

PMSE Consultation Response – ICAO comments

1. Introduction

On 4 October 2018, Padhraic Kelleher (ICAO Air Navigation Commissioner) and Andy Wells (UK CAA Policy Lead Spectrum and Surveillance) met with Steve Creamer (Director Air Navigation Bureau, ICAO), Richard Macfarlane (Deputy Director Air Navigation Bureau, ICAO), Yong Wang (Chief, Airport Operations and Infrastructure Section, ICAO), Loftur Johannsen (Technical Officer, Spectrum, ICAO) and Mie Utsunomiya (Technical Officer, Spectrum and Surveillance, ICAO), at ICAO Montreal to discuss spectrum sharing with Programme Making and Special Events wireless audio systems. Copies of the safety assurance case, that had been sent by the UK's telecommunications regulator to the CAA, were presented to ICAO and an invitation offered to review the documentation and provide comment.

An e-mail from the ICAO Technical Officer, Spectrum, was received on 18 October which thanked the CAA for the opportunity to review the document and provided a number of general and specific comments regarding the safety assurance case document.

The UK CAA's Chief Executive, Richard Moriarty wrote to Director of the Air Navigation Bureau on 21 December 2018 to thank him for the technical comments received from ICAO, which were considered by the CAA Board and to apprise him of developments.

This document provides a response to the comments provided.

2. Comment Response Document Relating to ICAO Comments on Ofcom Safety Assurance Case

Comment received on Ofcom safety assurance case from ICAO	CAA response
<p>1. No evidence is provided that only “professionals” will use PMSE equipment in this frequency band. As evident from Ofcom’s website (referenced above) 700 MHz PMSE equipment is currently owned and operated by professional sound stage engineers managing large venues as well as by amateur performers, conferencing personnel and other lower skillset users.</p> <p>No certification of competency is required. The professional users will possess sufficient knowledge of their equipment and the associated frequency management rules and regulations to operate in accordance with the use cases contained in the study. However since there is no certification requirement for the competency of users, the expectation cannot be validated that all users will possess the required knowledge and skillset to operate inside of the licensing rules.</p> <p>It has been confirmed verbally by a number of spectrum regulators that a large portion of PMSE users operate today without a license. See also Cambridge Consultants Report (page 27), [which noted “it would be very helpful to [film] production mixers to have a smartphone app which allowed very rapid licensing with PMSE, to avoid the need to ‘go illegal’ in order not to hold up the film shooting schedule.” Use/failure case analysis taking this fact into account is missing from the safety assurance study.</p>	<p>While this term, by itself, carries no meaning, the headline assumption is backed up by two extensive appendices contained within the safety assurance case. The term professional users are used to identify the group of users that the band will accommodate. Appendix 1 explores existing use within the UK and identifies in further details the events that are expected to utilize equipment in the band. Appendix 2 explains the operational practices currently being executed by those users. We consider that in order to establish the detail behind the term ‘professional users’, the explanation within both Appendices must be considered. In addition, as with all assumptions made in the Ofcom document, this will be under regular review by the CAA and Ofcom to ensure the user base is retained within the parameters set.</p> <p>There are two aspects that restricts use of the 960-1164 MHz band. The first is that there remains wide availability of equipment that currently operates in the 470-790 MHz. Although the 694-790 MHz band will no longer be licenced for use after 1 May 2020 in the UK, the vast majority of requirements for amateur performers, conferencing personnel and other lower skillset users can continue to be accommodated in this band and may not require any new equipment. In particular, the UK Wireless Microphone Licence is a popular licence for these types of activity which allows UK-wide shared access to Channel 38 (606.500 to 613.500 MHz) or in the VHF range 175.250 to 209.800 on a non-protected basis for 1-2 years. The second aspect is the application of the licensing regime and application process. The safety assurance case notes that the frequencies available to a user when applying for a licence will be subject to location, equipment, duration and other frequency assignments.</p> <p>The CAA has considered a requirement for completion of a radio certificate of competence but does not consider this to be a suitable vehicle to achieve the aims behind achieving an understanding by the licence holder of PMSE equipment of the Radio Frequency (RF) environment in which it is proposed to operate. However the CAA will review those PMSE licence holders who elect to operate in the 960-1164 MHz band and ensure that they have appropriate briefing and education material that achieve this objective.</p> <p>It is the CAA’s understanding that PMSE operations and licensing regimes across the</p>

