RECOMMENDATION ITU-R SA.1027-3

SHARING AND COORDINATION CRITERIA FOR SPACE-TO-EARTH DATA TRANSMISSION SYSTEMS IN THE EARTH EXPLORATION-SATELLITE AND METEOROLOGICAL-SATELLITE SERVICES USING SATELLITES IN LOW-EARTH ORBIT

(Questions ITU-R 139/7 and ITU-R 141/7)

(1994-1995-1997-1999)

The ITU Radiocommunication Assembly,

considering

a) that frequency bands allocated to the Earth exploration-satellite and meteorological-satellite services may be shared by several systems, including systems operating in other services;

b) that for the Earth exploration-satellite and meteorological-satellite services, Recommendation ITU-R SA.1026 specifies interference criteria for some frequency bands in the form of permissible levels of total interference to earth stations operating with satellites in low-Earth orbit;

c) that Recommendation ITU-R SA.1023 provides a methodology for deriving sharing criteria based on interference criteria, the anticipated spatial deployment of interfering stations and the associated temporal characteristics of interfering signals;

d) that the typical deployment of interfering stations may change over a period of several years as a result of growth in the number of systems and revisions to frequency band allocations that are adopted by world radio conferences;

e) that by governing the use of the radio-frequency spectrum in their territory and through international coordination of frequency assignments, administrations may exercise a degree of control over the number of systems that may generate interference at significant levels;

f) that the interference environment encountered by shipborne earth stations in the meteorological-satellite service is unlikely to be worse than that encountered by earth stations operating on land;

g) Recommendation ITU-R IS.848, which provides the methodology for determining when coordination is warranted between receiving and transmitting earth stations that operate in the same band;

h) Recommendation ITU-R IS.849, which provides the methodologies for determining when coordination is warranted between transmitting terrestrial stations and earth stations receiving transmissions from non-geostationary spacecraft,

recommends

1 that the single entry interference levels presented for some frequency bands in Table 1 be used as sharing criteria, or as the basis for alternative forms of sharing criteria (e.g. power flux-density limits), for the protection of earth stations operating in the Earth exploration-satellite and meteorological-satellite services;

2 that the criteria specified in § 1 be used as the basis for coordination thresholds for receiving earth stations operating in the Earth exploration-satellite and meteorological-satellite services in bands shared with terrestrial services;

3 that a 6% increase in equivalent link noise temperature be used as the threshold for coordination between transmitting space stations and receiving earth stations operating in the Earth exploration-satellite and meteorological-satellite services;

4 that the deployment of interferers specified in Annex 1 be reviewed periodically in order to determine whether the typical interference environment and consequential sharing criteria should be revised.

NOTE 1 – The coordination provisions of the Radio Regulation (RR) No. S9.11A/Resolution 46 (Rev.WRC-97) are applied in some of the bands addressed in this Recommendation. The sharing criteria specified in this Recommendation should be used to determine whether these consultations or coordinations may be warranted in the absence of other established criteria.

NOTE 2 – The sharing criteria in Table 1 (including the Notes therein) are intended to be applied in frequency sharing analyses and the coordination of frequency assignments (i.e. as the interference thresholds for applicable earth stations). In the coordination process, the actual interference environment seen by the receiving earth station should be compared with that assumed in Annex 1 in order to help determine whether an interfering signal power greater than the permissible single entry level can be accepted. Generally, this consideration may enable acceptance of single entry interference at levels that may be as high as those specified in the interference criteria applicable to the permissible total level of interfering signal power (Recommendation ITU-R SA.1026).

NOTE 3 – The coordination threshold specified in § 3 is sufficiently conservative to assure that interference will be below permissible levels in cases where coordination is not triggered. In order to apply that criterion when determining whether interference from transmitting spacecraft might be at unacceptable levels, the methodology of RR Appendix S8 may be adapted and applied to the stations concerned. In order to avoid unnecessary coordination, administrations may wish to assume that a certain level of antenna discrimination is available from the receiving earth station (e.g. a level of discrimination that is available for 99.9% of the time).

NOTE 4 – The criteria in Table 1 are based on the interference environment given in Annex 1 (see also § 4).

