

PLENARY MEETING

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Working Group 2

PROPOSED MODIFICATIONS TO THE DRAFT CPM REPORT

AGENDA ITEM 1.11

(WP 7B / WP 4A, WP 4C, WP 5A, WP 5C, (WP 3M))

1.11 to consider a primary allocation for the Earth exploration-satellite service (Earth-to-space) in the 7-8 GHz range, in accordance with Resolution 650 (WRC-12);

Resolution 650 (WRC-12): Allocation for the Earth exploration-satellite service (Earth-to-space) in the 7-8 GHz range

2/1.11/1 Executive summary

Resolution 650 (WRC-12) invites ITU-R to conduct a study of spectrum requirements in the 7-8 GHz frequency range for EESS (Earth-to-space) telecommand operations in order to complement telemetry operations of EESS (space-to-Earth) in the 8 025-8 400 MHz frequency band and to conduct compatibility studies between EESS (Earth-to-space) systems and existing services, with priority to the frequency band 7 145-7 235 MHz, and then within other portions of the 7-8 GHz frequency range only if the frequency band 7 145-7 235 MHz is found not to be suitable. WRC-15 agenda item 1.11 calls for providing a worldwide primary allocation to the EESS (Earth-to-space) in the frequency range 7-8 GHz with priority to the frequency band 7 145-7 235 MHz.

Studies of spectrum requirements for the EESS have been addressed in Report ITU-R SA.2272 and indicates that the EESS system spectrum requirements are between 38 and 56 MHz. 38 MHz spectrum required in the case when the allocation is made in frequency bands not shared with other space services, while 56 MHz spectrum required in the case when the allocation is made in bands shared with other space services (like the frequency band 7 190-7 235 MHz).

Sharing studies between stations of the EESS (Earth-to-space) and the SRS, FS, MS and SOS in various portions of the 7-8 GHz frequency range are addressed in Reports ITU-R SA.2275, ITU-R SA.2309, and PDN Report ITU-R SA.[GSO EESS-Space 7GHz]. These studies show that sharing would be feasible in the frequency band 7 190-7 250 MHz, covering therefore the spectrum requirements identified.

Three methods have been proposed to satisfy this agenda item. Methods A and B propose a new primary allocation to the EESS in the frequency band 7 190-7 250 MHz with different conditions establishing protection of currently allocated services. The third method, Method C, with the proposal of no change to the Radio Regulations was also included. All these methods support the suppression of Resolution 650 (WRC-12).

2/1.11/2 Background

A sizable number of future EESS missions will require to uplink to the spacecraft a large amount of data for operations plans and dynamic spacecraft software modifications.

The spectrum that globally would be required on the Earth-to-space link for these telecommanding functions cannot be accommodated in the only EESS (Earth-to-space) allocation that is currently available in RR Article 5 for telecommanding, i.e. the 2 025-2 110 MHz frequency band. This 2 025-2 110 MHz frequency band is of fundamental importance, since there are already more than 1 100 satellite networks filed with the ITU and many new satellite networks are expected to enter into this frequency band, also including many microsattelites, nanosattelites and picosattelites. It would be extremely difficult, if not impossible, to coordinate satellites with such large spectrum requirements within this frequency band.

An EESS (Earth-to-space) allocation in the 7-8 GHz frequency range would allow alleviating the problems posed by this new type of EESS mission. The TT&C (Telemetry, Tracking and Control) function could be implemented by pairing this new allocation with the already existing EESS (space-to-Earth) allocation in the frequency band 8 025-8 400 MHz. This may also eventually lead to a simplified on-board architecture and operational concept for some future EESS missions.

2/1.11/3 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Existing relevant ITU-R Recommendations: ITU-R SA.609, ITU-R SA.1157-1, ITU-R SA.514-3, ITU-R F.758-5, ITU-R F.1245, ITU-R SA.363-5, ITU-R S.465-6.

Relevant ITU-R Reports: ITU-R SA.2272, ITU-R SA.2275, ITU-R SA.2309, PDN Rep ITU-R SA.[GSO EESS-SPACE-7GHz], PDN Rep ITU-R S.[FSS 7/8 GHz Compatibility].

The ITU-R has developed various studies on sharing and compatibility in the 7 145-7 250 MHz frequency band. The studies have examined the compatibility between a transmitting EESS earth station and stations in the FS, SOS and SRS. Sharing of EESS systems with SRS and SOS systems was evaluated using the static and dynamic simulation methods and the results have been reported. The ITU-R has also developed Report ITU-R SA.2272 on the spectrum requirements for EESS operations in the 7-8 GHz frequency range.

