system receive earth station antenna diameter[24] (m)	Orbital inclination of the geostationary satellite (degrees)
10.7-11.7 in all Regions 11.7-12.2 in Region 2 12.2-12.5 in Region 3, and 12.5-12.75 in Regions 1 and 3 (prior to 31 December 2005)	−163 −166 −167.5 −169.5	100	40	3 6 9 ≥ 18	≤ 2.5
	−160 −163 −164.5 −166.5	100	40	3 6 9 ≥ 18	> 2.5 and ≤ 4.5
10.7-11.7 in all Regions 11.7-12.2 in Region 2 12.2-12.5 in Region 3, and 12.5-12.75 in Regions 1 and 3 (from 31 December 2005)	−161.25 −164 −165.5 −167.5	100	40	3 6 9 ≥ 18	≤ 2.5
	−158.25 −161 −162.5 −164.5	100	40	3 6 9 ≥ 18	> 2.5 and ≤ 4.5

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[21] **22.5H.1**   For certain geostationary fixed-satellite service receive earth stations, see also Nos. **9.7A** and **9.7B**.   (WRC-2000)

[22] **22.5H.2**   In addition to the operational limits shown in Table **22-4A**, the additional operational limits in Table **22-4A1** apply to certain geostationary fixed-satellite service earth station antenna sizes in the frequency bands listed in Table **22-4A**.   (WRC-2000)

[23] **22.5H.3**   The operational limits on the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service shall be the values given in No. **22.5C.4** or Table **22-4A**, whichever are the more stringent.   (WRC-2000)

[24] **22.5H.4**   For antenna diameters between the values given in this Table, the limits are given by linear interpolation using a linear scale for epfd↓ (dB) and a logarithmic scale for antenna diameter (m).   (WRC-2000)

TABLE **22-4A1**   (WRC-2000)

Additional operational limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service into 3 m and 10 m geostationary fixed-satellite service earth station antennas

epfd↓ (dB(W/(m² · 40 kHz)))	Percentage of time during which epfd↓ may not be exceeded	Geostationary-satellite system receive earth station antenna diameter (m)
−182	99.9	3
−179	99.94	
−176	99.97	
−171	99.98	
−168	99.984	
−165	99.993	
−163	99.999	
−161.25	99.99975	
−161.25	100	
−185	99.97	10
−183	99.98	
−179	99.99	
−175	99.996	
−171	99.998	
−168	99.999	
−166	99.9998	
−166	100	

TABLE **22-4B**   (WRC-2000)

Operational limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[21, 25]

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Geostationary-satellite system receive earth station antenna gain (dBi)	Orbital inclination of geostationary satellite (degrees)
19.7-20.2	−157	100	40	≥ 49	≤ 2.5
	−157	100	40	≥ 43 [25]	≤ 2.5
	−155	100	40	≥ 49	> 2.5 and ≤ 4.5
19.7-20.2	−143	100	1 000	≥ 49	≤ 2.5
	−143	100	1 000	≥ 43 [25]	≤ 2.5
	−141	100	1 000	≥ 49	> 2.5 and ≤ 4.5
17.8-18.6	−164	100	40	≥ 49	≤ 2.5
	−162	100	40	≥ 49	> 2.5 and ≤ 4.5
17.8-18.6	−150	100	1 000	≥ 49	≤ 2.5
	−148	100	1 000	≥ 49	> 2.5 and ≤ 4.5

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[25] **22.5H.5**   The operational limit applies to non-geostationary-satellite systems operating at altitudes of 7 000 km or above in order to protect geostationary-satellite systems in the fixed-satellite service employing adaptive coding.   (WRC-2000)

TABLE **22-4C**   (WRC-2000)

Operational limits to the epfd↓ radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands[26]

Frequency band (GHz)	epfd↓ (dB(W/m²))	Percentage of time during which epfd↓ may not be exceeded	Reference bandwidth (kHz)	Geostationary-satellite system receive earth station antenna diameter (m)	Orbital inclination of geostationary satellite (degrees)
12.2-12.7 in Region 2	−167	100	40	≥ 2.4	≤ 0.5

22.5J   7)   In case of *force majeure*, telecommand and ranging carriers transmitted to non-geostationary satellites in the fixed-satellite service are not subject to the limits given in Table **22-2**.   (WRC-2000)

