

REPORT 927-2*

**GENERAL CONSIDERATIONS RELATIVE TO HARMFUL INTERFERENCE FROM
THE VIEWPOINT OF THE AERONAUTICAL MOBILE SERVICES
AND THE AERONAUTICAL RADIONAVIGATION SERVICE**

(Questions 1/8 and 62/8 and
Study Programme 21A/8)

(1982-1986-1990)

1. Background

The ITU definition of "harmful interference" is contained in Radio Regulation No. 163 as follows:

"Harmful Interference: 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 these Regulations."

The term "harmful interference" is not generally definable in a precise quantitative manner and therefore an assessment of harmful interference must be construed in the light of the nature of the operations and the safety environment. This leads directly to the conclusion that the determination of quantitative threshold levels of harmful interference for the various aeronautical mobile radiocommunication services requires the examination of the appropriate safety criteria.

2. Aviation safety criteria

A prime basis of aviation safety is the *statistical* assessment of performance criteria and failure rates. The following statistical "failure rates" may have been used as criteria by some civil aviation administrations in the international aeronautical community:

- the air traffic systems which ensure separation between aircraft flying *en route* are designed to reduce the chances of mid-air collisions to a level no greater than 2 in 10^8 ; and
- the certification of aircraft automatic landing equipment by many civil aviation administrations requires that the control system in each aircraft be demonstrated statistically to have a failure rate no greater than 1 in 10^7 landings.

In light of the above, it is evident that for aeronautical mobile radiocommunication services, the required interference protection ratios will be very much influenced by the statistical characteristics of the particular service. For instance, a radionavigation aid providing the sole guidance to an aircraft during automatic landing requires very high protection from harmful interference. Indeed, it would follow that the statistical probability of harmful interference in such cases needs to be more stringent than 1 in 10^7 . In comparison it may be possible to identify other aeronautical systems which do not require this same degree of protection. § 5 of this Report examines this aspect further for the various aeronautical systems.

The above points lead directly to the thought that whilst it may be possible to quantify a signal level for unwanted harmful interference which would permit safe operation of a particular type of radio service, the promulgation of such a level without an associated description of its assumed nature and statistical variation could be of little value and could have serious implications. This would apply particularly to those environments where there are a multitude of potential interfering sources, possibly of more than one type, and where the aggregate harmful interferences at any particular point, therefore, could be expected to vary with time.

* The Director, CCIR, is requested to bring this report to the attention of ICAO and IEC and Study Groups 1, 10 and 11.

3. Aeronautical and non-aeronautical sources of harmful interference

An important aspect of the study of harmful interference is the determination of whether or not the criteria for harmful interference from non-aeronautical sources has, or should have, any relationship with the technical planning criteria established in the aeronautical services for co-channel and adjacent channel assignments. Frequency assignment planning criteria adopted internationally within the aeronautical services are based on practical considerations which take into account the operational usage of the particular service. In addition, the planning criteria are based, reasonably enough, on the premise that mutual cooperation and internationally agreed aviation standards and procedures are used by everyone involved. It is a point of fact that the 146 Contracting States of ICAO are under certain obligations relative to the adoption of aeronautical standards, recommended practices, and procedures, as set forth in Article 38 of the Convention on International Civil Aviation (Chicago, 1944). Pursuant to these obligations, there is a highly developed international information and registration service which ensures that all aviation facilities and their "frequency protected" service volumes are formally promulgated and available on charts in accordance with Annex 15 to the Convention on International Civil Aviation; and appropriate information from this service becomes part of aircraft flight deck documentation. Thus, in respect of all technical protection criteria adopted in the international civil aviation community against "aeronautical-to-aeronautical" harmful interference, there is comprehensive and significant additional protection provided through the organizational structure of international civil aviation, with ICAO at its focal point.