Sharing with FS systems was evaluated using methods of RR Appendix 7 to determine separation distances under certain circumstances such as flat terrain and an obstacle of up to 50 m in height located 5 km from the transmitting EESS earth station. The separation distances calculated using the static analysis, the time-invariant gain (TIG) and time-variant gain (TVG) methods were compared and addressed in Report ITU-R SA.2275.

Similar frequency bands are being considered under WRC-15 agenda items 1.9.1 (for the FSS) and 1.11 (for the EESS), and the conditions of compatibility between potential stations of both services have been studied. PDN Report ITU-R S.[FSS 7/8 GHz Compatibility] examines the impact of such EESS (Earth-to-space) earth stations into new potential FSS earth stations.

2/1.11/4 Analysis of the results of studies

2/1.11/4.1 Earth exploration-satellite service spectrum requirements in the 7-8 GHz frequency range

Report ITU-R SA.2272 deals with the spectrum requirements for future EESS missions operating under a potential new EESS uplink allocation in the 7-8 GHz frequency range. In order to estimate the number of missions that could use this new EESS uplink allocation in the 7-8 GHz frequency

range, a query in the ITU Space Network Systems was made and 130 EESS missions were found to have a downlink in 8 025-8 400 MHz. Under the assumption that within 10-15 years there will be an increase of approximately 25% in the number of EESS missions using the frequency band 8 025-8 400 MHz for data downlink and that approximately 50% of these satellites could be using the new EESS (Earth-to-space) allocation, the estimated number of EESS missions with an uplink in 7-8 GHz frequency range in 10-15 years would be 81, each with an average uplink bandwidth of 1.4 MHz.

According to this analysis, most Earth exploration-satellites use very similar (polar) orbits and the ground stations are co-located at high latitudes (e.g. Kiruna (Sweden), Poker Flat (Alaska), Prince Albert (Canada), Troll (Antarctica)). For the hypothetical case where the EESS uplink band is being used for support of EESS missions only, the bandwidth requirement is 38 MHz. However, considering that the EESS would probably be sharing the whole or part of the allocated band with other space services, the bandwidth requirement for the EESS (Earth-to-space) increases to approximately 56 MHz. The upper edge of the new frequency allocation, the frequency band 7 235-7 250 MHz, would be used for some EESS satellites that may have difficulties sharing with some SRS and/or SOS missions as a function of their orbital characteristics.

2/1.11/4.2 Earth exploration-satellite service sharing with the fixed service

Report ITU-R SA.2275 provides the results of sharing assessments between the non-GSO EESS (Earth-to-space) and the FS, which apply to the whole frequency range 7-8 GHz. The TIG and TVG methodologies described in RR Appendix 7 were applied to assess the coordination area around EESS earth stations where coordination would be required with FS assignments. However, the TVG gives a more realistic coordination distance for this particular case, as the TIG methodology overestimates the coordination distances for non-GSO satellites, particularly on low Earth orbits such as polar orbits often used for Earth observation. The TVG contour, relevant when dealing with earth stations tracking non-GSO satellites as EESS satellites leads to a maximum coordination distance of 74 km for an EESS earth station located in Kiruna in Sweden, 103 km for an EESS earth station located in Villafranca in Spain and 156 km for a station located in Kourou in French Guiana, and this considering that the FS station is pointing directly towards the EESS earth station.

This coordination distance drops rapidly down to 3 km when the FS station does not point directly towards the EESS earth station, which would likely be the case when dealing with cross border coordination. The 3 km distance is obtained for offset angles greater than 50°. For 80% of FS stations, the coordination distance would be lower than 5 km. For 90% of the FS stations, it would be lower than 10 km.

It should also be noted that these findings take into account a flat terrain but that, when taking into account actual terrain elevation, on a site-by-site basis, the coordination distance would be much more reduced. Examples of such calculations are provided in Report ITU-R SA.2275.

The actual coordination distance calculated using TVG methodology will depend on the location of the EESS earth station, its characteristics and the orbit of the EESS satellite it is tracking.

It should be pointed out that a number of SRS earth stations operating today in the frequency band 7 145-7 235 MHz have been successfully coordinated with the fixed service, although they use a much higher emission power than EESS earth stations, leading to larger coordination areas.

Similar to what is happening for these SRS earth stations, for each individual EESS satellite mission and earth station a specific uplink licence will have to be obtained from the relevant administration. This implies that the compatibility with the FS systems operating within the coordination area will always have to be analysed (in a few cases this could involve the neighbouring administrations). Only when and if the administration(s) will have verified that there will be no impact to the FS

systems the individual licences for operating the uplinks will be given. In other words the FS systems will always be fully protected.

For the sharing compatibility in the other direction, no harmful interference is expected in the EESS satellite receivers based on the studies presented here and the number of FS links deployed in the whole frequency range 7.1-8.5 GHz.

