

RECOMMENDATION ITU-R SA.1263

**INTERFERENCE CRITERIA FOR METEOROLOGICAL AIDS OPERATED
IN THE 400.15-406 MHz AND 1 668.4-1 700 MHz BANDS**

(Question ITU-R 144/7)

(1997)

The ITU Radiocommunication Assembly,

considering

- a) that interference criteria are needed to ensure that systems can be designed to achieve adequate performance in the presence of interference;
- b) that the performance objectives are specified in Recommendation ITU-R SA.1165;
- c) that interference criteria assist in the development of criteria for sharing bands among systems, including those operating in other services;
- d) that systems in the meteorological aids (MetAids) service must specify interference thresholds at least equal to the permissible levels;
- e) that Annex 1 presents the parameters of representative systems that provide the basis for permissible levels of interference to transmissions in the MetAids service,

recommends

- 1** that the interference levels specified in Tables 1 and 2 be used as the permissible total levels of interfering signal power at the antenna output of receiving stations operating in the MetAids service.

TABLE 1

Interference criteria for radiosonde systems in the MetAids service

Parameter	Radio direction finding (RDF) radiosonde system 1 668.4-1 700 MHz	NAVAID radiosonde system with directional antenna 400.15-406 MHz	NAVAID radiosonde system with omnidirectional antenna 400.15-406 MHz
System reference bandwidth	1.3 MHz	300 kHz	300 kHz
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than 0.02% of the time ⁽¹⁾	−135.3	−140.6	−141.9
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than 1.25% of the time ⁽¹⁾	−148.5	−149.6	−154.4
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time ⁽¹⁾	−149.4	−154.9	−156.1

⁽¹⁾ 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	20 kHz	3 MHz
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than 0.02% of the time ⁽¹⁾	−153.3	−124.9
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than 0.03% of the time ⁽¹⁾	−161.5	−125.5
Interference signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time ⁽¹⁾	−167.1	−134.7

⁽¹⁾ This percentage of time shall not be exceeded on a per-flight basis.

ANNEX 1

**Basis for performance and interference criteria
for MetAids in the 400.15-406 MHz and 1 668.4-1 700 MHz bands**

1 Introduction

The bands 400.15-406 MHz (referred to as the 403 MHz bands throughout) and 1 668.4-1 700 MHz (referred to as the 1 680 MHz band throughout) are allocated to MetAids on a primary basis. The bands 400.15-403 MHz and 1 670-1 700 MHz are also allocated to the meteorological satellite (METSAT) users on a co-primary basis; and the band 400.15-401 MHz is allocated to the mobile satellite service (MSS) worldwide, and the bands 1 675-1 700 MHz are allocated to the MSS on a co-primary, non-interference basis in ITU Region 2.

The terms MetAids is used to describe a variety of types of meteorological equipment; radiosondes, dropsondes and rocketsondes. MetAids are flown worldwide for the collection of upper atmosphere meteorological data for weather forecasts and severe storm prediction, collection of ozone level data, and measurement of atmospheric parameters for various military applications. The data collected from these flights, or soundings, is of extreme importance for the protection of life and property through the prediction of severe storms and providing vital data for commercial airlines operations.

2 Methodology for calculation of MetAids interference criteria

Since MetAids are typically most vulnerable to interference at the maximum slant range of operation, the interference criteria will be established based on the link margin at the maximum slant range. Although this assumption does not allow other potential users of the band the flexibility of taking advantage of the higher link margins at shorter slant ranges, this factor may be applied, if appropriate, in detailed sharing studies. This range will be a typical maximum slant

range for most of the world, but does not represent the extreme conditions encountered in wintertime at high latitudes. The interference criteria of MetAids will be established at three points: an interference level and percentage time for loss of receiver lock, an interference level and percentage time for loss of data, and a long term interference level at 20% of the time. Since the different types of MetAids are utilized in different applications and exhibit different characteristics, criteria will be established for each.

The first level of interference to be established will be the level associated with loss of receiver lock, which is allowable for only a brief period of time. The total time percentage, $P\%_{TOTAL}$, loss of lock that may occur will be calculated according to the system and application. That percentage will then be subdivided into a percentage for intrasystem sources, and a percentage for intersystem sources. In this case, loss of lock will be subdivided so that 25% of $P\%_{TOTAL}$ is attributed to intersystem interference.

