RECOMMENDATION ITU-R SA.1277-0*, **

SHARING IN THE 8 025-8 400 MHz FREQUENCY BAND BETWEEN THE EARTH EXPLORATION-SATELLITE SERVICE AND THE FIXED, FIXED-SATELLITE, METEOROLOGICAL-SATELLITE AND MOBILE SERVICES IN REGIONS 1, 2 AND 3

(Question ITU-R 214/7)

(1997)

The ITU Radiocommunication Assembly,

considering

a) that fixed services (FS), fixed-satellite services (FSS) and mobile services are allocated on a primary basis in the 8 025-8 400 MHz frequency band in the three Regions;

b) that the meteorological-satellite (METSAT) service is allocated on a primary basis in the 8 175-8 215 MHz frequency band in the three Regions;

c) that the Earth exploration-satellite service (EESS) is allocated on a primary basis in Region 2, and on a secondary basis in Regions 1 and 3 in the 8 025-8 400 MHz frequency band;

d) that no interference can be caused by the EESS to the FS and the mobile service when the power flux-density (pfd) limits imposed by the Radio Regulations (RR) No. S21.16 are respected (see § 1 of Annex 1);

e) that no interference can be caused by the EESS to the FSS and the METSAT when the pfd limits at the geostationary orbit, imposed by the RR No. S22.5, are respected (see § 2 of Annex 1);

f) that the study in § 2 of Annex 2 shows that there exists extensive possibilities for siting of EESS earth stations among a network of fixed stations;

g) that *considering* f) may be extended also for siting EESS earth stations with respect to fixed-satellite and meteorological earth stations (see § 3 of Annex 2);

h) that the study in § 4 of Annex 2 shows that, as in *considering* f), there exists extensive possibilities for siting of EESS earth stations among mobile stations;

j) that from the experience gained over the last 20 years, it is demonstrated that no frequency sharing problems can be encountered between the EESS and the FS, the FSS, the METSAT and mobile services in the three Regions;

k) that the effective planning and development of future EESS networks with global coverage require a primary allocation status in the three Regions,

recommends

1 that sharing between the EESS and the FS, the FSS, the METSAT and the mobile services in the 8 025-8 400 MHz band is feasible subject to the following conditions:

– RR No. S22.5 and RR No. S21.16 provisions apply;

– the method described in Annex 2 be used to calculate separation distances between earth stations of the EESS and terrestrial stations or earth stations of the other services. (Separation distance refers to the distance that could be achieved in coordination).

---

* This Recommendation should be brought to the attention of Radiocommunication Study Groups 4, 8 and 9.

** Radiocommunication Study Group 7 made editorial amendments to this Recommendation in the year 2017 in accordance with Resolution ITU-R 1.

ANNEX 1

Analysis of interference from the EESS to other services in the frequency band 8 025-8 400 MHz

1 Interference potentiality from space stations of the EESS to terrestrial stations of the FS and the mobile service

The RR No. S21.16 imposes pfd limits at the ground level relative to the space stations' emissions. These limits are given in Table 1 for the 8 025-8 400 MHz frequency band in 4 kHz bandwidth.

TABLE 1

pfd limits in the 8 025-8 400 MHz frequency band

Arrival angle, θ	pfd limit (dB(W/(m^2.4 kHz))
0° ≤ θ ≤ 5°	–150
5° < θ ≤ 25°	–150 + (θ – 5) / 2
25° < θ ≤ 90°	–140

In so far as the transmitters of the Earth exploration-satellite stations respect these constraints, the FS and mobile service receivers are protected because these limits have been set so as to avoid the interferences from space stations transmitters to terrestrial services.

2 Interference from space stations of the EESS to space stations of the FSS and the METSAT service

The relative position of the near-polar circular orbit of an EESS satellite and the GSO is shown in Fig. 1.

The EESS satellite directs its maximum e.i.r.p. to the horizon of its coverage. The worst case occurs when this satellite, the horizon of its coverage and a geostationary satellite (FS or meteorological service) are in alignment as shown in Fig. 2.

According to RR No. S22.5 the pfd at the GSO shall not exceed –174 dB(W/m^2) in any 4 kHz bandwidth. With typical EESS satellite characteristics, as given in Table 2, the actual pfd produced at GSO in the worst case is –183 dB(W/m^2) in 4 kHz.