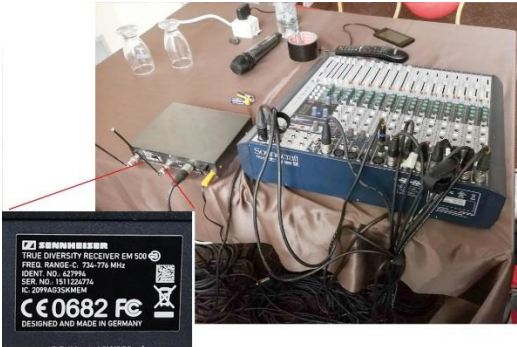
	<p>region/world can vary significantly. Therefore not all users across states or different bands within states can be considered the same. The safety assessment is based on the specific UK PMSE operations along with the knowledge of the current manager of the licensing regime, Ofcom.</p> <p>In respect of the Cambridge Consultants report, the safety assurance case does identify a rapid licensing system accessible 'in the field' in addition to the provision of a mobile phone number for emergency out-of-hours frequency co-ordination.</p>
<p>2. The 960-1164 MHz band is being explored for PMSE use due to the 700 MHz band no longer being available for PMSE use after 2020. As per description on Ofcom's website (see "What are the legitimate uses of PMSE frequencies?"), PMSE is not only for large radio and television broadcast events, but also for other public or private events, at any location, e.g. sporting, music, theatrical, religious, political, hobby and corporate retailing. No specific ownership certification or licensing is proposed for equipment operating in the 960-1164 MHz band. Also, the web-based licensing tool appears not to be intended to steer use towards the 470 MHz band first, see also discussion on core assumption below. Hence a much larger use of the 960-1164 MHz band may be expected than the one postulated.</p>	<p>As previously discussed, there are a number of bands and options available to PMSE users, a user based that spans a broad range of users. Removal of access to the 700MHz band is a small portion of the total spectrum access offered to PMSE users. In addition to spectrum that can be licenced on an annual basis in the frequency ranges 606.500-613.500MHz (Channel 38), 175.25-209.8MHz and access to the 'PMSE guard band' 694-703MHz, the frequency ranges 173.7 – 175.1 MHz, 863.1 – 864.9 MHz and 2400 - 2483.5 MHz are licence exempt frequencies where wireless microphones can be used without a licence subject to certain conditions specified in Interface Requirements..</p> <p>As discussed in appendix 1 and 2 of the safety assurance case, the bulk of these users are not expected to operate in the 960 MHz band and there are multiple barriers that will push the majority of users to other available bands. The CAA has accepted the review of the potential users expected in band as outlined by Ofcom, the policy owners, executors of the current licensing regime and enforcement agency. Ofcom are the best placed organization to make such an assessment given this.</p>
<p>3. There is no PMSE equipment ownership licensing or enforcement mechanism being proposed that would steer the loading of the frequency bands. It is reasonable to assume that a significant portion (all?) of the existing 700 MHz band equipment would be replaced by 960-1164 MHz equipment. Users would utilize the tuning range of the equipment they have available before seeking additional equipment. In other words, the distribution between the two frequency bands would eventually become evenly distributed, governed only by the equipment base available. Hence a much larger use of the 960-1164 MHz band may be expected than the one postulated.</p>	<p>As the current tuning range of equipment operating in the 470-694 MHz band and, in particular, UK-wide shared access to Channel 38 (606.500 to 613.500 MHz) will retain significant capacity in the existing band (i.e. the ability to continue to use the remaining channels available) the expectation is that a number of users will not choose to upgrade equipment. UK users that have equipment that only operates in the 700 MHz being vacated will be eligible to participate in a UK Government grant scheme; the value of the grant related to the estimated replacement cost of their equipment. As the current equipment available on the market is at the premium end of the range of equipment and indications are that international adoption of this band for PMSE unlikely, the market for such equipment is likely to remain small. Therefore, we do not agree with the comment that a significant portion or all of the existing 700 MHz band equipment would be replaced by 960-1164 MHz equipment.</p>

