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Recommendation ITU-R SM.1051-3
(08/2014)

**Priority of identifying and eliminating
harmful interference in the
band 406-406.1 MHz**

SM Series
Spectrum management

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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 SM.1051-3

Priority of identifying and eliminating harmful interference in the band 406-406.1 MHz

(1994-1995-1997-2014)

Scope

This Recommendation describes the priority that should be given to interference detected in the band 406-406.1 MHz by Administrations and their monitoring authorities, because interference impairs the detection and geolocation of actual distress beacons. Cospas-Sarsat is an international satellite-based search and rescue (SAR) distress alert system which detects and locates emergency beacons activated by aircraft, ships and backcountry hikers in distress worldwide. The Recommendation provides additional references to the ITU Monitoring programme for 406 MHz, as well as references to Report ITU-R SM.2258.

Keywords

EPIRB; safety; Cospas-Sarsat; distress; beacon; interference.

Abbreviations/Glossary

BR – Radiocommunication Bureau;

EPIRB – Emergency position indicating radio beacon;

GNSS – Global Navigation Satellite System;

LEO – low earth orbit;

LUT – Local user terminal;

WARC – World Administrative Radio Conference.

Related ITU Recommendations, Reports

Recommendation ITU-R M.1478-2; Report ITU-R SM.2258; Report ITU-R M.1042.

NOTE – In every case the latest edition of the Recommendation/Report in force should be used.

The ITU Radiocommunication Assembly,

considering

- a)* that the band 406-406.1 MHz has been allocated in the Radio Regulations (RR) to the mobile-satellite (Earth-space) service for use by emergency position indicating radio beacons (EPIRBs) in cases of distress or emergency;
- b)* that administrations may also authorize use of personal locator beacons, emergency locator transmitters, or equivalent systems, on a national basis using transmitter radiation parameters and characteristics similar to those of EPIRBs;
- c)* that as part of the Global Maritime Distress and Safety System, the International Maritime Organization has required carriage of EPIRBs aboard ships operating under the Safety of Life at Sea Convention;
- d)* that the purpose of EPIRBs and equivalent systems is to facilitate search and rescue operations by means of satellite locating techniques;
- e)* that the use of EPIRBs and related satellite systems is designed to save lives by efficiently bringing rescue services quickly and directly to those in distress;

- f) that satellite receivers in operation on board low orbit, medium orbit and geostationary orbit satellites reveal the presence of many signals causing harmful interference in the band 406-406.1 MHz in various regions of the Earth;
- g) that interference be eliminated immediately because the presence of any interference leads to deterioration in the search and rescue satellite system which works on the basis of statistical processing of low-power signals and that such interference may threaten the safety of life or property;
- h) that severe interference in the band 406-406.1 MHz has already been shown to be able to completely mask EPIRB transmissions over areas of the earth covering thousands of square kilometres;
- i) that Article 15 of the RR establishes a procedure for administrations to communicate directly to resolve interference problems;
- j) that the Radiocommunication Bureau (BR) has a programme to coordinate reports of interference in the band 406-406.1 MHz on a worldwide basis and can intervene when the procedures in *considering i)* are not feasible to communicate reports to appropriate administrations, requesting their assistance in eliminating such interference;
- k) that national radio monitoring services may be in a good position to assist in detecting, localizing, and identifying interference sources in this band and thereby significantly contribute to protection of life and property;
- l) that feedback on the located source of interference provides valuable information that may be useful in eliminating and preventing future interference problems,

recommends

- 1** that administrations should immediately locate and eliminate interference in the band 406-406.1 MHz when notified of the interference;
- 2** that full use be made of available monitoring and direction-finding capabilities to detect, localize, identify and eliminate radio interference in the band 406-406.1 MHz on a priority basis;
- 3** that administrations having the capability for monitoring and identifying interference in the band 406-406.1 MHz are strongly urged to participate and report regularly to the BR;
- 4** that administrations should consider installing and operating local user terminals (LUTs) for detecting emergency distress signals and interference. This will facilitate faster detection and geolocation of signals and improve response times in areas presently underserved;
- 5** that the information regarding the operation of EPIRBs and the associated satellite processing systems given in Annex 1 should be used as an aid to eliminating interference in this band;
- 6** that reporting administrations communicate on a priority basis and include, at a minimum, the information as set forth in Annex 2;
- 7** that administrations provide feedback to the reporting administration and/or the BR as set forth in Annex 3.

