

RESOLUTION 739 (REV.WRC-19)

Compatibility between the radio astronomy service and the active space services in certain adjacent and nearby frequency bands

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

- a)* that adjacent or nearby primary service allocations have been made to the radio astronomy service (RAS), and to various space services, such as the fixed-satellite service (FSS), radionavigation-satellite service (RNSS), mobile-satellite service (MSS) and broadcasting-satellite service (BSS), hereafter referred to as “active space services”;
- b)* that, in many cases, the frequencies used by the RAS are chosen to study natural phenomena producing radio emissions at frequencies fixed by the laws of nature, so shifting frequency to avoid or mitigate interference problems may not be possible;
- c)* that Report ITU-R SM.2091 provides a methodology for conducting, and a framework for documenting the results of, compatibility studies between active space service and RAS band pairs;
- d)* that Report ITU-R SM.2091 also provides the results of compatibility studies between the RAS and an active space service in certain adjacent and nearby frequency bands;
- e)* that appropriate consultation between administrations has the potential to lead to the development of innovative solutions and to the rapid deployment of systems;
- f)* that, for technical or operational reasons, more stringent spurious emission limits than the general limits in Appendix 3 may be required to protect the RAS from active services in specific frequency bands,

noting

- a)* that the additional burden of undertaking any technical examination should not be placed on the Radiocommunication Bureau (BR);
- b)* that a consultation procedure, as contained in this Resolution, would not place an additional burden on BR;
- c)* that Recommendation ITU-R M.1583 provides a methodology based on the equivalent power flux-density (epfd) concept for calculation of interference resulting from unwanted emissions from non-geostationary-satellite (non-GSO) systems of the MSS or RNSS into radio astronomy stations;
- d)* that Recommendation ITU-R S.1586 provides a methodology based on the epfd concept for calculation of interference resulting from unwanted emissions from non-GSO systems of the FSS into radio astronomy stations;

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- e) that the methodology described in these Recommendations may also be used to study the case of non-GSO systems in the BSS;
- f) that Recommendation ITU-R RA.1631 provides antenna patterns to be used for compatibility analyses between non-GSO systems and RAS stations, based on the epfd concept;
- g) that Recommendation ITU-R RA.1513 provides acceptable levels of data loss to radio astronomy observations, stating in particular that the percentage of data loss caused by any system should be lower than 2%;
- h) that some of the results documented in Report ITU-R SM.2091 may be used as threshold levels to initiate the consultation procedure;
- i) that the results of successful consultation between concerned administrations would ensure that the interests of both the active services and the RAS are considered;
- j) that measures taken by active space services to protect radio astronomy stations from interference may result in increased costs and/or reduced capabilities for those services;
- k) that, conversely, not taking such measures may result in additional operating costs and reduced operational effectiveness for the radio astronomy stations concerned;
- l) that the implementation of additional interference mitigation measures at the radio astronomy station may increase operating costs and reduce observational effectiveness;
- m) that, conversely, not implementing such measures may impose upon the active space services an additional cost burden and reduction in service capability,

recognizing

- a) that unwanted emissions produced by stations of the active space services may cause unacceptable interference to stations of the RAS;
- b) that, although some unwanted emissions from transmitters on space stations can be controlled through careful design methods and appropriate testing procedures, other unwanted emissions, such as narrowband spurious emissions, generated by uncontrollable and/or unpredictable physical mechanisms, may only be detected after the spacecraft is launched;
- c) that there is an uncertainty in the pre-launch assessment of the levels of unwanted emissions;
- d) that it is necessary to ensure equitable burden-sharing for achieving compatibility between the active space services and the RAS;
- e) that, for those cases where difficulties are encountered in meeting the values in the Annex to this Resolution, a consultation procedure could be used to resolve the difficulties,

resolves

1 that an administration take all reasonable steps to ensure that any space station or satellite system being designed and constructed to operate in the frequency bands in the Annex to this Resolution meets the values given therein at any radio astronomy station operating in the corresponding frequency bands identified in that Annex;

