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| A close up of a sign  Description automatically generated | **World Radiocommunication Conference (WRC-23)Dubai, 20 November - 15 December 2023** |  |
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| PLENARY MEETING | **Addendum 16 toDocument 111-E** |
|  | **29 October 2023** |
|  | **Original: Chinese** |
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| China (People's Republic of) |
| PROPOSALS FOR THE WORK OF THE CONFERENCE |
|  |
| Agenda item 1.16 |

1.16 to study and develop technical, operational and regulatory measures, as appropriate, to facilitate the use of the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) by non-geostationary fixed-satellite service earth stations in motion, while ensuring due protection of existing services in those frequency bands, in accordance with Resolution **173 (WRC‑19)**;

# Introduction

WRC‑23 agenda item 1.16 considers the use of the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz, 19.7-20.2 GHz (space-to-Earth), 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) by earth stations in motion (ESIMs) communicating with non-geostationary (non-GSO) space stations in the fixed-satellite service (FSS). Under this agenda item studies have been carried out on sharing and compatibility between ESIM and terrestrial as well as space services allocated in the frequency bands above. For this agenda item, two methods have been identified:

## Method A

No changes to the Radio Regulations and suppression of Resolution **173 (WRC‑19)**.

## Method B

Add a new footnote in RR Article **5** that refers to a new WRC Resolution with technical, operational and regulatory conditions for the operation of non-GSO maritime and aeronautical ESIMs while ensuring protection of existing allocated services, and therefore suppress Resolution **173 (WRC‑19)**.

APT Members are considering supporting Methods A or B in the CPM Report. However, this Administration notes that there are further options in the preliminary APT common proposals (PACPs) and APT common proposals (ACPs) with respect to a number of remaining issues in the draft new Resolution **[A116] (WRC-23);** due to time constraints, these aspects were not discussed either at the CPM23-2 session or in the APT PACP/ACP. Accordingly, this contribution puts forward further considerations and proposals, for consideration by the Conference.

# Proposal

Based on ITU-R studies and the CPM Report, China would like to make proposals for the modification of relevant parts of the draft new Resolution, taking into account of the following:

1 This Administration proposes to make relevant modifications by referring to certain contents in draft new Resolution **[A116] (WRC-23)** of ACP, such as the those in: *considering d)* option 1, *considering further a)* option 3, *resolves* 1.1*bis* option 1, *resolves*1.3.1 option 1, *resolves* 5 option 1 and *resolves* 8 option 2, and also the additional modifications in *resolves* 1.1.2, 1.1.3, 1.1.5.1, 1.2.2*bis* and *resolves further* 1 and 4 (see the attachment to this document for reference);

2 In addition, this Administration proposes to make further modifications to the draft new Resolution **[A116] (WRC-23)**, in particular:

– As for the title, this Administration agrees with option 1, considering that the title of Resolution **173 (WRC-19)** is in line with option 1;

– As for resolves further 9, this Administration prefers to use option 2, namely maintain Annex 4;

– As for *instructs the Director of the Radiocommunication Bureau* 5, considering the workload of BR and that of the administrations, China prefers to use option 2, namely to avoid publication of the names of countries which give authorization;

– As for Annex 1, this Administration prefers to use14 MHz as the reference bandwidth while making other modifications to deal with the issue of inconsistency;

– As for Annex 2, this Administration prefers to make relevant modifications so that the same methodology as that in Recommendation ITU-R S.2158-0 is adopted;

– As for Annex 3, to protect the EESS this Administration prefers to give priority to option 3 while also giving consideration to option 1;

– As for Annex 4, taking into account the requirements to describe the capabilities of ESIMs, this Administration agrees to maintain Annex 4 and make modifications as shown in the attachment to this document,

On this basis, the specific modifications are highlighted in the attachment in turquoise.

attachment

ARTICLE 5

Frequency allocations

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

MOD CHN/111A16/1#1880

15.4-18.4 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 17.7-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A 5.517A ADD 5.A116(Earth-to-space) 5.516MOBILE | 17.7-17.8FIXEDFIXED-SATELLITE(space-to-Earth) 5.517 5.517A ADD 5.A116(Earth-to-space) 5.516BROADCASTING-SATELLITEMobile5.515 | 17.7-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A 5.517A ADD 5.A116(Earth-to-space) 5.516MOBILE |
|  | 17.8-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A 5.517A ADD 5.A116(Earth-to-space) 5.516MOBILE5.519 |  |
| 18.1-18.4 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.517A ADD 5.A116(Earth-to-space) 5.520 MOBILE 5.519 5.521 |

**Reasons:** In the relevant Ka band, this Administration supports developing a regulatory framework for the operation of ESIMs communicating with non-GSO satellite systems in the FSS while ensuring the protection of the incumbent services in accordance with Resolution **173 (WRC‑19)**.

MOD CHN/111A16/2#1881

18.4-22 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 18.4-18.6 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.517A ADD 5.A116 MOBILE |
| … |  |  |
| 18.8-19.3 FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.517A 5.523A ADD 5.A116 MOBILE |
| … |
| 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.484B 5.516B 5.527A ADD 5.A116Mobile-satellite (space-to-Earth) | 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.484B 5.516B 5.527A ADD 5.A116MOBILE-SATELLITE(space-to-Earth) | 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.484B 5.516B 5.527A ADD 5.A116Mobile-satellite (space-to-Earth) |
| 5.524 | 5.524 5.525 5.526 5.527 5.528 5.529 | 5.524 |
| 20.1-20.2FIXED-SATELLITE (space-to-Earth) 5.484A 5.484B 5.516B 5.527A ADD 5.A116 MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528 |

**Reasons:** In the relevant Ka band, this Administration supports developing a regulatory framework for the operation of ESIMs communicating with non-GSO satellite systems in the FSS while ensuring the protection of the incumbent services in accordance with Resolution **173 (WRC‑19)**.

MOD CHN/111A16/3#1882

24.75-29.9 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 27.5-28.5 FIXED 5.537A FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.517A 5.539 ADD 5.A116 MOBILE 5.538 5.540 |
| 28.5-29.1 FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.517A 5.523A 5.539 ADD 5.A116 MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540 |
| … |
| 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 ADD 5.A116Earth exploration-satellite(Earth-to-space) 5.541Mobile-satellite (Earth-to-space) | 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 ADD 5.A116MOBILE-SATELLITE(Earth-to-space)Earth exploration-satellite(Earth-to-space) 5.541 | 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 ADD 5.A116Earth exploration-satellite(Earth-to-space) 5.541Mobile-satellite (Earth-to-space)  |
| 5.540 5.542 | 5.525 5.526 5.527 5.529 5.540  | 5.540 5.542 |

**Reasons:** In the relevant Ka band, this Administration supports developing a regulatory framework for the operation of ESIMs communicating with non-GSO satellite systems in the FSS while ensuring the protection of the incumbent services in accordance with Resolution **173 (WRC‑19)**.

MOD CHN/111A16/4#1883

29.9-34.2 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 29.9-30 FIXED-SATELLITE (Earth-to-space) 5.484A 5.484B 5.516B 5.527A 5.539 ADD 5.A116 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.543 5.525 5.526 5.527 5.538 5.540 5.542 |

**Reasons:** In the relevant Ka band, this Administration supports developing a regulatory framework for the operation of ESIMs communicating with non-GSO satellite systems in the FSS while ensuring the protection of the incumbent services in accordance with Resolution **173 (WRC‑19)**.

ADD CHN/111A16/5#1884

5.A116The operation of earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service in the frequency bands 17.7-18.6 GHz (space-to-Earth), 18.8-19.3 GHz (space-to-Earth) and 19.7-20.2 GHz (space-to-Earth), 27.5-29.1 GHz (Earth-to-space) and 29.5-30 GHz (Earth-to-space) shall be subject to the application of Resolution **[A116] (WRC‑23)**.     (WRC‑23)

**Reasons:** This administration supports developing a regulatory framework for the operation of ESIMs communicating with non-GSO satellite systems in the FSS in relevant Ka band while ensuring the protection of the incumbent services in accordance with Resolution **173 (WRC-19)**.

