Programme-making and special events

Future spectrum access

Statement

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Section 1

Executive summary

1.1 This statement sets out our decisions on a number of key issues relating to future spectrum access for programme-making and special events (PMSE). This encompasses a broad and diverse set of stakeholders, ranging from broadcasters and major theatrical companies to churches and schools, whose use of spectrum includes wireless microphones, wireless cameras and related equipment. Together, they make a major contribution to the economic, social and cultural well-being of the UK.

1.2 These issues originally arose as a result of the Government's decision in 2003 to release a digital dividend of spectrum freed up by digital switchover (DSO). Our Digital Dividend Review considered how best to release this spectrum for new uses. The PMSE sector was an important element of our thinking as it shares spectrum with terrestrial television and has exclusive use of adjacent frequencies. We subsequently broadened our consideration to include all spectrum used for PMSE. We have consulted at length throughout this process to ensure our proposals and decisions fully take into account users' interests and concerns.

1.3 Our digital-dividend statement of December 2007 concluded it was in the best long-term interests of the PMSE sector to move to a market-based approach to spectrum. To overcome specific identified barriers to the formation of a market for PMSE spectrum access, we decided to establish a band manager that would be able to aggregate users' demand. It would have to pay a licence fee for the spectrum awarded to it but would be able to recoup this by charging users for access. The band manager would be selected by beauty contest and have specific obligations to protect the interests of the PMSE sector. Subject to meeting those obligations, it would be able to provide access to the spectrum to non-PMSE users on whatever terms it saw fit.

1.4 We consulted twice on the detailed design of the band-manager award:

- in July 2008 on the spectrum we should award, the selection criteria we should apply in the beauty contest and how we should protect PMSE users' interests; and

- in June 2009 on the licence fee the band manager would have to pay, how commitments made by the successful applicant in the course of the award would translate into licence conditions and under what circumstances we would allow non-PMSE use of the spectrum awarded.

1.5 Separately, we consulted in February 2009 on proposals to clear PMSE users from the spectrum adjacent to the digital dividend that they use exclusively for wireless microphones. We decided in June 2009 to implement these proposals as they would significantly benefit citizens and consumers by harmonising spectrum suitable for next-generation mobile-broadband services with the release plans of other European countries.

1.6 In April 2010, we published an interim statement setting out our decision to defer the band-manager award until after the London 2012 Olympic Games and Paralympic Games. This was in part because there were complexities in the award which remained to be resolved. But it was also because we considered there would be

insufficient time before the London 2012 Games for us to develop, test and implement the necessary arrangements between us and the band manager to coordinate spectrum use in London without an unacceptable risk of disruption to the Games. While deferring changes to the institutional arrangements for managing PMSE spectrum, we indicated that we would implement proposals from our consultations that concerned the terms of PMSE spectrum access. .

1.7 This statement therefore sets out our decisions on four key issues:

- **what spectrum will be available for future PMSE access.** The spectrum currently available for PMSE access will remain so, with some inclusions (notably 2290-2300 MHz) and exclusions (notably 11.7-12 GHz);

- **the technical licence conditions (TLCs) for use of that spectrum.** These will be based on block-edge masks (BEMs), presented to reflect existing PMSE use.;

- **spectrum fees based on administered incentive pricing (AIP).** We confirm our proposed band-by-band AIP levels and phasing durations, which we will only review in future where there is evidence of material misalignment between the fees charged and the value of the spectrum. In the meantime, we will consider introducing an element of temporal and geographic peak pricing on those occasions where there is a known scarcity of spectrum for PMSE use (such as at some major sporting events); and

- **explicit security-of-tenure provisions for PMSE spectrum use.** These will last until at least September 2021 for all spectrum made available for future PMSE access and be subject to a five-year notice period we cannot activate for spectrum-management reasons without PMSE users having an expectation of some form of redress.

1.8 We are very grateful to stakeholders who have responded to our consultations and otherwise contributed to our consideration of these issues. Taken together, we believe our decisions will contribute to achieving our objectives of facilitating the participation of PMSE users in a market-based approach to spectrum while avoiding disruption that adversely affects their ability to provide a wide range of services to citizens, consumers and business customers, promoting the optimal use of spectrum in relation to all potential uses and users over time and avoiding the risks of regulatory and market failure.

1.9 We aim to consult later this year on new fees for PMSE spectrum access that take into account the AIP levels and phasing durations in this statement. In parallel we are undertaking a re-tender exercise to ensure value for money in the arrangements for licensing PMSE users up to the time when the band-manager award is reactivated after the London 2012 Games.

Section 2

Introduction

Background

2.1 On 13 December 2007, we published a statement (the digital-dividend statement) on our approach to awarding the digital dividend: the spectrum in UHF Bands IV and V (470-862 MHz) being freed up for new uses as a result of DSO.[1] A key element of that statement was our approach to future spectrum access for PMSE. Informed by a consultation (the PMSE consultation) we published on 20 June 2007,[2] we concluded the long-term interests of the PMSE sector would best be served if it moved to a market-based approach to spectrum access. This contrasts with the current situation in which we have outsourced the granting of licences but continue to decide the spectrum PMSE users can access, the technical characteristics of the equipment they can use and the conditions (including price) of their access.

2.2 To help the sector move to a market-based approach, we decided we would award a single package of interleaved spectrum and channel 69 via a beauty contest to a band manager with obligations toward PMSE users. We would use criteria designed to ensure the band manager's interests were aligned with those of PMSE users. The band manager would pay a charge for its spectrum, set by us on the basis of AIP, to reflect the opportunity cost of that use and would be able to earn revenue by charging its customers for access. Regulation would ensure it had to meet reasonable demand from PMSE users, but as long as these obligations were met, the band manager could allow its spectrum to be used by other services.

Consultations on the band-manager award and the London 2012 Games

2.3 We published two consultations on the detailed design of the band-manager award. In the first band-manager consultation, published on 31 July 2008[3] we proposed:

- we should award most of the spectrum currently allocated to PMSE to the band manager;
- the selection criteria for the beauty contest should address—
  - the extent to which each applicant would secure efficient use of the spectrum to be awarded for both PMSE and other uses;
  - the extent to which each applicant demonstrated an understanding of, and a commitment to, the needs of PMSE users; and
  - the financial, managerial and technical ability of each applicant to establish and maintain efficient systems and procedures to secure efficient use of the spectrum to be awarded for both PMSE and other uses; and
- the band manager's licence should be indefinite with no initial period and notice periods of one year for bands currently used for PMSE and five years for bands currently unused for PMSE.

[1] http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/statement/statement.pdf.
[2] http://stakeholders.ofcom.org.uk/binaries/consultations/pmse/pmse.pdf.
[3] http://stakeholders.ofcom.org.uk/binaries/consultations/bandmngr/summary/condoc.pdf.

2.4 In the second band-manager consultation, published on 22 June 2009,-[4] we proposed:

- we should calculate AIP levels on a band-by-band basis, with phasing-in periods to allow PMSE users to respond to any significant rises compared to current fee levels;
- the band manager would have, until 2018, a licence obligation to meet demand from PMSE users on fair, reasonable and non-discriminatory (FRND) terms ahead of other, competing non-PMSE use; and
- TLCs for the spectrum to be awarded should be service and technology neutral, albeit based in the first instance on existing PMSE use.

2.5 Separately, we published a consultation (the London 2012 Games consultation) on 27 May 2009 with our proposals for making spectrum available for wireless communications at the Games.[5] This noted the Games present a special challenge to our normal authorisation arrangements due to the volume and variety of requests for spectrum we will receive. As a result, we believed it would be necessary for us to establish special licensing arrangements.

2.6 Respondents to the London 2012 Games consultation made important observations about the need for proper provision of licensing arrangements for both members of the Olympic Family and other stakeholders. They also noted such arrangements should avoid the inconvenience and confusion that could arise from requiring stakeholders to seek spectrum authorisation from a number of different sources. Dealing with these issues would require effective cooperation between us and the band manager. Respondents to the second band-manager consultation also questioned the relationship between our timetable for that award and the licensing arrangements for the Games.

Deferring the band manager award

2.7 Our proposals and the responses we received led us to publish an interim statement (the interim PMSE statement) on 15 April 2010 with our decision to defer the band-manager award until after the Games. This was because:

- our key objectives for the PMSE sector require us to strike a difficult balance between sometimes-competing interests, particularly PMSE users' desire for continuity of spectrum access on the one hand and the band manager's and non-PMSE users' ability to access that spectrum to provide new wireless services on the other;
- enshrining that balance as legally enforceable conditions in the band manager's licence would represent a challenge for the existing framework for spectrum management; and most significantly
- there would be insufficient time to develop, test and implement the necessary arrangements between us and the band manager to coordinate spectrum use between the Games and business-as-usual spectrum use in London. This was because the timing of the band-manager award had slipped significantly since the digital-dividend statement. At that time, we envisaged its taking place in late 2008

[4] http://stakeholders.ofcom.org.uk/binaries/consultations/bandmanager09/summary/bandmanager09.pdf.
[5] www.ofcom.org.uk/consult/condocs/london2012/london2012.pdf.

after a single consultation on award design. But we could not now conclude the award until early 2011, with the possibility of the successful applicant not beginning operation until the second half of that year. With the Opening Ceremony of the Olympic Games starting on 27 July 2012, the risk of disruption from changes in processes as a consequence of moving from a management contract to a band manager, as well as from a possible change in the identity of the PMSE spectrum manager from JFMG to a successful competing applicant, had become, in our view, unacceptable.

2.8 We continue to believe band management is the best long-term approach to PMSE spectrum access and expect the delay will give us the time we need to deal with the issues raised through consultation. We therefore anticipate revisiting these aspects of our proposals after the conclusion of the Games in 2012.

2.9 In the meantime, we indicated we would continue to take forward proposals that concerned the terms of PMSE spectrum access rather than the institutional arrangements for managing it. Our decisions on those proposals are the subject of this statement.

Impact assessment

2.10 The analysis presented in this statement as a whole represents an impact assessment, as defined in section 7 of the Communications Act 2003.[6]

2.11 Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best-practice policy-making. This is reflected in section 7 of the Communications Act, which means generally we have to carry out impact assessments where our proposals would be likely to have a significant effect on businesses or the general public or when there is a major change in our activities. However, as a matter of policy, we are committed to carrying out and publishing impact assessments in relation to the great majority of our policy decisions. For further information about our approach to impact assessments, see "Better policy making: Ofcom's approach to impact assessment."[7]

2.12 We do not consider specific equality issues are raised as a result of the decisions set out in this statement.

Our duty and objectives

2.13 Our principal duty is to further the interests of citizens in relation to communications matters and the interests of consumers in relevant markets, where appropriate by promoting competition.

2.14 In this statement, we assess alternative policy options against our four key stated objectives for future PMSE access to spectrum, namely:

- *avoiding disruption to PMSE users that adversely affects their ability to provide a wide range of services to citizens, consumers and business customers*.

  This objective is clearly related to our duty to secure the interests of citizens and consumers by ensuring they can continue to benefit from the many important

[6] www.opsi.gov.uk/acts/acts2003/pdf/ukpga_20030021_en.pdf.
[7] http://stakeholders.ofcom.org.uk/binaries/consultations/ia_guidelines/condoc.pdf.

products and services to which PMSE use of spectrum is presently integral. However, the objective is more relevant in the short term than the long term as the ability of PMSE users to adapt to change should increase over time;

- *facilitating participation of the PMSE sector in a market-based approach to spectrum*.

  This objective is related in particular to our duties to secure the optimal use of spectrum and to promote the efficient management and use of spectrum in the interests of citizens and consumers. Most of our work in relation to spectrum management is focused on the supply of spectrum. However, if we can facilitate PMSE users' ability to participate in a market-based approach to spectrum by helping them to reflect their demand for spectrum more appropriately, we will further improve the means through which citizens' and consumers' needs, tastes and interests can be met efficiently;

- *promoting the optimal use of spectrum in relation to all potential users over time.*

  This objective relates to the fact there are potential users of spectrum in addition to PMSE users and the set of potential users is likely to increase over time given trends in technology and consumer behaviour and the attractiveness of some of the spectrum currently used for PMSE; and

- *avoiding the risks of regulatory and market failure.*

  This objective relates to the need to consider carefully the effects of regulatory intervention including any possible adverse, unintended consequences. The risks of regulatory failure can be particularly pertinent in areas with rapid change in technology and consumer behaviour.

2.15 We consider and address points made by respondents to both band-manager consultations in Annex 1.

The citizen and/or consumer interest

2.16 Generally speaking, we consider the market is best placed to secure the optimal use of spectrum. In the long term, we would also expect this to be true for PMSE spectrum access. However, we have recognised PMSE users face significant risks of market failure—and, indeed, impediments to market formation—that mean they are not currently able to take part in a market-based approach to spectrum.

2.17 As a result of the PMSE sector's contribution to the well-being of the UK, and in light of the barriers to the formation of a market for PMSE spectrum access we have identified, we set out a series of proposals to ensure the long-term future of the PMSE sector was secured. The decisions set out in this document are designed to achieve this and are in the interests of citizens and consumers who benefit from the services provided by PMSE users.

Structure of this document

2.18 Section 3 sets out our conclusions on the spectrum that will be made available for PMSE use.

2.19 Section 4 details the TLCs for that spectrum.

2.20 Section 5 confirms our approach to setting AIP-based fees for PMSE access to that spectrum, including band-by-band AIP levels.

2.21 Section 6 sets out our decisions on the security of tenure we will give to PMSE use of that spectrum.

2.22 Section 7 sets out the next steps in our work on PMSE spectrum access.

What is not included in this statement

2.23 We recognise there are a number of other issues of particular concern to the PMSE sector at this time but not directly related to the terms of their future spectrum access. These are not addressed in detail in this statement but will be subject to separate announcements as appropriate.

Clearing channel 69

2.24 The Government announced on 28 July 2010 it would make funding available for PMSE users cleared from channel 69 to facilitate the release of the 800 MHz band (790-862 MHz) for next-generation mobile-broadband services.[8] Subsequent to this announcement, we published a statement (the funding statement) on 5 August 2010 setting out eligibility for receipt of funding and how claims can be made.[9]

Future PMSE spectrum management

2.25 The interim PMSE statement indicated we were assessing the options for PMSE spectrum management in the period before we restart the band-manager award. We saw a choice between continuing to outsource the granting of licences and carrying out this function ourselves—both options we were confident could deliver the service PMSE users had come to expect. We subsequently published a prequalification questionnaire on 14 July 2010 for organisations interested in providing these services.[10] The deadline for responses was 29 July 2010, and they will be used as a first step in selecting parties to tender in a competitive procurement process. We continue to consider an in-sourced solution as an alternative approach. At the forefront of our considerations are minimising disruption for PMSE users and risks for the London 2012 Games, alongside maximising value for money.

Availability of interleaved spectrum after DSO

2.26 We published a statement on 16 January 2008 setting out the availability of interleaved spectrum for PMSE after DSO,[11] responding to concerns from a number of stakeholders there would not be sufficient spectrum to meet their needs in future.

2.27 One of the consequences of our decision to clear the 800 MHz band is the need to replan the frequencies that will be used by digital terrestrial television (DTT) after DSO with neighbouring European countries. This will change the configuration of interleaved spectrum and affect the frequencies that will be available for PMSE use. We expect the negotiations to clear the 800 MHz band will be finalised later this year, soon after which we will publish an updated assessment of the future availability of interleaved spectrum for PMSE.

[8] http://nds.coi.gov.uk/content/Detail.aspx?ReleaseID=414707&NewsAreaID=2.
[9] http://stakeholders.ofcom.org.uk/binaries/consultations/pmse_funding/statement/statement.pdf.
[10] https://ofcom.bravosolution.co.uk/esop/toolkit/notice/public/tender.do?caller=0&tenderId=tender_34507.
[11] http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/statement.pdf.

Section 3

Spectrum availability

Introduction

3.1 The issue of how best to secure future PMSE access to spectrum was initially raised in our consultation on awarding the digital dividend, published on 19 December 2006.[12] Specifically, we concerned ourselves with PMSE access to spectrum in the digital dividend at 470-854 MHz.

3.2 Most of the digital dividend used for PMSE is interleaved spectrum. This is accessed on a shared basis with terrestrial television, which is the primary user. PMSE users also access channel 69—854-862 MHz—without the need to share with other services. The main PMSE use of the digital dividend is wireless microphones, although there is also use by talkback devices and increasingly so by in-ear monitors (IEMs).

3.3 But much more spectrum than this is used for PMSE. JFMG currently licenses PMSE access to spectrum on our behalf from 47 MHz to 48 GHz, for programme links, wireless cameras and a wide range of other equipment. It was clear any arrangements we put in place for future PMSE spectrum access would have to take into account the needs of all PMSE users. In particular, when we decided in our digital-dividend statement the licensing of PMSE spectrum access should be undertaken by a single band manager with obligations to users, we signalled we would need to consider whether this arrangement should include all spectrum allocated to PMSE.

3.4 With this in mind, we set out a number of proposals in the first band-manager consultation to gather views on the best way to proceed. This section deals with the issues that were raised, namely:

- which spectrum currently allocated to PMSE and managed by us should be made available for future PMSE access;
- what should be the terms of PMSE access to spectrum managed by the Ministry of Defence (MOD) in light of the arrangements it is putting in place for the future management of that spectrum;
- what approach should we take to licence-exempt cognitive access to interleaved spectrum; and
- what arrangements should be put in place for temporary access to cleared digital-dividend spectrum.

3.5 Our decisions are set out below and summarised in Annex 2. A number of our proposals in the first band-manager consultation have since been superseded by other proposals and decisions we have made. Where this is the case, we explain the interactions between those developments and our original proposals.

[12] http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/summary/ddrmain.pdf.

The impact of deferring the band-manager award

3.6 Our decision to defer the band-manager award has changed the focus of our decisions. Proposals that referred to spectrum being awarded to the band manager are now taken as proposals to make spectrum available for future PMSE access. But the key questions about spectrum availability remain irrespective of how PMSE access is managed as PMSE users still need to be able to make efficient investment decisions about future equipment purchase.

Ofcom-managed spectrum

Channel 38

3.7 We described how the primary, radioastronomy use of channel 38 (606-614 MHz) was affected by UK interest in developing new facilities at a proposed global radiotelescope facility in the southern hemisphere from 2014. We also explained how, in the meantime, AIP would be phased in and payable by the Science and Technology Facilities Council for the continued use of channel 38 for radioastronomy.

3.8 These developments raised the prospect radioastronomy use of channel 38 could cease voluntarily more quickly than would previously have been the case. In subsequent discussions, the then-Department for Innovation, Universities and Skills and HM Treasury agreed terms under which it would cease during 2012.

3.9 At the time of the first band-manager consultation, we set out our thinking channel 38 would realise the greatest value for citizens and consumers by being included in the award of the lower band of cleared spectrum, which would now comprise channels 31-40. Accordingly, we asked the following question:

Question 2. Do you agree with our proposal to award access rights to channel 38 that will last as long as we sustain the protection of radioastronomy in the UK?

Summary of responses

3.10 Although the future of channel 38 has changed significantly since the first band-manager consultation, it is still worthwhile recognising a number of responses to our initial proposal stated channel 38 was valuable to the PMSE sector and should be awarded to the band manager.

3.11 In particular, JFMG had noted channel 38 could be part of an equipment tuning range that would give PMSE users spectrum access in most used locations in the UK. The BBC stated channel 38 should be available for PMSE use as long as protection for international radioastronomy was needed. The Professional Light and Sound Association (PLASA) suggested the TLCs for the channel should be defined so as to be suitable for low-power uses such as wireless microphones in the event it was awarded with the lower cleared band.

Our revised approach to channel 38

3.12 Our approach to the future use of channel 38 has evolved significantly since July 2008. On 2 February 2009, we published a consultation (the 800 MHz consultation) on proposals to clear the 800 MHz band.[13] This responded to a number of other European countries' plans or decisions to create a digital dividend comprising the

[13] http://stakeholders.ofcom.org.uk/binaries/consultations/800mhz/summary/800mhz.pdf.

entirety of that band. This contrasted with our original plans to release an upper band of cleared spectrum at 806-854 MHz. We proposed it would be in the best interests of UK citizens and consumers to adopt the same approach as the increasing number of other European countries. Doing so would require us to clear channels 61 and 62 of DTT and channel 69 of PMSE.

3.13 The 800 MHz consultation recognised the importance PMSE users placed on channel 69 for its ability to accommodate eight wireless microphones on a UK-wide basis relatively free from harmful interference. We stated any decision to clear PMSE use would need to be accompanied by our finding substitute spectrum that could replicate these key characteristics. We assessed various options before proposing channel 38 should be awarded to the band manager on the same terms as would have applied to channel 69.

3.14 An impact assessment of clearing channel 69 and making available channel 38 as a replacement was included in Annex 5 of the 800 MHz consultation. The decision was confirmed, in light of strong stakeholder support and our technical and economic assessment of the requirements of PMSE users, in a statement (the 800 MHz statement) we published on 30 June 2009.[14] The impact of that decision was assessed in Annex 2 of that statement.

Our decision

3.15 As set out in the 800 MHz statement, channel 38 has been made available for future PMSE access by low-power (10 mW handheld) wireless microphones. The most up-to-date details of its availability can be found in the interim PMSE statement with a revised timetable for UK-wide access to channel 38 in the funding statement.

3.16 The terms of temporary access to channel 69 are set out in paragraphs 3.75-3.82 below.

Channels 61 and 62

3.17 We noted the growing interest among other European countries of the 800 MHz band (including channels 61 and 62) being used for mobile services. To facilitate the benefits that could be realised if we aligned ourselves with this approach, we carried out an initial technical study of the feasibility of operating two-way mobile services in interleaved spectrum, with particular focus on channels 61 and 62, where such services might start to operate in other parts of Europe in the medium term.

3.18 We concluded interleaved spectrum could potentially offer useful value for such services although the interference environment for their operation would be challenging given the need to coordinate fixed transmissions with existing DTT services at various locations. We also considered interleaved spectrum in channels 61 and 62 might be attractive to a bidder interested in creating a sub-UK DTT multiplex in combination with either cleared spectrum or other interleaved spectrum.

3.19 We therefore proposed this spectrum should be offered at the same time and as part of the same award as the cleared spectrum.

3.20 This spectrum was available for PMSE use on an interleaved basis, although it was not used on an extensive basis compared to other channels (e.g. channels 67-69). We asked the following question:

[14] http://stakeholders.ofcom.org.uk/binaries/consultations/800mhz/statement/clearing.pdf.

Question 3. Do you agree with our proposal to include the interleaved spectrum in channels 61 and 62 in the cleared award?

Our revised approach to channels 61 and 62

3.21 Our approach to the future use of channels 61 and 62 has changed as result of our decision to clear the 800 MHz band. As set out in paragraphs 3.12-3.14, above, we decided in the 800 MHz statement to clear this spectrum of DTT to create an upper band comprising all of channels 61-69.

Our decision

3.22 As set out in the 800 MHz statement, channels 61 and 62 will be cleared of DTT and interleaved PMSE use and awarded for new use as part of the 800 MHz band. The terms of temporary access to channels 61 and 62 are set out in paragraph 3.80 below.

Protecting DTT

3.23 As part of our consultation on the detailed design of awards of geographic-interleaved spectrum (the geographic-interleaved consultation) published on 12 June 2008, we assessed the level of protection from new uses of that spectrum that should be given to existing DTT services.[15] This was relevant to the band-manager award as this level of protection would also dictate the amount of interleaved spectrum available for PMSE.

3.24 In our first band-manager consultation, we referred to the options set out in the geographic-interleaved consultation. We had proposed adopting the so-called "median" option that protects the following (with a higher variable increase in interference of more than 1 dB):

- the digital preferred service area (DPSA, where we protect only the transmitter affording the best DTT reception in any one location);
- the transmitter that offers the best analogue coverage; and
- the "correct" national/regional service, particularly in border areas.

3.25 Our subsequent decision on how we would approach protection of DTT services in Cardiff and Manchester was set out in our statement on the award of geographic-interleaved spectrum in those locations, published on 29 October 2008.[16] We still believe the median approach in general offers the best balance between providing opportunities for new services and protecting the interests of viewers and existing broadcasters. But we also concluded there are circumstances where this level of protection could be relaxed to the benefit of the former with very limited impacts on the latter.

3.26 One of the effects of the median option, if adopted UK-wide, would be to increase the availability of interleaved spectrum for PMSE compared to previous assumptions. We therefore sought comments on all three options set out in the geographic-interleaved consultation in the first band-manager consultation.

[15] http://stakeholders.ofcom.org.uk/binaries/consultations/ddrinterleaved/summary/interleaved.pdf.
[16] http://stakeholders.ofcom.org.uk/binaries/consultations/notice524/statement/statement.pdf.

Question 4. Do you have any views on our proposed approach to protecting reception of DTT services?

Summary of responses

3.27 Responses to this question were favourable to any proposal that increased the quantity of interleaved spectrum available for PMSE.

3.28 The BBC and the British Entertainment Industry Radio Group (BEIRG) raised a concern about how the median approach might impact on PMSE. Although the protection of DTT from PMSE would be relaxed in some areas, there was no indication as to whether interference from DTT into PMSE was being taken into account. As a result, these respondents raised some doubts as to whether there would be any real gain from the proposals as outlined.

