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Radiocommunication Sector of ITU

Recommendation ITU-R M.1841-1
(02/2013)

**Compatibility between FM
sound-broadcasting systems in the
frequency band of about 87-108 MHz and
the aeronautical ground-based
augmentation system in the frequency band
108-117.975 MHz**

M Series
**Mobile, radiodetermination, amateur
and related satellite services**



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RA	Radio astronomy
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SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

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

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RECOMMENDATION ITU-R M.1841-1*

Compatibility between FM sound-broadcasting systems in the frequency band of about 87-108 MHz and the aeronautical ground-based augmentation system in the frequency band 108-117.975 MHz

(2007-2013)

Scope

Resolution 413 (WRC-03) invited ITU-R to study any compatibility issues between the broadcasting and aeronautical services operating around 108 MHz and to develop new or revised ITU-R Recommendations as appropriate. This Recommendation provides technical and operational requirements that may be used by administrations as a technical guideline for establishing the compatibility of the ICAO ground-based augmentation system (GBAS) above 108 MHz and frequency modulation (FM) broadcasting systems operating up to 108 MHz.

The ITU Radiocommunication Assembly,

considering

- a) that, in order to improve the efficiency of spectrum utilization, there is a need to refine the criteria used when assessing compatibility between the FM sound-broadcasting service and the aeronautical services in the nearby frequency band;
- b) that there is a need for a compatibility analysis method for identifying potential incompatibilities associated with a large broadcasting assignment plan;
- c) that there is a need for a detailed, case-by-case compatibility analysis method to investigate potential incompatibility cases identified by a large scale analysis or for individual assessment of proposed broadcasting or aeronautical assignments;
- d) that there is a need to continue the refinement of the compatibility criteria and assessment methods,

recommends

- 1 that the criteria given in Annex 1 may be used for compatibility calculations;
- 2 that the method given in Annex 2 may be used for predicting potential incompatibilities associated with a large broadcasting assignment plan;
- 3 that the techniques in Annex 3 may be used for detailed, case-by-case compatibility calculations concerning potential interference cases identified by the method given in Annex 2 or concerning individual assessment of proposed assignments to broadcasting or aeronautical stations;
- 4 additionally, that results of practical verification of predicted compatibility situations as well as other relevant information may be used for coordination and to effect further refinement of the compatibility criteria, assessment method and techniques given in Annexes 1, 2 and 3 respectively.

* This Recommendation should be brought to the attention of Radiocommunication Study Group 6.

Annex 1

Interference mechanisms, system parameters and compatibility assessment criteria

CONTENTS

	<i>Page</i>
1 Background and introduction	3
2 Types of interference mechanisms	3
3 Compatibility assessment parameters.....	4
4 Compatibility assessment criteria.....	9
Appendix 1 to Annex 1 – GBAS coverage and minimum field strengths (Extracted from Annex 10 to the Convention on International Civil Aviation).....	13

1 Background and introduction

FM broadcasting service interference to aeronautical mobile systems used for navigation and surveillance purposes is a widely recognized problem among users of aviation facilities. In airborne GBAS receivers, the interference problem causes errors in navigation correction information. The interference to these receivers is a serious problem, especially during the critical approach and landing phase, as it is not readily evident to the pilot.

The effects of interference to aircraft receivers vary with the aircraft location, altitude and intermodulation and spurious emission conditions. The way in which the presence of such interference is flagged varies with the make and model of the receiver. There is an increasing probability of harmful interference due to the growing need for additional aeronautical and broadcasting frequency assignments.

This Annex describes:

- interference mechanisms;
- system parameters of the aeronautical mobile systems affected;
- system parameters of the FM broadcasting stations;
- compatibility assessment criteria for GBAS receivers.

2 Types of interference mechanisms

In general, from a GBAS receiver point of view, FM broadcasting transmission modulation can be regarded as noise.

2.1 Type A interference

2.1.1 Introduction

Type A interference is caused by unwanted emissions into the aeronautical band from one or more broadcasting transmitters.

2.1.2 Type A1 interference

A single transmitter may generate spurious emissions or several broadcasting transmitters may intermodulate to produce components in the aeronautical frequency bands; this is termed Type A1 interference.