ADD CHN/111A16/6#1885

draft new RESOLUTION [A116] (WRC‑23)

Use of the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space)
by earth stations in motion communicating with non-geostationary
space stations in the fixed-satellite service

The World Radiocommunication Conference (Dubai, 2023),

considering

*a)* that there is a need for global broadband mobile satellite communications, and that some of this need could be met by allowing earth stations in motion (ESIMs) to communicate with space stations of the non-geostationary-satellite orbit (non-GSO) fixed-satellite service (FSS) operating in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth), and 27.5-29.1 GHz and 29.5-30.0 GHz (Earth-to-space);

*b)* that the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) are allocated to space services, and the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz, and 27.5-29.1 GHz are allocated to terrestrial services on a primary basis worldwide; in the countries identified in No. **5.524** of the Radio Regulations, the frequency band 19.7-20.2 GHz is allocated to the fixed and mobile services on a primary basis; and, in the countries identified in No. **5.542** of the Radio Regulations, the frequency band 29.5-30 GHz is allocated to the fixed and mobile services on a secondary basis, and used by a variety of different systems and these existing services and their future development need to be protected, without any additional constraints, from the operation of non-GSO ESIMs;

*c)* that the frequency band 18.6-18.8 GHz is allocated to the Earth exploration-satellite service (EESS) (passive) and space research service (SRS) (passive) and that these services need to be protected from operation of non-GSO FSS in the space-to-Earth direction;

*d)* that there is no specific regulatory procedure for the coordination of non-GSO ESIMs relative to terrestrial stations for these services since the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) are not allocated for the operation of non-GSO ESIMs;

*e)* that regulatory procedures and interference-management mechanisms, including necessary mitigation measures, are required for the operation of non-GSO ESIMs to protect other space and terrestrial services allocated in the frequency bands mentioned in *considering a)*,

considering further

*a)* that aeronautical and maritime ESIMs operating within the service area of the non-GSO FSS systems with which they communicate may provide service within the territories under the jurisdiction of multiple administrations;

*b)* that this Resolution does not establish any technical or regulatory provisions for the operation and use of land ESIMs communicating with non-GSO FSS space stations, and any authorization of land ESIMs remains strictly a national matter, taking also into account the need to avoid cross-border interference,

recognizing

*a)* that the administration authorizing non-GSO ESIMs on the territory under its jurisdiction has the right to require that non-GSO ESIMs referred to above only use those assignments associated with non-GSO FSS systems which have been successfully coordinated, notified, brought into use and recorded in the Master International Frequency Register (MIFR) with a favourable finding under Articles **9** and **11**, including Nos. **11.31**, **11.32** or **11.32A**, where applicable;

*b)* that the provisions of No. **22.2** apply to non-GSO FSS satellite systems with which ESIMs operate in the frequency band 17.7-17.8 GHz (space-to-Earth) with respect to GSO FSS and GSO BSS networks;

*c)* that, under the provisions of No. **22.2**, non-GSO ESIMs in the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz shall not claim protection from GSO FSS and GSO BSS networks operating in accordance with these Regulations, and non-GSO ESIMs in the frequency bands 27.5-28.6 GHz and 29.5-30 GHz shall not cause unacceptable interference to GSO FSS and GSO BSS networks operating in accordance with the Radio Regulations, and No. **5.43A** does not apply in this case;

*d)* that there is no obligation for administration to authorize/license any non-GSO ESIMs to operate within the territory under its jurisdiction;

*e)* that, for the implementation of the relevant parts of *resolves* 1.1.2 below that a non-GSO FSS system operating in the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-28.6 GHz and 29.5-30 GHz (Earth-to-space) in compliance with the epfd limits referred to in Nos. **22.5C**, **22.5D** and **22.5F** is considered as having fulfilled its obligations under No. **22.2** with respect to any geostationary-satellite network;

*f)* that, with respect to GSO FSS networks, in the frequency bands 18.8-19.3 GHz (space-to-Earth) and 28.6-29.1 GHz (Earth-to-space) Nos. **9.12A** and **9.13** apply, and No. **22.2** does not apply;

*g)* that, for the use of the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5‑29.1 GHz and 29.5-30 GHz (Earth-to-space) by non-GSO FSS systems, No. **9.12** applies,

recognizing further

*a)* that frequency assignments to non-GSO ESIMs need to be notified to the Radiocommunication Bureau (BR);

*b)* that the notification by different administrations of frequency assignments to be used by the same non-GSO satellite system may create difficulties to identify the responsible administration in case of unacceptable interference;

*c)* that, an administration authorizing the operation of ESIMs within the territory under its jurisdiction may modify or withdraw that authorization at any time,

resolves

1 that, for any aeronautical or maritime ESIMs communicating with non-GSO FSS space stations in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5‑29.1 GHz and 29.5-30 GHz (Earth-to-space), or parts thereof, the following conditions shall apply:

1.1 with respect to space services in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz, 19.7-20.2 GHz (space-to-Earth), and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space), and in their adjacent bands in the frequency band 18.6-18.8 GHz, non-GSO ESIMs shall comply with the following conditions:

1.1*bis* an administration the territory of which is situated inside the service area of a non-GSO FSS satellite system and has provided explicit authorization to receive the service/to be served by any type of ESIM has no obligation nor any mandate, whatsoever, to be involved directly or indirectly in detection, identification, reporting, resolution of any interference caused by the operation of the ESIM the operation of which was authorized:

1.1.1 to prevent potential interference with respect to satellite networks or systems of other administrations non-GSO ESIMs characteristics shall remain within the envelope characteristics of typical earth stations associated with the non-GSO FSS system with which these ESIMs communicate;

1.1.1.1 for the implementation of *resolves* 1.1.1 above, the notifying administration for the non-GSO FSS system with which the non-GSO ESIMs communicate shall, in accordance with this Resolution, send to the BR Appendix **4** notification information related to the characteristics of the non-GSO ESIMs intended to communicate with that non-GSO FSS system, together with the commitment that the operation shall be in conformity with the Radio Regulations, including this Resolution;

1.1.1.2 upon receipt of the notification information referred to in *resolves* 1.1.1.1 above, the Bureau shall examine it with respect to the provisions referred to in *resolves* 1.1.1 above, including the commitment referred to in *resolves* 1.1.1.1 above, and publish the result of such examination in the International Frequency Information Circular (BR IFIC);

1.1.2 the notifying administration of the non-GSO FSS system with which the ESIMs communicate shall ensure that the operation of ESIMs complies with the coordination agreements for the frequency assignments of the typical earth station of this non-GSO FSS system obtained under the provisions of Article **9** of the Radio Regulations, in particular, taking into account *recognizing b)*;

1.1.3 the notifying administration of the non-GSO FSS system with which the ESIMs communicate shall ensure that non-GSO ESIMs comply with the epfd limits referred to in Nos. **22.5C**, **22.5D** and **22.5F** for the protection of GSO FSS networks operating in the frequency bands 17.8-18.6 GHz, 19.7-20.2 GHz (space-to-Earth), 27.5-28.6 GHz and 29.5-30 GHz (Earth-to-space) ;

1.1.4 non-GSO ESIMs shall not claim protection from BSS feeder-link earth stations operating in accordance with the Radio Regulations in the frequency band 17.7‑18.4 GHz;

1.1.5 with respect to protection of EESS (passive) operating in the frequency band 18.6-18.8 GHz, any non-GSO FSS systems with an orbital apogee of less than 20 000 km operating in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz with which aeronautical and/or maritime ESIMs communicate and for which the complete notification information has been received by the BR after 1 January 2025 shall comply with the provisions indicated in Annex 3 to this Resolution;

1.1.5.1 for the implementation of *resolves*1.1.5 above, the notifying administration for the non-GSO FSS system with which the non-GSO ESIMs communicate shall send to the BR the relevant Appendix **4** notification information including the commitment that the operation shall be in conformity with *resolves*1.1.5;

1.2 with respect to terrestrial services in the frequency bands 17.7‑18.6 GHz, 18.8-19.3 GHz, 19.7-20.2 GHz, 27.5-29.1 GHz and 29.5-30 GHz, non-GSO ESIMs shall comply with the following conditions:

1.2.1 receiving non-GSO ESIMs in the frequency bands 17.7-18.6 GHz and 18.8-19.3 GHz and 19.7-20.2 GHz (see No. **5.524**) shall not claim protection from assignments in the terrestrial services to which those frequency bands are allocated and that operate in accordance with the Radio Regulations;