Our response

3.29 We recognise the concerns over the quantity of available interleaved spectrum after DSO. In particular, we understand the importance professional touring companies place on there being sufficient interleaved spectrum in a number of key locations throughout the UK. As a result, we have made a provisional assessment of the likely quantity of interleaved spectrum available for PMSE access after DSO has been completed, and we are confident this will be sufficient to more than meet peak historic PMSE demand. Full details of this will be made available once we have concluded negotiations to clear the 800 MHz band later in 2010. We will also ensure these reflect DTT interference into wireless microphones.

Our decision

3.30 We intend to follow the median approach (with the possibility of relaxing protection in the appropriate circumstances) when assessing the availability of interleaved spectrum for PMSE after DSO.

11.7-12 GHz

3.31 We stated in the first band-manager consultation there were four discrete bands at 11.7-12 GHz allocated for use for low-power camera links in a sharing arrangement with direct-to-home (DTH) satellite television. We stated the primary use of the spectrum was likely to intensify in the coming years and there was no current PMSE use of these bands and no evidence they would be of particular importance for future PMSE use. Accordingly, we asked the following question:

Question 5. Do you agree with our proposal not to award the bands between 11.7 GHz and 12 GHz to the band manager?

Summary of responses

3.32 There were no objections to this proposal, although Arqiva stated a future band manager should be free to apply to use this spectrum if there was demand for it.

Our response

3.33 We agree with Arqiva's suggestion a future band manager should be free to negotiate with the primary user if it finds a demand for this spectrum. Indeed, in

principle, we agree a future band manager should be free to approach any licensee if it wishes to negotiate access to any part of the spectrum.

Our decision

3.34 In light of the lack of objections to this proposal, we have decided the spectrum at 11.7-12 GHz will not be available for future PMSE access. This will be made effective from the date this statement is published.

The remaining 49 bands

3.35 We considered whether the remaining 49 bands allocated to PMSE and managed by us should be awarded to the band manager. It led us to propose doing so as this option scored best against our key objectives. Accordingly, we asked the following question:

Question 6. Do you agree with our general approach of awarding the remaining 49 Ofcom-managed bands allocated to PMSE but lying outside the digital dividend to the band manager?

Summary of responses

3.36 Responses to this question were generally favourable, although BEIRG signalled the link between awarding this spectrum to the band manager and the end of protected PMSE access in 2018 was unacceptable.

3.37 Arqiva stated the issue of what should happen to spectrum required for the geographic-interleaved awards should be addressed as early as possible.

Our response

3.38 We deal at length with the end date for PMSE protection in section 6.

3.39 Our plans for future geographic-interleaved awards are on hold pending Government decisions on local television. The Government is currently working on policy options to help create a regulatory environment that will support a strong, independent and vibrant local-media sector. It has set out its vision for a network of local television services across the UK and has asked Nicholas Shott, the Head of UK Investment Banking at Lazard, to carry out an independent assessment of the commercial potential of local television in the UK.[17] The findings of that review will help produce a local-media action plan, due to be published in the autumn.

Our decision

3.40 We have decided to take the general approach of making available for future PMSE access the entire remaining spectrum allocated to PMSE and managed by us except where there are specific exceptions to this rule as outlined in paragraphs 3.31-3.34 above.

Key bands

3.41 In our assessment of whether there should be any exceptions to the general principle of awarding to the band manager the remaining 49 bands allocated to PMSE and

[17] www.culture.gov.uk/news/media_releases/7137.aspx.

managed by us, we simplified our analysis by grouping bands together to reflect the importance they had to the PMSE sector. We referred to these groups as:

- key PMSE bands (where there were more than 100 PMSE assignments in 2007);
- low-demand PMSE bands (where there were between one and 99 PMSE assignments in 2007); and
- no-demand PMSE bands (where there were no PMSE assignments in 2007).

3.42 We then assessed the desirability of awarding these bands to the band manager.

3.43 We had a strong preference for awarding key PMSE bands to the band manager. This was because we considered PMSE users would need to maintain access to this spectrum in the medium term, at least in the absence of any readily identifiable substitute spectrum. If access to this spectrum were jeopardised, there would be a risk of major disruption to PMSE users. Accordingly, we asked the following question:

Question 7. Do you agree with our proposal to award key PMSE bands to the band manager?

Summary of responses

3.44 There was general approval of this proposal. JFMG argued we should consider adding further spectrum at 175-210 MHz in the award. Mr. Adrian Pickering suggested we should help to facilitate making other licensees' unused spectrum available for PMSE.

Our response

3.45 We note JFMG's comments on spectrum at 175-210 MHz and will consider any specific proposals to make further spectrum in this band available for future PMSE access (subject to meeting obligations to primary services).

3.46 In terms of other licensees' unused spectrum, there should be sufficient commercial incentives for them to negotiate access rights (whether for PMSE or other services) with the future band manager without the need for us to intervene.

Our decision

3.47 We will make available for future PMSE access the key bands we identified in the first band-manager consultation.

2290-2300 MHz

3.48 One of the key PMSE bands we identified was the spectrum at 2290-2300 MHz. This was viewed as needing special consideration because of the temporary nature of PMSE access.

3.49 On 19 December 2007, we announced we would allow temporary access to 2290-2300 MHz for use for wireless cameras, up to the point where any future award for

the band was completed.[18] In light of the continuing lack of identified use of this spectrum, the first band-manager consultation asked the following question:

Question 8. Do you agree with our proposal to award 2290-2300 MHz to the band manager on the same terms as other wireless-camera channels at 2 GHz?

Summary of responses

3.50 Respondents agreed with this proposal. There was one issue of concern, raised by JFMG, who questioned whether sharing arrangements with the spectrum holder above 2300 MHz created any difficulties or constraints on wireless-camera access to 2290-2300 MHz.

Our response

3.51 At the time we announced temporary access to 2290-2300 MHz, we assessed whether there were any constraints on PMSE access because of other uses of the spectrum above 2300 MHz. This is managed by the Home Office, and our analysis did not show any issues of harmful interference into PMSE from that use. In terms of interference into Home Office users, we concluded there should also be no significant risk as long as PMSE operated at 1 W effective isotropic radiated power (EIRP).

Our decision

3.52 We have decided the spectrum at 2290-2300 MHz should be made available for future PMSE access on the same terms and conditions as other spectrum currently used by wireless cameras in the 2 GHz bands. To ensure there is no interference into services above 2300 MHz, power will continue to be limited to 1 W EIRP.

Low-demand bands

3.53 Unlike key PMSE bands, we did not consider there was any significant risk of disruption to the PMSE sector from not awarding low-demand bands to the band manager. This was because of the limited use of this spectrum and the potential for many of those who do use it to move to the key bands we had proposed to award.

3.54 However, we did state at the time awarding this spectrum to the band manager could help us to fulfil our objective of promoting optimal use of spectrum. This was because PMSE users might react to any rising fees for certain bands by moving to other, less expensive spectrum where this was appropriate. A future band manager would be able to provide information to PMSE users about the availability of those other bands. This would be a key factor in developing a market for PMSE spectrum access.

3.55 Because of these factors, we asked the following question:

Question 9. Do you agree with our proposal to award low-demand PMSE bands to the band manager?

Summary of responses

3.56 Although all respondents were in favour of this proposal, a number of comments questioned our assessment users could move from bands where there is currently

[18] www.ofcom.org.uk/consult/condocs/2ghzdiscuss/temp_access/22902300.pdf.

high PMSE demand to those where there is low PMSE demand. For example, BEIRG stated it would be impossible to migrate wireless microphones or IEMs to these bands because they would not offer sufficient bandwidth and the propagation characteristics of the spectrum would be unsuitable for the requirements of equipment.

3.57 Other respondents, such as JFMG and SIS Outside Broadcast, stated the lack of demand for low-demand spectrum should be reflected in our AIP calculations.

Our response

3.58 We agree with respondents there may be no scope for PMSE equipment to use low-demand bands in the short term. For example, we accept analogue wireless microphones are currently designed to use particular frequencies and standardised in such a way they require particular bandwidths. However, we cannot anticipate how PMSE technology will develop over the coming years. Indeed, some developments may be stimulated by the PMSE sector being faced with the true value of the spectrum it uses. As an example, we might see digital technology becoming more attractive to users if access to the spectrum that supports it is less expensive than spectrum that supports analogue technology.

3.59 However, since we are making spectrum available for future PMSE access, the risk of any significant disruption is likely to be minimised.

3.60 Respondents who stated prices for low-demand spectrum should be low may, in principle, have discounted the potential for any non-PMSE uses of this spectrum. In theory, if we find PMSE access is excluding other services, this would lead to an increased opportunity cost for that spectrum. In the event, the opportunity cost for low-demand spectrum has been set at either zero or a relatively low rate in the first instance. Where there is evidence of material misalignment between the level of the fees being charged for spectrum access and the opportunity cost of that spectrum in the future, we can pick this up in an AIP review. Further details on this are given in paragraphs 5.171-5.179 below.

Our decision

3.61 We have decided to make available low-demand spectrum for future PMSE access.

No-demand bands

3.62 Our proposal on whether to award no-demand bands to the band manager rested on a similar assessment to that for low-demand bands. In other words, we noted the advantages that could be gained from having available spectrum that could facilitate PMSE users moving from higher- to lower-value spectrum.

3.63 With no-demand bands, we also considered there was additional incentive for the band manager to promote optimal use by introducing new services and/or technologies. We pointed to the use of new wireless-camera technology at the Turin 2006 Winter Olympic Games that suggested there may be scope, for example, to develop similar use of the bands at 24 GHz and 48 GHz.[19]

3.64 Accordingly, we asked the following question.

[19] www.nhk.or.jp/strl/publica/bt/en/to0026.pdf.

Question 10. Do you agree with our proposal to award no-demand PMSE bands to the band manager?

Summary of responses

3.65 Responses to this proposal were similar in substance to those for low-demand bands. While there was general approval for our approach, some respondents questioned the ability of PMSE users to move between bands. Others stated they would expect prices for this spectrum to be low in recognition of the lack of demand to use it.

Our response

3.66 We reiterate the points made in paragraph 3.58 above concerning the potential for PMSE users to use alternative bands in the medium to long term.

Our decision

3.67 In light of the generally positive responses to our proposal, we have decided to make no-demand bands available for future PMSE access.

MOD-managed spectrum

3.68 A number of bands currently allocated for PMSE are managed by the MOD. Some of these are of particular significance to PMSE users, such as talkback use at 425-470 MHz and wireless-camera use at 3400-3600 MHz. When we made our initial proposals, we were conscious the MOD was considering how it would reform its future management of spectrum, not least in light of the Independent Audit of Spectrum Holdings[20] and our review of the management of public-sector spectrum.[21]

3.69 In the first band-manager consultation, we stated our preferred general approach to these bands was continued PMSE access until such time this was incompatible with new arrangements the MOD put in place.

3.70 We consider this is still the best approach and have concluded we will proceed on this basis.

3400-3600 MHz

3.71 We signalled in the first band-manager consultation there was some uncertainty over future PMSE access to spectrum at 3400-3600 MHz. This was because the MOD had identified it as a candidate for early release as part of its future spectrum-management arrangements.

3.72 In December 2008, the MOD informed PMSE licensees in this spectrum they should prepare to vacate it in anticipation of recognised spectrum access (RSA) being granted in September 2009. This followed an MOD statement on its programme of spectrum reform.[22] The MOD has indicated PMSE users will continue to be able to access this spectrum until such time it transfers rights of use to new licensees.

[20] www.spectrumaudit.org.uk.
[21] http://stakeholders.ofcom.org.uk/binaries/consultations/sfrps/summary/sfrps.pdf.
[22] www.mod.uk/NR/rdonlyres/40622FC9-DC7B-40FC-B48A-90408F6F7676/0/spectrumstatement_051208.pdf.

Licence-exempt cognitive access to interleaved spectrum

3.73 We asked a number of questions on future access to interleaved spectrum by cognitive devices. We set out a summary of responses in the second band-manager consultation. Most expressed significant concern the deployment of such devices would be incompatible with ongoing use of low-power PMSE equipment. We recognise these concerns and reiterate we will only permit the deployment of such devices if we are satisfied they will not cause harmful interference to licensed uses, including PMSE.

3.74 We consulted on proposed parameters for licence-exempt cognitive devices accessing interleaved spectrum on 16 February 2009.[23] In a statement published on 1 July 2009,[24] we concluded cognitive devices should either sense the presence of other signals or make use of a geolocation database to determine unused spectrum in their vicinity. We published a discussion document on 17 November 2009 that focused on geolocation and the mechanisms likely to be needed to make it work.[25]

Temporary access to cleared spectrum

3.75 Continuing access to cleared spectrum has been an issue of some importance to the PMSE sector as the configuration of interleaved spectrum after DSO is finalised. We initially announced, on 12 October 2007, our intention to allow temporary PMSE access to channels 63-68 in the regions where DSO would take place before the end of 2009, up to the point where new users needed access to the spectrum.[26] At that time, this would have entailed a notice period of six months.

3.76 We subsequently proposed, in the first band-manager consultation, extending this notice period to 12 months in recognition of the value placed by PMSE users on this temporary access and the low likelihood any new licensee would be in a position to roll out new services within 12 months of DSO occurring in any one region. We also extended this proposal to the lower cleared spectrum in channels 31-40. We asked the following question.

Question 14. Do you have any views on the appropriate notice period for temporary PMSE access to channels 63-68 and/or on whether we should extend temporary access to channels 31-40?

Summary of responses

3.77 Although all respondents supported the increase in the notice period and the extension of temporary access to both bands of cleared spectrum, some stakeholders stated this did not go enough to meet the concerns of the PMSE sector.

3.78 BEIRG welcomed temporary access but felt we should not continue with the current programme of spectrum release until we had demonstrated there would be sufficient interleaved spectrum after DSO to meet the needs of the PMSE sector.

3.79 PLASA argued temporary access to cleared spectrum should be extended on a UK-wide basis until after the London 2012 Games. This would enable the PMSE sector to retain a sufficient stock of equipment to service the Games and give users

[23] http://stakeholders.ofcom.org.uk/binaries/consultations/cognitive/summary/cognitive.pdf.
[24] http://stakeholders.ofcom.org.uk/binaries/consultations/cognitive/statement/statement.pdf.
[25] www.ofcom.org.uk/consult/condocs/cogaccess/cogaccess.pdf.
[26] http://stakeholders.ofcom.org.uk/binaries/consultations/pmse/statement.pdf.

additional time to amortise past investments before having to purchase new stock to use in the new configuration of interleaved spectrum. PLASA stated it did not consider it likely any new licensee would be interested in deploying services in the cleared spectrum until it was available UK-wide at the end of 2012. As a result, we should allow PMSE access to the cleared spectrum until that time.

Our revised approach to temporary access to cleared spectrum

3.80 We revisited our approach to temporary access to cleared spectrum in light of our decision to clear the 800 MHz band. As set out in the 800 MHz statement and the interim PMSE statement:

- we will maintain PMSE access to channel 36 on 12 months' notice to cease or until DSO is completed in the UK in late 2012, whichever is the sooner;
- we will maintain PMSE access to the rest of the 600 MHz band (channels 31-35 and 37) until DSO is completed in the UK; and
- we will maintain PMSE access to the 800 MHz band until at least 1 July 2012 and in London, northeast England and Northern Ireland until at least 1 October 2012. We will review in 2011 whether these dates can be extended, up to 31 December 2012 at the latest, in light of any further information about how quickly new services will be ready to deploy in the band.

3.81 These decisions more closely reflected the expressed wishes of most PMSE stakeholders.

3.82 An impact assessment of the timing of clearing PMSE from channel 69, weighing up the benefits of early clearance against the cost of disruption, was included in Annex 2 of the 800 MHz statement. The final details of the timing of clearance were set out in the interim PMSE statement. Details of our plans to help mitigate the impact of channel 69 clearance through funding assistance were detailed in the funding statement.

Temporary access to 2500-2690 MHz

3.83 On 23 December 2002, the Radiocommunications Agency announced the spectrum at 2500-2690 MHz (the 2.6 GHz band) would cease to be available for ongoing wireless camera use after 31 December 2006 following the recent decision by the Electronic Communications Committee of the European Conference of Postal and Telecommunications Administrations about the spectrum allocated for the expansion of IMT-2000.[27].

3.84 In our statement of 4 April 2008 on the then 2.6 GHz band award,[28] we announced we would instead revoke existing PMSE licences on 1 September 2008. We would also allow temporary PMSE access until the time we invited applications for the award and would give three months notice to PMSE licensees to ensure they stopped using the band at that point.

[27] www.ofcom.org.uk/static/archive/ra/topics/broadcasting/document/notice-rev1.doc.
[28] http://stakeholders.ofcom.org.uk/binaries/consultations/2ghzrules/statement/statement.pdf.

3.85 We will maintain this approach, now in the context of the combined auction of the 800 MHz and 2.6 GHz bands the Government has indicated it intends to direct us to hold.[29] We estimate this will happen by the end of 2011 at the earliest.

3.86 Separately, we published a consultation on 23 August 2010 with a proposal to reserve the 2.6 GHz band for wireless-camera use during the Olympics.[30]

Summary of our decisions on spectrum availability

3.87 Table 1 below summarises our decisions on spectrum availability for future PMSE access.

Table 1. Spectrum availability for future PMSE access

Spectrum	Availability
Channels 31-35 and 37	Until DSO is completed in the UK in late 2012
Channel 36	On 12 months' notice to cease or until DSO is completed in the UK in late 2012, whichever is the sooner
Channel 38	Already available (effectively UK-wide from 21 September 2011)
Channels 61-69	Until at least 1 July 2012 and in London, northeast England and Northern Ireland until at least 1 October 2012 (review in 2011 could extend up to 31 December 2012 at the latest)
The 2.6 GHz band	On three months notice to cease when we invite applications for the award.
Interleaved spectrum	Determined by median approach to protecting DTT (relaxed where appropriate) and negotiations to clear the 800 MHz band (should be known later in 2010)—will need to be protected from harmful interference by cognitive devices
11.7-12 GHz	No longer available
Other bands (key, low-demand and no-demand) managed by us	Available
MOD-managed bands	Until incompatible with new arrangements put in place by MOD

[29] http://nds.coi.gov.uk/content/Detail.aspx?ReleaseID=414707&NewsAreaID=2.
[30] http://stakeholders.ofcom.org.uk/binaries/consultations/band-2500-2690-london-2012-games/summary/condoc.pdf.

Section 4

Technical licence conditions

Introduction

4.1 Our proposed approach to setting TLCs for the spectrum to be awarded to the band manager, as well as the proposed TLCs themselves, were set out in the second band-manager consultation. These followed on from the first band-manager consultation, in which we made proposals on the best approach to determining how equipment should be allowed to use the spectrum being awarded.

The impact of deferring the band-manager award

4.2 The deferral of the band-manager award does not affect our decisions on TLCs. We consider providing clarity on how spectrum can be used for PMSE is still the right thing to do for the interim period before the award is reactivated.

Approach to defining TLCs

4.3 The first band-manager consultation proposed:

- we should use BEMs to determine the TLCs relevant to the spectrum being awarded; and
- we should base these BEMs broadly on existing emission masks for PMSE equipment.

4.4 The key benefits we identified for BEMs compared to the alternative approach of spectrum usage rights (SURs) were as follows:

- BEMs would be more readily understood by stakeholders;
- it would be easier to determine whether equipment was compliant with BEMs given SURs are designed for stable networks and PMSE spectrum use is transient in nature; and
- compliance with BEMs would eventually result in lower transaction costs for the band manager because of their relative simplicity.

4.5 We also proposed the BEMs should be based broadly on existing arrangements for PMSE access. We stated we could, in the future, adopt SUR-based TLCs in respect of certain bands. This would happen where alternative use of that spectrum was permitted (see section 6) and SURs were seen as a more appropriate TLC for that alternative use.

4.6 Accordingly, we asked the following question:

Question 26. Do you agree with our proposal to use the block-edge mask approach to determine the technical licence conditions relevant to this award and to base these masks broadly on existing arrangements for PMSE spectrum access?

Summary of responses

4.7 There was general agreement from respondents the BEM approach was most appropriate for PMSE spectrum use.

4.8 BEIRG argued any variation to change the TLCs to SURs should be subject to an assessment of the impact on the PMSE industry. PLASA similarly argued any moves toward using SURs should be assessed in the context of whether this furthered the interests of the PMSE sector.

4.9 JFMG agreed BEMs were the most appropriate form of TLC but stated SURs could be used in the future where non-PMSE use of spectrum was allowed. However, it also stated BEMs should remain the basis of TLCs for spectrum being made available for PMSE use.

4.10 The BBC and SIS Outside Broadcast agreed with our general approach but pointed to the importance of basing BEMs on the most relevant standards from the European Telecommunications Standards Institute (ETSI).

Our response

4.11 We accept the general point made by both BEIRG and PLASA about the need to assess any future move toward SURs, particularly where this is accompanied by the introduction of non-PMSE services in spectrum available for PMSE access. We deal with our approach to allowing such non-PMSE use in section 6.

4.12 We agree with JFMG's argument future PMSE spectrum access could be based on other forms of TLCs such as SURs. Our approach to defining those TLCs would be set at that time when we were in full possession of the facts.

4.13 In defining BEMs, we have had full regard to the relevant ETSI standards for all PMSE equipment and therefore accept the importance of the point made by the BBC and SIS Outside Broadcast.

Our decision

4.14 In light of the broad support for our proposal, we confirm our general approach to defining the TLCs for spectrum being made available for future PMSE access, as set out in paragraph 4.3 above.

Proposed TLCs

4.15 We set out detailed proposed TLCs, based on the BEMs for existing PMSE use as set out in relevant ETSI standards, in our second band-manager consultation. We asked the following question:

Question 38. Do you agree with our proposed TLCs?

Summary of responses

4.16 While responses to this question generally supported the proposed TLCs, the BBC argued the initial resolution bandwidth used to specify the out-of-band limits for BEMs 15-17 was too narrow. A number of other respondents pointed to a discrepancy in the representation of the TLCs, which was subsequently corrected and published.

4.17 JFMG commented one TLC (at 1.5 GHz) precluded the use of analogue links while another (at 7 GHz) excluded the ability to deploy airborne video links.

Our response

4.18 With regard to the BBC's point, initially the BEMs were specified with a resolution bandwidth of 4 kHz. This may have led to a situation where legacy equipment (e.g. wireless video links) did not comply with the relevant BEM but would have complied with the ETSI standard from which the BEM was derived. To correct this, we are now specifying BEMs with a resolution bandwidth of 10 MHz, 20 MHz or 25 MHz to more accurately align them with ETSI standards.

4.19 For all the in-band limits, we now consider it would be better to specify the effective radiated power (ERP) without reference to any particular bandwidth. This is in preference to our initial approach, where we normalised each BEM to a particular bandwidth. For example, in the 47.55-48.8 MHz band, the in-band ERP was defined as 39 dBm/4 kHz but this will now read 25 W. This will ensure the ERP of any transmission in this band will only be 25 W regardless of its bandwidth. This is consistent with the approaches taken in other spectrum awards (e.g. 10-40 GHz). It will also be a clearer approach for PMSE users.

4.20 In terms of the specific points raised by JFMG, the changes we have made to the representation of the TLCs will facilitate the deployment of both analogue and digital technologies at 1.5 GHz. JFMG's point on 7 GHz airborne use was based on an understanding this had been allowed in the past. On investigation, we have found these frequencies have not previously been allocated for airborne use.

Our decision

4.21 Subject to the revisions set out in paragraphs 4.11-4.13 above, we have confirmed the TLCs in Annex 3.

Summary of our decisions on TLCs

4.22 In summary, our decisions on TLCs for spectrum available for future PMSE access are as follows:

- TLCs will be defined as BEMs;
- in the first instance, each BEM will be defined using the most appropriate ETSI standards for the current typical PMSE use of that spectrum; and
- any decision to allow non-PMSE use of that spectrum will need to be reflected in the TLCs. This may involve a move toward SURs or other methods of defining TLCs.

Section 5

Spectrum fees

Introduction

5.1 In both band-manager consultations, we said we considered it was in the best long-term interests of PMSE users to move away from a command-and-control approach to spectrum access toward a market-based or user-led approach. One of the key elements underpinning this approach was our intention PMSE users move away from the current arrangement of spectrum fees set to reflect costs and start to pay fees based on AIP instead.

5.2 The purpose of applying AIP to PMSE spectrum access is to promote spectrum efficiency. In general, it is our aim to ensure those who value spectrum most are able to access it. Conversely, those who value spectrum less should be incentivised to exploit alternative, less valuable spectrum that otherwise meets their needs.

5.3 Our second band-manager consultation set out in detail our proposed objectives for and approach to introducing AIP-based fees to the PMSE sector. In that consultation, we set out our estimates of the opportunity cost of the bands proposed for award to the band manager, based on work from Analysys Mason. We also made proposals for how AIP should be phased in to allow PMSE users time to efficiently respond to any significant rises compared to current fee levels and in a way that would not cause undue disruption to end-users.

5.4 On 29 March 2010, we published a consultation on a revised framework for spectrum pricing[31] (the spectrum-pricing consultation). In that consultation, we set out a number of proposals that reflect our current thinking with respect to spectrum pricing. Where this impacts on our proposals for spectrum allocated to PMSE, we address that in this section.

