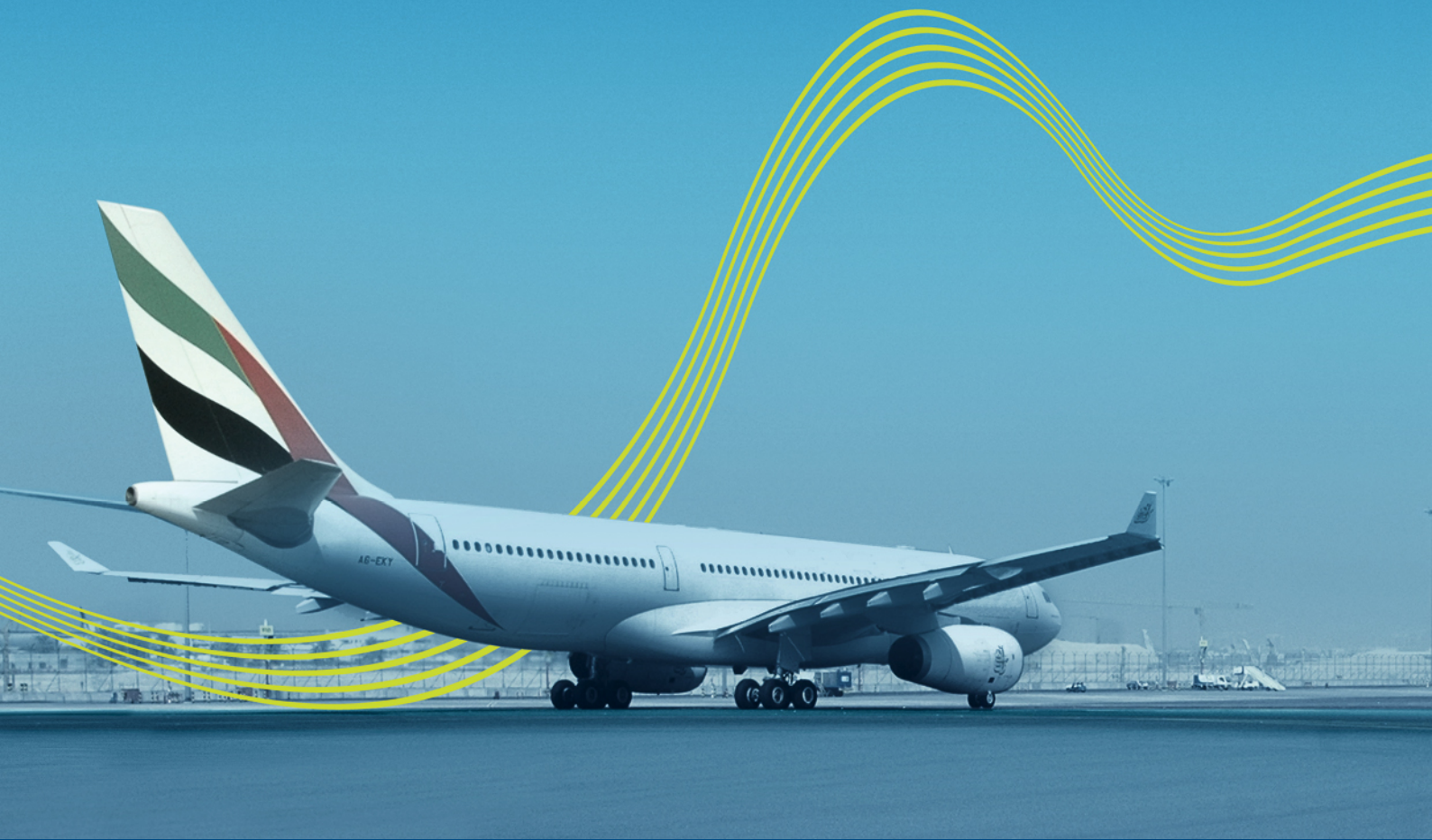
A response to Ofcom's consultation: New Spectrum for Audio PMSE

Version 1.0
18th December 2015

Prepared by Stephen Parry



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1 Introduction

NATS welcomes the opportunity to respond to Ofcom's consultation "New Spectrum for Audio PMSE" and we would be happy to follow up on our comments with Ofcom.

NATS owns and operates the majority of the UK en-route DME transponders and a network of en-route Secondary Surveillance Radar systems across the UK, including some located at the London airports. NATS is also involved in the operation of terminal DME transponders and SSR systems at a number of the major UK airports; in addition we are involved in the operation of a number of local and wide area multilateration systems operating on 1030 and 1090 MHz using the extended Mode S / ADS-B protocols.