2.1.3 Type A2 interference

A broadcasting signal may include non-negligible components in the aeronautical bands; this interference mechanism, which is termed Type A2 interference, will in practice arise only from broadcasting transmitters having frequencies near 108 MHz and will only interfere with aeronautical mobile services with frequencies near 108 MHz.

2.2 Type B interference

2.2.1 Introduction

Type B interference is that generated in an aeronautical receiver resulting from broadcasting transmissions on frequencies outside the aeronautical band.

2.2.2 Type B1 interference

Intermodulation may be generated in an aeronautical receiver as a result of the receiver being driven into non-linearity by broadcasting signals outside the aeronautical band; this is termed Type B1 interference. In order for this type of interference to occur, at least two broadcasting signals need to be present and they must have a frequency relationship which, in a non-linear process, can produce an intermodulation product within the wanted RF channel in use by the aeronautical receiver. One of the broadcasting signals must be of sufficient amplitude to drive the receiver into regions of non-linearity but interference may then be produced even though the other signal(s) may be of significantly lower amplitude.

Only third-order intermodulation products are considered; they take the form of:

$$\begin{aligned} f_{intermod} &= 2f_1 - f_2 && \text{two-signal case or} \\ f_{intermod} &= f_1 + f_2 - f_3 && \text{three-signal case} \end{aligned}$$

where:

$$\begin{aligned} f_{intermod} &: && \text{intermodulation product frequency (MHz)} \\ f_1, f_2, f_3 &: && \text{broadcasting frequencies (MHz) with } f_1 \geq f_2 > f_3. \end{aligned}$$

2.2.3 Type B2 interference

Desensitization may occur when the RF section of an aeronautical receiver is subjected to overload by one or more broadcasting transmissions; this is termed Type B2 interference.

3 Compatibility assessment parameters

3.1 Introduction

This section identifies the parameters of GBAS aeronautical transmitters and receivers relevant for a compatibility assessment.

3.2 Characteristics of aeronautical systems

3.2.1 Designated operational coverage

GBAS can be operated in the following two modes:

- a) a precision approach service; or
- b) a positioning service.

ICAO requires that GBAS offers at least the precision approach service. Moreover, optionally a positioning service may be provided.

3.2.1.1 Precision approach service

Figure 1A illustrates the horizontal extension of a typical designated operational coverage (DOC) for GBAS precision approach service based on the requirements described in Annex 10 to the Convention on International Civil Aviation. It covers a keyhole-shaped area composed of a sector with a width of $\pm 35^\circ$ extending 28 km (15 NM) from the runway stop-end and a second sector with a width of $\pm 10^\circ$ extending additional 9 km (5 NM). Further details are depicted in Fig. 1B.

The lower coverage boundary (H) at the maximum distance from the landing threshold point (LTP) for a given glide path angle (α) shall be computed as follows:

$$H = \left(Dist_{max} + \frac{TCH}{\tan(\alpha)} \right) \cdot \tan(0.3 \cdot \alpha)$$

where:

$Dist_{max}$: maximum distance in metres from LTP;

$TCH/\tan(\alpha)$: distance in metres from LTP to the glide path intercept point (GPIP i.e. the point where the final approach path intercepts the local level plane);

α : glide path angle (nominal value is 3 degrees);

TCH : threshold crossing height (height of the approach path above LTP), nominal value is 15 m.

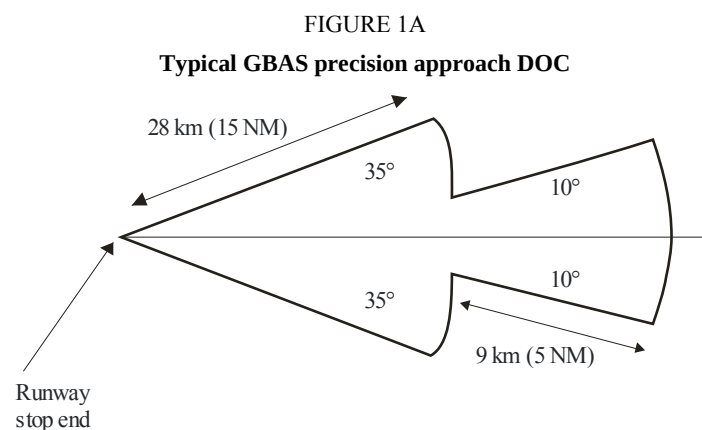
This is further illustrated in Fig. 1B.