TABLE 1

Sharing criteria for Earth exploration-satellite and meteorological-satellite earth stations using spacecraft in low-Earth orbit

a) Frequency ranges 137-138 MHz and 400.15-401.00 MHz

Frequency band (MHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than p% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
137-138	Analogue receiver 2 dBic antenna gain Direct data readout	–156 dBW per 50 kHz(1)	–155 dBW per 50 kHz(1)	–146 dBW per 50 kHz(1) p = 0.006	–145 dBW per 50 kHz(1) p = 0.012
	Digital receiver 10 dBic antenna gain Direct data readout	–142 dBW per 150 kHz	–147 dBW per 150 kHz	–133 dBW per 150 kHz p = 0.012	–133 dBW per 150 kHz p = 0.012
	Digital receiver 2 dBic antenna gain Direct data readout	–147 dBW per 150 kHz(1)	–146 dBW per 150 kHz(1)	–137 dBW per 150 kHz(1) p = 0.006	–137 dBW per 150 kHz(1) p = 0.012
400.15-401.00	0 dBic antenna gain Direct data readout	–162 dBW per 177.5 kHz	–163 dBW per 177.5 kHz	–148 dBW per 177.5 kHz p = 0.006	–148 dBW per 177.5 kHz p = 0.012

TABLE 1 (*continued*)

b) Frequency range 1 670-1 710 MHz

Frequency band (MHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than *p*% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
1 670-1 675	46.8 dBic antenna gain Recorded data acquisition	–148 dBW per 5 334 kHz	–128 dBW per 5 334 kHz	–121 dBW per 5 334 kHz $p = 0.003$	–121 dBW per 5 334 kHz $p = 0.011$
	29.8 dBic antenna gain Direct data readout	–166 dBW per 2 668 kHz	–150 dBW per 2 668 kHz	–138 dBW per 2 668 kHz $p = 0.003$	–138 dBW per 2 668 kHz $p = 0.008$
1 675-1 690	46.8 dBic antenna gain Recorded data acquisition	–131 dBW per 5 334 kHz	–131 dBW per 5 334 kHz	–121 dBW per 5 334 kHz $p = 0.010$	–121 dBW per 5 334 kHz $p = 0.005$
	29.8 dBic antenna gain Direct data readout	–149 dBW per 2 668 kHz	–152 dBW per 2 668 kHz	–138 dBW per 2 668 kHz $p = 0.010$	–138 dBW per 2 668 kHz $p = 0.005$
1 690-1 700	46.8 dBic antenna gain Recorded data acquisition	–131 dBW per 5 334 kHz	–131 dBW per 5 334 kHz	–121 dBW per 5 334 kHz $p = 0.010$	–121 dBW per 5 334 kHz $p = 0.005$
	29.8 dBic antenna gain Direct data readout	–149 dBW per 2 668 kHz	–149 dBW per 2 668 kHz	–138 dBW per 2 668 kHz $p = 0.010$	–138 dBW per 2 668 kHz $p = 0.005$
1 700-1 710	46.8 dBic antenna gain Recorded data acquisition	–135 dBW per 5 334 kHz	–129 dBW per 5 334 kHz	–121 dBW per 5 334 kHz $p = 0.003$	–121 dBW per 5 334 kHz $p = 0.019$
	29.8 dBic antenna gain Direct data readout	–156 dBW per 2 668 kHz	–150 dBW per 2 668 kHz	–138 dBW per 2 668 kHz $p = 0.001$	–138 dBW per 2 668 kHz $p = 0.002$

c) Frequency range 7 750-8 400 MHz

Frequency band (MHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than *p*% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
7 750-7 850	54.0 dBic antenna gain Recorded data acquisition	–135 dBW per 100 MHz	–132 dBW per 100 MHz	–115 dBW per 100 MHz $p = 0.001$	–115 dBW per 100 MHz $p = 0.001$
8 025-8 400	55.2 dBic antenna gain Recorded data acquisition	–151 dBW per 100 MHz	–134 dBW per 100 MHz	–117 dBW per 100 MHz $p = 0.005$	–117 dBW per 100 MHz $p = 0.010$
	42.5 dBic antenna gain Direct data readout (System A)	–156 dBW per 40 MHz	–139 dBW per 40 MHz	–126 dBW per 40 MHz $p = 0.030$	–126 dBW per 40 MHz $p = 0.011$
	56.3 dBic antenna gain Direct data readout (System B)	–145 dBW per 40 MHz	–128 dBW per 40 MHz	–117 dBW per 40 MHz $p = 0.030$	–116 dBW per 40 MHz $p = 0.011$

TABLE 1 (*end*)

d) Frequency range 25.5-27.0 GHz

Frequency band (GHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than *p*% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
25.5-27.0	55.2 dBic antenna gain Recorded data acquisition	–154 dBW per 10 MHz(1)	–137 dBW per 10 MHz(1)	–118 dBW per 10 MHz(1) $p = 0.05$	–118 dBW per 10 MHz(1) $p = 0.1$
	42.5 dBic antenna gain Direct data readout	–157 dBW per 10 MHz(1)	–140 dBW per 10 MHz(1)	–120 dBW per 10 MHz(1) $p = 0.05$	–120 dBW per 10 MHz(1) $p = 0.1$
	42.5 dBic antenna gain High-speed direct data readout	–156 dBW per 10 MHz(1)	–139 dBW per 10 MHz(1)	–122 dBW per 10 MHz(1) $p = 0.05$	–122 dBW per 10 MHz(1) $p = 0.1$

(1) In this case, the interfering signal powers (dBW) in the reference bandwidths are specified for reception at elevation angles ≥ 25°.

