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| **World Radiocommunication Conference (WRC-15) Geneva, 2–27 November 2015** |  |
| **INTERNATIONAL TELECOMMUNICATION UNION** |  |
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| PLENARY MEETING | **Addendum 2 to Document 8(Add.23)-E** |
|  | **10 October 2015** |
|  | **Original: Russian** |
|  | |
| Regional Commonwealth in the field of Communications Common Proposals | |
| Proposals for the work of the conference | |
|  | |
| Agenda item 9.1(9.1.2) | |

9 to consider and approve the Report of the Director of the Radiocommunication Bureau, in accordance with Article 7 of the Convention:

9.1 on the activities of the Radiocommunication Sector since WRC‑12;

9.1(9.1.2) Resolution **756 (WRC-12)** − Studies on possible reduction of the coordination arc and technical criteria used in application of No. **9.41** in respect of coordination under No. **9.7**

Introduction

The RCC Administrations support retention of the existing procedures of RR Nos 9.7, 9.41 and 11.32A when modifying the technical criteria associated with those provisions, on the basis of Option 1A in the CPM Report (see the example of regulatory text and draft Resolution [RCC\_A912] (WRC-15)).

For the purposes of addressing issue 9.1.2 of WRC-15 agenda item with respect to *resolves* 1 of Resolution 756 (WRC-12), the RCC Administrations propose the following:

a) Use of the C/I criterion instead of the ΔT/T criterion when justifying the inclusion of networks outside the coordination arc in, or their removal from, the list(s) of affected administrations when applying RR No. 9.41 and in application of RR No. 9.7, in cases when the coordination arc criterion is not used.

b) Determination of the new value of single entry interference criterion С/I = С/N–10lg(ΔТ/Т) (dB), taking into account the increase in the value of criterion ΔТ/Т from 6% (-12.2 dB) to a value not exceeding 20% (−7.0 dB).

c) Continued examination of the probability of harmful interference under RR No. 11.32A based on the C/I criterion, transferring the description thereof from Part B, Section B3, of the Rules of Procedure into RR Appendix 8.

d) Application of a C/I criterion, determined on the basis of ΔТ/Т = 6%, for systems shown under item 9) of Table 5-1 of RR Appendix 5, in which criterion ΔТ/Т was previously applied.

The RCC Administrations consider that the new values of the C/I criterion should be applied only between the assignments of new satellite networks notified for coordination after the entry into force of the new regulatory procedures:

– when applying RR No. 9.41;

– when BR identifies affected administrations under RR No. 9.7, only in frequency bands in the range 20/30 GHz that are allocated to FSS and MSS;

– when applying RR No. 11.32А.

The said provisions should be applied in accordance with Resolution [RCC\_A912] (WRC-15).

The RCC Administrations consider that if WRC-15 decides to maintain the criterion for permissible single-entry interference at the level ΔТ/Т = 6%, the criterion С/I = С/N–10lg(ΔТ/Т) (dB) applies to all satellite network assignments, irrespective of the date of submission to the Bureau.

The RCC Administrations consider that if WRC-15 adopts the pfd mask method for the examination under RR No. 11.32A of FSS satellite networks in the C-band and of FSS and BSS networks in the Ku-band, the new regulatory arrangements should apply only between newly notified GSO FSS and BSS networks for which requests for coordination are received by the Bureau following the entry into force of the new procedures. In the case of GSO FSS networks in the C‑band and FSS and BSS networks in the Ku-band for which requests for coordination are received by the Bureau before that date, the regulatory arrangements in force at that time should continue to be applied.

The RCC Administrations are considering the possibility of a further reduction of the coordination arc in the frequency band 4/6 GHz from ±8 to ±6 degrees, and do not object to a reduction of the coordination arc in the frequency bands 11/12/13/14 GHz from ±7 to ±5 in order to address issue 9.1.2 with respect to *resolves* 2 of Resolution 756 (WRC-12).

Proposals

EXAMPLE OF REGULATORY TEXT ON THE BASIS OF OPTION 1A

NOC RCC/8A23A2/1

ARTICLE 9

Procedure for effecting coordination with or obtaining agreement of other administrations1, 2, 3, 4, 5, 6, 7, 8, 8*bis*    (WRC‑12)

**Reasons:** No changes to the provisions of RR Article 9 are required under Option 1A.

ARTICLE 11

Notification and recording of frequency   
assignments1, 2, 3, 4, 5, 6, 7, 7*bis*    (WRC‑12)

Section II − Examination of notices and recording of frequency assignments   
in the Master Register

MOD RCC/8A23A2/2

11.32A *c)* with respect to the probability of harmful interference that may be caused to or by assignments recorded with a favourable finding under Nos. 11.36 and 11.37 or 11.38, or recorded in application of No. 11.41, or published under Nos. 9.38 or 9.58 but not yet notified, as appropriate, for those cases for which the notifying administration states that the procedure for coordination under Nos. 9.7, 9.7A, 9.7B, 9.11, 9.12, 9.12A, 9.13 or 9.14, could not be successfully completed (see also No. 9.65);14, ADD 14*bis* or     (WRC‑15)

**Reasons:** Inclusion of the requisite reference to the method for determining the probability of harmful interference.

NOC RCC/8A23A2/3

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14 11.32A.1 The examination of such notices with respect to any other frequency assignment for which a request for coordination under Nos. **9.7**, **9.7A**, **9.7B**, **9.12**, **9.12A** or **9.13**, as appropriate, has been published under No. **9.38** but not yet notified shall be effected by the Bureau in the order of their publication under the same number using the most recent information available.     (WRC‑2000)