22.5K   8)   Administrations operating or planning to operate non-geostationary-satellite systems in the fixed-satellite service in the bands listed in Tables **22-1A** to **22-1D** of No. **22.5C** will apply the provisions of Resolution **76 (WRC-2000)**[*] to ensure that the actual aggregate interference into geostationary fixed-satellite service and geostationary broadcasting-satellite service networks caused by such systems operating co-frequency in these frequency bands does not exceed the aggregate power levels shown in Tables **1A** to **1D** of Resolution **76 (WRC-2000)**[*]. In the event that an administration operating a geostationary-satellite network in conformity with the Radio Regulations identifies equivalent power flux-density levels from non- geostationary-satellite systems in the fixed-satellite service which may be in excess of the aggregate limits contained in Tables **1A** to **1D** of Resolution **76 (WRC-2000)**[*], the administrations responsible for the non-geostationary-satellite systems in the fixed-satellite service will apply the provisions contained in *resolves* 2 of Resolution **76 (WRC-2000)**[*].   (WRC-2000)

Section III − Station keeping of space stations[27]

22.6   § 6   1)   Space stations on board geostationary satellites which use any frequency band allocated to the fixed-satellite service or the broadcasting-satellite service[28]:

22.7   *a)*   shall have the capability of maintaining their positions within ±0.1° of the longitude of their nominal positions;

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[26] **22.5H.6**   These limits apply into geostationary-satellite system earth stations located in Region 2 west of 140° W, north of 60° N, pointing toward geostationary satellites in the broadcasting-satellite service at 91° W, 101° W, 110° W, 119° W and 148° W with elevation angles greater than 5°. This limit is implemented during a transition period of 15 years.   (WRC-2000)

[*]   *Note by the Secretariat*: This Resolution was revised by WRC-15.

[27] **A.22.III.1** In the case of space stations on board geosynchronous satellites with circular orbits having an angle of inclination greater than 5°, the positional tolerance shall relate to the nodal point.

[28] **22.6.1**   Space stations in the broadcasting-satellite service on geostationary satellites operating in the band 11.7-12.7 GHz are exempted from these provisions but shall maintain their positions in accordance with Appendix **30**.

22.8   *b)*   shall maintain their positions within ±0.1° of longitude of their nominal positions; *but*

22.9   *c)*   experimental stations on board geostationary satellites need not comply with No. **22.7** nor No. **22.8**, but shall maintain their positions within ±0.5° of longitude of their nominal positions;

22.10   *d)*   however, space stations need not comply with No. **22.8** nor No. **22.9** as appropriate as long as the satellite network to which the space station belongs does not cause unacceptable interference to any other satellite network whose space station complies with the limits given in Nos. **22.8** and **22.9**.

22.11   2) Space stations on board geostationary satellites which do not use any frequency band allocated to the fixed-satellite service or the broadcasting-satellite service:

22.12   *a)*   shall have the capability of maintaining their positions within ±0.5° of the longitude of their nominal positions;

22.13   *b)*   shall maintain their positions within ±0.5° of longitude of their nominal positions; *but*

22.14   *c)*   need not comply with No. **22.13** as long as the satellite network to which the space station belongs does not cause unacceptable interference to any other satellite network whose space station complies with the limits given in No. **22.13**.

22.15   3) Space stations[29] on board geostationary satellites which are put into service prior to 1 January 1987, with the advance publication information for the network having been published before 1 January 1982, are exempted from the provisions of Nos. **22.6** to **22.14** inclusive; however they

22.16   *a)*   shall have the capability of maintaining their positions within ±1° of the longitude of their nominal positions, but efforts should be made to achieve a capability of maintaining their positions at least within ±0.5° of the longitude of their nominal positions;

22.17   *b)*   shall maintain their positions within ±1° of longitude of their nominal positions; *but*

22.18   *c)*   need not comply with No. **22.17** as long as the satellite network to which the space station belongs does not cause unacceptable interference to any other satellite network whose space station complies with the limits given in No. **22.17**.

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[29] **22.15.1**   Space stations in the broadcasting-satellite service on geostationary satellites operating in the band 11.7-12.7 GHz are exempted from these provisions but shall maintain their positions in accordance with Appendix **30**.

Section IV − Pointing accuracy of antennas on geostationary satellites

22.19   § 7   1) The pointing direction of maximum radiation of any earthward beam of antennas on geostationary satellites[30] shall be capable of being maintained within:

     a)   10 % of the half-power beamwidth relative to the nominal pointing direction, or

     b)   0.3° relative to the nominal pointing direction, whichever is greater. This position applies only when such a beam is intended for less than global coverage.

22.20   2) In the event that the beam is not rotationally symmetrical about the axis of maximum radiation, the tolerance in any plane containing this axis shall be related to the half power beamwidth in that plane.

22.21   3) This accuracy shall be maintained only if it is required to avoid unacceptable interference to other systems.

