Source: CPG03(2003)2

EUROPEAN COMMON PROPOSALS

PART 8A

Agenda Item 1.8.1 - Issues related to unwanted emissions, boundary between spurious and out-of-band emissions

Introduction

WRC-2003 agenda Item 1.8.1 invites the Conference to consider the boundary between the spurious and out-of-band emissions with a view to include the boundary in Appendix 3.

The proposal herein amends Article **1** and Appendix **3** to take into account the most recent studies identifying the unwanted emissions to which the limits of Appendix **3** Section II apply. These studies define the out-of-band and spurious domains of an emission and determine the boundary between them:

– Recommendation ITU-R SM.329-10 "Unwanted Emissions in the Spurious Domain"

– Recommendation ITU–R SM.1541-1, "Unwanted Emission in the Out-of-Band Domain"

– Recommendation ITU-R SM.1539-1, "Variation of the Boundary between the Out-of-Band and Spurious Domains required for the application of Recommendation ITU-R SM.1541 and SM.329"

Based on the results of the studies undertaken in Task Group 1/5, CEPT proposes the modification of Article 1 and the modification of Appendix 3 by providing specific exceptions from the general 2.5Bn boundary based on Recommendations ITU-R SM.1539 and 1541.

The sequence of the text contained in Section II, existing paragraphs 8-10 in Appendix 3 of the Radio Regulations (2001), has been altered for clarity and in order to address potential ambiguities in the interpretation of the reference bandwidths relating to the various services. As a related issue on the agenda item, a reference bandwidth for a further type of radar has also been included subsequent to work undertaken in WP8B.

Proposals

ARTICLE 1

Terms and definitions

Section VI – Characteristics of emissions and radio equipment

ADD EUR/1.8.1/1

1.146*bis* *out-of-band domain* (of an emission): The frequency range, immediately outside the necessary bandwidth but excluding the *spurious domain*, in which *out-of-band emissions* generally predominate.

Reasons: *Out-of-band emissions, defined based on their source, occur in the out-of-band domain and, to a lesser extent, in the spurious domain. Spurious emissions likewise may occur in the out-of-band domain as well as in the spurious domain.*

ADD EUR/1.8.1/2

1.146*ter* *spurious domain* (of an emission): The frequency range beyond the *out-of-band domain* in which *spurious emissions* generally predominate.

Reasons: *Adoption of these two definitions will provide a means to distinguish between frequency ranges within which the emission limits of Appendix 3, Section II either apply or do not apply.*

ARTICLE 3

Technical characteristics of stations

MOD EUR/1.8.1/3

3.6 Transmitting stations shall conform to the maximum permitted power levels specified in Appendix **3**.

MOD EUR/1.8.1/4

3.7 Transmitting stations shall conform to the maximum permitted power levels for out-of-band emissions, or unwanted emissions in the out-of-band domain, specified for certain services and classes of emission in the present Regulations. In the absence of such specified maximum permitted power levels transmitting stations should, to the maximum extent possible, satisfy the requirements relating to the limitation of the out-of-band emissions, or unwanted emissions in the out-of-band domain, specified in the most recent ITU-R Recommendations (see Resolution **27 (Rev. WRC-97)**[*]).

Reasons: *Slight modification of **3.6** and **3.7** to accommodate emissions specified using both the existing definitions of out-of-band emission and spurious emission, and the definitions proposed above.*

Source: **Annex V to CPG03(2002)93r1**

MOD EUR/1.8.1/5

APPENDIX 3 (WRC-2000)

Table of maximum permitted power levels for spurious or spurious domain emissions

(See Article **3**)

Reasons: *Section I of this Appendix applies to spurious emissions, while Section II applies to unwanted emissions in the spurious domain. The proposed title encompasses both types of emission limits.*

1 The following sections indicate the maximum permitted levels of certain unwanted emissions, in terms of power as indicated in the tables, of components supplied by a transmitter to the antenna transmission line. Section I, which provides spurious emissions limits, is applicable until 1 January 2012 to transmitters installed on or before 1 January 2003; Section II, which limits emissions in the spurious domain, is applicable to transmitters installed after 1 January 2003 and to all transmitters after 1 January 2012. The provisions of No. **4.5** apply to unwanted emissions not covered in Sections I or II.