The interference criteria for loss of lock will be calculated in the following manner:

$$I_{LOCKLOSS} = N_{RX} + 10 \log (10^{M/10} - 1) \quad (1)$$

where:

- N_{RX} : receiver noise spectral density from link budget (see Table 4)
- M : margin calculated for loss of lock calculated from link budget (see Table 4).

The level, $I_{LOCKLOSS}$, shall not be exceeded more than $P\%_{LOCKLOSS}$, where:

$$P\%_{LOCKLOSS} = 0.25 (P\%_{TOTAL})$$

The second level of interference is the level at which loss of data will occur. The percentage of time for this occurrence may be obtained from the user's data availability objectives. The published data availability requirements of MetAids typically is for all sources of data loss and data error. MetAids flights experience sensor data errors, in addition to data loss, which are filtered out during data processing. Twenty five percent of the total data loss/error percentage $P\%_{TOTAL}$ will be attributed to interference and 25% of this may be attributed to intersystem interference, hence:

$$P\%_{DATALOSS} = (25\%) (25\%) (P\%_{TOTAL}) = (6.25\%) (P\%_{TOTAL})$$

The interference criteria for data loss will be calculated in the following manner:

$$I_{DATALOSS} = N_{RX} + 10 \log (10^{M/10} - 1) \quad (2)$$

where:

- N_{RX} : receiver noise spectral density from link budget (see Table 4)
- M : margin calculated for data loss from link budget (see Table 4).

The level $I_{DATALOSS}$ shall not be exceeded more than $P\%_{DATALOSS}$.

The third interference level will be the long term level, at 20% of the time. The long-term interference level can be calculated based on both the short term margins for loss of lock and data loss. The level calculated from the short-term loss of lock margin is insignificant since it is dominated by the level calculated from the data loss margin. For the long term (20%), 2/3 of the margin associated with data loss will be retained for MetAids. The interference criteria for data loss will be calculated in the following manner:

$$I_{20\%} = N_{RX} + 10 \log (10^{M/30} - 1)$$

or

$$N_{RX} - 10 \text{ dB, whichever is greater} \quad (3)$$

where:

- N_{RX} : receiver noise spectral density from link budget (see Table 4)
- M : margin calculated for data loss from link budget (see Table 4).

The level $I_{20\%}$ shall not be exceeded more than 20% of time.

3 Analysis of MetAids data availability requirements

3.1 Synoptic operations radiosonde data availability requirements

Table 3 lists the proposed radiosonde data availability requirements. All limits within the data loss column must be met in order to meet the objective. The numbers are not cumulative, each requirement applies to only the time period specified. In addition to the requirements of Table 3, missing and/or rejected pressure or temperature data must not occur for more than 3 consecutive minutes at any point in the flight.

TABLE 3

Synoptic operations performance objectives of radiosondes as used in North America

Flight time (min)	Maximum data loss for no more than 2% of the soundings (per site, per month ⁽¹⁾)
0-120 (entire flight)	15 min
0-5	60 s
5-15	2 min
15-30	3 min
30-60	6 min
60-120	12 min (20%)

⁽¹⁾ Soundings that fail to meet the 2% requirement are considered failed flights and will necessitate a second release if the failure determination is made within 30 min after launch. Flights which do not meet the requirement after the 30 min time are classified failures.

Missing and/or rejected pressure and temperature data shall not occur for more than 3 consecutive minutes.

The specified data availability objective is for data loss from all sources (interference, operator error, equipment failure, radiosonde failure and sensor data error). For the period covering the end of the flight (60-120 min), a maximum of 20% data loss may occur. This 20% data availability will be subdivided to provide a level attributed to intersystem interference, $I_{\text{INTERSYSTEM}}$, resulting in $P\%_{\text{DATA LOSS}}$:

$$P\%_{\text{DATA LOSS}} = (6.25\%) (20\%) = 1.25\% \text{ data loss due to } I_{\text{INTERSYSTEM}}$$

