

## RESOLUTION 121 (WRC-23)

**Use of the frequency band 12.75-13.25 GHz by earth stations in motion  
on aircraft and vessels communicating with geostationary  
space stations in the fixed-satellite service**

The World Radiocommunication Conference (Dubai, 2023),

*considering*

- a)* that WARC Orb-88 established an Allotment Plan for the use of the frequency bands 4 500-4 800 MHz, 6 725-7 025 MHz, 10.70-10.95 GHz, 11.20-11.45 GHz and 12.75-13.25 GHz by the fixed-satellite service (FSS);
- b)* that WRC-07 revised the regulatory regime governing the use of the frequency bands referred to in *considering a)* above;
- c)* that the objective of providing broadband mobile-satellite communications may also be met by allowing earth stations in motion (ESIMs), on aircraft (A-ESIMs) and vessels (M-ESIMs), to communicate with geostationary space stations of an FSS network in the frequency bands 12.75-13.25 GHz (Earth-to-space) and the associated downlink frequency bands of that satellite; thus, for example, the frequency bands 10.70-10.95 GHz and 11.20-11.45 GHz of Appendix **30B** may be used;
- d)* that the frequency band 12.75-13.25 GHz is currently allocated on a primary basis to the FSS (Earth-to-space), fixed and mobile services and on a secondary basis to the space research service (space-to-Earth);
- e)* that the operation of services to which the frequency band 12.75-13.25 GHz is allocated and of services in adjacent bands needs to be protected from A-ESIMs and M-ESIMs;
- f)* that the frequency band 12.75-13.25 GHz (Earth-to-space) is used in the geostationary-satellite orbit (GSO) by FSS networks in accordance with the provisions of Appendix **30B** (No. **5.441**) and that there are many existing GSO FSS satellite networks operating in that frequency band;
- g)* that the objective of the procedures in Appendix **30B** is to guarantee, for all countries, equitable access to the GSO in the frequency bands of the FSS covered by that Appendix;
- h)* that regulatory provisions and interference-management mechanisms, including necessary mitigation measures and associated techniques, are required for the operation of A-ESIMs and M-ESIMs in the frequency band 12.75-13.25 GHz (Earth-to-space) to protect other services with allocations in that frequency band and adjacent frequency bands and without adversely affecting those services and their future development, taking into account the provisions of Appendix **30B** (see also *further resolves 2* on responsibilities);

i) that, in Appendix **30B**, the frequency bands in the space-to-Earth direction corresponding to the frequency band 12.75-13.25 GHz (Earth-to-space) are 10.70-10.95 GHz and 11.20-11.45 GHz, which may be used by A-ESIMs and M-ESIMs, subject to not claiming protection from other services and applications of the FSS and other radiocommunication services to which the frequency band is allocated;

j) that there is no publicly available information on coordination agreements reached among administrations regarding GSO FSS satellite networks, except on whether coordination has been completed, which is provided to the Radiocommunication Bureau;

k) that the operation of A-ESIMs and M-ESIMs requires the establishment of one or more gateway earth station facilities in one or several countries that are within the service area of the associated satellite network and that are authorized by the administration of the territory where such earth stations are located,

*considering further*

a) that A-ESIMs and M-ESIMs operating within the agreed service area of the satellite network with which they communicate may provide services within the territories under the jurisdiction of multiple administrations;

b) that the operation of ESIMs within the territory under the jurisdiction of administrations mentioned in *considering further a)* above is subject to obtaining authorization from those administrations,

*recognizing*

a) that Article 44 of the ITU Constitution contains the basic principles for the use of the radio-frequency spectrum and the GSO and other satellite orbits, taking into account the needs of developing countries;

b) that administrations intending to authorize A-ESIMs and M-ESIMs, when establishing national licensing rules, may consider adopting other interference management procedures and/or mitigation measures than those contained in this Resolution, as long as the provisions in Annex 2 are unchanged in cross border applications;

c) that, pursuant to the relevant provisions in Appendix **30B**, the operation of ESIMs in the frequency band 12.75-13.25 GHz may only be within the service area of the Appendix **30B** network for which the explicit agreement of any administration whose territory is partially or wholly included in that service area has been obtained;

d) that § 6.16 of Article 6 of Appendix **30B** provides the opportunity to any administration at any time to request that its territory be excluded from the service area of any assignment governed by Appendix **30B**;

e) that the operation of an A-ESIM or M-ESIM associated and communicating with a space station of a given satellite network needs the earth station to be within the coordinated and agreed service area of the satellite network under the relevant provisions of Appendix **30B**;

*f)* that, based on the available information in the Bureau's database in May 2022, there is no contiguous regional or worldwide coordinated and agreed service area for any satellite network using the Appendix **30B** frequency band 12.75-13.25 GHz recorded in the Master International Frequency Register (MIFR);

*g)* that, in order for A-ESIMs and M-ESIMs to operate in the Appendix **30B** frequency band 12.75-13.25 GHz (Earth-to-space) in an efficient and operationally viable manner, having a contiguous regional or worldwide coordinated and agreed service area is an important issue to be taken into account;

*h)* that the administration authorizing ESIMs on the territory under its jurisdiction has the right to require that the ESIMs referred to above only use those assignments associated with GSO FSS networks which have been successfully coordinated, notified, brought into use and recorded in the MIFR with a favourable finding under § 8.11 of Article 8 of Appendix **30B**, except those arising from the application of § 6.25 of Appendix **30B**;

*i)* that Resolution **170 (Rev.WRC-23)** provides the procedure to enhance equitable access to frequency bands under Appendix **30B** by developing countries;

*j)* that the protection of current usage and future development of Appendix **30B** in the frequency band 12.75-13.25 GHz (Earth-to-space) is a fundamental issue without any adverse effect thereto;

*k)* that the availability of the methodology to examine conformity with the power flux-density (pfd) limits as contained in Annex 2 to this Resolution is a fundamental and crucial element;

*l)* that there is a need to establish regulatory, technical and recording procedures for the usage of these types of ESIM that may differ from the current FSS Appendix **30B** Plan and List recording procedures;

*m)* that successful implementation of this Resolution does not oblige any administration to authorize/license A-ESIMs and M-ESIMs communicating with GSO space stations in the FSS in the frequency band 12.75-13.25 GHz (Earth-to-space) to operate on the territory under its jurisdiction (see *resolves 7*);

*n)* that, in accordance with Appendix **30B**, the examination by the Bureau of the frequency assignments in the frequency band 12.75-13.25 GHz (Earth-to-space) is limited to the test-points on land; it is necessary to examine the compatibility of A-ESIMs and M-ESIMs using grid points generated within the entire service area of A-ESIMs and M-ESIMs submitted under Appendix **4** (see Annex 1 to this Resolution);

*o)* that any administration retains its right to regulate and exercise its authority within its jurisdiction, recalling the Preamble to the Constitution,

*recognizing further*

*a)* that, under *resolves 1.1.4* below, frequency assignments to GSO A-ESIMs and M-ESIMs need to be notified to the Bureau;

*b)* that, for the operation of GSO A-ESIMs and M-ESIMs, notification of any frequency assignment under Annex 1 to this Resolution shall only be made by one single administration, which is the notifying administration for the GSO FSS network with which the ESIMs communicate;

- c) that an administration authorizing the operation of GSO A-ESIMs and M-ESIMs within the territory under its jurisdiction may modify and/or withdraw that authorization at any time;
- d) that the three elements consisting of the interference management mechanism, switching facility for on/off function and the function of the network control and monitoring centre (NCMC) and their relations with each other and sequence of actions, together with estimated time for that action/function, are needed for the proper and effective operation of GSO A-ESIMs and M-ESIMs;
- e) that the operation of A-ESIMs and M-ESIMs shall comply with the provisions of No. **5.340**;
- f) that, when the Appendix **30B** GSO FSS satellite network with which A-ESIMs and M-ESIMs communicate transmits in the frequency bands 10.70-10.95 GHz and 11.20-11.45 GHz, it shall operate under the levels that were coordinated and included in the List, and that these Appendix **30B** satellite transmissions shall not change to accommodate A-ESIMs and M-ESIMs,