**Reasons:** No change required to this RR provision.

ADD RCC/8A23A2/4

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14*bis*11.32A.2 The calculation method to assess harmful interference and the criteria for the formulation of the findings of the Bureau for the coordination under No. 9.7are contained in Appendix 8.     (WRC‑15)

**Reasons:** Inclusion of the requisite reference to the method for determining the probability of harmful interference.

MOD RCC/8A23A2/5

APPENDIX 5 (REV.WRC‑15)

Identification of administrations with which coordination is to be effected or  
agreement sought under the provisions of Article 9ADD [[1]](#footnote-1)\*

MOD RCC/8A23A2/6

TABLE 5-1     (Rev.WRC‑15)

Technical conditions for coordination

(see Article 9)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference of Article 9 | Case | Frequency bands (and Region) of the service for which coordination is sought | Threshold/condition | Calculation  method | Remarks |
| No. **9.7** GSO/GSO | A station in a satellite network using the geostationary-satellite orbit (GSO), in any space radiocommunication service, in a frequency band and in a Region where this service is not subject to a Plan, in respect of any other satellite network using that orbit, in any space radiocommunication service in a frequency band and in a Region where this service is not subject to a Plan, with the exception of the coordination between earth stations operating in the opposite direction of transmission | 1) 3 400-4 200 MHz 5 725-5 850 MHz (Region 1) and 5 850-6 725 MHz 7 025-7 075 MHz | i) Bandwidth overlap, and  ii) any network in the fixed-satellite service (FSS) and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8°\* of the nominal orbital position of a proposed network in the FSS |  | With respect to the space services listed in the threshold/condition column in the bands in 1), 2), 3), 4), 5), 6), 7) and 8), an administration may request, pursuant to No. **9.41**, to be included in requests for coordination, indicating the networks for which the value of *C*/*I* calculated by the method in Appendix **8** **(Rev.WRC‑15)** is lower than the appropriate criterion (*C*/*N*+ X[[2]](#footnote-2) (dB)). When the Bureau, on request by an affected administration, studies this information pursuant to No. **9.42**, the calculation method given in Appendix **8** **(Rev.WRC-15)** shall be used |
| 2) 10.95-11.2 GHz 11.45‑11.7 GHz  11.7-12.2 GHz  (Region 2) 12.2-12.5 GHz  (Region 3) 12.5‑12.75 GHz (Regions 1 and 3) 12.7‑12.75 GHz (Region 2) and  13.75‑14.5 GHz | i) Bandwidth overlap, and  ii) any network in the FSS or broadcasting-satellite service (BSS), not subject to a Plan, and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±7°\* of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan |

TABLE 5-1 (*continued*)     (Rev.WRC‑15)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference of Article 9 | Case | Frequency bands (and Region) of the service for which coordination is sought | Threshold/condition | Calculation  method | Remarks |
| No. **9.7** GSO/GSO (*cont.*) |  | 3) 17.7‑20.2 GHz, (Regions 2 and 3),  17.3-20.2 GHz  (Region 1) and 27.5‑30 GHz | i) Bandwidth overlap, and  ii) any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8°\* of the nominal orbital position of a proposed network in the FSS |  |  |
|  |  | 4) 17.3‑17.7 GHz  (Regions 1 and 2) | i) Bandwidth overlap, and  ii) a) any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8°\* of the nominal orbital position of a proposed network in the BSS,  or  b) any network in the BSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8°\* of the nominal orbital position of a proposed network in the FSS |  |  |

TABLE 5-1 (*continued*)     (Rev.WRC‑15)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference of Article 9 | Case | Frequency bands (and Region) of the service for which coordination is sought | Threshold/condition | Calculation  method | Remarks |
| No. **9.7** GSO/GSO (*cont.*) |  | 5) 17.7‑17.8 GHz | i) Bandwidth overlap, and  ii) a) any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8°\* of the nominal orbital position of a proposed network in the BSS,  or  b) any network in the BSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8°\* of the nominal orbital position of a proposed network in the FSS  NOTE – No. **5.517** applies in Region 2. |  |  |
|  |  | 6) 18.0-18.3 GHz (Region 2) 18.1-18.4 GHz (Regions 1 and 3) | i) Bandwidth overlap, and  ii) any network in the FSS or meteorological-satellite service and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8°\* of the nominal orbital position of a proposed network in the FSS or the meteorological-satellite service |  |  |

TABLE 5-1 (*continued*)     (Rev.WRC‑15)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference of Article 9 | Case | Frequency bands (and Region) of the service for which coordination is sought | Threshold/condition | Calculation  method | Remarks |
| No. **9.7** GSO/GSO (*cont.*) |  | 6*bis*) 21.4-22 GHz  (Regions 1 and 3)    7) Bands above 17.3 GHz, except those defined in § 3) and 6) | i) Bandwidth overlap; and  ii) any network in the BSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±12° of the nominal orbital position of a proposed network in the BSS (see also Resolutions **554 (WRC‑12)** and **553 (WRC‑12)**).  i) Bandwidth overlap, and  ii) any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8°\* of the nominal orbital position of a proposed network in the FSS (see also Resolution **901 (Rev.WRC‑07)**) |  | No. **9.41** does not apply. |
|  |  | 8) Bands above 17.3 GHz except those defined in § 4), 5) and 6*bis*) | i) Bandwidth overlap, and  ii) any network in the FSS or BSS, not subject to a Plan, and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±16° of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan, except in the case of a network in the FSS with respect to a network in the FSS (see also Resolution **901 (Rev.WRC‑07)**) |  |  |