1.2.2 transmitting non-GSO ESIMs in the frequency band 27.5-29.1 GHz shall not cause unacceptable interference to terrestrial services to which the frequency band is allocated and that operate in accordance with the Radio Regulations, and Annex 1 to this Resolution shall apply;

1.2.2*bis* for the implementation of paragraph 1.2.2, the following actions need to be pursued;

*a)* the notifying administration of the inter-satellite assignments submitting Appendix **4** information/data elements shall also send a firm objective, measurable, enforceable and actionable commitment that, in case of reported unacceptable interference, it shall immediately cease the interference or reduce it to an acceptable level;

*b)* in the commitment, the notifying administration shall state that in case no action is taken with regard to the obligation referred to in *a)* above, the Bureau shall send a reminder and request that administration to comply with the requirements referred to in commitment;

*c)* should the interference continued to persist 30 days after the above-mentioned reminder has been sent, the Bureau shall submit the case to the subsequent meeting of the RRB for review and necessary action, as appropriate;

1.2.3 transmitting non-GSO ESIMs in the frequency band 29.5-30.0 GHz shall not adversely affect the operations of terrestrial services to which this frequency band is allocated on secondary basis and that operate in accordance with the Radio Regulations, and limits in Annex 1 to this Resolution shall apply with respect to administrations mentioned in No. **5.542**;

1.2.4 the provisions in this Resolution, including Annex 1, set the conditions for the purpose of protecting terrestrial services from unacceptable interference from non-GSO ESIMs in neighbouring countries in accordance with the provisions included in *resolves* 1.2.2 and 1.2.3 above in the frequency band 27.5-29.1 GHz and in the frequency band 29.5-30.0 GHz, in particular, with respect to assignments of the administrations mentioned in No.**5.542**; however, the requirement not to cause unacceptable interference to, or claim protection from, terrestrial services to which the frequency bands are allocated and operating in accordance with the Radio Regulations shall be respected, irrespective of compliance with Annex 1 (see *resolves* 6);

NOTE: START of a section that was not discussed in detail during CPM23-2

***Scenario 1 (Applies if the relevant methodology is included in Annex 2)***

1.2.5 the Bureau shall examine, in accordance with the provisions included in *resolves* 1.2.2 and 1.2.3 and with the methodology in Annex 2, the characteristics of aeronautical non‑GSO ESIMs with respect to the conformity with the power flux-density (pfd) limits on the Earth’s surface specified in Part 2 of Annex 1 to this Resolution and publish the results of such examination in the BR IFIC;

1.2.5.1 however, the compliance with the technical conditions in Annex 1, does not release the notifying administration of the A-ESIM and M-ESIM with respect to discharging its responsibility that such earth station shall not cause unacceptable interference and any interrelated receiving part shall not claim protection from the terrestrial stations;

*Scenario 2 (Applies if the relevant methodology is not included in Annex 2 by the end of WRC‑23)*

1.2.5 the Bureau shall examine, in accordance with the provisions included in *resolves* 1.2.2 and 1.2.3, the characteristics of aeronautical non-GSO ESIMs with respect to the conformity with the power flux-density (pfd) limits on the Earth’s surface specified in Part 2 of Annex 1, and publish the results of such examination in the BR IFIC;

1.2.6if the BR is unable to examine, in accordance with *resolves* 1.2.5, non-GSO aeronautical ESIMs with respect to conformity with the pfd limits specified in Part 2 of Annex 1, the notifying administration shall send to the BR a commitment to ensure that the aeronautical non-GSO ESIMs comply with those limits;

1.2.7 the BR shall formulate a qualified favourable finding under No. **11.31** with respect to the pfd limits contained in Part 2 of Annex 1, otherwise the BR shall formulate an unfavourable finding;

1.2.8 once the methodology to examine the characteristics of aeronautical non-GSO ESIMs with respect to conformity with the pfd limits on the Earth’s surface specified in Part 2 of Annex 1 is available, *resolves*1.2.4 shall be applied by the Bureau;

1.2.9 after the successful application of *resolves*1.2.6 and 1.2.7, once the methodology to examine the characteristics of aeronautical non-GSO ESIMs with respect to conformity with the pfd limits on the Earth’s surface specified in Part 2 of Annex 1 is available, *resolves*1.2.5 shall be applied by the Bureau;

NOTE: END of a section that was not discussed in detail during CPM23-2

1.3 that, in the case unacceptable interference caused by A‑ESIM and/or M‑ESIM is reported:

1.3.1 only the notifying administration of the non-GSO FSS system with which ESIMs communicate is responsible for resolving the case of unacceptable interference;

1.3.2 the notifying administration of the non-GSO FSS system with which the ESIMs communicate shall immediately take the required action to eliminate or reduce interference to an acceptable level;

1.3.3 the affected administration(s) may assist resolving or provide information that would facilitate resolving the case of unacceptable interference;

1.3.4 the administration authorizing the operation of A‑ESIM and M‑ESIM on territory under its jurisdiction, subject to its explicit agreement, may provide assistance, including information for the resolution of unacceptable interference;

1.3.5 the administration responsible for the aircraft or vessel on which the ESIM operates shall provide a point of contact to assist identifying the notifying administration of the satellite with which the ESIM communicates;

1.4 that the notifying administration of non-GSO FSS satellite system with which ESIMs communicate shall ensure that:

1.4.1 for the operation of A‑ESIM and M‑ESIM, techniques are employed to maintain adequate antenna pointing accuracy with the associated non-GSO FSS satellite;

1.4.2 all necessary measures shall be taken so that earth stations on aircraft and vessels are subject to permanent monitoring and control by a Network Control and Monitoring Centre (NCMC) in order to comply with the provisions in this Resolution, and are capable of receiving and immediately acting upon inter alia “enable transmission” and “disable transmission” commands from the NCMC (see Annex 4);

1.4.3 measures are taken so that the A‑ESIM and/or M‑ESIM do not transmit on the territory under the jurisdiction of an administration, including its territorial waters and its national airspace, that has not authorized its use;

1.4.4 the notifying administration of the non-GSO FSS system with which ESIMs communicate shall provide a permanent point of contact in the Appendix **4** submission and this shall be published in the relative special section of the BR IFIC for the purpose of tracing any suspected cases of unacceptable interference from A‑ESIMs or M‑ESIMs and for the purpose of immediately responding to the relevant requests;

NOTE: START of a section that was not discussed in detail during CPM23-2

2 that non-GSO ESIMs shall not be used or relied upon for safety-of-life applications;

3 that the operation of non-GSO ESIMs within the territory, including territorial waters and airspace, under the jurisdiction of any administration shall be carried out only if an authorization or a licence according to No. **18.1** from that administration is obtained;

4 that the notifying administrations of those non-GSO FSS systems with which non-GSO ESIMs in the frequency bands in *considering a)* above are intended to operate shall submit a commitment to the Bureau to immediately act to eliminate or reduce the interference to an acceptable level upon receiving a report of unacceptable interference (see *resolves*5);

**NOTE: END of a section that was not discussed in detail during CPM23-2**

5 in case there is more than one administration involved in the notification of frequency assignments of the same non-GSO satellite system with which ESIMs communicate, those administrations shall nominate one administration as the notifying administration responsible to act on their behalf to be responsible to eliminate any unacceptable interference cases and inform the Bureau accordingly;

**NOTE: START of a section that was not discussed in detail during CPM23-2**

Option 1

6 that the application of this Resolution does not provide regulatory status to non-GSO ESIMs different from that derived from the non-GSO FSS satellite system with which they communicate, taking into account the provisions referred to in this Resolution (see *recognizing b)*,

7 that any course of action taken under this Resolution has no impact on the original date of receipt of the frequency assignments of the non-GSO FSS satellite system with which non-GSO ESIMs communicate or on the coordination requirements of that satellite system;

**NOTE: END of a section that was not discussed in detail during CPM23-2**

8 the implementation of this Resolution is conditioned on providing a description to the administrations whose authorization is sought of interference management system(s), monitoring facilities (NCMC), dealing with the cessation of transmission over territories which have not authorized (*see resolves*3) the functioning and operation of any ESIM over their territories in order to provide a satisfactory resolution of the problem as referred to in *recognizing further d)* above,