Furthermore, if a flight is not flown to the 120 min completion point, it is also classified a failure. Many factors may reduce a flight length, including interference. Interference will typically cause loss of receiver system lock on the desired signal. If the signal is not reacquired in sufficient time (approximately 1 s or less), the receiver automatic frequency control (AFC) will retune the receiver to another signal of sufficient strength to achieve receiver lock. In RDF systems, the problem is further aggravated by the RDF antenna with a small antenna beamwidth losing the movement of the radiosonde. The percentage of time, $P\%_{\text{LOCK LOSS}}$, for which this is allowable is:

$$P\%_{\text{LOCK LOSS}} = 25\% \frac{1 \text{ s}}{24 \text{ min}} = 0.02\%$$

3.2 Data availability requirements of space agencies

Space agencies use radiosondes and rocketsondes for meteorological data collection in support of space launch operations. The radiosonde data availability requirements of the synoptic users are adequate to meet the requirements of these users. Rocketsonde objectives must be established though. Due to the speed at which rocketsondes fall back to Earth in the upper atmosphere, the rocketsonde data loss percentage must be very small. Loss of even small blocks of data can result in loss of important structure in portions of the upper atmosphere. Therefore, data loss of more than approximately 15 s over a period of a flight results in failure of the flight. As with radiosondes, this percentage must be subdivided between intrasystem and intersystem sources. The maximum intersystem interference, $I_{\text{INTERSYSTEM}}$, percentage is calculated as follows:

$$P\%_{\text{DATA LOSS}} = (6.25\%) \frac{15 \text{ s}}{60 \text{ min}} = 0.03\% \text{ maximum data loss due to } I_{\text{INTERSYSTEM}}$$

The percentage of time of 0.02% associated with loss of lock calculated for radiosondes also applies to rocketsondes.

$$P\%_{\text{LOCK LOSS}} = 0.02\%$$

3.3 Dropsonde data availability requirements

Data collection from dropsondes is performed as they fall through the atmosphere with the descent rate controlled by a parachute in a very similar manner that rocketsondes are used. Therefore, the space agency data availability requirements of rocketsondes discussed in § 3.2 are sufficient for the protection of dropsonde data.

3.4 Data availability requirements of defence establishments

Defence establishments use radiosondes, rocketsondes and dropsondes, though the largest percentage is radiosondes. The data availability requirements of radiosondes discussed in § 3.1, of rocketsondes in § 3.2 and of dropsondes in § 3.3 is considered sufficient to protect these MetAids operations.

4 Link budget analysis for MetAids

The various types of MetAids are utilized for different purposes, and as a result have different link budget calculations. Table 4 lists the performance characteristics for RDF radiosondes, NAVAID radiosondes, dropsondes, and rocketsondes.

TABLE 4

Analysis of performance criteria for MetAids systems

Performance Factor	RDF	RDF	NAVAID directional antenna	NAVAID directional antenna	NAVAID omnidirectional antenna	NAVAID omnidirectional antenna	Dropsonde	Dropsonde	Rocketsonde	Rocketsonde
Modulation Type	MA	MA	FM	FM	FM	FM	FM	FM	MA	MA
Frequency range (MHz)	1 668.4-1 700	1 668.4-1 700	400.15-406	400.15-406	400.15-406	400.15-406	400.15-406	400.15-406	400.15-406	400.15-406
Percent time performance is not exceeded (%)	0.02 Loss of lock	1.25 Data loss	0.02 Loss of lock	1.25 Data loss	0.02 Loss of lock	1.25 Data loss	0.02 Loss of lock	0.03 Data loss	0.02 Loss of lock	0.03 Data loss
1. Transmitter output power (dBW)	−6.0	−6.0	−6.0	−6.0	−6.0	−6.0	−8.0	−8.0	−5.2	−5.2
2. Antenna gain average (dBi)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0	0
3. Radiosonde e.i.r.p. (dBW)	−4.0	−4.0	−4.0	−4.0	−4.0	−4.0	−6.0	−6.0	−5.2	−5.2
4. Maximum link length (km)	250	250	250	250	150	150	350	350	70	70
5. Free space path loss (dB)	144.90	144.90	132.5	132.5	128.0	128.0	135.4	135.4	121.4	121.4
6. Excess path loss (rain, fading, etc.) (dB)	2.0	2.0	1.5	1.5	1.0	1.0	4.0	4.0	0.25	0.25
7. Ground station antenna gain (dBi)	28	28	8.0	8.0	2.0	2.0	0.0	0.0	20	20
8. Ground station antenna pointing error (dB)	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5
9. Receiver system loss (antenna feed, cables, etc.) (dB)	3.0	3.0	2.0	2.0	2.0	2.0	0.0	0.0	2.0	2.0
10. Polarization mismatch loss (dB)	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	0.5	0.5
11. Received signal power (dBW)	−126.9	−126.9	−132.5	−132.5	−133.5	−133.5	−145.4	−145.4	−109.85	−109.85
12. Receiver reference bandwidth (dB/Hz)	1.3	1.3	0.3	0.3	0.3	0.3	0.02	0.02	3.0	3.0
13. Reference bandwidth (dB)	61.1	61.1	54.8	54.8	54.8	54.8	43	43	64.8	64.8
14. Received energy per Hz, C_0 (dB(W/Hz))	−188.0	−188.0	−187.3	−187.3	−188.3	−188.3	−188.4	−188.4	−174.65	−174.65
15. Receiver system noise temperature (K)	738	738	600	600	600	600	410	410	738	738
16. Receiver noise spectral density, N_0 (dB(W/Hz))	−200.5	−200.5	−200.9	−200.9	−200.9	−200.9	−202.5	−202.5	−200.5	−200.5
17. Minimum C_0/N_0 (dB)	7	12	7	12	7	12	7	12	7	12
18. Actual C_0/N_0 for flight (dB)	12.5	12.5	13.6	13.6	12.6	12.6	14.1	14.1	25.85	25.85
19. Margin (dB)	5.5	0.5	6.6	1.6	5.6	0.6	7.1	2.1	18.95	13.85

