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| **34 MEETING OF PERMANENT****CONSULTATIVE COMMITTEE II:****RADIOCOMMUNICATIONS****August 12 to 16, 2019****Ottawa, Ontario, Canada** | **OEA/Ser.L/XVII.4.2.34****CCP.II-RADIO/doc. /19****26 July 2019****Original:**  |
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|  | **MODIFICATION OF DRAFT INTER-AMERICAN PROPOSAL ON WRC-19 AGENDA ITEM 1.6** |  |
|  | **AGENDA ITEM 1.6** |  |
|  | **(Item on the Agenda: 3.1 (SGT-3))****(Document submitted by the delegation of United States of America)** |  |

Introduction

This document contains an update from the USA proposal on WRC-19 Agenda Item 1.6 based on discussions during the July meeting of ITU-R WP4A for consideration in CITEL’s preparation to WRC-19 Agenda Item 1.6.

**Agenda Item 1.6**: *to consider the development of a regulatory framework for non-GSO FSS satellite systems that may operate in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space‑to‑Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space), in accordance with Resolution* ***159 (WRC-15);***

**BACKGROUND INFORMATION**:

Article **22** of the Radio Regulations contains provisions to ensure compatibility of non-GSO FSS operations with GSO networks for the 14/11 GHz and 30/20 GHz bands. Among these provisions are uplink and downlink equivalent power flux density (epfd↑ and epfd↓) limits to protect GSO networks from unacceptable interference pursuant to RR No**. 22.2.** There are currently no defined technical provisions for sharing between non-GSO systems and GSO networks in the 50/40 GHz frequency bands. Moreover, there are no existing mechanisms in the RR establishing coordination procedures applicable to non-GSO systems operating within the FSS allocations in frequency bands in the 37.5 to 51.4 GHz range, such as application of RR No. **9.12**.

To address these issues, and the uncertainty they create among potential operators of non-GSO FSS satellite systems in this 50/40 GHz range, WRC-15 established agenda item 1.6 and associated Resolution **159 (WRC-15)** for WRC-19.

Resolution 159 (WRC-15) discusses the development of new technologies in the Fixed Satellite Service (FSS) in frequency bands above 30 GHz that would allow for the provision of high-capacity and low-cost communications in all parts of the world, especially in remote and isolated areas. This Resolution considers that satellite constellations in both geostationary-satellite orbits (GSO) and non-geostationary-satellite orbits (NGSO) would allow for the implementation of these new technologies in the FSS bands and that the Radio Regulations should enable the introduction of such technologies to ensure efficient use of the radio spectrum.

Resolution 159 (WRC-15) resolves to invite the ITU-R to conduct and complete in time for WRC-19 studies on the regulatory provisions to enable the operation of NGSO FSS satellite systems in the abovementioned frequency bands, including sharing studies with GSO, EESS, and RAS.

The proposals below present a regulatory solution for providing certainty and technical provisions to allow for sharing between non-GSO FSS systems and for protection of co-frequency GSO networks and adjacent-band EESS (passive) systems under WRC-19 AI 1.6. The proposals have been developed based on the results of ITU-R studies called for in Resolution **159 (WRC-15),** and identify a methodology to allow for maximum spectrum efficiency for non-GSO FSS systems, while protecting operations of GSO networks from operations of non-GSO FSS systems. This proposal also provides a regulatory solution to ensure that aggregate emissions from operating non-GSO FSS systems do not exceed aggregate protection requirements of GSO networks.

Regarding the protection of GSO systems, CITEL supports the following approach of defining in the Radio Regulations:

a) a maximum value for the time allowance for degradation exceeding the minimum short-term performance objectives, in terms of C/N, of a set of GSO reference links due to the interference caused by a single non-geostationary system, as well as the aggregate value for all NGSO FSS systems; and

b) a maximum value for the decrease in the time-averaged throughput (spectral efficiency) caused by a single non-GSO system, as well as the aggregate value for all NGSO FSS systems, into a set of GSO reference links using adaptive coding and modulation.

**For sharing between NGSO systems**:

Studies on sharing conditions between non-GSO FSS systems operating in the frequency bands 37.5-42.5 GHz (space-to-Earth) and 47.2-48.9 GHz (limited to feeder links only), 48.9-50.2 GHz and 50.4-51.4 GHz (all Earth-to-space) have shown the possible effectiveness of mitigation techniques such as orbital angle avoidance and earth station site diversity in assisting NGSO operators to achieve compatibility between the non-GSO FSS systems studied.

To address sharing considerations between NGSO systems, that the use of the bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) by non-GSO FSS systems should be subject to coordination procedures under No. **9.12**.

In order to provide additional guidance on the coordination of non-GSO systems, and ensure the efficient use of spectrum and orbital resources, that an ITU-R Recommendation could be further developed, which would, inter alia, address the criteria to adequately protect a non-GSO system from the interference caused by all other non-GSO systems operating co-frequency.

**USA**

Regarding protections of EESS (passive) and modifications to Resolution **750 (Rev. WRC-15)**, this proposal specifically proposes changes to both GSO and NGSO FSS earth station out of band emission limits as studies have shown that GSO FSS systems alone cause exceedance to the EESS (passive) protection criteria and that in order to allow the aggregate interference from both GSO and NGSO FSS earth stations emission to meet this criteria modifications to both limits are needed. This proposal tracks with Method A of Issue 1 and Option B of Issue 2 in the draft CPM Report, developing resolutions that contain both the calculation procedures and reference links for sharing between non-GSO systems and GSO networks and leaving the specific values for GSO and NGSO systems as TBD for further analysis of protection of EESS (passive) systems. Since *recognizing i)* of Resolution **159 (WRC-15)** states that potential revisions to the protection of passive services will be impractical to apply to GSO FSS networks that are operational, planned for near term operation or filed, the proposed changes would not apply to any GSO systems whose complete notification information was received by the bureau before [January 1, 2020].

