Preliminary investigations on regulatory and legal issues on the feasibility of introducing low power audio PMSE[[1]](#footnote-2) in the band 960-1164 MHz

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Report to WGFM

# Executive summary

At its 86th meeting, WG FM tasked FM PT51 to carry out a preliminary investigation on the regulatory and legal issues of introducing low power audio PMSE (wireless microphones and in ear monitors operating with a radiated power of less than 50 mW). This report addresses various regulatory and legal issues with regard to the feasibility of introducing audio PMSE in the frequency band 960 to 1164 MHz.

Within the International Telecommunication Union (ITU) Radio Regulations (RRs) the frequency band 960 to 1164 MHz is allocated to the Aeronautical Radionavigation Service (ARNS), Aeronautical Mobile en-Route Service AM(R)S and in part to the Aeronautical Mobile-Satellite en-Route Service (AMS(R)S) (earth-to-space). In addition, the frequency band is shared with Link16, a military datalink and communications system and RSBN, a military short-range navigation system. In addition to the Aeronautical Radionavigation Service (ARNS), the adjacent band 1164 - 1215 MHz is also used by the radionavigation satellite service (RNSS).

Article 4.4[[2]](#footnote-3) of the RRs provides the regulatory mechanism by which administrations could authorise PMSE within the frequency band 960-1164 MHz. However, should administrations allow access to the frequency band for PMSE then they need to ensure compliance with the provisions on Article 4.10[[3]](#footnote-4) of the RRs (as is the case for Link16 operating in the band).

The ICAO Convention (Chicago Convention) obliges States to undertake or adopt measures to ensure the safety of overflying aircraft. ICAO Annex 10 includes standards and recommended practices which require aircraft and aeronautical service providers on the ground to operate certain ICAO standardized equipment for Communication, Navigation and Surveillance.

As per the provisions contained in ICAO Annex 19, “Safety Management” each State, as part of its state safety programme, shall ensure that service providers under its authority implement a safety management system. As part of the safety management system a service provider needs to develop a safety case for each of the systems it operates including the necessary hazard identification and risk management processes.[[4]](#footnote-5)

Safety cases are required as means to support aircraft operations by structuring and documenting the demonstration of the safety of air traffic management services and systems. The introduction of a new system in the band 960-1164 MHz would change the RF environment thus invoking the requirement to reviewing the safety cases. The safety risk assessment developed by the aeronautical service provider will need to demonstrate that an equivalent level of safety or an alternative acceptable means of compliance can be achieved.

Safety cases do not only take account of the technical environment, but also of human factor issues. If a new system such as PMSE were to be introduced in an aeronautical frequency band, the safety case analysis would need to take a number of additional factors into account, such as PMSE users not respecting their license conditions (intentional or unintentional wrong frequency selection, wrong location etc.). Similarly, the safety risk assessment would need to address the potential of PMSE equipment not meeting its specifications.

This report identifies a number of regulatory issues which may affect the feasibility of audio PMSE sharing in the band. It also notes a number of risks and areas of concern that administrations should be aware of. Introducing a new non-aeronautical system in the 960-1164 MHz band without following an appropriate process, including safety assessment and validation, could impact the efficient use of spectrum designated for aeronautical use, and in the worst case cause safety issues. The report also identifies possible effects of potential harmful interference from PMSE on aeronautical systems and aircraft, including some elements addressing potential costs.

The potential for effectively sharing in the band depends on two conditions, firstly providing adequate protection to incumbent systems, and secondly the spectrum providing sufficient quality for PMSE to operate. A second order consideration is the quantity of spectrum that would be available for use by PMSE, as a small amount would not be operationally or economically viable.

Provided that international radio regulatory and aeronautical safety obligations are met, the introduction of low power audio PMSE in the band 960-1164 MHz is a sovereign decision on the designation of spectrum under the full liability of the state. Such a decision would involve agreement between the national spectrum regulator, the national aviation authorities, ANSPs and Defence.

Testing and trials of PMSE operation in the 960 to 1164 MHz band has been carried out in the UK since July 2016 by PMSE stakeholders.

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LIST OF ABBREVIATIONS

| Abbreviation | Explanation (style: ECC Table Header red font) |
| --- | --- |
| CEPT | European Conference of Postal and Telecommunications Administrations |
| ECC | Electronic Communications Committee |
| EUROCONTROL | European Organisation for the Safety of Air Navigation |
| ICAO |  |
| EASA |  |
| NATO |  |
| NSAs | National Supervisory Authorities ensure the supervision of the regulatory framework in all Member States. They are responsible, in particular, for certifying and overseeing air navigation service providers as well as for the preparation of national performance plans of the Member States concerned. |

# Introduction

At the 86th meeting of WG FM it was proposed to ask WG SE to carry out compatibility studies between audio PMSE and incumbent systems in the band 960 to 1164 MHz (960 MHz band). WG FM generated a new work item for FM PT51 ([FM51\_10](http://eccwp.cept.org/WI_Detail.aspx?wiid=592) ). This work item was separated into two separate requirements:

* Scope out the requirements for compatibility studies (this has been completed [date]; and
* Carry out preliminary investigations on the regulatory and legal status of introducing low power audio PMSE into the 960 MHz band.

In addition, at the its 89th meeting, WG FM agreed the following guidance to FM51:

* the draft report is an internal WG FM document;
* FM51 shall bring the completed report to the May 2018 meeting of WG FM and that no extensions were envisaged;
* WG FM requires presentation of the issues, with balanced positions when there is no agreement;
* WG FM does not expect conclusions, but a short summary of the issues is appropriate;
* the work in FM51 on this work item will be paused at the May 2018 WG FM meeting and resumed again when the outcome of the WG SE studies is available;
* the final deliverable will be an ECC Report with a deadline of May 2020.

Background

Spectrum availability for audio PMSE in the band 470 to 790 MHz is reducing as a consequence of the decision to allocate the 700 MHz band (694 to 790 MHz) for terrestrial systems capable of providing wireless broadband electronic communications services. Within CEPT additional spectrum for audio PMSE has been identified and included in ERC Recommendation 25/10.

Testing and trials of PMSE operation in the 960 to 1164 MHz band has been carried out in the UK since July 2016 by PMSE stakeholders in a variety of scenarios. Trials have predominately been indoors within studios, with a limited number of outdoor deployments. In addition, PMSE stakeholders have also carried out spectrum monitoring (from the perspective of interference into PMSE).

Incumbent use

The 960 MHz band is used by a number of aeronautical safety and regularity of flight systems, for both civil and military purposes, to provide CNS (communications, navigation and surveillance) which require an appropriate coordination between all of them.

The main use of the band is for Distance Measuring Equipment (DME). This is an interrogator (airborne) / transponder (ground based) system which provides an aircraft with its slant range from the ground transponder. The aircraft interrogates the ground transponder on a frequency and the transponder replies on a separate frequency separated by 63 MHz. The military system TACAN is similar in operation to DME but with additional modulation which allows an aircraft to determine its bearing from the transponder as well as its slant range.

In addition to DME there are a number of systems which operate on 1030 and 1090 MHz. Principally this is Secondary Surveillance Radar which is also an interrogator/transponder system, however, in this case the interrogator is ground based and transmits on 1030 MHz using a rotating, high gain antenna, and the aircraft responds on 1090 MHz. The radar is then able to determine the range and bearing of the aircraft. Aircraft replies can also include additional data such as aircraft identity, altitude and speed.

In addition to SSR a number of other systems also utilise 1030 and 1090 MHz such as mutilateration systems and Airborne Collision Avoidance and Traffic Collision Avoidance Systems (ACAS and TCAS). Automatic Dependent Surveillance-Broadcast (ADS-B) provides aircraft identity, aircraft derived position plus other data (this is also receivable in space). The military also use 1030/1090 MHz for Identification Friend or Foe (IFF).

The band 960-1215 MHz is allocated to the Aeronautical Radionavigation Service (ARNS),

WRC-07 allocated the 960 to 1164 MHz band to the aeronautical mobile (route) service (AM(R)S) subject to footnote 5.327A ('The use of the band 960-1 164 MHz by the aeronautical mobile (R) service is limited to systems that operate in accordance with recognized international aeronautical standards. Such use shall be in accordance with Resolution 417 (WRC-07)'). WRC-15 revised Res 417 and in the current edition of the Radio Regulations, footnote 5.327A refers to the revised Res 417. The band has been identified for use by L-DACS (L band Digital Aeronautical Communication System). While not currently operational, standardisation work is underway in ICAO and the system is expected to be introduced in the mid-2020s.

WRC-15 allocated part of the 960 to 1164 MHz band to the Aeronautical mobile-satellite en-Route service (AMS(R)S) (Earth-to-space) in all three ITU Regions.

The adjacent band 1164-1215 MHz is used by the Radionavigation Satellite Service in addition to DME and TACAN. Galileo band E5a and GPS band L5 are immediately adjacent (1164 to 1189 MHz).

There are other aeronautical systems operating in 960 MHz band, and a full list of incumbent and future systems is provided in section 3.

Regulatory aspects

The 960 MHz band is subject to regulations under a number of regulatory bodies. Some of these relate directly to the spectrum band itself, i.e. the ITU Radio Regulations, and others relate to aeronautical use of the band, i.e, ICAO's responsibility relating to civil aviation Standards and Recommended Practices (SARPs) and policies.

In accordance with current usage of the 960 MHz band, other organisations are involved in the regulatory process. It is important to take into account these regulations if considering introducing audio PMSE into the 960 MHz band.

# regulatory and operational responsibility

## International Telecommunication Union (ITU)

### Constitution and Convention

The International Telegraph (later Telecommunication) Convention, today the Constitution and Convention of ITU, is the basic treaty that establishes the legal basis for the Union and defines its purpo​se and structure.

A thoroughly revised Constitution and Convention of the International Telecommunication Union was adopted at the 1992 Additional Plenipotentiary Conference held in Geneva. Subsequent plenipotentiary conferences have adopted only amending instruments to the 1992 documents. The Constitution and Convention currently in force are the Constitution and Convention of the International Telecommunication Union (Geneva, 1992) as amended by subsequent plenipotentiary conferences[[5]](#footnote-6).

The ITU Constitution (CS) states:

* CS Article 40 : Priority of Telecommunications Concerning Safety of Life:

191 International telecommunication services must give absolute priority to all telecommunications concerning safety of life at sea, on land, in the air or in outer space, as well as to epidemiological telecommunications of exceptional urgency of the World Health Organization.

* CS No. 1003 (also RR No. 1.169) :

1003 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 the Radio Regulations.

### ITU Radio Regulations

The ITU Radio Regulations (RR) also state:

* ITU RR No. 4.4 : Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations.
* ITU RR No. 4.10 : Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies.
* ITU RR, Article 43 "Special rules relating to the use of frequencies"

43.1 § 1 Frequencies in any band allocated to the aeronautical mobile (R) service and the aeronautical mobile-satellite (R) service are reserved for communications relating to safety and regularity of flight between any aircraft and those aeronautical stations and aeronautical earth stations primarily concerned with flight along national or international civil air routes.

ITU RR Article 5 (see table 1) states that the band 960-1164 MHz is allocated to the Aeronautical Radionavigation Service (ARNS), Aeronautical Mobile en-Route service AM(R)S and in part to the Aeronautical mobile-satellite en-Route service (AMS(R)S) (Earth-to-space) in all three ITU Regions.

Moreover, the adjacent band 1164-1215 MHz is allocated to the radionavigation-satellite service (RNSS) space-to-Earth) and used by GNSS systems and to the Aeronautical Radionavigation Service (ARNS).

Table : RR allocation in the band 960-1164 MHz

|  |  |
| --- | --- |
| Frequency band | RR Allocation to services |
| 960 MHz - 1164 MHz | AERONAUTICAL MOBILE (R) 5.327A  AERONAUTICAL RADIONAVIGATION 5.328  5.328AA |

5.327A : The use of the frequency band 960-1 164 MHz by the aeronautical mobile (R) service is limited to systems that operate in accordance with recognized international aeronautical standards. Such use shall be in accordance with Resolution 417 (Rev.WRC-15). (WRC-15)

5.328 : The use of the band 960-1 215 MHz by the aeronautical radionavigation service is reserved on a worldwide basis for the operation and development of airborne electronic aids to air navigation and any directly associated groundbased facilities. (WRC-2000)

5.328AA : The frequency band 1 087.7-1 092.3 MHz is also allocated to the aeronautical mobile-satellite (R) service (Earth-to-space) on a primary basis, limited to the space station reception of Automatic Dependent Surveillance-Broadcast (ADS-B) emissions from aircraft transmitters that operate in accordance with recognized international aeronautical standards. Stations operating in the aeronautical mobile-satellite (R) service shall not claim protection from stations operating in the aeronautical radionavigation service. Resolution 425 (WRC-15) shall apply. (WRC-15)

WRC-07[[6]](#footnote-7) has allocated the band 960 to 1164 MHz to the aeronautical mobile (R) service (AM(R)S) in order to make available this frequency band for new AM(R)S systems, and in doing so enabled further technical developments, investments and deployments by the aeronautical sector. This WRC-07 AM(R)S allocation in the band 960-1164 MHz is limited to systems operating in accordance with international aeronautical standards.

This AM(R)S allocation is to support the introduction of applications and concepts in air traffic management supporting safety critical aeronautical communication.

## International Civil Aviation Organization (ICAO)

ICAO is a UN specialized agency, established by States in 1944 to manage the administration and governance of the [Convention on International Civil Aviation](https://www.icao.int/publications/Documents/7300_cons.pdf)[[7]](#footnote-8).

### ICAO Standards and Recommended Practices (SARPs)

ICAO works with the Convention’s 192 Member States and industry groups to reach consensus on Standards and Recommended Practices (SARPs) and policies in support of a safe, efficient, secure, economically sustainable and environmentally responsible civil aviation sector.

The SARPs contained in the Annexes to the Convention on International Civil Aviation, constitute the rule of law for international civil aviation. These SARPs and policies, as used by the ICAO Member States, ensure that their national civil aviation operations and regulations conform to global norms, which in turn permits more than 100,000 daily flights in aviation’s global network to operate safely and reliably in every region of the world.

### SARPs for Radiocommunication and Radionavigation systems

The SARPs for radiocommunication and radionavigation systems (in aeronautical terms: Communication, Navigation and Surveillance (CNS) systems), as contained in Annex 10 "Aeronautical Telecommunications", are developed in accordance with Article 37 of the ICAO Convention for the purpose of ensuring the safety and regularity of air navigation. In addition to the Radio Regulations, the SARPs and related documents specify interface and performance standards for internationally agreed aeronautical systems to ensure that they meet the specific operational requirements of those aeronautical systems. Several systems used for aeronautical radionavigation and radiocommunication are operated in the band 960 - 1215 MHz, see section 3 for further details.

### SARPs for Safety Management

The SARPs contained in Annex 19 "Safety Management", outline the safety management responsibilities of States, aeronautical service providers and aircraft operators, ensuring preventative action to avoid any issue which would compromise the safety of aeronautical operations. Additional provisions on safety management are provided in ICAO Doc 9859 "Safety Management Manual". Safety Cases are a means of structuring and documenting the demonstration of the safety of air traffic management services and systems as well as aircraft operations. Examples of a requirement for a Safety Case assessment include: Whenever a new system or service is taken into use by an aeronautical operator, e.g. radiocommunication, radionavigation aids or surveillance systems; whenever there may be a significant change to the quality of the service provided by those systems; whenever an aircraft operator starts operating on a new air route or whenever there may be a significant change to operational parameters associated with that air route, such as reduced reliability of radionavigation aids along the air route.

### "No Country left behind initiative"

In addition to its core work, ICAO also coordinates assistance and capacity building for States in support of numerous aviation development objectives; produces global plans to coordinate multilateral strategic progress for safety and air navigation; monitors and reports on numerous air transport sector performance metrics; and audits States’ civil aviation oversight capabilities in the areas of safety and security.

## European Conference of Postal and Telecommunications administrations (CEPT)

As refers to EFIS ECA table (see [ERC Report 25](http://www.erodocdb.dk/docs/doc98/official/pdf/ERCRep025.pdf) []), , the allocation for 960 to 1164 MHz at CEPT level refers to ITU with additional footnote regarding the harmonisation by NATO in this band.

Table : ECA table allocations and applications in the band 960-1164 MHz

| 960 MHz - 1164 MHz | | | |
| --- | --- | --- | --- |
| RR (including Region 1) Allocation and RR footnotes applicable to CEPT | European Common Allocation and ECA Footnotes | Applications | Notes |
| AERONAUTICAL MOBILE (R) 5.327A  AERONAUTICAL RADIONAVIGATION 5.328 5.328AA | AERONAUTICAL MOBILE (R) 5.327A  AERONAUTICAL RADIONAVIGATION 5.328  5.328AA        ECA36 | Aeronautical military systems  Aeronautical navigation | Military use includes JTIDS/MIDS  Including DME, SSR, TACAN |

5.327A : The use of the frequency band 960-1 164 MHz by the aeronautical mobile (R) service is limited to systems that operate in accordance with recognized international aeronautical standards. Such use shall be in accordance with Resolution 417 (Rev.WRC-15). (WRC-15)

5.328 : The use of the band 960-1 215 MHz by the aeronautical radionavigation service is reserved on a worldwide basis for the operation and development of airborne electronic aids to air navigation and any directly associated groundbased facilities. (WRC-2000)

5.328AA : The frequency band 1 087.7-1 092.3 MHz is also allocated to the aeronautical mobile-satellite (R) service (Earth-to-space) on a primary basis, limited to the space station reception of Automatic Dependent Surveillance-Broadcast (ADS-B) emissions from aircraft transmitters that operate in accordance with recognized international aeronautical standards. Stations operating in the aeronautical mobile-satellite (R) service shall not claim protection from stations operating in the aeronautical radionavigation service. Resolution 425 (WRC-15) shall apply. (WRC-15)

ECA36 : Frequency band, which has been harmonised by NATO and NATO member nations for military use as defined in the NATO Joint Civil/Military Frequency Agreement (NJFA) 2014. Note: A public version of the NJFA 2014 has been provided by NATO and presented to ECC in February 2017.

