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Methodology for determining terrestrial and space-to-Earth sharing and coordination criteria for meteorological aids in the 400.15-406 MHz and 1 668-1700 MHz bands

RS Series

Remote sensing systems

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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

RECOMMENDATION ITU-R RS.1884

Methodology for determining terrestrial and space-to-Earth sharing and coordination criteria for meteorological aids in the 400.15-406 MHz and 1 668-1 700 MHz bands

(2011)

Scope

This Recommendation provides information on determining terrestrial and space-to-Earth sharing and coordination criteria for meteorological aids (radiosondes, dropsondes and rocketsondes) operating in the 400.15-406 MHz and 1 668.4-1 700 MHz bands.

The ITU Radiocommunication Assembly,

considering

a)   that frequency bands allocated to the meteorological aids service may be shared by systems operating in other services, including the Earth exploration-satellite and meteorological-satellite services;

b)   that sharing and coordination criteria for these systems should relate to the maximum level of interference that can be accepted from an individual interferer;

c)   that the methodology used to develop sharing and coordination criteria for the Earth exploration-satellite and meteorological-satellite services may be applied to systems operating in the meteorological aids service in order to determine acceptable single-entry levels of interference that are greater than or equal to the permissible levels,

recommends

1   that the methodology given in Annex 1 should be used for the development of sharing and coordination criteria and in compatibility studies between Earth exploration-satellite and meteorological-satellite services, and meteorological aids service;

2   that the example given in Annex 2 should be used as a guide in implementation of the methodology given in Annex 1;

3   that the interference criteria given in Recommendation ITU-R RS.1263 for meteorological aids operating in the 400.15-406 MHz and 1 668.4-1 700 MHz bands, should be considered in the development of coordination criteria for the specific systems operating in the Earth exploration-satellite and meteorological-satellite services.

Annex 1

Methodology for determining sharing and coordination criteria

1   Initial division of interference criteria

In cases involving space and terrestrial services, it is useful to initially divide the permissible level of total interfering signal power (i.e. interference criteria) between interference via terrestrial signal paths (i.e. for earth and terrestrial station transmissions) and space-to-Earth signal paths because the assumed number of interferers and the associated interference statistics usually differ between these two categories of interfering services. In other cases, this initial division is unnecessary. The initial division is accomplished using the following equations:

$$i_S\,(20) = i\,(20) \,\times\, (A_S\,/100) \tag{1a}$$

$$i_t\,(20) \,=\, i\,(20) \,-\, i_S\,(20) \tag{1b}$$

$$i_t\,(p_t) \,=\, i\,(p) \,-\, i_S\,(p_S) \tag{2a}$$

$$p_S \,=\, p \,\times\, (a_S\,/100) \tag{2b}$$

$$p_t \,=\, p \,-\, p_S \tag{2c}$$

where:

$i\,(20)$:   permissible level of total interfering signal power (W) to be exceeded for no more than 20% of the time (i.e. long-term interference criteria)

$i_S\,(20)$, $i_S\,(p_S)$:   interfering signal power (W) level budgeted for space-to-Earth signals that is to be exceeded for no more than 20% and p_S% of the time, respectively

$i_t\,(20)$, $i_t\,(p_t)$:   interfering signal power (W) level budgeted for terrestrial signal paths that is to be exceeded for no more than 20% and p_t% of the time, respectively

A_S :   percentage of permissible level of total interfering signal power (W) allotted for interference from space-to-Earth signals

$i\,(p)$:   permissible level of total interfering signal power (W) to be exceeded for no more than p% of the time (i.e. short-term interference criteria)

p :   percentage of time associated with the short-term interference criteria

p_S :   percentage of time that space-to-Earth signals may exceed the interference threshold

p_t :   percentage of time that signals propagated over terrestrial paths may exceed the interference threshold

a_S :   portion of the percentage of time p allotted to interference from space-to-Earth signals.

In equations (1a) and (1b), the long-term interference criteria are divided on a power basis among interference categories. This is because long-term space-to-Earth and terrestrial interference levels are expected to be present simultaneously.

The short-term interference criteria are divided, in equations (2a), (2b) and (2c), among space-to-Earth and terrestrial interference categories. Short-term enhanced levels of interference are not likely to occur simultaneously. However, interference from space-to-Earth paths at their long-term levels must be considered when the short-term interference budget is established for terrestrial interfering signal paths, and vice versa.

Values for the parameters A_s and a_s should be selected to correspond with the relative levels of interference expected from space and terrestrial services. These parameter values are estimated from the allocations, interfering service characteristics, and anticipated usage of the subject frequency band.