While the operation of airborne equipment is largely a matter for aircraft operators, given our experience of the interactions between the ground and airborne elements of the systems we have included comments where appropriate about airborne equipment. NATS is however unable to comment on the suitability of the proposed guard bands around 1030 and 1090 MHz to fully protect the operation of Airborne Collision Avoidance System / Traffic Collision Avoidance System (ACAS/TCAS), noting also that these types of systems were not specifically tested.

In NATS' opinion Ofcom has not made available sufficient information to allow respondents to confirm or otherwise its conclusions. We have also identified technical issues with aspects of the JCSys work and we do not believe that it has taken account of the real world DME environment to appropriately assess the potential for interference into safety of life applications, nor tested a sufficiently representative set of aviation equipment. NATS is concerned that Ofcom risks creating an unsafe operational environment for DME in particular that would result in the withdrawal from operation service of the DME transponders concerned and may also be underestimating the levels of interference that would be received by PMSE equipment. NATS also believes that Ofcom may not have considered (or yet be aware of) the full implications of potential changes to aviation systems, including DME, in this band.

The main body of the consultation document quotes the 1030/1090 MHz results from JCSys (that cannot at this time be positively confirmed as fully protecting the surveillance uses) however the parameters used in Ofcom's coexistence modelling deriving the spectrum that Ofcom believes to be available for low power audio PMSE have not been stated. As Ofcom has not provided the details of its coexistence modelling, as NATS has informally requested on at least two occasions, respondents are not in a position to assess or agree to the numbers quoted for the apparent amounts of spectrum that Ofcom asserts to be available at the four sites considered.

For these reasons, in order to safeguard DME and 1030/1090 MHz operations NATS has to object at this time to Ofcom's proposal to allow low power PMSE into this band as we are unable to confirm Ofcom's conclusions and have concerns about the testing carried out so far. This position may be able to be reviewed once Ofcom has provided sufficient information, in line with HMG "Better Regulation" principles, as to how it has reached its stated conclusions.

There are also a number of statements in the consultation document that, along with informal discussions with Ofcom appear to indicate that Ofcom may be considering restriction of future aviation access to 960 – 1164 MHz. In general, spectrum access for aviation is achieved through global allocations in the Radio

Regulations and due to the development cycles for aviation systems, these allocations may be agreed some years ahead of systems being implemented. Recent WRC processes have also effectively restricted aviation to seeking new terrestrial allocations in bands where there were already existing aviation allocations and 960 – 1164 MHz was identified as the only band in which long range datalinks could be accommodated. The band has been allocated globally in the ITU (with UK support) for harmonised aviation purposes that may, in addition, be the subject of European mandates on States and Air Navigation Service Providers. Any potential UK policy decision that risks leading to any restriction on 960 – 1164 MHz use for international civil aviation is therefore of serious concern to NATS and, we believe, needs to be considered separately irrespective of whether the results of technical studies appear favourable to Ofcom's plans.

It is NATS' view that national or (sub) regional spectrum sharing should not seek to circumvent decisions on spectrum use taken at World Radiocommunication Conferences. Aviation developments rely on international interoperability, such that a single aircraft is able to fly to or across any country in the world and operate safely and expeditiously without having to carry multiple radio systems to deal with local variations in radio spectrum use. If non-aviation sharers are introduced and were to be given or promised an elevated status over aviation systems developed to operate within the aviation allocations then this would be of significant concern to NATS and the wider aviation community and may lead to operational business or safety related issues. If access to these allocations for globally standardised aviation systems was to be restricted or even denied then this could prevent the UK from meeting its international obligations, such as those under the Convention on International Civil Aviation (the Chicago Convention) or under Single European Skies legislation. This would also risk placing the UK at an economic disadvantage as airlines may choose to route flights away from the UK or reduce flights stopping in the UK, thus reducing choice for the travelling public and commerce.

NATS also commented in more general terms about concerns that we also have with Ofcom's current proposal in our response to the Ofcom consultation "A framework for spectrum sharing", July 2015.

2 Ofcom question 1

Do you agree with our assessment that minimal growth in demand and stability in spectrum supply means that we do not need to implement any changes to meet the ongoing spectrum requirements for talkback, audio links and telemetry and tele-command applications?

NATS has no view on this question.

3 Ofcom question 2

"Do you agree with our sharing analysis which concludes that audio PMSE (low power microphones and IEMs) could co-exist with incumbent services in the bands 960-1164 MHz and 1525-1559 MHz? If not please provide specific details/evidence to illustrate your view."

3.1 General

NATS will not address the question in relation to the 1525–1559 MHz band as our major concerns are in the 960-1164 MHz band.

NATS does not agree with the 960-1164 MHz band sharing analysis presented by Ofcom.