Annex 1

Operation of the Cospas-Sarsat 406 MHz system

1 Principle of 406 MHz EPIRB detection and location

Once activated, a 406 MHz EPIRB transmits a 0.5 s burst every 50 s (see Recommendation ITU-R M.633). A digital message containing identification data is modulated onto the burst. EPIRBs transmit independently of each other, resulting in random timing between bursts from different EPIRBs.

The frequency of each received burst is measured by a receiver-processor aboard the Cospas-Sarsat satellites. The frequency, time of reception and any beacon identification data is stored in the satellite on-board memory as well as retransmitted in real-time in a continuous loop as the satellite orbits the earth. This information is retransmitted to Cospas-Sarsat ground stations around the world when the satellite is within range of a ground station.

The position of each EPIRB is calculated by the ground stations using the frequencies and times obtained from the satellite, and the satellite position at each of the burst times. This calculation is based on the well-known Doppler effect which relates the received burst frequency to the satellite's relative speed.

The current generation of satellite receiver-processors have input bandwidths of 100 kHz, centred at 406.05 MHz.

In addition to having on-board receiver-processors, polar orbiting satellites are also equipped with repeaters to relay transmissions in the 406-406.1 MHz band directly to ground stations for further processing. The time and frequency measurements can then be made by the ground station and the location is then determined in a manner similar to that described above. Some geostationary satellites are also equipped with such repeaters, which allow 406 MHz signals to be detected, but not located due to the lack of a significant Doppler shift. However, many beacons now incorporate Global Navigation Satellite System (GNSS) receivers, and the transmissions from these beacons include the beacon's specific identification, as well as its position, provided by its GNSS receiver. This allows a ground station to determine the beacon's position by demodulating the coordinates from the digital bitstream, either through transmissions relayed from geostationary or polar orbiting satellites.

Eventually, the Galileo satellites, as well the GPS and GLONASS satellites, will all be equipped with on-board repeaters that will improve the detection rate of distress beacons.

2 Processing 406 MHz interference signals

Any signals in the 406-406.1 MHz band which are not transmitted by EPIRBs can interfere with the detection of real EPIRB signals. Such interfering signals are not necessarily produced by transmitters operating in the 406-406.1 MHz band, but can result from out-of-band emissions, sidebands, spurious emissions or harmonics falling in the 406-406.1 MHz band from transmitters operating at other frequencies¹.

In accordance with Resolution 205 (World Administrative Radio Conference for the Mobile Services, Geneva, 1983 – WARC MOB-83), revised during WRC-12, administrations are invited to

¹ Further technical studies are being considered to adequately address the impact of aggregate emissions from a large number of transmitters operating in adjacent bands (390-406 MHz and 406.1-420 MHz) and the consequent risk to space receivers intended to detect low-power distress-beacon transmissions.

monitor and report on such interference and urged to take the appropriate measures to eliminate harmful interference caused to the distress and safety system².

This requires installation of a LUT having the capability to monitor signals received from the space station³. Sources of harmful interference received at the LUT can only be located using the satellite repeater on polar orbiting satellites. Typical 406 MHz interferers generally transmit continuous signals for a long period of time compared to the half-second EPIRB bursts. Like the EPIRB signals, these near-continuous signals, when observed and processed through the orbiting satellite, exhibit a Doppler frequency variation that can be used to compute the approximate interferer location. Unlike the processing of EPIRB emissions, no identification code or coordinates can be extracted from an interfering signal, since its modulation, if any, would not contain that information. It is after the detection of such interference and notification to the appropriate administration (either directly or through the BR) that terrestrial monitoring facilities can more precisely locate the station or other RF source causing the interference using ground-based assets.

According to Resolution **205 (Rev.WRC-12)**, the frequency band 406-406.1 MHz is constantly monitored. It is to be noted that a new generation of instruments already flying on board various low earth orbit (LEO) satellites make noise measurements: each time the LEO receiver demodulates a signal within the 406-406.1 MHz band, the receiver provides an estimate of the strength of the signal power as well as the corresponding noise density. That data (signal and noise density) are useful for statistics as well for monitoring purposes.