2 Determination of permissible single-entry interference levels

Equations (3), (4a) and (4b) accomplish subdivision of the interference budgeted to space-to-Earth signal paths (and terrestrial signal paths, where applicable) in order to establish an appropriate permissible level of interfering signal power from individual transmitters (i.e. single-entry interference).

$$i'(20) = i(20) / n \tag{3}$$

$$i'(p') = i(p) / yn - (i(20) \times (1 - y)) \tag{4a}$$

$$p' = p / n \tag{4b}$$

where primed (′) parameters denote the permissible level of single-entry interfering signal power (i.e. sharing criteria) and:

$i'(20)$: permissible level of interfering signal power (W) for individual space or terrestrial interferers (depending on value of $i(20)$ that is used) to be exceeded for no more than 20% of the time

$i(20)$: permissible level of total interfering signal power (W) for space or terrestrial interferers to be exceeded for no more than 20% of the time

p: percentage of time associated with the short-term interference criteria (equals p_S or p_t in cases where the initial subdivision of interference is made)

p': percentage of time calculated for use in specifying short-term single-entry sharing criteria

n: equivalent number of space or terrestrial interferers

$i'(p')$: permissible level of interfering signal power (W) for individual space or terrestrial interferers (depending on value of $i(p)$ that is used) to be exceeded for no more than p'% of the time

$i(p)$: permissible level of total interfering signal power (W) for space or terrestrial interferers to be exceeded for no more than p% of the time

y: fraction of space or terrestrial interferers producing interference at enhanced levels $(0 < y < 1)$, (y is analogous to a correlation coefficient and is usually equal to $1/n$, i.e. interference entries are mutually uncorrelated).

Equations (3), (4a) and (4b) are similar in nature to equations (1a), (1b), (2a), (2b) and (2c). Long-term interference allowances are subdivided on a power basis and short-term interference allowances are subdivided on a percentage of time basis. In equation (4), only some of the interferers are assumed to be enhanced to their short-term levels because they are uncorrelated. While these interference entries are enhanced, all other entries are assumed to be at their long-term levels.

Annex 2

Example of the application of the methodology

1   Introduction

This example is for calculation of sharing and coordination criteria for meteorological aids systems operating in the bands 400.15 to 406 MHz (referred to as the 403 MHz band throughout) and 1 668.4 to 1 700 MHz (referred to as the 1 680 MHz band throughout). For reference purposes these bands are allocated to the meteorological aids service (MetAids) on a primary basis.

2   Methodology for calculation of MetAids sharing and coordination criteria

The interference criteria for MetAids are given in Recommendation ITU-R RS.1263-1 and are presented in Tables 1 and 2. With these values, the sharing and coordination criteria for MetAids can be determined in accordance with the methodology that was outlined in Annex 1.

2.1   Initial division of interference criteria

Annex 1 states that the long-term allowable interference levels for each type of MetAids system listed in Tables 1 and 2 must be subdivided between terrestrial services ($i_t(20)$) and space-to-Earth paths ($i_s(20)$). Since long-term interference is present for large percentages of time (the levels from terrestrial services and from space-to-Earth will both be present simultaneously for large percentages of time), the interference is divided on a power basis. Subdivision is accomplished using equations (1a) and (1b) of Annex 1. For illustrative purposes within the 403 MHz and 1 680 MHz bands, the power will be subdivided such that 40% is attributed to space-to-Earth paths and 60% will be apportioned to terrestrial paths. The long-term interference criteria for the terrestrial services and the space-to-Earth paths are presented in Table 3.

TABLE 1

Interference criteria for radiosonde systems in the MetAids service

Parameter	Radio direction finding (RDF) radiosonde system 1 668.4-1 700 MHz	GPS radiosonde system 1 675-1 683 MHz	NAVAID with directional antenna 400.15-406 MHz	NAVAID with omnidirectional antenna 400.15-406 MHz
System reference bandwidth (kHz)	1 300	150	300	300
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than $p_{LOCK\text{-}LOSS}$ (%) of the time	−135.3	−137.2	−141.9	N/A[1]
Percentage of time, $p_{LOCK\text{-}LOSS}$ (%)[2]	0.02	0.025	0.02	N/A[1]
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than $p_{DATA\text{-}LOSS}$ (%) of the time	−139.4	−145.7	−149.6	−154.4
Percentage of time, $p_{DATA\text{-}LOSS}$ (%)[2]	0.8	0.125	0.2	0.2
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time[2]	−155.2	−152.6	−156.1	−156.1

N/A: Not applicable.