The effect of such pfd on the FSS and on the METSAT service is illustrated here below.

To estimate the worst-case interference from the EESS satellite to the geostationary-satellite receiver we can express the ratio between the received powers at the input of this receiver, from the earth stations transmitting to the geostationary satellite and the EESS satellite respectively:

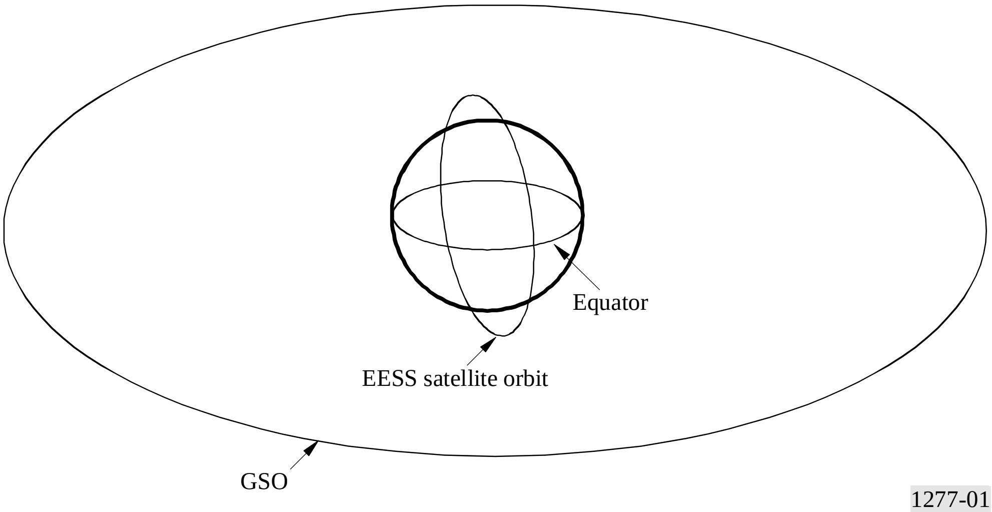
$$C/I = (P_{tw} + G_{tw}) - (P_{tu} + G_{tu}) + \Delta L_p + 10 \log (\mathrm{B}_u/\mathrm{B}_w)$$

where:

- P_{tw}: transmitter power of the earth station (dBW)
- G_{tw}: antenna gain of the earth station (dBi)
- P_{tu}: transmitter power of the EESS satellite (dBW)
- G_{tu}: antenna gain of the EESS satellite to the horizon of its coverage (dBi)
- ΔL_p: differential path loss between the desired and undesired signals (dB)
- B_u: emission bandwidth of the unwanted signal (Hz)
- B_w: emission bandwidth of the desired signal (Hz).

FIGURE 1

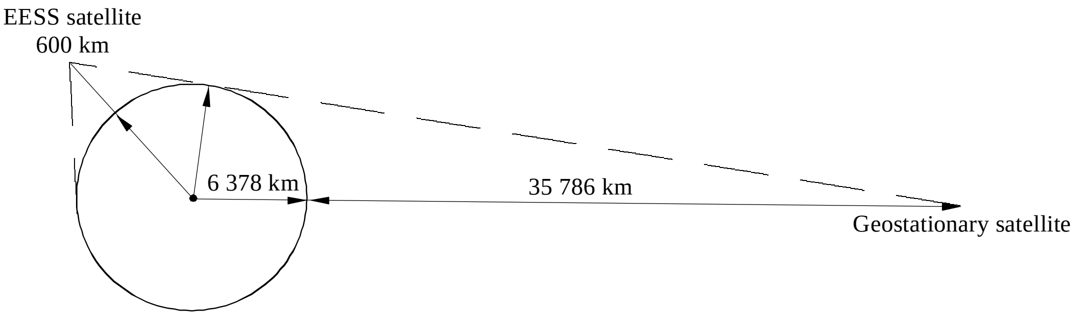
Relative positions of the GSO and the near-polar orbit of an EESS satellite (100° retrograde)



1277-01

FIGURE 2

Representation of the worst case of interference from an EESS satellite to a FS or a METSAT service



1277-02

In this formula it is assumed that the emission bandwidth of the unwanted signal is greater than or equal to the emission bandwidth of the desired signal and that the spectrum of the unwanted signal completely recovers the desired signal one. Then we can replace the previous formula by the formula below:

$$C/I = p_{tw} + G_{tw} - (p_{tu} + G_{tu}) + \Delta L_p$$

where:

p_{tw}: average transmitter power density of the desired signal (dB/Hz)

p_{tu}: average transmitter power density of the undesired signal in the band of the desired signal (dB/Hz).