TABLE 5-1 (*continued*)     (Rev.WRC‑15)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reference of Article 9 | Case | Frequency bands (and Region) of the service for which coordination is sought | Threshold/condition | Calculation  method | Remarks |
| No. **9.7** GSO/GSO (*cont.*) |  | 8*bis*) Frequency bands in 3) and 7) where the radio service of the proposed network or affected networks pertains to the mobile-satellite service (MSS) and to any corresponding space operation functions | i) Bandwidth overlap, and  ii) Value of *C/I* is lower than the appropriate criterion *C*/*N* + X[[3]](#footnote-3)32 (dB) | Appendix **8 (Rev.WRC‑15)** | In application of Article 2A of Appendix **30** for the space operation functions using the guardbands defined in § 3.9 of Annex 5 of Appendix **30**, the threshold/condition specified for the FSS in the bands in 2) applies.  In application of Article 2A of Appendix **30A** for the space operation functions using the guardbands defined in § 3.1 and 4.1 of Annex 3 of Appendix **30A**, the threshold/condition specified for the FSS in the bands in 7) applies |
| 9) All frequency bands, other than those in 1), 2), 3), 4), 5), 6), 6*bis),* 7) and 8), allocated to a space service, and the bands in 1), 2), 3), 4), 5), 6), 6*bis),* 7) and 8) where the radio service of the proposed network or affected networks is other than the space services listed in the threshold/ condition column, or in the case of coordination of space stations operating in the opposite direction of transmission | i) Bandwidth overlap, and  ii) Value of *C*/*I* is lower than the appropriate criterion *C*/*N* + 12.2 (dB) |

\* NOTE − Depending upon decisions of WRC-15 in respect of *resolves* 2 of Resolution **756 (WRC-12)**, the numerical values for the size of the coordination arc in one or more of the listed frequency bands of Table 5-1 may change. This option is neutral in respect of the size of the coordination arc and decisions on the size of the coordination arc will not lead to a need for consequential changes in respect of this option or vice versa.

**Reasons:** To reflect the regulatory provisions contained in the proposals for transition to a C/I criterion.

MOD RCC/8A23A2/7

APPENDIX 8 (REV.WRC‑15)

Method of calculation for determining if coordination is required or if there is a probability of harmful interference between geostationary-satellite networks sharing the same frequency bands

*[Editorial Note – Description of the method transferred from Part B, Section B3, of the Rules of Procedure into RR Appendix 8. Start of text.]*

# 1 Introduction

The criterion based on calculation of carrier/interference (*C*/*I*) ratios is used for identification of coordination requirements in application of the provisions:

− No. **9.7**, when the Bureau identifies affected administrations only in frequency bands within the range 20/30 GHz that are allocated to FSS and MSS;

− No. **9.41**,when giving technical reasons for including in/removing from the list of affected administrations/networks satellite networks that are within/beyond the coordination arc;

− No. **11.32А**, with respect to the probability of harmful interference.

The description of the calculation method and criteria to be used for the interference assessment, as well as the findings to be formulated with respect to coordination of networks under No. **9.7**, are as follows.

# 2 Probability of harmful interference

The Bureau, in performing its mandatory tasks relating to the application of the above-mentioned provisions, and administrations in applying No. **9.41**,shall proceed as follows:

2.1 Recommendation ITU‑R S.741‑2 should be used to examine the subject assignments with respect to the provisions of Nos. **9.7**, **9.41** and **11.32A**.

2.2 The Bureau/administrations, when determining the need for coordination or probability of harmful interference, shall use either the single-entry limits or the mutually agreed criteria provided by the administrations concerned for accepted interference, as appropriate.

2.2.1 To examine the subject frequency assignments with respect to the provisions of Nos. **9.7** and **9.41**, the Bureau/administrations shall use the single-entry limits defined in Table 1, which is derived from Table 2 of Recommendation ITU‑R S.741‑2, together with the information submitted in accordance with Appendix **4**:

*a)* where a given level of interference is less than or equal to the single-entry interference limits indicated in Table 1, coordination is not required;

*b)* where a given level of interference is greater than the single-entry interference limits defined in Table 1, the frequency assignments should be taken into account in coordination.

2.2.2 To examine the subject assignments with respect to the provisions of No.**11.32А**, the Bureau shall use the mutually agreed criteria provided by the administrations concerned for accepted interference in the format appearing in Table 2 of Recommendation ITU‑R S.741‑2, or, in the absence of such information, the Bureau shall use the single-entry limits defined in Table 1, together with the information submitted in accordance with Appendix **4**.

2.2.2.1 In the case where this information is provided by the administrations concerned:

*a)* the probability of harmful interference is considered to be negligible if the *C*/*I* calculation shows that the applicable criteria for a particular examination between two networks concerned are satisfied. In this case, the finding in respect of No. **11.32A** shall be favourable and the assignment shall be recorded in the Master Register;

*b)* the probability of harmful interference is considered not to be negligible if the *C*/*I* calculation shows that the applicable criteria for a particular examination between two networks concerned are not satisfied. Accordingly, the finding shall be unfavourable and the notice shall be returned with an indication of the appropriate actions.

2.2.2.2 In the case where this information is not provided by the administrations concerned:

*a)* the probability of harmful interference is considered to be negligible if the interference is less than or equal to the single-entry interference limits indicated in Table 1. In this case, the finding shall be favourable, and the assignment shall be recorded in the Master Register;

*b)* the probability of harmful interference is considered not to be negligible if the interference is greater than the single-entry interference limits indicated in Table 1. Accordingly, the finding shall be unfavourable and the notice shall be returned with an indication of the appropriate actions.

