RECOMMENDATION ITU-R SA.1625*

Feasibility of sharing between the space research service (space-to-Earth) and the fixed, inter-satellite, and mobile services in the band 25.5-27 GHz

(2003)

The ITU Radiocommunication Assembly,

considering

a) that the fixed, inter-satellite (ISS) (limited to space research, and Earth exploration-satellite applications), Earth exploration and mobile services, *inter alia*, are allocated on a primary basis in the 25.5-27 GHz band;

b) that World Radiocommunication Conference (Geneva, 2003) (WRC-03) agenda item 1.12 addresses consideration of an allocation to the space research service (SRS) near 26 GHz;

c) that requirements exist for wideband SRS downlinks above 25 GHz to transmit future high data rate scientific data;

d) that required separation distances between receiving SRS earth stations and transmitting fixed stations are relatively small (typically 10-20 km) because atmospheric effects, vegetation loss, and space loss increase significantly compared to lower frequencies;

e) that currently no plans are known for mobile service use of this band;

f) that this band is used by some countries for high-density fixed applications,

recognizing

a) that there are already pfd limits in Table 21-4 of the Radio Regulations (RR) applying to the Earth exploration-satellite service allocated (EESS) in the same band,

noting

a) that due to the small number of expected SRS earth stations to be deployed worldwide (10-40 stations) and propagation characteristics in this band, coordination between fixed and land mobile systems and the SRS stations would not put undue constraints on either of the services,

recommends

1 that sharing between transmitting SRS satellites and receiving data relay satellites (DRS) operating in the ISS near 26 GHz is feasible given the following constraints:

– SRS satellites in an orbit that is near to the orbits of the DRS user satellites should not produce a pfd greater than –155 dB(W/m^2) in 1 MHz at any location on the GSO for more than 0.1% of the time;

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

– SRS satellites in orbits other than that mentioned above should not produce a pfd greater than –155 dB(W/m^2) in 1 MHz at any location on the GSO for more than 1% of the time;

2 that, when designing SRS systems, the probability of receiving brief periods of interference from DRS user satellites in the ISS should be taken into account. This interference should exist for less than 0.1% of the time;

3 that SRS systems operate within pfd limits at the Earth's surface under assumed free space propagation conditions in the band 25.5-27 GHz:

Limit (dB(W/m^2)) in 1 MHz bandwidth for angle of arrival, δ, above the horizontal plane		
0°-5°	5°-25°	25°-90°
–115	$-115 + 0.5(\delta - 5)$	–105

4 that separation distances required by SRS receiving earth stations for protection from fixed and mobile services transmitting stations may be derived using the methodology outlined in Annex 1 and the protection criterion for space-to-Earth SRS links contained in Recommendation ITU-R SA.609;

5 that suitable measures related to the deployment of SRS earth stations may need to be identified in order not to constrain the use of the band 25.5-27 GHz by the fixed service.

Annex 1

Feasibility of sharing between the SRS (space-to-Earth) and the ISS, EESS, fixed and mobile services in the band 25.5-27 GHz

1 Summary of technical and operational studies, and relevant ITU-R Recommendations

International space agencies are currently planning on implementing high data rate space research missions with bandwidth requirements up to 400 MHz. Satellites for these missions will carry telescopes and/or other passive instruments to measure phenomenon such as the Earth's magnetosphere and solar flares. At present, 8 450-8 500 MHz is the only band below the 37-38 GHz band that is available on a primary basis in the SRS to transmit moderate- to high-rate data directly from Earth-orbiting satellites to earth stations. Since this band will not meet the requirements of future high rate space research missions, a new allocation is needed.

The band 25.5-27 GHz has been proposed as a possibility for a primary SRS allocation to satisfy these requirements. The current allocations in the band 25.5-27 GHz are shown in Table 1. They include primary allocations to the fixed and mobile services, EESS (space-to-Earth) and ISS. There is also a secondary allocation to the standard frequency and time signal-satellite service (Earth-to-space). The use of the allocations is further constrained by provisions: RR No. 5.536 sets conditions on the use of the band by stations in the ISS; RR No. 5.536A limits the protection afforded EESS earth stations from the emissions of stations in the fixed and mobile services; and, RR No. 5.536B further limits the protection and status of EESS earth stations in a number of countries.