At a general level, lab tests have been carried out on relatively small sample sizes of specific examples of equipment with the results then assumed to be valid for all equipment. NATS recognises that Ofcom is proposing a wider guard band around 1030 and 1090 MHz than was directly indicated by the JCSys study results however we question whether it is appropriate to measure the performance of a combination of what is understood to be a ground ADS-B receiver and a general aviation Mode S transponder / ADS-B transmitter and to then extrapolate the performance as being representative of a full Mode S interrogator and every aircraft SSR transponder, aircraft ADS-B receiver or ACAS/TCAS system that may fly into UK airspace.

Test parameters have been used that appear to favour a more positive outcome for PMSE and that potentially take advantage of specific performance of the equipment tested. The tests also appear to take benefit for PMSE from operating margins above standardised minimum operational performance that are necessary to enable the aviation systems to maintain operations above those performance minima. The interference environment modelled does not, in our opinion, represent the real world situation for DME transponders in particular as our understanding of the JCSys test environment is that it uses clean, non-overlapping pulses. It is noted that parameter values have been used that are based on those used for JTIDS testing: NATS' view is that as PMSE will appear to DME as a constant interference source, unlike JTIDS, then the applicability of these values for sharing with PMSE must be reassessed as currently we believe them to be unrepresentative of this sharing scenario.

NATS is concerned that "worst case" parameters appear to have not been considered. Whilst use of best / average case may be acceptable to Ofcom including for assessing the impact of aviation systems into PMSE – although in NATS' view this risks interference being experienced by the PMSE equipment at levels above those predicted – in NATS' view it is necessary to also consider "worst case" in addition to real world scenarios and parameters when assessing sharing feasibility with safety of life applications, in particular where the interfering signals are of a continuous nature and would be present for a significant length of time as would be the case here.

3.2 1030 / 1090 MHz:

In principle, while NATS recognises the approach of having guard bands around the two frequencies and not seeking to geographically interleave PMSE, NATS

cannot at this time comment on whether the proposed +/- 10 MHz guard band would be adequate to protect 1090 MHz reception in local or wide area multilateration systems of the types used in the NATS environment as it has not yet been possible to obtain feedback from the equipment manufacturers. We have evaluated the proposal against the performance of the type of ground based Mode S interrogator used in the UK civil en-route environment and concluded that a +/- 10 MHz guard band around 1090 MHz will most likely be satisfactory to protect its receiver, although this is based only on a paper study and not any specific tests of the equipment.

NATS is not able to comment on whether the proposed guard bands are adequate to protect aircraft reception of 1030 MHz or 1090 MHz for SSR, ADS-B or for ACAS/TCAS.

3.3 Distance Measuring Equipment:

We have significant concerns with the report by JCSys as we believe that it is likely to lead to the derivation of potentially inadequate protection of DME services in the UK as we believe that the full extent of the potential for PMSE to degrade the operation of DME has not been addressed satisfactorily in the study.

There are inappropriate assumptions made within both the study and in Ofcom descriptions of DME parameters in the main body of its consultation document. Minimum operational performance levels of parameters (such as beacon reply efficiency, BRE and threshold sensitivity) are taken from standards and appear to be applied as if they are the target operating points of the equipment. This is a misinterpretation of what they signify and their use out of context for non-aviation sharing studies appears at best to be a misunderstanding of their purpose.

For interrogator testing, an assumption that the transponder is only working at the 70% minimum may be valid as it represents the lowest level of return rate that should be expected. It is however then necessary to take into account real world reductions in performance at the interrogator receiver, such as the effects of the L band suppression bus, see later and we believe the absence of this is a shortcoming in the study.

Considering the transponder however, the 70% BRE is the minimum performance level below which the systems alarm and may then require to be withdrawn from operational service. ANSPs therefore seek to operate their systems such that the BRE is as high as possible. Ofcom's interpretation of this 70% figure as some sort of fixed operating point for the DME transponders in isolation without consideration of other real world effects on DME performance means that the introduction of PMSE seriously risks harmful interference to DME transponders and is not acceptable to NATS.

3.3.1 Real world effects on the DME service have not been taken into account:

It is assumed in the report that the existing DME services are near perfect and that the DME service will work satisfactorily in all airspace provided that the minimum Annex 10 requirements are met. Unfortunately, although overall the DME Service in the UK is good, it is not perfect. With reference to the 46 en-route DME transponders in the UK, 13 have promulgations in the UK Aeronautical Information Publication showing where they have shortcomings in meeting the

coverage. Other areas of the DME service volumes have marginal operation. In both cases these limitations are due to reduced signal levels because of terrain and obstructions or due to multipath situations or other environmental effects. Service providers such as NATS have made best endeavours to improve and optimise the operational service as much as practically possible. One action taken by NATS was the provision of high sensitivity receivers in the current generation[1] of en-route ground transponders, which exceed the Annex 10 sensitivity requirements in order to help compensate for siting limitations, environmental issues etc. such that the minimum performance requirements can be met under all circumstances to the greatest extent possible.