TABLE 1

Single-entry interference (SEI) protection criteria

|  |  |  |  |
| --- | --- | --- | --- |
| Interfering  carrier  type  Desired  carrier type | Analogue (TV-FM) or other | Digital | Analogue (other than TV-FM) |
| Analogue (TV-FM) | *C*/*N* + 14 (dB) | | |
| Digital | If DeNeBd ≤ InEqBd then  *C*/*N* + 9.4 + 3.5 log (δ) − 6 log (i/10) (dB)  (i.е. *C*/*N* + 5.5 + 3.5 log (DeNeBd (MHz)))  Otherwise if DeNeBd > InEqBd then  *C*/*N* + 12.2 (dB) | *C*/*N* + [К] (dB)\* | *C*/*N* + 12.2 (dB) |
| Analogue  (other than TV-FM) | 13.5 + 2 log (δ) − 3 log (i/10) (dB)  (i.е. 11.4 + 2 log (DeNeBd (MHz))) | *C*/*N* + 12.2 (dB) | |
| Other | 13.5 + 2 log (δ) − 3 log (i/10) (dB)  (i.е. 11.4 + 2 log (DeNeBd (MHz))) | *C*/*N* + 14 (dB) | |

where:

*C*/*N*: ratio (dB) of carrier to total noise power, which includes all internal system noise and interference from other systems

DeNeBd: necessary bandwidth of desired carrier (Appendix **4**, Annex 2, item C.7.a)

InEqBd: equivalent bandwidth of interfering carrier (equal to total power to power density ratio (see Appendix **4**, Annex 2, items C.8.a.1 and C.8.a.2, respectively))

δ: ratio of desired signal bandwidth to peak-to-peak deviation of the TV carrier caused by the energy dispersal signal (a peak-to-peak deviation of 4 MHz is used in all cases)

i: pre-demodulation interference power in the desired signal bandwidth expressed as a percentage of the total pre-demodulation noise power (a value of 20 is used in all cases)

К factor defined in Table **5‑1** of Appendix **5**.

\*NOTE: Factor К = X dB (criterion *C*/*I* < *C*/*N* + X (dB)) shall be applied at examination of frequency assignments (digital carrier case) between frequency assignments of new networks whose coordination requests were submitted to the Bureau after the closing date of WRC-15.

7.0 dB ≤ X ≤ 12.2 dB. For an interference level equivalent to Δ*T*/*T* = 20%, X = 7.0 dB. If other levels of interference are to be considered, X may be adjusted by XY% = 7.0 − 10log(Y/20).

Factor К = 12.2 dB (criterion *C*/*I* < *C*/*N* + 12.2 (dB)) shall continue to be applied to check interference in respect of frequency assignments (digital carrier case) of networks whose coordination requests were submitted to the Bureau before the closing date of WRC-15.

# 3 Calculation methodology for calculating C/I ratios

To perform the above-mentioned compatibility analysis, the following methodology is used.

The methodology is based on Recommendation ITU‑R S.741‑2. A set of carrier-to-interference (*C*/*I*) calculations are performed following the geometrical considerations of Recommendation ITU‑R S.740, and an interference adjustment factor is calculated as shown below to take into consideration the frequency offset situations as well as the difference in the bandwidths between the wanted and the interfering carriers. These *C*/*I* values (*C*/*I* calculated) are then compared with the required *C*/*I* values (*C*/*I* required) derived from the criteria appearing in Table 1 which contains a set of single-entry interference criteria to protect different types of carriers. In the case of required *C*/*I* values agreed by administrations and communicated to the Bureau (see § 2.2.2), the calculated *C*/*I* values are compared with these mutually agreed *C*/*I* values.

Thereafter, a set of margins *M* (*C*/*I* calculated – *C*/*I* required) are derived. It should be noted that to evaluate the *C*/*I* value required for each test point, a set of carrier-to-noise ratio (*C*/*N*) objectives are used (performance) and a K value, generally of either 7.0, 12.2 or 14.0 dB, is added in accordance with the above-mentioned Table 1. It should also be noted that these values correspond to a maximum permissible single-entry interference of 20%, 6% or 4%, correspondingly, of the total noise power *N* of the protected assignments (performance).

The *C*/*N* objectives, submitted to the Bureau in accordance with Appendix **4** (Annex 2 item C.8.e.1) by the administration responsible for the satellite network under examination, will be used to assess the probability of harmful interference received by this satellite network. To assess the probability of harmful interference generated by this satellite network into other satellite networks, *C*/*N* objectives submitted by responsible administrations for those other networks will be used only if they are lower than the corresponding calculated *C*/*N* values for those networks. Otherwise, those calculated *C*/*N* values will be used. If no *C*/*N* objectives were submitted by responsible administrations those calculated *C*/*N* values will be used.

Table 1 and Recommendation ITU-R S.741-2 define *C*/*N* as a “ratio (dB) of carrier to total noise power which includes all internal system noise and interference from other systems”. Therefore, and to comply with this definition, an additional margin defined by wanted emissions type will be added to the margins calculated on the basis of the internal system noise values provided by the concerned administrations. Attachment 2 contains the calculation methodology used for deriving the above-mentioned additional margin.

## 3.1 Interfering cases

Although most of the cases consider digital carriers, actions for different interference cases have also been considered for generality. Table 2 presents a summary of the different interfering situations to be dealt with when performing *C*/*I* calculations.