5.5 This section sets out our final decisions in relation to our objectives and approach in applying AIP to the spectrum available for future PMSE access, the band-by-band opportunity-cost estimates on which PMSE fees will be based and our decisions regarding the phasing in of AIP.

The impact of deferring the band-manager award

5.6 The introduction of AIP-based fees was proposed as a key element in facilitating the participation of the PMSE sector in a market-based approach to spectrum. Our second band-manager consultation set out our AIP proposals in detail.

5.7 After the deferral of the band-manager award, we considered whether introducing AIP for PMSE spectrum access continued to be appropriate or whether this should be postponed until the band-manager award was reactivated. We believe postponement would be inappropriate as this would delay the participation of PMSE users in a market-based approach to spectrum and the associated incentives for more efficient spectrum use. The deferral of the band-manager award has not changed our view applying AIP-based fees for PMSE users will promote efficiency in their use of spectrum. These benefits remain, irrespective of how PMSE spectrum

[31] http://stakeholders.ofcom.org.uk/binaries/consultations/srsp/summary/srsp_condoc.pdf.

access is authorised. We believe moving to an AIP-based approach to spectrum pricing remains consistent with our objective to promote efficient spectrum usage and the benefits can still be realised in the absence of the band manager.

5.8 Therefore, we have concluded on introducing AIP as planned. However, where we had consulted on charging AIP-based fees to the band manager, we will now consider opportunity costs, alongside our relevant spectrum-management costs, as inputs into our own proposals for end-user licence fees. The structure and level of those fees will be considered in a further consultation we aim to publish later this year.

Proposals in the first band-manager consultation

5.9 We asked the following questions in the first band-manager consultation about the application of AIP to the PMSE sector:

Question 27. Do you agree with our proposal to set a separate fee for each Ofcom-managed band to be awarded?

Question 28. Do you agree with our proposal initially to set fees for access to MOD-managed spectrum on a comparable basis?

Question 29. Do you agree with our proposal to determine the band manager's licence fee first by deriving estimates of the opportunity costs of the spectrum to be awarded and second by setting band-by-band prices that strike an appropriate balance between our objectives for this award?

Question 30. What are your views on the options for phasing in AIP to full opportunity cost?

Question 31. Do you agree with our proposal to set the band manager's licence fee for three years and to review it after that period?

Question 32. Do you agree with our proposal to review the band manager's licence fee periodically but no more frequently than every three years thereafter?

5.10 A summary of the responses received, with our responses, can be found in Annex 6 of the second band-manager consultation.

5.11 All of these proposals have since been superseded by developments (e.g. the decision to defer the band-manager award) or were revisited in the second band-manager consultation and are therefore covered in the discussion below.

Proposals in the second band-manager consultation

Objectives and approach in applying AIP to the band manager

5.12 The first band-manager consultation set out a number of ways in which the potential disruption to PMSE users of introducing significantly higher AIP fees could be mitigated. These were:

- we would, in line with the recommendations of Professor Martin Cave and Indepen/Aegis, set AIP with reference to a lower-end estimate of the spectrum's opportunity cost;

- we would phase in the AIP-based fee over a period of time where we considered significant rises would cause disruption to PMSE users; and

- we would review our initial AIP figures after a period of three years and afterward no more frequently than every three years.

5.13 In our second band-manager consultation, we said we still considered the three-year time period struck an appropriate balance between giving the band manager a level of certainty for developing a business plan and allowing us to make any changes to AIP levels in reasonable time where our initial proposals were clearly in need of amendment. Accordingly, we asked the following question:

Question 24. Do you agree with our objectives and approach in applying AIP principles to the licence fee payable by the band manager?

Summary of responses

5.14 A number of respondents disagreed with AIP being introduced. Transfinite stated an increase in fees would have a harmful effect on the wider UK economy, such as through tourism, and this should be taken into account.

5.15 Other respondents suggested various alternative arrangements to AIP. ITV suggested our efficiency objective could be met by ring-fencing available spectrum for different categories of PMSE use and incentivising the band manager to seek efficiency improvements (e.g. with a bonus for technology improvements). BEIRG suggested AIP in the initial three-year period should only take PMSE use of the spectrum into account and fees should be charged retrospectively at the end of each year based on levels of receipts and a reasonable level of costs incurred by the band manager.

5.16 A number of respondents argued AIP should be set at a level that took into account potential disruption to the PMSE sector. For example, BEIRG said the PMSE sector needed time to adapt to new arrangements. Therefore, if AIP were implemented, initial levels (at least in the first year) should be no more than current JFMG licence receipts with subsequent phasing to be implemented on a conservative basis. BEIRG also said AIP should also be set at the low end of the estimate of the opportunity cost.

5.17 Some respondents were concerned opportunity-cost estimates that took into account the risk of significant disruption to the PMSE sector would result in a limited ability to manage excess demand. For example, Arqiva agreed PMSE users needed to move to a more market-based approach and this was consistent with our statutory duty to secure optimal use of spectrum. However, it raised concerns the proposed approach would not promote efficiency, would force difficult trade-offs in dealing with congestion and would generate disputes. Similarly, Plum (which had been commissioned by Arqiva to review the regulatory arrangements for the band manager) argued the AIP-based fees results would likely be below actual opportunity cost and so would have little impact on managing excess demand.

5.18 JFMG raised concerns we appeared to be paying greater attention to ensuring affordable fees for PMSE users than to applying true AIP. Along with Arqiva, it argued this could harm the PMSE sector's ability to adjust to a market-based approach in the long term. As an example, it suggested the proposed AIP levels

would fail to provide an incentive for wireless-camera users to move from the 2 GHz bands (where there is evidence of congestion) to alternative, less-congested spectrum because the opportunity cost of the latter was above zero.

5.19 JFMG also noted the calculation of AIP according to the methodology employed by Analysys Mason results in a different result than the model provided in 1996 by Smith Systems and NERA (Smith NERA).[32] It argued this could be critical if it resulted in cliff edges between the levels of AIP charged to different groups using the same band.

5.20 Plum stated their view in some cases it is questionable whether the opportunity-cost calculations already include spectrum-management costs. For example, in the case of interleaved spectrum, the estimates are based on auction results from a variety of countries, some of which charge additional annual fees to cover spectrum-management costs. Also, estimates for business radio are based on the costs of moving to less-congested bands, and spectrum-management costs would be incurred in both congested and uncongested bands.

Our response

5.21 The interim PMSE statement signalled our intention to take forward our proposals on AIP-based fees for PMSE spectrum access despite the deferral of the band-manager award. It noted we, and not the band manager, will now decide how our opportunity-cost estimates and relevant spectrum-management costs will translate into end-user fees. This will be the case until the band-manager award is reactivated. Therefore, although the application of AIP to the sector is still relevant, this statement does not address any band-manager-specific issues.

5.22 With regard to the issue of whether AIP should be levied at all, we appreciate the importance of the PMSE sector to the UK's economic, social and cultural well-being. Therefore, in line with our key objectives for the PMSE sector, we have endeavoured to find a balance between the efficiency benefits of introducing AIP and avoiding significant disruption to PMSE users. We believe the introduction of AIP is an important development in moving PMSE toward market-based spectrum-access arrangements.

5.23 AIP is designed to create incentives for users of spectrum to take decisions that will contribute to efficient spectrum use. Many users of spectrum already pay AIP-based fees. The introduction of AIP for spectrum with a positive opportunity cost is expected to lead to a more efficient use of a scarce resource.

5.24 In response to the suggested alternative approaches to spectrum pricing, we do not believe the ring-fencing approach suggested by ITV would provide sufficient incentives for the efficient use of spectrum and would specifically restrict the opportunities for spectrum to move to its highest-value use. We therefore believe this approach would not fit with our key objective of promoting the efficient use of spectrum.

5.25 Likewise, the alternative method of applying fees retrospectively and based on PMSE use only as suggested by BEIRG is not consistent with achieving optimal use of the spectrum in cases where higher-value uses and users exists. The uncertainty created would also distort the incentive for PMSE users to make efficient use of spectrum as prices would only become available after the fact and could not

[32] www.ofcom.org.uk/static/archive/ra/topics/spectrum-price/documents/spec_rev/ha129.doc.

therefore be used effectively as an input to decisions on spectrum use. Therefore, this structure would limit the efficiency benefits of introducing AIP. In general, fees that are a percentage of revenues or profits form a tax, distort decisions at the margin and hence be likely to distort service prices charged to consumers and are inconsistent with our statutory duties.

5.26 With regard to the arguments about how significant disruption to PMSE users might be avoided, we recognise the sector's concerns regarding the initial level of AIP fees. We have also had specific regard to the proposals for dealing with uncertainties in opportunity-cost estimates outlined in the spectrum-pricing consultation, specifically any estimated level of opportunity cost used to set fees should reflect any uncertainties over the feasibility of alternative services and in the value of spectrum to such alternative uses. Furthermore, to minimise disruption to the PMSE sector, we conclude AIP will be phased in over a period of time to allow users to efficiently respond to any significant rises compared to current fee levels and in a way that will not cause undue disruption.

5.27 We do not agree with BEIRG's suggestion the initial baseline levels (at least in the first year) should be no more than JFMG's licence receipts and then phased in. This would have the effect simply of delaying any incentive impact for a year and hence the efficiency gains to be made from beginning the process. However, we have used the existing licence-receipt levels as a baseline for ensuring band-by-band fees do not increase by more than 40% in the first year. We set out the reasoning behind this 40% level in paragraphs 5.136-5.149 below.

5.28 We considered the argument AIP set below opportunity cost will have little effect on managing excess demand. First, as discussed above, we believe there are sufficient uncertainties about possible alternative uses of the spectrum and, more specifically, uncertainties in the value of this spectrum to those uses, the risk of setting fees too high exceeds the risk of setting them too low. In addition, when developing our approach to setting AIP, we were mindful of the significant increases in fees indicated by our estimation of the opportunity cost of some bands. Therefore, we chose to phase in any significant increases in order to minimise inefficient disruption to the PMSE sector arising from their making short-term responses to what is designed as a long-term signal.

5.29 We acknowledge this approach imposes limitations on the effectiveness of AIP during the phase-in period as it leads to fees being set below true opportunity cost. We believe the proposed AIP levels are a significant step toward creating appropriate pricing signals but agree, because they are based on cautious estimates of value, they might not prevent congestion entirely. However, we believe the proposed approach will be an improvement to the current arrangements and a positive step toward a fully market-based approach. If, following the end of the phase-in period, we find congestion remains an issue in some bands, this would provide evidence we should consider reviewing these fees. The alternative approach of setting fees at the opportunity cost of uncertain feasible alternative services without phasing of the increased fee levels risks major disruption to PMSE users, who might abandon the spectrum if not given time to respond to these prices in the short term with no surety the alternative use will materialise and make better use of the spectrum.

5.30 We also note, given the band-manager award has been deferred, there is also a possibility for us to effectively implement temporally and geographically specific congestion charging. We address this in paragraphs 5.150-5.161 below.

5.31 In response to the comments made on our choice of the Analysys Mason approach over the Smith NERA approach, as we discussed in our recent consultation on spectrum pricing, we do not propose to continue the Smith NERA approach to setting AIP (i.e. aligning spectrum below 1 GHz with the mobile spectrum trading unit—STU—and that above 1 GHz with the fixed-links STU) for fees in the future. Instead, we propose to use a method that takes into account the opportunity cost of feasible alternative uses and better reflect the variation of spectrum value across frequency bands. Such an approach is therefore likely to produce a greater number of reference rates than the two produced by the current application of the Smith NERA approach.

5.32 While we have yet to conclude on this proposal for PMSE spectrum access, we believe it is appropriate for fees to better reflect the variations in value between the frequency bands by reflecting the variations in demand for spectrum for PMSE and/or other secondary feasible alternative uses across a large number of frequency bands that have significantly differing values.

5.33 In particular, Analysys Mason set out a three-stage approach we believe more accurately reflects the opportunity costs of the spectrum to be available for future PMSE spectrum access, both in PMSE and alternative uses, which is consistent with our proposed approach in the current pricing consultation. This analytical framework, consistent also with previous approaches, consisted of:

- an assessment as to whether there is congestion among PMSE users ("own use" congestion);
- an assessment as to whether there is a viable (or "feasible") alternative user of the spectrum; and
- where there is likely to be congestion among PMSE users and/or with a viable alternative use, a calculation of the value of the spectrum in the PMSE and/or alternative use to derive the opportunity cost.

5.34 As long as PMSE users are aware of the price differences between bands, we believe cliff edges—large price differences between specific bands—are only problematic if they do not reflect a true difference in opportunity cost between those bands. Significant price differences between bands for which PMSE use is similar will incentivise users to choose the band with the lower opportunity cost, thus making the higher-value spectrum available for the alternative use that values it so much higher. Concerns raised in relation to cliff edges are addressed below.

5.35 We considered the point whether our cost calculations already include spectrum-management costs. In general, the estimated values have been derived by assessing what value other users place on using spectrum in different configurations that are already managed. This value is usually higher than any costs of managing the spectrum. For some less popular bands, however, on occasion the value placed on the spectrum may be close to our spectrum-management costs. In such situations, as we discuss in the spectrum-pricing consultation, our current view is our costs of spectrum management should act as the minimum fee for access to the spectrum (i.e. they act as an AIP floor). When setting fees, we have a power to set these higher than our costs for spectrum-management reasons but not on both a cost-reflective *and* AIP basis.

Our decision

5.36 We have decided to retain our proposed objectives and approach in applying AIP. However, as the band-manager award has been deferred, these AIP figures will not determine the licence fee payable by the band manager at this stage. Rather, they will feed into the process for setting end-user licence fees.

Assessing opportunity cost based on the secondary nature of PMSE use

5.37 The second band-manager consultation said we considered it appropriate to assess the feasibility of alternative uses in light of PMSE users' secondary access to spectrum (with the exception of those few bands where PMSE operates on a primary basis). We said this would give an accurate reflection of the value placed on that spectrum in light of the technical constraints inherent in its use for PMSE.

5.38 We explained the level of AIP is based on the opportunity cost of the spectrum being used. Therefore, where there is no competing demand for spectrum, by either an alternative or an existing user, the opportunity cost would be zero. In those circumstances, we would not apply an AIP figure to that band.

5.39 With the exception of channel 69, 2290-2300 MHz and a small number of frequencies in UHF 1 and UHF 2, PMSE accesses spectrum on a secondary basis. This means there is a primary service using that spectrum and PMSE is allowed to share so long as it does not cause harmful interference to that primary service, nor expect protection from interference from this Primary service. In practice, this usually means PMSE users must either transmit at low power levels or observe geographic restrictions when using the spectrum available to them. These restrictions often make the spectrum unattractive to other alternative users or services.

5.40 We asked the following question:

Question 25. Do you agree with our proposal to assess viability of alternative use of spectrum based on the secondary nature of PMSE access where applicable?

Summary of responses

5.41 Respondents to the consultation broadly agreed with our proposal to base opportunity-cost calculations on the secondary nature of PMSE spectrum access.

Our decision

5.42 We have decided to retain our proposal to assess the feasibility of alternative use of spectrum based on the secondary nature of PMSE use where applicable.

Assessing opportunity cost of spectrum based on competing PMSE use

5.43 Our second band-manager consultation explained there may still be an opportunity cost to spectrum where there is congestion among PMSE users even if there are no alternative uses for it. However, we acknowledged spectrum congestion in the context of PMSE tends to be sporadic and focused on a small area for a short period of time (e.g. at major outdoor sporting or cultural events, such as the British Grand Prix or Glastonbury Festival). Therefore, a particular frequency may be available for use for the vast majority of the time and in the vast majority of locations within the UK, but still be congested at a time when there is particular demand for it from PMSE users.

5.44 Therefore, we proposed to consider whether a band has sufficient excess demand from existing PMSE use for it to have an opportunity cost as opposed to judging whether the spectrum is either definitively congested or not congested.

5.45 We said we used an approach to do this that looked at the effect of reducing the amount of spectrum in the band available to PMSE by a marginal decrement and assessing whether any equipment is likely to be rendered unusable as a consequence. This allows to us to assess the amount existing PMSE users would be willing to pay to retain access to the band or other PMSE users would be willing to pay to gain access to it. The opportunity cost based on own-use excess demand is derived from this value.

5.46 We explained the most important measure of this value is represented by the additional costs—primarily equipment costs—PMSE users would need to incur if they lost access to the decrement of spectrum concerned. If equipment can be reused in alternative spectrum to deliver the same output with no additional costs, the opportunity cost of the spectrum in the decrement can be judged to be zero. If instead the equipment would be stranded in existing use and new equipment costs incurred to sustain the same output, the value of the spectrum in the decrement can be judged to be more than zero. In this latter case, we would then consider the band has sufficient excess demand for us to be able to apply an opportunity cost figure to it.

5.47 In assessing the materiality of own-use opportunity costs in a particular band, we proposed to adopt a guideline by which if no PMSE equipment is stranded by a reduction of a marginal decrement of spectrum, there are insufficient levels of excess demand for that band for us to ascribe a positive opportunity cost to it.

5.48 We asked the following question:

Question 26. Do you agree with our approach to assessing whether there is an opportunity cost of spectrum based on competing PMSE use?

Summary of responses

5.49 Respondents raised concerns about the exclusion of temporary PMSE-use congestion from the assessment of opportunity cost. For example, JFMG disagreed with the marginal-decrement approach as applied by Analysys Mason due to the sporadic nature of PMSE congestion and the nature of the supply chain (where many users do not own their own equipment). It argued the fact excess demand is sporadic does not imply it is low cost.

5.50 JFMG said the nature and cost of the loss need to be estimated to estimate the own-use opportunity cost of spectrum. It suggested a better methodology would be to adapt the marginal-decrement approach to specifically target PMSE use at events. It would then be possible to derive an opportunity cost of congestion on a per-event basis. It suggested an overall annual opportunity cost could be derived from the product of the value per event and the forecast number of congested events per year.

5.51 Plum also disagreed with our ascribing a zero opportunity cost to spectrum where congestion only occurs for relatively short periods of time and/or in specific locations. It argued if access is denied at a particular point in time and/or at a particular location, the opportunity cost of the spectrum will not be zero because the spectrum has value to the user denied access.

5.52 Arqiva argued, as congestion is principally short term and event based, the obvious efficient solution would be to permit the band manager to manage excess demand by price on the occasions when such short-term, event-based congestion occurs.

5.53 Arqiva also argued AIP estimates should be forward looking by taking account of available information on anticipated demand growth that might arise.

Our response

5.54 Now the band-manager award has been deferred, we no longer have concerns about rent seeking. It might therefore be possible to effectively implement a process by which pricing could be more flexible to respond to temporally and geographically specific congestion as suggested by Arqiva. We will consider this separately from overall AIP estimates. We will address this in our consultation on end-user fees later this year. We are likely to propose the introduction of some form of peak pricing where we have identified evidence of PMSE congestion.

5.55 With regard to taking into account anticipated future demand, Analysys Mason noted in its report it was difficult to estimate with confidence how sensitive PMSE users would be to price rises. As result, the phased-in levels of AIP should be set at levels where PMSE users would be unlikely to suffer significant short-term disruption and would be given sufficient time to respond efficiently to these increased fee levels. These could be reassessed at the first formal review when there were data to judge reactions to changes in those fees.

5.56 We acknowledge concerns AIP-based fees charged might be an underestimate of the true opportunity cost of the spectrum should demand for the spectrum increase due to expansion of the PMSE sector or movement from other bands. However, in light of the uncertainty Analysys Mason set out in its AIP study over the feasibility of alternative services to PMSE, we still consider the levels we have proposed are appropriate.

Our decision

5.57 We have decided to retain our proposed approach to assessing whether there is an opportunity cost of spectrum based on competing PMSE use. In our assessment of own-use opportunity cost in any particular band, we will consider whether the extent of excess demand is significant enough for it to have a positive opportunity cost. This will be guided by whether any PMSE equipment is stranded by a reduction of a marginal decrement of spectrum in that band[33].

Opportunity-cost figures for key bands

5.58 The second band-manager consultation set out our detailed proposals for AIP based on opportunity-cost estimates by Analysys Mason. Individual band-by-band estimates, stakeholder responses and our final decisions are discussed below.

UHF 1 and UHF 2

5.59 The primary PMSE use of this spectrum is talkback equipment, which is typically (though not exclusively) deployed by production and broadcasting users. The first band-manager consultation suggested a lower bound of the opportunity costs would

[33] This approach to assessing the opportunity cost based on own-use PMSE congestion was set out in Analysys Masons' 2009 report on AIP for PMSE-allocated spectrum

be around £280k per year for UHF 1 and £750k per year for UHF 2 based on business mobile radio being a potential alternative use.

5.60 The second band-manager consultation showed further work had confirmed our initial assessment of business radio being the most likely potential alternative use. In the case of UHF 1, this would be subject to some geographic restrictions, while the limitations in UHF 2 would consist of a small number of power constraints. Business-radio equipment able to use this spectrum is already available, and business-radio users are themselves currently using other heavily congested adjacent bands. As a result, we consider business-radio use to be a very strong technical and commercial alternative to talkback use in UHF 1 and UHF 2.

5.61 We explained Analysys Mason's more detailed analysis of business-radio users' potential willingness to pay to use this spectrum resulted in our estimating opportunity costs to be higher than suggested in the first band-manager consultation. Our revised estimates were £359k per year for UHF 1 and £1.21m per year for UHF 2. The 2008 revenue figures from the PMSE licensing database show PMSE users paid £88k for licences in UHF 1 and £466k for licences in UHF 2. As a result, we would expect fees for spectrum access that reflected full opportunity costs to cause significant difficulties to PMSE users if implemented too quickly. We discuss this further in the context of phasing in paragraphs 5.136-5.149 below.

5.62 We asked the following question:

Question 27. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity costs of UHF 1 and UHF 2?

Summary of responses

5.63 A number of respondents said they would be concerned if fees for access to UHF 1 and UHF 2 that reflected full opportunity costs were implemented too quickly.

5.64 Other respondents raised concerns about the calculation of different opportunity costs for the bands because a large pricing differential between UHF 1 and UHF 2 could lead to excess demand for the former. For example, ITN believed the calculation for UHF 2 was problematic because creating such a differential would mean UHF 1 would become subject to excess demand or, if charges were spread across UHF 1 and UHF 2, UHF 1 users will have to pay an unfair price. It suggested a fairer method may be to create four bands across the frequency ranges, thereby allowing a greater granularity in price.

5.65 JFMG also raised concerns about the disaggregation of UHF 1 and UHF 2, specifically because a popular temporary-use requirement for duplex talkback is split across the two bands—a necessary arrangement at present because the spectrum available in UHF 1 is not able to be configured to support duplex operations.

Our response

5.66 We appreciate the concerns related to the implementation of fees that reflect the full opportunity cost of UHF 1 and UHF 2. To address the effects, we will phase AIP in so it will not increase by more than 40% in the first year of transition (see paragraphs 5.136-5.149 below).

5.67 In the interests of freeing up spectrum for higher-value use, it is desirable users are incentivised to move from bands with higher opportunity costs to bands with lower

opportunity costs where this is efficient for them. This is the purpose of AIP. We have estimated UHF 2 has a higher opportunity cost than UHF 1. Therefore, it is efficient for users to move into UHF 1 from UHF 2 *if this is possible*. Therefore, we do not share ITN's concerns about the impact of differential AIP levels between these two bands.

5.68 The specific licence fees for access to these bands are still to be determined. Where users need access to both bands for duplex talkback purposes, it is likely the licence fee will reflect a combination of the higher cost of UHF 2 and the lower cost of UHF 1, thus continuing to send accurate price signals. We do not consider this to be as problematic as JFMG suggests or necessarily agree we would have to split the two bands into four to provide more granularity as suggested by ITV. However, we will address the point in detail in our fees consultation later this year, where we can assess the viability of all options.

Our decision

5.69 We have decided to retain our opportunity-cost estimates of £359k per year for UHF 1 and £1.21m per year for UHF 2, based on Analysys Mason's detailed analysis of existing business-radio users' demand for this spectrum.

Interleaved spectrum

5.70 Interleaved spectrum is currently used for PMSE primarily by wireless microphones and (increasingly) in-ear monitors, although there is some use by talkback and high-power audio links.

5.71 We suggested in the first band-manager consultation a lower bound of the opportunity cost for this spectrum would be in the region of £900k per year. This was based on low-power business mobile radio being the highest-value alternative user, although we noted further assessment might identify other alternative uses.

5.72 The second band-manager consultation assessed further the other identified plausible alternative users of this spectrum, namely:

- business radio;
- mobile television;
- DTT on a local, regional or sub-UK basis; and/or
- local or regional wireless broadband and WiMAX.

5.73 Our assessment of the technical and commercial viability of these services suggested, while one or more of them could potentially make use of interleaved spectrum in the future, it was unclear from the information we had at the time whether demand for this spectrum from these or any other services would materialise over the next three years. In particular:

- a more detailed assessment had found, although there was some evidence of interest to use interleaved spectrum for business radio, this interest was on a UK-wide basis and the technical constraints inherent in using geographically restricted spectrum would pose significant technical challenges;

- mobile television could make use of interleaved spectrum because of handsets' wider tuning range. However, we considered the evidence of actual demand from this service for this spectrum—particularly in light of potentially more suitable spectrum already on the market—was insufficiently strong for us to apply an opportunity-cost figure based on this service; and

- DTT was a technically suitable alternative use of interleaved spectrum. However, we were separately awarding the most suitable interleaved spectrum to provide these services—compatible ("in group") with existing aerials—on a service- and technology-neutral basis in areas of likely demand. While we explicitly did not rule out the use of the interleaved spectrum to be awarded to the band manager for DTT, we considered the evidence of demand at this stage was not clear enough for us to derive an opportunity-cost figure based on this service.