2 that in the event that during construction and prior to launch it is determined that, after having considered all reasonable means, the unwanted emissions from the space station or satellite system cannot meet the values given in the Annex, the administration that notified the space station or satellite system contact, as soon as possible, the administration operating the radio astronomy station to confirm that *resolves* 1 has been fulfilled, and the concerned administrations enter into a consultation process in order to achieve a mutually acceptable solution;

3 that in the event that, following the space station launch, an administration operating a radio astronomy station determines that, due to unexpected circumstances, a space station or satellite system does not meet the values for unwanted emissions given in the Annex at that radio astronomy station, it contact the administration that notified the space station or satellite system for the latter administration to confirm that *resolves* 1 has been fulfilled, and the concerned administrations enter into a consultation process in order to identify further steps with a view to achieving a mutually acceptable solution;

4 that the radio astronomy stations to be taken into account in applying *resolves* 1, 2 and 3 are those which are operating in the frequency band(s) identified in the Annex and which are notified before the date of receipt of the advance publication information (API) of the space station or satellite system to which this Resolution applies;

5 that the space stations or satellite systems to be considered in the application of *resolves* 1 to 4 above are those designed to operate in the space service frequency bands listed in the tables in the Annex for which API is received by BR following the entry into force of the Final Acts of the appropriate conference, as specified in those tables;

6 that the objective of the consultation process in *resolves* 1, 2 and 3 is to achieve a mutually acceptable solution, using as guidance Report ITU-R SM.2091 and any other ITU Radiocommunication Sector Recommendations deemed relevant by the concerned administrations;

7 that BR shall make no examination or finding with respect to this Resolution under either Article 9 or 11,

invites administrations

1 to take all appropriate and practicable steps, from the design phase onward, to ensure that unwanted emissions are minimized from space stations that are planned to operate in one or more space service allocations, in order to avoid exceeding the threshold levels of unwanted emissions identified in the Annex at any radio astronomy station;

2 to take all practicable steps, from the design phase onward, to minimize the sensitivity of radio astronomy stations to interference and to take into account the need to implement interference mitigation measures.

ANNEX TO RESOLUTION 739 (REV.WRC-19)

Unwanted emission threshold levels

The unwanted emission threshold levels applicable to geostationary space stations are given in Table 1 in terms of power flux-density (pfd) in a reference bandwidth produced at a radio astronomy station.

In Table 1, the unwanted emission threshold levels given in the fourth, sixth and eighth columns (associated with the reference bandwidth contained in the adjacent columns) should be met by any GSO space station operating in the frequency bands indicated in the second column at the radio astronomy station operating in the frequency band mentioned in the third column.

The unwanted emission threshold levels applicable to space stations of a non-geostationary-satellite (non-GSO) system are given in Table 2 in terms of the equivalent power flux-density (epfd) produced at a radio astronomy station in a reference bandwidth by all the space stations in a non-GSO system that are visible to the radio astronomy station considered, not to be exceeded during a given percentage of time, over the whole sky.

In Table 2, the epfd value given in the fourth, sixth and eighth columns (associated with the reference bandwidths contained in the adjacent column) should be met by all the space stations of a non-GSO system operating in the frequency bands indicated in the second column at the radio astronomy station operating in the frequency band mentioned in the third column. The epfd value at a given radio astronomy station shall be evaluated by using the antenna pattern and the radio astronomy service maximum antenna gain given in Recommendation ITU-R RA.1631-0. Guidance on the calculation of epfd can be found in Recommendations ITU-R S.1586 and ITU-R M.1583. The elevation angles of the radio astronomy stations to be taken into account in the epfd calculation are those higher than the minimum elevation angle θ_{min} of the radio telescope. In the absence of such information, a value of 5° shall be taken. The percentage of time during which the epfd level shall not be exceeded is mentioned in Note ⁽¹⁾ to Table 2.

Some sections of Report ITU-R SM.2091 indicate levels of unwanted emissions in radio astronomy frequency bands that certain satellite systems, by design, do not exceed.