For nominal values of the glide path angle 3 degrees and a threshold crossing height of 15 m at a typical maximum distance of 37 km (20 NM) the following lower coverage boundary is obtained:

$$H = \left(37\,000 + \frac{15}{\tan(3^\circ)} \right) \cdot \tan(0.3 \cdot 3^\circ) = 586\,m \quad (\approx 1900\,ft)$$

This DOC is defined on a per runway basis. As a single GBAS ground station may serve multiple aerodromes with multiple runways in its vicinity, the overall DOC may be considered as the sum of the DOCs.

Some administrations may also use the GBAS in a way such that the DOC may not be aligned with a runway.

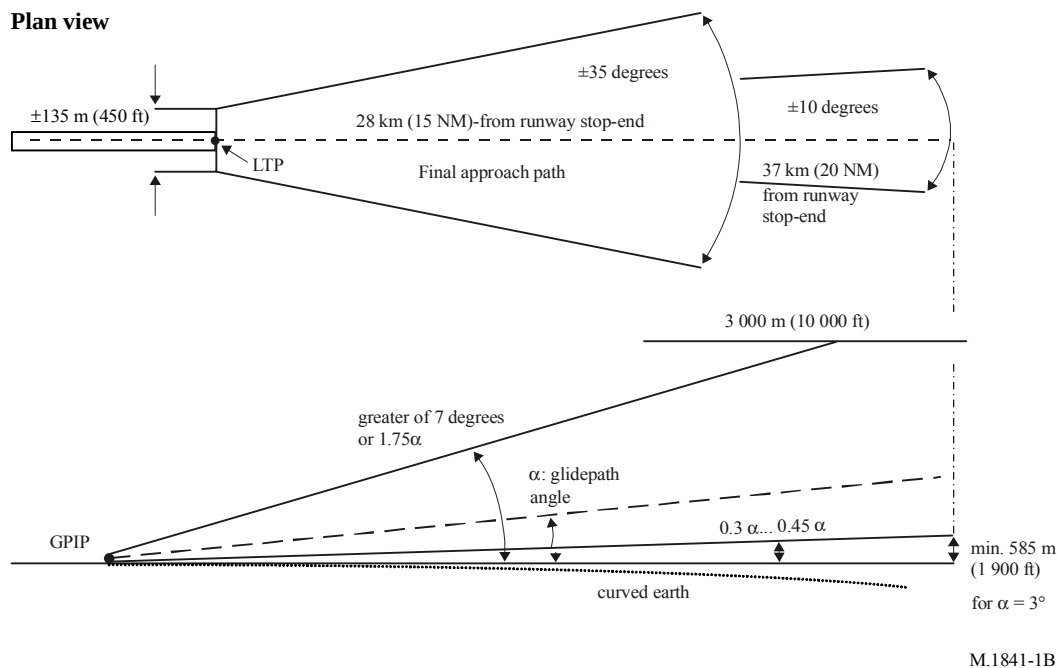


NOTE – Not drawn to scale.

M.1841-01A

FIGURE 1B

More detailed specification of typical DOC for GBAS precision approach



NOTE – Not drawn to scale.

Editorial Note – The DOC is derived from the requirements for GBAS in Annex 10 to the Convention on International Civil Aviation. The depicted elevation diagram for GBAS is not the same as for ILS in Fig. 1 of Recommendation ITU-R SM.1009-1.

3.2.1.2 Positioning service

The DOC of a GBAS for positioning can vary from one installation to another: a typical DOC for GBAS for positioning may be circular and have a radius of 43 km (23 NM) from the GBAS transmitter. Some installations may have a greater radius depending on the operational requirements and frequency planning constraints. Details can be obtained from the appropriate national Aeronautical Information Publication (see definitions in Annex 4) (AIP).

3.2.2 Field strength

The minimum field strength to be protected throughout the DOC (see § 3.5.4.4.2.2 of Appendix 1) is 215 $\mu\text{V/m}$ (46.6 dB($\mu\text{V/m}$)).