Given the relatively small separation distance requirements, coordination of FS stations and EESS earth stations becomes a national matter for all currently known locations. To this effect, a separation distance between the location of the EESS earth station and the border of neighbouring administrations might be included in the RR, as a replacement for coordination. In addition, existing provisions within RR Article 21 ensure that FS systems will not be constrained beyond that with which they currently operate in the 7 145-7 250 MHz frequency band in regards to other co-primary services.

The PDN Report ITU-R SA.[GSO EESS-SPACE-7 GHz] examines the interference from the proposed GSO EESS system uplink into the FS systems using TIG methodology described in RR Appendix 7. The static analysis leads to a maximum coordination distance of 334 km for a GSO EESS earth station at Wallops (USA) when considering that the victim FS station is pointing directly towards the EESS earth station. This coordination distance drops rapidly to less than 50 km when the FS station does not point directly towards the EESS earth station, which would likely be the case when dealing with cross border coordination. The 50 km distance at Wallops is obtained for offset angles greater than 20°. For 90% of FS stations, the coordination distance would be lower than 50 km.

No change is being proposed on the sharing criteria that are currently applied to sharing between the FS and the SRS in the 7 145-7 235 MHz frequency band, and no additional constraints will be placed on the use of FS systems in this band or other bands under this agenda item.

2/1.11/4.3 Earth exploration-satellite service sharing with the mobile service

Within the frequency range 7-8 GHz, the frequency band above 7 125 MHz is not currently used by MS systems and therefore no study was performed with regard to MS stations. However if the MS systems would use this band in the future, it is considered that the separation distances derived for the protection provided to the FS systems would be sufficient for the protection of the MS systems.

2/1.11/4.4 Earth exploration-satellite service sharing with the space research service (deep-space)

The protection of SRS deep-space uplinks in the frequency band 7 145-7 190 MHz is critical to the success of the deep-space missions. This is especially important as almost all current and future SRS deep-space missions rely on this band as their lifeline for routine and emergency operations. Interference to the uplink of these missions should be minimized during their routine operations, but must be avoided completely during their near-Earth operations.

Based on the analysis in Report ITU-R SA.2309, SRS (deep space) spacecraft receivers in the 7 145-7 190 MHz frequency band are compliant with the applicable ITU criterion when the spacecraft is in deep space (i.e. at distances greater than 2 million km from the Earth). However, interference levels may be above the ITU criterion of deep space missions during their near-Earth operations, such as launch and early orbit operation phases, flybys, and sample returns.

Additionally, the interference from SRS deep space uplinks into EESS satellite receivers would be well above the applicable ITU criterion in case of co-frequency operations and either geographically co-located or nearby earth station operations.

Finally, the interference levels from SRS deep space uplinks could damage the satellite receiver for certain EESS missions.

Therefore, this analysis suggests that the coexistence of EESS and deep-space SRS uplinks would not be practical within the same operational frequency band. The frequency band 7 145-7 190 MHz band should hence not be considered for future EESS Earth-to-space links.

2/1.11/4.5 Earth exploration-satellite service sharing with the space research service (near-Earth)

The analysis in Report ITU-R SA.2309 and PDN Report ITU-R SA.[GSO EESS-SPACE-7 GHz] indicates that interference levels from EESS uplinks into near-Earth SRS satellite receivers in the frequency band 7 190-7 235 MHz are compliant with the applicable ITU criterion and that this type of operation is compatible without the need of any special mitigation techniques.

On the other hand, in some cases for co-frequency operations, in particular when the earth stations are either geographically co-located or nearby, the interference levels from near-Earth SRS uplinks into EESS satellites would exceed the applicable ITU criterion. This could put some limitations in the selection of individual frequency assignments or earth station locations for EESS (Earth-to-space) within the frequency band 7 190-7 235 MHz.

However, it should be noted that a similar situation currently exists for near-Earth SRS uplinks of different missions and that these missions are successfully coordinated among space agencies in the frame of the applicable RR procedures (i.e. RR No. **9.3**). Therefore, there should be compatibility between SRS (Earth-to space) and EESS (Earth-to space) systems in the 7 190-7 235 MHz frequency band if frequency and earth station coordination takes place.

It is noted that no change is being proposed on the sharing criteria that are currently applied to sharing among the SRS and no additional constraints beyond those currently applied to the SRS would need to be placed on the EESS in this frequency band.

2/1.11/4.6 Earth exploration-satellite service sharing with the space operation service

In the Russian Federation, the frequency bands 7 100-7 155 MHz and 7 190-7 235 MHz are also allocated by RR No. **5.459** to the SOS (Earth-to-space) on a primary basis, subject to agreement obtained under RR No. **9.21**. Report ITU-R SA.2309, contains the analysis of three studies that have been conducted independently to assess the interference from the proposed non-GSO EESS system uplink into the SOS system uplink.