TABLE 1

Allocations in the band 25.5-27 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
25.5-27	EARTH EXPLORATION-SATELLITE (space-to Earth) 5.536A 5.536B FIXED INTER-SATELLITE 5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)	

5.536 Use of the 25.25-27.5 GHz band by the inter-satellite service is limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space.

5.536A Administrations installing Earth exploration-satellite service earth stations cannot claim protection from stations in the fixed and mobile services operated by neighbouring administrations. In addition, earth stations operating in the Earth exploration-satellite service should take into account Recommendation ITU-R SA.1278. (WRC-2000)

5.536B In Germany, Saudi Arabia, Austria, Belgium, Brazil, Bulgaria, China, Korea (Rep. of), Denmark, Egypt, United Arab Emirates, Spain, Estonia, Finland, France, Hungary, India, Iran (Islamic Republic of), Ireland, Israel, Italy, Jordan, Kenya, Kuwait, Lebanon, Libya, Liechtenstein, Lithuania, Moldova, Norway, Oman, Uganda, Pakistan, the Philippines, Poland, Portugal, Syria, Slovakia, the Czech Rep., Romania, the United Kingdom, Singapore, Sweden, Switzerland, Tanzania, Turkey, Viet Nam and Zimbabwe, earth stations operating in the Earth exploration-satellite service in the band 25.5-27 GHz shall not claim protection from, or constrain the use and deployment of, stations of the fixed and mobile services. (WRC-97)

Based on these allocations, establishment of a primary SRS allocation in this band requires the consideration of a variety of interference scenarios as detailed in Table 2. An analysis of these environments to facilitate the identification of appropriate sharing conditions has been performed and is documented herein. Section 2 provides information on the SRS system characteristics used for this analysis. Section 3 provides key characteristics of example point-to-point (P-P) and point-to-multipoint (P-MP) fixed service systems in the 25.5-27 GHz band. The criteria for protection of fixed service stations from SRS emissions are derived in Section 4. Section 5 derives interference to SRS receiving earth stations from fixed service station transmissions. Section 6 addresses sharing conditions for SRS (space-Earth) and receiving DRS operations. Protection of EESS links is addressed in Section 7. Section 8 provides the conclusions of this study. Since there are no known characteristics for mobile service systems operating in the 26 GHz band, no studies were conducted to determine if there are additional conditions for sharing.

TABLE 2

Interference scenarios considered

Interferer	Victim	Comments
SRS (space-to-Earth) Low-orbiting satellite GSO satellite	Receiving fixed service station	pfd limits given in RR Table 21-4 assumed to adequately protect fixed service stations
Transmitting fixed service station	SRS receiving earth station	Separation distances determined using the methods of Recommendation ITU-R SM.1448 assuming mode (1) propagation over an inland great-circle path (zone A2)
SRS (space-to-Earth) Low-orbiting satellite GSO satellite	Receiving DRS Adjacent Near antipodal	Line-of-sight propagation assumed
SRS (space-to-Earth) Low-orbiting satellite GSO satellite	EESS receiving earth station	Further study is required

2 Characteristics of future high rate SRS missions

These missions will be limited in number with an estimated three to five satellites per year worldwide, and will generally be in an equatorial orbit with some at geostationary altitudes and others at the L1 or L2 libration points. The characteristics of GSO and low-orbiting SRS satellites transmitting in the space-to-Earth direction are reflected in the link budgets in Table 3.

SRS systems were assumed to support a data rate of 400 Mbit/s on the space-to-Earth link. The e.i.r.p. spectral density was adjusted so that the pfd limits of RR Table 21-4 would be satisfied at low elevation angles. The radiation pattern of the receiving antenna of the SRS earth station was assumed to conform to Recommendation ITU-R SA.509. Sharing feasibility was assessed on the basis of the protection criteria given in Recommendation ITU-R SA.609.