NOTE: Provided the description mentioned above is properly addressed and concluded, *resolves*9 above may be deleted at WRC-23

resolves further

1 that ESIMs shall not cause unacceptable interference to nor claim protection from other services as referred to *recognizing c)* and in *resolves*1.1.1, 1.1.4, 1.1.5, 1.2.1, 1.2.2 and 1.2.4;

2 that the notifying administration for the ESIMs shall send to the BR, when submitting the relevant Appendix **4** data a commitment (as stipulated in *resolves*5) that, upon receiving a report of unacceptable interference, the notifying administration for the non-GSO system with which ESIMs communicate shall remove such interference;

3 that the commitment referred to in *resolves further*2 shall be objective, measurable and enforceable;

4 that, in case of continued unacceptable interference despite of the commitment referred to in *resolves further*2, the assignment causing interference shall be submitted to the Radio Regulation Board for review and necessary action, as appropriate;

5 that compliance with the provisions contained in Annex 1 does not release the notifying administration of the non-GSO satellite system with which ESIMs communicate of its obligations mentioned in *resolves further*1 above;

NOTE: START of a section that was not discussed in detail during CPM23-2

6 that frequency assignments to ESIMs shall be notified by the notifying administration of the non-GSO satellite system in the FSS with which ESIMs communicate;

7 that the notifying administration of the satellite system shall ensure that non-GSO ESIMs operate only in the territory under the jurisdiction of administrations from which an authorization has been obtained, taking into account *recognizing further* *c)*;

8 that ESIMs shall be designed and operate so as to cease transmission over the territory of any administration/country from which authorization has not been obtained;

9 that, for the implementation of *resolves further* 2 above, the system shall employ the minimum software and hardware capabilities listed in Annex 4;

10 that, for the implementation of *resolves further* 1, the notifying administration responsible for the operation of aeronautical and maritime non-GSO ESIMs shall also be responsible for observing and complying with all relevant regulatory and administrative provisions applicable to the operation of the ESIMs as included in this Resolution and those contained in the Radio Regulations;

11 that the authorization to non-GSO ESIM to operate in the territory under the jurisdiction of an administration shall in no way release the notifying administration of the non‑GSO satellite system with which the non-GSO ESIM communicates from the obligation to comply with the provisions included in this Resolution and those contained in the Radio Regulations;

12 that, should an administration authorizing aeronautical and/or maritime non-GSO ESIMs agree to less stringent limits than those contained Annex 1 within the territory under its jurisdiction, such agreement shall not affect other countries that are not party to that agreement,

instructs the Director of the Radiocommunication Bureau

1 to take all necessary actions to facilitate the implementation of this Resolution, together with providing any assistance for the resolution of interference, when required;

2 to report to future world radiocommunication conferences any difficulties or inconsistencies encountered in the implementation of this Resolution, including whether or not the responsibilities relating to the operation of aeronautical and maritime non-GSO ESIMs have been properly addressed;

3 not to examine, under No. **11.31**, the conformity of non-GSO FSS systems with the provisions of *resolves*1.1.5 of this Resolution,

Option 1

Option 2

4 to report to future world radiocommunication conferences any difficulties or inconsistencies encountered in the implementation of Recommendation ITU‑R S.1503 for verifying that the non-GSO FSS systems under this Resolution comply with the epfd limits specified in Article **22**;

5 to publish the list of non-GSO satellite systems with which ESIM communicate brought into use with information about its service area; this information shall be updated regularly,

invites administrations

to take into consideration the relevant recommendations to employ Annex 4 procedures when licensing/authorizing the operation of earth stations in motion in their territories,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the International Maritime Organization and of the Secretary General of the International Civil Aviation Organization.

**NOTE: END of a section that was not discussed in detail during CPM23-2**

Annex 1 to draft new Resolution [A116] (WRC‑23)

was not discussed in detail during CPM23-2Provisions for maritime and aeronautical non-GSO ESIMs to protect terrestrial services operating in the frequency band 27.5-29.1 GHz and for the frequency band 29.5-30.0 GHz on the territories of administrations mentioned in No. 5.542

The parts below contain provisions to ensure that maritime and aeronautical non-GSO ESIMs do not cause unacceptable interference in neighbouring countries to terrestrial service operations when non‑GSO ESIMs operate in frequencies overlapping with those used by terrestrial services at any time to which the frequency band 27.5-29.1 GHz is allocated and operating in accordance with the Radio Regulations. And for the frequency band 29.5-30.0 GHz on the territories of administrations mentioned in No. **5.542**, the provisions below also could apply in order not to adversely impact the terrestrial services that have secondary allocations.

Part 1: Maritime non-GSO ESIMs

1 The notifying administration of the non-GSO FSS satellite system with which maritime ESIMs communicates shall ensure compliance of the maritime ESIMs with both of the following conditions for the protection of terrestrial services to which the frequency band is allocated within a coastal State:

1.1 The minimum distance from the low-water mark as officially recognized by the coastal State beyond which maritime ESIMs can operate without the prior agreement of any administration is 70 km. Any transmissions from maritime ESIMs within the minimum distance shall be subject to the prior agreement of the coastal State(s) concerned.

1.2 The maximum maritime ESIMs e.i.r.p. spectral density towards the territory of any coastal State shall be limited to 24.44 dBW in a reference bandwidth of 14 MHz. Transmissions from maritime ESIMs with higher e.i.r.p. spectral density levels towards the territory of any coastal State shall be subject to the prior agreement of the coastal State(s) concerned.

Part 2: Aeronautical non-GSO ESIMs

Option 1:

2 The notifying administration of the non-GSO FSS satellite system with which aeronautical ESIMs communicates shall ensure compliance of the aeronautical ESIMs with all of the following conditions for the protection of the terrestrial services to which the frequency band is allocated:

2.1 When within line-of-sight of the territory of an administration, and above an altitude of 3 km, the maximum pfd produced at the surface of the Earth on the territory of an administration by emissions from a single aeronautical ESIM shall not exceed:

 pfd(θ) = −124.7 (dB(W/(m2 ∙ [14] MHz))) for 0° ≤ θ ≤ 0.01°

 pfd(θ) = −120.9 + 1.9 ∙ logθ (dB(W/(m2 ∙ 14 MHz))) for 0.01° < θ ≤ 0.3°

 pfd(θ) = −116.2 + 11 ∙ logθ (dB(W/(m2 ∙ 14 MHz))) for 0.3° < θ ≤ 1°

 pfd(θ) = −116.2 + 18 ∙ logθ (dB(W/(m2 ∙ 14 MHz))) for 1° < θ ≤ 2°

 pfd(θ) = −117.9 + 23.7 ∙ logθ (dB(W/(m2 ∙ 14 MHz))) for 2° < θ ≤ 8°

 pfd(θ) = −96.5 (dB(W/(m2 ∙ 14 MHz))) for 8° < θ ≤ 90.0°

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

2.2 When within line-of-sight of the territory of an administration, and up to an altitude of 3 km, the maximum pfd produced at the surface of the Earth on the territory of an administration by emissions from a single aeronautical ESIM shall not exceed:

 pfd(θ) = −136.2 (dB(W/(m2 ∙ 1 MHz))) for 0° ≤ θ ≤ 0.01°

 pfd(θ) = −132.4 + 1.9 ∙ logθ (dB(W/(m2 ∙ 1 MHz))) for 0.01° < θ ≤ 0.3°

 pfd(θ) = −127.7 + 11 ∙ logθ (dB(W/(m2 ∙ 1 MHz))) for 0.3° < θ ≤ 1°

 pfd(θ) = −127.7 + 18 ∙ logθ (dB(W/(m2 ∙ 1 MHz))) for 1° < θ ≤ 12.4°

 pfd(θ) = −108 (dB(W/(m2 ∙ 1 MHz))) for 12.4° < θ ≤ 90°

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

2.3 The pfd levels provided in §§ 2.1 and 2.2 above relate to the pfd and angles of arrival that shall be obtained using free-space propagation and attenuation due to the aircraft fuselage. Unless there is an available ITU‑R Recommendation to calculate attenuation due to the aircraft fuselage in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz, the formulas in the table below shall be used for the calculation of attenuation due to the aircraft fuselage in these frequency bands.