Two studies carried out using the applicable SOS protection criteria contained in Recommendation ITU-R SA.363-5 conclude that the non-GSO EESS and the SOS systems are compatible.

The third study indicates potential harmful interference under certain conditions. This study was based on the protection ratio C/I given in the applicable Recommendation ITU-R SA.363-5, although considering the daily time percentage referred to the daily SOS operation time instead of 24 hours as indicated in the Recommendation ITU-R SA.363-5.

The PDN Report ITU-R SA.[GSO EESS-SPACE-7 GHz] also contains one study to assess the interference from the proposed GSO EESS system uplink into the SOS system uplink.

It can therefore be concluded that on the basis of the protection criteria contained in the applicable Recommendation ITU-R SA.363-5, and the characteristics considered for both EESS and SOS systems in Report ITU-R SA.2309 (non-GSO) and PDN Report ITU-R SA.[GSO EESS-SPACE-7 GHz] (GSO) compatibility is possible.

2/1.11/5 Methods to satisfy the agenda item

2/1.11/5.1 Method A

This method proposes to add a global primary allocation to the EESS in the frequency band 7 190-7 250 MHz in the Table of Frequency Allocations in RR Article 5 and to include a provision with regard to this allocation for the modification of RR footnote No. 5.460 in order to indicate that geostationary EESS systems shall not claim protection from existing and future stations of the FS and the MS, that RR No. 5.43A does not apply and that EESS usage is restricted to TT&C for spacecraft operations. For the SOS, the obtaining of agreement under RR No. 9.21 (see RR No. 5.459) with regard to the EESS is not applied.

Additionally, Table 7b in RR Appendix 7 is modified to include the EESS allocation, and Table 21-3 in RR Article 21 is modified to extend the frequency range 7 190-7 235 MHz to 7 190-7 250 MHz.

Resolution 650 (WRC-12) would be consequentially suppressed.

Advantages

- A new EESS (Earth-to-space) allocation of 60 MHz would be usable by various EESS missions.
- A new EESS (Earth-to-space) allocation would provide a needed companion band to the telemetry operations of EESS (space-to-Earth) in the 8 025-8 400 MHz frequency band.
- The EESS systems that may have difficulties in sharing with SRS and/or SOS systems as a function of their orbital characteristics could be accommodated in the 7 235-7 250 MHz frequency band not allocated to the SRS and the SOS.
- The operation and development of the FS systems in the frequency band 7 190-7 250 MHz would not be constrained due to the very low number of EESS earth stations in the world and their remote locations far away from the border of neighbouring countries.
- This method does not impose unnecessary additional coordination burden (RR No. 9.21) on the EESS developers, on the administrations and ITU BR.

Disadvantages

- The request for a footnote making the GSO EESS (Earth-to-space) secondary relative to the FS and the MS in the frequency band 7 235-7 250 MHz is not justified by any ITU-R study result. These studies have confirmed compatibility between systems of the EESS and the terrestrial services.

2/1.11/5.2 Method B

This method proposes to add a global primary allocation to the EESS (Earth-to-space) in the frequency band 7 190-7 250 MHz into the Table of Frequency Allocations in RR Article 5 and to include provisions with regard to this allocation under which:

- for operation of EESS systems in the frequency band 7 190-7 235 MHz subject to obtaining agreement under RR No. 9.21 with regard to the SOS which is applied in accordance with RR No. 5.459;
- space stations in the EESS (Earth-to-space) shall not claim protection from existing and future stations in the FS and the MS in the frequency band 7 190-7 250 MHz, and that RR No. 5.43A does not apply.

- space stations in the EESS (Earth-to-space) shall not claim protection from SRS earth stations in the frequency band 7 190-7 235 MHz.

Additionally, Table 7b in RR Appendix 7 is modified to include the EESS allocation, and Table 21-3 in RR Article 21 is modified to extend the frequency range 7 190-7 235 MHz to 7 190-7 250 MHz.

Note: Table 21-2 in RR Article 21 is not modified with this Method B.

Resolution 650 (WRC-12) would be consequentially suppressed.

Advantages

- A new EESS (Earth-to-space) allocation of 60 MHz would be usable by the various EESS missions.
- A new EESS (Earth-to-space) allocation would provide the needed companion frequency band to the telemetry operations of EESS (space-to-Earth) allocation in the 8 025-8 400 MHz frequency band.
- The EESS systems that may have difficulties in sharing with SRS and/or SOS systems as a function of their orbital characteristics could be accommodated in the 7 235-7 250 MHz frequency band not allocated to the SRS and the SOS.
- The operation and development of the FS systems in the frequency band 7 190-7 250 MHz would not be constrained due to the very low number of EESS earth stations in the world and their remote locations far away from the border of neighbouring countries.
- The regulatory conditions on the FS in the frequency band 7 235- 7 250 MHz will not be changed since the provisions of RR No. 21.3 and No. 21.5 applicable to the FS in the 7 190-7 235 MHz frequency band will not be extended to 7 250 MHz.
- This method ensures compatibility between the SOS and the EESS on an equal basis.