## National regulatory status in CEPT

In CEPT countries, the band 960-1164 MHz is allocated to the aeronautical mobile en-Route, aeronautical radionavigation services, and in part to the Aeronautical Mobile satellite en-Route service (Earth-to-space).

One administration has made the decision to make parts of this band available for audio PMSE[[8]](#footnote-9). According to EFIS[[9]](#footnote-10), one administration has made part(s) of this band available for fixed services.

In many CEPT administrations, this frequency band is shared between Civil Aviation and the Military based on national joint agreements and on mutually agreed sharing procedures.

## Other organisations

### EU

#### Single European Sky (SES)

Within the EU, Single European Sky (SES) legislation, e.g. Commission IRs (EU) 1035-2011[[10]](#footnote-11) and 1034/2011[[11]](#footnote-12), is in force[[12]](#footnote-13) and may also have more wide applicability. This regulatory regime requires that hazard identification as well as risk assessment and mitigation are systematically conducted for any changes to those parts of the ATM functional system and supporting arrangements within their managerial control by air traffic service providers (ANSPs) before bringing new Air Traffic Management facilities into use or when changes to existing facilities are foreseen; in the present context such changes to be investigated may include changes to the RF environment.

Since 2004, the European Union (EU) has gained competences in air traffic management (ATM) and the decision-making process has moved away from an intergovernmental practice to the EU framework. The EU’s main objective is to reform ATM in Europe in order to cope with sustained air traffic growth and operations under the safest, most cost- and flight-efficient and environmentally friendly conditions. This implies de-fragmenting the European airspace, reducing delays, increasing safety standards and flight efficiency to reduce the aviation environmental footprint, and reducing costs related to service provision. Achievements have already been made at operational, technological and institutional levels; efforts are ongoing to maximise the benefits of activities initiated under the SES framework.

The SES legislative framework consists of four Basic Regulations (N° 549/2004, 550/2004, 551/2004 and 552/2004) covering the provision of air navigation services (ANS), the organisation and use of airspace and the interoperability of the European Air Traffic Management Network (EATMN). The four Regulations adopted in 2004 (the SES I Package) were revised and extended in 2009 with Regulation (EC) n° 1070/2009 aimed at increasing the overall performance of the air traffic management system in Europe (the SES II Package). On this basis, the Commission adopted and implemented extensive and comprehensive implementing legislation; this framework also includes more than 20 Implementing Rules and Community Specifications ("technical standards") adopted by the European Commission in view of ensuring the interoperability of technologies and systems.

Major developments have been possible due to the extensive involvement of stakeholders from the ATM community: industry partners, air navigation service providers (ANSPs), national supervisory authorities (NSAs), social dialogue with staff unions, airport authorities, the military and the certification authorities, and enhanced cooperation with EUROCONTROL.

The SES framework has been supplemented by an integrated approach towards safety by the extension of the competencies of the EASA in the field of aerodromes, air traffic management and air navigation services, through the establishment of a joint undertaking (JU) on research & development, the SESAR JU (SESAR standing for the Single European Sky ATM Research) and of a SESAR Deployment Manager. A Network Manager for the European ATM network has been created, while an independent Performance Review Body (PRB) supports the Commission in the development and management of the SES performance scheme in which Functional Airspace Blocks (FABs) have a key role to play.

The overall SES objectives will be achieved through a holistic approach that encompasses five interrelated pillars: the performance-based regulatory framework, the safety pillar, the technological contribution, the human factor and the optimisation of airport infrastructure.

The SES does not stop at the border of the European Union. Its extension to third ‘neighbouring’ countries primarily relies on the EU’s policy in the field of international relations. This policy, which gives priority to the association and/or integration of third countries into the EU legal framework, also considers the added value of regional cooperation activities carried out at the level of international organisations, such as the ICAO and EUROCONTROL. EU representatives are active in these organisations to ensure overall consistency between its action in the external field and action undertaken under the aegis of such organisations. Cooperative operational arrangements with ANSPs from key partners of the EU are also being promoted by the Commission as a significant task of the Network Manager in order to better manage intercontinental traffic to/from the EU and improve the performance of the European ATM network.

The Single European Sky (SES) is an ambitious initiative launched by the European Commission in 2004 to reform the architecture of European ATM. It proposes a legislative approach to meet future capacity and safety needs at a European rather than local level.

The key objectives of the SES are:

• To restructure European airspace as a function of air traffic flows

• To create additional capacity

• To increase the overall efficiency of the air traffic management system.

In order to fulfil these objectives, the European Commission set the following High-Level Goals

• Enable a 3-fold increase in capacity which will also reduce delays both on the ground and in the air

• Improve safety by a factor of 10

• Enable a 10% reduction in the effects flights have on the environment

• Provide ATM services to the airspace users at a cost of at least 50% less

EU Co-operation with EUROCONTROL

The European Commission is working closely together with the European Organisation for the Safety of Air Navigation (EUROCONTROL) to achieve the objectives of the Single European Sky Initiative.

Over the last decade, several elements of the EUROCONTROL regime, such as the charging and performance review and the common air traffic flow management system, have been successfully enhanced under EU law. As a result, EUROCONTROL performs tasks now under the SES legislation. Starting from 2010, the organisation has been charged with four major tasks/roles:

1. technical support to the European Commission and EASA for assisting them in their regulatory actions;

2. the Performance Review Body to assist the Commission in the development and implementation of the performance scheme (designation by the Commission until 2016);

3. the Network Manager for the ATM Network functions;

4. furthermore, EUROCONTROL plays an important role in the SESAR Joint Undertaking's activities as a founding member together with the EU (since 2007).

In December 2012, a High Level Agreement (HLA) was signed which recognises the contribution that each organisation can make to European ATM. The respective roles of the EU as single pan-European regulator and that of EUROCONTROL in technical support of the achievement of the objectives of the SES policy were reaffirmed in this agreement.

The European Union will become a member of EUROCONTROL. Currently the Union’s membership is being implemented on a provisional basis to enable the Union's participation in EUROCONTROL governing bodies. Full membership will be realised when all EUROCONTROL member states have ratified the protocol on the accession of the European Union to the EUROCONTROL convention.

Agreement between the European Union and the European Organisation for the Safety of Air Navigation providing a general framework for enhanced cooperation, Council Decision 2013/36/EU

Council Decision concerning the conclusion by the European Community of the Protocol on the accession of the European Community to the European Organisation for the Safety of Air Navigation [5565/1/04, 29/04/2004]

FINAL ACT of the diplomatic conference on the protocol on the accession of the European Community to the EUROCONTROL international convention relating to co-operation for the safety of air navigation of 13 December 1960, as variously amended and as consolidated by the protocol of 27 June 1997.

#### European Aviation Safety Agency (EASA)

The European Aviation Safety Agency (EASA) [[13]](#footnote-14) is established under the European  in Regulation (EC) No[[14]](#footnote-15)216/2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency in order to :

* •Ensure the highest common level of safety protection for EU citizens
* •Ensure the highest common level of environmental protection
* •Establish a single regulatory and certification process among Member States
* •Facilitate the internal aviation single market & create a level playing field
* •Work with other international aviation organisations & regulators
* EASA undertakes the following activities:
* •Draft implementing rules in all fields pertinent to the EASA mission
* •Certify & approve products and organisations, in fields where EASA has exclusive competence (e.g. airworthiness)
* •Provide oversight and support to Member States in fields where EASA has shared competence (e.g. Air Operations , Air Traffic Management)
* •Promote the use of European and worldwide standards
* •Cooperate with international actors in order to achieve the highest safety level for EU citizens globally (e.g. EU safety list, Third Country Operators authorisations)

The EU and EASA rules ensure that the flight is safe for passengers and crew, and free from risk of damage to persons and property on the ground. Building on the ICAO regulatory framework, the processes of airworthiness approval, equipment type certification and safety management are described in detail in these rules. As a part of this regulatory process, the radio installations must conform to agreed performance standards, must operate in correct frequency bands, must be licensed by appropriate authorities, and be operated by licensed personnel.

To illustrate the above: The radio in an aircraft requires the assurance of correct functioning after its installation, which includes its performance as a working communications or radionavigation system, as well as its compatibility with other on-board radio and electronic systems. Prior to its installation, the installation must have received approval issued by EASA.

The EASA rules ensure that the flight is safe for passengers and crew, and free from risk of damage to persons and property on the ground. As a part of this regulatory process, the radio installations must conform to agreed performance standards, must operate in correct frequency bands, must be licensed by appropriate authorities, and be operated by licensed personnel.

#### European Sky ATM Research (SESAR)

The SESAR Joint Undertaking (SJU) was established under Council Regulation (EC) 219/2007 of 27 February 2007 (as modified by Council Regulation (EC) 1361 / 2008 (SJU Regulation) and last amended by the Council Regulation (EU) 721/2014).

As the technological pillar of Europe’s ambitious Single European Sky (SES) initiative, SESAR is the mechanism which coordinates and concentrates all EU research and development (R&D) activities in ATM, pooling together a wealth experts to develop the new generation of ATM. Today, SESAR unites around 3,000 experts in Europe and beyond.

In 2007, the SESAR Joint Undertaking was set up in order to manage this large scale and truly international public-private partnership.

Air traffic management (ATM) is an essential part of European air transport and aviation, connecting cities and people citizens as well as boosting jobs and growth. While unseen and unnoticed by passengers, ATM plays several specific and important roles:

* Acts as a guardian of safety
* Connects European cities and Europe with the rest of the world
* Addresses climate change by enabling green and efficient routes
* Maximises current infrastructure while delivering advanced information services
* Acts as a catalyst for Europe’s competitiveness and innovative capacity

However, Europe’s ATM system is based on ageing technology and procedures and needs updating particularly in light of the expected traffic growth between now and 2035. This is where SESAR comes in. As one of the most innovative infrastructure projects ever launched by the European Union, SESAR’s role is to define, develop and deploy what is needed to increase ATM performance and build Europe’s intelligent air transport system.

The objective of SESAR is to modernise European ATM by defining, developing and delivering new or improved technologies and procedures (SESAR Solutions).

SESAR’s vision builds on the notion of trajectory-based operations’ and relies on the provision of air navigation services (ANS) in support of the execution of the business or mission trajectory — meaning that aircraft can fly their preferred trajectories without being constrained by airspace configurations.

This vision is enabled by a progressive increase of the level of automation support, the implementation of virtualisation technologies as well as the use of standardised and interoperable systems. The system infrastructure will gradually evolve with digitalisation technology, allowing air navigation service providers (ANSPs), irrespective of national borders, to plug in their operations where needed, supported by a range of information services. Airports will be fully integrated into the ATM network level, which will facilitate and optimise airspace user operations.

Going beyond 2035 towards 2050, performance-based operations will be implemented across Europe, with multiple options envisaged, such as seamless coordination between ANSPs or full end-to-end ANS provided at network level. Furthermore, it is widely recognised that to increase performance, ATM modernisation should look at the flight as a whole, within a flow and network context, rather than segmented portions of its trajectory, as is the case today. With this in mind, the vision will be realised across the entire ATM system, offering improvements at every stage of the flight.

Among different SESAR key features it is important to mention the 4th key feature: Enabling aviation infrastructure. The enhancements described in the remaining key features will be underpinned by an advanced, integrated and rationalised aviation infrastructure, providing the required technical capabilities in a resource-efficient manner. This feature will rely on enhanced integration and interfacing between aircraft and ground systems, including ATC and other stakeholder systems, such as flight operations and military mission management systems. Communications, navigation and surveillance (CNS) systems, SWIM, trajectory management, Common Support Services and the evolving role of the human will be considered in a coordinated way for application across the ATM system in a globally interoperable and harmonised manner.

In order to create the single European sky, on 10 March 2004 the European Parliament and the Council adopted Regulation (EC) No 549/2004 laying down the framework for the creation of the single European sky (the framework Regulation) (1), Regulation (EC) No 550/2004 on the provision of air navigation services in the single European sky (the service provision Regulation) (2), Regulation (EC) No 551/2004 on the organisation and use of the airspace in the single European sky (the airspace Regulation) (3), and Regulation (EC) No 552/2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation) (4).

The project to modernise air traffic management in Europe, (the SESAR project), is the technological element of the single European sky. It aims by 2020 to give the Community a high-performance air traffic control infrastructure which will enable the safe and environmentally friendly development of air transport, benefiting fully from the technological advances of programmes.

Following the European Community's accession to EUROCONTROL, the Commission and EUROCONTROL have signed a cooperation framework agreement for the implementation of the single European sky and for research and development activities in the field of air traffic control.

The SESAR project includes evaluation of LDACS under SESAR 2020 P14.2.1 - FCI Terrestrial Data Link which is a solution of the PJ14 EECNS (Essential and Efficient CNS) SESAR 2020 project. PJ14 EECNS project providing advanced, integrated and rationalised aviation infrastructure for Communication, Navigation and Surveillance (CNS), and providing the underlying technical capabilities to meet the operational improvements described in the European ATM Master plan.

As the technological pillar of the Single European Sky, SESAR (Single European Sky ATM Research) is one of the key contributors with goals through the delivery and deployment of SESAR Solutions with demonstrated and measurable performance benefits. The SESAR performance ambition for 2035 is as follows:

* Efficiency and predictability: up to 6% reduction in flight times and up to 30% reduction in departure delays;
* Environment: up to 10% reduction in fuel burn and CO2 emissions;
* Capacity: a system capable of handling up to 100% more traffic, and up to 10% additional flights landing at congested airports;
* Cost-efficiency: up to 40% reduction in air navigation services costs per flight;
* Safety: improved by a factor of 3-4 times coping with the expected traffic increase.

#### Spectrum needs for other specific Union policies

Decision No 243/2012/EU of The European Parliament and of the Council of 14 March 2012 established a multiannual radio spectrum policy programme which includes:

Article 8: Spectrum needs for other specific Union policies

* 1. Member States and the Commission shall ensure spectrum availability and protect the radio frequencies necessary for monitoring the Earth’s atmosphere and surface, allowing the development and exploitation of space applications and improving transport systems, in particular for the global civil navigation satellite system established under the Galileo programme, for the European Earth monitoring programme (GMES), and for intelligent transport safety and transport management systems.

Galileo is an RNSS system that operates in a range of bands including 1 164 to 1 189 MHz.

### EUROCONTROL

EUROCONTROL is an intergovernmental organisation with 41 Member and 2 Comprehensive Agreement States. EUROCONTROL is committed to building, together with its partners, a Single European Sky that will deliver the air traffic management (ATM) performance required for the twenty-first century and beyond.

EUROCONTROL has multiple expertise; covering both operational and technical elements; advising on both civil and military aspects of ATM; having experience at bringing States with different needs together for a common goal.

EUROCONTROL helps its Member States to run safe, efficient and environmentally-friendly air traffic operations throughout the European region. In working together with its partners to deliver a Single European Sky that will help overcome the safety, capacity and performance challenges facing European aviation in the 21st century.

EUROCONTROL support the European Commission, EASA and National Supervisory Authorities in their regulatory activities.

EUROCONTROL is actively involved in research, development and validation and make a substantial contribution to the SESAR Joint Undertaking. Aiming to deliver tangible results which will improve the ATM system's performance in the medium- and long-term.

EUROCONTROL have a unique platform for civil-military aviation coordination in Europe.

The single European sky (SES) framework Regulation establishes a harmonised regulatory framework in conjunction with the airspace, service provision and interoperability Regulations and calls for the adoption of implementing rules by the European Commission.

EUROCONTROL develops specifications which can act as Means of Compliance (MoC) to SES regulations. EUROCONTROL also develops guidance material and provides implementation support activities to its stakeholders.

Under the SES framework, the European Commission may develop the implementing rules themselves, but may also issue a mandate to an organisation which is then tasked with implementing rule drafting. EUROCONTROL is one such organisation and has developed numerous draft regulations which were submitted by the EC to the Single Sky Committee (SSC) for its formal opinion.

#### Directorate Central Route Charges Office

It operates, maintains and develops the Multilateral Route Charges System on behalf of the Member States. In addition, the CRCO operates 19 bilateral agreements for the collection of terminal/communication charges or air navigation charges (of which 4 agreements with non-Member States). In all, the CRCO collects charges on behalf of 43 States.

#### Maastricht Upper Area Control Centre

It provides air traffic services to defined standards of safety and performance levels in the upper airspace of Belgium, Luxembourg, the Netherlands and the north west of Germany. MUAC provides also its operational and technical know-how to other parts of the Agency for the development and deployment of SESAR. MUAC supports the participating States in establishing the Functional Airspace Block Europe Central (FABEC).

#### Directorate Pan-European Single Sky

It delivers the Agency’s contribution to the implementation of the Single European Sky, supporting all the EUROCONTROL Member States, the European Commission (EC) and the European Aviation Safety Agency (EASA).

#### Directorate Air Traffic Management

It leads and coordinates ATM development and its contribution to the achievement of the SES objectives and performance scheme. It ensures that the Agency ATM research effort is aligned to the SESAR initiatives in accordance with the ATM Master Plan. It provides the appropriate military-military and civil-military ATM coordination and is also responsible for overseeing the Agency ATM Policy and Strategy.

#### Network Manager Directorate

In it role as the SES Network Manager, it coordinates network management functions relating both to network planning (airspace design) and operations (ATFCM, AIM) and also to the coordinated pan-European deployment of operational and technical improvements, including those related to SESAR. It provides support to airport activities; it coordinates safety actions and the management of spectrum, frequencies and scare resources. It also delivers support services to air navigation service providers and FABs (when required) as well as ATM training; finally it monitors the network management contribution to the performance targets of the SES.

The Network Manager has extended the role of the former Central Flow Management Unit and now proactively manages the entire ATM Network (with nearly ten million flights every year), in close liaison with the air navigation service providers, airspace users, the military and airports.

The network functions have been created by the Single European Sky II legislation with the strong support of stakeholders. They are aiming to:

* develop and create Route Network Design
* organise the management and operations of the functions, including ATFM
* provide a central function for Frequency Allocation, and
* coordinate the improvement of SSR Code Allocation

The Network Functions Implementing Rule (Commission Regulation (EU) No 677/2011 ) lists at Article 4 the tasks to be performed by the Network Manager in relation to the functions listed above. The Network Manager also supports the work of the European Aviation Crisis Coordination Cell, responsible for mitigating events having a negative impact on aviation at network level and to coordinate appropriate responses between Member States; it also contributes to the deployment of SESAR.