**Canada**:

**For the protection of EESS (passive) systems:** For the band 36-37 GHz: Canada is of the view that based on the results of studies, EESS (passive) systems operating in the 36- 37 GHz band and non-GSO FSS systems are compatible and no regulatory measures are required to address the compatibility between these two services.

For the band 50.2-50.4 GHz: Canada is of the view that based on the results of studies, regulatory measures such as revising the current unwanted emission limits in Resolution **750 (WRC-15)** are required to ensure compatibility between EESS (passive) systems operating in the band 50.2-50.4 GHz and non-GSO FSS systems, but has not yet decided on appropriate values.

**Mexico**

For the protection of EESS (passive) systems in the band 50.2-50.4 GHz, Mexico is of the view that the current unwanted emission limits in Resolution **750 (WRC-15)** are required to be revised to ensure compatibility between EESS (passive) systems and non-GSO FSS systems, and provides values for power limits in table 1-1 of Resolution **750 (WRC-15)**. Mexico is also of the view that current unwanted emission limits in Resolution **750 (WRC-15)** forGSO networks operating in the adjacent bands to 50.2-50.4 GHz should not be revised, since this is out of the scope of AI 1.6 and Resolution **159 (WRC-15)**.

**Proposals:**

ARTICLE 5

**Frequency allocations**

**Section IV – Table of Frequency Allocations**

**MOD CAN, MEX, USA/1.6/1**

|  |
| --- |
| 34.2-40 GHz |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 37.5-38 FIXED FIXED-SATELLITE (space-to-Earth) **ADD 5.A16** MOBILE except aeronautical mobile SPACE RESEARCH (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.547 |
| 38-39.5 FIXED FIXED-SATELLITE (space-to-Earth) **ADD 5.A16** MOBILE Earth exploration-satellite (space-to-Earth) 5.547 |
| 39.5-40 FIXED FIXED-SATELLITE (space-to-Earth) 5.516B  MOBILE MOBILE-SATELLITE (space-to-Earth)  Earth exploration-satellite (space-to-Earth) 5.547, **ADD 5.A16** |

|  |
| --- |
| 40-47.5 GHz |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 40-40.5 EARTH EXPLORATION-SATELLITE (Earth-to-space) FIXED FIXED-SATELLITE (space-to-Earth) 5.516B  MOBILE MOBILE-SATELLITE (space-to-Earth)  SPACE RESEARCH (Earth-to-space) Earth exploration-satellite (space-to-Earth) **ADD 5.A16** |
| 40.5-41FIXEDFIXED-SATELLITE (space-to-Earth) ADD 5.484A **ADD 5.A16** BROADCASTINGBROADCASTING-SATELLITEMobile5.547 | 40.5-41FIXEDFIXED-SATELLITE (space-to-Earth) 5.516B **ADD 5.A16**BROADCASTINGBROADCASTING-SATELLITEMobileMobile-satellite (space-to-Earth)5.547 | 40.5-41FIXEDFIXED-SATELLITE (space-to-Earth) **ADD 5.A16** BROADCASTINGBROADCASTING-SATELLITEMobile5.547 |
| 41-42.5 FIXED FIXED-SATELLITE (space-to-Earth) 5.516B **ADD 5.A16** BROADCASTING BROADCASTING-SATELLITE Mobile 5.547 5.551F 5.551H 5.551I |
| 47.2-47.5 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 **ADD 5.A16**  MOBILE 5.552A |

|  |
| --- |
| 47.5-51.4 GHz |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 47.5-47.9FIXEDFIXED-SATELLITE(Earth-to-space) 5.552 **ADD 5.A16** (space-to-Earth) 5.516B 5.554A MOBILE | 47.5-47.9 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 **ADD 5.A16** MOBILE |
| 47.9-48.2 FIXED FIXED-SATELLITE (Earth-to-space) 5.552 **ADD 5.A16**  MOBILE 5.552A |
| 48.2-48.54FIXEDFIXED-SATELLITE(Earth-to-space) 5.552 **ADD 5.A16** (space-to-Earth) 5.516B5.554A 5.555BMOBILE | 48.2-50.2 FIXED FIXED-SATELLITE (Earth-to-space) 5.516B MOD 5.338A 5.552 **ADD 5.A16**  MOBILE |
| 48.54-49.44FIXEDFIXED-SATELLITE(Earth-to-space) 5.552 **ADD 5.A16** MOBILE5.149 5.340 5.555 |  |
| 49.44-50.2FIXEDFIXED-SATELLITE(Earth-to-space) MOD 5.338A 5.552 **ADD 5.A16** (space-to-Earth) 5.516B5.554A 5.555B MOBILE |  5.149 5.340 5.555 |
| 50.4-51.4 FIXED FIXED-SATELLITE (Earth-to-space) 5.338A **ADD 5.A16** MOBILE Mobile-satellite (Earth-to-space) |

**Reasons:** To insert provisions for coordination among non-GSO satellite services

ADD [CAN], [MEX], USA/1.6/2

5.A16The use of the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space‑to‑Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) by a non-GSO‑satellite system in the fixed-satellite service or mobile satellite-service is subject to the application of the provisions of No. **9.12** for coordination with other non-GSO-satellite systems in the fixed-satellite service and/or non-GSO satellite systems in the mobile satellite service, but not with non-GSO systems in other services. Draft new Resolution [A16-A] and **[A16] (WRC-19)** shall also apply, and No. **22.2** shall continue to apply.     (WRC-19)

**Reasons:** To address coordination among non-GSO FSS systems in the 50/40 GHz bands

MOD CAN, MEX, USA/1.6/3

**5.338A** In the frequency bands 1 350-1 400 MHz, 1 427-1 452 MHz, 22.55-23.55 GHz, 30-31.3 GHz, 49.7-50.2 GHz, 50.4-50.9 GHz, 51.4-52.6 GHz, 81-86 GHz and 92-94 GHz, Resolution 750 (Rev.WRC-19) applies. (WRC-19)