TABLE 2

Interference cases

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Desired  Interfering | Digital | Analogue  (TV-FM) | Analogue  (other than TV-FM) | Other |
| Digital | Use *C*/*I* plus interference adjustment factor1  (I) | Use *C*/*I* plus interference adjustment factor1  (II) | Use *C*/*I* plus interference adjustment factor1  (III) | Use *C*/*I* plus interference adjustment factor1  (XI) |
| Analogue (TV-FM) | Use *C*/*I* plus interference adjustment factor2  (IV) | *Co-frequency:*  use *C*/*I* plus interference adjustment factor1  (X)  *Non co-frequency:*  use relative protection ratio mask3  (V) | Use *C*/*I* plus interference adjustment factor2  (VI) | Use *C*/*I* plus interference adjustment factor2  (XII) |
| Analogue (other than TV-FM) | Use *C*/*I* plus interference adjustment factor2  (VII) | Use *C*/*I* plus interference adjustment factor2  (VIII) | Use *C*/*I* plus interference adjustment factor2  (IX) | Use *C*/*I* plus interference adjustment factor2  (XIII) |
| Other | Use *C*/*I* plus interference adjustment factor2  (XIV) | Use *C*/*I* plus interference adjustment factor2  (XV) | Use *C*/*I* plus interference adjustment factor2  (XVI) | Use *C*/*I* plus interference adjustment factor2  (XVII) |
| 1 Interference adjustment factor for Cases I, II, III, X and XI is the same (see § 3.8.1).  2 Interference adjustment factor for Cases IV, VI to IX and XII to XVII is the same (see § 3.5).  3See § 3.10. | | | | |

The selection of an interference case defined in Table 2 requires the identification of the type of each carrier, taking into account the information submitted to the Bureau by administrations in accordance with Appendix **4** (i.e. the class of emission as defined in Annex 2 item C.7.a).

## 3.2 Margin *M, C*/*I, C*/*N* algorithms

The algorithms described shall be used to evaluate compliance with the mutually accepted interference criteria or with the single-entry interference limits established in Table 1.

## 3.3 Single channel per carrier (SCPC) cases

When dealing with composite interference from a number of narrow-band carriers such as a transponder loaded with SCPC carriers the assumption is made, in the absence of more detailed data from administrations, that the interfering satellite has its transponder fully loaded with SCPC carriers and the individual carriers can be replaced with one wideband carrier which has a total power equal to the sum of the powers of the individual SCPC carriers. The protection ratios given in Recommendation ITU‑R S.671 are used to protect SCPC transmissions interfered with by analogue television carriers only modulated with energy dispersal signals.

## 3.4 Interference between analogue FDM-FM signals (Case (IX) in Table 2)

When dealing with FDM-FM carriers, and to find out the resulting margin, the *C*/*I* ratio is calculated and compared with the required *C*/*I*. However a *C*/*N* + *K* type protection criteria is developed based on the equations of Recommendation ITU‑R SF.766 which are required to calculate the *B* factor (interference reduction factor). In the absence of detailed information for the calculation of the *B* factor, the interference adjustment factor described in § 3.5 shall be used.

## 3.5 Other interference cases

For cases (IV), (VI), (VII), (VIII), IX and (XI) to (XVII) in Table 2, the interference adjustment factor mentioned in § 3 shall be used. In calculating this factor, if the interfering power spectrum is not known, a worst-case calculation of interference can be made with the approximation that the power spectral density of the interfering carrier is constant over the bandwidth of the desired carrier and is equal to the maximum value. The interfering power can then be calculated as the product of the maximum interfering power spectral density and the occupied bandwidth of the desired carrier, provided the result does not exceed the total power of the interfering carrier, see Recommendation ITU‑R S.741‑2.

## 3.6 Margin algorithm

To compute the margins, it is necessary first to determine the minimum required  value, which is a function of the *C*/*N* and the *K* factor:

,

where:

 minimum required *C/I* value (dB)

 *C*/*N* objective or calculated *C*/*N* value(dB) (see the 4th paragraph of § 3)

*K* : factor used in computing the minimum required *C*/*I* (dB) value (see Table 1), defining permissible level of single-entry interference and depending on the modulation characteristics of the desired signals (see Recommendations ITU‑R S.483 and ITU‑R S.523).

The margin is the difference between the calculated *C*/*I* value and the required *C*/*I* value:



where:

*M*: margin (dB)

 adjusted value of calculated *C*/*I,* taking into account the interference adjustment factor (dB)

 is the minimum required *C*/*I* value (dB) computed above.

Since  and values will vary depending on the geographical location, both values are computed:

– at the geographical locations of the associated specific earth stations, if any, or

– in case of associated typical earth stations, at the test point located within the service area where the  value is minimum.



## 3.7 The algorithm for interfering situations

The basic *C*/*I* is adjusted as follows:



where:

 adjusted *C*/*I* value, taking into account the interference adjustment factor (dB)

 basic calculated *C*/*I* value, before taking into account the interference adjustment factor (dB)

*Ia*: interference adjustment factor (dB).

The adjusted *C*/*I* values are determined separately for the uplink and downlink, keeping in mind that the interference adjustment factor may be different for the uplink and for the downlink.

The overall *C*/*I* value is also computed. If there are uplink calculations only (i.e. no downlink for the desired or interfering signal, or both, or no downlink frequency overlap between the desired and interfering signals), the values of the overall *C*/*I* are simply the uplink values of *C*/*I*. Similarly, if there are downlink calculations only (i.e. no uplink for the desired or interfering signal, or both, or no uplink frequency overlap between the desired and interfering signals), the values of the overall *C*/*I* are simply the downlink values of *C*/*I*. However, if the desired and interfering signals have both an uplink and a downlink, the overall *C*/*I* value is computed for each downlink test point using the worst-case uplink *C*/*I* value and the individual downlink *C*/*I* values:



where:

 overall *C*/*I* value of for a particular downlink test point (dB)

 worst-case uplink *C*/*I* value at any uplink test point (dB)

 downlink *C*/*I* for a particular downlink test point (dB).