*resolves*

1 that, for any A-ESIM or M-ESIM communicating with a GSO FSS space station within the frequency band 12.75-13.25 GHz (Earth-to-space) or parts thereof, the following conditions shall apply:

- 1.1 with respect to space services in the frequency band 12.75-13.25 GHz and adjacent bands, A-ESIMs and M-ESIMs shall comply with the following conditions:
  - 1.1.1 the use of the frequency band 12.75-13.25 GHz (Earth-to-space) by A-ESIMs and M-ESIMs shall not result in any changes or restrictions to allotments in the Plan, assignments in the List of Appendix **30B**, and assignments recorded in the MIFR, including the assignments arising from the implementation of Resolution **170 (Rev.WRC-23)**;
  - 1.1.2 with respect to satellite networks of other administrations, the characteristics of A-ESIMs and M-ESIMs shall remain within the envelope of typical characteristics of notified earth stations associated with the satellite networks with which these earth stations communicate, as published by the Bureau and included in its relevant International Frequency Information Circular (BR IFIC), and Annex 1 to this Resolution applies;
  - 1.1.3 the use of A-ESIMs and M-ESIMs shall not cause any interference to Appendix **30B** allotments, assignments received by the Bureau under Article 6 either in process or yet to be processed, assignments in the List, assignments notified under Article 8 of that Appendix, and assignments recorded in the MIFR, as well as submissions under Appendix **30B**, beyond that specified in the relevant Annexes to that Appendix;
  - 1.1.4 for the implementation of *resolves* 1.1.1, 1.1.2 and 1.1.3 above, the notifying administration for the GSO FSS network with which the above-mentioned A-ESIMs and M-ESIMs communicate shall follow the procedure in Annex 1 to this Resolution, together with the commitment that the operation of ESIMs shall be in conformity with the Radio Regulations, including this Resolution;

- 1.1.5 upon receipt of the notification information referred to in *resolves* 1.1.4 above, the Bureau shall process the submission in accordance with Annex 1 to this Resolution;
- 1.1.6 for the protection of non-GSO FSS systems operating in the frequency band 12.75-13.25 GHz, the above-mentioned A-ESIMs and M-ESIMs communicating with GSO FSS networks referred to above shall comply with the provisions contained in Annex 3 to this Resolution;
- 1.1.7 the notifying administration for the GSO FSS network with which the above-mentioned A-ESIMs and M-ESIMs communicate shall ensure that the operation of the A-ESIMs and M-ESIMs complies with the coordination agreements for the frequency assignments to the earth station of that GSO FSS satellite network of Appendix **30B** obtained under the relevant provisions of that Appendix;
- 1.1.8 the receiving part of the above-mentioned A-ESIMs and M-ESIMs in their associated frequency band shall not adversely affect the allotments in the Plan or the assignments in the List and shall not claim protection from other applications of the FSS or other radiocommunication services to which the frequency band is allocated;
- 1.2 with respect to the protection of terrestrial services to which the frequency band 12.75-13.25 GHz is allocated and that operate in accordance with the Radio Regulations, A-ESIMs and M-ESIMs shall comply with the following conditions:
  - 1.2.1 transmitting GSO A-ESIMs and M-ESIMs in the frequency band 12.75-13.25 GHz (Earth-to-space) shall not cause unacceptable interference to terrestrial services to which that frequency band is allocated and that operate in accordance with the Radio Regulations, and Annex 2 to this Resolution shall apply;
  - 1.2.2 the receiving part of the above-mentioned GSO A-ESIMs and M-ESIMs operating in the frequency bands mentioned in *recognizing further f)* shall not claim protection from terrestrial services to which those frequency bands are allocated and that are operating in accordance with the Radio Regulations;
  - 1.2.3 the requirement not to cause unacceptable interference to terrestrial services to which the frequency band 12.75-13.25 GHz is allocated and that operate in accordance with the Radio Regulations shall be respected, irrespective of compliance with Annex 2 (see *further resolves 7)*;
  - 1.2.4 for the application of Part II of Annex 2 as referred to in *resolves* 1.2.1 above, the Bureau shall examine the characteristics of A-ESIMs with respect to conformity with the pfd limits at any point on the Earth's surface specified in Part II of Annex 2, in accordance with the methodology described in Annex 4 to this Resolution, and publish the results of such examination in the BR IFIC; in the event of non-compliance with the pfd limits set out in Part II of Annex 2, the Bureau shall formulate an unfavourable finding and return the notice to the notifying administration;
  - 1.2.5 if an administration authorizing A-ESIMs agrees to pfd levels higher than the limits contained in Part II of Annex 2 within the territory under its jurisdiction, such agreement shall in no way affect other administrations that are not party to that agreement;

1.3 A-ESIMs and M-ESIMs communicating with GSO FSS networks shall not cause unacceptable interference to the aeronautical radionavigation service (ARNS) operating in accordance with the Radio Regulations in the frequency band 13.25-13.40 GHz;

2 that only frequency assignments of Appendix **30B** recorded in the List may be used as supporting assignments for A-ESIMs and M-ESIMs communicating with GSO FSS networks in the frequency band 12.75-13.25 GHz (Earth-to-space), if those assignments are recorded in the MIFR with a favourable finding under § 8.11 of Article 8 of Appendix **30B**;

2.1 if assignments to GSO FSS networks notified under § 6.25 of Appendix **30B** are used for the operation of the above-mentioned A-ESIMs and M-ESIMs, those assignments may be used for GSO A-ESIMs and M-ESIMs only in accordance with §§ 6.26 and 6.29 of Appendix **30B**;

2.2 for the implementation of *resolves* 2.1 above, the notifying administration for the GSO FSS network with which GSO A-ESIMs and M-ESIMs communicate shall send the Bureau a commitment that the operation shall be in conformity with *resolves* 2.1 and *further resolves* 2, 2.1 and 2.2 below;

3 that the operation of A-ESIMs and M-ESIMs communicating with GSO FSS space stations in the frequency band 12.75-13.25 GHz (Earth-to-space) shall be within the coordinated and notified service area of the GSO FSS network;

4 that, for the implementation of *resolves* 3 above, the notifying administration for the GSO FSS network with which the A-ESIMs and M-ESIMs communicate shall ensure that the necessary arrangements and switching facilities are built into the A-ESIMs and M-ESIMs to cease emissions once approaching the territory under the jurisdiction of those administrations which either are not within the notified and coordinated service area of the subject space station or have not authorized operation over their territories;

5 that any course of action taken under this Resolution have no impact on the original date of receipt of the frequency assignments of the GSO FSS satellite network with which A-ESIMs and M-ESIMs communicate, or on the coordination requirements of that satellite network;

6 that A-ESIMs and M-ESIMs shall not be used or relied upon for safety-of-life applications;

7 that the operation of A-ESIMs and M-ESIMs within territorial waters and/or airspace under the jurisdiction of another administration shall be carried out only if a licence under No. **18.1**, or the authorization of that administration, is obtained;

8 that gateway earth station facilities for A-ESIMs and M-ESIMs shall be within the service area of the satellite network associated with that gateway;

9 that, in the event that unacceptable interference caused by A-ESIMs and/or M-ESIMs is reported:

9.1 the notifying administration for the GSO FSS network with which the A-ESIMs and M-ESIMs communicate be responsible for eliminating the case of unacceptable interference; consequently, no other administration shall be held responsible for eliminating cases of unacceptable interference (see also *resolves* 9.2 below);