We can evaluate the term ΔL_p for a worst case with an EESS satellite orbit altitude of 600 km and an earth station located at the nadir of the geostationary satellite:

$$\Delta L_p = 20 \log \left[\frac{\sqrt{(35\ 786 + 6\ 378)^2 - 6\ 378^2} + \sqrt{(6\ 378 + 600)^2 - 6\ 378^2}}{35\ 786} \right]$$

namely:

$\Delta L_p = 1.9$ dB

Table 2 gives the technical characteristics of the EESS satellites SPOT 1/2/3/4. The spectral power density is the maximal density (i.e. at the centre of the QPSK signal) that represents the worst case of the interference.

TABLE 2

Main characteristics of the EESS satellites SPOT 1/2/3/4

Modulation	Bit rate (Mbit/s)	Power (dBW)	Maximal spectral power density (dB(W/Hz))	Maximal gain (dB)
QPSK	50	12.5	– 61.5	6.2

Table 3 gives the technical characteristics of the earth stations transmitting to a governmental telecommunication satellite in the 8 025-8 400 MHz frequency band, as well the *C*/*I* ratios obtained for the telecommunication satellite with the characteristics of the EESS satellite given in Table 2.

TABLE 3

Main technical characteristics of earth stations transmitting to a governmental telecommunication satellite in the 8 025-8 400 MHz frequency band and *C/I* ratios obtained for thetelecom munication satellite with the characteristics of the EESS satellite given in Table 2

Earth station category	Antenna diameter (m)	Maximum antenna gain (dBi)	Maximum power density (dB(W/Hz))(1)	Bandwidth (MHz)	*C*/*I* (dB)
G	18	61	– 43.5	60	74.7
H	8	54	–34	60	77.2
I	3	44.5	– 44	40	57.7
J	1.5	39.5	– 44	40	52.7
K	1.3	38.5	–38	40	57.7
L	0.9	35	–38.8	80	53.2
L'	0.9	34.5	–38.8	80	52.9

(1) In the worst case 4 kHz band.

Table 4 gives the main technical characteristics of the METSAT earth stations and the *C*/*I* ratios obtained for the meteorological satellite with the characteristics of the EESS satellite given in Table 2.

TABLE 4

Characteristics of a METSAT earth station and *C/I* ratios obtained for the meteorological satellite with the characteristics of the EESS satellite given in Table 2

Antenna gain (dBi)	Maximum transmitter power (dB)	e.i.r.p. (dBW)	Bandwidth (MHz)	power density (dB(W/Hz))	*C*/*I* (dB)
44	30	74	0.960	–29.6	71.6
44	20	64	0.018	–22.6	78.6
44	13	57	0.0024	–20.8	80.4
44	17	61	0.0004	–9.0	92.2

We conclude that there would not be interference from the EESS space stations with characteristics similar to those ones given in Table 2 to the fixed-satellite or METSAT receivers.

ANNEX 2

Analysis of interference to the EESS from other services in the frequency band 8 025-8 400 MHz

Method for calculating separation distances between earth stations of the EESS and terrestrial stations or earth stations of the other services

1 Introduction

This Annex concerns the *a priori* evaluation of the order of magnitude for acceptable separation distances between an EESS earth station on one hand and a fixed, fixed-satellite, METSAT or mobile station on the other hand, as a function of given parameters. It is precised that the following calculation does not replace the method given in Appendix S7 of the RR and it is not intended to use it for evaluation of coordination distances. The calculation of the attenuation over the interference path is not based on the worst case but on an average case, which only refers to diffraction caused by an obstacle located between the two stations. The separation distances calculated here gives a realistic idea of practical sharing possibilities between EESS and FS, FSS, METSAT or mobile services.

2 Interference from terrestrial fixed service transmitters to EESS earth station receivers

The sharing criterion for this interference path is a coordination distance required to ensure adequate separation between the terrestrial service transmitters and the EESS earth station receivers.