EUROCONTROL was nominated as the Network Manager for the Single European Sky via a Commission Decision on 7 July 2011 (C(2011) 4130 final).

The Network Manager, play a vitally important role for the competitiveness of Europe's aviation industry, is a key actor for the operational network performance in the areas of capacity and flight efficiency.

The European Commission’s Single European Sky (SES II) foresaw the creation of a Network Manager as a centralised function. The Network Manager is the operational arm of the SES and manages air traffic management network functions (airspace design, flow management) as well as scarce resources (transponder code allocations, radio frequencies), as defined in Commission Regulation (EU) N° 677/2011.

The European Commission nominated EUROCONTROL as the Network Manager in July 2011, with a mandate that runs until the end of the Performance Scheme’s second Reference Period - that is, until 31 December 2019. EUROCONTROL has been undertaking major organisational changes to ensure its re-designation as Network Manager for the period beyond 2019.

The Network Manager addresses performance issues strategically, operationally and technically. Its overarching mission is to contribute to the delivery of air traffic management’s (ATM) performance in the pan-European network in the areas of safety, capacity, environment/flight efficiency and cost-effectiveness.

With the comprehensive picture of the European ATM network and unique in-depth expertise, the Network Manager’s priority is to forge operational partnerships and to foster cooperative decision-making, both of which are needed to achieve the performance targets in a transparent and impartial way.

The European ATM network includes all the European Union’s 28 and EUROCONTROL’s 41 Member States, as well as others which have bilateral agreements with the Network Manager.

Besides the binding legal acts governing the network management functions and tasks of all actors involved, the Network Manager needs to develop the tools to execute those functions and tasks and accomplish the Strategic Objectives as defined in the Network Strategy Plan. Among the contributors are the Network Strategic Projects. They are the main operational and technical evolutions led by the Network Manager. They include network-wide deployment of those technological developments and operational procedures in the course of a Reporting Period.

### NATO

The primary role of NATO military forces is to promote peace and to guarantee the territorial integrity, political independence and security of member states. In support of this, NATO use of the radio frequency (RF) spectrum has to be in accordance with ITU Radio Regulations (RR) and also in accordance with NATO military spectrum and frequency doctrine, policies and procedures. Both of these types of governing documents are applicable in times of peace, crisis and war.

The Civil/Military Spectrum Capability Panel (CaP3) is the sole competent source of advice and decisions on the management of the RF spectrum within the Alliance. It works with the NATO Military Committee (MC), the C3 Board (C3B) and the NATO Command Structure (NCS) to satisfy NATO RF spectrum requirements. The CaP3 is composed of representatives from the military and civil spectrum management authorities of NATO member and partner nations, and the Strategic Commands (SCs).

Within NATO the national administrations have agreed to the military use of certain designated frequency bands throughout NATO Europe. This agreement is recorded in the NATO Joint Civil/Military Frequency Agreement (NJFA). The NJFA entries are also reflected in the ECA (ERC Report 25). In the frequency band 960-1164 MHz, military use includes DME, TACAN, SSR, IFF and also JTIDS/MIDS.

NATO member nations delegated the control of certain frequencies and frequency bands in HF, VHF and UHF ranges to the CaP3, which is supported by the NATO Headquarter C3 Staff / Spectrum & C3 Infrastructure Branch (NHQC3S/SC3IB). The NHQC3S/SC3IB is the supporting staff for the CaP3, and is also the day-to-day staff charged with carrying out the necessary operational work in support of the exercises and operations. In particular, the Staff is dynamically assigning TACAN channels for air/air and deployable land stations. The NATO Mariritime Command (MARCOM) is dynamically assigning channels to TACAN maritime stations.

(source: Allied Spectrum Publication 01 (ASP-01), Spectrum Management In Military Operations, Oct 2017)

### International Air Transport Association (IATA)

Founded in 1945, the International Air Transport Association (IATA) is the trade association for the world’s airlines, representing some 284 airlines or 84% of total air traffic. IATA supports many areas of aviation activity and help formulate industry policy on critical aviation issues and is the prime vehicle for inter-airline cooperation in promoting safe, reliable, secure and economical air services - for the benefit of the world's consumers. The modern IATA is the successor to the International Air Traffic Association founded in The Hague in 1919 - the year of the world's first international scheduled services.

Safety and reliability are fundamental to airline operations. The IATA Operational Safety Audit (IOSA) program is an internationally recognized and accepted evaluation system designed to assess the operational management and control systems of an airline. It is the flagship component of a comprehensive strategy that includes audits, cargo, flight operations, infrastructure, training and data collection. IOSA is the global standard for airline safety management that is well recognized by State aviation authorities and government agencies and the IOSA audit creates a standard that is comparable on a world-wide basis. All IATA members are IOSA registered and must remain registered to maintain their IATA membership. Additionally, as of October 2017, 143 (34%) of the 424 airlines on the IOSA Registry are non-IATA member airlines.

The IATA Safety Audit for Ground Operations (ISAGO) is an aviation industry ground service provider registration scheme. It is aimed primarily at establishing safe ground operations and raising cost benefits by, respectively, reducing the risk of aircraft damage and personal injuries and eliminating redundant audits.

# Current and future systems and technologies in the frequency band 960 - 1164 MHz within CEPT

The frequency band 960-1164 MHz is a globally harmonized radionavigation and communications band which is used intensively, and extensively, to support a number of aviation systems, for both civil and military purposes. It is important to note that these aeronautical systems operate up to 1215 MHz. Moreover, the adjacent band 1164-1215 MHz is allocated to the radionavigation-satellite service (RNSS) (space-to-Earth).

The following tables provide preliminary information on systems designed for use in the band 960-1164 MHz.

It should be noted that some of the uses quoted may extend beyond the band and the lists of systems may not be complete.

## Civil radionavigation and communication systems

Table 1: Civil aeronautical systems currently in use in the band 960 to 1164 MHz

|  |  |  |
| --- | --- | --- |
| System | Frequency (MHz) | Notes/Description |
| Distance Measuring Equipment (DME/TACAN) | 962-1164 Note 1 | Aircraft (interrogator) determines slant range to a ground beacon (transponder) at a known location based on round trip timing of pulses. Aircraft transmits and ground beacon replies on an assigned pair of frequencies separated by 63 MHz both using omnidirectional antennas – for some operational requirements the ground antenna may be directional. Multi-channel interrogators use simultaneous ranging to multiple transponders for the aircraft to determine its location via a multilateration process. DME/TACAN channelisation is across the 960 – 1215 MHz band. |
| Secondary Surveillance Radar | 1030 (Gnd Tx, limited Air Tx, Air Rx)  1090 (Air Tx, Gnd Rx, limited Air Rx) | Ground (interrogator) at a known location determines azimuth and slant range of aircraft transponder based on round trip timing of pulses. Ground transmissions on 1030 MHz, using a rotating, high gain antenna; all aircraft reply omnidirectionally on 1090 MHz. Different SSR Modes (A, A/C, S) have different additional capabilities with different signal structures including a data channel. Mode A codes aircraft identity, A/C codes identity and aircraft derived altitude, Mode S as for A/C with ability to selectively call specific aircraft / request other aircraft data. There is also limited use of airborne interrogators transmitting on 1030 MHz and receiving on 1090 MHz |
| Far Field Monitors (FFM) | 1090 (Gnd Tx)  1030 (Gnd Rx) | SSR interrogators have up to two ground based monitors at fixed locations several nautical miles from the interrogator to provide constant confirmation of correct operation and monitoring of health and performance of interrogators |
| Universal Access Transceiver (UAT) (ADS-B and multiple broadcast services) | 978 MHz | Universal Access Transceiver (UAT), an ICAO standardized system and a wideband broadcast data link operating on 978 MHz. UAT supports multiple broadcast services, including flight information services (FIS-B) and traffic information services (TIS-B), in addition to automatic dependent surveillance — broadcast (ADS-B). Currently it is used in a number of states outside of Europe, including China, Republic of Korea, South Africa and United States. Some limited trials are taking place in Europe. UAT is being examined as one enabler technology to support RPAS/Drone and smaller aircraft use. |
| Automatic Dependent Surveillance-Broadcast (ADS-B) | 1090 (Air Tx, Air, Gnd and space Rx) Note 2 | Air to air, air to ground, air to space datalink. Provides aircraft identity, aircraft derived (hence “dependent”) position plus other data. An extension of the SSR Mode S data set (also permitted to be received in space following an allocation by WRC-15). Aircraft fit could be part of SSR transponder or a separate transmitter / receiver. |
| Airborne Collision Avoidance System / Traffic Collision Avoidance System (ACAS/TCAS): | 1030 and 1090 (Air Tx and Rx) | Aircraft system on both 1030 and 1090 MHz operating independently of ground-based equipment and air traffic control in warning pilots of the presence of other aircraft that may present a threat of collision. If the risk of collision is imminent, the system initiates a manoeuvre that will reduce the risk of collision. |
| Multilateration systems (MLAT) | 1030 (Gnd Tx, Air Rx)  1090 (Gnd and Air Tx, Gnd Rx) | Largely passive network of ground receivers (of order of 40 to 50 for a large airport) to enable independent determination of aircraft (and suitably equipped ground vehicle) position on or near an airport using difference in time of arrival techniques based upon SSR Mode S transmissions. MLAT systems also have several ground based 1030 MHz emitters to elicit additional replies from aircraft transponders where necessary .and 1090 MHz emitters to provide constant confirmation of correct system operation |
| Wide area multilateration (WAM) | 1030 (Gnd Tx, Air Rx)  1090 (Gnd and Air Tx, Gnd Rx) | Similar to MLAT but over a wider geographic area and typically having a greater reliance on active interrogation at 1030 MHz to augment SSR- and Mode S based Radar detection of aircraft. |
| RSBN (Radiosystem of short range navigation) | 960-1164 | A civil/military Aeronautical Navigation system that operates under ITU footnote RR 5.312 which is a non-ICAO aeronautical system. RSBN provides information for approach / landing and En Route navigation similar to ILS, VOR, DME and TACAN. |

Note 1: Airborne transmissions limited to 1025-1150 MHz

Table 2: Civil aeronautical systems foreseen in the band 960 to 1164 MHz

|  |  |  |
| --- | --- | --- |
| System | Frequency (MHz) | Notes/Description |
| L Band Digital Aeronautical Communication System (LDACS) | 960-1164 | LDACS received an allocation between 960 to 1164 MHz at the WRC 2007 (RES 417 modified in 2015) and is presently under standardization by ICAO. LDACS is envisaged to use a cellular point-to-multipoint concept, which means that the airspace is segmented into cells. In each cell, all aircraft are connected to a centralised ground station which controls the entire air/ground communication within the cell. It is designed as a frequency-division duplex system, preferably deployed using an inlay approach, interleaving with DME. Expected to be introduced in the mid-2020s. |
| Mode S Phase overlay | 1090 | Additional Phase Overlay modulation to the 1090 MHz Mode S telegram to enhance the data throughput to ~ 4 MB/s. Currently under standardization within ICAO 1090 MHz transmission and reception |
| Remotely Piloted Aircraft System / Unmanned Aircraft System | 960-1164 | (RPAS/UAS) command and control and detect and avoid: systems under development – could be introduced if seen as a viable solution (MOPS EUROCAE WG-105) |

## Military radionavigation and communication

Table 3: Military aeronautical systems currently in use in the band 960 to 1164 MHz

|  |  |  |
| --- | --- | --- |
| System | Frequency (MHz) | Notes/Description |
| Tactical Air Navigation (TACAN) | 962-1164 (Note 1) | Similar to DME in that it allows determination of slant range from aircraft to a known location but with the addition of further modulation(s) that allow aircraft to determine their bearing from the ground beacon. TACAN is also used by Civil Aviation as DME. TACAN also has an air-to-air mode, where aircraft transmit on the beacon frequencies. |
| Interrogation Friend or Foe (IFF) | 1030 and 1090 | Mode 4 and it’s successor IFF Mode 5 operating on the SSR frequencies 1030 and 1090 MHz, since about 1980. Employs different modes (signal structures) with different capabilities. |
| Joint Tactical Information Distribution System/Multifunctional Information Distribution System (JTIDS/MIDS) – also known as Link16 | 51 channels across the range 969 to 1207 (Note 2) | Link16 is a multi-platform (air, ground, sea) military datalink and communications system providing secure, flexible and highly survivable communications links which are resistant to jamming. The system employs TDMA and frequency hopping, spread spectrum over 51 distinct channels. Equipment is required to use standardised additional capabilities to mitigate risks of interference to aviation systems. |
| RSBN (Radiosystem of short range navigation) | 960-1000.5 | A civil/military Aeronautical Navigation system operates under an ITU footnote RR 5.312 which is a non-ICAO aeronautical system. RSBN provides information for approach / landing and En Route navigation similar to ILS, VOR, DME and TACAN. |

Note 1: Airborne transmissions are limited to 1025-1150 MHz except for TACAN used in air-to-air mode for which channels in the whole band could be used (the transponder and the interrogator are both on-board) [[15]](#footnote-16).

Note 2: A frequency remapping of the 51 channels for JTIDS/MIDS is currently being implemented in some terminals. This would lead to a reduction in the number of frequencies used by those JTIDS/MIDS terminals, and a corresponding increase in the usage of the remaining frequencies.

Note 3: The standard performance criteria for MIDS terminal equipment to be used by all military are defined in STANAG 4175 . In particular the purpose of its Annex A is to define the technical characteristics required to:

* a) Achieve interoperability among MIDS terminals;
* b) Ensure that the electromagnetic emissions from MIDS will not unduly interfere with other users of the frequency bands employed by MIDS.

# Legal and Regulatory issues of introducing low power audio pmse in the band 960-1164 MHz

## Global level

### ITU

Referring to the ITU-R RR, there is no appropriate allocation supporting PMSE in the band 960 - 1164 MHz which is globally allocated to the Aeronautical Radionavigation Service (ARNS), Aeronautical Mobile en-Route service AM(R)S and in part to the Aeronautical mobile-satellite en-Route service (earth-to-space).

However, the ITU-R Regulations do not prevent any administration introducing PMSE applications in the band 960-1164 MHz, providing that such uses shall not cause any harmful interference to the aeronautical systems, within or outside the national borders, or claim protection from harmful interference.

The following ITU RR Article should be considered:

* Article 4.4: "Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations."

Then, at this stage, PMSE could only operate under RR N° 4.4 as referred to above that means, in particular, that no protection can be ensured for the usage of PMSE in the band 960-1164 MHz.

* Article 1.169: "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 Radio Regulations (CS)."
* Article 4.10: "Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies."

### ICAO

The various articles of the ICAO Convention (Chicago Convention)[[16]](#footnote-17) oblige States to undertake or adopt measures to ensure the safety of overflying aircraft. These measures include standards and recommended practices which require aircraft and aeronautical service providers on the ground to operate certain ICAO standardized equipment for Communication, Navigation and Surveillance.

The 960-1164 MHz frequency band is in extensive use on a worldwide basis for aeronautical safety of life systems. In line with the consistent annual growth of air traffic of 5% on a global basis, the use of those systems keeps growing and flexibility in changing frequency assignments is a key element in managing the band.

At WRC-07, WRC-12 and WRC-15, ICAO and the aviation community looked for additional spectrum allocations to support new aviation safety systems. After study, the approach chosen was to implement those systems under new allocations to aeronautical services in bands already allocated and in use by other existing aeronautical services. This approach was only possible because aviation controls the environment in these bands, through the mandatory use of international aeronautical standards (SARPs[[17]](#footnote-18)) and regionally coordinated air navigation agreements.

Due to its safety of life nature, aviation cannot afford to be reactive.  Hence the ICAO regulatory framework provides provisions not only on equipment standardization and certification, but also on safety management and aeronautical safety oversight, thus ensuring preventative action to minimise operational risks to an acceptable level, consistent with safe aircraft operation.  When the regulatory regime is judged to be insufficient, then aviation has to take appropriate action to maintain safety.  That action will be in the form of modifying or in the worst case (e.g. volcanic ash from Eyjafjallajökull Iceland) cease operations with a resultant economic and political impact.

There is an example of a non-civilian aeronautical system (JTIDS/MIDS) operating in an aeronautical frequency band. This was accomplished through implementation of terminal-resident EMC features that shut the emitter down if it attempts to operate outside the parameters assumed in the safety case. It should be noted the form and function of those EMC features required aviation certification. The current arrangements are the ongoing results of over 40 year's experience.

Aircraft operations need to be supported by appropriate safety cases as a means of structuring and documenting the demonstration of the safety of air traffic management services and systems. In addition to the ICAO regulatory framework, see for example Commission Implementing Regulation (EU) 2017/373. Risk classification schemes have been developed at a global level, e.g. ICAO Doc 9859 – Safety Management Manual, and at European level, e.g. EUROCONTROL ESARR 4 - Risk Assessment and Mitigation in ATM. In addition, national authorities have also developed guidance on hazard identification, risk assessment and the production of safety cases, for example CAP 760 in the UK.

In accordance with Annex 8 to the ICAO Convention, aeronautical equipment is required to undergo stringent certification (e.g. ETSO, issued by EASA) and in accordance with Annex 19, its operation is required to undergo safety-cases to ensure safe operation of aircraft. If any new system sharing an aeronautical safety of life frequency band is introduced, the existing aeronautical safety cases shall be reviewed.

The current safety cases are conducted on the basis that any aeronautical equipment and its operation in the band must be standardized, certified and licensed[[18]](#footnote-19) for operation in each specific aircraft type (e.g. assurance against causing a safety issue to the aircraft due to equipment malfunction), and comply with appropriate standards and the items listed above, or shut off. If a new system does not comply with these standards is introduced, a new framework for the safety cases needs to be developed.

Human factors principles need to be observed in the design and certification of radio navigation aids and surveillance systems (Ref: ICAO Annex 10 Vol I, Navigation Systems and Vol IV, Surveillance Systems). From the aviation sector perspective, the same considerations should apply to any other systems, which may affect the operations of the radionavigation aids and surveillance systems.