9.2 any authorizing administration, subject to its explicit agreement and to the extent of its ability, provide any available information that may help eliminate the case of unacceptable interference;

9.3 the administration responsible for the aircraft or vessel on which an ESIM operates shall provide, when requested, the affected administration with a point of contact to assist in identifying the notifying administration for the satellite with which the ESIM communicates, which is responsible for eliminating the case of unacceptable interference (see *resolves* 9.1 and 9.2);

10 that the notifying administration for the GSO FSS satellite network with which the GSO A-ESIMs and M-ESIMs communicate shall ensure that:

10.1 A-ESIMs and M-ESIMs employ the minimum requirements specified in Annex 5 to this Resolution;

10.2 for the operation of A-ESIMs and M-ESIMs, techniques are employed to maintain adequate pointing accuracy of the antenna towards the associated GSO FSS satellite to avoid inadvertently tracking an adjacent GSO satellite;

10.3 all necessary measures shall be taken so that A-ESIMs and M-ESIMs are subject to permanent monitoring and control by an NCMC or equivalent facility in order to comply with the provisions of this Resolution, and are capable of receiving and immediately acting upon, *inter alia*, “enable transmission” and “disable transmission” commands from the NCMC;

10.4 measures are taken so that the A-ESIMs and/or M-ESIMs do not transmit on territory under the jurisdiction of an administration, including its territorial waters and national airspace, that either is not in the coordinated and notified service area of the GSO satellite network or has not authorized their use on its territory;

10.5 a permanent point of contact shall be provided in the Appendix 4 submission under Annex 1 of this Resolution and published in the special section by the notifying administration for the GSO FSS network for the purpose of tracing any suspected cases of unacceptable interference from A-ESIMs and M-ESIMs and to immediately respond to such requests;

11 that the operation of GSO A-ESIMs and M-ESIMs, including operation of the NCMC, interference management system, and mechanism and functioning of switching facilities, be subject to the availability of the ITU-R Recommendation referred to in *invites the ITU Radiocommunication Sector* below, with the understanding that, in the meantime, *further resolves* 2, 2.1 and 2.2 strictly apply;

12 that the operation of GSO A-ESIMs and M-ESIMs under frequency assignments recorded under § 6.25 of Appendix **30B**, including operation of the NCMC, interference management system, and mechanism and functioning of switching facilities, be subject to the availability of the ITU-R Recommendation referred to in *invites the ITU Radiocommunication Sector* below, with the understanding that, in the meantime, *further resolves* 2, 2.1 and 2.2 strictly apply,

*further resolves*

1 that compliance with this Resolution in no way whatsoever release the notifying administration(s) from its/their obligation not to cause unacceptable interference to, or claim protection from, the incumbent services as referred to in this Resolution;

2 that the notifying administration for the GSO network, when submitting Appendix 4 information/data elements, shall send a firm, objective, actionable, measurable and enforceable commitment that, in the event of unacceptable interference being reported, it undertakes to immediately eliminate the interference or reduce it to an acceptable level;

2.1 in case of no action being taken with regard to the obligation referred to in *further resolves* 2 above, the Bureau shall send a reminder and request the notifying administration for the GSO network to comply with the requirements referred to in the commitment;

2.2 should the interference persist 30 days after the dispatch date of the above-mentioned reminder, the Bureau shall submit the case to the subsequent meeting of the Radio Regulations Board (RRB) for review and necessary actions (including suppression of the frequency assignment to the ESIM concerned), as appropriate;

3 that frequency assignments in the frequency band 12.75-13.25 GHz (Earth-to-space) used by A-ESIMs and M-ESIMs communicating with geostationary space stations in the FSS shall be notified to the Bureau under Annex 1 to this Resolution by the notifying administration for the satellite network with which the ESIMs communicate;

4 that the notifying administration for the satellite network shall ensure that A-ESIMs and M-ESIMs operate only in the territory under the jurisdiction of administrations from which authorization has been obtained, taking into account *recognizing further c)* above;

5 that, in accordance with *instructs the Director of the Radiocommunication Bureau* 4 below, the notifying administration for the Appendix **30B** FSS satellite network operating A-ESIMs and M-ESIMs, upon request by the Bureau regarding cases of unacceptable interference reported by affected administrations, shall provide the Bureau with the list of administrations that have authorized ESIM operations to communicate with that satellite network and that are potentially related to a reported case of unacceptable interference;

6 that, for the implementation of *further resolves* 2, the notifying administration responsible for the operation of GSO A-ESIMs and M-ESIMs shall also be responsible for observing and complying with all relevant regulatory and administrative provisions applicable to the operation of the above-mentioned GSO A-ESIMs and M-ESIMs, as contained in this Resolution and in the Radio Regulations;

7 that the authorization for a GSO A-ESIM or M-ESIM to operate in the territory under the jurisdiction of an administration shall in no way release the notifying administration for the satellite network with which the ESIM communicates from the obligation to comply with the provisions contained in this Resolution and in the Radio Regulations,

*instructs the Director of the Radiocommunication Bureau*

1 to take all necessary actions to facilitate the implementation of this Resolution;

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



3 to accelerate, to the maximum extent possible, the development and availability of the software required for implementation of the methodology contained in Annex 4 to this Resolution to examine compliance with the pfd limits in Part II of Annex 2 to this Resolution;

4 in the event of unacceptable interference:

4.1 based on information provided by the affected administration, to request the notifying administrations for satellite networks communicating with A-ESIMs and M-ESIMs that could potentially be causing unacceptable interference to promptly provide the relevant list of administrations that have authorized such ESIM operations to the affected administration;

4.2 to provide the affected administration with the list of networks potentially related to the reported case of unacceptable interference;

4.3 if a notifying administration fails to provide the information required under *instructs the Director of the Radiocommunication Bureau* 4.1 above within 45 days from the date of dispatch of the Bureau's request referred to in *instructs the Director of the Radiocommunication Bureau* 4.1, to send the notifying administration a reminder to provide the required list within 15 days from the date of that reminder;

4.4 if a notifying administration fails to provide the required information following the reminder under *instructs the Director of the Radiocommunication Bureau* 4.3 above and if the affected administration has not confirmed to the Bureau that the case of unacceptable interference has been resolved, to submit the case to the subsequent meeting of RRB for review and the necessary actions, as appropriate,

*invites the ITU Radiocommunication Sector*

to study, as a matter of urgency, with the objective of preparing a Recommendation to be adopted and approved in accordance with Resolution ITU-R 1, the functionalities and implementation of NCMC for ESIMs,

*instructs the Secretary-General*

1 to bring this Resolution to the attention of the International Maritime Organization and the International Civil Aviation Organization;

2 to bring this Resolution to the attention of the ITU Council with a view to its considering whether cost recovery should be applied to GSO A-ESIMs and M-ESIMs.

## ANNEX 1 TO RESOLUTION 121 (WRC-23)

## PART I

**Procedure to be followed by the administrations and the Bureau for submission of the earth stations in motion on aircraft and vessels operating in the frequency band 12.75-13.25 GHz (Earth-to-space) and for the protection of allotments in the Plan, assignments in the Appendix 30B List and those submitted under Articles 6 and 7 of Appendix 30B as well as under Resolution 170 (Rev.WRC-23)**

**Section A – Procedure for entering assignments to earth stations in motion on aircraft and vessels in the Appendix 30B ESIM List<sup>1</sup>**

1 When an administration, or one acting on behalf of a group of named administrations, intends to use as a supporting frequency assignment one or more Appendix **30B** assignments already included in the List and the Master international Frequency Register (MIFR) in support of the operation of earth stations in motion on aircraft (A-ESIMs) and earth stations in motion on vessels (M-ESIMs) in the frequency band 12.75-13.25 GHz, it shall send to the Radiocommunication Bureau, not earlier than eight years but preferably not later than two years before the operation of A-ESIMs and M-ESIMs, the information specified in Appendix **42**.