## 3.8 Determination of interference adjustment factor

### 3.8.1 Interference from noise-like digital carriers (interference adjustment factor 1)

The current version of Recommendation ITU‑R S.741‑2 covers the case of co-frequency interference from noise-like digital carriers. For non-co-frequency interference, an interference adjustment factor (or bandwidth advantage factor) must be used, applying a factor A as defined below (mentioned as *Ia* above).

For the case of frequency offset between carriers, the resultant *C*/*I* ratio can be determined by the following equation:

*C*/*I*  10 log (*c*/*i* ) – *A*

where *A* is the bandwidth advantage factor (dB).

The factor A is the ratio of the interfering carrier power contained in the desired signal bandwidth to the total interfering carrier power under the assumption that the interfering carrier has uniform power spectral density across its occupied bandwidth.

### 3.8.2 Interference from noise-like analogue carriers (interference adjustment factor 2)

For these cases, the resultant *C*/*I* can be determined by using the equation in § 3.8.1 where the factor A is the ratio of the interfering carrier power contained in the desired signal bandwidth to the interfering carrier power with the approximation that the power spectral density of the interfering carrier is constant over the bandwidth of the desired carrier and is equal to the maximum value (see § 3.5).

## 3.9 The *C*/*N* calculation algorithm

The algorithm for *C*/*N* calculation requires the computation of the value of *N*, as follows:



where:

*N* : noise value (dBW)

*TR* : receiving system noise temperature (K) (space station or earth station)

*BW* : bandwidth (MHz).

The value of *N* is determined for the uplink (if there is an uplink) and for the downlink (if there is a downlink) for the desired system. Once *N* is determined, *C*/*N* will be computed at each uplink test point (if there is an uplink) and each downlink test point (if there is a downlink):

 (dB)

where:

*C* : carrier (dBW)

*N* : noise value (dBW) computed above.

The overall *C*/*N* is also computed. If there is an uplink only, the values of the overall *C*/*N* are simply the uplink values of *C*/*N*. Similarly, if there is a downlink only, the values of the overall *C*/*N* are simply the downlink values of *C*/*N*. However, if there is both an uplink and a downlink, the overall *C*/*N* value is computed for each downlink test point using the *worst*-*case* uplink *C*/*N* value and the individual downlink *C*/*N* values:



where:

 overall *C*/*N* value for a particular downlink test point (dB)

 worst-case uplink *C*/*N* value at any uplink test point (dB)

 downlink *C*/*N* value for a particular downlink test point (dB).

## 3.10 Determination of relative protection ratio for Case (V) in Table 2 (TV-FM) into (TV-FM)

When dealing with a non-co-frequency interfering situation from a TV-FM carrier into another TV‑FM carrier, the Radiocommunication Bureau/administrations are using the protection ratio masks defined in the Rules of Procedure relating to § 3.5.1 and § 3.8 of Annex 5 to Appendix **30** for the same case of interference, as appropriate. The resulting protection ratio relaxation is applied to the *K* factor of 14.0 dB (see Recommendation ITU‑R S.483).

ANNEX 1

Used parameters and calculation of the wanted-carrier-to-interference (C/I) ratio for cases of conventional and reverse band sharing situations (Cases 1 and 2)

Two possible cases are considered:

*Case I:* wanted and interfering networks share one or more frequency bands, each in the same direction of transmission;

*Case II:* wanted and interfering networks share one or more frequency bands, each in opposite directions of transmission (bidirectional use).

These two cases cover all relative satellite positions from closely-spaced to near-antipodal positions.

*[Editorial Note – A set of carrier-to-interference (C/I) calculations are performed following the geometrical considerations of Recommendation ITU R S.740.]*

ANNEX 2

Additional margins to be taken into consideration

# 1 Introduction

To finally assess the interfering effect on a given emission, it is necessary to adjust the resulting margins taking into consideration the definition of *C*/*N* which is necessary to derive the required single-entry interference levels for FSS carriers (see Table 1). In Table 1, *C*/*N* is defined as: “ratio (dB) of carrier to total noise power which includes all internal system noise and interference from other systems”. Therefore, and to comply with this definition, an additional margin defined by the wanted emission type will be added to the margins calculated on the basis of the internal system noise values provided by the concerned administrations.

# 2 Calculations performed according to No. 1.174

No. **1.174** defines the equivalent satellite link noise temperature as follows:

“The noise temperature referred to the output of the receiving antenna of the *earth station* corresponding to the radio frequency noise power which produces the total observed noise at the output of the *satellite link* excluding the noise due to *interference* coming *from satellite links* using other *satellites* and from terrestrial systems.”

The internal system noise temperature values provided by the administrations to derive the internal system noise, *N*, i.e. *Ts* and *Te*,are defined as follows:

“*Ts* : the receiving system noise temperature of the space station, referred to the output of the receiving antenna of the space station (K)”

“*Te* : the receiving system noise temperature of the earth station, referred to the output of the receiving antenna of the earth station (K).”

The above-mentioned values are combined (see Recommendation ITU‑R S.738) to derive *Tmin*, lowest *equivalent satellite link noise temperature*, as follows:

*Tmin*  *Te*  *min* *Ts*  *Ta*,

where:

*Ta* : other internal noise

*min* : minimum transmission gain of a specific satellite link subject to interference.

# 3 Noise to be calculated

To be in accordance with Recommendation ITU‑R S.741‑2 it seems necessary to add to the values of *N* calculated on the basis of *Te* and *Ts* mentioned above, the maximum permissible level of aggregate interference caused by other space networks (as appears in Recommendations ITU‑R S.466 (for FDM-FM telephony), ITU‑R S.483 (for TV analogue) and ITU‑R S.523 (for digital emissions)) as well as the contribution of terrestrial emissions sharing the same frequency bands.