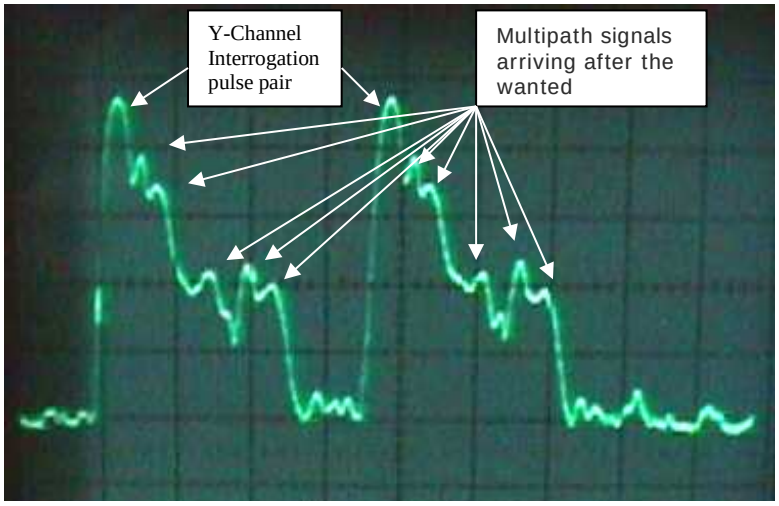

Figure 1 - Multipath

3.3.2 Real world active in-band interference sources from other DME (e.g. DME multi-path) and civil aeronautical systems have not been considered in the test scenarios:

The inherent existing self-interference within the DME service is not considered in the report. In practice there are multiple intra-system sources of interference that all contribute to the overall interference environment and, for the most part, these appear to have not been taken into account in the laboratory tests. An example of this for transponders is where interrogations from multiple aircraft arrive with overlapping pulse pairs and only using "clean" pulse pairs to represent the wanted signals, as has been done in the testing here based upon our understanding of the JCSys test environment, does not fully represent the real world operational DME environment into which the PMSE signals are being considered for introduction.

At airports where both SSR interrogators and DME transponders are located, due to the high output power of the SSR pulses and the high sensitivity of the DME Receiver, SSR break-through can occur. This can potentially cause the transponder to not decode certain interrogations such that the corresponding reply is not made.

1 Installed between 1993 and 1999

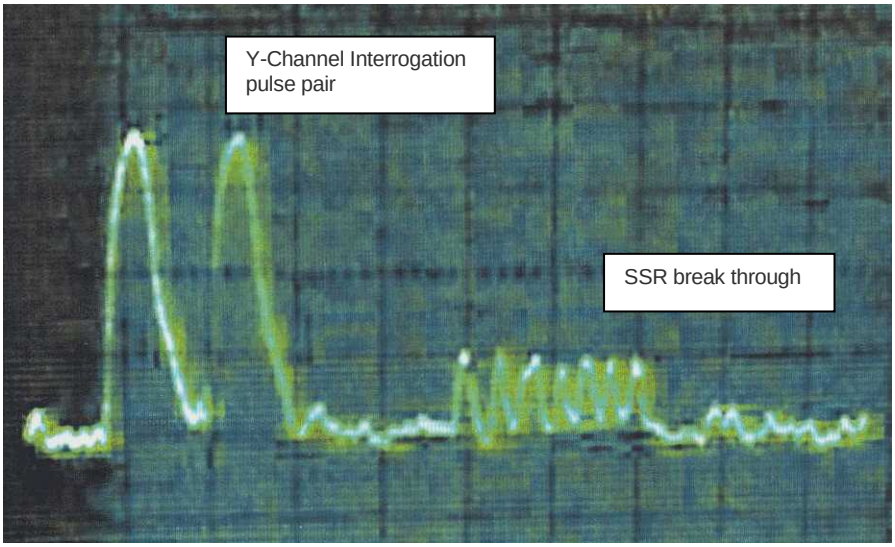

Figure 2 - SSR break through as recorded at a DME transponder Receiver

Interference into DME airborne interrogators includes squitter and Ident. Transmissions from transponders on adjacent channels may also be received. Where multiple DME interrogators and SSR transponders are installed on an aircraft, mutual interference occurs and consequently a reduction in effective sensitivity can result due to the actions of the aircraft "L band suppression bus" that *inter alia* suppresses the DME receiver when the SSR transponder is about to transmit in order to avoid interference or potential damage from strong signal levels into the DME receiver.