An assignment in the Appendix **30B** ESIM List shall lapse if it is not brought into use within eight years of the date of receipt by the Bureau of the relevant complete information specified above. A proposed assignment not included in the Appendix **30B** ESIM List within eight years after the date of receipt by the Bureau of the relevant complete information shall also lapse.

2 If the information received by the Bureau under § 1 is found to be incomplete, the Bureau shall immediately seek any clarification required and information not provided from the administration concerned.

3 Upon receipt of a complete notice under § 1, the Bureau shall examine it with respect to its conformity with:

- a) the Table of Frequency Allocations and other provisions<sup>3</sup> of the Radio Regulations, except those provisions relating to conformity with the FSS Plan and the coordination procedures;

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<sup>1</sup> The List of assignments for earth stations in motion (ESIMs) in the frequency band 12.75-13.25 GHz in Appendix **30B**.

<sup>2</sup> Submissions may include only the frequency band 12.75-13.0 GHz or 13.0-13.25 GHz.

<sup>3</sup> The “other provisions” shall be identified and included in the Rules of Procedure.

- b) Annex 3 to Appendix **30B**;
- c) the on-axis equivalent isotropically radiated power (e.i.r.p.) density and off-axis e.i.r.p. density of the supporting Appendix **30B** assignment(s);
- d) the service area of the supporting Appendix **30B** assignment(s) in respect of explicit agreements of those administrations whose territories are included in the service area<sup>4</sup>; and
- e) the frequency band of the supporting Appendix **30B** assignment(s) in the List in the frequency band 12.75-13.25 GHz.

4 When the examination with respect to § 3 leads to an unfavourable finding, the relevant part of the notice shall be returned to the notifying administration with an indication of the appropriate action.

5 When the examination with respect to § 3 leads to a favourable finding, the Bureau shall use the method of Annex 4 to Appendix **30B** (see § 23) to determine administrations whose:

- a) allotments in the Plan;
- b) assignments which appear in the List; or
- c) assignments which the Bureau has previously examined under § 6.5 of Article 6 of Appendix **30B** after receiving complete information in accordance with § 6.1 of that Article

are considered as being affected and receiving more interference than that produced by the supporting Appendix **30B** assignment(s).

6 The Bureau shall publish, in a special section of its International Frequency Information Circular (BR IFIC), the complete information received under § 1, and examined under § 5, together with the names of the affected administrations, the corresponding allotments in the Plan, assignments in the List and assignments for which the Bureau has previously received complete information in accordance with § 6.1 of Article 6 of Appendix **30B** and which it has examined under § 6.5 of that Article.

7 The Bureau shall immediately inform the administration proposing the assignment in the Appendix **30B** ESIM List, drawing its attention to the information contained in the relevant BR IFIC and the requirement to seek and obtain the agreement of those affected administrations.

8 The Bureau shall also inform each administration listed in the special section of the BR IFIC published under § 6, drawing its attention to the information it contains.

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<sup>4</sup> The service area may be reduced by excluding certain countries for which explicit agreement was obtained.

9 An administration that has not notified its comments either to the administration seeking agreement or to the Bureau within a period of four months following the date of the BR IFIC referred to in § 6 shall be deemed to have not agreed to the proposed assignment in respect of its allotment in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, Article 7 request transferred to Article 6, submission in accordance with Resolution **170 (Rev.WRC-23)**, as appropriate, where the absence of reply/comments shall be construed as its disagreement to the request for coordination. This time-limit shall be extended for an administration that has requested the assistance of the Bureau by up to 30 days following the date on which the Bureau communicated the result of its action. In respect of its frequency assignments under Article 6 of Appendix **30B** other than those mentioned above, the same course of action outlined in § 6.10 of that Article shall apply.

10 Unless coordination is no longer required, the administration responsible for the notice published under § 6 shall seek and obtain the explicit agreement of the relevant affected administrations contained in the special section published under § 6 in respect of allotments in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, an Article 7 request transferred to Article 6, a submission in accordance with Resolution **170 (Rev.WRC-23)**, as appropriate. In this specific case of explicit agreement, any request for the assistance of the Bureau shall not change it to implicit/tacit agreement.

11 If agreements have been reached in accordance with §§ 9 and 10 with administrations published under § 6, the administration responsible for the notice published under § 6 may request the Bureau to have the assignment entered into the Appendix **30B** ESIM List, indicating the final characteristics of the notice<sup>5</sup> together with the names of the administrations with which agreement has been reached.

12 In submitting such information, noting the requirement of § 1 of Section B, the administration may also request the Bureau to examine the submission in respect of notification under Section B.

13 If the information received by the Bureau under §§ 11 and 12 is found to be incomplete, the Bureau shall immediately seek any clarification required and information not provided from the administration concerned. The Bureau may also provide additional information in order to assist the notifying administration in complying with requirements under §§ 14, 16 and 17.

14 Upon receipt of a complete notice under § 11, the Bureau shall examine each assignment in the notice with respect to its conformity with:

- a) the Table of Frequency Allocations and other provisions<sup>6</sup> of the Radio Regulations, except those provisions relating to conformity with the FSS Plan and the procedures for coordination;
- b) Annex 3 to Appendix **30B**;
- c) the service area published under § 6;

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<sup>5</sup> Submissions may include only the frequency band 12.75-13.0 GHz or 13.0-13.25 GHz.

<sup>6</sup> The “other provisions” shall be identified and included in the Rules of Procedure.

- d) the on-axis e.i.r.p. density and off-axis e.i.r.p. density of the assignments published under § 6; and
- e) the frequency band of the assignments published under § 6.

15 When the examination with respect to § 14 of an assignment received under § 11 leads to an unfavourable finding, the notice shall be returned to the notifying administration with an indication that subsequent resubmission under § 11 will be considered with a new date of receipt.

16 When the examination with respect to § 14 of an assignment received under § 11 leads to a favourable finding, the Bureau shall use the method described in Annex 4 to Appendix **30B** to examine if there is any administration and corresponding:

- a) allotment in the Plan;
- b) assignment which appears in the List at the date of receipt of the examined notice submitted under § 1;
- c) assignments which the Bureau has previously examined under § 6.5 of Article 6 of Appendix **30B** after receiving complete information in accordance with § 6.1 of that Article at the date of receipt of the examined notice submitted under § 17,

considered as being affected and receiving more interference than that produced by the supporting Appendix **30B** assignment(s) and whose agreement has not been provided under § 11.

17 The Bureau shall determine if the cumulative interference is caused to an allotment in the Plan or an assignment in the List or an assignment for which the Bureau has received complete information in accordance with Article 6 of Appendix **30B** before the date of receipt of the complete notice under § 11. The cumulative interference shall be calculated based on Appendix 1 to Annex 4 of Appendix **30B**, taking into account assignments in the Appendix **30B** ESIM List together with assignments submitted under § 11. The cumulative interference is considered as being caused when the overall aggregate  $(C/I)_{aggregate}$  value is less than that resulting from the supporting Appendix **30B** assignment(s) with a tolerance of 0.25 dB (inclusive of the 0.05 dB computational precision), except for an allotment in the Plan, an assignment stemming from the conversion of an allotment into an assignment without modification, or when the modification is within the envelope characteristics of the initial allotment, as well as assignments relating to application of Article 7 of Appendix **30B** for which the 0.05 dB computational precision is applicable.