Disadvantages

- The request for coordination under RR No. 9.21 with regard to the SOS is not justified by the ITU-R sharing studies results based on the SOS protection criteria contained in the applicable Recommendation ITU-R SA.363-5, that show compatibility with the incumbent services. It would put unnecessary burden on the EESS developers, ITU BR and on the administrations.
- The request for a footnote making the EESS (Earth-to-space) secondary relative to the SRS is not necessary. The ITU-R studies have indicated that potential interference cases can be resolved by coordination of EESS and SRS systems under the applicable provisions of the Radio Regulations.
- The request for a footnote making GSO and non-GSO EESS (Earth-to-space) secondary relative to the FS and the MS in the frequency band 7 235-7 250 MHz is not justified by any ITU-R study result. These studies have confirmed compatibility between systems of the EESS and the terrestrial services.
- This Method does not fully satisfy the requirements of agenda item 1.11 as it makes the EESS allocation secondary relative to the FS, MS and SRS.
- Additional burden on administrations to coordinate EESS systems with SOS systems.

2/1.11/5.3 Method C

No change in the RR Article 5 and suppression of Resolution 650 (WRC-12).

There would be no allocation to the EESS (Earth-to-space) in the frequency band 7 190-7 250 MHz.

Advantages

None.

Disadvantages

- The demand for the EESS spectrum, as identified in the studies presented in Report ITU-R SA.2272, will not be met.
- The congestion currently observed in 2 GHz frequency band will not be relieved.
- This method is not based on any ITU-R study results.

2/1.11/6 Regulatory and procedural considerations

2/1.11/6.1 Method A

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. 2.1)

MOD

5 570-7 250 MHz (end)

Allocation to services		
Region 1	Region 2	Region 3
...		
7 145-7 190	FIXED MOBILE SPACE RESEARCH (deep space) (Earth-to-space) 5.458 MOD 5.459	
7 190-7 235	EARTH EXPLORATION-SATELLITE (Earth-to-space) ADD 5.A111 FIXED MOBILE SPACE RESEARCH (Earth-to-space) MOD 5.460 5.458 MOD 5.459	
7 235-7 250	EARTH EXPLORATION-SATELLITE (Earth-to-space) ADD 5.A111 FIXED MOBILE 5.458	

MOD

5.459 *Additional allocation:* in the Russian Federation, the frequency bands 7 100-7 155 MHz and 7 190-7 235 MHz are also allocated to the space operation service (Earth-to-space) on a primary basis, subject to agreement obtained under No. **9.21**. In the frequency band 7 190-7 235 MHz obtaining agreement under No. **9.21** with respect to the Earth exploration-satellite service (Earth-to-space) is not applied. (WRC-15)

Reasons: In the frequency band 7 190-7 235 MHz RR No. **9.21** is applied to the space operation service in order to provide protection for the existing radio services and shall not be applied with respect to a new service (the EESS) not to impose new constraints on the existing radio service.

MOD

5.460 No emissions to spacecraft operating in deep space shall be effected in the frequency band 7 190-7 235 MHz. Geostationary satellites in the space research service operating in the frequency band 7 190-7 235 MHz shall not claim protection from existing and future stations of the fixed and mobile services and No. **5.43A** does not apply. (WRC-15)

Reasons: Deletion of first sentence as consequential changes. Addition of words “spacecraft operating in” to be more precise.

ADD

5.A111 The usage of the frequency band 7 190-7 250 MHz by the Earth exploration satellite service shall be limited to tracking, telemetry and command for the operation of the spacecraft and that Earth exploration-satellite service geostationary satellites in this frequency band, shall not claim protection from existing and future stations of the fixed and mobile services and No. **5.43A** does not apply. (WRC-15)

Reasons: To provide a new allocation to the EESS (Earth-to-space) in the frequency band 7 190-7 250 MHz. The TT&C function could be implemented by pairing this new allocation with the already existing EESS (space-to-Earth) allocation in the frequency band 8 025-8 400 MHz. It restricts the usage of the frequency band 7 190-7 250 MHz to the operation of the EESS spacecraft, because the aim for the Resolution **650 (WRC-12)** is to obtain a new allocation in the frequency range 7-8 GHz for the TT&C operations and no studies regarding other purpose except for TT&C function have been performed. If there were no restriction, this new allocation might be used for other purposes (e.g. data dissemination).

SUP

RESOLUTION 650 (WRC-12)

Allocation for the Earth exploration-satellite service (Earth-to-space) in the 7-8 GHz range

Reasons: This Resolution is no longer necessary.