[1] Systems with omnidirectional antennas are not vulnerable to losing antenna lock on the signal due to interference or signal fading.

[2] This percentage of time shall not be exceeded on a per-flight basis.

TABLE 2

Interference criteria for rocketsonde and dropsonde systems in the MetAids service

Parameter	Airborne dropsonde systems 400.15-406 MHz	Rocketsonde systems 400.15-406 MHz
System reference bandwidth (kHz)	20	3
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than $p_{LOCK-LOSS}$ (%) of the time	N/A[1]	−116.9
$p_{LOCK-LOSS}$ (%)[2]	N/A[1]	0.02
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than $p_{DATA-LOSS}$ (%) of the time	−161.6	−122.1
$p_{DATA-LOSS}$ (%)[2]	0.060	0.060
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time	−168.9	−135.6

N/A: Not applicable.

[1]   Systems with omnidirectional antennas are not vulnerable to losing antenna lock on the signal due to interference or signal fading.

[2]   This percentage of time shall not be exceeded on a per-flight basis.

TABLE 3

Terrestrial and space-to-Earth long-term interference criteria

System type	a_S (%)	$i_S(20)$	a_t (%)	$i_t(20)$
1 680 MHz RDF	40	−157.4 dB(W/1.3 MHz)	60	−159.2 dB(W/1.3 MHz)
GPS radiosonde (1 675-1 683 MHz)	40	−154.8 dB(W/150 kHz)	60	−156.6 dB(W/150 kHz)
403 MHz NAVAID with directional antenna	40	−158.3 dB(W/300 kHz)	60	−160.1 dB(W/300 kHz)
403 MHz NAVAID with omnidirectional antenna	40	−158.3 dB(W/300 kHz)	60	−160.1 dB(W/300 kHz)
403 MHz dropsonde	40	−171.1 dB(W/20 kHz)	60	−172.9 dB(W/20 kHz)
403 MHz rocketsonde	40	−137.8 dB(W/3.0 MHz)	60	−136.9 dB(W/3.0 MHz)

The short-term interference criteria associated with loss of lock and loss of data must then be calculated using equations (2a) and (2b) of Annex 1. Since short-term interference from the two services is mutually uncorrelated (short-term interference occurs for only very small percentages of time, and the probability of short-term interference from the two services occurring simultaneously is negligible), the short-term criteria are divided on a time basis. Since the probability of long-term levels being present during periods of short-term interference is high, the long-term level must be subtracted from the short-term level in this calculation. For the 403 MHz and 1 680 MHz bands, the time will be subdivided such that 40% is apportioned to space-to-Earth paths, and 60% will be apportioned to terrestrial paths. The results of the short-term subdivision are presented in Table 4.

TABLE 4

Short-term terrestrial and space-to-Earth interference criteria

System type		p_s (%)	$i_s(ps)$	pt (%)	$i_t(pt)$
1 680 MHz RDF	Lock loss	0.008	−135.3 dB(W/1.3 MHz)	0.012	−135.3 dB(W/1.3 MHz)
	Data loss	0.5	−139.5 dB(W/1.3 MHz)	0.75	−139.4 dB(W/1.3 MHz)
GPS	Lock loss	0.01	−137.28 dB(W/150 kHz)	0.015	−137.25 dB(W/150 kHz)
Radiosonde (1 675-1 683 MHz)	Data loss	0.05	−146.27 dB(W/150 kHz)	0.075	−146.1 dB(W/150 kHz)
403 MHz NAVAID with directional antenna	Lock loss	0.008	−142.0 dB(W/300 kHz)	0.012	−141.9 dB(W/300 kHz)
	Data loss	0.5	−150.2 dB(W/300 kHz)	0.75	−150.0 dB(W/300 kHz)
403 MHz NAVAID with omnidirectional antenna	Lock loss	0.008	N/A[1]	0.012	N/A[1]
	Data loss	0.5	−156.7 dB(W/300 kHz)	0.75	−155.8 dB(W/300 kHz)
403 MHz dropsonde[1]	Lock loss	0.008	N/A[1]	0.012	N/A[1]
	Data loss	0.012	−162.1 dB(W/20 kHz)	0.018	−161.9 dB(W/20 kHz)
403 MHz rocketsonde	Lock loss	0.008	−116.9 dB(W/3.0 MHz)	0.012	−116.9 dB(W/3.0 MHz)
	Data loss	0.012	−122.2 dB(W/3.0 MHz)	0.018	−122.2 dB(W/3.0 MHz)

N/A: Not applicable.

