

RECOMMENDATION ITU-R SM.1535*

The protection of safety services from unwanted emissions

(Question ITU-R 211/1)

(2001)

The ITU Radiocommunication Assembly,

considering

- a) that, in some cases, safety services and services employing high-power transmitters have been allocated to adjacent or nearby frequency bands;
- b) that, in making these allocations, practical transmitter and receiver compatibility may not have been considered;
- c) that No. 1.59 of the Radio Regulations (RR) defines a safety service as any radiocommunication service used permanently or temporarily for the safeguarding of human life and property;
- d) that some radiocommunication services, such as those safety services concerned with safety of life or property, are based on the reception of emissions with a higher probability of integrity and availability than is generally required for other radio services;
- e) that RR No. 1.169 defines harmful interference as interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with the RR;
- f) that RR No. 4.10 recognizes the requirement of radionavigation and other safety services for special measures to ensure their freedom from harmful interference;
- g) that it is important to avoid harmful interference to safety services because of the potential for loss of life and property;
- h) that several footnotes of the RR draw attention to the need for greater availability and priority for safety services in certain bands (e.g. Nos. 5.353A, 5.357A, 5.362A). High-power emissions and emissions from spaceborne or airborne stations can be particularly harmful;
- j) that there are various operational practices and mitigation techniques that can be used by safety services to minimize the impact of interference from other services;
- k) that there are various operational practices and mitigation techniques that can be used to avoid causing harmful interference to the safety services;
- l) that for spurious domain emissions, general limits specified in RR Appendix 3 may not protect to the desired extent the safety services from interference;

* This Recommendation should be brought to the attention of Radiocommunication Study Groups 4, 6, 7, 8 and 9.

- m) that Recommendation 66 (Rev.WRC-2000) called for ITU-R to “study those frequency bands and instances where, for technical or operational reasons, more stringent spurious emission limits than the general limits in Appendix 3 may be required to protect safety services and passive services such as radio astronomy, and the impact on all concerned services of implementing or not implementing such limits”;
- n) that Recommendation 66 (Rev.WRC-2000) called for ITU-R to “study those frequency bands and instances where, for technical or operational reasons, out-of-band limits may be required to protect safety services and passive services such as radio astronomy, and the impact on all concerned services of implementing or not implementing such limits”;
- o) that suitable measures can be taken to avoid the potential of harmful interference to safety services;
- p) that mobility of aircraft and the large viewing area to which aircraft are exposed, together with variability and uncertainty of the occurrence of harmful interference to safety-of-life aeronautical services may make it necessary to use statistical techniques in conjunction with other techniques to assess harmful interference;
- q) that statistical techniques have been successfully employed in other arenas such as manufacturing quality control and reliability analysis;
- r) that the term “harmful interference” must be construed in the light of the nature of the operations and the safety environment,

recognizing

that the RR contain definitions and terminology related to safety services (e.g. Nos. 1.28-1.31, 1.32, 1.33, 1.36, 1.43, 1.44, 1.46, and 1.47: services; Nos. 4.10 and 1.59: general; Nos. 1.166, 1.167, 1.168 and 1.169: interference),

noting

- a) that explanations of why safety services may need special attention with respect to interference from out-of-band or spurious emissions are presented in Annex 1;
- b) that safety services can only be defined in terms of safety requirements which seek to show that the system reaches a specified integrity level under all operational conditions of use. In the case of protection requirements it is necessary to demonstrate that a safety system's integrity is not compromised;
- c) that information on the history of compatibility between safety services and other services is likely to be useful,

recommends

1 that the following measures may be taken to avoid the potential of harmful interference to safety services:

- 1.1 consultation and exchange of technical and operational information between the relevant parties;
- 1.2 cooperation on the selection and implementation of the most suitable measures between operators of safety systems and other systems; and
- 1.3 appropriate spectrum management techniques including unwanted emission limits;