MOD

APPENDIX 7 (Rev.WRC-15)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

MOD

TABLE 7B (Rev.WRC-15)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation	Fixed-satellite, mobile-satellite	Aeronautical mobile-satellite (R) service	Aeronautical mobile-satellite (R) service	Fixed-satellite	Fixed-satellite	Fixed-satellite	Fixed-satellite	Earth exploration - satellite, space operation, space research		Fixed-satellite, mobile-satellite, meteorological-satellite		Fixed-satellite	Fixed-satellite	Fixed-satellite	Fixed-satellite ³	Fixed-satellite	Fixed-satellite ³				
								A	N	A	N							A	N		
Frequency bands (GHz)	2.655-2.690	5.030-5.091	5.030-5.091	5.091-5.150	5.091-5.150	5.725-5.850	5.725-7.075	7.100-7.250 ⁵		7.900-8.400		10.7-11.7	12.5-14.8		13.75-14.3	15.43-15.65	17.7-18.4	19.3-19.7			
Receiving terrestrial service designations	Fixed, mobile	Aeronautical radio-navigation	Aeronautical mobile (R)	Aeronautical radio-navigation	Aeronautical mobile (R)	Radiolocation	Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Radiolocation radionavigation (land only)	Aeronautical radionavigation	Fixed, mobile				
Method to be used	§ 2.1	§ 2.1, § 2.2				§ 2.1		§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1, § 2.2		§ 2.2	
Modulation at terrestrial station ¹	A						A	N	A	N	A	N	A	N	A	N	–		N	N	
Terrestrial station interference parameters and criteria	P_O (%)	0.01					0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01		0.005	0.005	
	n	2					2	2	2	2	2	2	2	2	2	2	1		2	2	
	p (%)	0.005					0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.01		0.0025	0.0025	
	N_L (dB)	0					0	0	0	0	0	0	0	0	0	0	0		0	0	
	M_S (dB)	26 ²					33	37	33	37	33	37	33	40	33	40	1		25	25	
W (dB)	0					0	0	0	0	0	0	0	0	0	0	0		0	0		
Terrestrial station parameters	G_X (dBi) ⁴	49 ²	6	10	6	6	46	46	46	46	46	46	50	50	52	52	36		48	48	
	T_e (K)	500 ²					750	750	750	750	750	750	1 500	1 100	1 500	1 100	2 636		1 100	1 100	
Reference bandwidth	B (Hz)	4×10^3	150×10^3	37.5×10^3	150×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	10^7		10^6	10^6	
Permissible interference power	$P_f(p)$ (dBW) in B	-140	-160	-157	-160	-143	-131	-103	-131	-103	-131	-103	-128	-98	-128	-98	-131		-113	-113	

1 A: analogue modulation; N: digital modulation.

2 The parameters for the terrestrial station associated with transhorizon systems have been used. Line-of-sight radio-relay parameters associated with the frequency band 5 725-7 075 MHz may also be used to determine a supplementary contour with the exception that $G_X = 37$ dBi.

3 Feeder links of non-geostationary-satellite systems in the mobile-satellite service.

4 Feeder losses are not included.

5 Actual frequency bands are 7 190-7 250 MHz for the Earth exploration-satellite service, 7 100-7 155 MHz and 7 190-7 235 MHz for the space operation service and 7 145-7 235 MHz for the space research service. (WRC-15)

Reasons: Consequential changes as a result of including the new allocation to the EESS (Earth-to-space) in Appendix 7, Table 7b (Parameters required for the determination of coordination distance for a transmitting earth station).

ARTICLE 21

Terrestrial and space services sharing frequency bands above 1 GHz

Section III – Power limits for earth stations

MOD

TABLE 21-3 (Rev.WRC-15)

Frequency band	Services
2 025-2 110 MHz	
5 670-5 725 MHz (for the countries listed in No. 5.454 with respect to the countries listed in Nos. 5.453 and 5.455)	Fixed-satellite Meteorological-satellite Mobile-satellite Space operation
5 725-5 755 MHz ⁶ (for Region 1 with respect to the countries listed in Nos. 5.453 and 5.455)	
5 755-5 850 MHz ⁶ (for Region 1 with respect to the countries listed in Nos. 5.453 , 5.455 and 5.456)	Space research
5 850-7 075 MHz	
7 190-7 250 MHz	
7 900-8 400 MHz	
10.7-11.7 GHz ⁶ (for Region 1)	
12.5-12.75 GHz ⁶ (for Region 1 with respect to the countries listed in No. 5.494)	
12.7-12.75 GHz ⁶ (for Region 2)	
12.75-13.25 GHz	
14.0-14.25 GHz (with respect to the countries listed in No. 5.505)	
14.25-14.3 GHz (with respect to the countries listed in Nos. 5.505 , 5.508 and 5.509)	
14.3-14.4 GHz ⁶ (for Regions 1 and 3)	
14.4-14.8 GHz	

Reasons: Consequential changes as a result of considering the new allocation to the Earth exploration-satellite service (Earth-to-space) the 7 190-7 250 MHz frequency band.