Fuselage attenuation model from Report ITU-R M.2221

|  |  |  |  |
| --- | --- | --- | --- |
| *Lfuse*(γ) = 3.5 + 0.25 · γ | dB | for | 0°≤ γ ≤ 10° |
| *Lfuse*(γ) = −2 + 0.79 · γ | dB | for | 10°< γ ≤ 34° |
| *Lfuse*(γ) = 3.75 + 0.625 · γ | dB | for | 34°< γ ≤ 50° |
| *Lfuse*(γ) = 35 | dB | for | 50°< γ ≤ 90° |

2.4 An aeronautical ESIM operating in the frequency bands 27.5-29.1 GHz and 29.5-30 GHz, or portions thereof, within the territory of an administration that has authorized fixed-service and/or mobile-service operation in the same frequency bands in accordance with the Radio Regulations shall not transmit in these frequency bands without prior agreement of that administration.

2.5 The maximum power in the out-of-band domain should be attenuated below the maximum output power of the aeronautical ESIM transmitter as described in Recommendation ITU‑R SM.1541.

NOTE: Annex 2 was not discussed in detail during CPM23-2.

Annex 2 to draft new Resolution [A116] (WRC‑23)

Methodology with respect to the examination referred to in Scenario 1 *resolves*1.2.5

*NOTE: This methodology has been developed based on the discussions in Working Party 4A regarding draft new Recommendation ITU-R S.[RES.169\_METH] which contains a methodology for assessing compliance of A-ESIM communicating with GSO FSS satellites to meet the obligations to protect terrestrial services in Resolution* ***169 (WRC-19)****. Proposals to WRC-23 on agenda item 1.16 including Doc. CPM23-2/175 may need to take into account any further progress/updates to this draft new Recommendation when considering a methodology for assessing compliance with Part 2 of Annex 1 of Resolution* ***[A116]*** *for A-ESIM communicating with non-GSO FSS satellites.*

*However, it should be emphasized that the discussion in the CG would lead to a satisfactory conclusion on the matter and there is no certainty that the work of the CG will be agreed at WP 4A and SG4. Consequently, decisions of the CPM on this matter should not be based on other actions by SG4 or RA-23 that may not be conclusive.*

Option 1 for the methodology:

1 Overview of the methodology

Option 1:

Aeronautical earth station in motion (A‑ESIM) can operate over time at different locations defined by latitude, longitude and altitude. This methodology determines the maximum allowable off-axis e.i.r.p. spectral density (“*EIRPC*”) for an A‑ESIM transmitter communicating with a non‑GSO FSS satellite that would ensure compliance with a set of pre-established power flux-density (pfd) limits defined on the Earth’s surface. This methodology derives the *EIRPC*considering the relevant loss and attenuation in the geometry considered, among other things.

Option 2:

An aeronautical earth station in motion (A‑ESIM) can operate over time at different locations defined by latitude, longitude and altitude. This methodology determines the maximum allowable off-axis e.i.r.p. spectral density (“*EIRPC*”) for an A‑ESIM transmitter communicating with a non‑GSO FSS space station that ensures compliance with a set of the defined pfd limits on the Earth’s surface in Annex 1 to this Resolution. This methodology derives the *EIRPC*considering the relevant loss and attenuation in the geometry considered, among other things.

The methodology then compares the computed *EIRPC* with the reference off-axis e.i.r.p. towards the ground (“*EIRPR*”) of the A‑ESIMs. For each emission in each group of a non-GSO FSS satellite system, *EIRPR* can be calculated by using the Appendix **4** data for that system as well as other input parameters that shall be provided by the notifying administration for that system.

Specifically, for each emission in the non-GSO FSS satellite system associated with a to-be-defined non‑GSO A‑ESIM class of station, the *EIRPR* is the algebraic summation (in logarithmic terms) of the maximum input power to the antenna (item C.8.a.1 of Appendix **4**), the peak gain of the A‑ESIM antenna (item C.10.d.3 of Appendix **4**), the maximum achievable off-axis gain isolation towards the ground of the A‑ESIM antenna and a parameter that would compensate for any difference between the emission bandwidth and the reference bandwidth of the pre-established set of pfd limits.

The operations of A‑ESIMs shall be evaluated over multiple predefined altitude ranges in order to establish as many *EIRPC* levels for comparison with *EIRPR*. This comparison is at the basis of the methodology and examination that are described more in detail in the following section. An examination by the Bureau shall apply this methodology for each altitude range, to determine whether the A‑ESIM operating under a given non-GSO satellite system complies with the defined pfd limits on the Earth’s surface in Annex 1 to this Resolution to ensure the protection of terrestrial services.

2 Parameters and geometry

Figure A2‑1 provides a description of the geometry considered under this methodology. The figure shows A‑ESIMs flying at two different altitudes and also some of the parameters used for the calculation. The model is agnostic to non-GSO ESIM geographical locations on Earth and assumes a spherical Earth model with a fixed radius for the calculation.

Figure a2-1

Geometry for the examination of compliance for two different ESIMs altitudes

The notifying administration for the non-GSO FSS system with which the A‑ESIM communicates shall send to the Bureau the relevant characteristics of the A‑ESIM intended to communicate with that non-GSO FSS network under *resolves* 1.1.3 above. All the parameters required by the Bureau to carry out the examination process are listed and briefly described in Table A2‑1. Additional considerations are further elaborated in section 3.

Option 1:

Table a2-1

Relevant parameters for pfd limits compliance examination

| Parameter  | Symbol | Type of parameter | Observation |
| --- | --- | --- | --- |
| Aeronautical non-GSO ESIM altitude | *H* | Established by the methodology as: *Hmin* = 0.01 km, *Hmax* = [13/15] km, *Hstep* = 1 km | The altitudes at which the examination is carried out range from *Hmin* to *Hmax* at *Hstep* intervals. |
| Angle of arrival of the incident wave on the Earth’s surface  | δ | Specified by the pre-established set(s) of pfd limits, variable from 0° to 90° | Pre-established set(s) of pfd limits should cover incident angles from 0° to 90°  |
| Angle below the horizontal plane of the ESIMs corresponding to the angle of arrival δ under examination | γ | Calculated from the geometry  | This angle is calculated considering the non-GSO ESIMs altitude *Hj* examined and angle of arrival δ under examination (see Fig. A.2.1) |
| Distance between the ESIMs and the point on the ground under examination | *D* | Calculated from the geometry | This distance is a function of the A‑ESIMs altitude and the angles and  |
| Frequency  | *f* | Taken from the Appendix **4** data | To evaluate the propagation loss or at the lower limits of the frequency range |
| Atmospheric loss | *Latm* | Calculated and established by the methodology | Based on Recommendation ITU‑R P.676  |
| Fuselage attenuation | *Lf* | See § 2.3 in Annex 1 | The attenuation depends on the angle (γ) below the horizontal plane of the non-GSO ESIMs.  |
| A‑ESIM antenna peak gain and off-axis gain pattern | *Gmax*, *G*(θ) | Taken from the Appendix **4** data (items C.10.d.3 and C.10.d.5.a.1, respectively) of the non-GSO system under examination | The A‑ESIM antenna gain is used to compute *EIRPR* |
| Emission bandwidth  | *BWEmission* | Taken from the Appendix **4** data (as part of item C.7.a) of the non-GSO system under examination | These two bandwidths shall be compared, and a correcting factor needs to be included in the computation of *EIRPR* in case *BWEmission* < *BWRef* |
| Reference bandwidth | *BWRef* | Taken from the set(s) of pre-established pfd limits |
| Effective isotropic radiated power required for compliance with the pfd limits in a reference bandwidth  | *EIRPC* | *EIRPC* is the result of the calculation; it depends on the ESIM altitude and the angle of arrival (δ) of the incident wave on the Earth’s surface  | For each of the altitudes *Hj*, the e.i.r.p. for compliance is calculated for the different incident angles (δ) considered to cover all the range of the pfd limits to be established by WRC‑23. This leads to a number of values of *EIRPC* associated to a given altitude *Hj*; for each altitude *Hj*, the lowest e.i.r.p. value is the one to be retained and compared with *EIRPR* (see section 3)  |
| A set of pre-established pfd limits on the Earth’s surface | *PFD*(δ) | Taken from Annex 1 to this Resolution | The pfd limits, expressed in dB(W/m2/BWref), are a function of the angle of arrival δ |

Option 2:

Table a2-1

Relevant parameters for pfd compliance examination

| Parameter  | Symbol | Type of parameter | Observation |
| --- | --- | --- | --- |
| Aeronautical non-GSO ESIM altitude | *H* | Established by the methodology as: *Hmin* = 0.01 km, *Hmax* = 15.01 km | The altitudes at which the examination is carried out range from *Hmin* to *Hmax* at the following altitudes: *Hmin*, 1.01 km, 2.01 km, 3.00 km, 3.01 km, 4.01 km… *Hmax*. |
| Angle of arrival of the incident wave on the Earth’s surface  | δ | Specified by the pre-established set(s) of pfd limits, variable from 0° to 90° | Pre-established set(s) of pfd should cover incident angles from 0° to 90°  |
| Angle below the horizontal plane of the ESIM corresponding to the angle of arrival δ under examination | γ | Calculated from the geometry  | This angle is calculated considering the non-GSO A‑ESIM’s altitude *Hj* examined and angle of arrival δ under examination (see Fig. A.2.1) |
| Distance between the ESIM and the point on the ground under examination | *D* | Calculated from the geometry | This distance is a function of the A‑ESIMs altitude and the angles δ and γ |
| Frequency  | *f* | Provided by the Appendix **4** data | To evaluate the propagation loss either at the centre frequency or at the upper and lower limits of the frequency range |
| Atmospheric loss | *Latm* | Calculated and established by the methodology | Based on Recommendation ITU‑R P.676  |
| Fuselage attenuation | *Lf* | Report ITU‑R M.2221‑0 or other ITU‑R Reports or Recommendations | The attenuation depends on the angle (γ) below the horizontal plane of the non-GSO A‑ESIM. The value(s) could come from ITU‑R Reports and/or Recommendations, such as Report ITU‑R M.2221. Note, the model contained in Report ITU‑R M.2221‑0 might require updating and/or clarifications.  |
| A‑ESIM antenna peak gain and off-axis gain pattern | *Gmax*, *G*(θ) | Taken from the Appendix **4** data (items C.10.d.3 and C.10.d.5.a.1, respectively) of the non-GSO system under examination | The A‑ESIM antenna gain is used to compute *EIRPR* |
| Emission bandwidth  | *BWEmission* | Taken from the Appendix **4** data (as part of item C.7.a) of the non-GSO system under examination | These two bandwidths shall be compared, and a correcting factor needs to be included in the computation of *EIRPR* in case *BWEmission* < *BWRef* |
| Reference bandwidth | *BWRef* | Taken from the set(s) of pre-established pfd limits |
| Effective isotropic radiated power required for compliance with the pfd limits in a reference bandwidth  | *EIRPC* | *EIRPC* is the result of the calculation; it depends on the ESIM altitude and the angle of arrival (δ) of the incident wave on the Earth’s surface  | For each of the altitudes *Hj*, the e.i.r.p. for compliance is calculated for the different incident angles (δ) considered to cover all the range of the pfd limits to be established by WRC‑23. This leads to a number of values of *EIRPC* associated to a given altitude *Hj*; for each altitude *Hj*, the lowest e.i.r.p. value is the one to be retained and compared with *EIRPR* (see section 3)  |

3 Calculation procedure

This section includes a step-to-step description of how the examination methodology would be implemented for a given group associated to the class of earth station for non-GSO A‑ESIMs in a non-GSO satellite system.

*START*

Calculate *EIRPR*

i) For each of the emissions included in the Group under consideration, compute the Reference EIRP (*EIRPR*, dB(W)) as:

  (1)

where:

 *GMax* is the A‑ESIM antenna peak gain in dBi

 is the maximum achievable gain isolation of the A‑ESIM antenna towards the ground in dB when operating in the examined non-GSO system

 *PMax* is the maximum power density at the A‑ESIM antenna flange in dB(W/Hz).

 *BW* in Hz is:

 *BWRef* if *BWemission* > *BWRef*

 *BWemission* if *BWemission*< *BWRef*

Calculate *EIRPC*

ii) For each aircraft altitude, it is necessary to generate as many δ*n* angles (angle of arrival of the incident wave) as required in order to test the full compliance with the set(s) of pre-established pfd limits. The *N* angles δ*n* shall be comprised between 0° and 90° and have a resolution compatible with the granularity of the pre-established pfd limits. Each of the angles δ*n* will correspond to as many *N* points on the ground.

iii) For each altitude *Hj*= *Hmin*, …, *Hmax*, compute *EIRPC\_j* using the following algorithm:

*a)* Set the altitude of the A\_ESIM to *Hj*

*b)* Compute the angle below the horizon γ*j,n* as seen from the A‑ESIM for each of the *N* angles δ*n* generated in ii) using the following equation:

  (2)

 where is the mean Earth radius.

*c)* Compute the distance *Dj,n*, in km, for *n*= 1, …, *N* between the A‑ESIM and the tested point on the ground:

  (3)

*d)* Compute the fuselage attenuation *Lf j,n* (dB) applicable to each of the *N* points on the ground as a function of the angles γ*j,n* computed in *b)* above

*e)* Compute the atmospheric loss *Latm\_j,n* (dB) applicable to each of the distances *Dj,n* computed in *c)* above

*f)* Compute the *EIRPC\_j,n* (dB(W/*BWRef*)), that is the maximum e.i.r.p. that can be radiated in the pfd mask’s reference bandwidth by the A‑ESIM towards each of the *N* points to be compliant with the set(s) of pre-established pfd limits, as per the following equation:

  (4)

*g)* Compute the minimum *EIRPC\_j* across all values calculated at the previous step, *EIRPC\_j*= Min (*EIRPC\_j,n* (δ*n*, γ*n*)). The output of this last step is the maximum *EIRPC* that can be radiated by the A‑ESIM to ensure it complies with the set(s) of pre-established pfd limits with respect to all angles δ*n* at the altitude *Hj*. There will be one *EIRPC\_j* for each of the *Hj* altitudes considered.

The output of step iii) is summarized in Table A2‑2 below:

Table a2-2

Computed *EIRPC\_j* values

|  |  |  |  |
| --- | --- | --- | --- |
| j | Hj | EIRPC\_j,n (δn, γn) dB(W/BWRef) | EIRPC\_j |
| - | (km) | δ = 0° | δ = 0.01° | … | δ = 90° | dB(W/BWRef) |
| 1 | *Hmin* | xxx | xxx | xxx | xxx | XXX |
| 2 |  | yyy | yyy | yyy | yyy | YYY |
| … | … | … | … | … | … | … |
| *jmax* | *Hmax* | zzz | zzz | zzz | zzz | ZZZ |

Compare *EIRPC* and *EIRPR*, and produce an examination finding

iv) For each of the emissions, check whether *EIRPC*\_*j* > *EIRPR*. The results of this check are illustrated in Table A2‑3 below.

Table a2-3

Comparison between *EIRPC\_j* and *EIRPR*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Group ID | Emission No. | *EIRPR*dB(W) | Is there at least one altitude *Hj* for which *EIRPC\_j* > *EIRPR*? | Smallest *Hj* for which *EIRPC\_j* > *EIRPR*(km) |
| X | 1 | XXX | Yes/No | AAA |
| Y | 2 | YYY | Yes/No | BBB |
| … | … | … | … | … |
| Z | *N* | ZZZ | Yes/No | CCC |

v) For the emissions included in the Group under examination which pass the test detailed in iv) above, the results of the Bureau’s examination for that Group is ***favourable*** (after removing emissions that have failed the examination), otherwise it is ***unfavourable***.

vi) The Bureau shall publish:

– the finding (favourable or unfavourable) for each Group of the non-GSO system examined;

– Table A2‑3, that is the output of step iii) of the algorithm.

Note: As part of standard procedure, the Bureau would publish the emissions with unfavourable findings in BR IFIC Part III‑S, which concerns frequency assignments that are returned to the responsible administration.

Option 2 for the methodology:

1 Examination methodology

1.1 Introduction

An A‑ESIM can operate at different locations defined by latitude, longitude and altitude. This methodology determines the maximum allowable Power *Pj* for an A‑ESIM transmitter communicating with a non-GSO FSS satellite and to ensure compliance with the pfd limits included in Part 2 of Annex 1 of this Resolution to protect terrestrial services, at all positions, for a defined set of altitude ranges. The methodology derives the *Pj*taking into account the relevant loss and attenuation in the geometry considered.