TABLE 3

Example high rate SRS system link budgets

Frequency (GHz)	26	
Satellite altitude (km)	800	35 785
Data rate (Mbit/s)	400	
Modulation method	QPSK	
Transmitter Power (W)	5.0	20.0
(dBW)	7.0	13.0
Filter, cable loss (dB)	–0.5	
Transmitting antenna diameter (m)	0.35	0.88
Transmitting antenna gain (dBi)	37.0	45.0
Antenna 3 dB beamwidth (degrees)	2.32	0.92
e.i.r.p. (dBW)	43.5	57.5
Beam-edge allowance (dB)	–3.0	
Path loss (dB)	–188.2	–212.9
Spectral pfd (dB(W/(m^2 · MHz)))	–118.0	–128.6
Receiving antenna gain (dBi)	45.0	55.0
Receiver noise temperature (K)	100.0	
Elevation angle (degrees)	10.0	
Antenna noise temperature (K)	50.0	
Receiving system temperature (K)	150.0	
Modulation filter loss (dB)	–0.5	
Demodulator loss (dB)	–0.5	
Mean received E_b/N_0 (dB)	18.1	17.4
Theoretical E_b/N_0 (BER = 1×10^{-6}) (dB)	10.5	
Required E_b/N_0 (BER = 1×10^{-6}) (dB)	11.5	
Margin (dB)	6.6	5.9

3 Key characteristics of example P-P and P-MP fixed service systems

Recommendation ITU-R F.758 provides characteristics of typical fixed wireless systems to be used in sharing studies. The key characteristics of P-P systems are given in Table 4a. Table 4b provides similar information for example P-MP systems.

TABLE 4a

Characteristics of P-P fixed wireless systems used in sharing studies
(Recommendation ITU-R F.758)

Frequency band (GHz)	25.25-27		
Modulation	4-PSK	16-QAM	16-QAM
Capacity (Mbit/s)	6	52	156
Channel spacing (MHz)	10	20	60
Antenna gain (maximum) (dBi)	46		
Feeder/multiplexer loss (minimum) (dB)	0		
Antenna type	Dish		
Maximum Tx output power (dBW)	–3		
e.i.r.p. (maximum) (dBW)	43		
Receiver IF bandwidth (MHz)	5.3	18.6	55.6
Receiver noise figure (dB)	8		
Receiver thermal noise (dBW)	–128.9	–123.5	–118.7
Nominal Rx input level (dBW)	$-112.2 + M$	$-100.0 + M$	$-95.2 + M$
Rx input level for 1×10^{-3} BER (dBW)	–116.2	–103.3	–98.5

TABLE 4b

Characteristics of P-MP fixed wireless systems used in sharing studies
(Recommendation ITU-R F.758)

Frequency band (GHz)	25.25-27.5		
Modulation	Q-PSK FDM/TDM	Q-PSK FDM/TDM	Q-PSK FDM/TDM
Capacity	1 ch/50 MHz BW	20 ch/50 MHz BW	20 ch/50 MHz BW
Channel spacing (MHz)	50	2.5	2.5
Condition	Clear-air	Clear-air	Rain-faded
Antenna gain (maximum) (dBi)	15	36	36
Feeder/multiplexer loss (minimum) (dB)	0		
Antenna type	Horn	Dish	Dish
Maximum Tx output power (dBW)	+10.0	–32.7	+4.0
Maximum Tx power spectral density (psd) (dB(W/MHz))	–7.0	–36.7	0
Maximum e.i.r.p. spectral density (dB(W/MHz))	+8.0[(1)]	–0.7	+36
e.i.r.p. (maximum) (dBW)	25.0	3.3	40.0

[(1)] The maximum e.i.r.p. spectral density is in conformity with *recommends* 1.1 of Recommendation ITU-R F.1509.

4 Protection of fixed service stations from SRS emissions

Pfd limits are currently in RR Table 21-4 to protect receiving stations in the fixed and mobile services from the emissions of space systems. For a reference bandwidth of 1 MHz, the pfd limits are:

-115 dB(W/m^2)	for $0^\circ < \delta \leq 5^\circ$
$-115 + 0{,}5(\delta - 5)$ dB(W/m^2)	for $5^\circ < \delta \leq 25^\circ$
-105 dB(W/m^2)	for $25^\circ < \delta \leq 90^\circ$

where δ is the angle of arrival above the horizontal plane (degrees).

Referring to Table 3, it is seen that space-to-Earth links supporting a data rate of 400 Mbit/s are feasible within the pfd limits given above.