On a global basis, the frequency band 960-1215 MHz is used for Distance Measurement Equipment (DME) systems; this use will continue and increase well beyond 2030. In most airspaces it is required to navigate by using multiple DME ground stations for position determination.

DME is an essential aircraft navigation aid as a part of the required navigation equipment on commercial aircraft, is used for departure, approach, landing and missed approach phases of flight as well as for en-route area navigation. The three facility performance categories of the Instrument Landing System (ILS) precision approach (CAT I, CAT II and CAT III) are all certified as integral systems which include DME as a vital component. In real-time, with the accurate azimuth, elevation and the distance to the runway threshold combined, these systems permit coupled auto-pilot and stabilised approaches to runways around the globe.

Many airport ILS/DME installations have been certified at the highest level of precision approach procedures (CAT IIIc) and are authorised to be used for autoland operations. Any loss of DME operation in normal or low visibility conditions results in the need for alternative ranging information that require ATC intervention and associated impacts to the operation of that airport, for example flow control being applied with much lower throughput than during normal operations. Any loss of a component part of the ILS requires a demonstration period to be completed, providing fault rectification or resolution to the issue that caused the loss. Depending on the severity of the loss varying periods will be required to prove the stability and operational capability of the facility, for example this could be between 24 and 300 hours or as specified by the ANSP for that aid.

In addition to DME, some commercial aircraft use GNSS navigation sensors as an additional navigation aid for PBN operation. It should be noted that not all commercial aircraft are equipped and the weak GNSS signal is not considered as reliable as DME and that GNSS is not considered reliable enough for ILS precision approach. Accordingly, DME-DME navigation capability is a fundamental requirement of the airspace classification structure, permitting aircraft to maintain specific navigational track accuracy. Degradation of the DME data received by an aircraft, as a result of aggregate interference, would impact the aircraft's ability to maintain the specified navigation solution and lateral track accuracy. This would lead to non-conformance with airspace requirements.

Two sub-bands centred around the frequencies 1 030 MHz and 1 090 MHz are reserved for Secondary Surveillance Radar (SSR) and are also used by a number of other aviation systems, including MLAT, WAM, ACAS, ADS-B, ADS-B IN applications and ADS-B reception by satellite.

Future systems that are planned to use the frequencies include new ADS-B IN applications and new ACAS, so called ACAS X variants which includes ACAS-Xu that is designed as detect and avoid systems for Unmanned Aircraft Systems (UAS). Due to significant growth of use of surveillance systems/applications and future expansions of usage of the frequencies, there have been concerns of congestion on those frequencies. In order to effectively manage the expected growth and additional loading of the R.F. environment on a single pair of frequencies, the aviation community is already considering possible solutions to ensure that continued growth in aviation capacity and the required safety levels are maintained.

In several Regions, the use of a second system, Universal Access Transceiver (UAT), provides frequency diversity for ADS-B applications and has proven highly effective in enhancing aviation safety. UAT, which operates on 978 MHz, also provides real-time weather and traffic information.

The frequency 978 MHz is globally used and UAT is an ICAO standardized system, which provides /will provide aviation a longer term solution of frequency diversity for ADS-B applications while being fully capable of handling the expected growth.

#### Application of International Law for aeronautical safety oversight

In accordance with the Chicago Convention, national safety oversight obligations require States to undertake measures to ensure that every aircraft flying over or manoeuvring within its territory complies with the specific operating regulations relating to the flight and manoeuvre of aircraft therein.

ICAO's Universal Safety Oversight Audit Programme (USOAP) was initially launched in January 1999, in response to widespread concerns about the adequacy of aviation safety oversight around the world. Initially, USOAP activities consisted in regular and mandatory audits of ICAO Member States' safety oversight systems. In 2010, a new approach, Continuous Monitoring Approach (CMA), based on the concept of continuous monitoring and incorporating the analysis of safety risk factors was introduced. USOAP CMA is performed by ICAO based on several principles, and includes the following.

a) Universality. All Member States shall be subject to continuous monitoring activities by ICAO, in accordance with the principles, methodologies, processes and procedures established for conducting such activities, and on the basis of the Memorandum of Understanding (MOU) signed by ICAO and each Member State.

b) All-inclusiveness. The scope of USOAP CMA includes the ICAO SARPs contained in all safety-related Annexes to the Convention, Procedures for Air Navigation Services (PANS), guidance material and related procedures and practices.

Based on this MOU as described above, to provide the necessary air navigation services and aerodromes, States are obliged to adopt and apply appropriate aeronautical standard systems and communications procedures and other operational practices and rules. Compliance with the State’s regulatory requirements is obligatory. Exemptions or exceptions of these requirements should not be granted by the State if such measures would not be supported by appropriate, robust and documented safety risk assessments or aeronautical studies and imposition of limitations, conditions or mitigation measures as appropriate (Ref: ICAO Doc 9734 "Safety Oversight Manual").

Any exception or exemption should only be granted on the basis of a robust rationale. Therefore, the issuance of exceptions or exemptions that are not supported by safety risk assessments or aeronautical studies and by thorough reviews by the competent authority is not acceptable. A safety risk assessment or aeronautical study should be developed by the service provider to demonstrate whether an equivalent level of safety or an alternative acceptable means of compliance can be achieved (Ref: ICAO Doc 9734 "Safety Oversight Manual").

Aeronautical systems operate in accordance with the International Law principles stated above. There is an example of a non-civilian aeronautical system (JTIDS/MIDS) operating in an aeronautical frequency band. This was accomplished in a manner ensuring compliance with the requirements described above, thus ensuring that international obligations were met.

In light of the above, ICAO is of the opinion that introduction of any new system in the 960-1164 MHz band would not be safe unless it can be ensured that:

* the new system is completely compatible with existing and planned aviation systems based the new system is completely compatible with existing and planned aviation systems based on testing and analysis that has been agreed by aviation regulators;
* the parameters for the new system will be captured in an internationally recognized standards document;
* the new system will be certified (including software and hardware) by the competent national regulatory authorities; will be maintained to meet throughout its service life the operational parameters assumed in the aviation testing/studies; will perform self-monitoring to ensure that it shuts down if it moves outside those agreed parameters; and the self-monitoring/shutdown function itself will also be certified;
* the new system will include time-stamped logging of essential transmitter parameters, such as frequency use and power levels for post incident/accident investigation purposes;
* the new system will not impact:
  1. the ability of aviation to manage existing and planned aviation systems and
  2. the ability of aviation authorities to modify operating frequency assignments, powers and signal contents of the aviation systems without introducing additional coordination mechanisms;
* the operator of the new system must accept all legal liability in case of interference to aviation systems [e.g., due to false channel selection, excessive power, human error, device failure], and recognize that aviation systems operators have no liability in case of interference to the new system; and
* personnel responsible for the operation of non-aviation systems in the 960-1164 MHz band shall be required to achieve similar levels of certification to those stipulated in the Radio Regulations for operators of aviation systems (radio operator's certificate).

## Regional and National level

### European law

Within the EU, Single European Skies (SES) legislation, i.e. Commission Implementing Regulations (EU) 2017/373[[19]](#footnote-20) is in force[[20]](#footnote-21). This regulatory regime requires that hazard identification as well as risk assessment and mitigation are systematically conducted for any changes to those parts of the ATM functional system and supporting arrangements within their managerial control by air traffic service providers (ANSPs) before bringing new Air Traffic Management facilities into use or when changes to existing facilities are foreseen.

### CEPT

Within CEPT in addition to the work at WG FM, it has been agreed that WG SE will carry out compatibility studies between low power audio PMSE and incumbent aeronautical systems in the 960-1164 MHz band (this will include compatibility studies with services in adjacent bands).

Based on the results of the technical compatibility studies, cross border coordination between concerned administrations may be required.

### National regulation

Provided that international radio regulatory, aeronautical safety obligations are met, the introduction of low power audio PMSE in the band 960-1164 MHz is a sovereign decision on the designation of this public resource.

Therefore, the introduction of PMSE into the band is a national decision, under the full liability of the State, which would involve cooperation between the spectrum regulator, the aviation authorities and Defence. The introduction of audio PMSE in the band 960-1164 MHz could imply review/updating of the national sharing framework between current users. This may be unacceptable to these users if these updates have impacts on their operational environment and requirements.

The amount of spectrum potentially available for audio PMSE applications in the 960-1164 MHz band may differ from country to country depending on incumbent usage as well as national decisions and agreements, including those of other countries.

In case of CEPT harmonisation measure, an administration may decide not to implement PMSE applications in the band 960-1164 MHz.

In general, authorisation for audio PMSE differs across administrations, i.e. licence exempt, general authorisation or individual licence.

For the introduction of audio PMSE in this band 960-1164 MHz, an individual licensing regime is likely to be required in order to have control of the PMSE usage in this band.

Detection of interference to the aircraft navigation systems by its pilot can be very difficult if not impossible. During a flight, the first priority for the pilot is the safety of the flight. Hence, typically a report of interrupted or reduced reception or performance of the air navigation system will not be filed by the pilot until after the flight, i.e., hours after the incident. In case of interference resulting in an incident or accident (aircraft new route, plane crash …) leading to economic, ecological, environmental, legal or human impacts, responsibilities have to be clarified and established, corrective actions need to be taken and liability issues have to be addressed in accordance with international law.

A PMSE user causing interference (due to the use of wrong channel selection, too high power emission, human error, device problem, etc.) should be identifiable in order to assume the legal and economic consequences of any impact (delays, incidents, re-routing, route-closures, and accidents) to the Air traffic flow.

On the other hand, Administrations would assume the responsibility of safety, legal and economic consequences if it appears that a PMSE user is in full respect of the issued authorisation/regulation and interference still occurs. Considering that the Administration in charge of enforcement might be also responsible for harmful interference and also its impact and consequences, appropriate methodology needs to be identified to ensure that all cases are appropriately resolved.

### NATO

The inclusion of new non-safety of life systems in an ARNS and AM(R)S frequency band necessitates robust EMC and regulatory studies, and strict compliance to avoid interference to the incumbent aeronautical and critical military systems. Safety of life aeronautical systems operating in that band must go through a certification process for both the equipment and the operators using the equipment. The band is shared with the military (governmental systems), which are subject to similar civil aviation safety constraints (i.e. Link 16). A system, such as PMSE, would also be expected to have similar requirements placed upon it which would include significant expense of resources to prove compatibility. Additionally, the proliferation of commercial non-safety of life equipment operating in the band can lead to an uncontrolled usage subject to operator error or illegal or unlicensed operation of PMSE equipment in disregard of various national requirements if equipment was procured in another country with different PMSE limitations. This would not be compatible with the safety requirements of existing and future aeronautical systems.[[21]](#footnote-22) It is important to note that, interference in this band, can have catastrophic and irreversible consequences. ICAO states, “Therefore, the severity of occurrences in this band should invite decision makers and regulatory authorities to more precaution.”[[22]](#footnote-23) “Efficient use of spectrum drives our decisions; PMSE sharing the band 960-1164 MHz will produce the opposite result by constraining Civil and Military users of the band and preventing aviation to conduct its modernization program.”[[23]](#footnote-24) ICAO has raised their opposition at 88th WGFM Meeting (Dublin, 15-19 May 2017)[[24]](#footnote-25) regarding PMSE sharing without meeting extensive conditions.

Of utmost interest to NATO is the fact that the introduction of PMSE equipment into the band 960-1164 MHz could impact the current and future operation of NATO systems that operate in the band, including TACAN, DME, Link 16, IFF/SSR, and UAS/RPAS CNPC system links that may be required for military UAs. Especially at risk is Link 16 which is operated under Article 4.4 of the Radio Regulations (RR) in the band. It should be ensured that the presence of PMSE operations will not affect the level of Link 16 compatibility with the primary aeronautical systems and the necessary Link 16 Frequency Clearance Agreement (FCA) criteria that should be met (i.e. no added Link 16 restrictions either for peacetime or large coordinated operations when necessary)[[25]](#footnote-26). While interference from PMSE equipment to military ground based equipment could be controlled by applying a necessary separation distance (if those locations are known and can be shared), overcoming the impact to an aircraft receiver which can fly essentially at any point in air space is much more difficult to achieve if not impossible. Thus, for example, PMSE equipment could impact airborne military TACAN operations due to the unknown locations and channel assignments for the associated and paired surface mobile TACAN beacons (e.g. shipboard, and ground transportable beacons). This same impact could result during air to air TACAN operations. In other words, the airborne TACAN channel and aircraft location may not be known making it difficult to deconflict those operations through frequency and distance management.

To authorize a system such as the PMSE, it is envisioned that a conservative robust test bench program between the PMSE equipment (both as a source and a victim) and all types or model numbers of the primary or incumbent aeronautical equipment would be required. The incorporation of a continuously transmitting signal of not specified modulation such as PMSE in this band raises compatibility concerns as receiver requirements for ICAO and governmental incumbent systems have not been specified to handle non-pulsed type modulated emissions. The additional ICAO requirements needed to support a continuously emitting transmitter[[26]](#footnote-27) would require specifications for robust receiver frequency selectivity and immunity from spurious responses. It is for this reason that all the incumbent system types operating in the band 960-1164 MHz (i.e. manufacturer and Model numbers) must be tested.

This test program must be performed in a simulated maximum RF environment including signals of all systems received under operationally realistic conditions experienced by the aeronautical equipment in the applicable CEPT nations, using the most stringent of compatibility criteria. The PMSE should also be certified to ensure that any equipment waveform characteristics are compatible and designed such that even in cases where the PMSE radio malfunctions, no interference is caused. To meet the latter requirement, monitor circuitry should be considered for integration into the PMSE device which prevents it from operating on unauthorized channels or deviating from transmission characteristics from those that have been determined necessary for compatibility. Also to be considered, is that the operation of PMSE equipment outside the licensed position/country should be inhibited in unauthorized locations as determined by GNSS (also known as “GNSS fencing”[[27]](#footnote-28)). Equipment acceptance testing prior to shipment should be performed to verify that the device is operating in accordance to required compatibility standards. Additionally, the operational use of the equipment must be verified to meet the special frequency management requirements for a system not operating under the proper service allocation in the band (i.e. non-primary user in the frequency band). For example, the military Link 16 radio terminals are required to incorporate EMC Features monitor circuitry and undergo these requirements as a condition for operating as a non-interference system in the band 960-1215 MHz.

To make a case that PMSE can be authorized and operated in the aeronautical frequency band within a nation, it must undergo a rigorous and robust test and evaluation process. This should also consider interference to airborne equipment operation not only in that nation’s airspace but also to airborne and ground equipment within a potentially large distance radio line of sight (RLOS) in another country. Criteria for cross border coordination should be established for those cases, when the aggregate signal of PMSE devices operated in one country can interfere with airborne or ground equipment in another country. Cross border coordination for systems and equipment operating on NIB are presently nonexistent in CEPT and need to be established. This would also set the conditions for its operation under frequency management rules. There are important points that must be considered which would include the PMSE transmitter as a source of interference, interference to the PMSE receiver as a victim to the existing RF environment, and with the frequency management process criteria.

### EUROCONTROL

#### Radionavigation

EUROCONTROL operates a number of stakeholder consultation meetings involving Air Navigation Service Providers (ANSP), regulators, aircraft operator and airport representatives. These forums help shape policy advice for the EU, EASA and ICAO, and are instrumental in setting research priorities and agreeing domain-specific strategies, such as the planned evolution of navigation services to support Air Traffic Management (ATM) improvements. Decisions at forums such as the Navigation Steering Group and its parent CNS Infrastructure team help determine the European ATM Master Plan, consistent with the ICAO Global Air Navigation Plan (GANP). A current development in navigation is the transition from station-referenced navigation using conventional navigation aids (which include the DME) to Performance Based Navigation (PBN - which also involves DME). PBN is enabled mainly by GNSS, but also by DME to a significant extent. No other terrestrial navigation system currently has the same level of suitability to support PBN than DME.

Since the current GNSS core constellations are operated by foreign entities (GPS, GLONASS), many States struggle with the approval of flight procedures based on signals from navigation aids not controlled by the State. This is due to air navigation service provision being a sovereign responsibility under the ICAO Convention. This concern was a major driver for the EU to decide to build Galileo. An essential mitigation to this sovereignty concern is for the State to provide its own independent navigation infrastructure using DME. Many States are working on optimizing their DME station networks to better support PBN navigation applications. While in the case of a GNSS outage, some reduction in network performance may be possible, the presence of a robust DME infrastructure helps in maintaining traffic levels, significantly limiting the vulnerability to GNSS issues.

While the introduction of Galileo will greatly help in mitigating these sovereignty concerns for EU member States, vulnerabilities of GNSS which require mitigation by aviation will remain. GNSS is a multi-modal system used in many sectors and applications. This means that aviation must be ready to deal with GNSS system outages due to interference, where often the interference may be intentional but not actually directed at aviation. Even with the introduction of additional GNSS signals, these concerns will remain. This is why ICAO, supported by European inputs, has decided to work on the topic of Alternate Positioning, Navigation and Timing (A-PNT). Within the EUROCONTROL Navigation Steering Group (NSG), a European A-PNT Strategy has been formulated. The A-PNT strategy has a short term and a long term objective. For the short term, the strategy is consistent with an ICAO recommendation:

Recommendation 6/8 – Planning for mitigation of global navigation satellite system

Vulnerabilities: That States:

f) where it is determined that terrestrial aids are needed as part of a mitigation strategy, give priority to retention of distance measuring equipment (DME) in support of inertial navigation system (INS)/DME or DME/DME area navigation, and of instrument landing system at selected runways.

(ICAO DOC 10007, Report of the 12th Air Navigation Conference)

To support the traffic density of the European aviation network, it is clear that terrestrial aids (meaning primarily DME, both to support PBN and ILS) are needed. This is why a new EUROCAE Working Group was started to clarify and formalize the role of DME in the context of mitigating GNSS outages while maintaining support to PBN (EUROCAE WG107, RNP Reversion using DME/DME). For ILS, the use of DME as a distance to threshold indication is a widely implemented standard in Europe (also based on ICAO safety recommendations). The only exceptions are areas with a high DME density, where insufficient DME channels are available. In this case, the ILS can only be supported by marker beacons. This saturization in the DME band illustrates that no margin is left to accommodate other non-aviation services, and that any further increase of the spectrum congestion will have negative impacts on aviation safety. Based on European stakeholder input coordinated by EUROCONTROL, this strategy has been agreed and captured in ICAO Annex 10, Vol 1 (Attachment H, Strategy for rationalization of conventional radio navigation aids and evolution toward supporting PBN).