18 In the event of a favourable finding under §§ 16 and 17, the Bureau shall enter the proposed assignment in the Appendix **30B** ESIM List and publish in a special section of the BR IFIC the characteristics of the assignment received under § 11, together with the names of administrations with which the provisions of this procedure have been successfully applied.

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<sup>7</sup> Similar course of action as prescribed in footnote 7bis of § 6.21 of Article 6 of Appendix **30B** applies.

19 When the examination under § 16 or § 17 leads to an unfavourable finding with respect to allotments in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, an Article 7 request transferred to Article 6, or a submission in accordance with Resolution **170 (Rev.WRC-23)**, the Bureau shall return the notice to the notifying administration. In this case, the notifying administration undertakes not to bring into use the frequency assignments until the finding with respect to allotments in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, an Article 7 request transferred to Article 6, or a submission in accordance with Resolution **170 (Rev.WRC-23)**, is favourable. The Bureau, in returning the notice to the notifying administration, shall indicate that the subsequent resubmission under § 11 will be considered with a new date of receipt.

20 When the examination under § 16 or § 17 leads to a favourable finding with respect to allotments in the Plan, conversion of an allotment into an assignment without modification or with a modification which is within the envelope characteristics of the initial allotment, an Article 7 request transferred to Article 6, a submission in accordance with Resolution **170 (Rev.WRC-23)**, but an unfavourable finding with respect to others, and if the notifying administration insists that the proposed assignment be included in the Appendix **30B** ESIM List, the Bureau shall enter the assignment provisionally in the Appendix **30B** ESIM List with an indication of those administrations whose assignments were the basis of the unfavourable finding. To this effect, the notifying administration shall include a signed commitment, indicating that the use of an assignment provisionally recorded in the Appendix **30B** ESIM List shall not cause unacceptable interference to, or claim protection from, those assignments for which agreement still needs to be obtained. The entry in the Appendix **30B** ESIM List shall be changed from provisional to definitive only if the Bureau is informed that all required agreements have been obtained.

21 Should the assignments that were the basis of the unfavourable finding not be brought into use within the period specified in § 6.1 of Article 6 of Appendix **30B** or within the extension period under § 6.31*bis* of Article 6 of Appendix **30B**, the status of the assignment in the Appendix **30B** ESIM List shall be reviewed accordingly.

22 Should unacceptable interference be caused by an assignment entered in the Appendix **30B** ESIM List under § 20 to any assignment in the List which was the basis of the disagreement, the notifying administration of the assignment entered in the Appendix **30B** ESIM List under § 20 shall, upon receipt of advice thereof, immediately eliminate this unacceptable interference.

23 For the examinations referred to in Part I and Part II, the Bureau shall generate a set of uplink grid points everywhere within the service area of the relevant assignments to A-ESIMs and M-ESIMs, assuming that A-ESIMs and M-ESIMs are located at these uplink grid points.

## **Section B – Procedure for notification and recording in the Master International Frequency Register of assignments to earth stations in motion on aircraft and vessels dealt with under this Resolution**

1 Any assignment in the ESIM List for which the relevant procedure of Section A and Part II of this Annex has been successfully applied shall be notified to the Bureau using the relevant characteristics listed in Appendix 4, not earlier than three years before the assignment is brought into use.

2 If the first notice referred to in § 1 has not been received by the Bureau within the required period mentioned in § 1 of Section A, the assignments in the Appendix **30B** ESIM List shall be cancelled by the Bureau after having informed the administration at least three months before the expiry of this period.

3 Notices not containing those characteristics specified in Appendix 4 as mandatory or required shall be returned with comments to help the notifying administration to complete and resubmit them, unless the information not provided is immediately forthcoming in response to an inquiry by the Bureau.

4 Complete notices shall be marked by the Bureau with their date of receipt and shall be examined in the order of their dates of receipt. Following receipt of a complete notice, the Bureau shall, as soon as possible after the date of entry of the corresponding assignment into the Appendix **30B** ESIM List or within not more than two months if the corresponding assignment has already been entered in the Appendix **30B** ESIM List, publish its contents, with any diagrams and maps and the date of receipt, in the BR IFIC, which shall constitute the acknowledgement to the notifying administration of receipt of its notice. When the Bureau is not in a position to comply with the time-limit referred to above, it shall periodically so inform the administrations, giving the reasons therefor.

5 The Bureau shall not postpone the formulation of a finding on a complete notice unless it lacks sufficient data to reach a conclusion thereon.

6 Each notice shall be examined:

6.1 with respect to its conformity with the Table of Frequency Allocations and other provisions<sup>8</sup> of the Radio Regulations, except those provisions relating to conformity with the FSS Plan and the procedures for coordination, which are the subject of the following subparagraph; and

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<sup>8</sup> The “other provisions” shall be identified and included in the Rules of Procedure.

6.2 with respect to its conformity with the FSS Plan, the procedures for coordination and the associated provisions<sup>9</sup>.

7 When the examination with respect to § 6.1 leads to a favourable finding, the assignment shall be examined further with respect to § 6.2; otherwise, the notice shall be returned with an indication of the appropriate action.

8 When the examination with respect to § 6.2 leads to a favourable finding, the ESIM assignment shall be recorded in the MIFR. When the finding is unfavourable, the notice shall be returned to the notifying administration, with an indication of the appropriate action.

9 In every case when a new ESIM assignment is recorded in the MIFR it shall, in accordance with the provisions of this Resolution, include an indication of the finding reflecting the status of the assignment. This information shall also be published in the BR IFIC.

10 A notice of a change in the characteristics of the ESIM assignment already recorded, as specified in Appendix 4, shall be examined by the Bureau under §§ 6.1 and 6.2, as appropriate. Any changes to the characteristics of an assignment that has been recorded and confirmed as having been brought into use shall be brought into use within eight years from the date of the notification of the modification. Any changes to the characteristics of an assignment that has been recorded but not yet brought into use shall be brought into use within the period provided for in § 1 of Section A.

11 In applying the provisions of this Section, any resubmitted notice which is received by the Bureau more than six months after the date on which the original notice was returned by the Bureau shall be considered to be a new notice.

12 All frequency assignments notified in advance of their being brought into use shall be entered provisionally in the MIFR. Any frequency assignment provisionally recorded under this provision shall be brought into use no later than the end of the period provided for in § 1 of Section A. Unless the Bureau has been informed by the notifying administration of the bringing into use of the assignment, it shall, no later than 15 days before the end of the regulatory period established under § 1 of Section A, send a reminder requesting confirmation that the assignment has been brought into use within the regulatory period. If the Bureau does not receive that confirmation within 30 days following the period provided for under § 1 of Section A, it shall cancel the entry in the MIFR and the corresponding assignment in the Appendix 30B ESIM List.

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<sup>9</sup> When an administration notifies any assignment with characteristics different from those entered in the Appendix 30B ESIM List through successful application of the relevant procedure of Section A and Part II of this Annex, the Bureau shall undertake calculations to determine if the proposed new characteristics increase the interference level caused to other allotments in the Plan, assignments in the List, an assignment for which the Bureau has received complete information in accordance with § 6.1 of Article 6 of Appendix 30B before the date of receipt of this notification, assignments in the Appendix 30B ESIM List and an assignment for which the Bureau has received complete information in accordance with § 1 of Section A before the date of receipt of this notification. The increase of the interference due to characteristics different from those entered in the Appendix 30B ESIM List will be checked by comparing the *C/I* ratios of these other allotments and assignments, which result from the use of the proposed new characteristics of the subject assignment on the one hand, and those obtained with the characteristics of the subject assignment in the Appendix 30B ESIM List, on the other hand. This *C/I* calculation is performed under the same technical assumptions and conditions.



13 When the Bureau has received confirmation that the assignment in the Appendix **30B** ESIM List has been brought into use, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC.