5 Protection of SRS earth stations from fixed service emissions

The example P-P and P-MP fixed service system characteristics given in Tables 4a and 4b have been used to assess the separation distances appropriate to satisfying the protection criteria of SRS earth stations based on Recommendation ITU-R SA.609. This recommendation specifies that the interference should not exceed −216 dB(W/Hz) for more than 0.1% of the time for unmanned missions. Because of the relatively high data rate of the space-to-Earth links, a reference bandwidth of 1 MHz will be used. The resulting interference power level criterion is −156 dB(W/MHz).

The following methodology was used to assess the range of separation distances required to protect an SRS receiving earth station:

– determine the e.i.r.p. spectral density in the worst 1 MHz band of the fixed service transmitting stations listed in Tables 4a and 4b;

– determine the maximum gain of the SRS earth station receiving antenna in the direction of the transmitting fixed service station using Recommendation ITU-R SA.509;

– compute the minimum permissible basic transmission loss for maximum emissions and for isotropic emissions of fixed service stations in the direction of the SRS earth station; and,

– using the procedures of Recommendation ITU-R SM.1448, compute the separation distance required to achieve the minimum permissible basic transmission loss assuming mode (1) propagation over an inland path (defined as zone A2 in the Recommendation).

5.1 e.i.r.p. spectral density of fixed service transmitting stations

The psd of an M-PSK and an M-QAM carrier modulated by a random data stream is maximum around the carrier frequency and when the symbol rate is large with respect to the reference bandwidth, is given by:

$$psd = P_{avg} T_S b_{ref} \tag{1a}$$

$$T_S = \frac{\log_2 M}{R_b} \tag{1b}$$

where:

psd: psd in the reference bandwidth, b_{ref}, at the input to the transmitting antenna (W/b_{ref})

P_{avg}: average power at the output of the transmitter (W)

T_s: the duration of one symbol (s)

M: number of discrete states of the signal space of transmitted signal (numeric)

R_b: combined information and coding bit rate of the transmitted signal (bit/s).

5.2 Typical separation distances

The minimum permissible basic transmission loss is given by

$$L_B = psd + G_T(\theta_{FS}) + G_R(\theta_{Rmin}) - I_{PC} \tag{2}$$

where:

L_B: minimum permissible basic transmission loss (dB)

I_{PC}: protection criteria (dBW/b_{ref})

psd: transmitter psd at the input to the transmitting antenna (dBW/b_{ref})

b_{ref}: reference bandwidth (1 MHz)

$G_T(\theta_{FS})$: fixed service transmitting antenna gain in the direction of the SRS receiving station (dB)

$G_R(\theta_{Rmin})$: maximum SRS receiving antenna gain in the direction of the fixed service station (dB).

The SRS receiving antenna that conforms to the reference radiation pattern of Recommendation ITU-R SA.509 has a maximum gain of +7 dBi towards the horizon when pointed at a minimum elevation angle of 10°.

The minimum permissible basic transmission loss is determined using the procedures given in Recommendation ITU-R SM.1448 for:

– 26 GHz operating frequency;

– propagation over smooth Earth on an inland path (zone A2);

– mode (1) propagation, minimum permissible transmission loss exceeded for more than 0.1% of the time;