2 Spurious and spurious domain emissions (covered by Sections I and II) from any part of the installation, other than the antenna and its transmission line, shall not have an effect greater than would occur if this antenna system were supplied with the maximum permitted power at the frequency of that emission.

3 These levels shall not, however, apply to emergency position-indicating radiobeacon (EPIRB) stations, emergency locator transmitters, ships' emergency transmitters, lifeboat transmitters, survival craft stations or maritime transmitters when used in emergency situations.

4 For technical or operational reasons, more stringent levels than those specified may be applied to protect specific services in certain frequency bands. The levels applied to protect these services, such as safety and passive services, shall be those agreed upon by the appropriate world radiocommunication conference. More stringent levels may also be fixed by specific agreement between the administrations concerned. Additionally, special consideration of transmitter spurious or spurious domain emissions may be required for the protection of safety services, radio astronomy and space services using passive sensors. Information on the levels of interference detrimental to radio astronomy, Earth exploration satellites and meteorological passive sensing is given in the most recent version of Recommendation ITU-R SM.329.

5 Spurious or spurious domain emission limits (covered by Sections I and II) for combined radiocommunication and information technology equipment are those for the radiocommunication transmitters.

Reason: *The revised paragraphs reflect the distinction between the types of emissions to which the limits of Sections I and II apply.*

NOC EUR/1.8.1/6

Section I – Spurious emission limits for transmitters installed on or before 1 January 2003 (valid until 1 January 2012)

MOD EUR/1.8.1/7

Section II – Spurious domain emission limits for transmitters installed after 1 January 2003 and for all transmitters after 1 January 2012

Application of these limits

7 The frequency range of the measurement of spurious domain emissions is from 9 kHz to 110 GHz or the second harmonic if higher.

Reason: *The provisions of this Section apply to unwanted emissions in the spurious domain, here called "spurious domain emissions," as opposed to the spurious emissions addressed in Section I*

8 The spurious domain emission levels are specified in the following reference bandwidths:

– 1 kHz between 9 kHz and 150 kHz

– 10 kHz between 150 kHz and 30 MHz

– 100 kHz between 30 MHz and 1 GHz

– 1 MHz above 1 GHz.

Reasons: *For clarity, the reference bandwidths relating to most of the services is best placed as part of the initial text in this Section and is transferred from the existing pararagraph 10. In addition, the provisions of this Section apply to unwanted emissions in the spurious domain, here called "spurious domain emissions," as opposed to the spurious emissions addressed in Section I.*

9 As a special case, the reference bandwidth of all space service spurious domain emissions should be 4 kHz.

Reasons*: For clarity, the above text warrants a separate paragraph No. and is text transferred form the existing paragraph 10. In addition, the provisions of this Section apply to unwanted emissions in the spurious domain, here called "spurious domain emissions," as opposed to the spurious emissions addressed in Section I.*

10 As a special case for radar systems, the reference bandwidths for defining spurious domain emission levels should be calculated for each particular system. Thus, for the four general types of radar pulse modulation utilized for radionavigation, radiolocation, acquisition, tracking and other radiodetermination functions, the reference bandwidth values are determined using the following:

– for fixed-frequency, non-pulse-coded radar, one divided by the radar pulse length, in seconds (e.g. if the radar pulse length is 1 μs, then the reference bandwidth is 1/1 μs = 1 MHz);

– for fixed-frequency, phase coded pulsed radar, one divided by the phase chip length, in seconds (e.g. if the phase coded chip is 2 μs long, then the reference bandwidth is 1/2 μs = 500 kHz);

– for frequency modulated (FM) or chirped radar, the square root of the quantity obtained by dividing the radar bandwidth in MHz by the pulse length, in microseconds (e.g. if the FM is from 1 250 MHz to 1 280 MHz or 30 MHz during the pulse of 10 μs, then the reference bandwidth is $(30 \text{ MHz}/10 \text{ μs})^{1/2} = 1.73$ MHz).