The additional protection indicated in the above paragraph is largely non-existent for non-aeronautical sources of harmful interference to aviation, some of which are only partially regulated by the ITU. Consequently, there is not necessarily an inherent relationship between aeronautical protection criteria and those criteria which may be appropriate to safety services for application to non-aeronautical sources of harmful interference. Each potential non-aeronautical source of harmful interference requires individual consideration in this respect.

The following external sources of man-made emissions and radiations are known to have caused harmful interference to aeronautical services:

- broadcasting, LF/MF AM and VHF FM;
- cable distribution systems;
- power line distribution systems;
- power line carrier;
- industrial, medical and scientific equipment;
- local oscillator emission from domestic electronic equipment;
- information technology equipment.

It should be observed that some of the above are not under the direct purview of the ITU, and therefore, it will be necessary to effect coordination between ITU, ICAO, and other concerned organizations. However, this need not influence CCIR involvement in the investigation of adequate protection criteria.

4. Shared and exclusive allocations

Regardless of the original intentions of radio spectrum planners, there can be no doubt that the pressure on the radio spectrum for additional allocations to the various radiocommunication services can result in aeronautical protection criteria being effectively regarded as non-aeronautical sharing criteria. As a consequence, a safety service must take considerable precautions to ensure that any radio service sharing the same radio band is constrained sufficiently to leave an adequate margin under all likely circumstances so that the aggregate harmful interference never exceeds the required protection criteria.

The constraints of weight, size, and power consumption placed upon airborne equipment have resulted in relatively low powered transmitters and sensitive receivers, which is consistent with general ITU guidance for efficient and effective use of the radio spectrum. Nonetheless, the above set of conditions does cause difficulties for the aeronautical community when interference problems arise. For instance, the wanted signal at the edge of a VHF radiotelephony service volume must be no less than 70 $\mu\text{V/m}$ to meet ICAO standards and recommended practices. For an aircraft flying at, say, 300 m above the ground, such a wanted field strength could be equalled by an unwanted signal source on the ground with an e.i.r.p. of only 16 μW . Many interfering sources can easily produce more than 16 μW . Article 8 of the Radio Regulations, the Table of Frequency allocations, contains examples of sharing arrangements between aeronautical and other radiocommunication services, some of which have resulted in harmful interference problems. In such cases, the need to maintain the necessary aeronautical protection criteria has led to a less efficient use of the radio spectrum for aeronautical purposes than could be achievable with separate exclusive allocations. Thus caution should be exercised before considering any sharing involving the aeronautical radiocommunication services.

Annex II details some of the items to be evaluated when considering the specific problem of sharing with the aeronautical flight test telemetry stations. In this regard Annex II responds to WARC-79 Resolution No. 505.

5. **Aeronautical radiocommunication and radionavigation systems included in Annex 10 to the ICAO Convention**

Precise details of aeronautical radiocommunication and radionavigation systems are contained in Annex 10 to the Convention on International Civil Aviation. Brief synopses are given below:

5.1 *HF and VHF digital data interchange and radiotelephony*

Air/ground digital data interchange or radiotelephony constitute a direct link between an aircraft in flight and aeronautical stations on the ground. The number of aircraft flying simultaneously in any given airspace and the multiplicity of air routes flown, result in a complex set of rules and procedures to ensure the safety of air operations. While it is true that interference to air/ground radiotelephony communications is relatively easier to detect, in as much as the pilot can hear it and is normally less likely to be misled, than in the case of interference to digital data interchange or to a radionavigation aid, such interference may nonetheless have serious consequences, particularly for aircraft contacting approach control of an airport while flying at positions where the ground clearance is of the order of a few hundred feet. Thus, regardless of adherence to precise phraseology and to other standard operational procedures, cases have arisen where even a slight interference to a single phrase has resulted in catastrophic consequences.

The conversion of the above factors into quantitative protection ratio criteria is a difficult task. On the one hand there is general acceptance of the view that some minimum interference to voice communications could normally be accepted, but on the other hand, it needs to be recognized that under difficult operational circumstances, errors that would normally be accepted can assume great significance, and under these circumstances an interference-free service can be vital. Therefore, a general protection ratio for HF and VHF radiotelephony should be developed such that the aggregate interference on any channel should not significantly add to the basic noise level of the safety service receivers used for air-ground communications. Following the same general idea, a protection ratio should be developed for HF and VHF digital data interchange.