14 Wherever the use of a frequency assignment in the Appendix **30B** ESIM List is suspended for a period exceeding six months, the notifying administration shall inform the Bureau of the date on which such use was suspended. When that assignment is brought back into use, the notifying administration shall so inform the Bureau, as soon as possible. On receipt of the information sent under this provision, the Bureau shall make that information available on the ITU website as soon as possible and shall publish it in the BR IFIC. The date on which the assignment is brought back into use shall be no later than three years from the date on which the use of the frequency assignment was suspended, provided that the notifying administration informs the Bureau of the suspension within six months from the date on which the use was suspended. If the notifying administration informs the Bureau of the suspension more than six months after the date on which the use of the frequency assignment was suspended, this three-year time period shall be reduced. In this case, the amount by which the three-year period shall be reduced shall be equal to the amount of time that has elapsed between the end of the six-month period and the date that the Bureau is informed of the suspension. If the notifying administration informs the Bureau of the suspension more than 21 months after the date on which the use of the frequency assignment was suspended, the frequency assignment shall be removed from the MIFR and the Appendix **30B** ESIM List.

15 If the supporting Appendix **30B** assignment(s) is removed from the List, the corresponding ESIM assignment shall also be removed from the Appendix **30B** ESIM List and the MIFR, as appropriate.

## PART II

### **Procedure to be followed by administrations and the Bureau for examination and protection of one earth station in motion (ESIM) with respect to other ESIMs**

1 In the publication of the special section referred to in § 6 of Section A, the Bureau shall also include the names of the affected administrations, the corresponding assignments in the Appendix **30B** ESIM List and assignments for which the Bureau has previously received complete information in accordance with § 1 of Section A and which it has examined under § 5 of Section A, as appropriate.

2 In determining administrations whose assignments in the Appendix **30B** ESIM List or assignments for which the Bureau has previously received complete information in accordance with § 1 of Section A and which it has examined under § 5 of Section A are considered as being affected, the Bureau shall apply the principle of Annex 4 to Appendix **30B** and the following criteria:

- a) orbital spacing as specified in § 1.2 of Annex 4;
- b) Earth-to-space single-entry carrier-to-interference as specified in § 2.1 of Annex 4 or Earth-to-space single-entry carrier-to-interference (C/I) derived from the supporting Appendix **30B** assignment(s), whichever is the lowest;

c) the Earth-to-space power flux-density as specified in § 2.2 of Annex 4.

3 An administration that has not notified its comments either to the administration seeking agreement or to the Bureau within a period of four months following the date of the BR IFIC referred to in § 6 of Section A shall be deemed to have agreed to the proposed assignment. This time-limit shall be extended for an administration that has requested the assistance of the Bureau by up to 30 days following the date on which the Bureau communicated the result of its action.

4 Unless coordination is no longer required, taking into account the final characteristics of the notice in § 11 of Section A, should harmful interference be caused by an assignment included in Appendix **30B** ESIM List to any assignment in Appendix **30B** ESIM List identified in § 1 for which agreement has not been obtained, the notifying administration shall, upon receipt of advice thereof, immediately eliminate this harmful interference.

## ANNEX 2 TO RESOLUTION 121 (WRC-23)

### **Provisions for earth stations in motion on aircraft and vessels to protect terrestrial services in the frequency band 12.75-13.25 GHz**

1 The parts below contain provisions to ensure that earth stations in motion on aircraft (A-ESIMs) and earth stations in motion on vessels (M-ESIMs) do not cause unacceptable interference to terrestrial service operations when A-ESIMs and M-ESIMs operate in frequency bands overlapping with those used at any time by terrestrial services to which the frequency band 12.75-13.25 GHz is allocated and operating in accordance with the Radio Regulations (see also *resolves* 1.2 of this Resolution).

## PART I

### **M-ESIMs**

2 The notifying administration for the geostationary-satellite (GSO) network in the fixed-satellite service (FSS) with which an M-ESIM communicates shall ensure compliance of the M-ESIM operating within the frequency band 12.75-13.25 GHz, or parts thereof, with both of the following conditions for the protection of terrestrial services to which the frequency band is allocated within a coastal State:

2.1 The minimum distance from the low-water mark as officially recognized by the coastal State beyond which an M-ESIM can operate without the prior agreement of any administration is 158 km in the frequency band 12.75-13.25 GHz. Any transmissions from an M-ESIM within the minimum distance shall be subject to the prior agreement of the coastal State concerned.

2.2 The maximum M-ESIM equivalent isotropically radiated power (e.i.r.p.) spectral density towards the horizon shall be limited to 12.5 dB(W/MHz). Transmissions from an M-ESIM 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 concerned.

## PART II

### A-ESIMs

3 The notifying administration of the GSO FSS satellite network with which an A-ESIM communicates shall ensure compliance of the A-ESIM operating within the frequency band 12.75-13.25 GHz, or parts thereof, with all of the following conditions for the protection of terrestrial services to which the frequency band is allocated:

#### POWER FLUX-DENSITY MASK

3.1 When within line-of-sight of the territory of an administration, and above an altitude of 3 km, the maximum power flux-density (pfd) produced at the surface of the Earth on the territory of an administration by emissions from a single A-ESIM shall not exceed:

$\text{pfd}(\theta) = -112$	$\text{dB(W/(m}^2 \cdot 14 \text{ MHz))}$	for	$\theta \leq 5^\circ$
$\text{pfd}(\theta) = -117.5 + \theta$	$\text{dB(W/(m}^2 \cdot 14 \text{ MHz))}$	for	$5^\circ < \theta \leq 40^\circ$
$\text{pfd}(\theta) = -77$	$\text{dB(W/(m}^2 \cdot 14 \text{ MHz))}$	for	$40^\circ < \theta \leq 90^\circ$

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

3.2 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 A-ESIM shall not exceed:

$\text{pfd}(\theta) = -123.5$	$\text{dB(W/(m}^2 \cdot \text{MHz))}$	for	$\theta \leq 5^\circ$
$\text{pfd}(\theta) = -128.5 + \theta$	$\text{dB(W/(m}^2 \cdot \text{MHz))}$	for	$5^\circ < \theta \leq 40^\circ$
$\text{pfd}(\theta) = -88.5$	$\text{dB(W/(m}^2 \cdot \text{MHz))}$	for	$40^\circ < \theta \leq 90^\circ$

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

4 The maximum power in the out-of-band domain should be attenuated below the maximum output power of the A-ESIM transmitter as described in the most recent version of Recommendation ITU-R SM.1541.

5 Higher pfd levels than those provided for in §§ 3.1 and 3.2 above, produced by an A-ESIM at any point on the surface of the Earth within the territory of another administration, shall be subject to the prior agreement of that administration (see also *resolves* 1.2.5 of this Resolution).