– for radars operating with multiple waveforms the reference bandwidth is determined empirically from observations of the radar emission and are obtained following the guidance given in Recommendation ITU-R M.1177.

– In the case of radars, where the bandwidths determined as above, are greater than 1 MHz, then a reference bandwidth of 1 MHz should be used.

Reasons :

This assists in clarification of the reference bandwidths for defining limits of spurious domain emissions and maintains consistency with the existing version of RR Appendix 3. Moreover, in cases where previously stipulated reference bandwidths exceeding 1 MHz could not be directly used as the measurement bandwidth, since they are not commonly available on spectrum analysers, it is proposed to use a maximum of 1 MHz reference bandwidth. Additionally, measurement bandwidths are specified within Recommendation ITU-R M.1177. Based on the output of the last WP8B meeting, it is proposed to cover the case of multiple waveform radars in Appx 3 (4th bullet in above). The text below the 3rd bullet has been deleted since the revised version of ITU-R Recommendation M.1177 provides acceptable measurement methods for all types of radars. Text has been transferred from existing paragraph 9. In addition, the provisions of this Section apply to unwanted emissions in the spurious domain, here called "spurious domain emissions," as opposed to the spurious emissions addressed in Section I.

10bis Guidance regarding the methods of measuring spurious domain emissions is given in the most recent version of Recommendation ITU-R SM.329. The e.i.r.p. method specified in that Recommendation should be used when it is not possible to accurately measure the power supplied to the antenna transmission line, or for specific applications where the antenna is designed to provide significant attenuation in the spurious domain. Additionally, the e.i.r.p. method may need some modification for special cases.

Specific guidance regarding the methods of measuring spurious domain emissions from radar systems is given in the most recent version of Recommendation ITU-R M.1177.

Reasons: *Text for guidance from both existing paragraphs 8 and 9 are best combined. In addition, the provisions of this Section apply to unwanted emissions in the spurious domain, here called "spurious domain emissions," as opposed to the spurious emissions addressed in Section I.*

11 The emission limits of this Section apply to all emissions, including harmonic emissions, intermodulation products, frequency conversion products and parasitic emissions, at frequencies in the spurious domain (See Figure 1). The upper and lower parts of the spurious domain extend outward from a boundary determined using Annex I.

Reasons: *Since the boundary between the out-of-band and spurious domains is determined using Annex I, the information is no longer needed here.*

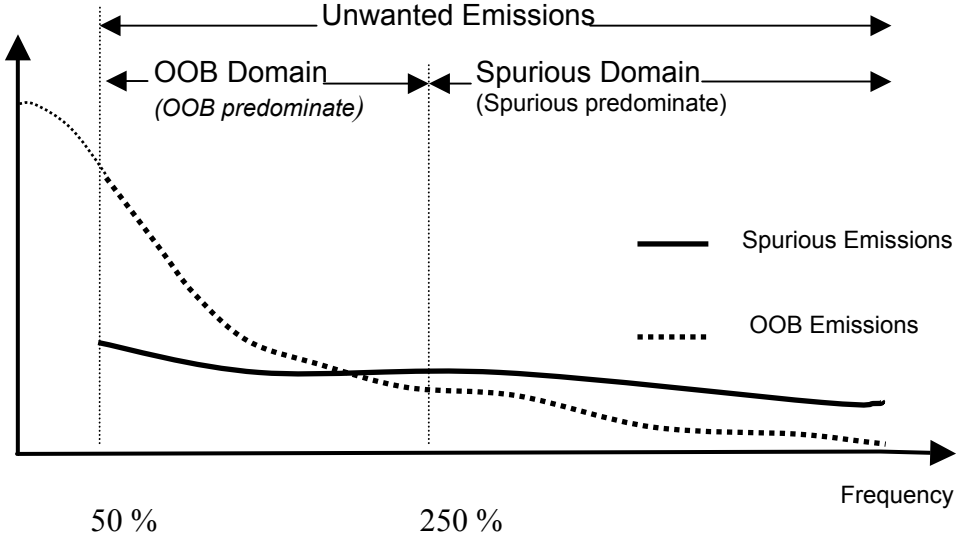


Figure 1

Out-of-band and spurious domains

Reasons: The figure illustrates the text description of the locations of the out-of-band and spurious domains from the previous paragraph.