The 406 MHz repeater on the Sarsat satellites relays all signals received in the 406-406.1 MHz band to specially equipped ground stations, where EPIRB signals and some interfering signals can be detected and located. This method of interferer location is only possible within about 4 000 km of a Cospas-Sarsat ground station, because it relies upon the simultaneous visibility, by the satellite, of the interferer and the ground station over a time period of at least four minutes. A large part of the southern oceans cannot presently be monitored for interferers or beacons in real-time, and must rely on stored information which is relayed by the satellites when entering ground station coverage. As additional ground stations are added in the Southern Hemisphere, the ability to detect and respond more quickly to signals in these areas may be improved.

When satellite measurements sufficiently refine the ground location of an interfering signal, information such as frequency, observation times, location coordinates and suggested search radius should be passed to the responsible administration (either directly, through the BR, or both) for their further investigation to precisely locate and mitigate the interference. The minimum recommended information is described in Annex 2.

When administrations locate, identify and mitigate an interference source, a report with the minimum information described in Annex 3 is desired to be returned to the reporting entity (generally an administration or the BR) to provide feedback to the Cospas-Sarsat analysis team to improve their analysis and estimates of source types, search radii and other factors, in order to improve the efficiency of detecting, locating and mitigating interference in this band. Also, some administrations participate in a monitoring programme in the 406-406.1 MHz band organized by the BR, in support of Resolution **205 (Rev.WRC-12)**. These administrations submit more detailed

2 In addition WRC-12 invited ITU-R to conduct, and complete in time for WRC-15, the appropriate regulatory, technical and operational studies with a view to ensuring the adequate protection of MSS systems in the frequency band 406-406.1 MHz from any emissions that could cause harmful interference, taking into account the current and future deployment of services in adjacent bands.

3 A "Local User Terminal" (LUT) is a Cospas-Sarsat ground station. These satellite receiving units are the ground stations that receive emergency beacon distress alerts.

reports of their observations to the BR regularly. The reports can be viewed and searched from the links found on this page (in Section IV):

<http://www.itu.int/ITU-R/index.asp?category=terrestrial&link=terrestrial-monitoring&lang=en>

Information submitted to the BR in support of this programme should be compliant with the format as in Table C.1 detailed in Cospas-Sarsat document C/S A.003 available at: http://www.cospas-sarsat.int/images/stories/SystemDocs/Current/cs_a003_oct_2013.pdf

Upon receipt of the reports, the BR requests that administrations responsible for the area where the unauthorized transmitters are located take immediate action with a view to stopping the emissions.

A more detailed description of the Cospas-Sarsat system, the beacon geolocation process, interference reporting and locating interference can be found in Report ITU-R SM.2258 – Overview of interference source detection and geolocation affecting the 406.0-406.1 MHz band used by emergency beacons.

3 Harmful interference levels

Recommendation ITU-R M.1478-2 provides detailed protection requirements for the various types of instruments mounted on board satellites in operation in low orbits, medium orbits and geostationary orbits. Recommendation ITU-R M.1478-2 should be the technical basis of calculations concerning the protection of the frequency band 406-406.1 MHz.

As general guidance for administrations searching for interference sources, harmful interference to the Cospas-Sarsat 406 MHz system can occur when interference signals in the 406-406.1 MHz band exceed $-190 \text{ dB(W(m}^2/\text{Hz))}$ at the satellite antenna (at 850 km for low orbit satellites), which increases the background noise level by 0.3 dB. This corresponds to an emitter on Earth having an e.i.r.p. of only -60 dB(W/Hz) for broadband noise or -40 dBW for a CW signal. Harmful interference from pulsed signals is described in Report ITU-R M.1042.

Annex 2

Information requested for reporting harmful interference affecting the 406–406.1 MHz spectrum

- a) Mean latitude and longitude (predicted);
- b) Probable search radius from mean location (including Country, Nearest city);
- c) Frequencies;
- d) Number of observations (total and number since last report);
- e) First and last date of occurrences;
- f) Modulation characteristics;
- g) Times and days-of-week of occurrences;
- h) Other details.

Annex 3**Information requested in a feedback report concerning the interference source**

- a) Latitude and longitude (actual);
 - b) Fundamental frequency of offending source (this may be outside the band);
 - c) Type of equipment;
 - d) Cause of interference;
 - e) Action taken.
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