The minimum permissible basic transmission loss to protect the earth station can be stated as:

$$L_b(p\%) = P_t + G_t(\theta_t) - (P_i - G_r(\theta_r))$$

where:

- P_t: terrestrial service transmitter power (dBW)
- $G_t(\theta_t)$: terrestrial service antenna gain in the direction of the earth station (dBi)
- $G_r(\theta_r)$: gain of the earth station antenna in the direction of the terrestrial station (dBi)
- P_i: maximum permissible interference at the earth station receiver input (dBW)
- θ_t: angle between the terrestrial service antenna axis and the interference path (degrees)
- θ_r: angle between the EESS antenna axis and the interference path (degrees)
- $L_b(p\%)$: the value of minimum acceptable basic transmission loss to be exceeded for all but p% of the time along the interference path between the terrestrial transmitter and the earth station receiver (dB).

The values of P_i and p are defined by Recommendation ITU-R SA.1027 and given in Table 5 for the 8 025-8 400 MHz frequency band.

TABLE 5

Sharing criteria for space-to-Earth data transmission systems operating in the EESS using satellites in low-Earth orbit, according to Recommendation ITU-R SA.1027

EESS earth station category	Reference bandwidth (MHz)	Interfering signal power to be exceeded for no more than 20% of the time at elevation angles ≥ 5° (dBW)	Interfering signal power to be exceeded for no more than *p*% of the time at elevation angles ≥ 5° (dBW)
55.2 dBic antenna, for recorded data acquisition	100	–130	–117 $p = 0.010$
36.4 dBic antenna, for direct data readout	40	–134	–126 $p = 0.011$

The values of gain G_r (θ_r) for the worst case, i.e. when the earth station antenna is plotted in azimuth to the undesired signal and at 5° of elevation can be obtained from the formulas below given in the Appendix S7 of the RR:

– for $D/\lambda \geq 100$:

$G_r(\theta_r) = 32 - 25 \log \theta_r$ for $\theta_n < \theta_r < 48°$

$G_r(\theta_r) = -10$ dBi for $48° \leq \theta_r \leq 180°$

– for $D/\lambda < 100$:

$G_r(\theta_r) = G_{max} - 2.5 \times 10^{-3}\left(\frac{D}{\lambda}\theta r\right)^2$ for $0 \leq \theta_r < \theta_m$

$G_r(\theta_r) = G_1$ for $\theta_m < \theta_r < 100\ \lambda/D$

$G_r(\theta_r) = 52 - 10 \log(D/\lambda) - 25 \log \theta_r$ for $100\ \lambda/D \leq \theta_r < 48°$

$G_r(\theta_r) = 10 - 10 \log(D/\lambda)$ for $48° \leq \theta_r \leq 180°$

where:

$$\theta_n = 15.85\ (D/\lambda)^{-0.6}$$
$$\theta_m = 20\ \lambda/D\ \sqrt{G_{max} - G_1}$$
$$G_1 = 2 + 15 \log (D/\lambda)$$

The value θ_r is given by:

$$\theta_r = 5 - \varepsilon_r$$

where:

ε_r: the elevation of the earth stations physical horizon in the direction of the terrestrial station.

The values of $G_r(\theta_r)$ for a 55.2 dBic antenna (for recorded data acquisition) and for a 36.4 dBic antenna (for direct data readout) are given in Tables 6 and 7.

TABLE 6

Earth station receiving antenna gains (55.2 dBic,* for recorded data acquisition) pointed in azimuth to the undesired signal and at 5° elevation towards the undesired signal

Elevation angle, ε_r (degrees)	Minimum separation angle between the antenna axis and the arrival direction, $\theta_r = 5° - \varepsilon_r$ (degrees)	Maximum gain for an antenna plotted at 5° elevation angle 5° (dBi)
0.5	4.5	15.7
1	4	16.9
2	3	20.1
3	2	24.5
4	1	32.0

* dBic refers to the gain of an isotropic antenna with circular polarization.