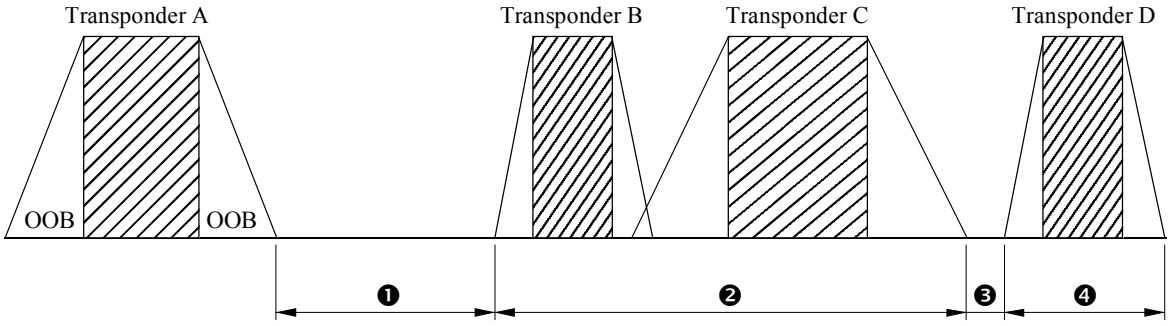
Reasons: *The information used to determine the boundary between the out-of-band and spurious domains is now found in Annex I.*

11*ter* For the case of a single satellite operating with more than one transponder in the same service area, and when considering the limits for spurious domain emissions as indicated in § 11 of this Appendix, spurious domain emissions from one transponder may fall on a frequency at which a second, companion transponder is transmitting. In these situations, the level of spurious domain emissions from the first transponder is well exceeded by the fundamental or out-of-band domain emissions of the second transponder. Therefore, the limits of this Appendix should not apply to those emissions of a satellite that fall within either the necessary bandwidth or the out-of-band domain of another transponder on the same satellite, in the same service area (see Fig. 2).

FIGURE 2

Example of the applicability of spurious domain emission limits to a satellite transponder

Source: **Annex V to CPG03(2002)93r1**



Transponders A, B, C and D are operating on the same satellite in the same service area. Transponder A is not required to meet spurious emission limits in frequency ranges ❷ and ❹, but is required to meet them in frequency ranges ❶ and ❸. (WRC-2000)

12 Examples of applying 43 + 10 log (*P*) to calculate attenuation requirements

Where specified in relation to mean power, spurious domain emissions are to be at least *x* dB below the total mean power *P*, i.e. –*x* dBc. The power *P* (W) is to be measured in a bandwidth wide enough to include the total mean power. The spurious domain emissions are to be measured in the reference bandwidths given in the Recommendation. The measurement of the spurious domain emission power is independent of the value of necessary bandwidth. Because the absolute emission power limit, derived from 43 + 10 log (*P*), can become too stringent for high-power transmitters, alternative relative powers are also provided in Table II.

Example 1

A land mobile transmitter, with any value of necessary bandwidth, must meet a spurious domain emission attenuation of 43 + 10 log (*P*), or 70 dBc, whichever is less stringent. The reference bandwidths used to define the limits for spurious domain emissions are defined in § 8 to 10 of this Appendix. Applying this in the frequency range between 30 MHz and 1 GHz gives a reference bandwidth of 100 kHz.

With a measured total mean power of 10 W:

– Attenuation relative to total mean power = 43 + 10 log (10) = 53 dBc.