For the long term, aviation is investigating if systems other than DME can replace the functions currently provided by DME. Many of those solutions are looking at systems in the L-Band, including LDACS, where a ranging function could be added. However, since the implementation of a next generation A-PNT system based on individual airline business case decisions will be lengthy, there will also be an extended time of transition where both the legacy DME and the new A-PNT system will need to be accommodated. Current studies are also looking into modifying the DME or using hybrid approaches. If additional non-aviation users need to be accommodated, this would further delay and complicate any such system evolution. While aviation does not expect to be given new spectrum, current research efforts assume that the current spectrum allocations can be retained without additional sharing so that the infrastructure can be evolved within already allocated bands to serve the expanding bandwidth needs or air navigation services. The EUROCONTROL network manager radio frequency function has already implemented measures to optimize future DME frequency assignments to facilitate compatibility with new GNSS signals, where reducing the so-called "hotspots" in the L5 frequency band (above 1164 MHz) will increase the need for DME assignments below 1164 MHz.

Both the short and long term A-PNT efforts are supported by a SESAR Horizon 2020 research project (Project 14 on "Essential and Efficient CNS"). The existence of research projects, standardization and other working group activities, and a variety of policy and strategic guidance material both at the European and global level clearly demonstrates the essential and continuing role of DME and its potential evolution in supporting the aviation system. Therefore, the protection of spectrum used by DME remains vital.

#### Proposed common military position (CMP) on low power audio programme making and special events (PMSE) sharing in the aviation band 960-1164 MHz

The Military acknowledge the consultation and studies related to the 960-1164 MHz aviation band[[28]](#footnote-29) for the possible use of low power audio Programme Making and Special Events (PMSE) equipment.

The band in question is used to support fundamental safety-of-life services for both civil and military aviation. These are based on the operation of systems such as DME[[29]](#footnote-30), TACAN[[30]](#footnote-31), SSR[[31]](#footnote-32), PSR[[32]](#footnote-33), ACAS[[33]](#footnote-34), Mode S, IFF[[34]](#footnote-35) and some bands of GPS and GALILEO. JTIDS/MIDS[[35]](#footnote-36) uses a set of frequencies in this band.

The Military acknowledge the risks associated with the UK OFCOM decision. Such risks result from sharing this L-band spectrum used for safety-related services with commercial and market-driven non-aviation services which would require strict governance to safeguard the aviation use of the band.

The Military highlight the importance of relevant regulatory and technical studies to be conducted on the feasibility of such spectrum sharing to completely mitigate the risks of interference with a negative impact on aviation safety. In this respect the Military fully support the approach described in the ICAO letter E3 5.15, dated 19/04/2017, to the CEPT ECC WG FM Chairman in particular to the 7 caveats identified as pre-conditions to be met to be able to accept any sharing of the band:

|  |
| --- |
| the new system is completely compatible with existing and planned aviation systems based on testing and analysis that has been agreed by aviation regulators;  the parameters for the new system will be captured in an internationally recognized standards document;  the new system will be certified (including software and hardware) by the competent national regulatory authorities; will be maintained to meet throughout its service life the operational parameters assumed in the aviation testing/studies; will perform self-monitoring to ensure that it shuts down if it moves outside those agreed parameters; and the self-monitoring/shutdown function itself will also be certified;  the new system will include time-stamped logging of essential transmitter parameters, such as frequency use and power levels for post incident/accident investigation purposes;  the new system will not impact:  the ability of aviation to manage existing and planned aviation systems and  the ability of aviation authorities to modify operating frequency assignments, powers and signal contents of the aviation systems without introducing additional coordination mechanisms;  the operator of the new system must accept all legal liability in case of interference to aviation systems (e.g., due to false channel selection, excessive power, human error, device failure), and recognize that aviation systems operators have no liability in case of interference to the new system; and  personnel responsible for the operation of non-aviation systems in the 960-1164 MHz band shall be required to achieve similar levels of certification to those stipulated in the Radio Regulations for operators of aviation systems (radio operator's certificate). |

In addition to the ICAO caveats, the Military could only support the introduction of any new system in the 960-1164 MHz band if it can also be ensured that:

- the related liability aspects be identified and clarified in advance;

- In case of (harmful) interference, (for instance due to wrong PMSE channel selection, too high power emission, human error, device problems,…) resulting in any incident and/or accident (infringement of safety), responsibilities have to be established and corrective actions need to be taken in a timely manner;.

- no additional technical and operational constraints, resulting from a possible sharing of this band with low power audio PMSE, be imposed to aeronautical applications in 960-1164 MHz band including the military systems.

In respect to the technical studies to be conducted, respecting the fact that NATO could not come to a unanimously agreed position on this issue as obligated to take a formal NATO position and to nevertheless respond to the request of WG FM to represent the military interest, NATO submitted the CaP 3 mil. session paper ‘PMSE Equipment EMC Evaluation Requirements’ Doc. SE7(17)083 dated 18 September 2017 to WG FM, WG SE and SE7 of CEPT. This document sets the technical parameters to be taken in account for the studies to protect the military interest and use in the respective band. This document and its content is fully supported. The Military in particular want to stress the rigorous and robust test and evaluation process that needs to be established including hardware testbeds in order to fully assess the electromagnetic compatibility situation.

#### Safety

From the early days of aviation, the aviation industry develops, maintains and operates safety of life and safety and regularity of flight systems (SoLS) operating in adequately protected spectrum.

The ITU Constitution (CS) and the ITU-R Radio Regulations (RR) have captured the absolute importance to protect SoLS spectrum.

By design aviation systems do not expect in-band interference from non-safety systems (NSS) operating in the same band; it goes the same for processes and operational procedures developed around these environments. Safety cases and mitigation techniques are also developed based on the same assumption.

The ICAO Doc 9718 states: “Non-safety-of-life services, willing to share a safety-of-life band, have to comply with the aviation safety requirements applicable in that band including certification of radio equipment, software and radio operators, as well as assumption of liability”.

NSSs, willing to share a safety-of-life / safety and regularity of flight (SoL) band, have to comply with the aviation safety requirements applicable in that band including certification of radio equipment, software and radio operators, as well as assumption of liability.

Radio Regulators, Non-Safety (NS) equipment manufacturers and users shall act under the supervision of a designated National Supervisory Authority (NSA) and provide evidence that:

1 All aspects of sharing an aviation SoL band are taken into consideration to preserve the safety of the aviation operational environment;

2 Effective actions are taken to prevent any proliferation of equipment having the capability to transmit in the SoL band in question;

3 Efficient market surveillance is performed to ensure that manufacturing and importing of such equipment are fully under control;

4 Efficient monitoring of the band is performed to prevent any illegal use and potential interferences with SoL systems;

5 Licenced NSSs are manufactured in conformance with the internationally agreed standards;

6 Traceability of NSS manufactured equipment;

7 Users of the NSS are qualified to operate in an ARNS, AM(R)S and AMS(R)S bands and hold a valid certificate; and:

7.1 Their operational handbooks are valid and maintained properly;

7.2 Their safety management system (SMS) is accepted and validated by the NSA;

7.3 They are insured for their liability;

An effective and continuous monitoring of the RF environment is put in place;

Measures are taken and resources are made available for a diligent intervention;

NS users can seek a licence only when they can provide evidence that their equipment, processes, operational procedures, SMS, safety cases and mitigations technics are approved by the National Supervisory Authority NSA;

It is the responsibility of the NSA to coordinate with the CAA and ANSPs;

The performance of NSS users regarding the scrupulous respect of rules and terms of their licence shall be recorded by the radio regulator and made available to the NSA;

NSS users sharing a SoL band cannot be under the responsibility and authority of the CAA; they have to operate under the full responsibility of the Radio Regulator having delivered the licence. As a CAA is liable for licences delivered to Air Navigation Service Providers (ANSPs), Airports, …; the same logic shall apply to the Radio Regulators to maintain the required SoL protection. As ANSPs and Airports are liable for their operations; the same logic shall apply to NSS users sharing a SoL band

Technical studies conducted to determine if a NSS can share an ARNS, AM(R)S and AMS(R)S band have to be based on the worst case scenario.

### Single European Sky

The objective of European Commission is to reduce the extra costs of close to 5 billion Euro each year to airlines and their customers and to develop means to allow airlines to fly their preferred (and more direct) routes (<http://europa.eu/rapid/press-release_IP-13-664_en.htm>).

This spectrum resource is considered as strategic for the Single European Sky to improve air traffic.

The mitigation of certain hazards may require that additional requirements may be placed in order to adequately reduce the associated risks to appropriate levels, perhaps involving additional functionality, processes, training of personnel etc.

This means practically that analyses need to be carried out during the development of the new / changed system as particular hazards may require mitigations that involve changes in design or additional functionality, processes or training that must be implemented before the change may be implemented.

Risk classification schemes have been developed at a European level, e.g. EUROCONTROL ESARR 4 - Risk Assessment and Mitigation in ATM, which provides minimum requirements.

Where the changes to facilities are deemed to have certain levels of potentially severe outcome then the competent authorities are required to review the safety arguments provided by the ANSPs associated with the new functional systems or proposed changes to existing functional systems. This collation of the safety arguments etc. can be known as a “safety case”.

It appears to be appropriate that consideration of the sharing of frequency bands within which ATM equipment operates should also be subject to a similar process of systematic hazard identification, risk assessment and mitigation consideration. It may be that the mitigation of certain risks may require technical mitigations to be introduced in the PMSE equipment and this may require additional requirement to be included in system standards.

1. Question: is there any link between 960-1164 MHz frequency band and Single European Sky regulation? TEXT to be IMPROVED by Eurocontrol.

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# Economic Aspects

1. To be completed with IATA letter (FM51(17) Info 70\_IATA letter to WGFM on PMSE in 960 - 1164 MHz)
2. To be discussed during the next DG session and proposal from UK and Sweden to remove the current text below.

## Current economic and social benefit of air transport

1. Section to be improved by French Civil Aviation

All CEPT Member States have been registering an increase in the number of air passengers for several years, This number grew about 6.8% in 2015, 6.3% in 2016 and 6.8% in 2017. For some Member States, (like Poland, Czech Republic, Hungary, Romania, Croatia, Slovenia…) the growth rate was even higher, or between 15 and 20 % in 2017. A key requirement to sustain this growth is the capability to reduce the separation between aircraft while maintaining or increasing the current levels of safety. This is only possible if sufficient performance of the radionavigation and surveillance systems operating in the band 960-1164 MHz (DME-DME and surveillance separation when available) or the adjacent band 1164-1215 MHz (DME-DME and GNSS/GPS) can be ensured.

The level of safety, as enforced by the Air Traffic Services allows for a strong public confidence, which in turn fosters the development of the aeronautical industry. Making a dedicated spectrum of radio frequencies available for safe operations is an integral part of establishing the required level of safety. Due to the many years of reliable and interference free operations enabled by the strictly controlled environment in the 960-1164 MHz band, a worldwide economic and social benefits model has been built. The high level of safety and reliability of operations has attracted massive financial investments in aircraft fleets, ground equipment, and facilities by businesses and commercial operators in order to provide their services. Any introduction of a newcomer in the band 960-1164 MHz which does not follow this model of safety oversight will decrease the current achieved levels of safety, an outcome which is not acceptable to Civil Aviation. To regain an acceptable level of safety, new constraints would be necessary, such as increasing the separation between aircraft. This reduction of air space capacity would have a large impact on the aeronautical economic model (as shown below) and has to be considered as a risk.

The data of this section comes from ATAG reports 2016[[36]](#footnote-37) “[Aviation : Benefits Beyond Borders](http://www.atag.org/component/downloads/downloads/346.html)” and Study on the Modelling of Airport Economic Value[[37]](#footnote-38).

### EMPLOYMENT

In 2014 the air transport industry supports 62.7 million jobs globally.

* It directly creates 9.9 million jobs worldwide (60% for airports, 27% for airliners, 11% for aerospace sector, 2% for air navigation service providers (ANSPs) …)
* 11.2 million indirect jobs are created via purchases of goods and services from companies in the air transport supply chain
* 5.2 million jobs are induced through spending by industry employees
* Almost 36.3 million direct and indirect jobs are created through air transport’s catalytic impact on tourism

Moreover, it is estimated that aviation supported 67.7 million supply-chain jobs in 2016 and underpinned $3.0 trillion in value-added output globally.

### ECONOMIC BENEFITS

* Aviation provides the only worldwide rapid transportation system which makes it essential for global business and tourism
* Aviation’s total global economic impact (including direct, indirect, induced and the catalytic effects of tourism) is estimated at $2.7 trillion, equivalent to 3.5% of world gross domestic product (GDP)
* Aviation transported approximately 3.57 billion passengers in 2015
* Aviation carried 51.2 million tonnes of freight in 2015 and 35% of interregional exports of goods by value
* Daily value of goods sent by air is now $17.5 billion
* Research conducted in the US suggests that for every $100 million dollars invested in aerospace yields an extra $70 million in GDP year after year.

### SOCIAL BENEFITS

* Aviation broadens people’s leisure and cultural experiences via wide choice/affordable access to destinations across the globe
* Improves living standards and alleviates poverty through tourism
* Often serves as the only means of transportation to remote areas promoting social inclusion

Contributes to sustainable development by:

* Facilitating tourism and trade
* Generating economic growth
* Creating jobs
* Increasing tax revenues

## SESAR (Single European Sky ATM Research) OBJECTIVES

The objective of European Commission is to reduce the extra costs of close to 5 billion Euros each year to airlines and their customers and to develop means to allow airlines to fly their preferred (and more direct) routes.

Further consideration is required on how the introduction of any non-safety of life systems, such as audio PMSE, may impact the following SESAR performances:

* Efficiency and predictability: up to 6% reduction in flight times and up to 30% reduction in departure delays;
* Environment: up to 10% reduction in fuel burn and CO2 emissions;
* Capacity: a system capable of handling up to 100% more traffic, and up to 10% additional flights landing at congested airports;
* Cost-efficiency: up to 40% reduction in air navigation services costs per flight;
* Safety: improved by a factor of 3-4 times coping with the expected traffic increase.

## PMSE introduction ECONOMIC impact

### Civil aviation side

PMSE introduction, in the 960 – 1164 MHz band, may slow down, constrain or freeze the evolution of aeronautical systems (such as those developed under SESAR for instance).

One of the additional points is that potential interferences may result an increase of the separation between aircraft to ensure safety. As a result of the domino effect, this non predictive air traffic flow reduction may also lead to an extra cost for airports and airliners.

In terms of safety enhancement, the introduction of PMSE in the band could lead to foreseen increased traffic levels and reductions in fuel consumption, noise and emissions not being achievable, while risking a reduction in public safety.

The current DME equipment is not designed to cope with continuous interference that could potentially be caused by an interfering PMSE device. The upcoming compatibility studies will be based on the assumption that the aeronautical equipment performs according to the current standards. However, if at a later stage a need is identified that may be necessary to modify the aeronautical equipment in order to better cope with a scenario with  interference caused by PMSE, this would be associated with a very high cost. The average recurring cost of an airborne air transport DME is roughly 50 kUS Dollars (Aircraft are equipped with two DMEs). As order of magnitude, any modification, new qualification and certification of a DME on an aircraft (Validation, Laboratory and Flight tests) will lead to a Non Recurring Cost between 400 kEuros and 500 kEuros for a given aircraft program.

Intensive and expensive testing of permanent cohabitation analysis between aeronautical systems (civilian and governmental) and PMSE need to be done in order ensure the required level of safety expected by ICAO and Airworthiness Authorities. In addition to that, PMSE user causing interference should be identified in order to assume the legal and economic consequences (costs) of any impact in the air traffic flow.

In situations where a DME facility is removed from service (potentially as a result of aggregate interference) due to aircraft reports of unavailability particularly during ILS precision approach, the DME would be Notam’d[[38]](#footnote-39) off the air. The loss of service of the DME as part of an ILS facility would then have a negative impact on airport capacity and the published approach procedures cannot be maintained.

To restore the DME back to service as a published navigation aid, this would normally require a flight inspection verification of the system parameters during an airborne analysis. Most States have flight inspection capability that may range from a medium sized commercial turboprop aircraft to twin engine jet aircraft. The cost of operating a flight inspection aircraft to restore a navigation aid back to operational service can range from 3000 to 7000 Euros per hour, depending on the aircraft type and the location it must fly from to perform the inspection.

### Military side

1. To be completed

Currently, the military usage of the frequency band 960-1164 MHz is based on non-interference-basis to civil aeronautical radionavigation systems. In particular, National frequency clearance agreements specify the sharing conditions for the use of L16 and constraints are imposed by civil aviation authorities (safety cases). A lot of studies and tests are required in relation to any new technology used in an aeronautical radionavigation equipment or to any additional aeronautical radionavigation system that could be introduced in this band. Introduction of PMSE in this band could modify the RF environment. Consequently, the current procedures should completely be reviewed with, at least, the risk of an important economic impact (who pays for extra cost?) . Moreover, in certain cases it may be impossible to implement such new tests which would be required for proving the non-interference on civil aeronautical radionavigation systems (for example, how to define accurately the extraneous environment) .

## European airline delay cost[[39]](#footnote-40)

The cost of delay is calculated separately for strategic delays (those accounted for in advance) and tactical delays (those incurred on the day of operations and not accounted for in advance). The type of strategic cost focused on is adding buffer to the airline schedule.

Interference caused by PMSE may generate additional delays (e.g. during landing approach and departure, en-route, etc.) which could be considered as tactical delays.

Tactical delay costs are given for 5, 15 and 30 minutes. These are scaled up to the network level because on the day of operations, original delays caused by one aircraft (‘primary’ delays) cause ‘knock-on’ effects in the rest of the network (known as ‘secondary’ or ‘reactionary’ delays).

The data presented here, are dominated primarily by passenger costs, and then fuel burn differences. Maintenance, crew and reactionary costs are also taking into account.