- 2 that the mitigation techniques and measures described in Annex 2 may be used by transmitting systems to avoid harmful interference generated by unwanted emissions, bearing in mind the constraints placed on system design;
- 3 that the mitigation techniques and measures described in Annex 3 may be used by safety services to reduce or avoid the impact of interference from other services where they do not degrade the performance of safety service equipment;
- 4 that where it is determined to be necessary, more stringent spurious emission limits than the general limits in RR Appendix 3 be used in the frequency bands in Annex 4; special cases may be resolved by using applicable ITU-R Recommendations;
- 5 that the frequency bands listed in Annex 4 are to be considered as those safety service bands where, for technical or operational reasons, out-of-band limits may be used by other services to protect safety services;
- 6 that the level of harmful interference for safety-of-life systems should be determined on a case-by-case basis in the form of a safety analysis. This analysis would assess the use being made of the safety system and demonstrate that the specified integrity level is still maintained under all operational conditions;
- 7 that the determination of quantitative threshold levels of harmful interference of the various aeronautical mobile services may include the examination of the operation and the appropriate safety criteria as described in Annexes 5 and 6.

ANNEX 1

Protection of safety services

Safety services are radiocommunications services used for safeguarding human life and property. For example, all aeronautical operational and air traffic control and many maritime communications are fundamentally safety of life. The systems, including radionavigation systems and radionavigation satellite systems, used for safety of life often depend on the ability to detect a weak or distant signal where interference can critically affect reception. This means special protection may be required for safety services as stated in RR No. 4.10, because of the criticality of protecting life and property. The necessity for safety systems to detect weak signals makes it important that these systems operate in an environment free from harmful interference. The international radio regulatory authorities recognize that special protection is required for the safety services. In view of the importance of safety systems and their vulnerability to interference, RR Article 31 specifically prohibits any emission causing harmful interference to distress and safety communications on any of the discrete frequencies identified at RR Appendices 13 and 15. Furthermore, in addition to the general spurious emission limits specified in the RR, specific standards or applicable ITU-R Recommendations are required to protect some safety services. Some examples are



Recommendations ITU-R M.218, ITU-R M.441, ITU-R M.589, ITU-R M.690, ITU-R M.1088, ITU-R M.1233, ITU-R M.1234, ITU-R M.1313, ITU-R M.1317, ITU-R M.1318, ITU-R M.1343, ITU-R M.1371, ITU-R M.1460, ITU-R M.1461, ITU-R M.1463, ITU-R M.1464, ITU-R M.1478, ITU-R S.1342, ITU-R SM.1009 and ITU-R SM.1051.

1 Aeronautical systems

For international civil aviation, specific safety standards are specified in International Civil Aviation Organization's (ICAO) Standards and Recommended Practices, Annex 10 to the Convention on International Civil Aviation. ICAO states “The Radio Regulations also have a major concern with the prevention of interference of all kinds, whether between services or regions, between assignments, or from other sources of radiation such as industrial or medical equipment. Particular attention is accorded to services where there is a predominant safety-of-life function, as in aeronautical services.”

In the design of aeronautical communications, navigation, and surveillance (CNS) systems, the attributes of spectrum efficiency and robustness of system operation (e.g. adequate link margin, resistance to interference, minimal failure modes) often will be in conflict. When this is the case, it should be recognized that robustness of system design must be given priority due to the safety-critical nature of aeronautical CNS systems.

2 Space-based distress alerting and location systems

Distress and safety systems operating in space stations with sensitive receivers are particularly vulnerable to interference from terrestrial and space-based emitters. Systems such as Cospas-Sarsat utilize low altitude Earth orbit satellites which have fields of view of millions of square kilometres and geostationary Earth orbit satellites which view approximately 1/3 of the Earth's surface. These satellites receive distress signals from low-power satellite emergency position-indicating radio beacons (EPIRBs) and are vulnerable to interference. Interference to Cospas-Sarsat in the band 406-406.1 MHz has been shown to originate from equipment in adjacent and near-adjacent bands as well as from transmitters with broadband modulation characteristics operating at frequencies as much as 20 MHz away from 406 MHz. The out-of-band and spurious emissions from high-power systems that use pulse and digital modulation techniques can be at levels that completely mask reception of EPIRB transmissions.