5.74 We said, as a result of these assessments, we believed a low-end estimate of the opportunity cost of interleaved spectrum was currently zero and PMSE users should, at least initially, only be faced with the band manager's administrative costs of managing this spectrum.

5.75 However, we explained we would monitor this situation in line with our general policy for reviewing AIP levels. If this or any other demand for interleaved spectrum materialised, the level of AIP may change as a result of a subsequent review of the value of the spectrum.

5.76 We asked the following question:

Question 28. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity cost of interleaved spectrum?

Summary of responses

5.77 There was general agreement with this estimate by respondents to the consultation.

Our decision

5.78 We have decided to confirm our estimate of the opportunity cost of interleaved spectrum at zero, based on Analysys Mason's estimate.

Channels 69 and 38

5.79 The first band-manager consultation suggested a lower bound of the opportunity cost of channel 69 of £2.8m per year based on the spectrum tariff unit (STU) for mobile cellular use at 900 MHz. We emphasised this estimate was likely to be very much at the low end of the potential range of opportunity costs given developments at a European level, which had led to an increased likelihood of this channel being part of a harmonised band for mobile communications services.

5.80 The second band-manager consultation said our subsequent work had confirmed a more accurate opportunity-cost estimate for channel 69 could be in the region of £24m per year given the increasing number of other European countries identifying the 800 MHz band (including channel 69) as suitable for mobile communications. In contrast, PMSE users currently paid licence fees amounting to £102k per year for this spectrum.

5.81 Therefore, we explained, even with prolonged phasing-in arrangements, we did not think it likely PMSE users could absorb such an increase in AIP fees regardless of any decision to phase in fees.

5.82 The 800 MHz consultation therefore proposed clearing PMSE from channel 69 to enable us to align part of the UK's digital dividend with the decisions being taken by other European countries. We identified channel 38 as the best alternative for PMSE use to channel 69 and proposed awarding it to the band manager on the same terms as would have applied to channel 69. We suggested its opportunity cost was in the region of £122k per year. We based this assessment on the potential for this spectrum to be used for DTT in Wales and Northern Ireland. Based on our approach to assessing whether there would be unusable equipment where we removed a marginal decrement of spectrum, we concluded there would not be PMSE excess demand in channel 38 given the ability for users to use the same equipment in adjacent frequencies to sustain output.

5.83 The second band-manager consultation said we were proposing £122k per year as being the estimated opportunity cost for channel 38.

5.84 We asked the following question:

Question 29. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity costs of channel 69 and channel 38?

Summary of responses

5.85 The majority of respondents who directly commented on this proposal said they accepted the estimate.

5.86 However, many respondents, including ITV, were concerned by our suggestion the opportunity cost of channel 38 could rise if radioastronomy ceased in the Netherlands. ITV stated this created uncertainty and it would welcome clarification from us. It also argued PMSE users should have secured access to channel 38 for a significant time, without interference and without any contingent possibility of costs rising in response to changes in other countries.

5.87 SIS Live noted the opportunity-cost estimate range in the report showed the estimation of opportunity cost was not an exact science. Therefore, it argued we should take the lowest value in the range. It conjectured economic circumstances could also have depressed these values since they were calculated.

Our response

5.88 We recognise concerns the opportunity cost of channel 38 could increase if it ceases to be used for radioastromomy in the Netherlands. We address this issue in paragraphs 6.22-6.24 below.

5.89 With regard to setting opportunity-cost levels at the lower end of estimated ranges, we have done so in the interests of avoiding disruption to the PMSE sector during the transition phase to market mechanisms. However, the more prices reflect the true value of the spectrum, the greater the efficiency benefits that will be realised from introducing AIP. Therefore, we need to strike a balance when making pricing decisions between ensuring the services delivered by PMSE users are not disrupted as they adjust to new fee levels and bringing those users toward market prices for

their spectrum access as soon as practicable so they can make efficient future decisions on how they use spectrum in light of more accurate signals of its value.

5.90 In the past, the number of channel 69 licences has grown even as fees have significantly increased. This leads us to believe the introduction of AIP at the proposed level is unlikely to lead to significant falls in demand.

Our decision

5.91 We have decided to retain our opportunity-cost estimate for channel 38 of £122k per year, based on Analysys Mason's report.

2-3 GHz

5.92 The 295 MHz of spectrum available for PMSE in bands between 2 GHz and 3 GHz (excluding the temporary availability of the 2.6 GHz band)) is heavily used for wireless cameras, primarily by broadcasters and production companies. Much of this spectrum is managed by the MOD and shared with PMSE use on a non-interference, non-protection basis. The remaining spectrum is shared with satellite services and with industrial, scientific and medical users at the higher frequencies.

5.93 The first band-manager consultation cited a lower bound of the opportunity cost for this spectrum of approximately £150k per year for the 210 MHz of spectrum identified as being congested as a result of existing PMSE use. At that time, we did not identify a feasible alternative service that would be able to share with the primary users for this spectrum, given the geographic and technical constraints inherent in sharing.

5.94 The second band-manager consultation said our further analysis had indicated there was, in fact, no likely excess PMSE demand based on our approach of assessing how much equipment would be rendered unusable by the removal of a decrement of spectrum. We considered the tuning range of wireless cameras would enable their continued use to sustain output in the event we removed 8 MHz of spectrum from PMSE use. As a consequence, there was a zero opportunity cost for most of this spectrum. With one exception, we still considered there was currently no suitable alternative use.

5.95 We explained the exception to this was spectrum at 2390-2400 MHz, which was identified for possible future harmonised wireless telecommunications use at the World Radiocommunication Conference in 2007. This spectrum is managed and used by the MOD, and we have confirmed ongoing PMSE access to this spectrum will depend on the arrangements the MOD is making for the future management of its spectrum (see paragraphs 3.68-3.70 above). Therefore, while the value of this band for wireless communications may be significant, there is also some uncertainty relating to future PMSE access to this spectrum. The MOD has said it expects there to be keen interest in continued PMSE use of its spectrum and proposed to continue to allow this use for as long as possible. It has also said it will take the longer-term use of its holdings by PMSE into consideration.

5.96 The MOD has not yet asked us to make the regulations needed to grant RSA for spectrum in the 2310-2450 MHz band but expects to do so by March 2012. Its final report on defence demand for spectrum indicated existing defence use of this band

made it unlikely spectrum could be released without altering defence demand and current use and could not, in any case, be released UK-wide.[34]

5.97 We reflected these uncertainties in our opportunity-cost calculations. Our estimate of the value of this band, based on the potential for future harmonisation of 2390-2400 MHz, was £216k per year. This figure contrasts with JFMG receipts for wireless-camera use of 2-3 GHz as a whole, which were £290k for 2008/09.

5.98 We asked the following question:

Question 30. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity cost of spectrum at 2-3 GHz?

Summary of responses

5.99 Some respondents raised concerns about the demand effects of the estimate. ITV argued the mid-band opportunity cost at 2-3 GHz was higher than at adjacent frequencies. This could affect demand for these bands. It argued we should think further about the effects on demand before setting the price. JFMG raised concerns about the effect congestion might have on industry costs if hirers were forced to replicate all equipment holdings for congested bands.

5.100 Some respondents questioned the accuracy of the estimate. JFMG believed considerable additional demand for these frequencies seemed likely to come from the known future closure to PMSE use of the 2.6 GHz and 3.5 GHz bands and this should be factored into prices. Plum questioned two downward adjustments of the estimates by Analysys Mason, which it described as arbitrary. The originally calculated number was reduced to 20% of its value on the grounds the initial calculation was likely to be an overestimate, and the resulting value was regarded as small and uncertain and so further reduced to zero. Plum also noted while the value of around £1k/MHz is small, a much lower value of £178/MHz was obtained for the 7 GHz band and yet opportunity cost was not estimated to be zero.

Our response

5.101 As discussed above, in the interests of freeing up spectrum for higher-value use, it is desirable users are incentivised to move from bands with higher opportunity costs to bands with lower opportunity costs where this is efficient for them. Therefore, we do not see it as problematic if the introduction of AIP encourages some uses to move into neighbouring bands.

5.102 We agree in some circumstances it might be efficient or indeed necessary for hiring companies to invest in equipment holdings across multiple bands, as suggested by stakeholders. If AIP is set correctly, price signals will indicate when such investment is efficient. This is unlikely to increase industry costs as hire companies would have to hold sufficient equipment to service peak demand periods in any case. Where demand overflows into alternative bands from time to time, hire companies would have to own some equipment that could tune to those bands. It is possible this equipment might not get used as often as the other equipment, in which case it would be replaced less often and so be unlikely to increase costs.

5.103 Any changes in demand and other factors affecting opportunity cost will be considered at AIP reviews, discussed in paragraphs 5.171-5.179 below.

[34] www.mod.uk/NR/rdonlyres/733C18ED-A59B-4282-BA66-98693FF0D29E/0/spectrum2008_2027.pdf.

5.104 We do accept there is a case for charging where there is temporal and/or geographic spectrum scarcity. As discussed in paragraphs 5.150-5.161 below, we will consider whether it is possible to incorporate such charging in the licence fee structure that implements our decisions on AIP.

5.105 With regard to Plum's response on the downward AIP adjustments, which it described as "arbitrary", as with the other estimates, we considered it appropriate to take a conservative view of the opportunity cost of spectrum at 2-3 GHz. Therefore, the estimates were adjusted downward in reflection of the uncertainty of the alternative use. The basis for the first reduction is the original estimate calculated is likely to provide an upper bound of the true opportunity cost because much of the equipment currently used in the spectrum increment could be used in alternative spectrum should the increment be removed. The basis for the second reduction is the estimate is so small, it is likely to be within reasonable error bounds of Analysys Mason's estimates. Therefore, we believe there is insufficient evidence to ascribe a positive opportunity cost to this band.

Our decision

5.106 We have decided to confirm our estimate, based on Analysys Mason's report, of the opportunity cost of spectrum at 2-3 GHz.

7 GHz

5.107 The 7110-7250 MHz and 7300-7425 MHz bands are currently used for PMSE for fixed programme links but may become increasingly important for mobile wireless-camera users. This is because peak spectrum demand for wireless cameras sometimes exceeds the available supply at 2-3 GHz, in particular now PMSE will no longer have access to the 2.6 GHz band after it is awarded for mobile services.

5.108 The second band-manager consultation explained PMSE users had identified the 7 GHz bands as possible complements to the core wireless-camera spectrum at 2-3 GHz. At that time, we understood from industry representatives some users had been trialling the use of 7 GHz cameras to assess its general suitability, against the backdrop of existing use for wireless cameras both in the UK and abroad.

5.109 We said this spectrum may be key for wireless-camera use in the future and we were mindful not to create any barriers to this occurring. We identified one alternative use of this spectrum—fixed links—we believed to be both technically and commercially plausible. We said we had not identified PMSE own-use congestion.

5.110 We therefore calculated an opportunity cost based on the likelihood of non-PMSE fixed-link deployment of £23.6k per year for both bands. This contrasts with the level of fees collected by JFMG in 2008/09 of £40k.

5.111 We asked the following question:

Question 31. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity cost of spectrum at 7 GHz?

Summary of responses

5.112 Some respondents, including JFMG, accepted the opportunity-cost estimate of spectrum at 7 GHz.

5.113 Some other respondents disagreed with the estimate. For example, the BBC did not believe demand for 7 GHz spectrum from non-PMSE fixed-link deployment was likely to be significant in practice. It argued, given we proposed a zero opportunity cost for most of the spectrum at 2-3 GHz band, a positive AIP for 7 GHz would tend to discourage users of wireless cameras from moving from lower bands into 7 GHz.

5.114 Plum again stated considerable additional demand for these frequencies seemed likely to come from the known future closure of the 2.6 and 3.5 GHz bands for PMSE use and this should be factored into prices.

Our response

5.115 The alternative use on which the 7 GHz opportunity-cost estimate is based is more certain than that for the 2 GHz low band. Therefore, we consider it appropriate to ascribe a positive opportunity cost to 7 GHz but not to the 2 GHz low band. It is unlikely fees reflecting the small opportunity cost in question will deter use of the 7 GHz band, particularly if wireless-camera operators are facing congestion or uncertainty of supply in their access to 2-3 GHz.

5.116 We consider it undesirable to factor in significantly uncertain future changes ahead of time as this might inefficiently distort price signals and cause unjustifiable disruption to the PMSE sector.

Our decision

5.117 We have decided to retain our estimate of £23.6k per year for the opportunity cost of spectrum at 7 GHz, based on Analysys Mason's report.

Cleared spectrum

5.118 In anticipation of any decision the cleared digital-dividend spectrum could be made available to the band manager for PMSE use on a temporary basis in advance of its use by new services, we asked Analysys Mason to calculate an opportunity cost for these bands. This calculation was made in the context of any alternative use also only having two to three years' worth of access to the spectrum. As a result of this limited-duration access, we considered the scope for alternative use was effectively removed as it would not be able to recoup upfront investments in such a short period of time. We also considered there would likely be a very limited amount of own-use congestion between wireless microphones for this period.

5.119 The second band-manager consultation explained, as a consequence, we believed the opportunity cost of temporary PMSE access to cleared spectrum to be zero. We asked the following question:

Question 35. Do you agree with our estimates of the opportunity cost of temporary PMSE access to cleared spectrum?

Summary of responses

5.120 All respondents broadly agreed with these estimates.

Our response

5.121 We have decided to retain our estimates of the opportunity cost of temporary PMSE access to cleared spectrum at zero, based on Analysis Mason' work.

Phasing in AIP on a band-by-band basis

5.122 In both band-manager consultations, we made proposals that had due regard to our key objectives for future PMSE spectrum access. At the heart of these when setting out our pricing proposals were our objectives of moving PMSE users move toward a market-based approach to spectrum while avoiding unnecessary and inefficient disruption to their ability to provide services to citizens, consumers and business customers. We proposed a key way of achieving this would be to phase in AIP-based fees for those bands where not to do so would result in a significant increase in the costs faced by PMSE users. After considering responses to the first band-manager consultation, we remained convinced this was the right approach to take.

5.123 The second band-manager consultation explained Analysys Mason had spoken to a selection of PMSE users to gain an understanding of the likely impact of rises in fees to access spectrum. In its report, Analysys Mason noted it was difficult to estimate with confidence how sensitive PMSE users would be to price rises and, as result, the levels of fees should initially be set at a level that avoided significant disruption to the sector. These should be reassessed at the first formal AIP review, when there were data to judge reactions to changes in those fees.

5.124 We stated we agreed with Analysys Mason it is difficult to know with much certainty what immediate impact initial increases in PMSE users' fees might have given the current structure and level of the licence fees they pay. As a result, we also considered we should set fees at a level that had due regard to our stated objective of helping the PMSE sector to avoid disruption.

5.125 The second band-manager consultation also explained we had considered two possible approaches to phasing in the band manager's opportunity-cost-based licence fee:

- phasing in on a band-by-band basis to reflect different types of PMSE use and different levels of current fees compared with opportunity costs; or
- phasing in the total of all opportunity costs across all bands, averaging different PMSE users' ability to adjust to price changes in different bands.

5.126 We said the first option had the advantage of maintaining a strong link between each band's opportunity cost and the current circumstances of its users. It also gives clearer signals to distinct groups of PMSE users about the value of the spectrum they are using. This, in turn, would more effectively bring them to a position where they faced paying a market rate for their access to spectrum, in line with our objective to facilitate a market-based approach. Finally—but significantly—this option also allows for less-aggressive rates of increase for bands facing the most challenging increases. As a result, where a full opportunity-cost-based licence fee for the band manager would lead to a significant increase in existing fees for end-users, we proposed to set the initial level of the licence fee on a band-by-band basis at a proportion of the full opportunity-cost estimate and then increase this proportion over time.

5.127 We said we considered the best approach was to determine a specific phasing-in period and gradient for each band based on the specific circumstances of the fee increases and PMSE users' circumstances in each case. Accordingly, we asked the following question:

Question 32. Do you agree with our proposal to phase in AIP on a band by band basis?

Summary of responses

5.128 Most respondents agreed with our proposal. For example, BEIRG said it was critical AIP was phased in in a manner that ensured spectrum pricing was affordable to all PMSE users. It agreed AIP should be phased in on a band-by-band basis. This recognised different users would be facing different fee changes and would have different abilities to respond

5.129 PLASA said phasing periods, determined by taking into account the opportunity cost and current revenues for each band, were the best way to bring the PMSE sector to a market-based approach to spectrum in a way that was simple, fair and transparent.

5.130 However, some respondents suggested exemptions as an alternative. For example, ITV suggested a complete exemption from AIP in the first three years to allow the band manager to establish itself and test the market. It also suggested any changes to AIP in the three-yearly reviews should be phased in over the following three years.

5.131 JFMG agreed in principle with phasing in AIP but made comments on specific bands:

- 1.5 GHz—it said phasing seemed superfluous as the spectrum had effectively been reallocated; and
- UHF 1 and UHF 2—in the steady state, it agreed it was right there should be incentives to move from the higher-value spectrum (UHF 2) to the lower-value spectrum (UHF 1). But it argued the cost per assignment of UHF 1 was likely to be 1½ times higher than for UHF 2 under our proposals. JFMG suggested identical assignments in UHF 1 and UHF 2 should remain the same with identical increases until the ceiling opportunity cost of UHF 1 was reached.

Our response

5.132 As discussed above, to avoid causing undue disruption while facilitating the PMSE sector's transition to market based spectrum prices, we have decided to phase in fees where full opportunity cost would result in large price increases. However, the longer it takes for fees to match the value of the spectrum, the longer current inefficient distribution of spectrum among possible uses will continue to impose costs on society. Therefore, we do not agree with ITV's suggestion to provide a complete exemption from AIP in the first three years. Additionally, the longer initial implementation is suspended, the steeper the climb from current prices toward market prices will be.

5.133 In terms of PMSE access to 1517-1518 MHz, we note there is continuing use of this spectrum by the sector. As a result, we consider it is still appropriate to apply phased-in AIP fees to end-users to use these frequencies.

5.134 We note JFMG's concern about distortions in phasing in full opportunity cost for UHF 1 and UHF 2 as a result of the nature of use of these bands by PMSE users, in particular the use of talkback duplex pairs in both bands. However, as discussed above, we believe this issue should be addressed in the consultation on end-user fees. We nonetheless consider the principle of phasing in fees according to the opportunity cost of the bands is appropriate.

Our decision

5.135 We have decided to implement our proposed approach to phasing in AIP on a band-by-band basis to reflect different types of PMSE use and different levels of current fees compared with opportunity costs.

Proposals for phasing in AIP

5.136 In the second band-manager consultation, we proposed to phase in AIP by setting a 40% maximum annual increase in fees. We argued this approach was the most consistent with our other proposals to introduce AIP in a way that would help the PMSE sector to avoid significant disruption while still moving to a market-based approach at an appropriate speed.

5.137 We said, with the levels of uncertainty inherent in our assessment of the opportunity cost of each band, it was prudent to set the phasing-in period at a duration consistent with our aim of facilitating participation of the PMSE sector in a market-based approach to spectrum.

5.138 We set out our proposed band-by-band opportunity costs and phasing periods alongside JFMG receipt levels from 2008/09 for comparison. These are replicated in table 2 below.

Table 2. Proposed phasing periods

Band	Frequencies (MHz)[35]	Annual opportunity cost	Proposed phasing-in period	Phased licence fee in year one	2008/09 licensing receipts
Band I	47-62.75	0	None	None	£47k
Low band	67.75-86.84	0	None	None	£10k
Mid band	139.54-148.74	£2.85k	None	£2.85k	£41k
Band III	175.15-210.1	0	None	None	£84k
UHF 1	425.31-447.51	£359k	8 years	£122k	£88k
UHF 2	454.99-455.48	£1.21m	5 years	£615k	£466k
Interleaved	470-790	0	None	None	£691k
Channel 38	606-614	£122K	None	£122k	£102k[36]
1.5 GHz low	1517-1518	£28.6k	3 years	£19k	£14k
1.5 GHz high	1518-1525	0	None	None	£13k
1.7 GHz	1785-1800	0	None	None	0
2 GHz low	2025-2300	0	None	None	£290k
2 GHz mid	2390-2400	£216k	None	£216k	
2 GHz high	2400-2500	0	None	None	
3.5 GHz	3400-3580	0	None	None	£7k
5 GHz low	5472-5875.5	0	None	None	£13k
5 GHz high	5875.5-5905	0	None	None	0
7 GHz	7110-7425	£23.6k	None	None	£40k
8-12 GHz	8460-12500	£35.5k	None	None	£51k
24-48 GHz	24250-48400	0	None	None	£4k
Totals		£2.03m			£1.97m

[35] PMSE users do not have access to the entire spectrum in the frequency ranges quoted.
[36] Relates to receipts for channel 69 which channel 38 is replacing.

5.139 We asked the following question:

Question 33. Do you agree with our proposal to phase in the band manager's AIP based licence fee such that no band increases by more than 40% in the first year that it is operating compared to 2008/09 licensing receipts?

Summary of responses

5.140 Some respondents considered, where phasing was thought to be appropriate, the proposed 40% cap on any increase in year one was too high. For example:

- ITN said it would prefer a maximum 20% rise in any band. It argued a 40% rise would jeopardise business plans;
- SIS Live stated it was presumptuous of us to assume a 40% increase in costs was bearable; and
- PLASA suggested AIP should be set at the level of 2008/09 licensing receipts during the first year of operation.

5.141 Some respondents, including JFMG, Arqiva and Plum, pointed out the phasing of AIP would not necessarily cap annual price rises at 40% because AIP was only one input cost. Therefore, cost reallocation (on a band-by-band basis) could increase the price for an end-user's licence beyond that of any underlying increase in AIP.

5.142 JFMG also suggested we needed to consider whether these administrative costs should be phased in also and, if so, how the band manager could recover its costs.

Our response

5.143 Our original impact assessment of this proposal, in which we considered whether to set the maximum increase at a level higher than 40%, is contained in section 6 of the second band-manager consultation.

5.144 In light of responses that expressed concern 40% was too high, we have considered the additional options of:

- reducing the limit to 20% of 2008/09 fee-receipt levels; and
- setting AIP in the first year equal to 2008/09 licensing receipts.

5.145 However, we believe both of these options would cause unacceptable delays to the convergence of PMSE spectrum fees with market rates and therefore delay the efficiency benefits of opportunity-cost-reflective prices. We are also concerned implementation of either of these options would likely weaken incentives for users to move to lower-cost bands and could therefore delay the opportunity for higher-value use. Setting AIP equal to 2008/09 licensing receipts has the added disadvantage of eliminating all the efficiency benefits of opportunity-cost-reflective price signals from the first year after implementation.

5.146 While we acknowledge the concerns raised by some stakeholders, it is important to note not all bands will increase in price. Therefore, some users will not face price rises at all. Users with licences to access more than one band or who are able to move to lower-cost bands, are also unlikely to face significant increases in licence

fees even if the price of accessing one of the bands they currently use increases. Additionally, as some respondents pointed out, a 40% increase in AIP does not necessarily translate to a 40% increase in fees for the end-user as the structure of fees and licences—which we will consider in a future consultation—might also impact on end-user prices.

5.147 Additionally, we noted in the second band-manager consultation the total number of PMSE licences issued continued to increase, even after licence fees for PMSE users rose by 20% in 2005 and in 2007. This leads us to believe a 40% increase in AIP for some PMSE bands is unlikely to lead to significant falls in demand, particularly as this represents a maximum increase for any one band rather than an average across all bands.

5.148 The detailed pricing structures for fees will not be set until after consultation later this year. Although we recognise a 40% increase in AIP does not necessarily translate directly into a 40% increase in end-user licence fees, we intend to ensure any increases in licence fees from existing levels will be bearable by the PMSE sector.

Our decision

5.149 We continue to consider phasing in AIP so no band increases by more than 40% in year one will strike a balance between moving PMSE users toward the market rate for spectrum and avoiding undue disruption. Therefore, we have decided to phase in AIP so no band increases by more than 40% in the first year compared to 2008/09 licensing receipts, as proposed in the second band-manager consultation.

Clearing excess demand through pricing

5.150 The second band-manager consultation identified some spectrum used for PMSE can be heavily congested at certain times of the year and/or in certain geographic locations. However, our methodology used to set AIP identified such spectrum as having a zero (or near-zero) opportunity cost. This is because our estimates of opportunity cost are derived from UK-wide use over a year. After the opportunity-cost estimates are scaled for the limited time period and geographic area in which congestion is present, resultant opportunity costs are limited. As such, the end-user licence fees for such spectrum would be based on spectrum-management costs, not opportunity cost.

5.151 We indicated we would prefer the use of non-price mechanisms in managing excess spectrum demand only at certain times and locations. We stated such an approach was comparable to JFMG's current practice of taking account of the needs of all PMSE users when deciding how to assign spectrum where demand exceeds supply.