3.3.3 DME interrogator testing with transponder simulator with Ident off during acquisition is not representative of real world DME operation:

During testing, interrogator acquisition time appears to have been measured with identification signal switched off in the transponder simulator. This has probably been done to provide a test method that could provide repeatable results. The ident is a Morse code signal consisting of pulse pairs broadcast at a specific rate for a period around every 30 to 40 seconds and for which the replies to aircraft interrogations are suppressed during a "keydown" time that may not exceed 5 seconds. During this identification period the transponder provides very few or no replies to aircraft interrogations. The number of replies to interrogations can drop by 60-70% so effectively this reduces the overall "process" reply efficiency as seen by the aircraft as pulse pairs sent by the aircraft cannot be matched to replies from the transponder. The impact of the identification signal transmission during search and acquisition has therefore not been measured in testing, thus providing results that can be seen as more favourable to PMSE.

Where DME signal reception is poor within the desired coverage area due to multipath interference or other effects, this reduction of replies due to identification transmission causes a low percentage of replies to interrogations and the service to the interrogator becomes vulnerable to break lock or delay in acquisition.

3.3.4 DME with threshold sensitivities below those of the test samples are not considered:

NATS applies a minimum threshold sensitivity requirement of -91dBm, in accordance with the Minimum Performance Specification for Distance Measuring Equipment (Ground Equipment), EUROCAE ED-57. We note the JCSys testing used a lower threshold value of -88dBm.

The sample interrogators and transponders used in the testing exhibit typical rather than minimum threshold sensitivity. Considering the Fernau 2020 and Thales 415 transponders tested, both have actual threshold sensitivities that are 2 to 4 dB more sensitive than the NATS minimum requirement of –91dBm.

The effect of the PMSE signals appears to be that they desensitise the DME receiver. Therefore it may appear that a higher PMSE signal level can be broadcast into a transponder that is more sensitive than the minimum requirement than could be broadcast into a transponder that operates at or close to the minimum threshold sensitivity. However, sensitivities better than the standardised minimum requirements cannot be guaranteed in the real world, as there will be equipment production variations such that other equipment examples of the same type may perform better or worse. Also other DME facilities may be used currently in the UK or introduced in the future that legitimately operates at the standardised minimum sensitivity levels. Therefore any actual sensitivity greater than the minimum should not be considered as a margin in any link budget used to assess sharing feasibility, as the additional performance is there to ensure that the effective sensitivity of the transponder can remain above the specified minimum under all circumstances. Furthermore, if a transponder is operating by design at or near the standardised minimum sensitivity level then it would appear that PMSE operating at a power level derived from measurements (as here) on more sensitive transponders would cause the minimum sensitivity threshold to be breached.

3.3.5 DME sensitivity reduction due to temperature variation is not considered:

It was noted during the original NATS Design Acceptance Testing of the DME 2020 transponder in the early 1990s that threshold sensitivity varied with temperature. A deterioration of 3 dB at channel 66X was noted when the temperature was elevated from +20°C to +55°C. As all NATS DME transponders are housed in accommodation with limited temperature control, in the summer months the ambient temperature can rise to temperatures in excess of +35°C. Mitigation of this temperature sensitivity to ensure that the required sensitivity threshold could always be maintained is one of the reasons for more sensitive receivers having been procured. The possibility of such reductions in DME sensitivity is not taken into account in the threshold sensitivities chosen for the testing.

3.3.6 The effect on DME transponders that have enabled LDES (Long Distance Echo Suppression) or extended *dead time* is not considered:

LDES and extended 'dead time' are selectable functions in DME transponders for minimising, where necessary, the effects of multipath and are effectively a self-induced reduction in performance. LDES is used by NATS at a number of airports and these features will have an impact on how the transponder performs in the presence of PMSE interference and reference has not been made in the JCSys

report as to how these functions were set. NATS assumes that they were not enabled and as LDES is used in the UK then the impact of the reduction of transponder performance on the response to PMSE interference must be assessed.

3.3.7 The selectivity testing result is taking advantage of rejection performance of the specific test samples that cannot be guaranteed in the wider real world population of transponders and interrogators:

NATS recognises that the specification of DME transponder and interrogator receiver rejection in the relevant ICAO and EUROCAE references is of limited help for this work as it is largely specified in terms of unwanted DME signals; however this is not surprising given that only intra-system compatibility would have been considered. It should not be assumed that all transponders and interrogators will have equivalent or better performance than that measured, thus more generally interference to DME may be being underestimated.

3.3.8 Only a very small sample of interrogator types tested:

Testing of interrogators has not been comprehensive or representative. There are a large number of different interrogator types in the global fleet, any of which may be present on aircraft flying into the UK and only 3 older types of interrogator have been tested for this work.

Interrogators can be categorised into three general classes: single channel, multi-channel and scanning. Only interrogators in the single channel class have been tested and this reduces the confidence that the "worst case" scenarios have been identified.

Testing of interrogators from the multi-channel and scanning interrogator classes is necessary: in the case of scanning DMEs, NATS understands that the tracking pulse rate is much lower than for the type of interrogator tested hence its operation would be at a greater risk of interference.