The methodology then compares the computed *Pj* with the range of notified power for A‑ESIM emission. The minimum and the maximum power *Pmin\_emission,j* and *Pmax\_emission,j* of the A‑ESIM are calculated from the data included in the Appendix **4** Notification information of non-GSO satellite system with which the ESIM communicates and from the A‑ESIM characteristics,.

A‑ESIM should be evaluated over a number of predefined altitude ranges in order to establish a number of *Pj* levels.

An examination by the Bureau should apply this methodology for the defined altitude range, to determine whether the A‑ESIM operating under a given non-GSO satellite system complies with the pfd limits included in Part 2 of Annex 1 of this Resolution to protect terrestrial services.

1.2 Input parameters

Considering a hypothetical non-GSO satellite system, Table 1 below provides an example of emissions that are included in one Group associated to the “UO” class of earth station transmitting in the 27.5-29.5 GHz band. Tables 2 and 3 provide additional assumptions and Figure 1 illustrates the geometry involved in the examination ..

TABLE 1

Example of a Group of applicable A-ESIM emissions
(with reference to relevant RR Appendix 4 data fields)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Emission No. | C.7.aDesignation of emission | *BWemission*MHz | C.8.c.3minimum power density dB(W/Hz) | C.8.a.2/C.8.b.2Maximum power density dB(W/Hz) |
| 1 | 6M00G7W-- | 6.0 | −69.7 | −66.0 |
| 2 | 6M00G7W-- | 6.0 | −64.7 | −61.0 |
| 3 | 6M00G7W-- | 6.0 | −59.7 | −56.0 |

TABLE 2

Additional example assumptions

| ID | Parameter | Notation | Value | Unit |
| --- | --- | --- | --- | --- |
| 1 | Frequency assignment | *f* | 29.5 | GHz |
| 2 | Reference bandwidth of pfd mask | *BWRef* | 1.0 or 14.0, depending on the altitude under examination | MHz |
| 3 | A‑ESIM antenna peak gain | *Gmax* | 37.5 | dBi |
| 4 | A‑ESIM antenna gain pattern | - | As per Rec. ITU-R S.580(see C.10.d.5.a.1) |

TABLE 3

Additional assumptions defined in the methodology

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Parameter | Notation | Value | Unit |
| 8 | A-ESIM minimum elevation angle towards non-GSO satellite | *ε* | 10 | degrees |
| 92) | Atmospheric attenuation | *Latm* | Computed with Rec. ITU‑R P.676 | dB |
| 10 | Angle of arrival of the incident wave on the Earth’s surface |  | Specified by the pre-established sets of pfd limits, variable from 0° to 90° | deg |
| 11 | Minimum examination altitude | *Hmin* | 0.01 | km |
| 12 | Maximum examination altitude | *Hmax* | 15 | km |
| 13 | Examination altitude spacing | *Hstep* | 1.0 | km |
| 14 | Fuselage attenuation | *Lf* | See Table 4 | dB |

NOTE: The atmospheric attenuation is computed with Recommendation ITU-R P.676, using the mean annual global reference atmosphere as defined in Recommendation ITU-R P.835.

Figure 1

Geometry for the examination of compliance for two different ESIM altitudes





TABLE 4

Fuselage attenuation model

|  |  |  |  |
| --- | --- | --- | --- |
| *Lfuse*(γ) = 3.5 + 0.25 ⸱ γ | dB | for | 0°≤ γ ≤ 10° |
| *Lfuse*(γ) =−2 + 0.79 ⸱ γ | dB | for | 10°< γ ≤ 34° |
| *Lfuse*(γ) = 3.75 + 0.625 ⸱ γ | dB | for | 34°< γ ≤ 50° |
| *Lfuse*(γ) = 35  | dB | for | 50°< γ ≤ 90° |

Note: This fuselage attenuation model is based on measurements made at 14.2 GHz (see Figure 3.6‑14 in Report ITU-R M.2221-0)

Table 5A and Table 5B are taken from Part 2 of Annex 1 of this Resolution. The reference bandwidth for the sets of pfd limits included in Table 5A and Table 5B are 1 MHz and 14 MHz, respectively.

Note: This example fuselage attenuation model from on Report ITU-R M.2221-0. [Additional models are being developed in WP 4A.]

TABLE 5A

Required conformance pfd mask for altitudes up to 3 km

 *pfd*(δ) = −136.2 (dB(W/(m2 ⋅ 1 MHz))) for 0° ≤ δ ≤ 0.01°

 *pfd*(δ) = −132.4 + 1.9 ∙ log δ (dB(W/(m2 ⋅ 1 MHz))) for 0.01° < δ ≤ 0.3°

 *pfd*(δ) = −127.7 + 11 ∙ log δ (dB(W/(m2 ⋅ 1 MHz))) for 0.3° < δ ≤ 1°

 *pfd*(δ) = −127.7 + 18 ∙ log δ (dB(W/(m2 ⋅ 1 MHz))) for 1° < δ ≤ 12.4°

 *pfd*(δ) = −108 (dB(W/(m2 ⋅ 1 MHz))) for 12.4° < δ ≤ 90°

TABLE 5B

Required conformance pfd mask for altitudes above 3 km

 *pfd*(δ) = −124.7 (dB(W/(m2 ⋅ 14 MHz))) for 0° ≤ δ ≤ 0.01°

 *pfd*(δ) = −120.9 + 1.9 ∙ log δ (dB(W/(m2 ⋅ 14 MHz))) for 0.01° < δ ≤ 0.3°

 *pfd*(δ) = −116.2 + 11 ∙ log δ (dB(W/(m2 ⋅ 14 MHz))) for 0.3° < δ ≤ 1°

 *pfd*(δ) = −116.2 + 18 ∙ log δ (dB(W/(m2 ⋅ 14 MHz))) for 1° < δ ≤ 2°

 *pfd*(δ) = −117.9 + 23.7 ∙ log δ (dB(W/(m2 ⋅ 14 MHz))) for 2° < δ ≤ 8°

 *pfd*(δ) = −96.5 (dB(W/(m2 ⋅ 14 MHz))) for 8° < δ ≤ 90.0°

**1.3 Calculation algorithm**

This section includes a step-by-step description of how the examination methodology would be implemented.

**START**

i) For each A-ESIM altitude, it is necessary to generate as many δ*n* angles (angle of arrival of the incident wave) as required in order to test the full compliance with the applicable set of pfd limits. The *N* angles δ*n* must be comprised between 0° and 90° and have a resolution compatible with the granularity of the pre-established pfd limits. Each of the angles δ*n* will correspond to as many *N* points on the ground.

ii) For each altitude *Hj*= *Hmin*, *Hmin*+ *Hstep*, …, *Hmax*,:

*a)* set the altitude of the A‑ESIM to *Hj*

*b)* compute the angle below the horizon γ*j,n* as seen from the A-ESIM for each of the *N* angles δ*n* generated in ii. using the following equation:

  (1)

 where is the mean earth radius.

*c)* Compute the distance *Dj,n*, in km, for *n*= 1, …, *N* between the A‑ESIM and the tested point on the ground:

  (2)

*d)* Compute the fuselage attenuation *Lf j,n* (dB) with *i* = 1, …, *N* applicable to each of the of the angles γ*j,n* computed in *b)* above

*e)* Compute the gaseous absorption *Latm\_j,n* (dB) with *i*= 1, …, *N* applicable to each of the distances *Dj,n* computed in *c)* above, using the applicable sections of Recommendation ITU-R P.676

iii)

*a)* For each altitude *Hj*= *Hmin*, *Hmin*+ *Hstep*, …, *Hmax*, and each angle below the horizon γ*j,n*, compute the maximum emission power in the reference bandwidth *Pj,n*(δ*n*, γ*j,n*) for which the pfd limits are met using the following algorithm:



 With *Gtx*(γ*j,n* + ε) being the transmit antenna gain with the off-axis angle from the boresight, consisting of the summation of both angles γ*j,n* and minimum elevation angle ε of 10 degrees as defined in Table 3.