	The safety assurance case identifies multiple barriers that will restrict those wishing to access the band, including the use of a licensing regime.
4. As already discussed extensively in the ongoing CEPT studies on PMSE in the DME band, JTIDS is not comparable with PMSE. JTIDS is pulsed while PMSE is continuous wave. A very strong JTIDS signal may not interfere with DME, while the duty cycle of the interfering pulsed signal is low, while a multiple orders of magnitude weaker continuous wave signal may interfere with or even block operation of a pulsed system.	The safety assurance of JTIDS is not used as a 'basis' for the safety assurance case. Ofcom have argued, as part of the safety assurance case that a number of the assumptions made in the JTIDS safety assurance can be used as part of the PMSE safety assurance case. Typically these assumptions are only in relation to the incumbent system in the band and associated availability. The interference techniques of PMSE are discussed in the Ofcom consultation and associated testing reports.
5. PMSE is also used at smaller events, such as by amateur performers or other (non-professional) hobby users and may not be licensed and so this is an incomplete picture.	See response under comment 2.
6. Reference is made to ongoing trials and the fact that there have been no reported instances of interference into aeronautical systems. The UK trials by PMSE users have focused on evaluating potential interference into PMSE, while not necessarily providing the reverse capability of detecting/assessing interference into the potentially affected aeronautical systems. The aeronautical systems in question have very limited tools for monitoring such interference. Hence the statement made is not valid. Ofcom has reported the successful conclusion of one trial where PMSE equipment was used to generate potential interference into a terminal-DME. However, some questions were raised in CEPT WGFM PT51 about the detailed outcome of this trial, including a CW-alarm which was raised by the DME equipment.	<p>The statement is in relation to licences that have been issued under the Innovation and Trial Licensing regime in the UK. Operation of the equipment is considered within the bounds established as part of the spectrum management rules and the 'success case'. This was established for aeronautical systems following testing that was conducted as part of the Ofcom consultation process.</p> <p>The Ofcom testing reported at WGFM PT51 is not considered as part of the safety assurance case and we understand the test power levels used when the DME equipment system provided a warning of the transmission fell a long way outside typical PMSE wireless audio equipment use.</p> <p>Consideration of the 'failure case' e.g operation of equipment outside of these rules does not make any assumptions about the behaviour of equipment and therefore assumes there will be an impact on aeronautical equipment.</p>
7. The safety assurance case states that "Timescale for implementation of L-DACS is uncertain..." We consider this to be statement bias. The task is on-track, operational implementation is projected by 2026.	Noted. The statement does go on to state "and is projected to be after 2025" which seems in keeping with the timescale indicated; also we believe that some latitude on the interpretation of the word "implementation" is possibly required depending on your particular point of view.
8. No effective real-time enforcement of licensing regime in the 960-1164 MHz band. Licensing of PMSE frequency assignments is based on voluntary use of a web-based tool, by a PMSE professional. This tool is intended to provide in real time a use-license of a specific frequency, based on time/location information entered, thus allowing the PMSE user to obtain a license quickly. In reality, many PMSE users are not frequency spectrum	The assumptions of the users expected in the band and the specific operational practices executed by these specific users are discussed within the safety assurance case. As discussed in comments 1 and 2, there are a wide range of PMSE users and a wide range of equipment available to meet this demand. We agree that not all PMSE users will be frequency spectrum professionals, however the safety assurance case argues that in order to access the band and