# 4 Calculations of additional margins

## 4.1 Telephony FDM-FM

### 4.1.1 Aggregate interference produced by other satellite networks sharing the same frequency band

In accordance with Recommendation ITU‑R S.466, in frequency bands in which the network does not practice frequency reuse: the aggregate interference noise power should not exceed 2 500 pW0p, psophometrically weighted one minute mean power for more than 20% of any month. This amount corresponds to 25% of the allowable noise power of 10 000 pW0p established by Recommendation ITU‑R S.353 for the same percentage of time.

### 4.1.2 Maximum allowable values of aggregate interference from radio-relay systems in a telephone channel of a system in the FSS

In accordance with Recommendation ITU‑R SF.356, the interference caused by the aggregate of the transmitters of radio-relay stations should not exceed 1 000 pW0p psophometrically weighted one minute mean power for more than 20% of any month. This amount corresponds to 10% of the allowable noise power of 10 000 pW0p established by Recommendation ITU‑R S.353 for the same percentage of time.

### 4.1.3 Calculation of the additional margin

*Ntot* : total link noise including all internal noise and interference from other systems

*Ni*: link internal noise

*X* : noise due to interference from other systems

then:

*Ntot* = *Ni* + *X*

where:

*X* = (0.25 + 0.1) *Ntot*

Therefore:

*Ntot* = *Ni* + 0.35 *Ntot*

*Ntot*(1 − 0.35) = *Ni*

*Ntot* = 1.53 *Ni*

Additional margin: 10 × log(1.53) = 1.87 dB.

In the absence of sufficient information to calculate an additional margin for cases in which uplink and downlink are treated independently, e.g. telemetry and telecommand signals, the initial margins will be used, i.e. no additional margin will be considered for these cases.

## 4.2 Digital emissions

### 4.2.1 Aggregate interference produced by other satellite networks sharing the same frequency band

In accordance with Recommendation ITU‑R S.523, in frequency bands in which the network does not practice frequency reuse: the aggregate interference power level averaged over any 10 min, should not exceed, for more than 20% of any month, 25% of the total noise power level at the input to the demodulator that would give rise to a bit error ratio of 1 in 106 as it is established by Recommendation ITU‑R S.522 for the same percentage of time.

### 4.2.2 Maximum allowable values of aggregate interference from radio-relay systems into systems in the FSS, employing 8-bit PCM encoded telephony

In accordance with Recommendation ITU‑R SF.558, interference caused by the aggregate of the transmitters of radio-relay stations, averaged over any 10 min, should not exceed, for more than 20% of any month, 10% of the total noise power at the input of the demodulator that would give rise to a bit error ratio of 1 x 10-6 as it is established by Recommendation ITU‑R S.522 for the same percentage of time.

### 4.2.3 Calculation of the additional margin

The same values as in § 4.1.3 are obtained (1.87 dB).

## 4.3 Analogue TV

### 4.3.1 Aggregate interference produced by other satellite networks sharing the same frequency band

In accordance with Recommendation ITU‑R S.483, the aggregate interference noise power should not exceed 10% of the permissible video noise in the hypothetical reference circuit for more than 1% of the month.

### 4.3.2 Maximum allowable values of aggregate interference from radio-relay systems into FSS analogue video channel

No recommendations have been arrived at yet for interference from transmitters of the fixed service into FSS analogue video channel.

### 4.3.3 Calculation of the additional margin

*Ntot* = *Ni* + 0.1 *Ntot*

*Ntot*(1 − 0.1) = *Ni*

*Ntot* = 1.11 *Ni*

Additional margin: 10 × log(1.11) = 0.46 dB.

**5** Based on the above, a value of 0.46 dB should be added to the margins involving wanted analogue TV emissions, and 1.87 dB for digital and other wanted emissions.

*[Editorial Note – Description of the method transferred from Part B, Section B3, of the Rules of Procedure into RR Appendix 8. End of text.]*

ANNEX 3

Method for calculating the apparent increase in equivalent noise temperature of the satellite link subject to an interfering emission

# 1 Introduction

Following is the methodology for calculation of apparent increase in the equivalent noise temperature of satellite link subject to interference, because the criterion for permissible single-entry interference Δ*Т*/*Т* is a key indicator to be relied on in the calculation of either protection ratios *I*/(*N* + *I*) or *С*/*I*.

*[Editorial Note – The purpose of the proposed modification to the text of Appendix 8 (WRC-03) is to maintain the useful procedural information set forth below on the determination of frequency assignment parameters.]*

# 2 Calculation of the apparent increase in equivalent noise temperature of the satellite link subject to an interfering emission

*[Editorial Note – Text unchanged.]**[Editorial Note –* *Deletion of the text and titles of §§ 3 and 4.]*

# 3 Calculation of the topocentric angular separation between two geostationary satellites

*[Editorial Note – Text of ANNEX I unchanged.]*

# 4 Calculation of the free-space transmission loss

*[Editorial Note – Text of ANNEX II unchanged.]*

# 5 Radiation patterns for earth station antennas to be used when they are not published

*[Editorial Note – Text of ANNEX II unchanged.]*

ANNEX 4

Example of an application of Appendix 8 (Rev.WRC‑15)

*[Editorial Note – Text to be developed. In preparing the example of an application of Appendix 8, it would be advantageous to have assistance from the Bureau, which has considerable experience of the examination of satellite network notifications under RR No. 11.32A.]*

ADD RCC/8A23A2/8

Draft New Resolution [RCC-A912] (wrc-15)