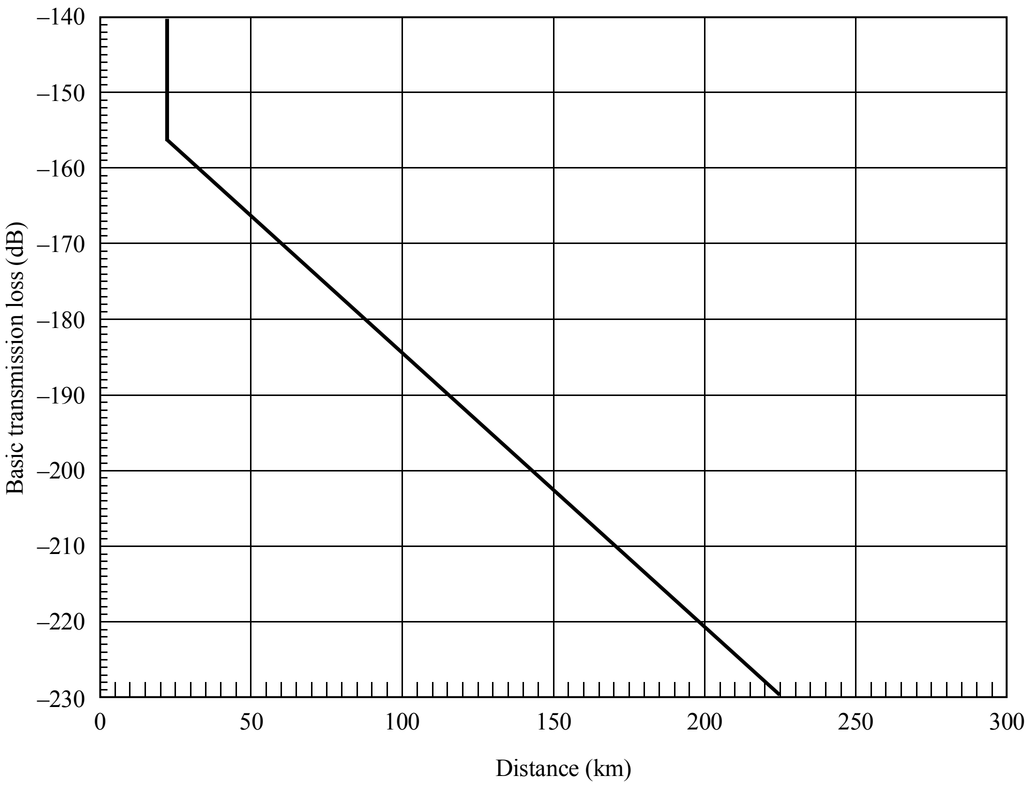
– receiving antenna of the SRS earth station is 10 m above the surface of the Earth;

– transmitting antenna of the fixed service station is 10 m above the surface of the Earth.

Using the assumptions given above and the procedures of Recommendation ITU-R SM.1448, the resulting mode (1) basic transmission loss as a function of the separation distance is as shown in Fig. 1.

FIGURE 1

Basic transmission loss not exceeded for more than 0.1% of the time for mode (1) propagation for an inland path over smooth Earth: f = 26 GHz; h_1 = 10 m; h_2 = 10 m



f = 26 GHz
Tx antenna height = 10 m
Rx antenna height = 10 m
Transmission loss not exceeded for more than 0.1% of the time
Climatic zone A2

1625-01

Calculations to determine the separation distances from P-P and P-MP stations are summarized in Tables 5a and 5b. In Table 5a it is shown that under the most favourable conditions, i.e. the gain of the fixed service transmitting antenna is isotropic in the direction of the SRS earth station, separation distances less than 24 km are feasible for SRS earth stations. The separation distances increase to 150 km or less, for the SRS earth stations when the maximum gain of the fixed service transmitting antenna is in the direction of the SRS earth station.

TABLE 5a

Typical separation distances between an SRS receiving earth station and P-P fixed service transmitting stations required to satisfy the protection criteria of Recommendation ITU-R SA.609: *f* = 26 GHz; height of the SRS receiving antenna is 10 m above smooth Earth, and the fixed service transmitting antenna is 10 m above smooth Earth

Modulation	Q-PSK		16-QAM		16-QAM	
Capacity (Mbit/s)	6		52		156	
Maximum Tx output power (dBW)	–3		–3			
Peak-to-average power (dB)	0		–3.5			
Output power backoff (dB)			–1			
Feeder/mux loss (dB)	0		0			
psd (dB(W/MHz))	–7.8		–18.6		–23.4	
Antenna gain in the direction of the SRS earth station (dB)	0	46	0	46	0	46
e.i.r.p. spectral density in the direction of the SRS earth station (dB(W/4 kHz))	–7.8	+38.2	–18.6	+27.4	–23.4	+22.6
Maximum antenna gain of the SRS earth station towards the fixed service station (dBi)	+7		+7			
Protection criterion (dB(W/MHz))	–156					
Minimum permissible basic transmission loss (dB)	–155.2	–201.2	–144.4	–190.4	–139.6	–185.6
Separation distance (km)	24[(1)]	150	< 20[(2)]	120	< 20[(2)]	100

(1) This distance is slightly beyond line-of-sight (LoS).