TABLE 1
 pfd thresholds for unwanted emissions from any GSO space station
 at a radio astronomy station

Space service	Space service frequency band (MHz)	Radio astronomy frequency band (MHz)	Single dish, continuum observations		Single dish, spectral line observations		VLBI		Condition of application: the API is received by BR following the entry into force of the Final Acts of:
			pfd ⁽¹⁾ (dB(W/m ²))	Reference bandwidth (MHz)	pfd ⁽¹⁾ (dB(W/m ²))	Reference bandwidth (kHz)	pfd ⁽¹⁾ (dB(W/m ²))	Reference bandwidth (kHz)	
MSS (space-to-Earth)	387-390	322-328.6	-189	6.6	-204	10	-177	10	WRC-07
BSS	1 452-1 492	1 400-1 427	-180	27	-196	20	-166	20	WRC-03
MSS (space-to-Earth)	1 525-1 559	1 610.6-1 613.8	NA	NA	-194	20	-166	20	WRC-03
MSS (space-to-Earth)	1 525-1 559 1 613.8-1 626.5	1 610.6-1 613.8	NA	NA	-194	20	-166	20	WRC-07
RNSS (space-to-Earth)	1 559-1 610	2 690-2 700	-177	10	NA	NA	-161	20	WRC-03
BSS	2 655-2 670	2 690-2 700	-177	10	NA	NA	-161	20	WRC-03
FSS (space-to-Earth)	2 670-2 690	2 690-2 700 (in Regions 1 and 3)	-177	10	NA	NA	-161	20	WRC-03
		(GHz)	-	-	-	-	-	-	
BSS	21.4-22.0	22.21-22.5	-146	290	-162	250	-128	250	WRC-03 for VLBI, and WRC-07 for other types of observation

NA: Not applicable, measurements of this type are not made in this frequency band.

⁽¹⁾ Integrated over the reference bandwidth with an integration time of 2 000 s.

TABLE 2
epfd thresholds⁽¹⁾ for unwanted emissions from all space stations of a non-GSO satellite system at a radio astronomy station

Space service	Space service frequency band (MHz)	Radio astronomy frequency band (MHz)	Single dish, continuum observations		Single dish, spectral line observations		VLBI		Condition of application: the API is received by BR following the entry into force of the Final Acts of:
			epfd ⁽²⁾ (dB(W/m ²))	Reference bandwidth (MHz)	epfd ⁽²⁾ (dB(W/m ²))	Reference bandwidth (kHz)	epfd ⁽²⁾ (dB(W/m ²))	Reference bandwidth (kHz)	
MSS (space-to-Earth)	137-138	150.05-153	-238	2.95	NA	NA	NA	NA	WRC-07
MMSS (space-to-Earth)	157.1875-157.3375 161.7875-161.9375	150.05-153	-238	2.95	NA	NA	NA	NA	WRC-19
MMSS (space-to-Earth)	157.1875-157.3375 161.7875-161.9375	322-328.6	-240	6.6	-255	10	-228	10	WRC-19
MSS (space-to-Earth)	387-390	322-328.6	-240	6.6	-255	10	-228	10	WRC-07
MSS (space-to-Earth)	400.15-401	406.1-410	-242	3.9	NA	NA	NA	NA	WRC-07
MSS (space-to-Earth)	1 525-1 559	1 400-1 427	-243	27	-259	20	-229	20	WRC-07
RNSS (space-to-Earth) ⁽³⁾	1 559-1 610	1 610.6-1 613.8	NA	NA	-258	20	-230	20	WRC-07
MSS (space-to-Earth)	1 525-1 559	1 610.6-1 613.8	NA	NA	-258	20	-230	20	WRC-07

NA: Not applicable, measurements of this type are not made in this frequency band.

⁽¹⁾ These epfd thresholds should not be exceeded for more than 2% of time.

⁽²⁾ Integrated over the reference bandwidth with an integration time of 2 000 s.

⁽³⁾ This Resolution does not apply to current and future assignments of the radionavigation-satellite system GLONASS/GLONASS-M in the frequency band 1 559-1 610 MHz, irrespective of the date of receipt of the related coordination or notification information, as appropriate. The protection of the radio astronomy service in the frequency band 1 610.6-1 613.8 MHz is ensured and will continue to be in accordance with the bilateral agreement between the Russian Federation, the notifying administration of the GLONASS/GLONASS-M system, and IUCAF, and with subsequent bilateral agreements with other administrations.