5 Calculation of MetAids interference criteria

5.1 Radiosondes

The interference criteria can be calculated utilizing equations (1), (2) and (3), and the results of the link budget analysis in Table 4. The interference criteria established for each of the three radiosonde systems are presented in Table 5.

TABLE 5

Interference criteria for radiosonde systems

Parameter	RDF radiosonde system 1 668.4-1 700 MHz	Radiosonde system with directional antenna 400.15-406 MHz	Radiosonde system with omnidirectional antenna 400.15-406 MHz
Receiver noise spectral density (dB(W/Hz))	−200.5	−200.9	−200.9
Receiver reference bandwidth (dB/Hz)	61.1	54.8	54.8
0.02% link margin (dB)	5.5	6.6	5.6
1.25% link margin (dB)	0.5	1.6	0.6
Interference level not to be exceeded more than 0.02% of the time (equation (1))	−135.3 dB(W/1.3 MHz)	−140.6 dB(W/300 kHz)	−141.9 dB(W/300 kHz)
Interference level not to be exceeded more than 1.25% of the time (equation (2))	−148.5 dB(W/1.3 MHz)	−149.6 dB(W/300 kHz)	−154.4 dB(W/300 kHz)
Interference level not to be exceeded more than 20% of the time (equation (3))	−149.4 dB(W/1.3 MHz)	−154.9 dB(W/300 kHz)	−156.1 dB(W/300 kHz)

5.2 Dropsondes

Equations (1), (2) and (3) can be used to calculate the interference criteria for dropsondes. The interference criteria for dropsondes is presented in Table 6.

5.3 Rocketsondes

Equations (1), (2) and (3) can be used to calculate the interference criteria for rocketsondes. The interference criteria for rocketsondes is presented in Table 7.

TABLE 6

Interference criteria for dropsonde systems

Parameter	Dropsonde systems 400.15-406 MHz
Receiver noise spectral density (dB(W/Hz))	– 202.5
Receiver reference bandwidth (dB/Hz)	43.0
0.02% link margin (dB)	7.1
0.03% link margin (dB)	2.1
Interference level not to be exceeded more than 0.02% of the time (equation (1))	–153.3 dB(W/20 kHz)
Interference level not to be exceeded more than 0.03% of the time (equation (2))	–161.5 dB(W/20 kHz)
Interference level not to be exceeded more than 20% of the time (equation (3))	–167.1 dB(W/20 kHz)

TABLE 7

Interference criteria for rocketsonde systems

Parameter	Rocketsonde systems 400.15-406 MHz
Receiver noise spectral density (dB(W/Hz))	– 200.5
Receiver reference bandwidth (dB/Hz)	64.8
0.02% link margin (dB)	11.1
0.03% link margin (dB)	10.6
Interference level not to be exceeded more than 0.02% of the time (equation (1))	–124.9 dB(W/3 MHz)
Interference level not to be exceeded more than 0.03% of the time (equation (2))	–125.5 dB(W/3 MHz)
Interference level not to be exceeded more than 20% of the time (equation (3))	–134.7 dB(W/3 MHz)