*b)* Compute the minimum *Pj* across all values calculated at the previous step,

 *Pj* = Min ()

 The output of this step is the maximum power in the reference bandwidth that can be used by the A-ESIM to ensure it complies with the pfd limits in Table 5A or Table 5B, as applicable, with respect to all angles δ*n* at the altitude *Hj*, and the elevation indicated in Table 3. There will be one *Pj* for each of the *Hj* altitudes considered.

The output is summarized in Table 7 below:

TABLE 7

Computed *EIRPC\_j* and *EIRPR\_j* values

| *Hj* | *Pj*(*Maximum power in the reference bandwidth that can be used at minimum elevation)* |
| --- | --- |
| (km) | dB(W/BW) |
| 0.01 | *TBD* |
| 1.0 | *TBD* |
| 2.0 | *TBD* |
| 2.99 | *TBD* |
| 4.0 | *TBD* |
| 5.0 | *TBD* |
| 6.0 | *TBD* |
| 7.0 | *TBD* |
| 8.0 | *TBD* |
| 9.0 | *TBD* |
| 10.0 | *TBD* |
| 11.0 | *TBD* |
| 12.0 | *TBD* |
| 13.0 | *TBD* |
| 14.0 | *TBD* |
| 15.0 | *TBD* |

*c)* For each altitude *Hj*= *Hmin*, *Hmin*+ *Hstep*, …, *Hmax*, and each of the emissions of the groups of emissions under examination, compute the minimum and the maximum powers of the emission in the reference bandwidth:

 

 

 For BW in Hz:

*BWRef* if *BWRef* =1 MHz

*BWRef* if *BWRef* =14 MHz & *BWemission* >= *BWRef*

*BWemission* if *BWRef* =14 MHz & *BWemission* < *BWRef*

*d)* For each of the emissions of the groups of emissions under examination, check if there is at least one altitude *Hj* for which:

 

iv) For each of the groups, check whether there is at least one *j)* for which *EIRPC*\_*j* > *EIRPJ*. The results of this check are illustrated in Table 8 below.

TABLE 8

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**Example comparison between *Pj* and (*P*min\_*emission,j*; *P*max\_*emission,j*)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Emission n.** | **C.7.aDesignation of emission** | ***BWemission*MHz** | **C.8.c.3minimum power density dB(W/Hz)** | **C.8.a.2/C.8.b.2Maximum power density dB(W/Hz)** | **Lowest altitude *Hj* (km) for which *P*max\_*emission,j >Pj>  P*min\_*emission,j*** |
| 1 | 6M00G7W-- | 6.0 | −69.7 | −66.0 | TBD |
| 2 | 6M00G7W-- | 6.0 | −64.7 | −61.0 | TBD |
| 3 | 6M00G7W-- | 6.0 | −59.7 | −56.0 | TBD |

*e)* Based on the test detailed in iii) d) above, which applies to all emissions of the group of emissions under examination, the results of the Bureau’s examination for that group is favourable, after removing emissions that have failed the examination, otherwise it is unfavourable (i.e. all emissions have failed the test).

iv) The output of this methodology should, at a minimum, include:

– those resulting parameters as contained in Table 7;

– the examination results for each group;

For cases where some emissions successfully passed the test and some do not, the test results for the new group includes only those emission(s) which successfully passed the test;

**END**

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Annex 3 to draft new Resolution [A116] (WRC‑23)

Provisions for non-GSO FSS systems[[1]](#footnote-1)1 transmitting to aeronautical and/or maritime ESIMs operating in or over an ocean in the frequency bands
18.3-18.6 GHz and 18.8-19.1 GHz with respect to EESS (passive)
operating in the frequency band 18.6-18.8 GHz
(in accordance with *resolves*1.1.6)

Option 1:

Non-GSO fixed-satellite space stations operating with an orbit apogee less than 20 000 km in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz with an aeronautical or maritime ESIM shall not exceed a pfd produced at the surface of the oceans across the 200 MHz of the frequency band 18.6-18.8 GHz, of −123 dB(W/(m² ∙ 200 MHz)). This value can be exceeded provided that the non-GSO fixed-satellite system does not exceed a pfd across the 200 MHz of the frequency band 18.6-18.8 GHz of −137 dB(W/(m² ∙ 200 MHz)) averaged over an area of 10 000 000 km² at the surface of the oceans.

 Option 3:

Any non-GSO fixed satellite space station operating in the frequency bands 18.3-18.6 GHz and 18.8-19.1 GHz with (i) an orbit apogee less than 20 000 km (ii) communicating with an aeronautical or maritime ESIM over the ocean, and (iii) for which complete notification information has been received by the Radiocommunication Bureau after 1 January 2025, shall not exceed an unwanted emission power flux-density produced at the surface of the ocean in the 18.6-18.8 GHz band, based on the following piecewise equation:

|  |  |  |
| --- | --- | --- |
| *for N ≥ 10:* | *pfd* = *min*(−77 − 10 \* log(*S*), −110) | dB(W/(m² · 200 MHz)) |
| *for N < 10:* | *pfd* = *min*(−67 − 10 \* log(*S*) − 10 \* log(*N*), −110) | dB(W/(m² · 200 MHz)) |

 where *S* is the non-GSO fixed satellite space station 3 dB beam footprint area on the ground expressed in km² and *N* is the maximum number of co-frequency beams generated by the non-GSO fixed satellite system within a 10 000 000 km2 square on the Earth.

NOTE: Annex 4 was not discussed in detail during CPM23-2

Annex 4 to draft new Resolution [A116] (WRC‑23)

Required ESIM capabilities

ESIM shall be designed with the following minimum capabilities:

In order to enable the ESIM to cease transmission when the conditions described are met, it is required the ESIM network be designed with appropriate capabilities. Table A5.1 describes applicable capabilities, with a justification for their requirement.

It is also important to note that the NCMC has a database of allowed power spectral density limits per angles (azimuth, elevation and skew), altitude and attitude that are critical to ensure pfd limits are met. The NCMC draws upon this comprehensive and detailed database of allowed levels and continually monitors feedback from the terminal to ensure emissions are fully compliant with regulatory limits.

For each ESIM, the NCMC should have a record of the location, the latitude, longitude and altitude, the transmit frequency, channel bandwidth and non-GSO satellite system with which the non-GSO ESIM communicates. This data can be made available to an administration or authorized agency for the purposes of detecting and resolving interference events.

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Table a4-1

Minimum ESIM capabilities and justification

| Capability | Justification |
| --- | --- |
| GNSS (or other geolocation capabilities) | To assess the ESIM’s geographic location so the ESIM is aware when entering an administration’s territory that has not given authorization and feedback to software to cease transmissions accordingly. |
|  |  |
|  |  |
| Monitor and control of the transmission frequency | To anticipate an error in transmission frequency, which could potentially lead to interference out of assigned transmission band. |
| Internal power off/on/reset | Required for the ESIM to have the ability to self-power down after experiencing a fault condition, then restart or power back on when fault is resolved. |
| Disable/enable transmission and level adjustment | To cease, adjust and re-enable transmissions as necessary to mitigate interference or unauthorized transmissions. |
| Receive and execute commands from NCMC | To receive commands to enable/disable transmission from NCMC or other commands as necessary to mitigate interference or unauthorized transmissions. |

Furthermore, it is recommended the ESIM have the ability to enter the states described in Table A4‑2. These states ensure the ESIM is in the correct radio-interface state after some event (such as an initial boot or resuming operations after a fault) and can test system functionality is correct before radiating to avoid any transmission errors.

Table A4-2

ESIM states and events

|  |  |  |
| --- | --- | --- |
| ESIM state | Radio-interface state | Corresponding event |
| Non-valid | Emissions disabled | After power-on, until ESIM can receive commands from NCMC and no-fault conditions are presentAfter any failure/faultDuring system checks |
| Initial phase | Emissions disabled | When waiting for a transmission enable or disable command from NCMC |
| Transmission enabled | Carrier-off | No carrier transmitted/need for carrier to be transmittedReceive synchronization is lostPointing threshold is exceeded |
| Carrier-on | During transmission and ESIM is correctly pointed |
| Transmission disabled | Emissions disabled | When commanded by NCMC or ESIM automatically enters based on a “Cease Transmission” conditionIn locations where transmission is not permitted |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. 1 These provisions do not apply to non-GSO systems using orbits with an apogee less than 2 000 km that employ a frequency reuse factor of at least three. [↑](#footnote-ref-1)