NATS recalls that tests were conducted in the UK on behalf of the Radiocommunications Agency in the lead up to WRC2000 on multi-channel / scanning interrogators during testing for the impact of RNSS on DME for sharing in the band 1164-1215MHz.

3.3.9 Test Measurement uncertainty is not considered:

When the results of PMSE tests are analysed or used to derive separation distances, no indication has been given of the consideration of measurement accuracy. There will be tolerances in the accuracy of measurements made with the test equipment. There are also limitations on setting the output levels of transponder simulator, PMSE signal source, transponder-under-test (interrogation level), etc.

3.3.10 Only one X-channel and one Y-channel are tested out of a possible 126

Testing of the effects of PMSE signals are only conducted at one X-channel and one Y-channel. The channels normally used in test programmes are 101Y/101X transponders and 32X/59Y interrogators. It is not possible to state with certainty that testing on these frequency channels will produce the "worst case" results for every type of DME interrogator and DME transponder. NATS would have expected that a number of test points would have been used to assess whether test results varied across the band.

3.3.11 Multipath of PMSE into DME is not considered:

As stated previously, multipath reflections are not uncommon as an interference mechanism into DME transponders. In the real environment there may be occurrences where direct PMSE signal and multiple reflections of PMSE signal arrive at the DME antenna delayed by a time period proportional to the distance of the reflection surface from the DME. This potential multiplying effect of PMSE signals is not simulated during testing and therefore does not represent "worst case" or real environment testing.

3.3.12 DME transponder loading (2200ppps X channel / 1200ppps Y channel) is not "worst case":

ICAO (Annex 10 Vol. 1 section 3.5.4.1.5.5) recommends a minimum transponder loading capacity of 2700ppps, taken to equate to 100 aircraft using the beacon and systems such as DME2020 used in the UK en-route environment are rated to up to 5000ppps, so a "worst case" testing scenario has not been used.

3.3.13 The JTIDS scenario (e.g. time slot duty factor used, single JTIDS net rather than multiple net) used for testing is not "worst case" for DME loss:

It is understood that JTIDS can be utilised with different configurations and signal scenarios. The effect of different JTIDS signal scenarios e.g. single net or multiple nets may have a different effect on the transponder or interrogator depending on the DME Channel type (X or Y) and should be investigated.

3.3.14 The false range anomalies observed during the X and Y mode break-lock tests on the KDM705 are a concern:

It is noted on page 40 of the JCSys report that range errors were observed when testing the KDM705. This is a safety (integrity) risk and the mechanisms involved need to be fully understood, however NATS recognises that this appears to not be directly related to the possibility of sharing with PMSE.

3.3.15 Specific questions on the JCSys report:

We have identified a number of issues with the JCSys report and clarification is requested.

Table 4-1 lists 4 "co-channel" and 4 adjacent channel PMSE frequencies tested around the DME channel centred on 1125 MHz, without indicating why these had

been chosen by Ofcom. On the basis that the DME channel spacing is 1 MHz, one of the quoted four "co-channel" PMSE signals listed is actually in the adjacent DME channel and hence it appears that the co-channel testing results may underestimate the impact on DME as only three co-channel PMSE emitters were present.

13.2. interrogator results quote -97dBm or greater as being the co-channel PMSE power that causes the interrogator to fail the test criterion and this is repeated in the section 14 Recommendations, however the results table 13-2 for interrogator selectivity on 0 MHz offset, which we understand to be the co-channel case, indicates that the lowest power at which one of the tested interrogators (Collins 860E-3) fails the test criteria is -98dBm. The incorrect higher -97dBm figure has been quoted in the recommendations and then, presumably, used by Ofcom in its coexistence modelling.

4 Ofcom question 3

"Do you have any comments on our proposal to allow low power audio PMSE applications (wireless microphones and IEMs) access to the 960-1164 MHz band?"

4.1 General

In NATS' opinion, as stated in the opening comments in our response Ofcom has not made available sufficient information in the consultation material to allow respondents to confirm or otherwise its conclusions. In addition, NATS believes that the testing carried out to establish parameters that Ofcom has used in its coexistence modelling have not considered even a realistic DME environment and has certainly not considered "worst case" scenarios and parameters for DME operation. Without further technical study with a set of parameters that are more appropriate for considering the potential for interference into safety of life applications and testing of a more representative and comprehensive set of DME equipment NATS is concerned that Ofcom risks creating an unsafe operational environment for DME in particular that would result in the withdrawal from operation service of the DME transponders concerned and may also be underestimating the levels of interference that would be received by PMSE equipment. NATS also believes that Ofcom may not have considered the full implications of potential changes to aviation systems in this band. We expand on this below but taking all of the above into account, NATS has little option at this point other than to object to Ofcom's current proposal and raise concerns about the testing carried out so far.

Section numbers below refer to the main body of the consultation document unless otherwise indicated.