NOTE 1 – The interfering signal powers (dBW) in the reference bandwidths are specified for reception at elevation angles ≥ 5°.

NOTE 2 – The single entry interfering signal power thresholds in the above table are the permissible levels of interfering signal power that fall within the specified reference bandwidth. Accordingly, the total power in interfering signals that are narrower than the reference bandwidth should be considered in frequency sharing analyses. In cases where the interfering signal bandwidth exceeds the reference bandwidth or does not fully overlap the passband of a specific receiver under study, the available frequency dependent rejection should be applied in conjunction with the specified permissible interference levels. The pertinent Recommendations should be consulted for guidance on this matter.

NOTE 3 – The sharing criteria can be expressed as permissible power flux-densities into the main beam of the receive antenna by subtracting $10 \log(G \lambda^2/4\pi)$ from the values given in Table 1, where G is the receive antenna gain and λ is the wavelength.

NOTE 4 – In deriving the above sharing criteria from permissible total levels of interfering signal power, no allowance has been made for interference from spurious emissions.

NOTE 5 – Both the long-term (20% of the time) and short-term (<1% of the time) sharing criteria must be met in order for interference to be at or below permissible levels.

NOTE 6 – Sharing criteria specified for terrestrial signal paths are applicable to transmitting stations in terrestrial services and transmitting earth stations.

ANNEX 1

Basis for sharing criteria

1 Introduction

The objectives of sharing criteria are, on the one hand, to ensure that interference from all sources will not exceed the applicable interference criteria (i.e. permissible levels of total interference) and, on the other hand, to enable efficient sharing by allowing the maximum possible number of systems to share a band in the same area of operation (preferably on a co-channel basis). This Annex presents the basis for subdividing the applicable interference criteria (Recommendation ITU-R SA.1026) among the anticipated interferers. Table 2 presents the factors used in apportioning the total permissible interference for each relevant band between the categories of space-to-Earth and terrestrial interference paths as well as among the anticipated number of interferers in each of those categories. The following paragraphs discuss the interference environment in each band.

2 137-138 MHz band

The 137-138 MHz band is allocated to the space operation, meteorological-satellite and space research services on a primary basis; the mobile-satellite (space-to-Earth) on a primary basis in parts of the band and with a secondary basis in other paths of the band; and the fixed and mobile (except aeronautical mobile (R)) services on a secondary basis (except in 35 administrations where that allocation is primary).

For most of the time at typical meteorological-satellite earth station sites, space stations such as those in the mobile-satellite service could produce higher levels of interference than terrestrial stations. The meteorological-satellite earth stations using antennas with 10 dBic gain will provide greater discrimination against terrestrial station emissions than will the earth stations using lower antenna gains (2 dBic). In the short-term, propagation enhancements on terrestrial interfering signal paths and the location variability of mobile stations may result in similar interference levels from space-to-Earth and terrestrial stations.

3 400.15-401.00 MHz band

The 400.15-401.00 MHz band is allocated on a primary basis to the space operation, meteorological-satellite, space research and mobile-satellite (space-to-Earth) services; the space research (space-to-space) service; and the meteorological aids service. In addition, the band is also allocated to the fixed and mobile services in 34 administrations on a primary basis.

For most of the time at typical meteorological-satellite earth station sites, space stations such as those in the mobile-satellite service could produce higher levels of interference than terrestrial stations. In the short-term, propagation enhancements on terrestrial interfering signal paths and the location variability of mobile and meteorological aids stations may result in similar interference levels from space-to-Earth and terrestrial stations.

4 1 670-1 710 MHz band

The band 1 670-1 675 MHz is allocated on a primary basis to the meteorological-satellite (space-to-Earth) service and the meteorological aids, fixed and mobile services, including aeronautical mobile (ground-to-air). The 1 675-1 690 MHz band is allocated on a primary basis to the meteorological-satellite (space-to-Earth) service; the meteorological aids, fixed and mobile (except aeronautical mobile) service; and the mobile-satellite (Earth-to-space) service in Region 2. The 1 690-1 700 MHz band is allocated to the meteorological-satellite (space-to-Earth) service on a primary basis and the Earth exploration-satellite (space-to-Earth) service on a secondary basis; the meteorological aids service on a primary basis; the mobile-satellite (Earth-to-space) service on a primary basis in Region 2; and to the fixed and mobile (except aeronautical mobile) services in Region 1 and several other areas on a secondary basis.