3.2.3 Frequencies

GBAS frequencies lie in the band near to the FM broadcasting band, and can operate on ILS/VOR frequencies as well as those in between. GBAS frequencies occupy channels at 25 kHz intervals and may be as follows: 108.025, 108.050 ... 117.950 MHz.

3.2.4 Polarization

There are two types of polarization that can be used by GBAS; horizontal and an optional additional vertical polarization. It is only the horizontal polarization that is intended for international civil aviation use and therefore only aircraft with horizontally polarized antennas are considered in this Recommendation. The use of the optional vertical polarization is only intended for national use.

3.3 Characteristics of FM broadcasting stations

3.3.1 Maximum effective radiated power

The most accurate available value of maximum e.r.p. should be used for compatibility calculations.

3.3.2 Horizontal radiation pattern

The most accurate available information for horizontal radiation pattern (h.r.p.) should be used for compatibility calculations.

3.3.3 Vertical radiation pattern

The most accurate available information for vertical radiation pattern (v.r.p.) should be used for compatibility calculations.

3.3.4 Spurious emission suppression

In the North American experience, it has not generally been necessary to require the suppression of spurious emissions by more than 80 dB. Considering special circumstances within some areas of Region 1 and some areas of Region 3, the values given in Table 1, for spurious emission suppression in the aeronautical band 108-137 MHz, may be recommended for the case of radiated intermodulation products from co-sited broadcasting transmitters.

TABLE 1

Maximum e.r.p. (dBW)	Suppression relative to maximum e.r.p. (dB)
≥ 48	85
30	76
< 30	46 + maximum e.r.p. (dBW)

NOTE 1 – Linear interpolation is used between maximum e.r.p. values of 30 and 48 dBW.

3.3.5 Frequencies

The bands of operation may be found in the Radio Regulations. In Region 1 and certain parts of Region 3, the band is 87.5-108 MHz, with channels every 100 kHz (87.6, 87.7 ... 107.9 MHz). In Region 2, the band is 88-108 MHz, with channels every 200 kHz (88.1, 88.3 ... 107.9 MHz).

3.3.6 Polarization

The polarization of an FM signal may be horizontal, vertical or mixed.

3.3.7 Free-space field-strength calculation for broadcasting signals

The free-space field strength is to be determined according to the following formula:

$$E = 76.9 + P - 20 \log d + H + V \quad (1)$$

where:

E : field strength (dB(μV/m)) of the broadcasting signal;

P : maximum e.r.p. (dBW) of broadcasting station;

- d : slant path distance (km) (see definition in Annex 4);
 H : h.r.p. correction (dB);
 V : v.r.p. correction (dB).

In the case of a broadcasting station with mixed polarization, the maximum e.r.p. to be used is the larger of the horizontal and vertical components. However, where both the horizontal and vertical components have equal values, the maximum e.r.p. to be used is obtained by adding 1 dB to the value of the horizontal component.

3.4 Receiver input power

Assuming an aircraft antenna radiation pattern with no directivity, the field strengths of the broadcasting signal and of the aeronautical signal are to be converted to power at the input to an aeronautical receiver according to the following formulas:

- a) for a broadcasting signal in the band 87.5-108.0 MHz:

$$N = E - 118 - L_s - L(f) - L_a \quad (2)$$

where:

- N : broadcasting signal level (dBm) at the input to the aeronautical receiver;
 E : field strength (dB(μ V/m)) of the broadcasting signal;
 L_s : signal splitter loss of 3.5 dB;
 $L(f)$: antenna system frequency-dependent loss at broadcasting frequency f (MHz) of 1.2 dB per MHz below 108 MHz (for a horizontally polarized antenna);
 L_a : antenna system fixed loss of 9 dB.

- b) for an aeronautical signal and a Type A1 signal in the band 108-118 MHz:

$$N_a = E_a - 118 - L_s - L_a \quad (3)$$

where:

- N_a : signal level (dBm) at the input to the aeronautical receiver;
 E_a : field strength (dB(μ V/m)) of the aeronautical or Type A1 signal.

Figure 2 illustrates how the GBAS minimum field strength of 46.6 dB(μ V/m) is converted to -84 dBm at the receiver input of a typical aircraft receiver installation using formula (3).