[1]   Systems with omnidirectional antennas are not vulnerable to losing antenna lock on the signal due to interference or signal fading.

2.2   Calculation of single-entry criteria

In accordance with Annex 1, single-entry criteria are normally calculated for individual emitters. Since the exact characteristics of the systems which could potentially be sharing in these bands is not known, the single-entry levels will be calculated for a single system rather than emitter. Subdivision of the levels for individual emitters can be accomplished in the formal coordination process. In order to divide the interference into individual systems, the number of terrestrial systems, nt, and the number of space-to-Earth, $ns - E$, systems must be estimated. For both bands it will be assumed that three terrestrial systems may be present ($nt = 3$) and three space-to-Earth systems may be present ($ns - E = 3$). The long-term interference is subdivided on a power basis since long-term levels are mutually correlated; and is calculated using equation (3) of Annex 1. Since the short-term levels can be assumed to be mutually uncorrelated, the short-term levels are subdivided on a time basis. The long-term level will also be present for large percentages of time and must be subtracted from the short-term level. This division is performed using equations (4a) and (4b) of Annex 1. The short-term and long-term single-entry (single service) criteria are calculated in accordance with Annex 1 and presented in Tables 5 and 6.

TABLE 5

Long-term single system entry criteria*

System type	$i'_{s(20)}$	$i'_{s(20)}$
1 680 MHz RDF	−164.0 dB(W/1.3 MHz)	−162.2 dB(W/1.3 MHz)
GPS radiosonde (1 675-1 683 MHz)	−161.4 dB(W/150 kHz)	−159.6 dB (W/150 kHz)
403 MHz NAVAID with directional antenna	−164.9 dB(W/300 kHz)	−163.1 dB(W/300 kHz)
403 MHz NAVAID with omnidirectional antenna	−164.9 dB(W/300 kHz)	−163.1 dB(W/300 kHz)
403 MHz dropsonde	−177.7 dB(W/20 kHz)	−175.9 dB(W/20 kHz)
403 MHz rocketsonde	−144.4 dB(W/3.0 MHz)	−142.6 dB(W/3.0 MHz)

*   Since details of systems which could potentially share are unknown, these levels are calculated for a single system. Further subdivision to the single emitter level may be performed during the formal coordination process.

TABLE 6

Short-term single system entry criteria*

System type		p'_s (%)	$i'_{s(p's)}$	p'_t (%)	$i'_{s(p't)}$
1 680 MHz RDF	Lock loss	0.003	−135.3 dB(W/1.3 MHz)	0.004	−135.3 dB(W/1.3 MHz)
	Data loss	0.167	−139.4 dB(W/1.3 MHz)	0.25	−139.4 dB(W/1.3 MHz)
GPS radiosonde (1 675-1 683 MHz)	Lock loss	0.003	−137.2 dB(W/150 kHz)	0.005	−137.2 dB(W/150 kHz)
	Data loss	0.017	−145.9 dB(W/150 kHz)	0.025	−145.7 dB(W/150 kHz)
403 MHz NAVAID with directional antenna	Lock loss	0.003	−141.9 dB(W/300 kHz)	0.004	−141.9 dB(W/300 kHz)
	Data loss	0.167	−149.8 dB(W/300 kHz)	0.25	−149.6 dB(W/300 kHz)
403 MHz NAVAID with omnidirectional antenna	Lock loss	0.003	N/A[1]	0.004	N/A[1]
	Data loss	0.167	−155.03 dB(W/300 kHz)	0.25	−154.4 dB(W/300 kHz)
403 MHz dropsonde	Lock loss	0.003	−153.4 dB(W/20 kHz)	0.004	−153.5 dB(W/20 kHz)
	Data loss	0.004	−161.8 dB(W/20 kHz)	0.006	−161.6 dB(W/20 kHz)
403 MHz rocketsonde	Lock loss	0.003	N/A[1]	0.004	N/A[1]
	Data loss	0.004	−122.1 dB(W/3.0 MHz)	0.006	−122.1 dB(W/3.0 MHz)

N/A: Not applicable.

*   Since details of systems which could potentially share are unknown, these levels are calculated for a single system. Further subdivision to the single emitter level may be performed during the formal coordination process.

[1]   Systems with omnidirectional antennas are not vulnerable to losing antenna lock on the signal due to interference or signal fading.