2.1 Cospas-Sarsat protection requirements

ITU has approved Recommendations that:

- identify protection requirements for Cospas-Sarsat search and rescue processors operating in the 406-406.1 MHz frequency band; and
- provide guidance for detecting and eliminating harmful interference in the 406-406.1 MHz frequency band.

Specifically, Recommendation ITU-R M.1478 – Protection criteria for Cospas-Sarsat search and rescue processors in the band 406-406.1 MHz – establishes the maximum acceptable broadband signal spectral power flux-density threshold level at the input to the satellite antenna as $-198.6 \text{ dB(W/(m}^2 \cdot \text{Hz))}$. This Recommendation also establishes that narrow-band spurious emissions should not exceed $-185.8 \text{ dB(W/m}^2)$ at the input to the Sarsat antenna. Recommendation ITU-R SM.1051 provides information on principles of EPIRB detection and location, the processing of 406 MHz interfering signals, harmful interference levels, and procedures for locating/eliminating harmful interference.

ANNEX 2

Mitigation techniques and measures that may be used at the transmitter

Several possible mitigation techniques have been described in ITU-R Recommendations, such as Recommendation ITU-R SM.328, which may have direct relevance to the categories listed below:

1 Practical hardware and system measures to be considered at an early stage in the design of systems in order to reduce interference from unwanted emissions

- Transmitter architecture.
- Design of the output power amplifier to avoid spectral regrowth of the signal into adjacent channels, or intermodulation.
- Use of components that operate with linear characteristics to the extent possible.
- Analysis and/or simulations to determine that ageing of transmitter components will not produce interference to distress and safety systems during the operational life of the transmitter.
- Design of the modulation process to avoid unwanted emissions.
- Antenna patterns.
- Power control.

2 Traffic loading management

Traffic loading management is the modification or reduction of potential interference source emissions during situations (time or scenarios) where harmful interference could result if no such reduction occurred. It is felt, in many cases, that the likely traffic considerations to determine whether the potential for interference could occur would need to be included in the overall compatibility assessment. Also felt, as a general comment, traffic loading management of the potential interference source for the purpose of protecting a safety service is not thought to be workable due to the high level of integrity required for such protection.

3 Band utilization

- One way to avoid co-channel harmful interference is to make optimum use of frequency reuse.
- Geographic and frequency separations are standard methods of precluding harmful interference.
- Safety services are more easily protected from harmful interference due to unwanted emissions when they are allocated frequency bands for their exclusive use.
- Space-based distress alerting and location systems have sensitive receivers and the following considerations should be addressed when planning new systems or upgrading old systems:
 - Proposed protection bandwidths must account for Doppler shifts due to relative motion between the transmitter and receiving space station. This is especially important when the transmitter is also located in space.
 - Special consideration must be given to the impact of out-of-band and spurious emissions from systems employing pulse, spread spectrum, and other broadband modulation techniques. These types of systems can cause interference when the transmitter frequency is relatively near in frequency to the safety system carrier frequency.
- Desensitization of amplifiers can occur when both the safety and non-safety systems are located in close spatial proximity. A potential for burnout of low noise amplifiers also exists where, e.g. orbital geometries are such that the safety and non-safety systems are in close proximity.
- Applicable ITU-R Recommendations identifying harmful interference levels to safety systems should be used as aids to establish proper frequency separation between safety and non-safety systems.

4 Guard channels

Channel 16 in the marine band has been protected in the past by providing vacant channels either side of the distress and safety calling and working channels. For example, in the past channels 15 and 17 were not used in order to avoid interference to channel 16. RR Appendix 18 includes protection for channel 16 by footnotes encouraging the use of low-power operation and on-board communications on channels 15, 75, 76 and 17. The use of guardbands in allocations adjacent to safety services can help to mitigate interference.

5 Monitoring

Reports of interference can be used to determine the type of interference or service received to determine whether the problem is to be resolved by local or international monitoring stations.

Monitoring of spectrum by mobile monitoring teams and electromagnetic compatibility (EMC) laboratories can be used to supplement the fixed monitoring facilities.