Space-to-Earth systems in the 1 670-1 675 MHz band must limit their emissions in order to protect the radioastronomy service operating in the adjacent band, such that terrestrial stations would produce most of the interference. Above 1 675 MHz, it is expected that greater numbers of space stations will operate and produce about the same long-term interference levels as terrestrial systems and relatively greater interference levels in the short-term (i.e. as a result of temporal variations in meteorological-satellite earth station antenna gain towards the interfering satellites). The expectation that mobile earth stations could contribute substantially to interference arriving via terrestrial signal paths does not warrant different interference allocations for terrestrial interfering signal paths in Region 2 because terrestrial stations and mobile earth stations are unlikely to use the same frequencies in the same area.

5 7 750-7 850 MHz band

The 7 750-7 850 MHz band is allocated to the non-geostationary meteorological-satellite (space-to-Earth) service and the fixed and mobile (except aeronautical mobile) services on a primary basis.

6 8 025-8 400 MHz band

The 8 025-8 400 MHz band is allocated to the fixed-satellite (Earth-to-space) service on a primary basis, the Earth exploration-satellite (space-to-Earth) service on a primary basis in Region 2 and a secondary basis elsewhere, and the fixed and mobile services on a primary basis. In Region 2, aircraft transmissions are prohibited. In addition, the 8 175-8 215 MHz segment is allocated to the meteorological-satellite (Earth-to-space) service on a primary basis. Because the only sources of interference on space-to-Earth paths are from Earth exploration-satellite systems, no long-term interference is assumed to occur on space-to-Earth paths (i.e. for most of the time there is no interferer in view or high levels of earth station antenna discrimination are available). In the short-term, interference may occur among Earth exploration-satellite systems on space-to-Earth paths, although interference on terrestrial signal paths will predominate (especially for direct data readout earth stations, which have less antenna discrimination towards the horizon than recorded data acquisition stations).

7 25.5-27.0 GHz band

The 25.5-27.0 GHz band is allocated to the fixed, mobile and inter-satellite services. Potential sources of interference on Earth exploration-satellite space-to-Earth paths are other Earth exploration-satellite system satellites, inter-satellite service satellites and terrestrial fixed and mobile systems. No long-term interference is assumed to occur on the Earth exploration-satellite space-to-Earth path due to Earth exploration-satellite and inter-satellite service satellite emissions because of the constant movement of the satellites (i.e. for most of the time there is no interferer in view or high levels of earth station antenna discrimination are available). In the short term, interference may occur between Earth exploration-satellite and inter-satellite service satellite systems on space-to-Earth paths, although interference on terrestrial signal paths will predominate.

TABLE 2

Parameters used to derive sharing criteria from interference criteria

Frequency band (MHz)	Type of earth station	Long-term apportionment between categories of interferers		Short-term apportionment between categories of interferers		Equivalent number of long-term interferers		Equivalent number of short-term interferers	
		Interfering signal path		Interfering signal path		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
137-138	2 dBic Antenna gain (non-tracking)	60%	40%	50%	50%	2	1	2	1
	10 dBic Antenna gain (tracking)	75%	25%	50%	50%	1	1	1	1
400.15-401.00	0 dBic Antenna gain (non-tracking)	75%	25%	50%	50%	2	1	2	1
1 670-1 675	46.8 dBic Antenna gain Recorded data acquisition	1%	99%	10%	90%	1	1	1	2
	29.8 dBic Antenna gain Direct data readout	1%	99%	10%	90%	1	2	1	3
1 675-1 690	46.8 dBic Antenna gain Recorded data acquisition	50%	50%	80%	20%	1	1	2	1
	29.8 dBic Antenna gain Direct data readout	50%	50%	80%	20%	1	2	2	1
1 690-1 700	46.8 dBic Antenna gain Recorded data acquisition	50%	50%	80%	20%	1	1	2	1
	29.8 dBic Antenna gain Direct data readout	50%	50%	80%	20%	1	1	2	1

TABLE 2 (*end*)

Frequency band (MHz)	Type of earth station	Long-term apportionment between categories of interferers		Short-term apportionment between categories of interferers		Equivalent number of long-term interferers		Equivalent number of short-term interferers	
		Interfering signal path		Interfering signal path		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
1 700-1 710	46.8 dBic Antenna gain Recorded data acquisition	20%	80%	25%	75%	1	1	2	1
	29.8 dBic Antenna gain Direct data readout	20%	80%	25%	75%	2	2	2	1
7 750-7 850	54.0 dBic Antenna gain Recorded data acquisition	20%	80%	75%	25%	1	2	2	2
8 025-8 400	55.2 dBic Antenna gain Recorded data acquisition	1%	99%	20%	80%	1	2	1	2
	42.5 dBic Antenna gain Direct data readout (System A)	1%	99%	10%	90%	1	2	1	2
	56.3 dBic Antenna gain Direct data readout (System B)	1%	99%	20%	80%	1	2	1	2
25 500-27 000	Recorded data acquisition Direct data readout	1%	99%	20%	80%	1	2	1	2