## ANNEX 3 TO RESOLUTION 121 (WRC-23)

**Provisions for earth stations in motion on aircraft and vessels to protect  
non-geostationary-satellite systems in the fixed-satellite service  
in the frequency band 12.75-13.25 GHz**

1 In order to protect the non-geostationary-satellite (non-GSO) systems in the fixed-satellite service (FSS) referred to in *resolves* 1.1.6 of this Resolution in the frequency band 12.75-13.25 GHz, earth stations in motion on aircraft (A-ESIMs) and earth stations in motion on vessels (M-ESIMs) communicating with geostationary-satellite (GSO) FSS satellite networks shall not exceed the following operational limits:

- a) on-axis equivalent isotropically radiated power (e.i.r.p.) density of 49 dB(W/1 MHz) for a GSO A-ESIM and M-ESIM with an antenna maximum gain lower than 38.5 dBi;
- b) on-axis e.i.r.p. density of 54 dB(W/1 MHz) for a GSO A-ESIM and M-ESIM with an antenna maximum gain equal to or greater than 38.5 dBi but lower than 45 dBi;
- c) on-axis e.i.r.p. density of 57.5 dB(W/1 MHz) for a GSO A-ESIM and M-ESIM with an antenna maximum gain equal to or greater than 45 dBi;
- d) e.i.r.p. density for any off-axis angle  $\phi$  which is  $3^\circ$  or more off the main-lobe axis of a GSO A-ESIM and M-ESIM antenna and outside  $3^\circ$  of the GSO arc:

<i>Off-axis angle</i>	<i>Maximum e.i.r.p. density</i>
$3^\circ \leq \phi \leq 31.6^\circ$	$37 - 25 \log \phi$ dB(W/40 kHz)
$31.6^\circ < \phi \leq 180^\circ$	-0.5 dB(W/40 kHz)

2 The above levels are operational and are not examined by the Radiocommunication Bureau.

## ANNEX 4 TO RESOLUTION 121 (WRC-23)

**Methodology for examining the compliance of earth stations in motion on  
aircraft communicating with geostationary space stations in  
the fixed-satellite service in the frequency band 12.75-13.25 GHz  
with the set of power flux-density limits pre-established in Part II of Annex 2 to  
this Resolution at the Earth's surface**

## 1 Overview

The methodology below is a functional description of how to conduct an examination of earth stations in motion on aircraft (A-ESIMs) operating with geostationary-satellite (GSO) networks and their conformity with the power flux-density (pfd) limits specified in Part II of Annex 2 to this Resolution.

## 2 A-ESIM parameters required for examination

To conduct the relevant examination of an A-ESIM and its conformity with respect to the pfd limits, the following parameters are required:

- satellite network name;
- GSO satellite longitude;
- GSO service area latitude bounds;
- GSO service area longitude bounds;
- A-ESIM peak antenna gain;
- A-ESIM minimum elevation;
- A-ESIM power density and bandwidth as given in Table 1; and
- fuselage attenuation mask expressed as a function of the angle below the horizon of the A-ESIM.

## 3 Examination methodology

### 3.1 Introduction

An A-ESIM can operate at different locations defined by latitude, longitude and altitude. This methodology determines the maximum allowable power  $P_j$  for an A-ESIM transmitter communicating with a GSO satellite network in the fixed-satellite service (FSS) to ensure compliance with the pre-established pfd limits to protect terrestrial services, at all positions, for a defined set of altitude ranges. The methodology derives  $P_j$ , taking into account the relevant loss and attenuation in the geometry considered.

The methodology then compares the computed  $P_j$  with the range of notified power for the A-ESIM emission. The minimum and maximum power values for emissions from the A-ESIM,  $P_{\min\_emission,j}$  and  $P_{\max\_emission,j}$ , are calculated from the data included in the Appendix 4 notification information for the GSO satellite network with which the A-ESIM communicates and from the A-ESIM characteristics.

A-ESIMs are evaluated over a number of predefined altitude ranges in order to establish a number of  $P_j$  levels.

An examination by the Radiocommunication Bureau should apply this methodology for the defined altitude range, to determine whether an A-ESIM operating under a given GSO satellite network complies with the pre-established pfd limits to protect terrestrial services.

### 3.2 Parameters and geometry

Considering a hypothetical GSO FSS network, Table 1 below provides an example of emissions that are included in one group transmitting in the frequency band 12.75-13.25 GHz. Tables 2 to 4 provide additional assumptions and Figure 1 illustrates the geometry involved in the examination.

TABLE 1

**Example of a group of A-ESIM emissions**  
(with reference to relevant Appendix 4 data fields)

Emission No.	C.7.a Designation of emission	BW <sub>emission</sub> MHz	C.8.a.3 Minimum power density dB(W/Hz)	C.8.a.2 Maximum power density dB(W/Hz)
1	6M00G7W--	6.0	−69.7	−66.0

TABLE 2

**Additional example assumptions**

ID	Parameter	Notation	Value	Unit
1	Frequency assignment	$f$	13	GHz
2	Reference bandwidth of pfd mask	$BW_{Ref}$	1.0 or 14.0, depending on the altitude under examination	MHz
3	A-ESIM antenna peak gain	$G_{max}$	36	dBi
4	A-ESIM antenna gain pattern	-	As per Rec. ITU-R S.580 (see C.10.d.5.a)	

TABLE 3

**Additional assumptions defined in the methodology**

ID	Parameter	Notation	Value	Unit
1	A-ESIM minimum elevation angle towards GSO satellite	$\varepsilon$	Appendix 4, C.10.d.10	degrees
2	Atmospheric attenuation	$L_{atm}$	Computed with Rec. ITU-R P.676 (see NOTE below)	dB
3	Angle of arrival of the incident wave on the Earth's surface	$\delta$	Specified in the pre- established sets of pfd limits, variable from 0° to 90°	degrees
4	Minimum examination altitude	$H_{min}$	0.01	km
5	Maximum examination altitude	$H_{max}$	15.0	km
6	Examination altitude spacing <sup>1</sup>	$H_{step}$	1.0	km
7	Fuselage attenuation	$L_f$	Use Table 4 if no ITU-R Recommendation provided in Appendix 4, C.10.d.11	dB

<sup>1</sup> The fourth altitude value ( $H_4$ ) computed in accordance with this  $H_{step}$  is adjusted to 2.99 km to facilitate the examination of compliance with the two sets of predefined pfd values indicated in Table 5A and Table 5B.

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

FIGURE 1

Geometry for examination of compliance for two different A-ESIM altitudes

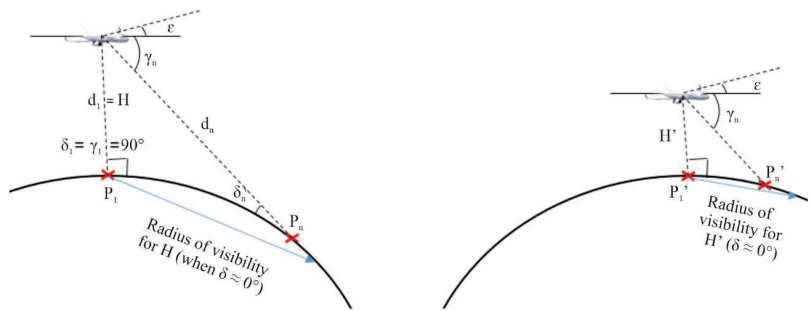


TABLE 4

Fuselage attenuation model based on Report ITU-R M.2221-0

$L_{fuse}(\gamma) = 3.5 + 0.25 \cdot \gamma$	dB	for	$0^\circ \leq \gamma \leq 10^\circ$
$L_{fuse}(\gamma) = -2 + 0.79 \cdot \gamma$	dB	for	$10^\circ < \gamma \leq 34^\circ$
$L_{fuse}(\gamma) = 3.75 + 0.625 \cdot \gamma$	dB	for	$34^\circ < \gamma \leq 50^\circ$
$L_{fuse}(\gamma) = 35$	dB	for	$50^\circ < \gamma \leq 90^\circ$

Notes:

- This fuselage attenuation model is based on measurements made at 14.2 GHz (see Fig. 3.6-14 in Report ITU-R M.2221-0).
- Table 5A and Table 5B are taken from Part II of Annex 2 to 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.