(2) This distance is within LoS.

Table 5b shows that the separation distances associated with P-MP fixed service systems are in all cases less than 64 km. It may be anticipated that the separation distances for both P-P and P-MP systems will decrease when account is taken of such factors as frequency channelization plans, natural site shielding, terrain clutter and other terrain features.

TABLE 5b

Typical separation distances between an SRS receiving earth station and P-MP fixed service transmitting stations required to satisfy the protection criteria of Recommendation ITU-R SA.609: *f* = 26 GHz; height of the SRS receiving antenna is 10 m above smooth Earth, and the fixed service transmitting antenna is 10 m above smooth Earth

<table>
<tr><td>Modulation</td><td>Q-PSK
Hub</td><td colspan="2">Q-PSK
Subscriber</td></tr>
<tr><td>Capacity</td><td>1 ch/50 MHz BW</td><td colspan="2">20 ch/50 MHz BW</td></tr>
<tr><td>Max Tx output power (dBW)</td><td>+10</td><td colspan="2">−32.7</td></tr>
<tr><td>Feeder/mux loss (dB)</td><td colspan="3">0</td></tr>
<tr><td>psd (dB(W/MHz))</td><td>−7.0</td><td colspan="2">−36.7</td></tr>
<tr><td>Antenna gain in the direction of the SRS earth station (dB)</td><td>15</td><td>0</td><td>36</td></tr>
<tr><td>e.i.r.p. spectral density in the direction of the SRS earth station (dB(W/MHz))</td><td>+8.0</td><td>−36.7</td><td>−0.7</td></tr>
<tr><td>Max antenna gain of the SRS earth station towards the fixed service station (dBi)</td><td colspan="3">+7</td></tr>
<tr><td>Protection criterion (dB(W/MHz))</td><td colspan="3">−156</td></tr>
<tr><td>Minimum permissible basic transmission loss (dB)</td><td>−171</td><td>−130.3</td><td>−166.3</td></tr>
<tr><td>Separation distance (km)</td><td>64</td><td>< 20(1)</td><td>50</td></tr>
</table>

(1) This distance is within LoS.

6 Protection of DRS operations from SRS emissions

There are three primary cases for which a GSO DRS will receive interference from the emissions of a satellite in the SRS:

Case 1: when a transmitting GSO SRS satellite is located adjacent to a receiving GSO DRS;

Case 2: when a transmitting GSO SRS satellite is in a near-antipodal location with respect to a receiving GSO DRS; and

Case 3: when a transmitting low-orbiting SRS satellite passes within view of a receiving GSO DRS.

For these three cases, conditions required to satisfy the protection criteria of Recommendation ITU-R SA.1155 is evaluated. For cases 1 and 2, the psd at the input to the transmitting antenna of the GSO SRS satellite is −10.5 dB(W/MHz) based on the example characteristics given in Table 1. For case 3, the psd at the input to the transmitting antenna of the SRS satellite at an orbital altitude of 800 km is −16.5 dB(W/MHz), also based on the example characteristics given in Table 3. Free-space propagation is assumed for all three cases.

The received interference psd and associated margin above the protection criteria are given by:

$$I_R = psd + G_T\ (\theta_T) + G_R\ (\theta_R) - L_{bf} \tag{3a}$$

$$M = I_{PC} - I_R \tag{3b}$$

where:

- I_R: received interference psd (dB(W/MHz))
- I_{PC}: DRS protection criteria given in Recommendation ITU-R SA.1155 (dB(W/MHz))
- M: margin above the interference criterion (dB)
- L_{bf}: free-space basic transmission loss (dB)
- psd: psd at the input to the transmitting antenna (dB(W/MHz)
- $G_T(\theta_T)$: transmitting antenna gain of the SRS satellite in the direction of the DRS (dBi)
- $G_R(\theta_R)$: receiving antenna gain of the DRS in the direction of the SRS satellite (dBi)
- θ_T: angle between boresight of the transmitting antenna and the DRS (degrees)
- θ_R: angle between boresight of the DRS receiving antenna and the SRS satellite (degrees).

The principle results from evaluating equation (3) for the three cases are summarized in Table 6. The results in the Table show that there will be negligible impact on systems in the ISS from the emissions of non-GSO and GSO SRS satellites.