TABLE 7

Earth station receiving antenna gains (36.4 dBic, for direct data readout) pointed in azimuth to the undesired signal land at 5° elevation towards the undesired signal

Elevation angle, ε_r (degrees)	Minimum separation angle between the antenna axis and the arrival direction $\theta_r = 5° - \varepsilon_r$ (degrees)	Maximum gain for an antenna plotted at 5° elevation angle (dBi)
0.5	4.5	21.3
1	4	22.6
2	3	23.6
3	2	28.6
4	1	34.2

Table 9 gives the minimum permissible basic transmission losses along the interference path evaluated from the data given in Table 5 corresponding to $p = 0.025\%$ of the time and the radio-relay system characteristics given in Table 8, for various offset angles between the radio-relay antenna axis and the direction of the EESS Earth station antenna and for the horizon elevation angles 0.5° and 3° (see Fig. 3).

TABLE 8

Characteristics of a radio-relay transmitter

Power transmitted per channel (dBW)	0 to 2
Channel bandwidth (MHz)	25
Number of channels in 100 MHz	3
P_{t1} : Power transmitted in 100 MHz (dBW)	5 to 7
Number of channels in 40 MHz	2
P_{t2} : Power transmitted in 40 MHz (dBW)	3 to 5
$G_t(0°)$: Antenna gain in the axis (dBi)	43
$G_t(10°)$: Antenna gain at 10° of the axis (dBi)	11
$G_t(45°)$: Antenna gain at 45° of the axis (dBi)	2
$G_t(90°)$: Antenna gain at 90° of the axis (dBi)	–2

TABLE 9

Minimum permissible basic transmission losses (dB) along the interference path to protect the EESS Earth station from the emissions of the radio-relay transmitter described in Table 8

	EESS 55 dBic antenna, for recorded data acquisition		EESS 36.4 dBic antenna, for direct data readout	
Offset angle, θ_t (degrees)	Elevation angle of the horizon ε_r = 0,5°	Elevation angle of the horizon ε_r = 3°	Elevation angle of the horizon ε_r = 0,5°	Elevation angle of the horizon ε_r = 3°
10	150.7	159.5	163.3	170.6
45	141.7	150.5	154.3	161.6
90	137.7	146.5	150.3	157.6

FIGURE 3

Representation of interference from a FS or mobile service station to an EESS Earth station

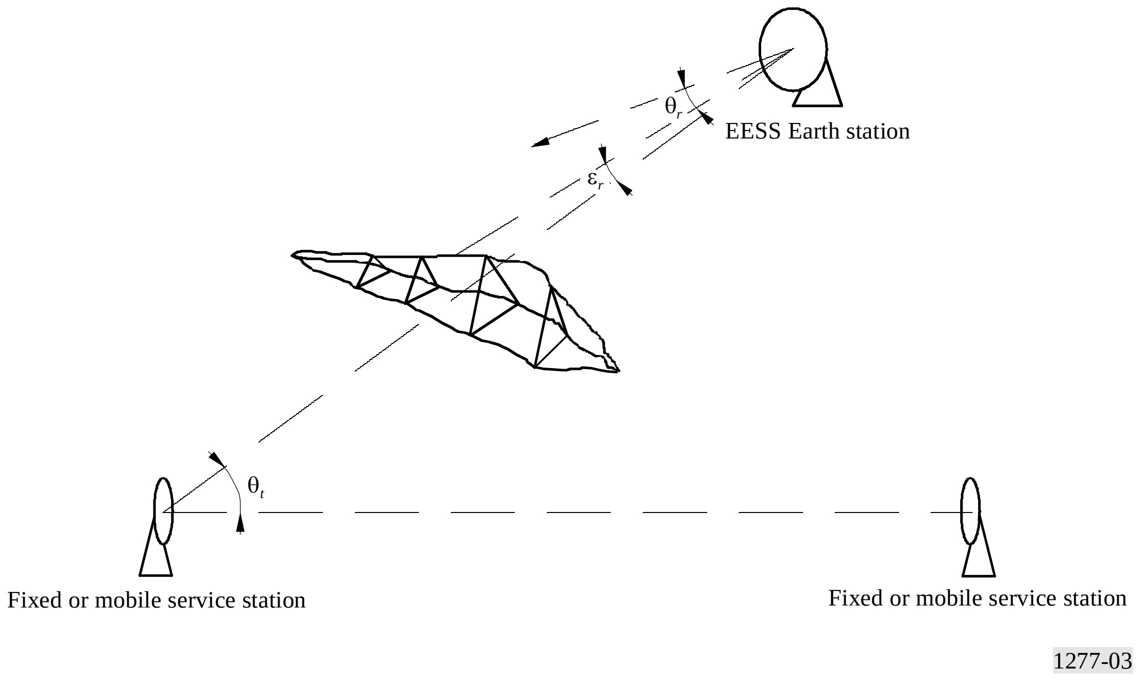


Table 10 gives the separation distances corresponding to these transmission losses, evaluated with the method described in § 5.