– The 53 dBc value is less stringent than the 70 dBc, so the 53 dBc value is used.

– Therefore: Spurious domain emissions must not exceed 53 dBc in a 100 kHz bandwidth, or converting to an absolute level, they must not exceed 10 dBW – 53 dBc = –43 dBW in a 100 kHz reference bandwidth.

With a measured total mean power of 1 000 W:

– Attenuation relative to total mean power = 43 + 10 log (1 000) = 73 dBc.

– The 73 dBc value is more stringent than the 70 dBc limit, so the 70 dBc value is used.

– Therefore: Spurious domain emissions must not exceed 70 dBc in a 100 kHz bandwidth, or converting to an absolute level, they must not exceed 30 dBW − 70 dBc = –40 dBW in a 100 kHz reference bandwidth.

Example 2

A space service transmitter with any value of necessary bandwidth must meet a spurious domain emission attenuation of 43 + 10 log (*P*), or 60 dBc, whichever is less stringent. To measure spurious domain emissions at any frequency, Note 10 to Table II indicates using a reference bandwidth of 4 kHz.

With a measured total mean power of 20 W:

– Attenuation relative to total mean power = 43 + 10 log (20) = 56 dBc.

– The 56 dBc value is less stringent than the 60 dBc limit, so the 56 dBc value is used.

– Therefore: Spurious domain emissions must not exceed 56 dBc in a 4 kHz reference bandwidth, or converting to an absolute level, they must not exceed 13 dBW − 56 dBc = –43 dBW in a 4 kHz reference bandwidth.

TABLE II (WRC-2000)

Attenuation values used to calculate maximum permitted spurious domain emission power levels for use with radio equipment

Service category in accordance with Article 1, or equipment type[15]	**Attenuation (dB) below the power supplied to the antenna transmission line**
All services except those services quoted below:	43 + 10 log (*P*), or 70 dBc, whichever is less stringent
Space services (earth stations)[10, 16]	43 + 10 log (*P*), or 60 dBc, whichever is less stringent
Space services (space stations)[10, 17]	43 + 10 log (*P*), or 60 dBc, whichever is less stringent
Radiodetermination[14]	43 + 10 log (*PEP*), or 60 dB, whichever is less stringent
Broadcast television[11]	46 + 10 log (*P*), or 60 dBc, whichever is less stringent, without exceeding the absolute mean power level of 1 mW for VHF stations or 12 mW for UHF stations. However, greater attenuation may be necessary on a case by case basis.
Broadcast FM	46 + 10 log (*P*), or 70 dBc, whichever is less stringent; the absolute mean power level of 1 mW should not be exceeded
Broadcasting at MF/HF	50 dBc; the absolute mean power level of 50 mW should not be exceeded
SSB from mobile stations[12]	43 dB below *PEP*
Amateur services operating below 30 MHz (including those using SSB)[16]	43 + 10 log (*PEP*), or 50 dB, whichever is less stringent
Services operating below 30 MHz, except space, radiodetermination, broadcast, those using SSB from mobile stations, and amateur[12]	43 + 10 log (*X*), or 60 dBc, whichever is less stringent, where $X = PEP$ for SSB modulation, and $X = P$ for other modulation
Low-power device radio equipment[13]	56 + 10 log (*P*), or 40 dBc, whichever is less stringent
Emergency transmitters[18]	No limit

P: mean power in watts supplied to the antenna transmission line, in accordance with No. **1.158**. When burst transmission is used, the mean power *P* and the mean power of any spurious domain emissions are measured using power averaging over the burst duration.

PEP: peak envelope power in watts supplied to the antenna transmission line, in accordance with No. **1.157**.

TABLE II *(end)*

dBc: decibels relative to the unmodulated carrier power of the emission. In the cases which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power *P*.

[10] Spurious domain emission limits for all space services are stated in a 4 kHz reference bandwidth.