TABLE 6

Level of interference to and the operating margin above the protection criteria of Recommendation ITU-R SA.1155 for a GSO DRS receiving interference from the space-to-Earth emissions of SRS satellites: *f* = 26 GHz

	Case 1	**Case 2**		**Case 3**
psd (dB(W/MHz))	–10.5	–10.5		–16.5
$G_T(\theta_T)$	0	0		0
$G_R(\theta_R)$	0	0	58(1)	58(1)
Range (km)	6.9	83 360		34 985(2)
Basic transmission loss (dB)	–137.5	–219.2		–211.6
I_R (dB(W/MHz))	–148	–229.7	–171.7	–170.1
I_{PC} (dB(W/MHz))	–148(3)	–148(3)		–148(3)
Margin (dB)	0	+81.7	+23.7	+22.1

(1) See Recommendation ITU-R SA.1414.

(2) Satellite at an altitude of 800 km located in the equatorial plane directly below the DRS.

(3) Protection criteria from Recommendation ITU-R SA.1155 scaled to 1 MHz reference bandwidth.

7 Protection of EESS receiving earth stations from the emissions (space-to-Earth) of non-GSO and GSO SRS satellites

Further study is required, preferably using Monte Carlo techniques, to determine the statistical characteristics of interference to EESS receiving earth stations from the emissions of non-GSO and GSO SRS satellites. It is anticipated that the probability of interference to an EESS earth station from the emissions of either a non-GSO SRS satellite or a GSO SRS satellite will be very small for the following reason. Both EESS and SRS satellite systems will use high gain transmitting antennas on the satellites and at the receiving earth stations to overcome the basic transmission loss at 26 GHz. Consequently, interference will be experienced only when there is little antenna discrimination either from the transmitting satellite antenna or from the receiving earth station antenna. Monte Carlo simulations are required to determine the statistical characteristics of interference to an EESS receiving earth station.

8 Summary and conclusions

The existing pfd limits given in RR Table 21-4 for the band 25.5-27 GHz should provide protection of P-P and P-MP fixed service systems from space-to-Earth emissions of low-orbiting satellites and GSO satellites to receiving earth stations in the SRS. In any 1 MHz band, these limits are:

$$-115 \text{ dB(W/m}^2) \quad \text{for} \quad 0^\circ < \delta \leq 5^\circ$$

$$-115 + 0,5(\delta - 5) \text{ dB(W/m}^2) \quad \text{for} \quad 5^\circ < \delta \leq 25^\circ$$

$$-105 \text{ dB(W/m}^2) \quad \text{for} \quad 25^\circ < \delta \leq 90^\circ$$

where δ is the angle of arrival above the horizontal plane (degrees).

Protection of SRS receiving earth stations from the emissions of P-P and P-MP fixed systems with the characteristics given in Recommendation ITU-R F.758 may be realized at separation distances less than 20 km under favourable conditions. Protection distances may be required at separation distances less than 150 km for P-P systems and less than 65 km for P-MP for less favorable conditions. These distances were determined for mode (1) propagation for an inland great-circle path over smooth Earth (zone A2). It is anticipated that these separation distances may decrease when account is taken of such factors as frequency channelization plans, natural site shielding, terrain clutter and other terrain features. However, it is noted that the addition of an allocation to the SRS would introduce further constraints when coordinating with fixed service systems.

It was shown that DRS networks operating in the ISS would be protected from the emissions of the example SRS low-orbiting satellites and GSO satellites. It was shown that the separation distance between a receiving GSO DRS and a transmitting GSO SRS satellite could be as little as 7 km (equivalent to an orbital separation of less than 0.01°). It was also shown that a minimum protection margin of +23.7 dB existed for the near-antipodal case of GSO SRS satellite emissions in the direction of a receiving DRS. Similar results were found for the case of a low-orbiting SRS satellite transmitting in the space-to-Earth direction that is located within the main beam of the receiving antenna of the DRS. In this case, the margin of the interference with respect to the protection criteria given in Recommendation ITU-R SA.1155 was +22 dB.

Further study is required, preferably using Monte Carlo techniques, to determine the statistical characteristics of interference to EESS receiving earth stations from the emissions of non-GSO and GSO SRS satellites.