The numerical values of Tables 9 and 10 give an idea of practical conditions for siting an EESS earth station in an already existing network of fixed stations.

Over the last 20 years, experience in EESS coordination shows that no major problem has been encountered between the EESS and the FS in the three Regions.

TABLE 10

Minimum separation distances (km) to protect the EESS Earth station from the emissions of the radio-relay transmitter described in Table 8

	EESS 55 dBic antenna, for recorded data acquisition		EESS 36.4 dBic antenna, for direct data readout	
Offset angle, θ_t (degrees)	Elevation angle of the horizon $\varepsilon_r = 0{,}5°$	Elevation angle of the horizon $\varepsilon_r = 3°$	Elevation angle of the horizon $\varepsilon_r = 0{,}5°$	elevation angle of the horizon $\varepsilon_r = 3°$
10	11.9	3.4	50.9	12.4
45	4.2	1.2	18.1	4.4
90	2.7	0.8	11.4	2.8

3 Interference from fixed-satellite or meteorological-satellite earth station transmitters to EESS earth station receivers

We can apply to ensure protection of an EESS earth station receiver from a FSS station using the same procedure as from a fixed terrestrial service transmitter, i.e. to establish a coordination distance according to the formula that we used in the previous case:

$$L_b(p\%) = P_t + G_t(\theta_t) - (P_i - G_r(\theta_r))$$

As in the previous case the values P_i and p are given in Table 5.

The values of the EESS earth station antenna gain $G_r(\theta_r)$ are given in Table 6 and Table 7 for various values of the elevation of the EESS Earth station's physical horizon in the direction of the FS satellite Earth station.

We can apply the same formulas to calculate the worst-case gain G_t of the METSAT service Earth station pointed in azimuth to the EESS Earth station. The minimum angular separation between the antenna's axis and the interference path is given by:

$$\theta_t = \alpha - \varepsilon_t$$

where:

α: elevation angle of the geostationary satellite relative to the FSS or METSAT service Earth station

ε_t: the elevation of the FS or METSAT service Earth station (see Fig. 4).

The gains that we obtain for various categories of FSS Earth stations given in Table 3 and various horizon elevation angles ε_t are given in Table 11 with the hypothesis of a geostationary satellite elevation angle $\alpha = 40°$.

Table 12 gives the minimum permissible basic transmission losses along the interference path evaluated from the data given in Table 5 and Table 20 corresponding to $p = 0.025\%$ of the time for the various stations given in Table 3 and a geostationary satellite elevation angle of 40°.

In this computation we assume that the elevations of the horizon angles ε_r and ε_t are the same for both Earth stations.

Table 13 gives the separation distances corresponding to these transmission losses, evaluated with the method described in § 5.

FIGURE 4

Representation of the worst case of interference from a FSS or METSAT service Earth station to an EESS Earth station