**Reasons:** Consequential change

ARTICLE 9

**Procedure for effecting coordination with or obtaining agreement of other administrations1, 2, 3, 4, 5, 6, 7, 8,** **9**    (WRC‑15)

**MOD CAN, MEX, USA/1.6/4**

**9.35** *a)* examine that information with respect to its conformity with No. **11.31 MOD**19;

(WRC-2019)

**MOD CAN, MEX, USA/1.6/5**

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MOD 19 **9.35.1** The Bureau shall include the detailed results of its examination under No. **11.31** of compliance with the limits in Tables **22-1** to **22-3,** or the single-entry limits in No. **22.5L,** of Article **22**, as appropriate,in the publication under No. **9.38**. (WRC-2019)

**Reasons:** To address the publication of the Bureau’s examination of the non-GSO single entry limits.

ARTICLE 22

**Space services**

**ADD [CAN], [MEX], USA/1.6/6**

**22.5L** 9) A non-GSO satellite system in the fixed-satellite service in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz shall not exceed:

**22.5L1** 9.1) a single-entry increase of 3% of time allowance for the C/N values associated with the shortest percentage of time specified in the short-term performance objectives of the generic GSO reference links; and

**22.5L2** 9.2) a single-entry permissible allowance of at most 3% reduction in time average throughput (spectral efficiency) calculated on an annual basis for the generic GSO reference links using adaptive coding and modulation

The generic reference links given in Annex 1 of Resolution [A16-A] and the calculation procedures given in Annex 2 of Resolution [A16-A] shall be used for the calculations. The epfd levels from the non-GSO FSS system should be derived using the most recent version of Recommendation ITU‑R S.1503. (WRC-19)

**ADD CAN, MEX, USA/1.6/7**

**22.5M** 10) Administrations operating or planning to operate non-GSO-satellite systems in the fixed-satellite and mobile-satellite service in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz shall ensure that the aggregate interference to GSO FSS, MSS, and BSS networks caused by all non-GSO FSS and non-GSO MSS systems operating in these frequency bands does not exceed 10% of the short-term and long-term performance objectives of GSO satellite networks by applying the provisions of draft new Resolution [A16] (WRC-19).

**Reasons:** Based on ITU-R studies, the detailed technical regulatory provisions presented above will introduce technical regulatory provisions into the Radio Regulations that will enable the introduction of non-GSO satellite systems that will protect GSO networks and provide for maximum spectral efficiency for simultaneous operations of non-GSO system and GSO network operations in the 50/40 GHz bands.

**ADD USA/1.6/9**

**DRAFT NEW RESOLUTION [A16-A] (WRC-19)**

Application of Article 22 of the Radio Regulations to the Protection of Geostationary Fixed-Satellite Service and Broadcasting-Satellite Service Networks from Non-Geostationary Fixed-Satellite Service Systems in the Frequency Bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz

The World Radiocommunication Conference (2019),

considering

*a)* that geostationary (GSO) and non-geostationary (non-GSO) fixed-satellite service (FSS) networks may operate in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz;

*b)* that this conference adopted Nos. **22.5L and 22.5M** which containsingle-entry and aggregate operating provisions applicable to the operations of non-GSO FSS systems in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHzto protect GSO networks operating in the same frequency bands;

*c)* that ITU‑R has developed Recommendation ITU‑R S.1503 to provide a methodology on how to compute the equivalent power flux density (epfd) for the calculation of interference from any one non-GSO system into potentially affected GSO earth stations and satellites;

*d)* that the calculation methodology contained in Recommendation ITU-R S.1503 results in the epfd generated by any one non-GSO FSS system considered and a GSO location that corresponds to the worst-case geometry (WCG) that generates the highest levels of epfd down corresponding to the considered receive GSO earth station antenna size in the short-term;

recognizing

a) that, in accordance with calculations utilizing Recommendation ITU-R S.1503, the verification of the epfd interference of any one non-GSO system can be carried out by a set of generic link budgets having characteristics that encompass global GSO network deployments that are independent of any specific geographic locations;

*b)* that the aggregate interference levels from multiple non-GSO FSS systems will be related to the actual number of systems providing service to a particular region and sharing a frequency band based on the single-entry operational use of each system;

*c)* that Recommendation ITU-R S.1503-3 does not provide guidance on the modelling of interference from multiple non-GSO systems into GSO networks and does not consider GSO satellite networks using adaptive-coding and modulation;

*d)* that Recommendation ITU-R S.1503-3 determines the worst-case geometry that provides the highest levels of downlink interference to the GSO in the short-term which may not be representative of the worst-case geometry that also produces the highest levels of downlink interference to the GSO in the long-term;

*e)* that the calculation of the aggregate impact from multiple non-GSO systems to GSO networks would benefit from the modelling of non-GSO systems into operational GSO reference links,

 resolves

1 that during the examination under Nos. **9.35** and **11.31**, to ensure non-GSO FSS systems compliance with the single-entry operating provisions given in **22.5L**, the generic technical characteristics of global GSO satellite networks contained in Annex 1 shall be used in conjunction with the methodology in Annex 2 to determine compliance with No. **22.5L**;

2 that notified frequency assignments to non-GSO FSS systems shall receive a favourable finding with a date of review under No. **11.31** with respect to the single-entry provision given in No. **22.5L**, if *resolves* 1 is satisfied, otherwise the non-GSO satellite system will receive an unfavourable finding under No. **11.36**;

3 that notwithstanding *resolves* 2, since the Bureau may be unable to examine non-GSO FSS systems subject to the single-entry provision given in No. **22.5L2** under Nos. **9.35** and **11.31** (see *recognizing d*), the notifying administration shall send the Bureau a commitment that the non-GSO FSS system complies with the limits given in **22.5L2**;

4 that notified frequency assignments to non-GSO FSS systems shall receive a qualified favourable finding under No. **9.35** with respect to the single-entry provision given in No. **22.5L2**, if *resolves* 3 is satisfied, otherwise the non-GSO satellite system will receive an unfavourable finding under No. **11.36**;