Section V − Radio astronomy in the shielded zone of the Moon

22.22   § 8   1) In the shielded zone of the Moon[31] emissions causing harmful interference to radio astronomy observations[32] and to other users of passive services shall be prohibited in the entire frequency spectrum except in the following bands:

22.23   *a)*   the frequency bands allocated to the space research service using active sensors;

22.24   *b)*   the frequency bands allocated to the space operation service, the Earth exploration-satellite service using active sensors, and the radiolocation service using stations on spaceborne platforms, which are required for the support of space research, as well as for radiocommunications and space research transmissions within the lunar shielded zone.

22.25   2) In frequency bands in which emissions are not prohibited by Nos. **22.22** to **22.24**, radio astronomy observations and passive space research in the shielded zone of the Moon may be protected from harmful interference by agreement between administrations concerned.

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[30] **22.19.1**   Transmitting antennas of space stations in the broadcasting-satellite service operating in the band 11.7-12.7 GHz are not subject to these provisions but shall maintain their pointing accuracy in accordance with § 3.14.1 of Annex 5 to Appendix **30**.

[31] **22.22.1**   The shielded zone of the Moon comprises the area of the Moon's surface and an adjacent volume of space which are shielded from emissions originating within a distance of 100 000 km from the centre of the Earth.

[32] **22.22.2**   The level of harmful interference is determined by agreement between the administrations concerned, with the guidance of the relevant ITU-R Recommendations.

Section VI − Off-axis power limits on earth stations of a geostationary-satellite network in the fixed-satellite service[33, 34]   (WRC-2000)

22.26   § 9   The level of equivalent isotropically radiated power (e.i.r.p.) emitted by an earth station of a geostationary-satellite network shall not exceed the following values for any off-axis angle φ which is 3° or more off the main-lobe axis of an earth station antenna:

Off-axis angle	*Maximum e.i.r.p.*	
3° ≤ φ ≤ 7°	$42 - 25 \log \varphi$ dB(W/40 kHz)	
7° < φ ≤ 9.2°	21 dB(W/40 kHz)	
9.2° < φ ≤ 48°	$45 - 25 \log \varphi$ dB(W/40 kHz)	
48° < φ ≤ 180°	3 dB(W/40 kHz)	(WRC-2000)

22.27   For frequency-modulated television emissions with energy dispersal, the limits in No. **22.26** above may be exceeded by up to 3 dB, provided that the off-axis total e.i.r.p. of the transmitted frequency-modulated television carrier does not exceed the following values:

Off-axis angle	*Maximum e.i.r.p.*	
3° ≤ φ ≤ 7°	$56 - 25 \log \varphi$ dBW	
7° < φ ≤ 9.2°	35 dBW	
9.2° < φ ≤ 48°	$59 - 25 \log \varphi$ dBW	
48° < φ ≤ 180°	17 dBW	(WRC-2000)

22.28   Frequency-modulated television carriers which operate without energy dispersal should be modulated at all times with programme material or appropriate test patterns. In this case, the off-axis total e.i.r.p. of the emitted frequency-modulated television carrier shall not exceed the following values:

Off-axis angle	*Maximum e.i.r.p.*	
3° ≤ φ ≤ 7°	$56 - 25 \log \varphi$ dBW	
7° < φ ≤ 9.2°	35 dBW	
9.2° < φ ≤ 48°	$59 - 25 \log \varphi$ dBW	
48° < φ ≤ 180°	17 dBW	(WRC-2000)

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[33] **22.VI.1**   The provisions of this section shall not be used for coordination of, or to evaluate interference between, geostationary fixed-satellite service networks (see No. **9.50.1**).   (WRC-2000)

[34] **22.VI.2**   Although the provisions of this section cover off-axis power limitations in all directions, the radiation pattern of geostationary fixed-satellite service earth station antennas in more than two orthogonal planes is not required.   (WRC-2000)

22.29   The e.i.r.p. limits given in Nos. **22.26**, **22.27** and **22.28** are applicable in the following frequency bands allocated to the fixed-satellite service (Earth-to-space):

12.75-13.25 GHz

13.75-14 GHz

14-14.5 GHz.   (WRC-97)

22.30   The e.i.r.p. limits given in Nos. **22.26**, **22.27**, **22.28** and **22.32** do not apply to earth station antennas in service or ready to be in service[35] prior to 2 June 2000, nor to earth stations associated with a satellite network in the fixed-satellite service for which complete coordination or notification information has been received before 2 June 2000.   (WRC-2000)