⁶ **21.12.1** The equality of right to operate when a band of frequencies is allocated in different Regions to different services of the same category is established in No. **4.8**. Therefore any limits concerning inter-Regional interference which may appear in ITU-R Recommendations should, as far as practicable, be observed by administrations.

2/1.11/6.2 Method B

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. 2.1)

MOD

5 570-7 250 MHz (end)

Allocation to services		
Region 1	Region 2	Region 3
...		
7 145-7 190	FIXED MOBILE SPACE RESEARCH (deep space) (Earth-to-space) 5.458 5.459	
7 190-7 235	EARTH EXPLORATION-SATELLITE (Earth-to-space) ADD 5.A111 ADD 5.B111 FIXED MOBILE SPACE RESEARCH (Earth-to-space) MOD 5.460 5.458 5.459	
7 235-7 250 ADD 5.B111	EARTH EXPLORATION-SATELLITE (Earth-to-space) ADD 5.A111 MOBILE 5.458	

MOD

5.460 No emissions from space research service (Earth-to-space) to deep space shall be effected in the frequency band 7 190-7 235 MHz. Geostationary satellites in the space research service operating in the frequency band 7 190-7 235 MHz shall not claim protection from existing and future stations of the fixed and mobile services and No. **5.43A** does not apply. (WRC-15)

Reasons: To provide a new allocation to the EESS (Earth-to-space) in the frequency band 7 190-7 250 MHz. The TT&C function could be implemented by pairing this new allocation with the already existing EESS (space-to-Earth) allocation in the frequency band 8 025-8 400 MHz. Deletion of first sentence as consequential changes.

ADD

5.A111 The use of the band 7 190-7 235 MHz (Earth-to-space) by the Earth exploration-satellite service is subject to agreement obtained under No. **9.21** with respect to the space operation service applied under No. **5.459**. Space stations in the Earth exploration-satellite service (Earth-to-space) shall not claim protection from existing and future stations in the fixed and mobile services operating in the frequency band 7 190-7 250 MHz and No. **5.43A** does not apply. (WRC-15)

Reasons: To ensure compatibility between the SOS and the EESS and ensure protection of FS, MS.

5.B111 Space stations in the Earth exploration-satellite service (Earth-to-space) shall not claim protection emission from the SRS in the frequency band 7 190-7 235 MHz. (WRC-15)

Reasons: In some cases for co-frequency operations, in particular when the earth stations are either collocated geographically or nearby the interference levels from near-Earth SRS uplinks into EESS satellites would exceed the applicable ITU criteria.

SUP

RESOLUTION 650 (WRC-12)

Allocation for the Earth exploration-satellite service (Earth-to-space) in the 7-8 GHz range

Reasons: This Resolution is no longer necessary.