Procedure for the transition to the new criterion of  
permissible single-entry interference established by WRC-15

The World Radiocommunication Conference (Geneva, 2015),

considering

*а)* that WRC‑15 adopted a new criterion for establishing the need for coordination and determining the probability of harmful interference, together with a calculation method which is described in Appendix **8 (Rev.WRC‑15)** or referred to therein;

*b)* that the frequency-sharing condition is the permissible single-entry interference,

considering further

*а)* the significant congestion of the geostationary orbit by submitted and brought into use networks in the unplanned 4/6 GHz and 10/11/12/14 GHz bands, where the average orbital separation between operational GSO satellites is currently 2-3 degrees;

*b)* the complexity and incompleteness of the coordination process, leading to a large number of cases in which No. **11.41** is applied;

*c)* the need for simplification of the coordination process to facilitate access to the GSO orbital‑spectrum resource for new satellite networks;

*d)* that the administrations to be coordinated with and frequency assignments to be taken into account in effecting coordination are identified using Appendix **5**,

recognizing

*a)* that in view of the change in the value of the permissible single-entry interference criterion, BR requires instructions from the conference in respect of the processing of notices insofar as establishing the need for coordination and determining the probability of harmful interference are concerned;

*b)* that it is necessary to establish the procedure for transition to the new permissible single-entry interference criterion for the following categories of satellite network notices:

− submitted for advance publication of information or for coordination after the closing date of WRC‑15;

− received under No. **9.6** but not yet processed by the Bureau before “Date”;

− at different stages of coordination/notification or recording;

− frequency assignments already notified and recorded in MIFR;

*c)* that, before WRC‑15, the criterion Δ*Т*/*Т* = 6% was used in determining frequency assignments to be taken into account under No. **9.7** or at the stage of applying No. **9.27**, depending on the applicability of the coordination arc criterion, and/or when applying Nos. **9.41** and **11.32A**;

*d)* that WRC‑15 established that cases where the *С*/*I* calculated value is less than the established criterion *C*/*N* + X\* (dB) (see Appendices **5** and **8**) constitute the conditions for establishment of the need coordination,

resolves

1 that as from [хх ххх 2015], when determining the need for coordination between frequency assignments to satellite networks under No. **9.7**, as well as when applying Nos. **9.41** and **11.32А**, criterion*C*/*I*, which is determined on the basis of permissible single-entry interference criterion (ΔТ/Т) (*C*/*I =C*/*N* + X (dB)[[4]](#footnote-4)1, shall be used;

2 that as from [хх ххх 201(5)], the established permissible single-entry interference criterion shall be applied:

− to all submissions of satellite networks under No. **9.1** sent to BR after the closure of WRC‑15, in respect of submissions sent to BR under Article **9** after the closure of WRC‑15;

− to all submissions of satellite networks under No. **9.1** sent to BR before WRC‑15, but in which respect submissions have not yet been sent under No. **9.6**, in respect of submissions sent to BR under Article **9** after the closing date of WRC‑15;

− to all submissions of satellite networks, a coordination request for which BR received after the closing date of WRC‑15 in respect of submissions sent to BR under Article **9** after the closing date of WRC‑15;

− to all submissions received by the BR not listed above,the criterion value existing before closing date of WRC‑15 shall continue to be applied,

3 that for all submissions received by BR and not listed under *resolves* 2 above, the criterion value for establishing the need for coordination (ΔТ/Т=6%) and determining the probability of harmful interference in force before the closing date of WRC-15 shall continue to apply,

resolves further

to recommend to BR that it refine the available software in a timely manner (within [X] months after the closing date of WRC‑15) and provide it to administrations for the purposes of:

− *С*/*I* ratio calculation;

− *С*/*N* ratio calculation using parameters submitted under Appendix **4**, and entry of the information into the notification database.

**Reasons:** This WRC resolution reflects the principle whereby any decision taken by WRC-15 with respect to any new criterion for establishing the need for coordination and determination of the probability of harmful interference shall not be applied retroactively, so as to ensure the protection of existing networks from additional unplanned interference from new networks for which new need-for-coordination criteria are being used.

The new regulatory arrangements should be applied only between satellite networks for which requests for coordination are received by the Bureau after the date of entry into force of these new procedures. In the case of satellite networks for which requests for coordination are received by the Bureau before that date, the regulatory regime in force before that date should continue to apply

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1. \* See also Resolution **[RCC-A912] (WRC‑15)**. [↑](#footnote-ref-1)
2. 7.0 dB ≤ X ≤ 12.2 dB. For an interference level equivalent to Δ*T/T* = 20%, X = 7.0 dB. If other levels of interference are to be considered, X may be adjusted by XY% = 7.0 − 10log(Y/20), where 6 ≤ Y ≤ 20. The value X is to be determined by a decision of WRC-15. [↑](#footnote-ref-2)
3. 32 7.0 dB ≤ X ≤ 12.2 dB. For an interference level equivalent to Δ*T/T* = 20%, X = 7.0 dB. If other levels of interference are to be considered, X may be adjusted by XY% = 7.0 − 10 log (Y/20), where 6 ≤ Y ≤ 20. The value X is to be determined by a decision of WRC-15. [↑](#footnote-ref-3)
4. 1 This criterion of single-entry interference corresponds to Δ*Т/T* = Y\*%.

   \* 7.0 dB ≤ *X* ≤ 12.2 dB. For an interference level equivalent to Δ*T/T* = 20%, *X* = 7.0 dB. If other levels of interference are to be considered, *X* may be adjusted by *X*Y% = 7.0 − 10log(Y/20), where 6 < Y ≤ 20. [↑](#footnote-ref-4)