Section 4.3: Ofcom asserts that more than 42 MHz is available in the aeronautical band at any location. Elsewhere in the document, the availability analysis is described as having been carried out for four specific locations so where is the basis for the "at any location" statement?

Ofcom states assumptions about DME usage being (only) inside the DOCs of the transponders: while outside the control of ANSPs, we are aware that aircraft systems such as scanning interrogators interrogate DME transponders outside their DOCs and that this may be a standard operating procedure in some cases. While this may not match Ofcom's expectations, as the assumption of use being limited to within DOCs is incorrect then Ofcom must address the implications of the operation of scanning DME interrogators in its coexistence modelling and assumptions of spectrum that may be available for PMSE use. Furthermore, should it be suggested that aviation operations or equipment be modified to facilitate Ofcom's proposals then given the potential implications NATS would strongly recommend that further Impact Assessments will be necessary before a policy decision can reasonably be taken.

It is stated in section 4.4 of the JCSys report that test PMSE frequencies were defined by Ofcom for co and adjacent channel testing and that these were simulated using unmodulated CW. The UK Interface Requirement for PMSE, IR2038, indicates that wireless microphone channel bandwidths are up to 200 kHz, assumed to be for analogue and up to 600 kHz for digital wireless microphones. As the unmodulated CW signals were used to effectively characterise the DME selectivity, what channel bandwidth has been assumed for PMSE and how has this been accounted for in the coexistence study?

Ofcom's description of the current uses of the 960 – 1164 MHz band starting from section 4.4 gives NATS cause for concern as it is incomplete: there is no recognition of the global primary allocation to the Aeronautical Mobile (R) Service that supports aeronautical data communications such as LDACS and ADS-B. NATS notes that Ofcom has considered LDACS perhaps as far as possible given the current stage of its development. We agree that deployment of datalink in this band will reduce the amount of spectrum available for PMSE; Ofcom indicates it hasn't been able to assess this reduction in detail but has still given an estimate of a reduction of 10 MHz in the spectrum it believes to be available for PMSE, without providing any basis for the figure. Given that the spectrum requirement figures being considered in the lead up to WRC-07, when the AM(R)S allocation was made, were of the order of 60 MHz, the 10 MHz estimate seems low, however the requirements for a UK deployment of the aviation datalink in this band will be developed in the coming years and the answer may be somewhere between the two figures.

Something of significant concern to NATS is that in informal discussions with Ofcom we have been given the impression that PMSE use in this band, were it to go forwards, would gain rights over future aviation uses and this may force future aviation systems to have to seek alternative spectrum allocations. As this band is globally allocated to aviation services in the ITU Radio Regulations it would be of serious concern if the WRC process could be circumvented in a way such that what may be a national use (perhaps extending over other countries according to Ofcom's stated aspirations) could block internationally standardised aviation systems from being used in the UK. The implementation of such future systems would be mandated under ICAO and likely subject to European Implementing Rules hence we would seek a clear statement from Ofcom as to what constraints it intends to place on future aviation developments in this band, were PMSE to be introduced.

Section 4.41: whilst maintaining our objection to Ofcom's overall proposal in this band, we would agree that any authorisation for systems sharing in a band used for safety critical aviation services such as here must be on a specifically co-ordinated and licensed basis. For the avoidance of doubt, NATS would not support the use of "dynamic access" type technologies for PMSE and would seek Ofcom's assurance that these would not be considered for this band (see also the NATS response to the Ofcom consultation "A framework for spectrum sharing", July 2015).

NATS recognises that Ofcom's proposal is to avoid 1030 and 1090 MHz with guard bands, however we note that the aviation applications on these frequencies are incompletely described. A civil SSR / Mode S interrogator does use a highly directional, rotating antenna transmitting and receiving on 1030 and 1090 MHz respectively and may also be capable of processing aircraft ADS-B transmissions on 1090 MHz. SSR multilateration ("MLAT") systems, both locally around an airport and as Wide Area Multilateration ("WAM") systems use non-rotating antennas, including wide beamwidth, sectored antennas to locate aircraft transponders using time of arrival techniques. As these latter systems differ in operation from classic SSR and are essentially multistatic, the 1090 MHz receivers are not necessarily co-located with a 1030 MHz emitter. 1090 MHz ADS-B ground receiver stations may use omnidirectional antennas.

Little detail has been provided on how the necessary separations between PMSE and DME has been determined and then used to establish potential spectrum availability, other than a general reference to ITU-R Recommendations P-425 and

P-528. This means it is not possible to comment on the application of the recommendation, the propagation model parameters used (time percentages, antenna heights etc.), transmit powers used and what if any margins that have been applied. In order for respondents to be able to independently assess the amount of spectrum potentially available for PMSE the parameter values used by Ofcom and further details of its coexistence study need to be made available.