MOD

APPENDIX 7 (Rev.WRC-15)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

MOD

TABLE 7B (Rev.WRC-15)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation	Fixed-satellite, mobile-satellite	Aero-nautical mobile-satellite (R) service	Aero-nautical mobile-satellite (R) service	Fixed-satellite	Fixed-satellite	Fixed-satellite	Fixed-satellite	Earth exploration-satellite, space operation, space research	Fixed-satellite, mobile-satellite, meteorological-satellite	Fixed-satellite	Fixed-satellite	Fixed-satellite	Fixed-satellite	Fixed-satellite ³	Fixed-satellite	Fixed-satellite ³
Frequency bands (GHz)	2.655-2.690	5.030-5.091	5.030-5.091	5.091-5.150	5.091-5.150	5.725-5.850	5.725-7.075	7.100-7.250 ⁵	7.900-8.400	10.7-11.7	12.5-14.8	13.75-14.3	15.43-15.65	17.7-18.4	19.3-19.7	
Receiving terrestrial service designations	Fixed, mobile	Aeronautical radio-navigation	Aeronautical mobile (R)	Aeronautical radio-navigation	Aeronautical mobile (R)	Radiolocation	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Radiolocation radionavigation (land only)	Aeronautical radionavigation	Fixed, mobile	Fixed, mobile
Method to be used	§ 2.1	§ 2.1, § 2.2	§ 2.1, § 2.2			§ 2.1	§ 2.1	§ 2.1, § 2.2	§ 2.1	§ 2.1	§ 2.1, § 2.2	§ 2.1		§ 2.1, § 2.2	§ 2.2	
Modulation at terrestrial station ¹	A						A N	A N	A N	A N	A N	A N	A N	–	N	N
Terrestrial station interference parameters and criteria	P_O (%)	0.01					0.01 0.005	0.01 0.005	0.01 0.005	0.01 0.005	0.01 0.005	0.01 0.005	0.01 0.005	0.01	0.005	0.005
	n	2					2 2	2 2	2 2	2 2	2 2	2 2	2 2	1	2	2
	p (%)	0.005					0.005 0.0025	0.005 0.0025	0.005 0.0025	0.005 0.0025	0.005 0.0025	0.005 0.0025	0.005 0.0025	0.01	0.0025	0.0025
	N_L (dB)	0					0 0	0 0	0 0	0 0	0 0	0 0	0 0	0	0	0
	M_S (dB)	26 ²					33 37	33 37	33 37	33 37	33 40	33 40	33 40	1	25	25
W (dB)	0					0 0	0 0	0 0	0 0	0 0	0 0	0 0	0	0	0	
Terrestrial station parameters	G_X (dBi) ⁴	49 ²	6	10	6	6	46 46	46 46	46 46	46 46	46 46	50 50	50 50	52 52	36	48 48
	T_e (K)	500 ²					750 750	750 750	750 750	750 750	750 750	1 500 1 100	1 500 1 100	2 636	1 100	1 100
Reference bandwidth	B (Hz)	4×10^3	150×10^3	37.5×10^3	150×10^3	10^6	4×10^3 10^6	4×10^3 10^6	4×10^3 10^6	4×10^3 10^6	4×10^3 10^6	4×10^3 10^6	4×10^3 10^6	10^7	10^6	10^6
Permissible interference power	$P_f(p)$ (dBW) in B	-140	-160	-157	-160	-143	-131 -103	-131 -103	-131 -103	-131 -103	-128 -98	-128 -98	-128 -98	-131	-113	-113

¹ A: analogue modulation; N: digital modulation.

² The parameters for the terrestrial station associated with transhorizon systems have been used. Line-of-sight radio-relay parameters associated with the frequency band 5 725-7 075 MHz may also be used to determine a supplementary contour with the exception that $G_X = 37$ dBi.

³ Feeder links of non-geostationary-satellite systems in the mobile-satellite service.

⁴ Feeder losses are not included.

⁵ Actual frequency bands are 7 190-7 250 MHz for the Earth exploration-satellite service, 7 100-7 155 MHz and 7 190-7 235 MHz for the space operation service and 7 145-7 235 MHz for the space research service. (WRC-15)

Reasons: Consequential changes as a result of including the new allocation to the Earth exploration-satellite service (Earth-to-space) in Appendix 7, Table 7b (Parameters required for the determination of coordination distance for a transmitting earth station).

ARTICLE 21

Terrestrial and space services sharing frequency bands above 1 GHz

Section III – Power limits for earth stations

MOD

TABLE 21-3 (Rev.WRC-15)

Frequency band	Services
2 025-2 110 MHz	
5 670-5 725 MHz (for the countries listed in No. 5.454 with respect to the countries listed in Nos. 5.453 and 5.455)	Fixed-satellite Meteorological-satellite Mobile-satellite Space operation
5 725-5 755 MHz ⁶ (for Region 1 with respect to the countries listed in Nos. 5.453 and 5.455)	
5 755-5 850 MHz ⁶ (for Region 1 with respect to the countries listed in Nos. 5.453 , 5.455 and 5.456)	Space research
5 850-7 075 MHz	
7 190-7 250 MHz	
7 900-8 400 MHz	
10.7-11.7 GHz ⁶ (for Region 1)	
12.5-12.75 GHz ⁶ (for Region 1 with respect to the countries listed in No. 5.494)	
12.7-12.75 GHz ⁶ (for Region 2)	
12.75-13.25 GHz	
14.0-14.25 GHz (with respect to the countries listed in No. 5.505)	
14.25-14.3 GHz (with respect to the countries listed in Nos. 5.505 , 5.508 and 5.509)	
14.3-14.4 GHz ⁶ (for Regions 1 and 3)	
14.4-14.8 GHz	

Reasons: Consequential changes as a result of considering the new allocation to the EESS (Earth-to-space) the 7 190-7 250 MHz frequency band.

⁶ **21.12.1** The equality of right to operate when a band of frequencies is allocated in different Regions to different services of the same category is established in No. **4.8**. Therefore any limits concerning inter-Regional interference which may appear in ITU-R Recommendations should, as far as practicable, be observed by administrations.

2/1.11/6.3 Method C

NOC

ARTICLE 5

Frequency allocations

SUP

RESOLUTION 650 (WRC-12)

**Allocation for the Earth exploration-satellite service
(Earth-to-space) in the 7-8 GHz range**

Reasons: This Resolution is no longer necessary.