<p>professionals and may not even be aware of rules, let alone the web-based frequency-assignment licensing application. It is unclear which equipment restrictions are being referred to and their overall effectiveness, as the method of implementation of exclusion bands, if any, is voluntary by the equipment manufacturer (ref paras A3.25 and A3.26).</p> <p>First hand equipment can be purchased without a specific license from regulator.</p> <p>Second hand equipment also bought/sold (see availability of Sennheiser/Shure equipment on eBay). User base is larger than report infers.</p>	<p>operate, a user will satisfy a certain level of awareness. The expectation of users is also based on the experiences of other licensed products such as business radio, VHF aeronautical radios and navigation equipment. This scenario is a consideration in the safety assurance case.</p> <p>Second-hand equipment being sold operates in a variety of bands, which includes licence exempt bands such as 863.100-864.900 MHz. Therefore, the availability of second hand equipment does not necessarily represent that of a piece of equipment that can only be used in a licensed band.</p>
<p>9. Paras 4.19 – 4.27</p> <ul style="list-style-type: none"> - This section describes only the "large event" use case. No attempt is made in the study to describe or analyse the "small event" or "hobby" use cases. - An assumption of an orderly loading scenario is made, filling the 470-703 MHz band to capacity before employing any assignments in the 960-1164 MHz band. However there are no tools proposed to provide for this orderly loading scenario. - 700 MHz equipment is owned/used today by a variety of users, including small/medium sized conferencing and hobby users such as amateur musicians. - Need also to consider the low-profile and ad-hoc operations by people who are not professionals and may not know frequency management rules. - The analysis only focusses on the so-called "reputable" users, although it is a given that the ownership base of PMSE equipment operating in the band will be larger. 	<p>See response to comment 1 and 2.</p> <p>The safety assurance case analyses the existing barriers to access, including:</p> <ul style="list-style-type: none"> - Limited number of systems available; - Premium cost of equipment capable of operating in the band; - Additional infrastructure required, such as antennas and radio frequency distribution systems
<p>10. Paras 4.31 – 4.46: Assignment process for PMSE use of the 960-1164 MHz band.</p> <ul style="list-style-type: none"> - This section describes only the "large event" use case. - The less professional ones not aware of rules. - It is known fact that portion of existing PMSE use is unauthorized. For instance Cambridge Consultants Report (page 27), [which noted "it would be very helpful to [film] production mixers to have a smartphone app which allowed very rapid licensing with PMSE, to avoid the need to 'go illegal' in order not to hold up the film shooting schedule." - Ofcom will perform periodic monitoring of the "large events" only, while not being able to monitor smaller unlicensed, and therefore unknown, events. 	<p>See response to comment 1.</p>
<p>11. Para 4.47 Intended mitigations:</p> <ul style="list-style-type: none"> - DME in table refers to geographical restrictions. This is license tool based only (voluntary), not automatic. Certification of user 	<p>See response to comment 1.</p> <p>A trial is underway that is testing the transmission of weather data from the ground to air, using 978</p>