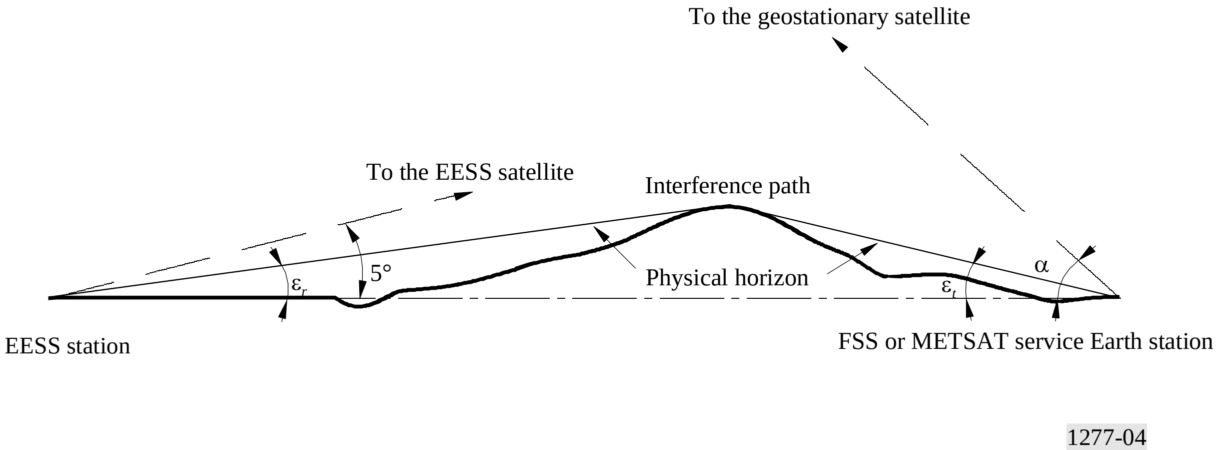


TABLE 11

Gains obtained in the direction of the interference path for the FSS Earth stations given in Table 3, a geostationary-satellite elevation angle of 40° and elevation angles of the physical horizon equal to 0.5° and 3°

Earth station category (see Table 3)	Antenna diameter (m)	Elevation of the horizon, ε_t (degrees)	Gain $G(40° - \varepsilon_t)$ (dBi)
G/H	18/8	0.5	–7.9
G/H	18/8	3	–7.2
I	3	0.5	–7.1
I	3	3	–6.3
J	1.5	0.5	–4.0
J	1.5	3	–3.3
K	1.3	0.5	–3.4
K	1.3	3	–2.7
L/L'	0.9	0.5	–1.8
L/L'	0.9	3	–1.1

TABLE 12

Minimum permissible basic transmission losses (dB) along the interference path to protect the EESS Earth station from the emissions of the FSS stations described in Table 3 and a geostationary-satellite elevation angle of 40°

	EESS 55 dBic antenna, for recorded data acquisition		EESS 36.4 dBic antenna, for direct data readout	
FSS Earth station category	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 3°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 3°$
G	159.0	168.6	171.9	179.9
H	168.5	178.1	181.4	189.4
I	157.6	167.2	172.3	180.3
J	160.6	170.2	175.3	183.3
K	167.3	176.8	181.9	189.9
L/L'	171.1	180.6	182.9	190.7

TABLE 13

Minimum separation distances (km) to protect the EESS Earth station from the emissions of the FSS earth stations described in Table 3 with a geostationary-satellite elevation angle of 40°

	EESS 55 dBic antenna, for recorded data acquisition		EESS 36.4 dBic antenna, for direct data readout	
FSS Earth station category	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 3°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 3°$
G	31	10	137	36
H	93	29	410	108
I	27	8	143	38
J	38	12	202	54
K	80	25	434	115
L/L'	125	39	475	126

The numerical values of Tables 11 to 16 give an idea of practical conditions for siting an EESS Earth station with respect to fixed-satellite and METSAT Earth stations.

Over the last 20 years, experience in EESS coordination shows that no major problem has been encountered between the EESS and the FSS or the METSAT.

TABLE 14

Gains obtained in the direction of the interference path for the METSAT service Earth stations given in Table 4, with a geostationary-satellite elevation angle of 20° and elevation angles of the physical horizon equal to 0.5° and 3°

Antenna diameter (m)	Elevation of the horizon, ε_t (degrees)	Gain $G(20° - \varepsilon_t)$ (dBi)
2.4	0.5	1.6
2.4	3	3.1

TABLE 15

Minimum permissible basic transmission losses (dB) along the interference path to protect the EESS earth station from the emissions of the METSAT service stations given in Table 4 with a geostationary-satellite elevation angle of 20°

EESS 55 dBic antenna, for recorded data acquisition		EESS 36.4 dBic antenna, for direct data readout	
Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 3°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 3°$
164.2	174.5	178.9	187.7

TABLE 16

Minimum separation distances (km) to protect the EESS Earth station from the emissions of the METSAT service station described in Table 4 with a geostationary-satellite elevation angle of 20°

EESS 55 dBic antenna, for recorded data acquisition		EESS 36.4 dBic antenna, for direct data readout	
Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 3°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_t = \varepsilon_r = 3°$
57	19	112	–23

4 Interference from mobile service transmitters to the EESS ground stations receivers

The characteristics of a land mobile transmitter are given in Table 17.