5.152 This approach to managing excess demand by means of a non-pricing mechanism would have been more in keeping with our general approach of ensuring prices to PMSE users were set at a conservative level to reduce the risk of regulatory failure.

5.153 We acknowledged both price and non-price mechanisms could work effectively but believed the non-pricing option was better aligned with our objective of avoiding disruption to PMSE users because it would mean the band manager could not recover revenues that exceeded its costs. It would also prevent authorisation decisions being made based only on end-users' ability to pay.

5.154 We said we would be interested to hear from stakeholders what they considered to be fair criteria for authorising spectrum access where there was excess PMSE demand for spectrum. Accordingly, we asked the following questions:

Question 3. Do you agree with our proposal that under the benchmark approach excess PMSE demand for spectrum should be dealt with by the band manager using non-pricing methods?

Question 4. Do you have any views on how best to deal with excess PMSE demand using non-pricing methods?

Summary of responses

5.155 While some respondents agreed with our proposal, a number, in particular JFMG and Arqiva, questioned whether our proposed approach to temporal and geographic congestion was the most appropriate. They argued the price charged should reflect the opportunity cost imposed in order to secure efficient use of spectrum where such congestion arose. To do otherwise would mean temporal and geographic congestion would continue to be present and users would not be exposed to price signals that might incentivise them to use spectrum more efficiently.

5.156 Other respondents, including Plum, argued non-pricing methods would be subjective, prone to challenge and encourage users to apply for more spectrum than they needed. It argued allowing willingness to pay to be taken into consideration would be more effective at dealing with congestion and could also be a more efficient way of recovering fixed common costs.

Our response

5.157 Our original proposal in part sought to address concerns setting UK-wide annual fees for the band manager to reflect geographic and/or temporal peaks in demand within a band would be too blunt an instrument to address congestion that was temporally and geographically limited. Such an approach would mean prices would be high at times and at locations where there was no excess demand. To avoid this outcome, we did not reflect these specific peaks in demand in the fees we proposed to charge to the band manager.

5.158 However, now we have deferred the band-manager award until after the London 2012 Games and we will be setting end-user fees in the interim period, there is scope for us to set licence fees that vary by location and time of year without risking PMSE users being charged excessive fees.

5.159 In this context, we considered whether to introduce a form of peak-demand or congestion pricing or to retain our original proposal for temporal and geographic congestion to be dealt with my non-price means.

5.160 We agree with stakeholder comments allowing peak-demand pricing would avoid the subjectivity of non-price demand management mechanisms and, if prices are set accurately, would secure the most efficient use of spectrum. However, we are also mindful it might be difficult to arrive at an accurate estimate in all situations at a cost that is proportionate to our objectives. Therefore, this option carries a risk of implementing a licence fee that is too low (which might leave some congestion remaining) or too high (which could result in underutilisation of spectrum at a time and location where there would otherwise be congestion). Such an outcome would

be inefficient and so inconsistent with our approach of setting fees to PMSE users that will help them to avoid significant disruption.

Our decision

5.161 We will explore how we can introduce greater granularity in the PMSE fee structure, particularly on a temporal and geographic basis and set out our proposed approach in our fees consultation later this year. Such an approach could provide a price signal to help secure the most efficient use of spectrum at times and in places of high demand and introduce PMSE users to the concept of fees that vary by time and location. Given our concern about implementing fees at the wrong level, it will only be helpful to introduce peak-demand pricing if this can be done in an efficient way without causing undue disruption.

Other aspects of introducing AIP

5.162 The second band-manager consultation explained, in developing our proposals for setting the band manager's licence fee, we had been mindful we should where possible try to secure consistent outcomes for PMSE users compared with those in other sectors that also face paying licence fees based on AIP. This is particularly the case where PMSE and other users may face different fees to use spectrum otherwise very similar in nature.

5.163 Therefore, we acknowledged the need to strike an appropriate balance between moving PMSE users to market-based, cost-reflective prices to ensure efficient use of spectrum on the one hand and avoiding disruption to the sector and the benefits it provides to citizens and consumers on the other.

5.164 We set out a summary of our proposals for introducing AIP for bands to be awarded to the band manager. We highlighted the fact a band shown as having a zero opportunity cost did not mean PMSE users would not be charged for access to that spectrum but instead would still have to pay a fee that covered the band manager's administration costs (including a reasonable return).

5.165 We asked the following question:

Question 34. Do you have any comments on any other aspects of our proposals to introduce AIP for the spectrum to be awarded to the band manager?

Summary of responses

5.166 SIS Live commented having to recover AIP on each band individually removed the freedom to balance demand across more than one band, even when bands are essentially the same to PMSE users.

5.167 JFMG anticipated difficult operational issues arising from cliff-edge pricing changes between bands perceived to be interchangeable by PMSE users. It also stated it was vital there was greater clarity about the issue of aggregating between bands and across assignment types.

Our response

5.168 We acknowledge SIS Live's comments the use of some bands that have differing opportunity costs are viewed as equal by PMSE users. However, this is precisely why we believe it is important to set AIP on a band-by-band basis. Efficient use of

spectrum will be promoted when users are incentivised to use a mix of inputs in producing their output taking full account of the opportunity cost of different choices. Therefore, it is important for users to have the incentive to consider moving from high-cost to low-cost bands, particularly if they can use them in the same way.

5.169 The details of the new pricing structure, including consideration of any impacts of price differentials between bands in relation to temporary or geographic congestion will be addressed in the fees consultation later this year.

5.170 We note JFMG's concerns about the issue of aggregating between bands and assignment types. We do not believe there should be aggregation of costs between bands because this would weaken the price signals from the introduction of AIP. The translation of band by band AIP fees into specific licence fees will be considered in more detail when the detailed pricing structure is developed.

Reviewing AIP

5.171 The first band-manager consultation proposed we would set the band manager's licence fee initially for a period of three years and then conduct a detailed review of the opportunity-cost estimates and associated licence-fee levels for the entire spectrum awarded. This review would take into account:

- our general spectrum-pricing framework at the time;
- specific market information on spectrum values that would become available following the digital-dividend and other relevant awards and secondary trading activity and following market developments in the PMSE and other sectors using spectrum; and
- broader market experience in the relevant bands and in the PMSE sector.

5.172 We went on to propose we would review the licence fee periodically but no more frequently than every three years. This would provide a degree of stability and regulatory certainty for the band manager and its customers and so reduce transaction costs.

5.173 The second band-manager consultation said this remained our favoured approach to reviewing AIP and we continued to propose we proceed on this basis. Accordingly, we asked the following question:

Question 37. In light of our further proposals, do you agree that we should first review the AIP charged to the band manager after three years?

Summary of responses

5.174 Many respondents agreed three years was a reasonable timeframe before the first review. JFMG argued reviews of AIP in PMSE should not be undertaken in isolation but should be linked to wider strategic reviews across all relevant sectors. The BBC agreed a first review of AIP after three years seemed sensible. BEIRG stated PMSE users would suffer unacceptable disruption if the basis of their fees for spectrum access was changed any more frequently than every three years. Transfinite believed the review of AIP after three years should be fundamental, with a different approach thereafter.

5.175 Arqiva and Plum argued there should be long lags between changes in spectrum use initiated by the band manager and recalculating AIP taking the changes into account because changing spectrum use is a slow process as a consequence of complementary investment in infrastructure and other systems.

5.176 PLASA argued a longer period before the first review of AIP would be more appropriate to allow the new arrangements to bed down and the PMSE sector to adapt. After that, every three years might be about right.

Our response

5.177 Our original proposal to review the levels of AIP after three years was designed to strike a balance between giving the band manager sufficient certainty to plan its business and allowing us to intervene with appropriate speed if any fee levels were set too high and were causing undue disruption to the PMSE sector.

5.178 Subsequently, we published a consultation (the spectrum-pricing consultation) on 29 March 2010 on a revised framework for spectrum pricing.[37] In order to promote regulatory stability, we proposed the principle we would normally seek stakeholders' views on a proposal to review fees only if the evidence suggested this would be justified, taking into account evidence of sufficiently material misalignment between actual fees and the current value of the spectrum (or the cost of managing it) and other relevant factors

Our decision

5.179 In light of the band-manager award being deferred and the proposals in the spectrum-pricing consultation we have decided to change our approach to align with the latter. As a consequence, we will only consider reviewing AIP where the evidence suggests this would be justified. We will take into account any changes in the use of and/or demand for bands with positive opportunity costs during phasing periods in determining the need for such a review.

Summary of our decisions on spectrum fees

5.180 In summary, our decisions on fees for future PMSE spectrum access are as follows:

- we will assess PMSE and non-PMSE uses of spectrum when we assess its opportunity cost;
- we will make this assessment based on the secondary nature of PMSE use where relevant;
- we confirm the band-by-band opportunity-cost estimates set out in the second band-manager consultation;
- AIP will be calculated on a band-by-band basis;
- AIP will be phased in on a band-by-band basis as set out in the second band-manager consultation;
- we will consider introducing an element of temporal and geographic congestion pricing in our fees consultation later this year; and

[37] http://stakeholders.ofcom.org.uk/binaries/consultations/srsp/summary/srsp_condoc.pdf.

- we will only consider reviewing AIP where the evidence suggests fees are materially out of line with the opportunity cost (or spectrum-management costs) it seeks to reflect.

Section 6

Security of tenure

Introduction

6.1 The PMSE consultation set out a number of reasons why we considered there were barriers to the formation of a market for PMSE spectrum access. One of the key factors we identified was the absence of enduring rights of spectrum access for users.

6.2 PMSE has historically been licensed on a short-term basis with licences typically issued on a 48-hour or annual basis. PMSE access to spectrum has, with a small number of exceptions, been on a secondary basis to one or more primary services. That access is granted on a non-interference, non-protection basis and confers no formal or enduring rights.

6.3 Our further work on moving the PMSE sector to a market-based approach to spectrum access sought to remedy this lack of enduring rights by establishing protected access for PMSE users to the spectrum we proposed to award to the band manager. The approach we set out in full in the second band-manager consultation was:

- the band manager would have to allow PMSE users to access the spectrum awarded to it so long as they were prepared to pay FRND prices; and
- this protected access would last until 2018, at which stage PMSE users would have to source their spectrum from the market.

6.4 We considered this represented a fair balance between giving certainty of spectrum access to the PMSE sector in the medium term while ensuring the spectrum could be made available for the most valuable use to society in the longer term.

6.5 However, in light of our decision to defer the band-manager award until after the London 2012 Games and in response to specific concerns raised in response to the second band-manager consultation, we have revisited our approach to providing protected spectrum access to PMSE users.

The impact of deferring the band-manager award

6.6 Our decision to defer the band-manager award means our approach to establishing enduring spectrum-access rights through the band manager is not relevant in the interim period.

6.7 This does not remove the benefits of establishing those rights through other means even before we reactivate the band-manager award. We refer to these other means as providing security of tenure to PMSE users. We are introducing security-of-tenure provisions in the interim period for the following reasons:

- when the band-manager award is reactivated, the establishment of enduring spectrum-access rights combined with the band manager's ability to aggregate PMSE users' spectrum demand will, as originally intended, go a significant way to

fulfilling our objective of moving the PMSE sector to a market-based approach to spectrum; and

- in the meantime, PMSE will users will be faced with other fundamental changes to the way they access spectrum—not least the introduction of AIP-based licence fees—and will need to have sufficient certainty of spectrum access when making long-term investment decisions.

6.8 We are conscious of the need for the PMSE sector to have confidence in its future access to spectrum at a time when it has undergone a period of significant uncertainty. In particular, our decision to clear channel 69 of PMSE use has thrown into sharp relief the need for a reasonable period of certainty before users can make efficient decisions to invest in new equipment. Our decisions on security of tenure are designed to deliver this.

What we mean by security of tenure

Security of tenure as a general principle

6.9 As a general principle, we believe defining security of tenure is a relatively straightforward proposition: if we degrade PMSE users' access to the spectrum available to them (especially by permitting competing non-PMSE use) within the period when security of tenure applies and this results in a loss to PMSE users (e.g. a need to replace equipment prematurely), affected PMSE users would be able to expect some redress.

6.10 However, in line with our statutory duty to secure the optimal use of spectrum for all users, we also have to ensure we observe the following:

- we should not rule out allowing non-PMSE use of this spectrum where there is greater value to society from that alternative use;

- we should not reduce the legitimate rights of primary users of spectrum shared with PMSE on a secondary basis and of users of adjacent spectrum to change their spectrum use in accordance with their rights; and

- we should not frustrate our duty to licence-exempt PMSE use of spectrum where we are satisfied this is not likely to cause harmful interference.

6.11 Subject to these considerations, we do want PMSE users to have sufficient security of tenure to be able to make more efficient investment decisions in the interests of a well-functioning market.

Allowing non-PMSE use of spectrum available for PMSE

6.12 The second band-manager consultation proposed we would allow the band manager to permit non-PMSE use of the spectrum awarded to it if it sought our permission in advance and could show it could otherwise meet its obligations to PMSE users. The terms of permitted non-PMSE use would not be regulated. This proposal was designed to promote efficient use of the spectrum.

6.13 In general, PMSE users responded favourably to the need for our prior approval. However, JFMG and Arqiva argued this proposal had the potential to reduce spectrum efficiency and disincentivise the band manager from seeking more valuable uses.

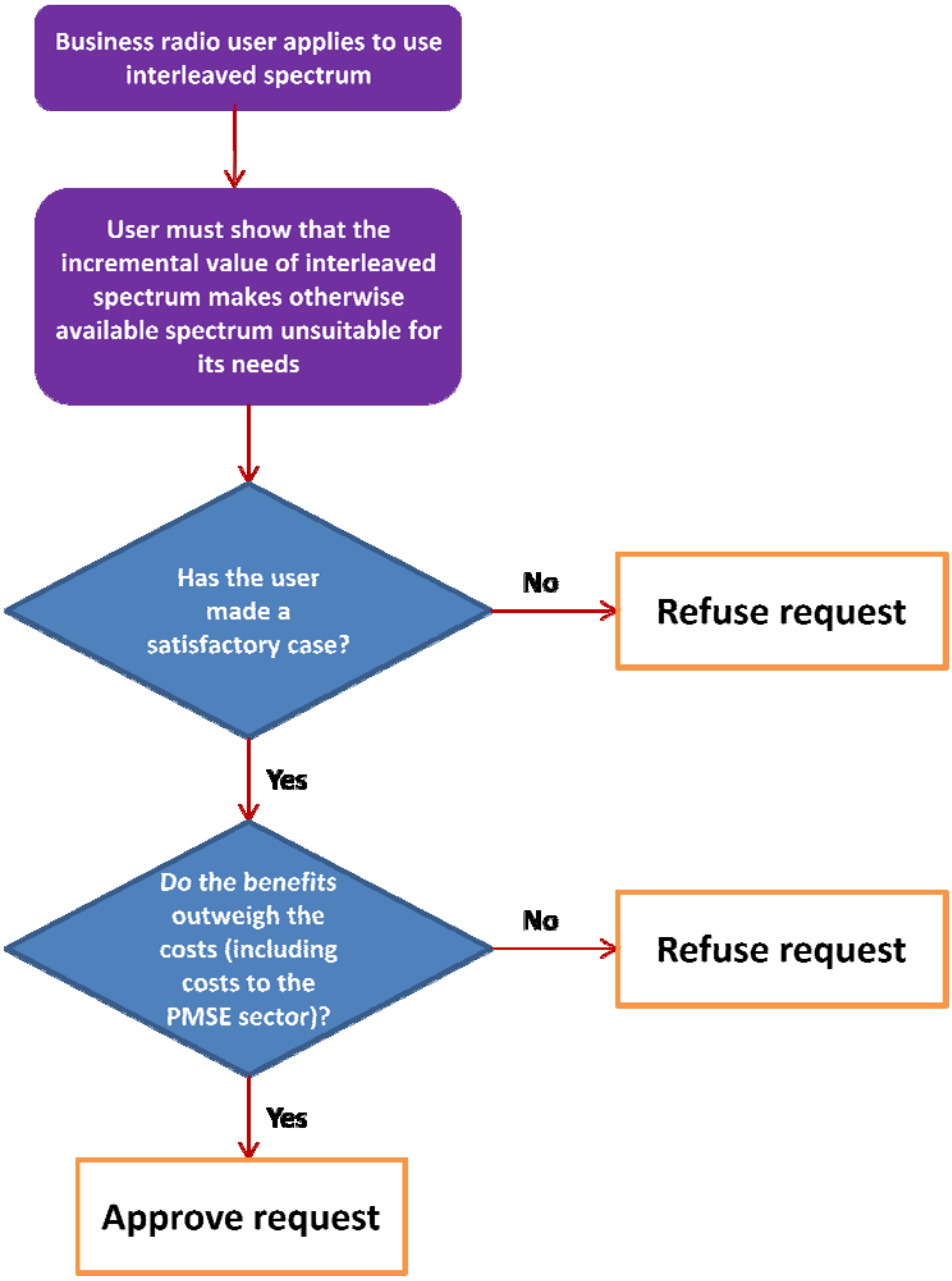
6.14 Now, of course, all decisions about non-PMSE use are ours to take until the band-manager award is reactivated. We recognise this issue is of particular concern to PMSE users. A number of stakeholders have pointed to their inability to compete financially with others who might want to use the same spectrum as PMSE in the future. We therefore need to approach this issue carefully, ensuring we meet our duty to secure optimal spectrum use in a manner consistent with our stated objective of helping the PMSE sector to avoid significant disruption.

6.15 Our approach in the interim period before we reactivate the band-manager award is to base our decisions on an assessment of the existing opportunities for the potential non-PMSE use to access spectrum not available for PMSE use. In other words, if a rival service wants to use spectrum available for PMSE, it would have to justify why the incremental value of this spectrum means other existing available spectrum is unsuitable for its needs.

6.16 Where an alternative user makes such a case, we would seek views from affected stakeholders, including PMSE users. We would make a decision at the time, and with reference to the significance to PMSE use, on the form the consultation would take. The more significant the impact on any existing or prospective PMSE use would be, the more detailed the consultation process we would be likely to initiate. We would ultimately only allow the non-PMSE use of spectrum available for PMSE if the benefits to society outweighed the costs.

6.17 The process for approving non-PMSE use of spectrum available for PMSE is set out in figure 1 below. It uses, for indicative purposes, one of the two most likely alternative services to PMSE identified by Analysys Mason in its work on AIP: business radio (the other being fixed links).

Figure 1. Illustrative process for approving business-radio use of spectrum available for PMSE



Short-term use

6.18 In defining the circumstances under which we would allow non-PMSE use of spectrum available for PMSE, we are keen not to unduly frustrate some short-term uses that would be unlikely to impact adversely on PMSE. An example of this might be a request for business-radio use of interleaved spectrum for a 48-hour period.

6.19 Such short-term use is not likely to be common as most spectrum users' requirements mean a much longer-term licence would be more appropriate than those currently issued by JFMG. Moreover, a requirement for short-term access to spectrum may well be for the purposes of a special event, albeit not necessarily with a programme-making aspect.

6.20 We intend to approach such short-term requests on a case-by-case basis, in particular at major events where spectrum is known to be scarce. We will be mindful of the impact of this approach to ensure ongoing PMSE use is not adversely affected.

6.21 It is worth noting we can already and will continue to grant nonoperational licences to use any part of the spectrum, subject to coordination with existing users.[38]

Channel 38

6.22 A number of PMSE stakeholders have expressed concern the opportunity cost of channel 38 would rise, with a resultant increase in their access fees, if the need to protect continental radioastronomy use of channel 38 ceased.

6.23 We recognise why stakeholders have raised these concerns, but we do not consider it appropriate to speculate on what might happen in these circumstances:

- we do not do so for any other spectrum users even though they may be faced by similar situations. We see no reason to treat PMSE users differently;
- there is no automatic assumption fees would rise if a more valuable alternative use of the spectrum were to emerge; and
- we cannot know in advance the full circumstances of any change in continental radioastronomy use of channel 38 and could only consider how to act when we were in possession of those facts.

6.24 In any case, we reiterate we know of no plans for radioastronomy to stop using channel 38 in the Netherlands, France or Belgium.

The period security of tenure should apply

6.25 The digital-dividend statement and the first band-manager consultation set out our reasoning for ending protected PMSE access to spectrum in 2018. This was based on a 10-year period from 2008, when we then expected to hold the band-manager award. We chose 10 years because we believed this balanced the lifecycle of equipment with the opportunity cost of precluding alternative uses of the spectrum and would give PMSE users sufficient time to adapt to the changes associated with the introduction of a band manager.

6.26 Despite the deferral of the band-manager award, there will still be changes to the way PMSE users access spectrum. However, these will take effect later than the original 2008 timeframe. Depending on the spectrum being used, they are as set out in table 3 below.

Table 3. Forthcoming changes to PMSE spectrum access

Change	Spectrum affected	Timing
Confirmation of availability of interleaved spectrum after DSO	Interleaved spectrum	Late 2010
Announcement of new, AIP-based licence fees	All spectrum available for PMSE	Spring 2011
Full UK-wide availability of channel 38	Channel 38	September 2011

[38] See http://licensing.ofcom.org.uk/binaries/spectrum/non-operational-tech-licence/ofw357nonopguide.pdf.

6.27 We consider PMSE users will only be able to make efficient investment decisions in response to the changes when all relevant information is available to them. This means security of tenure should take effect when users know:

- what fees they will be paying; and
- what spectrum they will be able to use.

6.28 In other words, it is the later of these changes.

6.29 This means, when calculating the end date for security of tenure for most spectrum available for PMSE, we should take spring 2011 as our starting point. However, another consideration for PMSE is channel 38 will not be available as an effective replacement for channel 69 across the UK until September 2011, although this will not preclude users from investing efficiently in new equipment. However, in light of the proximity of these dates and the risk of introducing unnecessary complexity, and acknowledging the uncertainty experienced by the sector due to recent changes in spectrum availability and policy, we have decided we will take September 2011 as our starting point for calculating the initial period security of tenure should apply for all spectrum available for PMSE.

6.30 In terms of the duration of that initial period, we have identified three options:

- five years, in line with licence conditions for other sectors;
- 10 years, for the reasons previously set out. We continue to believe this would allow for efficient investment decisions by PMSE users while not unduly sterilising the spectrum for alternative uses in the longer term; or
- 15 years, in common with our assessment of the average equipment lifecycle for funding clearance of channel 69.

6.31 We have looked at how other spectrum users are licensed and note our standard approach is set out in the General Licence Conditions Booklet.[39] That approach is to have a rolling five-year notice period for individual licences issued for earth stations, business radio and coastal stations. Five years is also the notice period we have set for varying or revoking auctioned licences for spectrum-management reasons when their initial term has expired.

6.32 This five-year security of tenure period, as provided to other sectors, is likely to be sufficient to allow efficient investment decisions by PMSE under normal circumstances. However, we are conscious of the recent uncertainty caused by the band manager proposals and their subsequent deferral as well the approaching period of significant change, due to the initial move to more market based pricing through the introduction of AIP for the first time. We believe it is appropriate to provide the sector with additional security than would otherwise be needed for the initial period of adaptation in order to minimise disruption to the sector and the services it provides.

6.33 While fifteen years' duration would reflect the lifecycle of many wireless microphones, we believe it goes further than is likely to be needed for PMSE users to make efficient investment decisions. The need for certainty to enable efficient investment

[39] http://licensing.ofcom.org.uk/binaries/spectrum/regulations-technical-reference/General_Licence_Conditions.pdf.

decisions must also be balanced against the risk of inefficiently sterilising the spectrum for alternative uses. We consider fifteen years' duration would increase that risk significantly and is certainly more likely to lead to inefficient sterilisation of the spectrum for alternative uses.

6.34 We have therefore decided a 10-year period continues to strike the appropriate balance between giving sufficient certainty for PMSE users to make efficient investment decisions while minimising the risk of inefficient spectrum use. Therefore, the initial period of security of tenure should end in August 2021.

Dealing with the cliff edge

6.35 One of the key concerns consistently raised by PMSE stakeholders was the uncertainty they would face as the date for the end of protected spectrum access approached. BEIRG, for example, argued in its response to the second band-manager consultation PMSE users would still be faced with market failure when this cliff edge was reached in 2018.

6.36 The interim PMSE statement indicated we accepted these arguments. We now consider PMSE users need an ongoing degree of certainty when making investment decisions that potentially continues after the end of the initial period of security of tenure in August 2021.

Our assessment of the options

6.37 In terms of how we provide that certainty, we have looked at how other spectrum users are licensed. As discussed above, that approach is to have a five-year notice period.

6.38 Given the very wide range of users to whom this applies, we considered whether PMSE users should be subject to equivalent arrangements—"equivalent" rather than "the same" because individual rights of spectrum access are likely to remain relatively short to reflect the nature of the sector's requirements. We also considered other options with longer and shorter notice periods, yielding four in total:

- option 1—ending PMSE protection when the initial 10-year period of security of tenure ends in August 2021;
- option 2—applying a rolling 10-year notice period to PMSE protection, not to end before the initial period of security of tenure ends;
- option 3—applying a rolling five-year notice period to PMSE protection, not to end before the initial period of security of tenure ends, in line with how other spectrum users are licensed; and
- option 4—applying a rolling two-year notice period to PMSE protection, not to end before the initial period of security of tenure ends.