<p>(including training/knowledge of frequency rules) is not required. - UAT in table is said to be not used in UK, yet there are on-going trials in UK</p>	<p>MHz. As this is limited in geographical coverage, subject to alteration and is licensed under a UK trial and innovation licence, we do not consider this to be on an operational basis. Any future operational use would be considered as part of the review mechanisms identified.</p>
<p>12. Para 5.2: JTIDS is pulsed, PMSE is continuous wave.</p>	<p>This reference applies to the safety requirement of DME, which is not a dependency of the interference source. The CAA believes that the hazard identification to an aircraft if a DME system is impacted is therefore the same.</p>
<p>13. Paras 5.10 – 5.18: VOR/DME Para 5.13 discusses false lock as identified in the JCSys test report. Very limited scenarios were tested in the JCSys study. Hence the problem could be more serious than indicated. Also, need to look at actual signal levels, for example a CAT II/III landing scenario with terminal DME transponder used to determine "outer marker" distance and being interfered with by PMSE directly underneath path of aircraft.</p>	<p>Minimum signal levels were tested as part of the testing regime, and are considered in the Spectrum Management Rules regardless of where the aircraft is operating within the DOC. The safety assurance case highlights that the effect was only experienced when an aircraft was operating outside of the DOC (i.e. the aircraft has a lower signal level than permitted) and therefore that this was not experienced as part of the extensive testing that was undertaken outside of this scenario.</p>
<p>14. Para 5.14 concludes that undetected corruption in the DME distance measurement is not credible. As per the above, there is not sufficient evidence to support this claim.</p>	<p>As discussed above, undetected corruption was not experienced during testing when the DME equipment was operating within the DOC.</p>
<p>15. Paras 5.16 and 5.17 make the claim that the increasing use of GNSS reduces the impact of interference to DME. This claim is not accurate. At most airports, GNSS for CAT I is not implemented. GNSS is currently not an option for CAT II/III and auto-land procedures. Hence most of this para is misleading. It is unclear to which extent the actual use/failure case of PMSE vs. CAT I/II/III and auto-land was studied.</p>	<p>Use of GNSS is not considered as part of the assurance to enable a worst-case assumption and this is made clear in the documentation. Many of the references to GNSS are to provide additional information.</p>
<p>16. Para 5.18 makes a reference to a conclusion of the risk assessment, contained in Annexes A4 and A5. Annexes A4 and A5 have a problem with core assumptions.</p>	<p>We concur with the risk assessment conclusion, based on the analysis provided. The specific assumptions that underpin the assessment are addressed under comments 17-22.</p> <p>Para 5.27 of the safety assurance case itself notes that analysis is predicated on [a number of] assumptions, which if not met, would invalidate this safety assurance case.</p>
<p>17. Para 5.27, Assumption 1: PMSE users who will be licensed to use 960-1164 MHz band PMSE equipment are expert users, belonging to highly professional and reputable organizations (see also "Critical assumption 1, component 1").</p> <p>As per description on Ofcom's website, PMSE is not only for large radio and television broadcast events, but also for other public or private events, at any location, e.g. sporting, music, theatrical, religious, political, hobby and</p>	<p>See comment 1.</p>

<p>corporate retailing. No certification of competency is required. A tool is provided to manage licensing to use certain frequencies based on time and location. Users can be anyone who owns such equipment, similar to those that own and operate 700 MHz PMSE equipment today.</p>	
<p>18. Para 5.27, Assumption 3: The peak number of PMSE frequency assignments authorized in the 960-1164 MHz band is in the order of 945 per day (see also “Critical assumption 2”). There is no ownership licensing or enforcement mechanism being proposed that would steer the loading of the frequency bands. It is reasonable to assume that a significant portion (all?) of the existing 700 MHz band equipment would be replaced by 960-1164 MHz equipment. Users would utilize the tuning range of the equipment they have available before seeking additional equipment. In other words, the distribution between the two frequency bands would be governed only by the equipment base available. Hence a much larger use of the 960-1164 MHz band may be expected than the one postulated in this core assumption.</p>	<p>See response to comment 3.</p>
<p>19. Para 5.27, Assumption 4: Reputational damage due to event failures... Assumes the use case is for large events only (see also “Critical assumption 1, component 2”). Reputational damage already today: Every regulator we speak to confirms verbally that a very high percentage of PMSE users operate outside of license.</p>	<p>Our understanding is that PMSE operations and licensing regimes across the region/world can vary significantly. Therefore, not all users across states or different bands within states can be considered the same and comparisons are not valid. The safety assessment is based on the specific UK PMSE operations along with the knowledge of the current manager of the licensing regime, Ofcom.</p>
<p>20. Para 5.27, Assumption 5: Price premium on equipment in the 960-1164 MHz band, compared to currently available equipment. Not convincing. This paragraph is implying that the only method regulating use of the band is the cost of the equipment. Conversely it could be stated that new equipment/technology would be attractive to the technophile "non-professional" users. Also, as evident by eBay and other second-hand market sites, there is a sizable market for second-hand equipment, where the users cannot be expected to be knowledgeable about frequency use regulation.</p>	<p>We consider it a reasonable assumption on the basis that the UK only implements this mitigation to the reduction in the PMSE wireless audio channels availability, that the overall market for the equipment will be relatively small. For those users wishing to purchase equipment, there will be price premium. Based on evidence provided concerning market reports etc., the indication appears that only the largest events will require the frequencies due to spectrum capacity issues. The assumption appears to have been interpreted as being the only method regulating use of the band and the safety assurance case does not claim this. A ‘technophile’ would, by its very name, indicate an increased level of technical knowledge about the band, however the alternative frequency is unlikely to affect the audio quality significantly, which is dictated by the components and manufacturing skill and probably of more interest to a PMSE technophile.</p>