Table 5 : Delay airline cost (Euros) EN-ROUTE and full tactical cost for 12 core aircraft

| Delay (mins) | 5 | 15 | 30 |
| --- | --- | --- | --- |
| Boeing 737-300 | 270 | 1130 | 3400 |
| Boeing 737-400 | 280 | 1200 | 3670 |
| Boeing 737-500 | 250 | 1030 | 3090 |
| Boeing 737-800 | 300 | 1290 | 3990 |
| Boeing 757-200 | 360 | 1570 | 4840 |
| Boeing 767-300 | 700 | 2710 | 7600 |
| Boeing 747-400 | 1160 | 4340 | 11810 |
| Airbus 319 | 270 | 1110 | 3390 |
| Airbus 320 | 280 | 1200 | 3720 |
| Airbus 321 | 320 | 1400 | 4380 |
| ATR42-300 | 80 | 360 | 1160 |
| ATR72 | 110 | 480 | 1530 |

It should be noted that the table above doesn't take into account several points:

* The cost of an eventual diversion due to the interference (which is between 5870 and 64 600 €);
* The passenger value of time (which is 47 to 60 € per hour and per passenger);
* The cost for the airport;
* The cost of the Air Navigation Services;
* The cost of harmful interference researches that leads to the delay (usually a flight inspection is required);
* The amount of Emissions released by fuel burn and the cost of polluants;
* The noise impact due to the delay;
* The network effect of the delay.

## Safety Case amendments

It is worth studying the cost implications of reviewing all safety cases, before changing the regulatory framework. Also, it is worth studying the cost of the enforcement of technical regulatory constraints that would apply PMSE in order to allow them to use the band. Indeed these costs may be prohibitive.

## Economic value of PMSE (example in UK)

1. The content of this section came from ASP contribution FM51(18)293 Rev1

It has to be noted, that this economic value has no direct link with the particular band 960-1164 MHz but is in relation with the current frequency bands that PMSE are using.

Audio PMSE is present in almost every media, cultural, sporting and entrainment activity it is dynamic and evolving. Producers continually seek new experiences for audiences exploiting the rapidly changing landscape including virtual reality, HD TV, 3D, and the web with consequential changes in demand for spectrum. Productions, particularly large-scale events, require significant investment and planning and have the potential to realise substantial returns on that investment. Consequently, a high degree of professionalism is applied in order to protect that investment.

As explained in ECC Report 204, it is difficult to clearly identify the specific financial and social value of PMSE as it is an enabling technology which allows for the production or event to take place. However, in the UK there have been studies and the entertainment and event sector do provide economic reports on a regular basis.

The Wyndham Report (now out of print) from the London School of Economics (LSE) in 1998 showed that an average of £4.4 was spent in the wider West End economy by theatregoers for every £1 they spent at the Box Office on tickets.

The Society of London Theatre’s 2016 Box Office figures provide economic figures for London’s theatre industry:

* attendances – 14.3 million
* gross box office revenue - £645 million
* VAT paid - £107.5 million

Applying the multiplier from the Wyndham Report, this equates to an additional £2,838 million for the economy.

UK Music is an industry-funded body established in October 2008 to represent the collective interests of the recorded, published and live arms of the British music industry. In its 2017 report on the contribution of live music to the UK economy[[40]](#footnote-41) it notes the following economic results for music tourism in 2016:

* 12.5 million music tourists
* £656 million in box office spend on tickets
* £4 billion (bn) in direct and indirect spend generated by music tourism

The economic benefits presented here are just for two examples of activities supported by PMSE in the UK only.

Additionally, the UK Government’s Department of Digital Culture Media and Sport has reported (in November 2017) that in 2016, the creative industries’ combined input to the UK economy was £92bn. This was an increase on the 2015 figure of £85bn – meaning that, in 2016, the creative sector grew by twice the rate of the UK economy. At the front end of content production, PMSE has played a pivotal role in that growth.

# Issues relative to a potential introduction of PMSE in the band 960-1164 MHz

## Impact on existing and future aeronautical systems related to introduction of PMSE in the frequency band 960-1164 MHz

### Constraint on aeronautical spectrum organisation

The frequency band 960 – 1164 MHz is used by aeronautical applications under the ARNS, AM(R)S and AMS(R)S allocations worldwide. This internationally recognised status allows worldwide-harmonised aeronautical systems to be standardised by ICAO (International Civil Aviation Organisation).

The idea of PMSE sharing the 960-1164 MHz band is to provide a long term solution for coping with local and temporary PMSE bandwidth demands. If this is to be the case, administrations that chose to open this band for PMSE may later, within their spectrum management responsibilities, need to limit the use for PMSE to avoid potential constraints when new aviation systems in the band are decided to be introduced.

Introducing a new non-aeronautical system in the 960-1164 MHz band (e.g. PMSE) may impact the way the aeronautical use of the band is currently organised worldwide.

Indeed, the introduction of PMSE in some countries may compromise the possibility to modify/adjust/optimise the harmonized aeronautical spectrum organisation within Europe and the efficient usage of the spectrum resource for global aircraft operation and the implementation of future aeronautical systems. In addition, there has been no constraint on the broadcast TV and radio spectrum shared with PMSE for the past thirty (30) years.

European countries that choose to make the band 960-1164 MHz available for PMSE may have to coordinate with other countries.

Due to the safety of life objective in the aeronautical domain, a process of international discussion and agreement (as prescribed in the ICAO Convention) is necessary to ensure that any systems introduced as part of the global aviation infrastructure evolution are appropriate and safe. For example, the lead-time for aeronautical equipment, standardisation and regulation is very long. Typically 10 years are necessary to introduce a change to an existing worldwide-harmonised aeronautical system.

1. The text below is to be discussed in the next meeting

[Introducing a new non-aeronautical system in the 960-1164 MHz band without following an appropriate process, validation and certification, and without considering the long lead time required for aeronautical systems could in the worst case cause safety issues and impact the efficient use of spectrum designated for aeronautical use.]

### Safety Case issue

Safety cases are required as means to support aircraft operations by structuring and documenting the demonstration of the safety of air traffic management services and systems. The introduction of a new system in the band 960-1164 MHz would change the RF environment thus invoking the requirement to reviewing the safety cases. A dynamic change in the RF environment would require an assessment and comparison to the situation in which the safety cases in force today were developed.

1. The text highlighted in blue below need to be reviewed by ICAO/UK/NATS/French CAA/EUROCONTROL/Sweden

As per the provisions contained in ICAO Annex 19[[41]](#footnote-42), Safety Management System (SMS) requirements shall be established by each State to ensure that aeronautical service providers operating within the State implement the necessary hazard identification processes and risk management. Based on these requirements, each aeronautical service provider shall develop and maintain a process which ensures that hazards associated with its aviation products or services are identified. Hazard identification shall be based on a combination of reactive, proactive and predictive methods of safety data collection. The aeronautical service provider shall develop and maintain a process that ensures analysis, assessment and control of the safety risks associated with the identified hazards.

ICAO Annex 11[[42]](#footnote-43) and ICAO Doc 9735[[43]](#footnote-44) instruct that any significant safety-related change to the ATS system, including the implementation of a reduced separation minimum, a new procedure and new equipment, shall only be effected after a safety assessment has taken place and demonstrated that an acceptable level of safety will be met, and after all affected users have been consulted. When appropriate, the responsible authority shall ensure that adequate provision is made for post-implementation monitoring to verify that the defined level of safety continues to be met. European Regulation (EC) No 552/2004 and European Commission implementing Regulation 2017/373 and EUROCAE ED-125 apply, as well as the EUROCONTROL Safety Regulatory Requirements ESARR1, ESARR2, ESARR3, ESARR4 and ESARR5.

Consequently, before introducing PMSE in the band 960-1164 MHz, in addition to a generic safety assessment of the PMSE itself under the authorization of relevant State authorities or agencies[[44]](#footnote-45), aeronautical service providers have the responsibility to re-assess their current safety risk assessments and/or develop new ones, taking account of the possible effects that PMSE may have to the air-navigation and surveillance systems operating in the band.

The safety risk assessment developed by the aeronautical service provider will need to demonstrate that an equivalent level of safety or an alternative acceptable means of compliance can be achieved. This may involve inputs and participation by civil aviation authorities, the aviation safety regulator and other interested parties (e.g. military, air navigation service providers, airports, airlines). As per the provisions contained in ICAO Doc 9734[[45]](#footnote-46), “Any exception or exemption should only be granted on the basis of a robust rationale. Therefore, the issuance of exceptions or exemptions that are not supported by safety risk assessments or aeronautical studies and by thorough reviews by the competent authority is not acceptable”.

As indicated above, aircraft operators and concerned aeronautical service providers may be required to review their safety cases based on the requirements developed by relevant authorities or agencies for existing airport, take-off, landing and en-route operations due to the potential impact on aeronautical navigation and surveillance systems and procedures.

Safety cases do not only take account of the technical environment, but also of human factor issues. Current safety cases rely on the assurance that users are properly trained and qualified (e.g. Air Traffic Safety Electronics Personnel). If a new system such as PMSE were to be introduced in an aeronautical frequency band, the safety case analysis would need to take a number of additional factors into account, such as PMSE users not respecting their license conditions (intentional or unintentional wrong frequency selection, wrong location etc.). Similarly, the safety risk assessment would need to address the potential of PMSE equipment not meeting its specifications.

If PMSE use is allowed in the 960-1164 MHz band before an appropriate safety risk assessment has taken place, this may result in potential restrictions being necessary to normal airspace access until the new required safety risk assessment has been developed, taking full account of the potential change to the RF environment. Such a restriction would include the application of greater separation distances between aircraft causing inefficient use of airspace and delays.

If the safety risk assessment identifies PMSE to have a potential impact on aeronautical navigation or surveillance systems then one potential outcome would be a requirement for less efficient air routes and procedures than the current existing ones, resulting in significant cost impact to the affected aeronautical operators and service providers. Also, the development of new safety cases may generate significant cost to the aeronautical operator or service provider.

### Interference considerations

It should be also noted that identification, sourcing and the research of any harmful interference in the band 960-1 215 MHz is a very complex and expensive undertaking as it involves critical safety services that are in continuous use. Having an established or published navigational aid removed from service due to harmful interference would be an unacceptable situation.

If a case of harmful interference in the band 960-1164 MHz leads to the removal of a safety service from operational use, an airborne flight inspection analysis would be required and usually take more than 12 hours to be implemented. As the harmful interference that could be caused by PMSE would be of short duration (less than 12 hours) and potentially non-continuous, it will be difficult to identify the main interfering source and to remove the interference in an expeditious manner.

Time-stamped logging PMSE usage may be required for post incident and accident investigation purposes.

Availability of accurate PMSE license and usage information could be used to correlate interference reports within a specific geographical location and useful in identifying the interfering source. However, interference from potential unlicensed use of PMSE would be very difficult to locate and remove.

### Flight safety

1. To be completed

### Safety of life

1. To be completed

## Impact for future PMSE in the frequency band 960-1164 MHz

### Impact of aeronautical planning on PMSE authorization regime

When there is an optimization/modification to the assignment of aeronautical systems in the band, PMSE licenses will have to be reviewed to maintain compatibility and avoid interference with the aeronautical systems.

### Long-term availability of the 960-1164 MHz frequency band for PMSE

As indicated in the ICAO Global Air Navigation Plan (5th edition, 2016[[46]](#footnote-47)), the frequency band 960-1164 MHz is already highly populated with safety critical aeronautical systems and is intended as the home for the implementation of evolving aeronautical systems. Hence, a long-term availability of this band for PMSE cannot be ensured.

## Impact for IATA and International Air Transport Community

1. To be developed by IATA (related to section 2.5.7 IATA)

Safety and reliability are fundamental to airline operations. Pilots and avionics system heavily rely on reliable aircraft navigation aids such as DMEs to ensuring safety of flight including that of aircraft, air crews and travelling publics. Harmful interference to navigation aids can lead to inefficient airline operations and, more importantly, can jeopardize the safety of flight.

A dynamic change in the RF environment would require an assessment and comparison to the situation in which airlines’ safety cases in force today were developed. Insufficient protection of DME frequency and adjacent frequency bands will lead to the need to reassess any safety implications to flight operations as the assessment is required within airlines’ safety management process, a mandatory process under State aviation laws and regulations.

In the worst case when it is no longer possible to safely operate current DMEs due to the uncertainty of RF environment, a new global standard for DME and associated aircraft avionics will need to be developed by ICAO and adopted by all ICAO Member States. This process is in itself very lengthy and complicated. This scenario will also eventually lead to extensive operational impacts and unacceptable costs to airline operators due the high cost associated to new avionics development, equipment re-certification and fitment / installation of the airborne equipment.

## 

1. Standards , operator certificates questions and conclusion to be provided by ICAO/Eurocontrol/CAA

# Potential mitigation measures

The [nomadic and] temporary nature of PMSE usage may make it difficult for enforcement authorities to locate an interference source; hence the consideration of licence conditions requiring identification within the PMSE signal would be necessary.

1. Sections below came from OFCOM-UK contribution FM51(18)290

## Considerations for sharing

The report identifies a number of regulatory limitations which may affect the feasibility of audio PMSE sharing in the band. It also notes a number of risks and areas of concern that administrations should be aware of. The report also identifies potential effect of harmful interference from PMSE on aeronautical systems and aircraft, including economic assessment of potential costs. Here we explore possible examples and scenarios to provide some context and assessment of likelihood of those issues occurring.

## A potential sharing scenario

In order to assess the risk some qualitative assumptions are made. Building on the experience of the UK’s work and decision to make the 960 to 1164 MHz band available for low power audio PMSE, this section summarises the risks and concerns and provides some possible mitigations.

The potential for effectively sharing in the band depends on two conditions, firstly providing adequate protection to incumbent systems, and secondly the spectrum providing sufficient quality for PMSE to operate. A second order consideration is the quantity of spectrum that would be available for use by PMSE, as a small amount would not be operationally or economically viable.

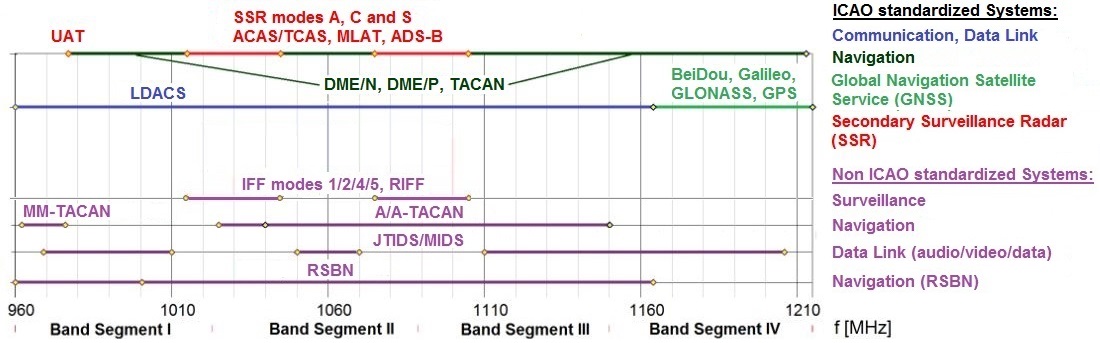


Figure 8-1: Systems currently residing in the frequency band 960 – 1215 MHz,

including Band Segment indication

Systems and equipment to be considered for mitigation:

DME/N, -/P, TACAN (all pulse codes), SSR based systems, UAT, LDACS, GNSS

Air/Air and Maritime Mobile TACAN, IFF and Reverse IFF, JTIDS/MIDS, RSBN

PMSE systems e.g. microphones, In-Ear Monitoring

There are four basic interference scenarios to consider for single interfering sources:

* 1. PMSE transmitter to aircraft receiver, both airborne and on the ground
* (system by system for Band segments I to IV)
* 2. Aircraft transmitter, both airborne and on the ground, to PMSE receiver
* (system by system for Band segments I to III)
* 3. PMSE transmitter to surface aeronautical receiver at a fixed or mobile location
* (system by system for Band segments I to III)
* 4. Surface aeronautical transmitter, at a fixed or mobile location, to PMSE receiver
* (system by system for Band segments I to IV)

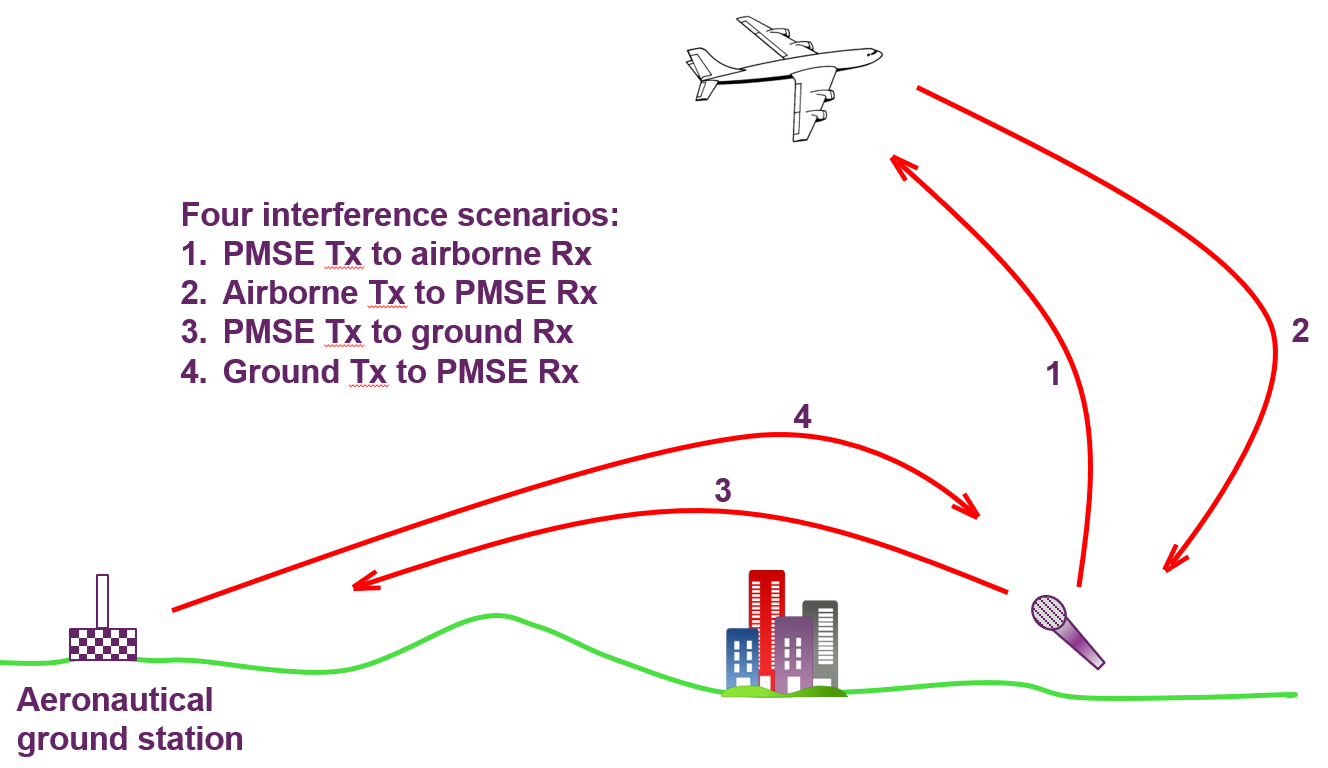


Figure 8-2: Interference scenarios for audio PMSE operating between 960 and 1164 MHz and aeronautical services operating between 960 and 1215 MHz

In addition, the aggregate interference impact of all systems operating in the band needs to be considered, taking into account the extraneous signal environment (ESE) of both the interfering and the desired systems onto the victim receiver:

* 5. ESE of aircraft transmitters, both airborne and on the ground; plus ESE of surface aeronautical transmitters; plus ESE of PMSE transmitters; onto each aircraft receiver, both airborne and on the ground (band segments I to IV)
* 6. ESE of aircraft transmitters, both airborne and on the ground; plus ESE of surface aeronautical transmitters; plus ESE of PMSE transmitters; onto each surface aeronautical receiver at a fixed or mobile location (band segments I to IV)
* 7. ESE of aircraft transmitters, both airborne and on the ground; plus ESE of surface aeronautical transmitters; plus ESE of PMSE transmitters; onto each PMSE receiver (band segments I to IV)

1. Find place for this definition: ESE consists of signals and spectrum from transmissions falling within the receiver selectivity of the interfered system

## MitigatiOn by definition of a guardband above and below the center frequencies used by the aeronautical surveillance systems in the band

A number of civil and military aeronautical services have been identified that operate presently at 978, 1030 and 1090 MHz (see Tables 1 to 3). These services are ubiquitous, and aircraft may receive signals on 978, 1030 MHz and 1090 MHz, so it is not possible to technically coordinate or geographically interleave PMSE in order to satisfy the first criterion of sharing, i.e. not to cause harmful interference into the aeronautical services.