[11] For analogue television transmissions, the mean power level is defined with a specified video signal modulation. This video signal has to be chosen in such a way that the maximum mean power level (e.g. at the video signal blanking level for negatively modulated television systems) is supplied to the antenna transmission line.

[12] All classes of emission using SSB are included in the category "SSB".

[13] Low-power radio devices having a maximum output power of less than 100 mW and intended for short-range communication or control purposes; such equipment is in general exempt from individual licensing.

[14] For radiodetermination systems (radar as defined by No. **1.100**), spurious domain emission attenuation (dB) shall be determined for radiated emission levels, and not at the antenna transmission line. The measurement methods for determining the radiated spurious domain emission levels from radar systems should be guided by Recommendation ITU-R M.1177. (WRC-2000)

[15] In some cases of digital modulation (including digital broadcasting), broadband systems, pulsed modulation and narrow-band high-power transmitters for all categories of services, there may be difficulties in meeting limits close to ±250% of the necessary bandwidth.

[16] Earth stations in the amateur-satellite service operating below 30 MHz are in the service category "Amateur services operating below 30 MHz (including those using SSB)". (WRC-2000)

[17] Space stations in the space research service intended for operation in deep space as defined by No. **1.177** are exempt from spurious domain emission limits. (WRC-2000)

[18] Emergency position-indicating radio beacon, emergency locator transmitters, personal location beacons, search and rescue transponders, ship emergency, lifeboat and survival craft transmitters and emergency land, aeronautical or maritime transmitters. (WRC-2000)

ADD EUR/1.8.1/8

ANNEX I

Determination of the boundary between the out-of-band and spurious domains

1 In general the boundary between the out-of-band and spurious domains occurs when the frequency is separated from the centre frequency of the emission by 250%, of the necessary bandwidth.

2 Except as provided below, the boundary between the out-of-band and spurious domains occurs at frequencies that are separated from the centre frequency of the emission by the values shown in Table 1. For most systems, the centre frequency of the emission is the centre of the necessary bandwidth. For multichannel or multicarrier transmitters/transponders, where several carriers may be transmitted simultaneously from a final output amplifier or an active antenna, the centre frequency of the emission is taken to be the centre of the 3 dB bandwidth of the transmitter or transponder and the transmitter or transponder bandwidth is used in place of the necessary bandwidth for determining the boundary. Some systems specify unwanted emissions relative to channel bandwidth, or channel spacing. These may be used as a substitute for the necessary bandwidth in Table 1, provided they are found in ITU–R Recommendations.

TABLE 1

Values for frequency separation between the centre frequency and the boundary of the spurious domain

Frequency range	Narrow-band case		Normal separation	Wideband case	
	for B_n <	Separation		for B_n >	Separation
9 kHz < f_c < 150 kHz	250 Hz	625 Hz	2.5 B_n	10 kHz	1.5 B_n + 10 kHz
150 kHz < f_c < 30 MHz	4 kHz	10 kHz	2.5 B_n	100 kHz	1.5 B_n + 100 kHz
30 MHz < f_c < 1 GHz	25 kHz	62.5 kHz	2.5 B_n	10 MHz	1.5 B_n + 10 MHz
1 GHz < f_c < 3 GHz	100 kHz	250 kHz	2.5 B_n	50 MHz	1.5 B_n + 50 MHz
3 GHz < f_c < 10 GHz	100 kHz	250 kHz	2.5 B_n	100 MHz	1.5 B_n + 100 MHz
10 GHz < f_c < 15 GHz	300 kHz	750 kHz	2.5 B_n	250 MHz	1.5 B_n + 250 MHz
15 GHz < f_c < 26 GHz	500 kHz	1.25 MHz	2.5 B_n	500 MHz	1.5 B_n + 500 MHz
f_c > 26 GHz	1 MHz	2.5 MHz	2.5 B_n	500 MHz	1.5 B_n + 500 MHz
NOTE—In Table 1, f_c is the centre frequency of the emission and B_n is the necessary bandwidth. If the assigned frequency band of the emissions extends across two frequency ranges, then the values corresponding to the higher frequency range shall be used for determining the boundary.					