<p>21. Para 5.27, Assumption 6: Discusses a large/professional PMSE user scenario, including security to prevent unauthorized use. Makes the claim that resale value diminishes quickly, that professional users are reluctant to buy second hand equipment and that there is no established market for second hand equipment.</p> <p>- This assumption only looks at the large event use case and ignores all other use cases. 700 MHz PMSE equipment is available in abundance on eBay and similar market sites. Typical buyers/users will then not be professionals with knowledge of frequency use rules.</p>	<p>The mechanisms of the market are discussed in the relevant appendices to the safety assurance case. Evidence is demonstrated arguing that the user expected in the band would obtain the appropriate knowledge. This is further discussed under response to comment 3.</p>
<p>22. The assumption implies that the method effectively regulating use of the band is the cost of the equipment. Conversely it could be stated that new equipment/technology would be attractive to the technophile "non-professional" users. Also, as evident by eBay and other second-hand market sites, there is a sizable market for second-hand equipment.</p>	<p>See response to comment 20.</p>
<p>23. The below pictures were taken in a meeting room during the meeting of CEPT ECC WGSE Project Team 7 (SE7), 19 – 21 September 2018. SE7 is the CEPT group tasked with the PMSE technical compatibility studies in the 960 – 1164 MHz band.</p> <p>The pictures show a mixing console used for the conferencing microphones and a wireless microphone + receiver operating in the 700 MHz PMSE band.</p>  <p>Due to a previous CEPT ECC decision, the 700 MHz PMSE band will not be available for PMSE after 2020. The 960-1164 MHz band is being proposed as a replacement frequency band for the 700 MHz band.</p> <p>As can be seen from the above pictures, the use case for PMSE equipment in the 700 MHz band is not limited to Professional large scale events such as the production of Television or Radio Programmes. This equipment is also commonly used for "Public or Private events, at any location, eg Sporting, Music, Theatrical, Religious, Political, Hobby, Corporate</p>	<p>It is noted that this CEPT ECC WGSE Project Team 7 meeting was held in Romania, at the invitation of ANCOM, the National Authority for Management and Regulation in Communications of Romania.</p> <p>Users of the band are discussed under comments 1 and 2. If transferred to a UK scenario, the PMSE operator may be eligible for a UK Government grant, which would contribute towards other similar-priced equipment that operates in the 470-790 MHz. The price premium for equipment that could operate in the 960-1164 MHz band in the UK is around 10 times that of equipment that operates in the 470-790 MHz. This price barrier is discussed as part of the safety assurance case. In addition, it is noted that the equipment is listed with a map indicating states in Europe where a licence is required for use.</p>

Retailing” (the quoted text was copied from the [website](#) of UK OfCom).

As there is no requirement for PMSE user certification, and as the equipment can be purchased without restrictions, it can reasonably be assumed that some PMSE equipment owners/users may not possess the necessary knowledge or skills to ensure there is no interference to other users sharing the frequency band. Some of these PMSE equipment owners/users may not be aware of PMSE frequency licensing requirements or have knowledge of frequency management regulations or requirements in general.

It is noted that there is a second hand market for 700 MHz PMSE equipment, such as can be found on eBay.

Civil Aviation Authority, UK
31 January 2019