5 that if an administration believes that a non-GSO FSS system, for which the commitment referred to in *resolves* 3 was sent, has the potential to exceed the limits given in No. **22.5L**, it may request from the notifying administration additional information with regard to the compliance with the limits mentioned above. Both administrations shall cooperate to resolve any difficulties, with the assistance of the Bureau, if so requested by either of the parties, and may exchange any additional relevant information that may be available;

6 that *resolves* 3, 4 and 5 shall no longer be applied after the Bureau has communicated to all administrations via a Circular Letter that epfd validation software adequate to address *recognizing d)* is available and the Bureau is able to verify compliance with the limit in No. **22.5L2**, invites the ITU Radiocommunication Sector

to study and, as appropriate, modify Recommendation ITU-R S.1503 to address recognizing d) to ensure the epfd down is representative of the long-term highest levels of interference into the generic GSO links assessed during validation,

 instructs the Director of the Radiocommunication Bureau

to review, once the studies are completed and any modifications are adopted under invites the ITU Radiocommunication Sector above, its findings made in accordance with Nos. **9.35** and **11.31**.

ANNEX 1 TO RESOLUTION [A16-A] (WRC-19)

Generic GSO satellite system characteristics for evaluation of compliance with single-entry requirements for non-GSO systems

The data in Annex 1 are to be regarded as a generic range of technical characteristics of GSO networks deployments that are independent of any specific geographic location, to be used only for establishing the interference impact of a non-GSO system impact into GSO satellite networks and not as a basis for coordination between satellite networks.

Table 1: Generic link parameters of GSO links to be used in examination of the downlink (space-Earth) impact from any one non-GSO network

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | Generic Link Parameters = service |  |  |  |  |  |
|  | Link type | User #1 | User #2 | User #3 | Gateway |  |
| 1.1 | Frequency band (GHz) | 40 | 40 | 40 | 40 |  |
| 1.2 | e.i.r.p. density (dBW/MHz) | 44.2 | 44.1 | 40.4 | 34.4 |  |
| 1.3 | Dish size (m) | 0.16 | 0.6 | 2 | 9 |  |
| 1.3 | Bandwidth (MHz) | 1 | 1 | 1 | 1 |  |
| 1.4 | ES antenna efficiency | 0.65 | 0.65 | 0.6 | 0.55 |  |
| 1.5 | Additional link losses (dB) | 1 | 1 | 1 | 1 |  |
| 1.6 | Polarization | Circular | Circular | Circular | Circular |  |
|  |  |
| **2** | **Generic Link Parameters -Parametric Analysis** | **Parametric Cases for Evaluation** |  |
| 2.1 | e.i.r.p. density variation | −6, 0, +6 dB from value in 1.2 |  |
| 2.2\* | Elevation angle (deg) | 20 | 55 | 90 |  |
| Additional link margin (dB) | 9.1 | 5.4 | 5.0 |  |
| Rain height (km) | 0.4, 3.6 | 2.3, 4.8 | 4.5, 5.0 |  |
| Latitude (deg) | 0, 30, 61.8 | 0, 30 | 0 |  |
| 2.3 | 0.01% Rain Rate (mm/hr) | 10, 50, 100 |  |
| 2.4 | Height of ES (m) | 0, 500, 1500 |  |
| 2.5 | ES noise temperature (K) | 250, 300 |  |
| 2.6 | Threshold C/N (dB) | −4.2, 6.2, 16.6 |  |
|  |  |
| **3** | **Example Implementation – Link Calculation** | **First Case parametric taken for examples** | **Equations to Calculate Downlink Availability** |
| 3,1 | ES Peak gain (dBi) | 34.7 | 46.1 | 56.2 | 68.9 |  |
| 3.2 | Path length (km) | 39554.4 | 39554.4 | 39554.4 | 39554.4 |  |
| 3.3 | Path loss (dB) | 216.4 | 216.4 | 216.4 | 216.4 |  |
| 3.4 | Unfaded wanted single strength (dBW/MHz) | -138.8 | -127,3 | -117.2 | -104.5 |  |
| 3.5 | Noise plus margin (dBW/MHz) | -141.6 | -141.6 | -141.6 | -141.6 |  |
|  |
| **4** | **Validation Checks** |  |
| 4.1 | Margin for rain fade (dB) | 2.8 | 14.3 | 24.4 | 37.1 |  |
| 4.2 | *PFDval* (dB(W/(m2 · MHz))) | -118.9 | -118.9 | -118.9 | -118.9 |  |
| 4.3 | Delta from Article 21 | -11.4 | -11.4 | -11.4 | -11.4 |  |
| \* For item 2.2, these three groups of data are be considered as unique sets of data to be used in the larger, overall set of total possible permutations. For example, 20 degrees of elevation angle will consider rain heights at 0.4 and 3.6 kilometres in combination with three different latitudes of 0, 30 and 61.8 degrees while 90 degrees of elevation will only consider a latitude of 0 degrees in combination with two possible rain heights of 4.5 and 5 km.  |

The following checks are done to ensure the combination of Generic and Parametric Parameters are valid:

1. The rain margin should be greater than zero Arain > 0
2. The calculated availability, p, should be in the range 1 – (0.001 ≤ p ≤ 10%)
3. The PFD should be below the limits in Article 21

Table 2: Generic link parameters of GSO links to be used in examination of the uplink (Earth-space) impact from any one non-GSO network