6.39 Option 1 has the advantages of providing incentives for users to invest in technology that can use low-value spectrum or is versatile and of allowing flexibility after 2021 to reallocate spectrum in the interests of securing efficient use. However, as raised by PMSE stakeholders, providing no ongoing security of tenure would create uncertainty in the sector as 2021 approaches and beyond that could disincentive otherwise-efficient investment and disadvantage users.

6.40 Option 2 presents the opposite problem as accepting a 10-year delay or the need for (potentially significant) redress would significantly reduce our flexibility to reallocate spectrum. Although we consider it to be appropriate to provide 10 years security for the initial adaptation period as discussed above, providing such a long notice period on a continuing basis would also insulate the PMSE sector from being exposed to market forces in the long term. It would provide certainty for PMSE users could extract the full value of any investments in new equipment. However we also consider it would encourage inefficient investment and/or deter efficient investment in developing equipment suitable for lower-value spectrum.

6.41 Option 3 also reduces our flexibility to reallocate spectrum compared to option 1. However, we believe it delivers a more appropriate level of flexibility than option 2 as a five-year notice period could likely be reasonably factored into policy proposals and new investment decisions in many cases. This option also has the benefits of giving more certainty to the PMSE sector than options one or four and, as discussed above, of being consistent with our approach to other spectrum users.

6.42 Option 4 more closely reflects the short-term nature of PMSE licensing arrangements than the other options. It also leaves us with more flexibility to reallocate spectrum than options two and three and provides more certainty for users than option one. However, we do not feel two years' notice is sufficient to allow PMSE users to confidently make investment decisions, so this option might reduce incentives for efficient investment.

Our decision

6.43 In light of this assessment, we have decided access to spectrum available for PMSE should not be degraded for spectrum-management reasons unless we have given five years' notice, not to be triggered before September 2016. We believe this strikes the appropriate balance between allowing the PMSE sector the security it needs to make efficient investment decisions, recognising the unique circumstances of the current period of change, and retaining our flexibility to effectively carry out our duty to ensure efficient spectrum use, as well as being consistent with our established approach to other spectrum users.

6.44 This decision refers to security of tenure of a band as a whole. Individual licences within a band can be revoked for breach of licence as well as through a process of individual notice as set out in the Wireless Telegraphy Act 2006.[40]

6.45 The exceptions to this are:

- if it appears to be requisite, necessary or expedient to do so in the interests of national security or for the purposes of complying with an international obligation of the UK; or

- if it appears to be requisite, necessary or expedient to do so for the purpose of complying with a Direction to us by the Secretary of State under section 5 of the Communications Act or section 5 of the Wireless Telegraphy Act.

Scope of decisions on security of tenure

6.46 Our decisions on security of tenure apply to the spectrum we are confirming as available for future PMSE access in this statement. They apply because users will

[40] www.opsi.gov.uk/acts/acts2006/pdf/ukpga_20060036_en.pdf.

need to adapt to the new arrangements (in particular, the introduction of AIP-based prices) we are starting to put in place as far as existing use of this spectrum is concerned.

6.47 If new spectrum is made available for PMSE access in future, there will be no presumption these provisions apply. We will instead need to determine the terms of PMSE access on a case-by-case basis. PMSE users will then need to choose whether to deploy in this new spectrum given the information they have at that time.

If security of tenure is breached

6.48 Security of tenure is only meaningful if there is a consideration of redress where we (as opposed to a primary or adjacent user acting within its rights) degrade PMSE users' access to spectrum within the period it applies.

6.49 We cannot say in advance what form redress would take if we breached security of tenure in this way because it will very much depend on the circumstances at the time. An example of circumstances where redress is being provided to PMSE users is the clearance of channel 69. To help PMSE users clear channel 69, we have made available replacement spectrum, and Government has committed to provide funding to help users move. Further details on channel 69 clearance are set out in the funding statement[41].

Summary of our decisions on security of tenure

6.50 In summary, our decisions on security of tenure of spectrum available for future PMSE access are as follows:

- PMSE users will have security of tenure of the spectrum confirmed in this statement as available for their future access until August 2021 or on five years' notice, whichever is later;
- this is subject to the legitimate rights of primary and adjacent spectrum users and our acting in the interests of national security or to comply with an international obligation of the UK or a Direction by the Secretary of State;
- non-PMSE use of this spectrum will need to be justified on the grounds of delivering greater benefit to society, and we will take the views of affected stakeholders into account in our decisions; and
- where we degrade security of tenure so there is a consideration of redress, we will assess its nature at the time in the light of all relevant factors.

[41] http://stakeholders.ofcom.org.uk/binaries/consultations/pmse_funding/statement/statement.pdf.

Section 7

Next steps

7.1 This statement concludes on most of the key outstanding issues raised in the two band-manager consultations.

7.2 In light of our decision to defer the band-manager award, we will need to engage further with stakeholders to determine how to translate our decisions on AIP into end-user fees. We expect to publish a consultation on this later in the year, followed by confirmation of new fee levels in spring 2011. These fees will take effect in the second half of 2011.

7.3 We intend to reactivate the band-manager award after the London 2012 Games.

Annex 1

Consultation responses

Introduction

A1.1 This Annex—specifically table A1 below—sets out key responses to those proposals in the band-manager consultations we have addressed in this statement. Because of the deferral of the band-manager award, we have not taken forward a number of other proposals and do not, therefore, consider consultation responses to them here. These proposals related to:

- the duration and notice period of the licence to be awarded to the band manager;
- the design of the selection process for the band manager; and
- details of how the band manager should meet its obligations to provide spectrum access to the PMSE sector on FRND terms and conditions.

A1.2 A number of other proposals have been taken forward in the context of related work, where consultation responses were fully addressed. Again, we do not deal with them here. These proposals related to:

- PMSE access to channels 69 and 38 (addressed in both the 800 MHz statement and the funding statement);
- PMSE access to channels 61 and 62 (addressed in both the 800 MHz statement and the funding statement); and
- licence-exempt cognitive access to interleaved spectrum (addressed in the context of that work).

A1.3 Finally, the second band-manager consultation addressed in detail responses to proposals in the first band-manager consultation that related to our approach to introducing AIP to the PMSE sector. We do not revisit those responses here, either.

Table A1. Consultation responses

Stakeholder response	Our response
Spectrum availability (First band-manager consultation)	
Question 4. Do you have any views on our proposed approach to protecting reception of DTT services?	
The BBC said relaxing the protection of DTT to the preferred multiplex would release additional radio-microphone channels but these channels would also suffer elevated noise levels due to co-channel interference from non-preferred DTT multiplexes. This was unlikely to meet the requirements of professional users and might also impact the reception of DTT services.	Our provisional assessments of the likely availability of interleaved spectrum for wireless-microphone use after DSO indicate there will be more than sufficient to meet historic peak PMSE demand. These assessments have taken into account interference from DTT into wireless microphones. A full assessment will be made available when negotiations to clear the 800 MHz band are completed later in

BEIRG welcomed the attempt to alter protection options for DTT but doubted significant gains in interleaved-spectrum availability would be made from using DPSA coverage. Non-preferred transmission sites would still cause interference, even though they were no longer protected, and prevent lower-power use of these frequencies. ITN could not specifically comment on the protection of DTT services but welcomed any measures that would increase the availability of interleaved spectrum for PMSE. Similarly, the Professional Services Association (PSA) stated any approach that actually increased the amount of spectrum available for PMSE as well as decreasing the amount of equipment required to access it UK-wide was welcomed. PLASA stated the potential benefits from increased interleaved-spectrum availability should be taken into account when considering the best coverage for DTT services. We should reassess the proposed approach for protecting the reception of DTT services further to a comparison of white-space maps and DPSA protection options.	2010.
Question 5. Do you agree with our proposal not to award the bands between 11.7 GHz and 12 GHz to the band manager?	
Arqiva agreed with this proposal but argued the band manager should be free to apply to gain access to this band if there was future demand. The BBC considered continuing use of 11.7-12 GHz might cause significant interference to BSkyB and freesat services (co-channel with Band E of the Astra 2B transponder). As a result, it might be appropriate to remove PMSE uses. Similarly, PMSE use of 12.2-12.6 GHz caused co-channel interference to Band F and Band G of the Astra 2B transponder.	We agree, in principle, any future band manager should be free to apply for access to 11.7-12 GHz (or, indeed, any other spectrum) if future demand emerges. We agree with the BBC continuing PMSE use of 11.7-12 GHz could cause interference into DTH satellite services. PMSE access to 12.2-12.6 GHz is on a non-interference and non-protection basis to primary services. Any evidence of interference should be forwarded to our Spectrum Engineering and Enforcement team for investigation.
Question 6. Do you agree with our general approach of awarding the remaining 49 Ofcom-managed bands allocated to PMSE but lying outside the digital dividend to the band manager?	
Arqiva agreed with this proposal but stated any geographic interleaved spectrum not awarded should also be offered to the band manager on a case-by-case basis, with AIP set to reflect the lack of alternative interest.	We agree with Arqiva any interleaved spectrum not released through other means (including any future geographic interleaved awards) should be made available for PMSE access.

BEIRG welcomed the award of spectrum to a band manager but objected to the time limit set for ending PMSE protection as 10 years might not be enough. Taking into account the latest date for DSO (2012), there would be insufficient time for PMSE equipment to be used throughout its lifecycle. It also expressed its doubts whether PMSE users could ever compete fully in a spectrum market. JFMG agreed and pointed out industry had already demonstrated its preference for a single organisation to manage and coordinate spectrum access.	We agree with BEIRG's concerns 2018 would be too soon for the initial period of protected PMSE access to end given the changes are being implemented later than originally anticipated. We have therefore decided PMSE users should have improved security of tenure in the spectrum we are confirming as available for future access. This will last until 2021 or after five years' notice has been given, whichever is later.
Question 7. Do you agree with our proposal to award key PMSE bands to the band manager?	
JFMG agreed but also noted future access to some spectrum might change due to MOD ownership. It also wanted us to consider adding VHF channels at 175-210 MHz to the list of key bands. Mr. Adrian Pickering agreed and also argued we should take measures to facilitate the lease of any spare spectrum to the band manager. The PSA agreed in principle but subject to improved understanding of our powers of enforcement and ability to effectively police PMSE use of spectrum and sanction pirate users.	We agree with JFMG access to MOD spectrum may change in the future depending on any changes the MOD puts in place. PMSE users can already access spectrum at 175-210 MHz on a case-by-case basis. We can consider whether to make it available on a more secure footing if there is evidence of sustained PMSE demand and this use is compatible with the rights of the primary user. With the deferral of the band-manager award, our enforcement role remains as before. We will seek to give greater clarity to the PMSE sector about this in the near future.
Question 8. Do you agree with our proposal to award 2290-2300 MHz to the band manager on the same terms as other wireless-camera channels at 2 GHz?	
The BBC agreed and pointed to the need to compensate for partial loss of the channel at 2200-2210 MHz. JFMG also agreed but stated issues regarding use of adjacent spectrum above 2300 MHz needed to be better understood if the band was to be available on a permanent basis. It also stated the price the band manager paid for access must reflect any additional constraints (geographic, temporal or transmission parameters) that resulted from ensuring compatibility with services above 2300 MHz. Spectrum for Programme Makers welcomed the award of more spectrum in the 2 GHz	We agree with JFMG we should take into account the use of spectrum above 2300 MHz. As a result, we have restricted use of 2290-2300 MHz to relatively low-power (1 W EIRP) mobile use. We have confirmed there is no opportunity cost of PMSE use of this spectrum as a consequence of the restrictions placed on its use. Any agreements to share bands with the MOD are a decision for it to make in agreement with PMSE and other users.

band to the band manager but also suggested users could share MOD spectrum more extensively.	
Question 9. Do you agree with our proposal to award low-demand PMSE bands to the band manager?	
BEIRG argued it was unrealistic to migrate wireless-microphone and IEM users to these bands as they are too high in frequency or too narrow in bandwidth to be of use. ITN stated demand would develop given time and available equipment. Talkback channels it used at 442 MHz were essential to operation in central London, where satellite newsgathering could not be used due to parking restrictions. Talkback microwave channels were the only reliable means to achieve return audio for interviews. JFMG agreed but considered the initial spectrum fees should reflect the low activity in this band at the time of licence issue (though it expected demand to increase). This view was broadly supported by SIS Outside Broadcast.	Although we recognise the technical difficulties in migrating to some low-value bands, we cannot say for certain this will not be more viable in the future as demand changes and technology develops. We recognise the points made by ITN and have ensured the channels it refers to will continue to be made available for PMSE access. The initial AIP levels for most low-demand spectrum has been set at or close to zero in light of the lack of alternative use and the absence of PMSE congestion in those bands.
Question 10. Do you agree with our proposal to award no-demand PMSE bands to the band manager?	
Arqiva agreed but argued the opportunity cost should not anticipate the new licensed uses. This point was also made by a number of other respondents. The BBC also agreed, stating PMSE users benefited from having a single point of contact so it was sensible to award low- and no-demand PMSE bands to the band manager. It said the fees for these bands should only cover administrative costs to reflect the absence of demand and therefore opportunity costs. BEIRG stated, as with low-demand PMSE bands, it was unrealistic to migrate wireless-microphone and IEM users to these bands as they were too high in frequency or too narrow in bandwidth to be of use.	Our approach to AIP for these bands has recognised the lack of alternative demand and the absence of PMSE congestion. As a result, we have set the AIP levels at zero or near-zero levels. Again, although we recognise the technical difficulties in migrating to some no-value bands, we cannot say for certain this will not be more viable in the future as demand changes and technology develops.
Technical licence conditions	
(First band-manager consultation)	
Question 26. Do you agree with our proposal to use the block-edge mask approach to determine the technical licence conditions relevant to this award and to base these masks broadly on existing arrangements for PMSE spectrum access?	
Arqiva agreed and stated any relevant geographic restrictions should be applied, especially for interleaved spectrum.	We agree with Arqiva's argument geographic restrictions should be applied to the BEMs and have done so.

The BBC stated the TLCs should be compatible with the compliance specifications appropriate to PMSE equipment and CE marking (ETSI EN302-06402 for wireless video links and ETSI EN300 422 V1.2.1 for wireless microphones). BEIRG argued a request by the band manager to vary its licence in favour of SURs should be subject to an impact assessment on the PMSE industry. Similarly, PLASA said due consideration must be given to the band manager's obligations to the PMSE sector and whether SURs would further its interests if SUR requests were made. JFMG stated BEMs remained the most appropriate way of defining PMSE use of spectrum and moving to SUR methods could cause unnecessary disruption and costs. SURs, however, might become more appropriate in the future for non-PMSE use of awarded spectrum. Mr. Adrian Pickering stated care must be taken not to constrain future technology or the band manager's ability to charge per unit of spectrum.	The BEMs have been derived from the most appropriate ETSI standards for existing PMSE equipment. Where we receive a request to allow non-PMSE use of spectrum available for future PMSE access, we will assess both the costs and the benefits of allowing this use. This will necessarily include an assessment of any costs to the PMSE sector. However, where we allow non-PMSE use of this spectrum, we could define the parameters of that use by means other than BEMs, including SURs. We agree with Mr. Pickering's concern future technology should not be constrained by the use of BEMs. As a result, where a viable new technology emerged that could be facilitated by changing the TLCs, we would consider such changes.
(Second band-manager consultation)	
Question 38. Do you agree with our proposed TLCs?	
The BBC pointed out the initial resolution bandwidth used to specify the out-of-band limits for BEMs 15-17 was too narrow. JFMG argued one TLC (at 1.5 GHz) precluded the use of analogue links while another (at 7 GHz) excluded the ability to deploy airborne video links. A number of other respondents pointed to a general discrepancy in the representation of the TLCs.	We accept the point made by the BBC and have specified BEMs with a resolution bandwidth of 10 MHz, 20 MHz or 25 MHz to more accurately align them with ETSI standards. The changes we have made to the representation of the TLCs will facilitate the deployment of both analogue and digital technologies at 1.5 GHz. We have investigated the possibility of 7 GHz airborne use with JFMG and concluded this is not an authorised use and so will not be included in the TLCs. We accepted the original error in the representation of the TLCs and these were subsequently corrected and republished.
Spectrum fees **(Second band-manager consultation)**	
Question 24. Do you agree with our objectives and approach in applying AIP principles to the licence fee payable by the band manager?	
Arqiva agreed PMSE users needed to move	Some respondents do not agree AIP should

to a more market-based approach and this was consistent with our statutory duty to secure optimal use of spectrum. However, it raised concerns the proposed approach would not promote efficiency, would force difficult trade-offs in dealing with congestion and would generate disputes. Plum, in the report it prepared for Arqiva, argued the AIP results we reported were likely to be below actual opportunity cost and so would have little impact on rationing excess demand. JFMG raised concerns there appeared to be greater attention paid to ensuring affordable fees for users than to applying true AIP. Along with Arqiva, it argued this could harm the PMSE industry's ability to adjust to the market in the long run. It gave the example the proposed AIP levels would fail to provide an incentive for wireless-camera users to move to less-congested spectrum from 2 GHz (where there is evidence of congestion) because the alternative spectrum had an opportunity cost above zero. JFMG also noted the calculation of AIP according to the methodology employed by Analysys Mason resulted in a different result than the Smith NERA approach. It argued this could be critical if it resulted in cliff edges between the fees charged to different user groups in the same band. Plum stated it was in some cases questionable whether the opportunity-cost calculations already included management costs. For example, in the case of UHF Bands IV and V, the estimates were based on auction results from a variety of countries, some of which charged additional annual fees to cover spectrum-management costs. Also, estimates for business radio were based on the costs of moving to a less-congested band; spectrum-management costs would be incurred in both congested and uncongested bands. Some respondents, including ASP FM and Transfinite, disagreed with AIP being levied. Transfinite stated an increase in AIP would have a harmful effect on the wider UK economy, such as through tourism, which should be taken into account.	<u>be levied</u> AIP is designed to create incentives for users to take efficient decisions about their use. Many users of spectrum already pay AIP-based fees. The introduction of AIP for spectrum with a positive opportunity cost is expected to lead to a more efficient use of a scarce resource, thus having a positive effect on the UK economy and international competitiveness. We appreciate the importance of the PMSE sector to the UK's economy and the well-being of citizens and consumers. Therefore, we have endeavoured to find a balance between the efficiency benefits of introducing AIP and the importance of avoiding significant disruption to PMSE users. <u>Alternative arrangements suggested by respondents</u> The ring-fencing approach suggested by ITV would not provide market signals or allow spectrum to move to its highest-value use. Therefore, this would be a less efficient method of maximising the value to society of spectrum use. The use of ring-fencing would also be a less transparent, more uncertain and more subjective method of securing efficient spectrum use than the use of AIP. Applying fees based on sales, suggested by BEIRG, is not consistent with incentivising optimal use of spectrum because the price signal would be delayed therefore limiting its effect on spectrum usage decisions. This would therefore limit, if not remove entirely, the efficiency benefits of introducing AIP. <u>Some respondents argued AIP levels should be set conservatively</u> We are conscious of BEIRG's concerns regarding the initial level of AIP fees and have had specific regard to the Cave and Indepen/Aegis recommendations any level of opportunity cost used to set fees should be estimated conservatively to reflect some of the uncertainties over any alternative service being viable in reality. Furthermore, AIP will be phased in over some time to allow for impacts to be assessed.

ITV was concerned about the use of AIP-based licence fees. It suggested, as an alternative, the efficiency objective could be set by ring-fencing available spectrum for different categories of PMSE use and incentivising the band manager to seek efficiency improvements (e.g. with a bonus for technology improvements). BEIRG suggested AIP in the initial three-year period should only take PMSE use into account. Fees should be charged retrospectively at the end of each year based on levels of sales and reasonable costs incurred by the band manager. It suggested initial baseline levels (at least in the first year) should be no more than current JFMG licence receipts if AIP was imposed. It should then be phased in on a conservative basis. The PMSE sector needed time to adapt to new arrangements. This initial year would also allow the band manager to communicate with PMSE users and inform them of changes. BEIRG also believed AIP should also be set at the low end of the estimate of the opportunity cost.	However, we do not agree with BEIRG's suggestion the initial baseline levels (at least in the first year) should be no more than JFMG's licence receipts and then phased in. This would have the effect simply of delaying any incentive impact for a year and hence delaying the immediate efficiency gains to be made from beginning the process. <u>AIP below opportunity cost will have little effect on rationing demand</u> When developing our approach to setting AIP, we had to be mindful of the specific features of the PMSE sector. In particular, we were aware there is some uncertainty as to PMSE users' ability to absorb significant increases in fees for spectrum access in a short timeframe. Therefore, we have chosen to adopt an estimate at the lower end of the indicated ranges and to phase in increases in order to minimise significant disruption to the PMSE sector. We acknowledge this approach imposes limitations on the effect of AIP where it leads to fees being set below true opportunity cost. The proposed AIP levels go some way to creating market signals but, because they are based on cautious estimates of value, might not prevent congestion entirely. We believe the proposed approach will be an improvement to the current arrangements, and a positive step toward a more market-based approach. Now the band-manager award has been deferred, there is also a question about whether it might be possible to effectively implement temporally and geographically specific congestion charging. <u>The balance between ensuring affordable fees for PMSE users and reflecting full value</u> We understand there is a trade-off between reflecting the full estimated value of spectrum and causing undue disruption to PMSE users. During this initial implementation period, we are particularly mindful of the importance of avoiding significant disruption to PMSE users. If we set fees at too high a level, we run the risk of major disruption to PMSE users.

	<u>Concerns about the choice of the Analysys Mason approach over the Smith NERA approach</u> We consider the Smith NERA approach to setting AIP for spectrum used by PMSE (i.e. aligning spectrum below 1 GHz with the mobile STU and that above 1 GHz with the fixed-links STU) not to be appropriate for PMSE fees, which should reflect more variations between the demand for spectrum for PMSE or other secondary uses between bands. Instead, Analysys Mason set out a three-stage approach that would more accurately reflect the opportunity costs of the spectrum, in both PMSE and alternative uses. This analytical framework, consistent with previous approaches, consisted of: • an assessment as to whether there was congestion among PMSE users; • an assessment as to whether there was a viable alternative use of the spectrum; and • where there was likely to be congestion among PMSE users and/or with a viable alternative use, a calculation of the value of the spectrum in the PMSE and/or alternative use to derive the opportunity cost. Cliff edges in prices are only a problem if they do not reflect a true difference in opportunity cost between the bands. <u>Respondents questioned whether cost calculations already include management costs</u> In general, the estimated values have been derived by assessing what value other users place on using spectrum, which is already managed, in different configurations. That is, the valuation implicitly already covers the costs of spectrum management. Therefore, adding administrative costs on top of the opportunity-cost valuation would lead to fees higher than the estimated opportunity cost at the end of the phasing period.