This problem is very similar to that of interference from FS transmitters which we have considered in § 4 (see Fig. 3).

TABLE 17

Characteristics of a mobile transmitter

Transmitter power (dBW)	0
Bandwidth (MHz)	29
$G_t(0°)$: antenna gain in the axis (dBi)	43
$G_t(0°)$: antenna gain at 10° of the axis (dBi)	11
$G_t(45°)$: antenna gain at 45° of the axis (dBi)	2
$G_t(90°)$: antenna gain at 90° of the axis (dBi)	–2

Table 18 gives the minimum permissible basic transmission losses along the interference path evaluated from the data given in Table 5 corresponding to $p = 0.025\%$ of the time and the radio-relay system characteristics given in Table 8, for various offset angles between the radio-relay antenna axis and the direction of the EESS earth station antenna and for the horizon elevation angles 0.5° and 3°.

TABLE 18

Minimum permissible basic transmission losses (dB) along the interference path to protect the EESS Earth station from the emissions of the mobile transmitter described in Table 17

	EESS 55 dBic antenna, for recorded data acquisition		EESS 36.4 dBic antenna, for direct data readout	
Offset angle, θ_t (degrees)	Elevation angle of the horizon $\varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_r = 3°$	Elevation angle of the horizon $\varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_r = 3°$
10	143.7	152.5	158.3	165.6
45	134.7	143.5	149.3	156.6
90	130.7	139.5	145.3	152.3

Table 19 gives the separation distances corresponding to these transmission losses, evaluated with the method described in § 5.

TABLE 19

Minimum separation distances (km) to protect the EESS Earth station from the emissions of the mobile transmitter described in Table 17

	EESS 55 dBic antenna, for recorded data acquisition		EESS 36.4 dBic antenna, for direct data readout	
Offset angle, θ_t (degrees)	Elevation angle of the horizon $\varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_r = 3°$	Elevation angle of the horizon $\varepsilon_r = 0.5°$	Elevation angle of the horizon $\varepsilon_r = 3°$
10	5.3	1.5	28.6	7.0
45	1.9	0.5	10.2	2.5
90	1.2	0.3	6.4	1.6

The separation distances calculated in Table 19 are lower than the ones calculated in Table 10 for FS.

5 Method of calculation of loss due to diffraction by any obstacle

The calculation of the loss on the interference is based on the following assumptions:

– free space propagation loss: A_d

– loss due to diffraction by an obstacle between the two stations: A_h.

The value of the first loss coefficient, A_d (dB), is obtained by calculating the relation:

$$A_d = 20 \log (4\pi \, d/\lambda)$$

where:

d: distance between the EESS Earth station and the fixed, fixed-satellite, METSAT or mobile station (m)

λ: wavelength of the transmitting frequency of the fixed, fixed-satellite, METSAT or mobile station (m).

The value of the second coefficient, A_h (dB), is obtained by calculating the relation:

$$A_h = 20 \log [1 + (4.5 \, f^{1/2} \, \varepsilon)] + f^{1/3} \, \varepsilon$$

where:

f: transmitting frequency of the fixed, fixed-satellite, METSAT or mobile station (GHz)

ε: elevation of the EESS earth station's physical horizon in the direction of the fixed, fixed-satellite, METSAT or mobile station.

The values of A_h for $f = 8.2$ GHz and various values of ε are given in Table 20.

TABLE 20

Loss due to diffraction by an obstacle between two stations, for various angles of the elevation of the EESS Earth station physical horizon ε

ε (degrees)	A_h (dB)
0,5	18.4
1	24.9
2	32.6
3	38.0
4	42.5

The interference level of the earth station is then considered to be below the permissible level assuming that the minimum permissible transmission loss $L_b(p\%)$ is smaller than the loss on the interference path ($A_d + A_h$). The condition which must be met is expressed by the following inequality:

$$L_b(p\%) \leq A_d + A_h$$

or the following inequality:

$$A_d \geq A_{d_{min}} = L_b(p\%) - A_h$$

With the value of $A_{d_{min}}$ we can evaluate a separation distance between the EESS earth station and the fixed, fixed-satellite, METSAT or mobile station:

$$d_{min} = (\lambda/4\pi) \times 10^{(A_{d_{min}}/20)}$$