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | Generic Link Parameters = service |  |  |  |  |
|   | Link type | Link #1 | Link #2 | Link #3 |  |
| 1.1 | Frequency band (GHz) | 48 | 48 | 48 |  |
| 1.2 | ES EIRP (dBW/Hz) | −8 | −8 | −8 |  |
| 1.3 | Satellite receive antenna gain (dBi) | 48 | 55 | 62 |  |
| 1.4 | Additional link losses (dB) | 1 | 1 | 1 |  |
| 1.5 | Polarization | Circular | Circular | Circular |  |
|  |  |
| **2** | **Generic Link Parameters -Parametric Analysis**  | **Parametric Cases for Evaluation** |  |
| 2.1 | e.i.r.p. density variation | −16, 0, +16 dB from value in 1.2 |  |
| 2.2\* | Elevation angle (deg) | 20 | 55 | 90 |  |
| Additional link margin (dB) | 9.1 | 5.4 | 5.0 |  |
| Rain height (km) | 0.4, 3.6 | 2.3, 4.8 | 4.5, 5.0 |  |
| Latitude (deg) | 0, 30, 61.8 | 0, 30 | 0 |  |
| 2.3 | 0.01% Rain Rate (mm/hr)  | 10, 50, 100 |  |
| 2.4 | Height of ES (m) | 0, 500, 1500 |  |
| 2.5 | Satellite noise temperature (K) | 250, 300 |  |
| 2.6 | Threshold C/N (dB) | −4.2, 6.2, 16.6 |  |
|  |  |
| **3** | **Example Implementation – Link Calculation** | **First Case parametric cases taken for examples** | **Equations to Calculate Uplink Availability** |
| 3.1 | Path length (km) | 39554.4 | 36780.4 | 39554.4 |  |
| 3.2 | Path loss (dB) | 216.4 | 216.4 | 216.4 |  |
| 3.3 | Unfaded wanted single strength (dBW/MHz) | -118.4 | -117.7 | -118.4 |  |
| 3.4 | Noise plus margin (dBW/MHz) | -140.2 | -141.6 | -141.6 |  |
|  |
| **4** | **Validation Checks** |  |
| 4.1 | Margin for rain fade (dB) | 11.8 | 23.3 | 23.3 |  |
| \* For item 2.2, these three groups of data are be considered as unique sets of data to be used in the larger, overall set of total possible permutations. For example, 20 degrees of elevation angle will consider rain heights at 0.4 and 3.6 kilometres in combination with three different latitudes of 0, 30 and 61.8 degrees while 90 degrees of elevation will only consider a latitude of 0 degrees in combination with two possible rain heights of 4.5 and 5 km.  |

The following checks are done to ensure the combination of Generic and Parametric Parameters are valid:

1. The rain margin should be greater than zero Arain > 0
2. The calculated availability, p, should be in the range 1 – (0.001 ≤ p ≤ 10%)

ANNEX 2 TO RESOLUTION [A16-A] (WRC-19)

Description of parameters and procedures for the evaluation of interference from any one non-GSO system into global set of generic GSO links

This Annex provides the process to validate compliance with the single-entry permissible interference of a non-GSO system into GSO networks using the generic link parameters in Annex 1 and the worst-case geometry interference impact using the latest version of Recommendation ITU-R S.1503 The procedure to determine the compliance with the single-entry permissible interference relies on the following principles.

*Principle 1*: The two time-varying sources of link performance degradation considered in the verification are link fading (from rain, cloud, gas and scintillation attenuation) plus the characteristics of the link and interference from other FSS or BSS networks.

The total *C*/*N* in the reference bandwidth for a given carrier is:

 (1)

where:

 *C*: wanted power (W) in the reference bandwidth, which varies as a function of fades and as a function of transmission configuration

 *NT* : total system noise (W) in the reference bandwidth (i.e. the thermal power)

 *I*: time-varying interference power (W) in the reference bandwidth generated by other networks.

*Principle 2*: The calculation of spectral efficiency is focused on satellite systems utilizing adaptive coding and modulation (ACM) by calculating the throughput degradation as a function of C/N, which varies depending on the long-term propagation and interference impacts on the satellite link.

*Principle 3*: It is assumed that for a GSO network the internetwork interference caused by the earth and space station emissions of all other satellite networks operating in the same frequency band and that can potentially cause interference of time-varying nature, are responsible for at most 10% of the time allowance for the BER (or C/N value) specified in the short-term performance objectives of the desired network.

*Principle 4*: During a fading event in the downlink direction, the interfering carrier is attenuated by the same amount as the wanted carrier. This results in some under-estimation of the total downlink degradation under circumstances where interference peaks and fading occur simultaneously.

By applying the following steps, the single-entry interference impact from a non-GSO system on the availability and spectral efficiency of a GSO link is determined. The generic GSO link parameters of Annex 1 are used, considering all possible parametric permutations, in conjunction with the worst-case geometry (“WCG”) epfd outputs, both short-term and long-term, of Recommendation ITU-R S.1503. The output of Recommendation ITU-R S.1503 is a set of interference statistics that a non-GSO system creates into each representative GSO link. The generic link parameters of Annex 1 are then used in conjunction with the interference statistics from ITU-R S.1503 to evaluate the impact of a non-GSO system into GSO networks.

For V-band calculations, ITU-R S.1503 procedures use the following parameters, in addition to those contained in the generic links:

* ES antenna gain pattern: ITU-R S.1428
* SS antenna spot size: computed from generic link SS antenna gain
* SS antenna gain pattern: ITU-R S,672
* SS antenna sidelobe level: -25 dB

**For each generic GSO link from Annex 1:**

*Step 1*: Determine x*fade*,the probability distribution function (pdf) of the propagation fading plus other time variations in the characteristics of the generic GSO link. These statistics can be calculated using the procedures of the latest version of Recommendation ITU-R P.618.

*Step 2*: Determine y*int*, the interference pdf corresponding to the worst-case short-term interference impact into the generic GSO link from the non-GSO system under examination using the procedures of Recommendation ITU-R S.1503.

*Step 3*: Determine zfade+intf, the discrete convolution of the rain degradation pdf (xfade), with the interference degradation pdf (yint). For each pair of degradation values, *X* and *Y* from xfade and yint, respectively, the convolved degradation value is determined by the product of the xfade(*X*) and yint(*Y*) degradation values (or equivalently, the sum of the log values in dB) and the combined probability, computed as the product of each of the individual probabilities, to the result is the appropriate convolved degradation pdf, zfade+intf(*Z*).