TABLE 5A

Required conformance pfd mask for altitudes up to 3 km

$\text{pfd}(\theta) = -123.5$	dB(W/(m <sup>2</sup> · MHz))	for	$\theta \leq 5^\circ$
$\text{pfd}(\theta) = -128.5 + \theta$	dB(W/(m <sup>2</sup> · MHz))	for	$5^\circ < \theta \leq 40^\circ$
$\text{pfd}(\theta) = -88.5$	dB(W/(m <sup>2</sup> · MHz))	for	$40^\circ < \theta \leq 90^\circ$

TABLE 5B

Required conformance pfd mask for altitudes above 3 km

$\text{pfd}(\theta) = -112$	dB(W/(m <sup>2</sup> · 14 MHz))	for	$\theta \leq 5^\circ$
$\text{pfd}(\theta) = -117 + \theta$	dB(W/(m <sup>2</sup> · 14 MHz))	for	$5^\circ < \theta \leq 40^\circ$
$\text{pfd}(\theta) = -77$	dB(W/(m <sup>2</sup> · 14 MHz))	for	$40^\circ < \theta \leq 90^\circ$

### 3.3 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  $\delta_n$  angles (angle of arrival of the incident wave) as required in order to test full compliance with the applicable set of pfd limits. The  $N$  angles  $\delta_n$  must be between  $0^\circ$  and  $90^\circ$  and have a resolution compatible with the granularity of the pre-established pfd limits. Each of the  $N$  angles  $\delta_n$  will correspond to as many  $N$  points on the ground.

- ii) For each altitude  $H_j = H_{min}, H_{min} + H_{step}, \dots, H_{max}$ :

- a) set the altitude of the A-ESIM to  $H_j$   
 b) compute the angles below the horizon  $\gamma_{j,n}$  as seen from the A-ESIM for each of the  $N$  angles  $\delta_n$  generated in i) using the following equation:

$$\gamma_{j,n} = \arccos \left( \frac{R_e \cdot \cos(\delta_n)}{(R_e + H_j)} \right) \quad (1)$$

where  $R_e$  is the mean earth radius.

- c) Compute the distance  $D_{j,n}$ , in km, for  $n = 1, \dots, N$  between the A-ESIM and the tested point on the ground:

$$D_{j,n} = \sqrt{R_e^2 + (R_e + H_j)^2 - 2R_e(R_e + H_j)\cos(\gamma_n - \delta_n)} \quad (2)$$

- d) Compute the fuselage attenuation  $L_{f,j,n}$  (dB) with  $n = 1, \dots, N$  applicable to each of the angles  $\gamma_{j,n}$  computed in b) above.  
 e) Compute the gaseous absorption  $L_{atm,j,n}$  (dB) with  $n = 1, \dots, N$  applicable to each of the distances  $D_{j,n}$ , computed in c) above, using the applicable sections of the most recent version of Recommendation ITU-R P.676.

- iii) a) For each altitude  $H_j = H_{min}, H_{min} + H_{step}, \dots, H_{max}$ , and each angle below the horizon  $\gamma_{j,n}$ , compute the maximum emission power in the reference bandwidth  $P_{j,n}(\delta_n, \gamma_{j,n})$  for which the pfd limits are met using the following algorithm:

$$P_{j,n}(\delta_n, \gamma_{j,n}) = pdf(\delta_n) + 10 \log_{10} \left( 4\pi (D_{j,n} \cdot 1000)^2 \right) + L_{f,j,n} + L_{atm,j,n} - Gtx(\gamma_{j,n} + \varepsilon)$$

with  $Gtx(\gamma_{j,n} + \varepsilon)$  being the transmit antenna gain with the off-axis angle from the boresight, consisting of the summation of both angles  $\gamma_{j,n}$  and minimum elevation angle  $\varepsilon$  as defined in Table 3.

- b) Compute the minimum  $P_j$  across all values calculated at the previous step:

$$P_j = \text{Min} \left( P_{j,n}(\delta_n, \gamma_{j,n}) \right)$$



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 indicated in Table 5A or Table 5B, as applicable, with respect to all angles  $\delta_n$  at the altitude  $H_j$ , and the elevation indicated in Table 3. There will be one  $P_j$  for each of the  $H_j$  altitudes considered.

The output of step *b*) is summarized in Table 6 below:

TABLE 6

**Computed  $P_j$  values**

<b><math>H_j</math> (Altitude)  (km)</b>	<b><math>P_j</math> (Maximum power in the reference bandwidth that can be used at minimum elevation)  dB(W/BW)</b>
0.01	<i>TBD</i>
1.0	<i>TBD</i>
2.0	<i>TBD</i>
2.99	<i>TBD</i>
4.0	<i>TBD</i>
5.0	<i>TBD</i>
6.0	<i>TBD</i>
7.0	<i>TBD</i>
8.0	<i>TBD</i>
9.0	<i>TBD</i>
10.0	<i>TBD</i>
11.0	<i>TBD</i>
12.0	<i>TBD</i>
13.0	<i>TBD</i>
14.0	<i>TBD</i>
15.0	<i>TBD</i>

- c) For each altitude  $H_j = H_{min}, H_{min} + H_{step}, \dots, H_{max}$ , and each emission in each group of emissions under examination, compute the minimum and the maximum powers of the emission in the reference bandwidth:

$$P_{\min\_emission,j} = \text{minimum power density}(\text{emission, dBW / Hz}) + 10 * \log_{10}(BW)$$

$$P_{\max\_emission,j} = \text{maximum power density}(\text{emission, dBW / Hz}) + 10 * \log_{10}(BW)$$

BW in Hz is:

$$BW_{Ref} \text{ if } BW_{Ref} = 1 \text{ MHz}$$

$$BW_{Ref} \text{ if } BW_{Ref} = 14 \text{ MHz and } BW_{emission} \geq BW_{Ref}$$

$$BW_{emission} \text{ if } BW_{Ref} = 14 \text{ MHz and } BW_{emission} < BW_{Ref}$$

The methodology assumes that only one emission within the reference bandwidth of 14 MHz is transmitted by A-ESIM.

- d) For each emission in each group of emissions under examination, check if there is at least one altitude  $H_j$  for which:

$$P_{\max\_emission,j} > P_j > P_{\min\_emission,j}$$

The results of this check are illustrated in Table 7 below.

TABLE 7

Example comparison between  $P_j$  and  $(P_{\min\_emission,j}, P_{\max\_emission,j})$

Emission No.	C.7.a Designation of emission	$BW_{emission}$ MHz	C.8.a.3 Minimum power density dB(W/Hz)	C.8.a.2 Maximum power density dB(W/Hz)	Lowest altitude $H_j$ (km) for which $P_{\max\_emission,j}$ > $P_j$ > $P_{\min\_emission,j}$
1	6M00G7W--	6.0	-69.7	-66.0	TBD

- e) Based on the test detailed in iii) d) above applied to all emissions in the group 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).

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

- the resulting parameters as contained in Table 6;
- the examination results for each group;
- for those cases when some emissions successfully pass and some do not, the examination results for the resulting new group that includes only the emission(s) which successfully passed the examination.

**END**

## ANNEX 5 TO RESOLUTION 121 (WRC-23)

**Required capabilities of earth stations in motion communicating  
with geostationary-satellite networks (in accordance  
with *resolves* 10.1 of this Resolution)**

This Annex provides the minimum requirements for earth stations in motion (ESIMs) communicating with geostationary-satellite (GSO) networks subject to this Resolution, as shown in Table 8 below.

TABLE 8

## GSO ESIM minimum requirements

Requirement	Associated provision(s)
Ability to monitor and control pointing of main beam in direction of satellite with which ESIM communicates	<i>Resolves</i> 10.2
Geolocation capability	<i>Resolves</i> 10.4
Ability of ESIM to receive information and execute commands from network control and monitoring centre (NCCM)	<i>Resolves</i> 10.3 <i>Resolves</i> 10.4
Ability to send information to NCCM	<i>Resolves</i> 10.4
Ability to monitor and control transmission power and frequency	<i>Resolves</i> 10.4
Ability to enable/disable ESIM transmission	<i>Resolves</i> 10.3