22.31   Telecommand and ranging[36] carriers transmitted to geostationary satellites in the fixed-satellite service in normal mode of operation (i.e. earth station transmitting telecommand and ranging carriers to a directional receiving antenna on the space station) may exceed the levels given in No. **22.26** by no more than 16 dB in the frequency bands 12.75-13.25 GHz and 13.75-14.5 GHz. In all other modes of operation, and in case of *force majeure*, telecommand and ranging carriers transmitted to geostationary satellites in the fixed-satellite service are exempted from the levels given in No. **22.26**.   (WRC-2000)

22.32   § 10   The level of equivalent isotropically radiated power (e.i.r.p.) density emitted by an earth station in a geostationary-satellite network in the 29.5-30 GHz frequency band shall not exceed the following values for any off-axis angle φ which is 3° or more off the main-lobe axis of an earth station antenna:

Off-axis angle	*Maximum e.i.r.p. density*
3° $\leq \varphi \leq$ 7°	$28 - 25 \log \varphi$ dB(W/40 kHz)
7° $< \varphi \leq$ 9.2°	7 dB(W/40 kHz)
9.2° $< \varphi \leq$ 48°	$31 - 25 \log \varphi$ dB(W/40 kHz)
48° $< \varphi \leq$ 180°	-1 dB(W/40 kHz) (WRC-2000)

22.33   Not used.   (WRC-2000)

22.34   Telecommand and ranging carriers transmitted to geostationary satellites in the fixed-satellite service in normal mode of operation (i.e. earth station transmitting telecommand and ranging carriers to a directional receiving antenna on the space station) may exceed the levels given in No. **22.32** by no more than 10 dB in the frequency band 29.5-30 GHz. In all other modes of operation, and in case of *force majeure*, telecommand and ranging carriers transmitted to geostationary satellites in the fixed-satellite service are exempted from the levels given in No. **22.32**.   (WRC-2000)

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[35] **22.30.1**   "Ready to be in service" relates to the case where antennas have been installed but the start of service has been delayed due to *force majeure*.   (WRC-2000)

[36] **22.31.1**   Measurement of the distance to the satellite.   (WRC-2000)

22.35   For geostationary-satellite systems in which the earth stations are expected to transmit simultaneously in the same 40 kHz band, e.g. for geostationary-satellite systems employing code-division multiple access, the maximum e.i.r.p. values given in No. **22.32** should be decreased by 10 log(N) dB, where N is the number of earth stations which are in the receive satellite beam of the satellite with which these earth stations are communicating and which are expected to transmit simultaneously on the same frequency.   (WRC-2000)

22.36   Earth stations operating in the frequency band 29.5-30 GHz should be designed in such a manner that 90% of their peak off-axis e.i.r.p. density levels do not exceed the values given in No. **22.32**. Further study is needed to determine the off-axis angular range over which these exceedences would be permitted, taking into account the interference level into adjacent satellites. The statistical processing of the off-axis e.i.r.p. density peaks should be carried out using the method given in the most recent version of Recommendation ITU-R S.732.   (WRC-07)

22.37   The limits given in Nos. **22.26** to **22.28** and **22.32** apply under clear-sky conditions. During rain-fade conditions, the limits may be exceeded by earth stations when using uplink power control.   (WRC-2000)

22.38   Earth stations in the fixed-satellite service operating in the 29.5-30 GHz band, which have lower elevation angles to the geostationary-satellite orbit, will require higher e.i.r.p. levels relative to the same terminals at higher elevation angles to achieve the same power flux-densities at the geostationary-satellite orbit, due to the combined effect of increased distance and atmospheric absorption. Earth stations with low elevation angles may exceed the levels given in No. **22.32** by the following amounts:

Elevation angle to geostationary-satellite orbit, ε	*Increase in e.i.r.p. density (dB)*	
$\varepsilon \le 5°$	2.5	
$5° < \varepsilon \le 30°$	$0.1(25 - \varepsilon) + 0.5$	(WRC-2000)

22.39   The values in No. **22.32** applicable to the off-axis angle range from 48° to 180° are intended to account for spillover effects.   (WRC-2000)

Section VII − Limits to the interference into the frequency band 14.5-14.8 GHz by the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting satellite service   (WRC-15)

22.40   Under assumed free-space propagation conditions, the power flux-density emitted by an earth station of a geostationary-satellite network not for feeder links for the broadcasting-satellite service in the frequency bands 14.5-14.75 GHz in countries listed in Resolution **163 (WRC-15)** and 14.50-14.8 GHz in countries listed in Resolution **164 (WRC-15)** shall not exceed the value of −76 dB(W/(m^2 · 27 MHz)) at any point in the geostationary-satellite orbit.   (WRC-15)