For the downlink direction, a modified convolution is used. This modified convolution is equivalent to a regular discrete convolution with the exception that the interference degradation values (yi) are first reduced by the applicable rain attenuation, i.e., the jth rain loss value, (LR)j, from the rain degradation pdf bin (xj) for which it is being combined.

The probability density function (pdf) of *zfade+intf* is the modified convolution of the pdf of *xfade* and *yint* the total *C*/*N* degradation *zfade+intf* (dB) is therefore:

 *zfade+intf* = *xfade* \* *yint* (2)

*Step 4:* Using the results of the convolution procedures to obtain the pdf z*fade+intf* described above for the total degradation for the propagation fade x*fade* and the interference impact from the non-GSO system (y*int*), the conditions for the single-entry case can be verified:

 *pz(zfade-intf)* = *p(xfade*) \* *p(yint*) (3)

Conditions to be verified for compliance are:

* For the short-term performance objectives of generic GSO reference links:

 *P*(*z* ≤ *zj*) ≤ 0.93 *pj* / 100 for  *j* = 1, …, *J* (4)

where the constant is derived by noting that corresponding to principle 3, 90% (a 0.9 fraction) of the time allowance is allocated to propagation effects and non-time varying interference and that No. **22.5L** allows for a single-entry increase of 3% (a 0.03 fraction) of time allowance due to non-GSO operations.

* For the long-term performance objective related to the spectral efficiency (SE) of the generic GSO links:

 (SE*xfade* – SE*zfade+intf*)/SE*xfade* ≤ 0.03 (5)

and

 (6)

Where is the maximum achievable spectral efficiency of the link and is the spectral efficiency for an achievable C/N at a given percentage of time over one year, . SExfade represents the operational capacity of the FSS link achieved due to propagation fading over a time period of one year and SEzfade+intf represents the operational capacity of the FSS link due to the combined mechanism of propagation and interference over a period of one year. These equations represent the conditions to be checked to ensure that the percent degraded throughput caused by interference fades does not exceed a certain threshold, when compared to fades caused by propagation conditions over a long-term period of operation.

This procedure is repeated for each generic GSO link from Annex 1, considering all parametric permutations and validation checks.

**ADD CAN, MEX, USA/1.6/8**

draft new RESOLUTION [A16] (WRC‑19)

**Protection of geostationary satellite FSS, MSS, and BSS networks from unacceptable interference from non-GSO satellite FSS systems in the 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz frequency bands and from non-GSO MSS systems in the 39.5-40.0 GHz and 40.0-42.5 GHz frequency bands**

The World Radiocommunication Conference (2019),

*considering*

*a)* that the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space), and 50.4-51.4 GHz (Earth-to-space) are allocated, *inter alia*, on a primary basis to the fixed-satellite service (FSS) in all Regions;

b) that the frequency bands 40.5-41 GHz and 41-42.5 GHz are allocated, on a primary basis to the broadcasting-satellite service (BSS) in all regions;

c) that the frequency bands 39.5-40 GHz and 40-40.5 GHz are allocated, on a primary basis to the mobile-satellite service (MSS) in all regions;

*d)* that Article **22** contains regulatory and technical provisions on sharing between geostationary satellite orbit (GSO) satellite networks and non-geostationary satellite orbit (non-GSO) FSS systems in these bands in *considering* *a)*;

*e)* that, in accordance with No. **22.2**, non-GSO systems shall not cause unacceptable

interference to GSO FSS and broadcasting-satellite service (BSS) networks and, unless otherwise

specified in the Radio Regulations, shall not claim protection from GSO FSS and BSS satellite

networks;

*f*) that non-GSO FSS systems would benefit from the certainty that would result from the quantification of technical regulatory provisions required for protection of GSO satellite networks operating in the bands referred to in *considering* a), b), and c) above;

*g)* that GSO FSS, MSS and BSS networks can be protected without placing undue constraints on non-GSO FSS systems in the bands in *considering a), b), and c) above*;

*h)* that WRC-19 modified Article **22** to limit single-entry and aggregate permissible time allowances for degradation in terms of C/N by non-GSO FSS systems to GSO satellite networks, , in the bands in *considering a)*;

*i)* that the operating parameters and orbital characteristics on non-GSO FSS systems are usually inhomogeneous;

*j)* that, as a result of this inhomogeneity, the time allowance for the *C*/*N* value specified in the short-term performance objective associated with the shortest percentage of time (lowest *C*/*N*) or decrease of the long-term throughput (spectral efficiency) caused to reference GSO links by non-GSO FSS systems is likely to vary between such systems;

*k)* that, the aggregate interference levels from multiple non-GSO FSS systems will be related to the actual number of systems sharing a frequency band based on the single-entry operational use of each system;

*l)* that to protect GSO FSS, MSS, and BSS networks in the frequency bands listed in *considering* *a)* from unacceptable interference, the aggregate impact of interference caused by all co-frequency non-GSO FSS systems should not exceed the maximum aggregate impact specified in No. **22.5M** of the Radio Regulations;

*m)* that the aggregate level of the time allowance for the *C*/*N* value specified in the short-term performance objective associated with the shortest percentage of time (lowest *C*/*N*) of GSO reference link is likely to be the summation of single-entry levels caused by non-GSO FSS systems,

*recognizing*

1. that non-GSO FSS systems are likely to need to implement interference mitigation techniques, such as orbital avoidance angles, Earth station site diversity, and GSO arc avoidance, to facilitate sharing of frequencies and to protect GSO networks;
2. that administrations operating or planning to operate non-GSO FSS systems will need to agree cooperatively through consultation meetings to share the aggregate interference impact allowance in a manner to achieve the level of protection for GSO FSS, MSS and BSS networks that is stated in No. **22.5M** of the Radio Regulations**;**
3. that, taking into account the single-entry allowance in No. **22.5L**,the aggregated impact of all non-GSO FSS systems can be computed without the need for specialized software tools based on the results of the single-entry impact for each system;
4. the need for administrations operating non-GSO FSS systems in the frequency bands listed in *considering* *a)* to agree cooperatively through consultation meetings takes on particular urgency whenever there could be aggregate interference at levels higher than the aggregate impact allowance from operational non-GSO FSS systems;
5. that representatives of administrations operating or planning to operate GSO FSS, MSS and BSS networks are encouraged to be involved in the determinations made pursuant to *recognizing* *b)*;