Similarly, as these aeronautical services transmit presently on 978, 1030 and 1090 MHz, including aircraft transmissions, airborne and on ground, the risk of interference into PMSE makes these channels unviable for use, and therefore the second criterion is not satisfied, i.e. the spectrum is not usable by PMSE. Therefore, the only viable mitigation is to implement appropriate guard bands presently around 978, 1030 and 1090 MHz to protect these services. This would protect all civil and military aeronautical services that presently operate on these three frequencies. By way of example, the UK has included guard bands for the 1030 and 1090 MHz frequencies within the spectrum management rules for PMSE sharing in the 960 MHz band.

Due to the risks identified above, PMSE equipment, as a minimum, must be unable to tune to 978, 1030 and 1090 MHz (± X MHz guard band) on safety grounds. This would ensure that compliant equipment could not accidently tune to these frequencies and would mitigate the risk of interference to aeronautical services that operate on these frequencies.



## Mitigating vulnerabilities of DME as a component of the Instrument Landing System (ILS)

The safe operation of aeronautical navigation systems, in particular ILS CAT I/II/III requires availability and integrity which is comparable to few if any other radio services, or of the order of magnitude of 1 ‑ 1\*10‑6 or better (the specified required integrity for CAT II/III is 1 ‑ 1\*10‑9). Such high availability and integrity can only be achieved by ensuring there is no interference to the various components of the ILS from other systems, In this context, extreme propagation anomalies need to be taken into account, as well as intentional or inadvertent co-sharing of a DME frequency by the PMSE user.

Some testing of potential interference scenarios has taken place in the UK to-date (Ref. [JCSys/C053/004/3](https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwitjoWipIPaAhUEF6wKHXxnBywQFggnMAA&url=https%3A%2F%2Fwww.ofcom.org.uk%2F__data%2Fassets%2Fpdf_file%2F0024%2F57840%2Fannex6.pdf&usg=AOvVaw1Vyu2P9fl_CAcqUl8nSjWO), "Test Report for the Coexistence of PMSE with Aeronautical Services in the band 960-1164 MHz"). One test scenario has revealed that certain tested DME receivers are vulnerable to the reception of a PMSE signal at a very low level (-97 dBm), resulting in ranging errors. Erroneous indication from any navigation system can be considered even more dangerous than the navigation system becoming inoperable due to interference. As there was a limited number of test scenarios, it may be possible that DME receivers may exhibit this behaviour at even lower signal levels.

Another issue of note is that even a short duration interference to DME, when used as a component of the ILS CAT I/II/III may not only have an impact on the safety of flight, due to aircraft not being able to initiate the CAT I/II/III approach and landing procedure during the interference event, this may also have a longer term effect on the efficiency of airport operations. Strict Air Traffic Control intervention would be required for the provision of alternative ranging information for each flight, this implies flow control with much reduced capacity. A demonstration period would need to be completed before normal operations could be restored, proving fault rectification or resolution to the issue that caused the loss. Depending on the severity of the loss, varying periods will be required to prove the stability and operational capability of the facility, for example this could be between 24 and 300 hours or as specified by the ANSP for that aid. In the meantime, the airport operations will be required to take place at a much lower capacity, thus causing significant financial burden.

## Mitigating Vulnerabilities of DME as an En-Route navigation Aid

[Text to be developed]

## Methods used in the United States of America (USA) to mitigate effects of the introduction of PMSE in a band used for aeronautical mobile telemetry

In USA, the frequency band 1435-1525 MHz[[47]](#footnote-49) has been made available for PMSE based on specific conditions as outlined in [FCC 15-100 Report and Order](https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwj3-L-Vr4DaAhVMaq0KHfiFAuIQFggnMAA&url=https%3A%2F%2Fapps.fcc.gov%2Fedocs_public%2Fattachmatch%2FFCC-15-100A1.pdf&usg=AOvVaw3CBT2x8f2Rixi88QDTbRU9). In ITU Region 2 this band is used for aeronautical mobile telemetry, which presents a very different regulatory status and RF environment than that compared with the multiple primary allocations to ARNS, AM(R)S and AMS(R)S services operating in the 960 – 1215 MHz band on a global basis. However, yet these specific conditions have been determined to be essential to protect the telemetry user in the band.

These conditions include the following:

Coordination requirement

Prior to operation for a specific time period and place, the user would have to request and successfully complete coordination with the AMT community (and the federal government).

Will permit 200 kHz analog and digital masks and adopt the emission masks in Section 8.3 of ETSI standard EN 300-422-1 v1.4.2 (2011-08), with power levels of up to 250mW.

Restricted use to specific fixed locations, such as large venues (whether outdoor or indoor), where there is a need to deploy large numbers of microphones (typically 100 or more) for specified time periods for situations in which the other available spectrum resources are insufficient.

The band is not available for either widespread use or for itinerant uses.

Additionally, authorization for all microphones operating in a particular area to access no more than 30 megahertz in the 1435-1525 MHz band. This requirement will facilitate coexistence in the band by ensuring that wireless microphones operating be able to coordinate around AMT operations.

Registration and Authentication

The wireless microphones would be tunable across the entire 1435-1525 MHz band, which enables easier coordination because the demands and requirements of commercial and military flight testing are variable across the band, immediately prior to commencing operation pursuant to successful coordination, the user would have to register and authenticate the equipment at the coordinated location, with registration repeated regularly

Deactivation controls requirement

The equipment would need to be designed to have deactivation controls so that operations would cease without periodic registration and authentication.

It should be noted that aeronautical mobile telemetry is not considered to be critical to the safety of flight. Hence, while applying conditions similar to the above, to a frequency band where safety of life services operate will clearly help, as evident from other subsections of this chapter, additional conditions will also be required.

## Proficiency of the PMSE sector versus certification and training requirements for air Traffic Safety electronics personnel (ATSEP)

A

Under the existing operational environment, events and productions means that, particularly for large scale, economically and culturally significant productions, sound design is entrusted to highly experienced and highly skilled individuals and organisations that can demonstrate the required proficiency to deliver interference-free live audio in a complex RF environment.

The proficiency of individuals and organisations operating in the PMSE sector is typically gained through prolonged experience within the sector and who are widely recognised, by consensus, as having the essential skills and knowledge to plan and manage the spectrum to deliver the necessary level of production free of interference. In many sectors the definition of an expert is well established by consensus and therefore it is not necessary for individuals to have a professional or academic qualification for them to be accepted as an expert, and this is the case across the PMSE sector.

ICAO Doc 9718[[48]](#footnote-50) states: “Non-safety-of-life services, willing to share a safety-of-life band, have to comply with the aviation safety requirements applicable in that band including certification of radio equipment, software and radio operators, as well as assumption of liability”.

ICAO Doc 9868[[49]](#footnote-51) and ICAO Doc 10057[[50]](#footnote-52) and European Regulation (EU) 2017/373 contain the required provisions for training and assessment of air traffic safety electronics personnel, building on the provisions and requirements contained in Articles 18 and 37 of the Radio Regulations. Doc 9868 specifies that “any practical training should be performed under the supervision of an instructor qualified and competent in the technical domain for which the certificate of competency shall be issued. In instances where practical training is provided through on-the-job training, the instructor shall be qualified and competent in the technical domain, and the training shall be conducted under the safety management system of the air navigation service provider”.

In order to maintain the safe RF operating environment of the safety critical aeronautical radionavigation and surveillance systems operating in the frequency band 960-1215 MHz, ICAO has indicated that the personnel responsible for the operation of the non-aviation systems in the 960-1164 MHz band would need to be required to achieve similar levels of certification. This is especially true due to the current vastly different operational cultures in aviation on the one hand and in the PMSE industry on the other hand.

Special note should be taken of the large differences between the operational environment of white spaces between television channels in the 470 and 700 MHz bands on the one hand and the aeronautical environment in the 960-1215 MHz on the other hand. In the television broadcast band, if a channel is free of interference from a nearby television broadcast, then it is normally clear for low-power PMSE use. On the other hand, the aeronautical radionavigation systems in the 960-1215 MHz band operate with a 63 MHz offset between transmit and receive, hence the PMSE user cannot assume that a frequency is clear if he doesn't detect a signal on the frequency. In addition, the very stringent uptime requirements of the aeronautical radionavigation and surveillance systems implies that those systems need to work through large fluctuations in the link budget due to atmospheric and similar effects. Due to the various issues highlighted above, experience and knowledge gained from operation in traditional PMSE bands are not applicable to the 960-1164 MHz band.

All personnel currently involved in the operation of systems in the band 960-1164 MHz are required to understand the principles of both quality management system (QMS) and SMS. While the PMSE industry may already plan events and operate equipment under a methodology similar to QMS, as indicated in ICAO Doc 9718, in order to continue safe aircraft operations and based on the aeronautical regulatory framework, any user operating within this frequency band would also need to apply SMS to their operation in order to ensure no adverse effect to the safety of aircraft operations.

|  |  |
| --- | --- |
| QMS | SMS |
| Quality | Safety |
| Quality assurance | Safety assurance |
| Quality control | Hazard identification and risk control |
| Quality culture | Safety culture |
| Compliance with requirements | Acceptable level of safety performance |
| Prescriptive | Performance-based |
| Standards and specifications | Organizational and human factors |
| Reactive > Proactive | Proactive > Predictive |

Principles of SMS and QMS[[51]](#footnote-53) [Make a Footnote XXXXXX (Ref ICAO Doc 9859, Table 5-1)

# SUMMARY OF REGULATORY ISSUES

1. Texts to be developed on the basis of the above sections
2. WGFM#89 meeting : "....WG FM requires presentation of the issues, with balanced positions when there is no agreement; WG FM does not expect conclusions, but a short summary of the issues is appropriate;...."

The introduction of PMSE in the band 960 to 1164 MHz raised regulatory and legal issues at least at 3 different levels: ITU-R, ICAO and CEPT. In parallel these three levels, some issues must also be carefully considered.

ITU-R (see relevant extracts of RR in annex 1)

1. To be completed with section 4.1 if needed

* no regulatory protection can be ensured for the usage of PMSE in the band 960-1164 MHz and PMSE shall not cause harmful interference to other existing or planned aeronautical systems operating in this band (see RR N° 4.4);
* due to safety aspects, special measures are required to ensure the freedom of harmful interference to the other aeronautical systems operating in this band (see RR N° 4.10).

1. Safety cases to be added

ICAO

1. To be aligned with section 4.2

In accordance with the Convention on International Civil Aviation (Chicago Convention), national regulations and safety oversight obligations require States to undertake measures to ensure the safety of every aircraft flying over or manoeuvring within its territory. This is accomplished through a framework of international and national regulations, ensuring the quality the services provided and the competency of the personnel providing those services, thus ensuring the safety of the flying public.

The potential introduction of PMSE in the band 960 to 1164 MHz raised regulatory and legal issues due to the addition of a frequency band sharer which might not be regulated in a similar stringent manner, while potentially interfering with safety critical aeronautical communication, navigation and surveillance systems.

The introduction of new systems/users in the band, outside of the aeronautical regulatory framework would require aviation to review the aeronautical safety cases currently in use. Proliferation of commercial equipment using the band 960-1164 MHz, without an appropriate and compatible regulatory framework and required user certification to protect the existing aeronautical safety services might lead to uncontrollable situations of frequent interference to those services. This may result in a situation where it will be impossible to track down and mitigate such interference in acceptable time. Hence, before allowing PMSE use in the band, Administrations need to consider how enforcement will be done.

In light of the above, any introduction of PMSE in the band will need to be made under a proper regulatory framework, that ensures that:

(I) the new system is completely compatible with existing and planned aviation systems based on testing and analysis that has been agreed by aviation regulators;

(2) the parameters for the new system will be captured in an internationally recognized standards document;

(3) the new system will be certified (including software and hardware) by the competent national regulatory authorities; will be maintained to meet throughout its service life the operational parameters assumed in the aviation testing/studies; will perform selfmonitoring to ensure that it shuts down if it moves outside those agreed parameters; and the self-monitoring/shutdown function itself will also be certified;

(4) the new system will include time-stamped logging of essential transmitter parameters, such as frequency use and power levels for post incident/accident investigation purposes;

(5) the new system will not impact:

i. the ability of aviation to manage existing and planned aviation systems and

ii. the ability of aviation authorities to modify operating frequency assignments, powers and signal contents of the aviation systems without introducing additional coordination mechanisms;

(6) the operator of the new system must accept all legal liability in case of interference to aviation systems [e.g., due to false channel selection, excessive power, human error, device failure], and recognize that aviation systems operators have no liability in case of interference to the new system; and

(7) personnel· responsible for the operation of non-aviation systems in the 960-1164 MHz band shall be required to achieve similar levels of certification to those stipulated in the Radio Regulations for operators of aviation systems (radio operator's certificate).

CEPT

1. To be aligned with section 4.3 and sub-section

* since in many CEPT countries, the frequency band 960-1164 MHz is shared between civil aviation and military systems based on national joint agreements and on mutually agreed sharing procedures; harmonization within CEPT of the PMSE usage in this band could be difficult,
* in case of national use of PMSE, this usage shall not cause harmful interference to nor claim protection from the other aeronautical systems operating in border countries.

European Organisations

The European Union has defined several High-Level Goals that will be supported by the frequency band 960-1164 MHz. Introducing PMSE within this frequency band may constraint or limit those High-Level Goals. It has to be noted that EUROCONTROL is working closely in order to achieve those objectives.

As a regulatory body, EASA will have to integrate the PMSE into its regulatory process in order to meet performance standards (Correct frequency bands, licensed by appropriate authorities and be operated by licensed personnel).

NATO will have to envision a robust test bench program and also take into account the RF change for the cross border coordination and equipment operating on NIB.

1. To be completed with EUROCONTROL part.

Economic Aspects

The introduction of PMSE may lead to reduce separation between aircraft in order to regain an acceptable level of safety. It has to be considered as a risk and has a potential economic impact.

SESAR has massively invested for developing future systems within the band and the introduction of PMSE may Impact the SESAR performances.

Other several risks with a potential economic impact for the civil aviation have been identified: certification of new equipment, DME shut down or research of harmful interferences, delays, etc…

For the military side, the modification of the RF environment may impact the national procedures that are currently in force in each country.

In consequence, it will be necessary to review the safety cases (civil aviation and military sides) currently in use; which can have a prohibitive cost.

ANNEX 1

ITU - Radio regulation regarding the Aeronautical services and harmful interference

PREAMBLE

0.4 All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Members or of recognized operating agencies, or of other duly authorized operating agencies which carry on a radio service, and which operate in accordance with the provisions of these Regulations (No. 197 of the Constitution)

CHAPTER I - Terminology and technical characteristics

ARTICLE 1 "Terms and definitions" - Section VII – "Frequency sharing"

1.169 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 Radio Regulations (CS).

CHAPTER II - Frequencies

ARTICLE 4 "Assignment and use of frequencies"

4.4 Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations.

4.10 Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies.

### 

[ANNEX 2

UK approach for the use of Audio-PMSE in the frequency band 960-1164 MHz]

[Section 7 à copier]

Si UK insiste, proposer à titre de compromis de déplacer le texte OFCOM-UK (avec amendelents si nécessaire) du paragraphe 8 (page 63) dans cette annexe pour bien cadrer le contexte "UK only".

1. Potential mitigation measures

The [nomadic and] temporary nature of PMSE usage may make it difficult for enforcement authorities to locate an interference source; hence the consideration of licence conditions requiring identification within the PMSE signal would be necessary.