Question 25. Do you agree with our proposal to assess viability of alternative use of spectrum based on the secondary nature of PMSE access where applicable?	
Respondents broadly agreed.	
Question 26. Do you agree with our approach to assessing whether there is an opportunity cost of spectrum based on competing PMSE use?	
JFMG disagreed with the marginal-decrement approach as applied by Analysys Mason due to the sporadic nature of PMSE congestion and the nature of the supply chain (where many users do not own their own equipment). It argued the fact excess demand is sporadic does not imply it is low cost. JFMG also suggested the nature and cost of the loss needed to be estimated to estimate the own-use opportunity cost of the spectrum. It suggested a better methodology would be to adapt the marginal-decrement approach to specifically target PMSE use at events. It would then be possible to derive an opportunity cost of congestion on a per-event basis. JFMG suggested an overall annual opportunity cost could be derived from the product of the value per event and the forecast number of congested events per year. In its report for Arqiva, Plum disagreed with our ascribing a zero opportunity cost to spectrum where congestion only occurs for relatively short periods of time and/or in specific locations. It argued the opportunity cost of the spectrum will not be zero if use is denied at a particular point in time and/or at a particular location because the spectrum has value to the user denied access. The use that is denied might be of high value. Arqiva argued congestion was principally short term and event based. Therefore, the obvious efficient solution would be to permit the band manager to ration by price on the occasions when such short-term, event-based congestion occurred. It was concerned our proposed approach was too general and could undermine the ability of the band manager to effectively manage demand. The proposals had the opportunity cost being determined by whether user equipment could be reused in alternative spectrum. This did not allow for adequate differentiation between users of spectrum. For example, those who owned highly flexible equipment	<u>AIP estimates should take into account anticipated future demand</u> AIP rates will be reviewed when warranted and increases in demand and other changes occurring since the previous review will impact the rates calculated at those times. In its report, Analysys Mason noted it was difficult to estimate with confidence how sensitive PMSE users would be to price rises and, as result, the levels of AIP should initially be set conservatively and reassessed when there were data to judge reactions to changes in those fees. <u>Access should be rationed by price when such short-term, event-based congestion occurs</u> As discussed above, now the band-manager award has been deferred and we therefore no longer have concerns about how we could guard against rent seeking, it might be relatively simple to effectively implement temporally and geographically specific charging as suggested by Arqiva.

might be able to use it in alternative spectrum, while those with equipment with less-flexible tuning ranges might not. It also argued AIP estimates should be forward looking by taking account of available information on anticipated demand growth that might arise.	
Question 27. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity costs of UHF 1 and UHF 2?	
ITN believed the calculation for UHF 2 was problematic because creating such a differential between UHF 1 and UHF 2 would mean UHF 1 would become subject to excess demand or, if charges are spread across UHF 1 and UHF 2, UHF 1 users would have to pay an unfair price. There was concern the large pricing differential between UHF 1 and UHF 2 could lead to excess demand in UHF 1. It suggested a fairer method might be to split the spectrum to give four bands across the frequency ranges, thereby giving greater granularity on price. JFMG raised concerns about the disaggregation of UHF 1 and UHF 2, specifically because a popular temporary-use requirement for duplex talkback is actually split across UHF 1 and UHF 2. This is necessary because the spectrum available in UHF 1 is not able to be configured to support duplex operations. As 425 MHz and the most significant allocation at 446/447 MHz are not paired bands, this limited the appeal for business radio. It argued the Analysys Mason report had not taken account of the configuration of the current PMSE allocation within UHF 1 in deriving the AIP value. JFMG also stated it was not clear if the Analysys Mason methodology took account of the technical constraints of some of the current PMSE allocations within UHF 2 in delivering the AIP value, leading to a problem for PMSE users when phasing in the fee. The BBC said it would be concerned if fees for access to UHF 1 and UHF 2 that reflected full opportunity costs were implemented too quickly.	It is desirable users be incentivised to move to the lower-cost band where this is efficient for them. We have estimated UHF 2 has a higher opportunity cost than UHF 1. Therefore, it is positive for users to move into UHF 1 from UHF 2 if this is possible. The specific licence fees for access to these bands are still to be determined. It is likely, where users need access to both bands for duplex talkback purposes, the licence fee will reflect a combination of the higher cost of UHF 2 and the lower cost of UHF 1, thus continuing to send accurate price signals. To address concerns and/or effects related to the implementation of fees that reflect the opportunity cost of UHF 1 and UHF 2, we are phasing AIP in so it will not increase by more than 40% in any one year.
Question 28. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity cost of interleaved spectrum?	
Respondents broadly agreed with this proposal.	
Question 29. Do you agree with our estimate, based on Analysys Mason's report, of the	

opportunity costs of channel 69 and channel 38?	
SIS Live noted the range of estimates of opportunity cost showed the estimation of opportunity cost was not an exact science. Therefore, it argued we should take the lowest value in the range. It also conjectured economic circumstances would have depressed these values since they were calculated. ITV agreed with our approach to the estimates of opportunity cost for channels 69 and 38. However, it was concerned by our suggestion the opportunity cost of channel 38 could rise if radioastronomy ceased in the Netherlands. It stated this created uncertainty and it would welcome clarification from us. It also argued PMSE users should have secure access to channel 38 for a significant time, without interference or any contingent possibility of costs rising in response to changes in other countries.	<u>We should take the lowest value in the range of estimates</u> As discussed previously, we have used very cautious estimates of value in the interests of avoiding disruption to the PMSE sector during the transition phase to market mechanisms. However, the more prices reflect the true value of the spectrum, the greater the efficiency benefits that will be realised from introducing AIP. Therefore, we need to strike a balance when setting our pricing proposals between ensuring the services delivered by PMSE users are not disrupted as they adjust to new fee levels and bringing users to paying a market level for their spectrum use as soon as is practicable so they can make efficient future decisions on how they use spectrum in light of their understanding of its value. In the past, the number of channel 69 licences has grown even as fees have increased. This indicates the introduction of AIP at the proposed levels will not lead to significant falls in demand. <u>Respondents are concerned the opportunity cost of channel 38 could increase if it ceases to be used for radioastronomy in the Netherlands</u> PMSE users will have security of tenure of channel 38 for a significant time without interference. However, the opportunity cost of spectrum is influenced by alternative uses. If a change in external factors makes the spectrum more attractive to alternative uses, this will be reflected in the estimate of the opportunity cost of that spectrum. Therefore, it would not be efficient spectrum management to allow PMSE access to channel 38 at low cost indefinitely, regardless of changes in relevant external factors. Going forward, it will remain important to balance the value of certainty and minimising disruption with the benefits of allowing spectrum to move to its highest-value use. The security-of-tenure arrangements, discussed in section 6 of the main document, are designed to meet this

	balance.
Question 30. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity cost of spectrum at 2-3 GHz?	
ITV argued the mid-band opportunity cost at 2-3 GHz is higher than that at adjacent frequencies. This could have similar effects to the differential between UHF 1 and UHF 2. It argued we should think further about the effects on demand before setting the price. JFMG believed considerable additional demand for these frequencies seemed likely to come from the known future closure of the 2.6 GHz and 3.5 GHz bands to PMSE use. It suggested a better methodology would be to adapt the marginal-decrement approach to specifically target PMSE use at events. It would then be possible to derive an opportunity cost of congestion on a per-event basis. JFMG suggested an overall annual opportunity cost could be derived from the product of the value per event and the forecast number of congested events per year. JFMG also raised concerns about the effect congestion might have on industry costs if hirers were forced to replicate all equipment holdings for congested bands. Plum questioned two downward adjustments of the estimates by Analysys Mason, which it described as arbitrary: • a reduction to 20% of original value on the grounds the initial calculation was likely to be an overestimate; and • a conclusion the resulting value is so small and uncertain as to be around zero. Plum also noted while the value of around £1,000/MHz is small, a much lower value was obtained for the 7 GHz band (£178/MHz) and yet AIP was not set equal to zero.	<u>Likely future increase in demand should be factored into prices</u> As discussed above, AIP will be reviewed where there is evidence of sufficiently material misalignment between the actual fees and the current value of the spectrum. Any changes in demand and other factors affecting opportunity cost will be considered at these reviews. However, we do accept there is a case for charging where there is temporal and/or geographic scarcity and will consider this further in the fees consultation. <u>The reasoning behind two of Analysys Mason's downward adjustments is unclear</u> As with the other estimates it was considered appropriate to take a conservative view of the opportunity cost of spectrum at 2-3 GHz. Therefore the estimates were adjusted downward in reflection of the uncertainty of the alternative use. The basis for the first reduction is the original estimate calculated is likely to provide an upper bound of the true opportunity cost because much of the equipment currently used in the spectrum increment could be used in alternative spectrum should the increment be removed. The basis for the second reduction is the estimate is so small, it is likely to be within reasonable error bounds of Analysis Mason's estimates. Therefore, we believe there is insufficient evidence to set an AIP level above zero for this band. <u>Congestion could force hiring companies to replicate equipment holdings, increasing industry costs</u> We agree in some circumstances it might be efficient for hiring companies to invest in equipment holdings across multiple bands. If AIP is set correctly, price signals will indicate when such investment is efficient. This is unlikely to increase industry costs as hire

	companies would have to hold sufficient equipment to service peak-demand periods in any case. Where demand overflows into alternative bands from time to time, hire companies would have to own some equipment that could tune into those bands. It is possible this equipment might not get used as often as the other equipment, in which case it would be replaced less often and so would still be unlikely to increase costs.
Question 31. Do you agree with our estimate, based on Analysys Mason's report, of the opportunity cost of spectrum at 7 GHz?	
Some respondents, including JFMG, indicated they accepted the estimate. The BBC believed demand for 7 GHz spectrum from non-PMSE fixed-link deployment was unlikely to be significant in practice. It argued a positive AIP for 7 GHz would tend to discourage users of wireless cameras from moving there from lower bands given we proposed a zero AIP for most of the 2-3 GHz band. Plum stated considerable additional demand for these frequencies seemed likely to come from the known future closure of the 2.6 GHz and 3.5 GHz bands to for PMSE use.	<u>Positive AIP values for 7 GHz will discourage wireless-camera users from moving into that band, particularly as we proposed a zero AIP for most of the 2-3 GHz band</u> The alternative use on which the 7 GHz opportunity-cost estimate is based is more certain than that for the 2 GHz low band. Therefore, it was considered appropriate to set a positive AIP for 7 GHz while setting a conservative cost-based fee for the low 2 GHz band. It is unlikely the small AIP value proposed will deter the use of the 7 GHz band, particularly if wireless-camera operators are facing congestion and/or uncertainty of supply in their use of the 2-3 GHz band. <u>Likely future increase in demand should be factored into prices</u> We consider it undesirable to factor in significantly uncertain future changes ahead of time as this might inefficiently distort price signals.
Question 32. Do you agree with our proposal to phase in AIP on a band by band basis?	
BEIRG argued it is critical AIP is phased in in a manner that ensures spectrum pricing is affordable to all PMSE users. It agreed AIP should be phased in on a band-by-band basis. This recognised different users would be facing different fee changes and would have different abilities to respond. PLASA believed phasing periods, determined by taking into account the AIP and current revenues for each band, were the best way to bring the sector to market in a way that was simple, fair and transparent.	To avoid causing undue disruption while facilitating the PMSE sector's transition toward market-based spectrum prices, AIP fees are being phased in where they would otherwise result in large price increases. However, the longer it takes for spectrum prices to match their value, the longer current inefficient distribution of spectrum among possible uses will continue to impose costs on society. Therefore, we do not agree with ITV's suggestion to provide a complete exemption from AIP in the first three years. Additionally, the longer initial implementation is suspended, the steeper the climb from

ITV suggested a complete exemption from AIP in the first three years to allow the band manager to establish itself and test the market. It also suggested any changes to AIP in the three-yearly reviews should be phased in over the following three years. JFMG agreed, in principle, with the proposal to phase in AIP in any band where the impact on users would be significant and/or disruptive but made comments on some specific bands: • 1.5 GHz—phasing seemed superfluous as it had effectively been reallocated; • UHF 1 and UHF 2—in the steady state, it was right there should be incentives to move from the higher-value spectrum (UHF 2) to the lower-value spectrum (UHF 1). But under the current proposals, the cost per assignment of UHF 1 was likely to be 1½ times higher than for UHF 2. JFMG suggested identical assignments in UHF 1 and UHF 2 should remain the same with identical increases until the ceiling AIP of UHF1 was reached.	current prices toward market prices could be. At this stage, we are not fettering our discretion on how any future AIP review revisions will be implemented. It might be the case future AIP changes will be phased in, but this will depend on the level of the increase and our assessment of the impact on the sector, among other considerations. In terms of PMSE access to 1517-1518 MHz, we note there is significant continuing use of this spectrum by the sector. As a result, we consider it is still appropriate to apply phased-in AIP-based fees to use these frequencies. We have noted JFMG's point about distortions in phasing UHF 1 and UHF 2 as a result of the nature of PMSE use of these bands, in particular talkback duplex pairs in both bands. However, this issue should be addressed in the consultation on end-user fees. For the purposes of assessing the opportunity costs of these bands based on the value of competing uses, we consider our estimates are broadly correct and the principle of phasing on a band-by-band basis is correct.
Question 33. Do you agree with our proposal to phase in the band manager's AIP based licence fee such that no band increases by more than 40% in the first year that it is operating compared to 2008/09 licensing receipts?	
JFMG, Arqiva and Plum all pointed out the phasing of AIP will not necessarily cap annual price rises at 40% because AIP is only one input cost. Therefore, cost reallocation (on a band-by-band basis) could increase the price for a licence beyond that caused by any underlying increase in AIP. JFMG suggested we needed to consider whether these administrative costs should be phased in also and, if so, how the band manager could recover its costs. ITN preferred a maximum 20% rise in AIP in any band. It argued a 40% rise would jeopardise business plans. Likewise, SIS Live stated it was presumptuous of us to assume a 40% increase in costs was bearable. PLASA suggested AIP should be set at the level of 2008/9 licensing receipts during the first year of operation.	It is important to note not all bands will increase in price and even where a 40% increase in AIP occurs, this does not necessarily translate to a 40% increase in prices for the end-user. Additionally, we note licence fees for PMSE users rose by a total of 20% in 2005 and again in 2007 and there was a subsequent increase in the total number of licences issued. The detailed pricing structures have not yet been finalised. However, we do intend to ensure increases in annual fee totals per band from existing levels will be bearable by PMSE users. At the same time, we do not agree with PLASA's suggestion to set AIP at the level of 2008/09 licensing receipts because we believe it is important to ensure the fees paid by PMSE users begin to converge with market rates.

Question 34. Do you have any comments on any other aspects of our proposals to introduce AIP for the spectrum to be awarded to the band manager?	
SIS Live commented having to recover AIP for each band individually removed the freedom to balance demand across more than one band, even when bands were essentially the same to PMSE users. JFMG anticipated difficult operational issues arising from cliff-edge pricing changes between bands perceived to be interchangeable by PMSE users. However, it was not clear how aggregating across bands was consistent with our FRND objectives to allocate costs/prices on a band-by-band basis. JFMG also stated it was vital there was greater clarity about the issue of aggregating between bands and across assignment types.	We acknowledge SIS Live's comments the use of some bands that have differing opportunity costs are viewed as equal by PMSE users. However, this is precisely why we believe it is important to set AIP on a band-by-band basis. Efficient use of spectrum will be promoted when users are incentivised to use the lowest opportunity-cost means (across all their inputs) of producing their output. Therefore, it is important for users to have the incentive to consider moving from high-cost to low-cost bands, particularly if they can use them in the same way. The details of the new pricing structure are yet to be finalised. However, it is anticipated while prices will be opportunity-cost reflective on a band-by-band basis, there will be sufficient flexibility to allow for smoothing if it is necessary to prevent excessive price differences between licences used for the same purpose. These decisions will be made following further consultation. If aggregation of costs occurs between bands it weakens the price signals from the introduction of AIP.
Question 35. Do you agree with our estimates of the opportunity cost of temporary PMSE access to cleared spectrum?	
Respondents broadly agreed with this proposal.	
Question 37. In light of our further proposals, do you agree that we should first review the AIP charged to the band manager after three years?	
Arqiva and Plum argued there should be long lags between changes in spectrum use initiated by the band manager and recalculation of AIP taking the changes into account as changing spectrum use is a slow process because of complementary investment in infrastructure and other systems. They also suggested we should provide continuing incentives to the band manager for efficient spectrum use and management by introducing a rolling incentive mechanism, with a lag of five rather than three years Many respondents agreed three years was a reasonable timeframe before the first review. JFMG argued reviews of AIP for PMSE should not be undertaken in isolation but	The impact on the band manager's ability to recoup investments, as raised by Plum and Arqiva, is not relevant at this time as the band-manager award has been deferred. In light of this and the publication of the spectrum-pricing consultation in which we signalled AIP would only be reviewed where there was evidence of sufficiently material misalignment between the actual fees and the current value of the spectrum, we have changed our approach to align with the latter. In considering the need for a review, we will take into account representations from stakeholders and evidence of changes of use in response to fees during the transition period.

should be linked to wider strategic reviews across all relevant sectors. However, it believed the proposed first review after three years was a reasonable compromise if the spectrum-pricing consultation was not completed in time for the band-manager award. The BBC agreed a first review of AIP after three years seemed sensible. BEIRG stated PMSE users would suffer unacceptable disruption if the basis of their licensing fees were changed any more frequently than every three years. Transfinite believed the review of AIP after three years should be fundamental, with a different approach thereafter. PLASA argued a longer period before the first review of AIP would be more appropriate to allow the new arrangements to bed down and the PMSE sector to adapt. After that, every three years might be about right.	

Annex 2

Summary of spectrum availability

A2.1 Table A2 below summarises details of the spectrum we have decided will be available for future PMSE access. It sets out the primary use(r)s of that spectrum as well as any other use(r)s who share those bands. It also identifies the current PMSE use, although, in light of our decision to allow any PMSE use that adheres to the relevant TLCs, there may be scope for other PMSE uses of some bands.

Table A2. Summary of spectrum available for future PMSE access

Band (MHz)	Current PMSE use	Primary user	Other users
47.55-48.8	Talkback	Land mobile	MOD
52-52.95	Talkback	Land mobile	MOD
53.75-55.75	Fixed audio links	Land mobile	MOD
60.75-62.75	Fixed audio links	Land mobile	MOD
67.75-67.8375	Talkback	Land mobile	MOD
69.15625-69.18125	Talkback	Land and maritime mobile	
74.68125-74.71875	Talkback	Land mobile	
75.2625-75.3	Talkback (airborne use permitted)	MOD	
76.80625-76.84375	Talkback	i) Fixed services ii) Land, maritime and aeronautical mobile	
78.18375-78.25875	Talkback	i) MOD ii) Land mobile	
82.65625-82.68125	Talkback	i) Fixed services ii) Land, maritime and aeronautical mobile	Astronomy
86.66875-86.68125	Talkback (geographic restrictions apply)	i) Fixed services ii) Land, maritime and aeronautical mobile	Astronomy
86.80625-86.84375	Talkback (some airborne use permitted, restrictions apply)	i) Fixed services ii) Land, maritime and aeronautical mobile	Astronomy
139.54375-139.55625	Talkback (geographic restrictions apply)	Land mobile	Space research
139.56875-139.58125	Talkback (geographic restrictions apply)	Land mobile	Space research
139.64375-139.66875	Talkback (geographic restrictions apply)	Land mobile	Space research
140.9875-141.4875	Talkback (geographic restrictions apply; some airborne use permitted, restrictions apply)	Land mobile	Space research
148.5625-148.5875	Talkback (geographic restrictions apply)	i) Fixed services ii) Land and maritime mobile	
148.7125-148.7375	Talkback (geographic restrictions apply)	i) Fixed services ii) Land and maritime mobile	
175.15-175.35	Wireless microphones (geographic restrictions apply)	Land and maritime mobile	
175.425-175.625	Wireless microphones (geographic restrictions apply)	Land and maritime mobile	

Band (MHz)	Current PMSE use	Primary user	Other users
176.3-176.5	Wireless microphones (geographic restrictions apply)	Land and maritime mobile	
176.5-176.9	Wireless microphones (geographic restrictions apply)	Land and maritime mobile	
176.9-177.1	Wireless microphones (geographic restrictions apply)	Land and maritime mobile	
181.69375-181.80625	Talkback and data links	Land and maritime mobile	
184.5-185.1	Wireless microphones	Land and maritime mobile	
189.69375-189.80625	Talkback and data links	Land and maritime mobile	
191.6-191.8	Includes fixed audio links and wireless microphones	Land and maritime mobile	
191.8-192	Wireless microphones	Land and maritime mobile	
192-193.1	Wireless microphones	Land and maritime mobile	
199.6-200.2	Includes fixed audio links (restrictions apply) and wireless microphones	Land and maritime mobile	
200.2-201.1	Wireless microphones	Land and maritime mobile	
207.6-210.1	Wireless microphones	Land and maritime mobile	
425.3125-425.5625	Talkback (geographic restrictions apply)	MOD	Land mobile
427.7625-428.0125	Talkback (geographic restrictions apply)	MOD	Land mobile
442.2625-442.5125	Talkback (geographic restrictions apply)	MOD	i) Aeronautical mobile ii) Land mobile
446.425-447.5125 (paired with frequencies at 467.8/9)	Talkback (power restrictions apply in certain geographic areas)	MOD	i) Aeronautical mobile ii) Land mobile
454.9875-455.475 (paired with frequencies at 468.0/3)	Talkback (geographic restrictions apply; some airborne use permitted, restrictions apply)	i) Fixed services ii) Land, maritime and aeronautical mobile	
457.25-457.475 (paired with frequencies at 467.2/3)	Talkback (some airborne use permitted, restrictions apply)	i) Fixed services ii) Land, maritime and aeronautical mobile	
461.23125-461.25625 (paired with frequencies at 468.5)	Talkback (some airborne use permitted, restrictions apply)	Land mobile	
462.75-463 (paired with frequencies at 469.4/5)	Talkback (some airborne use permitted, restrictions apply; power restrictions apply)	i) Fixed services ii) Land, maritime and aeronautical mobile	

Band (MHz)	Current PMSE use	Primary user	Other users
467.2625-469.875 (paired with frequencies at 457.2)	Talkback (geographic restrictions apply; some airborne use permitted, restrictions apply)	i) Fixed services ii) Land, maritime and aeronautical mobile	
470-550	Includes talkback and wireless microphones (restrictions apply)	Terrestrial television (542-550 MHz awarded for new use in Cardiff area)	
550-590	Includes talkback and wireless microphones (restrictions apply)—available until late 2012	Terrestrial television until DSO in late 2012; subject to award	
590-598	Wireless microphones—available on 12 months' notice or until late 2012, whichever is sooner	Subject to award	
598-606	Includes talkback and wireless microphones (restrictions apply)—available until late 2012	Terrestrial television until DSO in late 2012; subject to award	
606-614	Low-power wireless microphones (geographic restrictions apply until 21 September 2011)	Radioastronomy until 21 September 2011	
614-790	Includes talkback and wireless microphones (restrictions apply)	Terrestrial television (758-766 MHz awarded for new use in Manchester area)	
790-854	Available until 1 July 2012 and in London, northeast England and Northern Ireland until 1 October 2012	Terrestrial television until DSO in late 2012	
854-862	Wireless microphones and audio fixed links (airborne use permitted) until 1 July 2012 and in London, northeast England and Northern Ireland until 1 October 2012		
1517-1525	Wireless microphones	i) Fixed services ii) Land and maritime mobile iii) Mobile satellite	
1785-1800	Digital wireless microphones	i) Fixed services ii) Land and maritime mobile	Space operations
2025-2110	Wireless cameras	i) MOD ii) Land, maritime and aeronautical mobile	
2200-2300	Wireless cameras	i) MOD ii) Land, maritime and aeronautical mobile	
2390-2450	Wireless cameras	MOD	i) Amateur ii) SRDs
2450-2500	Wireless cameras	i) Fixed services ii) Land and maritime mobile	SRDs
2500-2690	Wireless cameras	Subject to award (on three months notice. Unavailable at the point where we invite applications for the 2.6 GHz band award,)	

Band (MHz)	Current PMSE use	Primary user	Other users
3400-3440	Wireless cameras (geographic restrictions apply; some airborne use permitted)	MOD	Amateur
3500-3580	Wireless cameras (geographic restrictions apply; some airborne use permitted)	MOD	
5472-5588	Fixed video links (geographic restrictions apply)	i) MOD ii) Land and maritime mobile	Wideband data
5682.5-5702.5	Fixed video links (geographic restrictions apply; some airborne use permitted)	i) MOD ii) Land and maritime mobile	i) Amateur ii) Wideband data
5705-5725	Fixed video links (geographic restrictions apply)	i) MOD ii) Land and maritime mobile	i) Amateur ii) Wideband data
5732.5-5752.5	Fixed video links (geographic restrictions apply)	i) MOD ii) Land and maritime mobile	i) Amateur ii) Wideband data
5770-5790	Fixed video links (geographic restrictions apply; some airborne use permitted)	i) MOD ii) Land and maritime mobile	i) Amateur ii) Wideband data
5795-5815	Fixed video links (geographic restrictions apply)	i) MOD ii) Land and maritime mobile	Wideband data
5850-5925	Fixed video links (geographic restrictions apply; some airborne use permitted)	i) Fixed services ii) Land, maritime and aeronautical mobile iii) Fixed satellite	MOD
7110-7250	Fixed video links (geographic restrictions apply; some airborne use permitted)	i) Fixed services ii) Land, maritime and aeronautical mobile iii) Space research	
7300-7425	Fixed video links	i) Fixed services ii) Land and maritime mobile iii) Fixed satellite	
8460-8500	Fixed video links (geographic restrictions apply)	i) Fixed services ii) Space research	
10300-10360	Fixed video links (geographic restrictions apply, some airborne use permitted)	MOD	Amateur
12200-12500	Fixed video links	Fixed satellite	
24250-24500	Fixed video links	Fixed services	
48000-48400	Video links	i) Fixed services ii) Fixed satellite iii) Land, maritime and aeronautical mobile	

Annex 3

Technical licence conditions

A3.1 Table A3 below sets out detailed TLCs for the spectrum available for future PMSE access. It also describes any restrictions that apply, whether temporal, geographic or operational.