Example 1: The necessary bandwidth of an emission at 26 MHz is 1.8 kHz. Since 2.5B_n is only 4.5 kHz, the minimum separation applies. The spurious domain begins 10 kHz each side of the centre of the necessary bandwidth.

Example 2: The necessary bandwidth of an emission at 8 GHz is 200 MHz. Since the wideband case applies for B_n > 100 MHz at that frequency, the spurious domain begins 400 MHz each side

of the centre of the necessary bandwidth. Using the general separation formula, the out-of-band domain would have extended to 2.5 × 200 MHz = 500 MHz either side of the centre frequency.

3 Tables 2 and 3 show exceptions to Table 1 for narrow-band and wideband cases, respectively, applicable to particular systems or services and frequency bands.

TABLE 2

Narrow-band variations for systems or services and frequency bands

System or service	Frequency range	Narrow-band case	
		for B_n <	Separation
FS	14 kHz - 1.5 MHz	20 kHz[1]	50 kHz
FS	1.5-30 MHz	80 kHz[2]	200 kHz

[1] This is based on an assumption that the maximum value of the necessary bandwidth is about 3 kHz for the frequency range 14 kHz - 1.5 MHz. The value of 50 kHz separation is extremely large as compared with the necessary bandwidth. It is because unwanted emissions of high power transmitters under modulated conditions have to be below the spurious limit (70 dBc) at the boundary between the out-of-band and spurious domains.

[2] This is based on an assumption that the maximum value of the necessary bandwidth is about 12 kHz for the frequency range 1.5-30 MHz. The value of 200 kHz separation is extremely large as compared with the necessary bandwidth. It is because unwanted emissions of high power transmitters under modulated conditions have to be below the spurious limit (70 dBc) at the boundary between the out-of-band and spurious domains. Also, if future systems in the fixed service operating in this frequency range require a necessary bandwidth larger than 12 kHz, it may become necessary to review the 200 kHz separation. It should be noted that for medium or low power transmitters (e.g. below 1 kW), a smaller value may be appropriate as the minimum separation. This matter requires further study.

TABLE 3

Wideband variations for systems or services and frequency bands

System or service	Frequency range	Wideband case	
		for B_n >	Separation
FS	14-150 kHz	20 kHz	1.5 B_n + 20 kHz
FSS	3.4-4.2 GHz	250 MHz	1.5 B_n + 250 MHz
FSS	5.725-6.725 GHz	500 MHz	1.5 B_n + 500 MHz
FSS	7.25-7.75 GHz and 7.9-8.4 GHz	250 MHz	1.5 B_n + 250 MHz
FSS	10.7-12.75 GHz	500 MHz	1.5 B_n + 500 MHz
BSS	11.7-12.75 GHz	500 MHz	1.5 B_n + 500 MHz
FSS	12.75-13.25 GHz	500 MHz	1.5 B_n + 500 MHz
FSS	13.75-14.8 GHz	500 MHz	1.5 B_n + 500 MHz

4 For primary radar systems, the variation of the boundary between the out-of-band and spurious domains is described in Recommendation ITU-R SM.1541.

Reasons: *Annex I is added for the following reasons:*

- *Section II of this Appendix states that the emission limits apply to unwanted emissions in the spurious domain. This Annex is needed to determine the boundary between the out-of-band and spurious domains, and thus the frequencies to which the emission limits of Section II apply.*

- *Table 1, taken from Recommendation ITU–R SM.1539, shows the normal boundary of $2.5B_n$, along with the narrowband and wideband exception. The information in the Recommendation, along with the text of existing paragraphs 11 and 11bis, have been included, though they have been shortened to bring them in line with the form of other Appendices.*

- *Tables 2 and 3 are also taken from Recommendation ITU–R SM.1539.*

- *In case of radar systems the boundary depends on the type of radar which is being considered; this variation is described in Recommendations ITU-R SM.1541 and ITU-R SM.1539*

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