*f)* that in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5-42.5 GHz (space‑to‑Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space), signals experience high levels of attenuation due to atmospheric effects such as rain, cloud cover and gaseous absorption;

*g)* that given these expected high levels of fading, it is desirable for GSO networks and non-GSO FSS systems to implement fade counter measures such as automatic level control, power control and adaptive coding and modulation,

*noting*

1. that Resolution [A16-A] (WRC-19) contains the methodology for determining conformity to the single-entry and aggregate limits to protect the GSO networks;
2. that Recommendation ITU-R S.1503 provides recommendations on how to compute the EPFD from a non-GSO FSS system into victim earth stations and satellites;
3. that Resolution [A16-A] (WRC-19) contains GSO satellite system characteristics to be considered in non-GSO/GSO frequency sharing analyses in the frequency bands 37.5-39.5 GHz, 39.5-42.5 GHz, 47.2-50.2 GHz and 50.4‑51.4 GHz;

 *resolves*

1 that administrations operating or planning to operate non‑GSO FSS and non-GSO MSS systems in the frequency bands referred to in *considering a)* above, shall, in collaboration, take all necessary steps, including, if necessary, by means of appropriate modifications to their systems or networks, to ensure that the aggregate interference into GSO FSS, MSS and BSS satellite networks caused by such systems operating co-frequency in these frequency bands does not exceed the aggregate protection limits as determined pursuant to No. **22.5M** of the Radio Regulations;

2 that to carry out the obligations in *resolves*1 above, administrations operating or planning to operate non-GSO FSS and non-GSO MSS systems shall agree cooperatively through regular consultation meetings referred to in *recognizing b*) to ensure that operations of all non-GSO networks do not exceed the aggregate level of protection for GSO satellite networks;

3 that to carry out the obligation of *resolves 2,* administrations shall use the generic GSO satellite characteristics listed in Resolution [A16-A] (WRC-19) and the supplemental links provided by administrations to determine the aggregate impact to GSO networks calculated by validation software;

4 that administrations operating or planning to operate non-GSO FSS and non-GSO MSS systems (including representatives of administrations operating GSO FSS, MSS and BSS networks) participating in a consultation meeting are allowed to use their own software in conjunction with any software tools used by the BR for the calculation and verification of the aggregate limits , subject to the agreement of the consultation meeting;

5 that *resolves* 2 and 3 above begin to apply when a second non-geostationary FSS systems with frequency assignments in the frequency bands referred to in *considering a*) meets the criteria listed in Annex 2 to this Resolution;

6 that administrations, in carrying out their obligations under *resolves* 1, shall take into account only those non-GSO FSS and non-GSO MSS systems with frequency assignments in the frequency bands referred to in *considering a*) above that have met the criteria listed in Annex 2 to this Resolution through appropriate information provided to consultation meetings referred to in *resolves* 2;

7 that administrations, in developing agreements to carry out their obligations under *resolves* 1, shall establish mechanisms to ensure that all potential FSS and MSS system and network notifying administrations and operators are given full visibility of, and the opportunity to participate in the consultation process;

8 that, taking into account *resolves* 2, failure by a responsible administration operating or planning to operate non-GSO FSS and non-GSO MSS systems to participate in the consultation process does not relieve that administration of obligations under *resolves* 1 above, nor does it remove their systems from consideration in any aggregate calculations by the consultation group;

9 that each administration, in the absence of an agreement reached at consultation meetings referred to in *resolves* 2, shall ensure that each of its non-GSO FSS and non-GSO MSS systems subject to this Resolution are operated in accordance with reduced single-entry interference impact allowances, calculated by the apportionment of the aggregate allowance commensurate to the number of simultaneously operating non-GSO systems, so as to ensure that the aggregate allowance in No. **22.5M** is not exceeded in operation;

10 that, in specific implementation of *resolves* 8 above, if the consultation discussions show that there would be an exceedance of the aggregate allowance from non-GSO FSS and non-GSO MSS systems in operation, every operational non-GSO FSS system shall reduce its emissions pro rata by the amount of the exceedance of the aggregate allowance;

11 that the administrations participating at the consultation meetings referred to in *resolves* 2 shall designate one convener to be responsible for communicating to the Bureau, such as shown in Annex 1, that the results of the aggregate non-GSO system operational calculation and sharing determinations made in application of *resolves* 1, 8 and 9 above, without regard to whether such determinations result in any modifications to the published characteristics of their respective systems, providing a draft record of each Consultation meeting, and providing the approved record for posting by the Bureau on the ITU website;

*invites the Radiocommunication Bureau*

to participate in the consultation meetings mentioned in *resolves* 2 as an observer and to provide advice as necessary of the aggregate interference impact calculation performed according to *resolves*1;

instructs the Radiocommunication Bureau

1 to publish in the International Frequency Information Circular (BR IFIC), the information referred to in *resolves* 7;

2 to exclude the aggregate calculations given in No. **22.5M** as part of a satellite network examination under No. **11.31**,

ANNEX 1 TO RESOLUTION [A16] (WRC-19)

List of GSO network characteristics and format of the result of
the aggregate calculation to be provided to BR for
publication for information

# I GSO network characteristics to be used in the calculation of aggregate emissions from non-GSO FSS and MSS systems

## **I-1 GSO Network Characteristics**

Annex 1 to Resolution [A16-A] (WRC-19).

## **I-2 Non-GSO satellite system constellation parameters**

For each non‑GSO satellite system, the following parameters should be provided to BR for publication in the aggregate calculation:

– Notifying administration;

– Number of space stations used in aggregate calculation;

– Single entry contribution to the aggregate value of each non-GSO FSS and each non-GSO MSS systems.