Table A3. TLCs for spectrum available for future PMSE access

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
1	47.55-48.8	25 W	8	On a non-interference basis to continental broadcasting.	
2	52-52.95	25 W	8	On a non-interference basis to continental broadcasting.	
3	53.75-55.75	5 W	9	On a non-interference basis to continental broadcasting. Within 55-55.75 MHz, subject to alternative use by non-PMSE on a case by case basis.	
4	60.75-62.75	5 W	9	On a non-interference basis to continental broadcasting. Use for audio distribution services is subject to non-interference to PMSE use and no protection from PMSE use.	
5	67.75-67.8375	25 W	1		
6	69.15625-69.18125	25 W	1	Two channels: 69.16250 MHz and 69.17500 MHz duplex with 82.66250 MHz and 82.67500 MHz.	
7	74.68125-74.71875	25 W	1		
8	75.2625-75.3	25 W	1		
9	75.2625-75.3	5 W	3	Airborne use until equipment reaches the end of its current life. Maximum altitude permitted 2,000 feet above ground level. These transmissions on a non-interference and unprotected basis.	Yes
10	76.80625-76.84375	25 W	1		
11	78.18375-78.25875	25 W	11	No transmissions allowed within the bands 78.18375-78.19625 MHz in West Wales and 78.51875-78.53125 MHz in the Outer Hebrides.	
12	82.65625-82.68125	25 W	1	Two channels: 82.66250 MHz and 82.67500 MHz duplex with 69.16250 MHz and 69.17500 MHz.	
13	86.66875-86.68125	25 W	1	Only in Wales and west England.	
14	86.80625-86.84375	25 W	1		

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
15	86.80625-86.81875	5 W	3	Not available over eastern Kent (greater than 100 km from Charing Cross within the southeast quadrant). Maximum altitude 2,000 feet above ground level. Subject to review.	Yes
16	139.54375-139.55625	10 W	2	Guernsey only.	
17	139.56875-139.58125	10 W	2	Jersey only.	
18	139.64375-139.66875	10 W	2	Only in the Channel Islands.	
19	140.9875-141	25 W	1	London area only. Base transmitter sites Kent House and NTL Croydon.	
20	141-141.4875	25 W	11	141-141.0125 MHz, 141.0875-141.1125 MHz and 141.2625-141.2875 MHz only in Northern Ireland and north of a line from Troon (NS 330 280) to Dunbar (NT 710 770). Not available in the Channel Islands.	
21	141-141.4875	5 W	12	141-141.0125 MHz, 141.0875-141.1125 MHz and 141.2625-141.2875 MHz not available. Maximum altitude 2,000 feet above ground level. Not available in the Channel Islands.	Yes
22	148.5625-148.5875	10 W	5	Channel Islands only.	
23	148.7125-148.7375	10 W	5	Channel Islands only.	
24	175.15-175.35	50 mW	14	On a non-interference basis to broadcasting. May be subject to interference from continental broadcasting. Not available in Northern Ireland.	
25	175.425-175.625	50 mW	14	These frequencies may be used anywhere within the UK except in Northern Ireland on a non-interference basis to broadcasting. May be subject to interference from continental broadcasting.	
26	176.3-176.5	50 mW	14	These frequencies may be used anywhere within the UK except in Northern Ireland on a non-interference basis to broadcasting. May be subject to interference from continental broadcasting.	
27	176.5-176.7	50 mW	14	These frequencies may be used anywhere within the UK except in Northern Ireland on a non-interference basis to broadcasting. May be subject to interference from continental broadcasting.	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
28	176.7-176.9	50 mW	14	These frequencies may be used anywhere within the UK on a non-interference basis to broadcasting. May be subject to interference from continental broadcasting.	
29	176.9-177.1	50 mW	14	These frequencies may be used anywhere within the UK except in Northern Ireland on a non-interference basis to broadcasting. May be subject to interference from continental broadcasting.	
30	181.69375-181.80625	25 W	1	On a non-interference basis to broadcasting.	
31	184.5-185.2	50 mW	14	On a non-interference basis to broadcasting.	
32	189.69375-189.80625	25 W	1	On a non-interference basis to broadcasting.	
33	191.6-191.8	1 W	6	Links on a non-interference basis to broadcasting. Emissions must be vertically polarised.	
34	191.8-192	50 mW	14	On a non-interference basis to broadcasting. May be subject to interference from continental broadcasting.	
35	192-193.2	50 mW	14	May be subject to interference from continental broadcasting.	
36	199.6-200.2	1 W	6	Maximum ERP of 100 mW in southeast England and the Channel Islands. Transmissions must be vertically polarised. On a non-interference basis to/from broadcasting.	
37	200.2-201.2	50 mW	14	On a non-interference basis to broadcasting. May be subject to interference from continental broadcasting.	
38	207.6-210.2	50 mW	14	On a non-interference basis to broadcasting. May be subject to interference from continental broadcasting.	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
39	425.3125-425.5625	25 W	7	Five contiguous 50 kHz channels are available, centred on 425.3375 MHz, 425.3875 MHz, 425.4375 MHz, 425.4875 MHz and 425.5375 MHz. For use in Bristol, Bournemouth, Dorchester, Newport (Isle of Wight), Portsmouth, Southampton and Weymouth only. A maximum of two channels may be used at each location. On a non-interference basis to MOD use within 50 km of Aberporth (SN 247 518) and Hebrides (NF 781 406).	
40	427.7625-428.0125	25 W	10	Not available within 50 km of Aberporth (SN 247 518).	
41	442.2625-442.5125	25 W	10	442.36875-442.38125 MHz not available within 30 km of Northolt (TQ 099 846).	
42	446.425-446.5125	5 W (25 W: see restrictions)	13	5 W available throughout the UK. 25 W within M25. On a non-interference basis to 12.5 kHz base station of Babcock Support Services Ltd (SU 622 660) at 446.45 MHz.	
43	446.5125-447.5125	25 W	10	446.60625-446.61875 MHz not available within 30 km of TQ 295 794, SO 915 223, TA 005 845 and SS 215 500. 446.7125-446.7375 MHz not available within 30 km of SD 385 365. Preemptible by the MOD on two weeks' notice.	
44	454.9875-455.4625	25 W	1		
45	454.9875-455.4625	5 W	13	Airborne use restricted to a maximum height of 2,000 feet above ground level.	Yes
46	457.25-457.475	25 W	1	Power commensurate with minimum operational requirements.	
47	457.25-457.475	100 mW	4	Power commensurate with minimum operational requirements. Airborne use restricted to a maximum height of 2,000 feet above ground level.	Yes
48	461.23125-461.25625	25 W	1	Power commensurate with minimum operational requirements.	
49	461.23125-461.25625	5 W	3	Power commensurate with the minimum operational requirements. Airborne use restricted to a maximum height of 2,000 feet above ground level.	Yes

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
50	462.75-463	25 W	1	Power commensurate with minimum operational requirements.	
51	462.75-463	100 mW	4	Power commensurate with minimum operational requirements. Airborne use restricted to a maximum height of 2,000 feet above ground level.	Yes
52	467.2625-469.875	25 W	10	On a non-interference basis to broadcasting in channel 21. Power commensurate with minimum operational requirements. 467.5125-467.5875 MHz not available within 16 km of the coast.	
53	467.2625-469.875	100 mW	4	On a non-interference basis to broadcasting in channel 21. Power commensurate with minimum operational requirements. Airborne use restricted to a maximum height of 2,000 feet above ground level. 467.5125-467.5875 MHz on a non-interference basis to the marine service and not available within 16 km of the coast.	Yes
54	470-550	5 W	3	On a non-interference basis to broadcasting. 542-550 MHz not available in the Cardiff area.	
55	550-582	5 W	3	On a non-interference basis to broadcasting. Available on a temporary basis until the end of DSO in 2012.	
56	582-590	25 W	1	On a non-interference basis to broadcasting. Available on a temporary basis until the end of DSO in 2012.	
57	590-598	50 mW	14	Available on a temporary basis on 12 months' notice or until the end of DSO in 2012, whichever is the sooner.	
58	598-606	5 W	3	On a non-interference basis to broadcasting. Available on a temporary basis until the end of DSO in 2012.	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
59	606-614	50 mW	14	Before 21 September 2011: on a non-interference basis to radioastronomy. Use allowed except in agreed protection zones as set out on JFMG's website.[42] From: 21 September 2011: available UK-wide on a non-interference basis to broadcasting in adjacent band. Refer to the JFMG website for further details.	
60	614-790	5 W	3	On a non-interference basis to broadcasting. 758-766 MHz not available in the Manchester area.	
61	790-854	5 W	3	On a non-interference basis to broadcasting. Available on a temporary basis until at least 1 July 2012 and in London, northeast England and Northern Ireland until at least 1 October 2012.	
62	854-856	25 W	1	On a non-interference basis to broadcasting in channels 68, 64 and 60. Available on a temporary basis until at least 1 July 2012 and in London, northeast England and Northern Ireland until at least 1 October 2012.	
63	854-856	50 mW	14	On a non-interference basis to broadcasting in channels 68, 64 and 60. Available on a temporary basis until at least 1 July 2012 and in London, northeast England and Northern Ireland until at least 1 October 2012.	Yes
64	856-858.75	5 W	20	On a non-interference basis to broadcasting and in-band military services. All primary transmissions to be contained within the band. For audio links, directional antennas to be used with a maximum gain of 7 dB. Available on a temporary basis until at least 1 July 2012 and in London, northeast England and Northern Ireland until at least 1 October 2012.	

[42] www.jfmg.co.uk/JfmgEcom/Wireless/Public/MicrophoneSh600.aspx.

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
65	858.75-859.75	50 mW	14	On a non-interference basis to broadcasting and in-band military services. All primary transmissions to be contained within the band. Band available on a temporary basis until at least 1 July 2012 and in London, northeast England and Northern Ireland until at least 1 October 2012.	
66	859.75-862	25 W	8	On a non-interference basis to broadcasting in channels 68, 64 and 60. Available on a temporary basis until at least 1 July 2012 and in London, northeast England and Northern Ireland until at least 1 October 2012.	
67	1517-1525	20 dBW	18	Antenna restrictions apply: 1517.25 MHz (horizontal polarisation), 1517.75 MHz (vertical polarisation). 1518-1525 MHz available until further notice by agreement with us.	
68	1785-1800	50 mW	19	Not available in Northern Ireland. 1790-1798 MHz on a secondary basis to Home Office links.	
69	2025-2070	20 dBW	15	Not available within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594).	
70	2025-2070	13 dBW	15	Not available for airborne use (i) in the airspace volume described by ±1° of elevation from the geostationary arc (for elevation of 4° or more) of an earth station within 5 km radius of Bude (SS 255 116) and Menwith Hill (SE 205 594) or (ii) within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594). No protection from, or interference to, tactical radio relay.	Yes
71	2070-2110	20 dBW	15	Not available within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594).	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
72	2070-2110	13 dBW	15	Not available for airborne use (i) in the airspace volume described by ±1° of elevation from the geostationary arc (for elevation of 4° or more) of an earth station within 5 km radius of Bude (SS 255 116) and Menwith Hill (SE 205 594) or (ii) within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594).	Yes
73	2200-2290	20 dBW	15	Not available within an exclusion zone of 8 km radius of Oakhanger (SU 815 345) and Harrogate (SE 203 577). 16 km coordination zone around Oakhanger (SU 815 345). Subject to non-interference basis to space science services.	
74	2200-2290	13 dBW	15	Not available for airborne use (i) in the airspace volume described by ±1° of elevation from the geostationary arc (for elevation of 4° or more) of an earth station within 5 km radius of Bude (SS 255 116) and Menwith Hill (SE 205 594), (ii) within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594), (iii) within an exclusion zone of 64 km/1,000 feet above ground level around Aberporth (SN 247 518), Hebrides (NF 781 406) and St Kilda (NF 094 987) or (iv) within 48 km or an exclusion zone of 64 km/1,000 feet above ground level of Oakhanger (SU 815 345).	Yes
75	2290-2300	0 dBW	15		
76	2390-2410	40 dBW	16	Not available within an exclusion zone of 5 km radius around Bude (SS 205 126), Menwith Hill (SE 209 561), Manorbier (SS 074 967) and Hebrides (NF 781 406).	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
77	2410-2450	40 dBW	16	Not available within an exclusion zone of 5 km radius around Bude (SS 205 126), Menwith Hill (SE 209 561), Aberporth (SN 247 518), Shoeburyness (TQ 949 857), Eskmeals (SD 070 930), Pendine Sands (SN 252 087), Fort Halstead (TQ 497 600), Farnborough (SU 850 544), Hurn (SZ 083 982), Chertsey (TQ 497 166) and Copehill Down (Salisbury Plain) (SU 065 455).	
78	2410-2450	20 dBW	16	Not available for airborne use (i) in the airspace volume described by ±1° of elevation from the geostationary arc (for elevation of 4° or more) of an earth station within 5 km radius of Bude (SS 255 116) and Menwith Hill (SE 205 594), (ii) within 5 km of Bude (SS 255 116), Menwith Hill (SE 205 594), Copehill Down (Salisbury Plain) (SU 065 455), Eskmeals (SD 070 930), Pendine Sands (SN 252 087), Fort Halstead (TQ 497 600), Farnborough (SU 850 544), Hurn (SZ 083 982) and Chertsey (TQ 497 166) or (iii) within an exclusion zone of 64 km/1,000 feet above ground level from Aberporth (SN 247 518) and Shoeburyness (TQ 949 857).	Yes
79	2450-2470	40 dBW	16	Not available within a 5 km radius of Bude (SS 205 126) and Menwith Hill (SE 209 561). Maximum power for digital links is 20 dBW.	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
80	2450-2470	23 dBW (13 dBW: see restrictions)	16	Maximum power for digital links is 20 dBW. Not available for airborne use within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594) and in the airspace volume described by ±1° of elevation from the geostationary arc (for elevation of 4° or more) of an earth station within 5 km radius of these two sites. Airborne use restricted to a maximum height of 5,000 feet above ground level. Airborne use not to exceed 13 dBW when directed toward and within 150 km of Belgium, France, Ireland or the Netherlands.	Yes
81	2470-2490	40 dBW	16	Not available within a 5 km radius of Bude (SS 205 126) and Menwith Hill (SE 209 561). Maximum power for digital links is 20 dBW.	
82	2470-2490	23 dBW	16	Not available for airborne use within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594) and in the airspace volume described by ±1° of elevation from the geostationary arc (for elevation of 4° or more) of an earth station within 5 km radius of these two sites. Maximum power for digital links is 20 dBW. Airborne use restricted to a maximum height of 5,000 feet above ground level.	Yes
83	2490-2500	40 dBW	16	Not available within a 5 km radius of Bude (SS 205 126) and Menwith Hill (SE 209 561). Maximum power for digital links is 20 dBW.	
84	2500-2690	0 dBW	15	Subject to award (on three months notice. Unavailable at the point where we invite applications for the 2.6 GHz band award)	
85	3400-3420	13 dBW	16	Not available within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594). Occasional interference may be encountered during operation near Boscombe Down, Defford, Malvern, Portland and Skipness.	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
86	3400-3420	13 dBW	16	Not available for airborne use within 48 km of Bude (SS 255 116) and Menwith Hill (SE 205 594) plus an additional 64 km for each 1,000 feet of altitude around these two sites. Occasional interference may be encountered during operation near Boscombe Down, Defford, Malvern, Portland and Skipness.	Yes
87	3420-3440	30 dBW	15	Not available within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594). Occasional interference may be encountered during operations near Boscombe Down, Defford, Malvern, Portland and Skipness.	
88	3420-3440	30 dBW	15	Not available for airborne use within 48 km of Bude (SS 255 116) and Menwith Hill (SE 205 594) plus an additional 64 km for each 1,000 feet of altitude around these two sites. Occasional interference may be encountered during operation near Boscombe Down, Defford Malvern, Portland and Skipness.	Yes
89	3500-3520	40 dBW	16	Not available within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594). Occasional interference may be encountered during operations near Boscombe Down, Defford, Malvern, Portland and Skipness.	
90	3500-3520	40 dBW	16	Not available for airborne use within 48 km of Bude (SS 255 116) and Menwith Hill (SE 205 594) plus an additional 64 km for each 1,000 feet of altitude around these two sites. Occasional interference may be encountered during operations near: Boscombe Down, Defford, Malvern, Portland and Skipness.	Yes

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
91	3520-3560	40 dBW	16	Not available except within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594). Occasional interference may be encountered during operation near Boscombe Down, Defford, Malvern, Portland and Skipness.	
92	3520-3560	40 dBW	16	Not available for airborne use within 48 km of Bude (SS 255 116) and Menwith Hill (SE 205 594) plus an additional 64 km for each 1,000 feet of altitude around these two sites. Occasional interference may be encountered during operation near Boscombe Down, Defford, Malvern, Portland and Skipness.	Yes
93	3560-3580	40 dBW	16	Not available within 5 km of Bude (SS 255 116) and Menwith Hill (SE 205 594). Occasional interference may be encountered during operations near Boscombe Down, Defford, Malvern, Portland and Skipness.	
94	3560-3580	40 dBW	16	Not available for airborne use within 48 km of Bude (SS 255 116) and Menwith Hill (SE 205 594) plus an additional 64 km for each 1,000 feet of altitude around these two sites. Occasional interference may be encountered during operations near Boscombe Down, Defford, Malvern, Portland and Skipness.	Yes
95	5472-5588	40 dBW	16	Not available within 35 km of Aberporth (SN 247 518) and Benbecula (NF 800 400).	
96	5682.5-5702.5	40 dBW	16	Not available within 35 km of Aberporth (SN 247 518) and Benbecula (NF 800 400).	
97	5682.5-5702.5	23 dBW	16	Not available within 35 km of Aberporth (SN 247 518) and Benbecula (NF 800 400). Airborne use restricted to a maximum height of 2,500 feet above ground level. On a non-interference basis to the MOD.	Yes
98	5705-5725	40 dBW	16	Not available within 35 km of Aberporth (SN 247 518).	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
99	5732.5-5752.5	40 dBW	16	Not available within 35 km of Aberporth (SN 247 518). On a non-protected basis from the fixed wireless access service.	
100	5770-5790	40 dBW	16	Power commensurate with minimum operational requirements. Not available within 35 km of Aberporth (SN 247 518). On a non-interference basis to the MOD. On a non-protected basis from the fixed wireless access service.	
101	5770-5790	23 dBW	16	Power commensurate with minimum operational requirements. Airborne use restricted to a maximum height of 2,500 feet above ground level. Not available within 35 km of Aberporth (SN 247 518). On a non-interference basis to the MOD. On a non-protected basis from the fixed wireless access service.	Yes
102	5795-5815	40 dBW	16	Power commensurate with minimum operational requirements. Not available within 35 km of Aberporth (SN 247 518) and Benbecula (NF 800 400). On a non-interference basis to the MOD.	
103	5795-5815	23 dBW	16	Power commensurate with the minimum operational requirements. Airborne use restricted to a maximum height of 2,500 feet above ground level. Not available within 35 km of Aberporth (SN 247 518) and Benbecula (NF 800 400). On a non-interference basis to the MOD.	Yes
104	5850-5925	40 dBW	16	Not available within 35 km of Aberporth (SN 247 518) and Hebrides (NF 800 400).	
105	5850-5925	13 dBW	16	Not available within 35 km of Aberporth (SN 247 518) and Hebrides (NF 800 400). Airborne use restricted to a maximum height of 2,500 feet above ground level.	Yes
106	7110-7250	40 dBW	16	Power commensurate with minimum operational requirements.	

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
107	7110-7250	30 dBW	16	Power commensurate with minimum operational requirements. Airborne use: minimum height 500 feet above ground structures and buildings; maximum height 2,500 feet above ground level.	Yes
108	7300-7425	40 dBW	16	7386-7425 MHz requires advance coordination.	
109	8460-8500	40 dBW	16	Not available within 5 km of Fort Halstead (TQ 497 600), Aberporth (SN 247 518), Lark Hill (SU 14 1445), the Hebrides range (NF 093 001 AND NF 781 406), the Firth of Clyde and Northern Ireland.	
110	10300-10360	40 dBW	16	Not available within 20 km of Marham (TF 720 090), Waddington (SK 980 960), Pendine (SN 260 079), Shoeburyness (TQ 961 877), Larkhill (SU 104 482), West Freugh (NX 212 554), Hebrides (NF 779 404), Aberporth (SN 242 523) Kirkudbright (NX 724 469) and Eskmeals (SD 080 927). Operations must not exceed -10 dBW/MHz at Ascot, Bath, Newbury, Salisbury and Wincanton.	
111	10300-10360	40 dBW	16	Not available within 20 km of Marham (TF 720 090), Waddington (SK 980 960), Pendine (SN 260 079), Shoeburyness (TQ 961 877), Larkhill (SU 104 482), West Freugh (NX 212 554), Hebrides (NF 779 404), Aberporth (SN 242 523), Kirkudbright (NX 724 469) and Eskmeals (SD 080 927). Airborne use at a maximum height of 1,000 feet above ground level and not within 64 km of the above sites. Operations must not exceed 3 dBW at Ascot, Bath, Epsom, Goodwood, Kempton Park, Newbury, Salisbury, Sandown Park, Wincanton and Windsor.	Yes
112	12200-12225	40 dBW	17	On a non-interference basis to DTH satellite television.	
113	12225-12250	40 dBW	17		

Band	Frequency (MHz)	Maximum in-band power (ERP)	BEM	Apparatus/restrictions	Airborne
114	12250-12275	40 dBW	17	On a non-interference basis to Belgian DTH satellite television. Maximum power when DTH satellite television to Belgium is operational of 10 dBW ERP toward Belgium when within 150 km of Belgian coastline.	
115	12275-12325	40 dBW	17		
116	12325-12375	40 dBW	17	On a non-interference basis to Belgian DTH satellite television. Maximum power when DTH satellite television to Belgium is operational of 10 dBW ERP toward Belgium when within 150 km of Belgian coastline.	
117	12375-12400	40 dBW	17		
118	12400-12425	40 dBW	17	On a non-interference basis to Belgian DTH satellite television. Maximum power when DTH satellite television to Belgium is operational of 10 dBW ERP toward Belgium when within 150 km of Belgian coastline.	
119	12425-12450	40 dBW	17		
120	12450-12475	40 dBW	17	On a non-interference basis to Belgian DTH satellite television. Maximum power when DTH satellite television to Belgium is operational of 10 dBW ERP toward Belgium when within 150 km of Belgian coastline.	
121	12475-12500	40 dBW	17		
122	24250-24500	40 dBW	17		
123	48000-48400	30 dBW	16	Until further notice by agreement with us.	

A3.2 Table A4 below sets out the BEMs referenced in column four of table A3 above.

Table A4: BEMs for spectrum available for future PMSE access

BEM	Δf from band edge (kHz unless otherwise stated)	Maximum PSD for out of band emissions (dBm/4 kHz unless otherwise stated)
1	0-2	9.03 – (15 × Δf)
	2-14	-19.30 – (0.833 × Δf)
	14-31.25	-30.97
2	0-2	5.05 – (15 × Δf)
	2-14	-23.28 – (0.833 × Δf)
	14-31.25	-34.95
3	0-2	2.04 – (15 × Δf)
	2-14	-26.29 – (0.833 × Δf)
	14-31.25	-37.96

BEM	Δf from band edge (kHz unless otherwise stated)	Maximum PSD for out of band emissions (dBm/4 kHz unless otherwise stated)
4	0-2	-13.45 – (14.25 × Δf)
	2-31.25	-41.95[43]
5	0-4.5	2.04 – (6.667 × Δf)
	4.5-29.5	-26.16 – (0.4 × Δf)
	29.5-62.5	-37.96
6	0-100	-46.99 – (0.2 × Δf)
	100-900	-65.74 – (0.0125 × Δf)
7	0-25	-26.99 – (0.8 × Δf)
	25-975	-46.73 – (0.01 × Δf)
8	0-2	9.03 – (15 × Δf)
	2-31.25	-20.56 – (0.204 × Δf)
9	0-2	2.04 – (15 × Δf)
	2-31.25	-27.55 – (0.204 × Δf)
10	0-2	9.03 – (15 × Δf)
	2-3.847	-19.30 – (0.834 × Δf)
	3.847-25	-20.97 – (0.4 × Δf)
	25-31.25	-30.97
11	0-2	9.03 – (15 × Δf)
	2-5.667	-19.26 – (0.855 × Δf)
	5.667-18.75	-21.09 – (0.527 × Δf)
	18.75-31.25	-30.97
12	0-2	2.04 – (15 × Δf)
	2-5.667	-26.25 – (0.855 × Δf)
	5.667-18.75	-28.08 – (0.527 × Δf)
	18.75-31.25	-37.96
13	0-2	2.04 – (15 × Δf)
	2-14	-26.29 – (0.833 × Δf)
	14-31.25	-37.96
14	0-250	-13 – (0.2 × Δf)
	250-900	-59.15 – (0.0154 × Δf)
15	0-10 MHz	-41.2 dBW/10 MHz
	10-20 MHz	-47.2 dBW/10 MHz
16	0-20 MHz	-41.2 dBW/20 MHz
	20-40 MHz	-47.2 dBW/20 MHz
17	0-25 MHz	-41.2 dBW/25 MHz
	25-50 MHz	-47.2 dBW/25 MHz
18	0-75	20 – (0.22 × Δf)
	75-200	4
	200-550	15.43 – (0.06 × Δf)
	550-1000	-16
19	0-300	-44.8 – (0.067 × Δf)
	300-700	-64.8
20	100-900	-40 – (0.2 × Δf)
	0-100	-58.75 – (0.0125 × Δf)

[43] Limited to -41.95 dBm/4 kHz due to limit in standard that states out-of-band emissions do not need to be below -37 dBm (in 12.5 kHz).

Annex 4

Glossary of abbreviations

Δf	Change in frequency
AIP	Administered incentive pricing
BEIRG	British Entertainment Industry Radio Group
BEM	Block-edge mask
dB	Decibel
dBm	Decibels relative to milliwatts
DPSA	Digital preferred service area
DSO	Digital switchover
DTH	Direct to home
DTT	Digital terrestrial television
EIRP	Effective isotropic radiated power
ERP	Effective radiated power
ETSI	European Telecommunications Standards Institute
FRND	Fair, reasonable and non-discriminatory
GHz	Gigahertz
IEM	In-ear monitor
kHz	Kilohertz
MHz	Megahertz
MOD	Ministry of Defence
mW	Milliwatt
PLASA	Professional Light and Sound Association
PMSE	Programme-making and special events
PSA	Professional Services Association
PSD	Power spectral density
RSA	Recognised spectrum access
SRD	Short-range device
STU	Spectrum trading unit
SUR	Spectrum usage right
TLC	Technical licence condition
UHF	Ultra-high frequency
W	Watt
WiMAX	Worldwide Interoperability for Microwave Access