1. Sections below came from OFCOM-UK contribution FM51(18)290
2. Considerations for sharing

While the report identifies that there are no regulatory barriers that would prevent audio PMSE sharing in the band it does note a number of risks and areas of concern that administrations should be aware of. The report also makes claims on the effect of harmful interference from PMSE on aeronautical systems and aircraft, including economic assessment of potential costs. Here we explore possible examples and scenarios to provide some context and assessment of likelihood of those issues occurring.

In order to assess the risk some qualitative assumptions are made. Building on the experience of the UK’s work and decision to make the 960 MHz band available for low power audio PMSE, this section summarises the risks and concerns and provides some possible mitigations.

The potential for effectively sharing in the band depends on two conditions, firstly providing adequate protection to incumbent systems, and secondly the spectrum providing sufficient quality for PMSE to operate. A second order consideration is the quantity of spectrum that would be available for use by PMSE, as a small amount would not be operationally or economically viable.

There are typically four interference scenarios to consider:

* 1. PMSE transmitter to airborne receiver
* 2. Airborne transmitter to PMSE receiver
* 3. PMSE transmitter to ground aeronautical receiver
* 4. Ground aeronautical transmitter to PMSE receiver

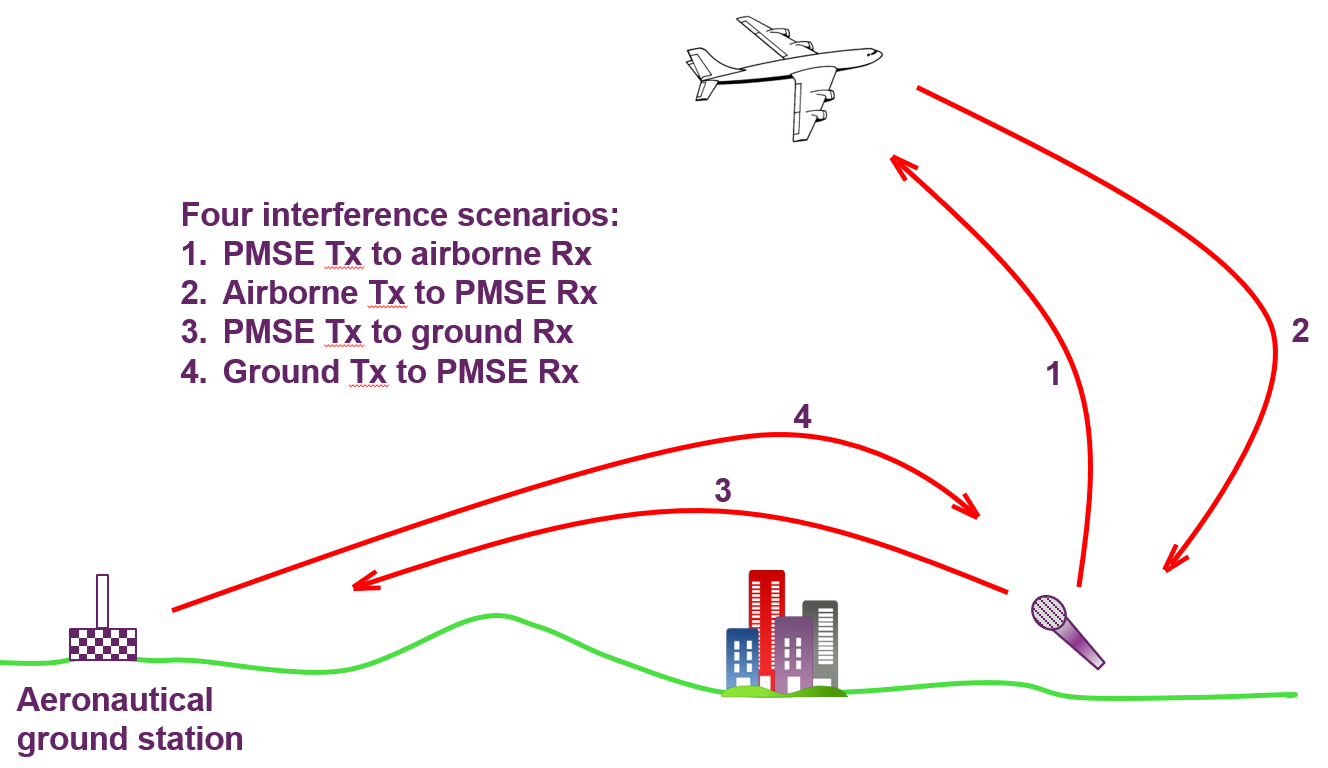


Figure 1: Interference scenarios for audio PMSE and aeronautical services in the 960 to 1164 MHz

1. Mitigating the risk of sharing at 1030/1090 MHz

A number of civil and military aeronautical services have been identified that operate at 1030 and 1090 MHz (see Tables 1 to 3). These services are ubiquitous, and aircraft may receive signals on 1030 MHz and 1090 MHz, so it is not possible to technically coordinate or geographically interleave PMSE in order to satisfy the first criterion of sharing, i.e. not to cause harmful interference into the aeronautical services.

Similarly, as these aeronautical services transmit on 1030 and 1090 MHz, including airborne transmissions, the risk of interference into PMSE makes these channels unviable for use, and therefore the second criterion is not satisfied, i.e. the spectrum is not usable by PMSE. This was demonstrated at the BBC where wireless microphone receivers were tuned to 1090 MHz (airborne SSR transmission frequency) and the level of interference was intolerable and would not be used by PMSE.

Therefore, the only viable mitigation is to implement appropriate guard bands around 1030/1090 MHz to protect both services. This would protect all civil and military aeronautical services that operate on these two frequencies. By way of example, the UK has included guard bands at these frequencies within the spectrum management rules for PMSE sharing in the 960 MHz band.

Although ‘operational’ PMSE use of these channels would unlikely occur, due to the level of incoming interference, consideration could be given to including a requirement in the relevant Harmonised Standard to specify that PMSE equipment must be unable to tune to 1030 and 1090 MHz (± X MHz guard band) on safety grounds. This would ensure that compliant equipment could not accidently tune to these frequencies and would fully mitigate all risk of interference to aeronautical services that operate on 1030/1090 MHz.

1. Option for licensing in the band

The UK has analysed its licensing data and it can be seen that approximately 90% of frequency authorisations for audio PMSE in the 470 to 790 MHz band (the core band for audio PMSE) on any given day are for long term (>300 days) fixed location, indoor use. The remaining 10% of ’short term’ assignments are typically at known, established venues and locations such as small theatres, stadia and locations such as used for Glastonbury or other festivals. Furthermore, analysis in the UK indicates that the vast majority of PMSE use cases (ca. 95%) would be able to continue to satisfy their spectrum requirements in the 470 MHz band after 700 MHz clearance, with only those events/venues with very high channel requirements needing to make use of alternative, additional spectrum, for example the 960 MHz band. The amount of spectrum needed for a particular number of audio PMSE channels is also provided in Annex 4 of CEPT Report 32 [ref] (see Table 1) and is broadly consistent with the UK study, and supports the assumption that only the largest events (and therefore the most economically and culturally significant productions) are likely to need alternative, additional spectrum outside the core 470 MHz band.

Table 1: Spectrum requirements for low power audio PMSE applications[[52]](#footnote-55)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Total number of PMSE links | Wireless microphones | IEMs | TV channels required | Amount of spectrum required (MHz) |
| 12 | 12 |  | 1 | 8 |
| 12 | 10 | 2 | 2 | 16 |
| 32 | 32 |  | 5 | 40 |
| 42 | 42 |  | 7 | 56 |
| 42 | 32 | 10 | 9 | 72 |
| 53 | 53 |  | 9 | 72 |
| 62 | 62 |  | 11 | 88 |
| 62 | 52 | 10 | 13 | 104 |
| 85 | 85 |  | 15 | 120 |
| 98 | 98 |  | 18 | 144 |

While some other administrations do not individually licence PMSE (and therefore there is no data to compare), there is no reason to consider that the profile of use is other administrations is substantively different to that in the UK as the PMSE requirement is similar. Given this assumption, administrations could use licensing to restrict use of the 960 MHz band to known users or class of user (e.g. broadcasters or fixed installations) or particular venues where there is known peak demand. Such restrictions could also include limits on indoor use only, as for example in Germany in the band 1350 to 1400 MHz.

1. Proficiency of the PMSE sector

ICAO has set out its view that personnel responsible for the operation of non-aviation systems in the 960-1164 MHz band shall be required to achieve similar levels of certification to those stipulated in the Radio Regulations for operators of aviation systems.

The economic and commercial importance of events and productions means that, particularly for large scale, economically and culturally significant productions, sound design is entrusted to highly experienced and highly skilled individuals and organisations that can demonstrate the required proficiency to deliver interference-free live audio in a complex RF environment.

The proficiency of individuals and organisations is typically gained through prolonged experience within the sector and who are widely recognised, by consensus, as having the essential skills and knowledge to plan and manage the spectrum to deliver the necessary level of production free of interference. In many sectors the definition of an expert is well established by consensus and therefore it is not necessary for individuals to have a professional or academic qualification for them to be accepted as an expert, and this is the case across the PMSE sector.

1. Programme Making and Special Events [↑](#footnote-ref-2)
2. Article 4.4: Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations [↑](#footnote-ref-3)
3. Article 4.10: Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies [↑](#footnote-ref-4)
4. A safety case is a structured argument, supported by evidence, intended to justify that a system is acceptably safe for a specific application in a specific operating environment [↑](#footnote-ref-5)
5. <http://www.itu.int/en/history/Pages/ConstitutionAndConvention.aspx> [↑](#footnote-ref-6)
6. RESOLUTION 417 (WRC-15) : Use of the band 960-1164 MHz by the aeronautical mobile (R) service

   https://www.itu.int/net/ITU-R/conferences/docs/ties/wrc-res-417-en.pdf [↑](#footnote-ref-7)
7. The Convention on Civil Aviation, also known as the Chicago Convention, ICAO Doc 7300 [↑](#footnote-ref-8)
8. In the one example of PMSE sharing in the 960 MHz band, guard bands of ±15 MHz have been introduced to protect 1030/1090 MHz and a 10 MHz guard band at 1154 MHz is applied to protect RNSS above 1164 MHz. To protect ground station receivers, additional frequency restrictions based on geographic exclusion zones are also implemented e.g.  ±25 MHz guard band at 1090 MHz within 500 m of an SSR ground receiver. [↑](#footnote-ref-9)
9. [www.efis.dk](http://www.efis.dk) (see applications of Georgia for military use) [↑](#footnote-ref-10)
10. COMMISSION IMPLEMENTING REGULATION (EU) No 1035/2011 of 17 October 2011 laying down common requirements for the provision of air navigation services [↑](#footnote-ref-11)
11. COMMISSION IMPLEMENTING REGULATION (EU) No 1034/2011 of 17 October 2011 on safety oversight in air traffic management and air navigation services [↑](#footnote-ref-12)
12. 1034/2011 and 1035/2011 have been repealed by COMMISSION IMPLEMENTING REGULATION (EU) 2016/1377, the main provisions of which become applicable on 1st January 2019. [↑](#footnote-ref-13)
13. [www.easa.europa.eu](http://www.easa.europa.eu) [↑](#footnote-ref-14)
14. Reference to be added (EC) No 592/2002 [↑](#footnote-ref-15)
15. TACAN operates in the UHF (1000 MHz) band with 126 two-way channels in the operational mode (X or Y) for 252 total;

    Air-to-ground DME frequencies are in the 1025 to 1150 MHz range;

    Ground-to-air frequencies are in the 962 to 1213 MHz range. [↑](#footnote-ref-16)
16. http://www.icao.int/publications/Pages/doc7300.aspx [↑](#footnote-ref-17)
17. Article 37 calls for the adoption of international Standards and Recommended Practices (SARPs) dealing with, inter alia, communications and navigation aids. SARPs normally address all interface parameters, including radio frequency (RF), performance, coding, etc., to ensure worldwide interoperability. These provisions form the major part of the international framework for aviation safety in regard to the radio systems carried by aircraft. It should be noted that ICAO SARPs are only adopted for systems which are standardized on a worldwide basis, and hence do not include such self-contained systems as radio altimeters and airborne weather radar, carried as a mandatory requirement by many aircraft, and which also meet the certificate of airworthiness requirements. [↑](#footnote-ref-18)
18. ICAO Annex 11 " Air Traffic Services "

    ICAO Annex 19 " Safety Management "

    ICAO DOC 9718  "Non safety of life services, willing to share a safety of life band have to comply with the aviation safety requirements applicable in that band including certification of radio equipment, software and radio operators, as well as assumption of liability".

    Commission regulation (EC) 1321/2014 : "on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks" [↑](#footnote-ref-19)
19. <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1519116652386&uri=CELEX:32017R0373>. Commission Implementing Regulation (EU) 2017/373 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight, repealing Regulation (EC) No 482/2008, Implementing Regulations (EU) No 1034/2011, (EU) No 1035/2011 and (EU) 2016/1377 and amending Regulation (EU) No 677/2011 (Text with EEA relevance. ) Applicability date: 2 January 2020. [↑](#footnote-ref-20)
20. 1034/2011 and 1035/2011 have been repealed by COMMISSION IMPLEMENTING REGULATION (EU) 2016/1377, which shall apply from 1st January 2019. [↑](#footnote-ref-21)
21. Interference statistics have been addressed within the CEPT where over a staggering 1700 cases of interference have been reported to aeronautical services within the CEPT nations; “CEPT ECC Working Group FM Report with subject “Summary of the Annual Interference Statistics Questionnaire for Reported Cases in 2016” dated 19 May 2017 [↑](#footnote-ref-22)
22. ICAO FSMP-WG/4 WP/24 Working Paper entitled “Agenda Item 9: Interference from non-aeronautical sources Importance of having ICAO position on PMSE sharing the 960-1164 MHz band” dated 30 March 2017. [↑](#footnote-ref-23)
23. ICAO FSMP-WG/4 WP/24 Working Paper entitled “Agenda Item 9: Interference from non-aeronautical sources Importance of having ICAO position on PMSE sharing the 960-1164 MHz band” dated 30 March 2017. [↑](#footnote-ref-24)
24. CEPT ECC Working Group FM Report with subject, “Final Minutes of the 88th WG FM Meeting” dated 24 May 2017 [↑](#footnote-ref-25)
25. Such restriction or controls would range from total loss of existing or potential Link 16 authorization to operate to affecting peacetime training by further limiting the levels of operation in a geographic area, disallowing required functionality, restricting location of operations and adding separation distances to other in-band users [↑](#footnote-ref-26)
26. ICAO FSMP Letter to ECC WG FM Chairman reference E3 5.15 with subject “Letter from CEPT ECC WG FM, entitled, “request for information on aeronautical, regulatory, legal and technical matters related to the possible sharing the frequency band 960-1164 MHz with wireless microphones” [↑](#footnote-ref-27)
27. Similar to what has been required for non-aircraft Mode S Squitter ADS-B transmissions [↑](#footnote-ref-28)
28. Considered by the International Telecommunications Union (ITU) as a band for Aeronautical Radio Navigation Service (ARNS), Aeronautical Mobile (Route) Service (AM(R)S and, around 1090 MHz for Aeronautical Mobile Satellite (Route) Service (AMS(R)S). [↑](#footnote-ref-29)
29. DME - Distance Measuring Equipment [↑](#footnote-ref-30)
30. TACAN - Tactical Air Navigation Aid [↑](#footnote-ref-31)
31. SSR - Secondary Surveillance Radar [↑](#footnote-ref-32)
32. PSR - Primary Surveillance Radar [↑](#footnote-ref-33)
33. ACAS - Airborne Collision Avoidance System [↑](#footnote-ref-34)
34. IFF – Identification Friend or Foe [↑](#footnote-ref-35)
35. JTIDS/MIDS - Joint Tactical Information Distribution System/Multifunctional Information Distribution System [↑](#footnote-ref-36)
36. <http://www.atag.org/component/downloads/downloads/346.html> [↑](#footnote-ref-37)
37. <http://www.eurocontrol.int/sites/default/files/publication/files/airport-economic-value-final-report.pdf> [↑](#footnote-ref-38)
38. Notice to airmen [↑](#footnote-ref-39)
39. <https://www.eurocontrol.int/sites/default/files/content/documents/sesar/business-case/european_airline_delay_cost_reference_values_2011.pdf> [↑](#footnote-ref-40)
40. UK Music: Wish You Were Here (2017) – The contribution of live music to the UK economy [↑](#footnote-ref-41)
41. ICAO Annex 19 “Safety Management” [↑](#footnote-ref-42)
42. ICAO Annex 11 “Air Traffic Services” [↑](#footnote-ref-43)
43. ICAO Doc 9735 “Universal Safety Oversight Audit Programme Continuous Monitoring Manual” [↑](#footnote-ref-44)
44. In ICAO Annex 19, the term “relevant authorities or agencies” is defined “in a generic sense to include all authorities with an aviation safety oversight responsibility, which may be established by the State as separate entities. This includes: Civil Aviation Authorities, Airport Authorities, Air Traffic Service Authorities, Accident Investigation Authority and Meteorological Authority”. [↑](#footnote-ref-45)
45. ICAO Doc 9734 “Safety Oversight Manual”. Doc 9734 has a similar regulatory status to SARPs, based on an MOU between ICAO and Member States. Ref: Universal Safety Oversight Programme (USOAP) [↑](#footnote-ref-46)
46. <https://www.icao.int/airnavigation/Pages/GANP-Resources.aspx> [↑](#footnote-ref-47)
47. **RR 5.343** ”In Region 2, the use of the band 1435-1535 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service.” [↑](#footnote-ref-49)
48. ICAO Doc 9718 “Handbook on Radio Frequency Spectrum Requirements for Civil Aviation” [↑](#footnote-ref-50)
49. ICAO Doc 9868 “Procedures for Air Navigation Service Training” [↑](#footnote-ref-51)
50. ICAO Doc 10057 “Manual on Air Traffic Safety Electronics Personnel Competency-based Training and Assessment” [↑](#footnote-ref-52)
51. ICAO Doc 9859 “Safety Management Manual”, Table 5-1 [↑](#footnote-ref-53)
52. From Annex 4 of CEPT Report 32 [↑](#footnote-ref-55)