## **II. Results of the aggregate calculation**

Results of aggregate calculation including systems studied and assessment results.

ANNEX 2 TO RESOLUTION [A16] (WRC-19)

**List of criteria for the application of *resolves* 5**

1 Submission of Notification Publication Information.

2 Entry into satellite manufacturing or procurement agreement, and entry into satellite launch agreement.

The non-GSO FSS system operator should possess:

i) evidence of a binding agreement for the manufacture or procurement of its satellites; and

ii) evidence of a binding agreement to launch its satellites.

The manufacturing or procurement agreement should identify the contract milestones leading to the completion of manufacture or procurement of satellites required for the service provision, and the launch agreement should identify the launch date, launch site and launch service provider. The notifying administration is responsible for authenticating the evidence of agreement.

The information required under this criterion may be submitted in the form of a written commitment by the responsible administration.

3 As an alternative to satellite manufacturing or procurement and launch agreements, clear evidence of guaranteedfunding arrangements for the implementation of the project would be accepted. The notifying administration is responsible for authenticating the evidence of these arrangements and for providing such evidence to other interested administrations in furtherance of its obligations under this Resolution.

**Reasons:** A mechanism is required to ensure that only those administrations operating or planning to operate non-GSO FSS or MSS systems in the frequency bands under study individually or in collaboration through consultation meetings take all possible steps to ensure that the aggregate long-term interference does not exceed the performance criteria of GSO reference links.

**MOD CAN, MEX, USA/1.6/9**

RESOLUTION 750 (Rev.WRC‑19)

Compatibility between the Earth exploration-satellite service (passive) and relevant active services

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

TABLE 1-1

| EESS (passive) band | Activeservice band | Active service | Limits of unwanted emission power fromactive service stations in a specified bandwidthwithin the EESS (passive) band1 |
| --- | --- | --- | --- |
| 1 400-1 427 MHz | 1 427-1 452 MHz | Mobile | −72 dBW in the 27 MHz of the EESS (passive) band for IMT base stations−62 dBW in the 27 MHz of the EESS (passive) band for IMT mobile stations2, 3 |
| 23.6-24.0 GHz | 22.55-23.55 GHz | Inter-satellite | −36 dBW in any 200 MHz of the EESS (passive) band for non-geostationary (non-GSO) inter-satellite service (ISS) systems for which complete advance publication information is received by the Bureau before 1 January 2020, and −46 dBW in any 200 MHz of the EESS (passive) band for non-GSO ISS systems for which complete advance publication information is received by the Bureau on or after 1 January 2020 |
| 31.3-31.5 GHz | 31-31.3 GHz | Fixed(excluding HAPS) | For stations brought into use after 1 January 2012: −38 dBW in any 100 MHz of the EESS (passive) band. This limit does not apply to stations that have been authorized prior to 1 January 2012 |
| 50.2-50.4 GHz | 49.7-50.2 GHz | Fixed-satelliteGSO (E‑to‑s)4 | For GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC‑07 and brought into use prior to 1 January 2024:−10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi−20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBiFor GSO earth stations brought into use on or after 1 January 2024:-25 dBW into the 200 MHz of the EESS (passive) band for stations with elevations angles less than 80°-45 dBW into the 200 MHz of the EESS (passive) band for stations with elevations angles greater than or equal to 80° |
| 50.2-50.4 GHz | 49.7-50.2 GHz | Fixed-satellitenon-GSO(E‑to‑s)4 | For non-GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC‑07 and brought into use before the date of entry into force of the Final Acts of WRC‑19: −10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi−20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBiFor non-GSO earth stations brought into use on or after the date of entry into force of the Final Acts of WRC‑19: -35 dBW into the 200 MHz of the EESS (passive) band for stations |
| 50.2-50.4 GHz | 50.4-50.9 GHz | Fixed-satelliteGSO (E‑to‑s)4 | For GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC‑07 and brought into use prior to 1 January 2024:−10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi−20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBiFor GSO earth stations brought into use on or after 1 January 2024:-25 dBW into the 200 MHz of the EESS (passive) band for stations with elevations angles less than 80°-45 dBW into the 200 MHz of the EESS (passive) band for stations with elevations angles greater than or equal to 80° |
| 50.2-50.4 GHz | 50.4-50.9 GHz | Fixed-satellitenon-GSO(E‑to‑s)4 |  For non-GSO earth stations brought into use after the date of entry into force of the Final Acts of WRC‑07 and brought into use before the date of entry into force of the Final Acts of WRC‑19: −10 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain greater than or equal to 57 dBi−20 dBW into the 200 MHz of the EESS (passive) band for earth stations having an antenna gain less than 57 dBiFor non-GSO earth stations brought into use on or after the date of entry into force of the Final Acts of WRC‑19: -35 dBW into the 200 MHz of the EESS (passive) band for stations |
| 52.6-54.25 GHz | 51.4-52.6 GHz | Fixed | For stations brought into use after the date of entry into force of the Final Acts of WRC‑07:−33 dBW in any 100 MHz of the EESS (passive) band |
| 1 The unwanted emission power level is to be understood here as the level measured at the antenna port.2 This limit does not apply to mobile stations in the IMT systems for which the notification information has been received by the Radiocommunication Bureau by 28 November 2015. For those systems, −60 dBW/27 MHz applies as the recommended value.3 The unwanted emission power level is to be understood here as the level measured with the mobile station transmitting at an average output power of 15 dBm.4 The limits apply under clear-sky conditions. During fading conditions, the limits may be exceeded by earth stations when using uplink power control. |

**Reasons:** Studies have shown that GSO FSS systems alone cause exceedance the EESS (passive) protection criteria and that in order to allow the aggregate interference from both GSO and NGSO FSS earth stations emission to meet this criteria modifications to the unwanted emission limits for both GSO and NGSO FSS systems are needed.

**MOD MEX/1.6/9**

RESOLUTION 750 (Rev.WRC‑19)

**Compatibility between the Earth exploration-satellite service (passive) and relevant active services**

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

[…]