Compatibility between the broadcasting service in the band of about 87-108 MHz and the aeronautical services operating in the band 108-136 MHz is addressed in Report 929.

5.2 *VHF emergency frequencies*

The Radio Regulations and Annex 10 to the Chicago Convention on Civil Aviation contain special provisions for the use and protection of the aeronautical mobile emergency frequencies 121.5 MHz and 243 MHz. Subsequently, the ICAO has agreed on special procedures for monitoring these frequencies while, in addition, the COSPAS-SARSAT system provides for essential alerting capabilities. Also, EPIRBs, compulsory in some countries for carriage on board aircraft, operate on these frequencies. It is important that reception of distress and emergency transmissions will not be impaired. These frequencies are also used by other services for communications with the aeronautical services in the event of an emergency.

5.3 Landing guidance systems

5.3.1 Instrument landing system (ILS)-(VHF and UHF)

The ILS consists of a "localizer" (VHF) providing lateral guidance for aircraft to the airport runway, a "glide-path" (UHF) providing the line of descent in the vertical plane, and one, two, or three "marker beacons" providing the aircraft with height and distance checks at known points from the runway threshold. One or more "locators" or other supplementary approach aids such as VOR may be used in conjunction with the ILS to assist in guiding aircraft to the "on-course" radio beams. Each of the above components of the ILS performs a different function and hence it can be seen that these components do not provide any form of redundancy for each other.

In the approach and landing phase of flight, when the aircraft is manoeuvring in close proximity to the ground, it is essential that harmful interference to any of the radio aids in use during this phase of flight be kept at an extremely low level of probability of occurrence. It is particularly relevant to note in this regard that the use of automatic landing systems which utilize ILS guidance signals, is the normal operating procedure for modern large aircraft, regardless of weather conditions. It should be noted that the very high level of protection against harmful interference required to support such operations is only needed within fairly constrained volumes of airspace around the ILS installations, e.g., around aerodromes. This factor may be helpful when considering the practical issues involved in protection against harmful interference.

Because of its critical nature considerable investigation of interference to ILS has occurred and Annex I gives more detailed information and derives protection ratios required under specified circumstances.

Compatibility between the broadcasting service in the band of about 87-108 MHz and the aeronautical services operating in the band 108-136 MHz is addressed in Report 929.

5.3.2 Microwave landing system (MLS)

The MLS is intended for international application and will provide instrument landing guidance for all classes of airports and all types of aircraft, including air carriers, vertical and short take-off and landing aircraft, business and light aircraft of general aviation. MLS will support operations at the large commercial airports with categories of service which permit all weather landings, as well as curved or segmented paths. This can increase the number of aircraft landing in high traffic situations. Simplified equipment will permit inexpensive installation at small airports which serve the private aviation sector and the "commuter" airlines. For instance, the simplified version may provide a smaller coverage angle, limited or no curved approaches and no flare guidance.

The MLS consists of angle guidance equipment in the 5.0 - 5.25 GHz frequency band. Azimuth equipment provides lateral guidance to the extended airport runway centre line, elevation equipment provides the line of descent in the vertical plane, and precision distance measuring equipment (DME/P) in the 960 - 1 215 MHz frequency band provides distance from the airport runway to the aircraft. Each of these components performs a separate function, and when integrated provides the aircraft with a precise three-dimensional position fix, and guidance with respect to the selected approach path. Azimuth guidance for the "back course" (e.g. missed approach) is also available, employing a separate azimuth transmitter directing its beam into the back course sector. A ground-to-air data capability is also provided throughout the angle guidance coverage volume via stationary sector coverage beams. Among other things, this allows for ground antenna siting geometry to be transmitted to the aircraft for use in its position determination algorithm.