We note that clutter and building effects were considered for the PMSE end (section 4.30) but how were these applied at the four locations modelled?

No reference is made in the consultation documentation of the application of an aviation safety margin (usually 6dB) in line with common ITU and ICAO practise when assessing sharing with safety critical aviation applications. NATS seeks Ofcom's assurance that this is incorporated into their coexistence modelling as it would be expected that a prudent and safe approach would be adopted by Ofcom in considering the compatibility of DME services with PMSE.

4.2 Future changes to DME use in the band:

In the third bullet of paragraph 5.2 on page 30 it is stated that "*the long term prospects for continuing access are extremely good. The nature of aeronautical use in this band means that it is extremely unlikely there would be any significant changes to the allocation, or services within, the band beyond those we have already identified i.e. LDACS.*"

While NATS agrees that the allocations in the band are unlikely to change, we believe that Ofcom may not yet have considered near term changes that are foreseen in DME implementation and operations that NATS believes will have the effect of further reducing the amount of spectrum available for PMSE. It is acknowledged that with regard to the 44 operational en-route DMEs operated by NATS the positions and number of transponders have been static for many years. However NATS will be implementing a ground DME site optimisation activity anticipated to take around 5 years in line with implementation of Performance Based Navigation (PBN) concepts as part of the global adoption of PBN in accordance with ICAO Resolutions and European Implementing Rules. The overall outcome will be more uniform en-route DME coverage across the UK, which will see an increase in the number of DME transponders in the north (especially Scotland) and ultimately a reduction of the number of en-route DME transponders in the south-east where there is currently a concentration of transponders. There may also be DOC changes. Overall NATS is anticipating that there would be an initial small increase in the total number of en-route transponders. Consideration would also have to be given as to potential changes in airport DME provision, although this is more a matter for airport operators and operational requirements than for NATS.

Ofcom needs to be aware that concerns have been raised about the assignment of frequencies for new DME installations above 1164 MHz in order to protect reception of RNSS signals in the band 1164–1215 MHz; the concern being that excessive use of these frequencies for DME may have a detrimental effect on GNSS receiver performance. While this scenario was not foreseen when the RNSS allocation was put in place, there are draft recommendations to avoid the assignment of new DME facilities in Europe in this upper band wherever

alternative options are available. This would increase the number of DME transponders operating in the band below 1164 MHz and will have the likely effect of reducing the spectrum available for both datalink and potential PMSE use. As approaching half of the UK en-route DMEs are assigned in this upper section of the band (channels 70-126X) NATS may be obliged to accept new DME assignments below 1164 MHz as part of the site optimisation activity described in the previous paragraph.

NATS would also point out that with the increase in the use of renewable energy, wind turbines in particular and other physical developments near DME transponder sites, it is necessary from time to time to modify operating parameters and review the AIP promulgations of the DME service limitations that are noted earlier in our response.

NATS would not accept an outcome of any sharing proposals to result in any constraint on the optimisation (e.g. re-siting for PBN), evolution or management of DME services in the UK and would seek an assurance from Ofcom that no such constraints would be applied.

4.3 Non-aviation sharing "policy" issues:

Leaving aside the results of the technical studies, safety critical spectrum users like aviation require of their own systems high integrity and reliability operations, certainty over performance and the radio environment as well as the ability of Regulators to take timely enforcement action should harmful interference be experienced. The performance, capabilities and failure modes of potential PMSE use need to be taken into account given that there would be transmitters available that are inherently capable of transmitting in-band with aviation systems and the risks that this presents. Issues such as the reliability of the proposed systems, appropriateness of the design, software assurance, construction, use and maintenance should be considered as precursors to decisions being taken on whether it is appropriate to pursue sharing and these may have to be reflected in aviation safety cases.

Consideration would also need to be given to the integrity and reliability of any databases and mitigation techniques used for the management of the sharers to assess the risk of data errors leading to equipment being set up with the wrong frequencies.

There would also need to be consideration of liability issues in the event of interference to aviation systems.

NATS is aware of a number of examples of harmful interference being caused to operational aviation systems in recent years by non-aviation equipment designed to operate in-band that required investigation by both NATS and Ofcom and subsequent enforcement action. While these were examples of illegal use, the availability of "legitimate" transmitters such as would be the case if Ofcom presses ahead with its proposal can only increase the risks of interference to safety critical aviation systems. In this context NATS has not been comforted by interviews with film production mixers quoted in a report[2] supporting Ofcom's February 2014 consultation on Public Sector Spectrum Release. Reference is made to it being

2 Technology Evolution in the PMSE Sector, by Cambridge Consultants Ltd

very helpful to very rapidly license wireless microphone frequencies to avoid the need to 'go illegal' in order not to hold up the film shooting schedule and NATS infers from this that the practice of some users picking frequencies without recourse to the licensing authority when deadlines are tight may not be uncommon.