OFFICE OF COMMUNICATIONS

Discussion document on the award of available spectrum 1452 – 1492 MHz: Technical aspects

The document discusses the technical conditions relating to the proposed grant of wireless telegraphy licences to use the 1452-1492 MHz spectrum

Discussion document

Publication date: 15 February 2007

Closing Date for Responses: 12 April 2007

Contents

Section 1

Introduction

1.1 Ofcom, in March 2006, consulted on its proposals for the award of available spectrum in the 1452 – 1492 MHz frequency band[1] ("the consultation document"). In the consultation document, Ofcom set out a number of factors relevant to the spectrum award. These included:

- the current use of the available spectrum (Section 2);
- background on potential uses of the available spectrum, based on a market study commissioned by Ofcom (Section 2);
- potential substitute spectrum that could be used to deliver similar services as those identified in the market study (Section 2);
- Ofcom's powers and duties (Section 3);
- Ofcom's approach to spectrum management, including its objectives for the award (Section 4);
- a range of international issues and an assessment of how these could impact on potential users of the available spectrum (Section 5);
- options for packaging the spectrum for the award (Section 6);
- issues to consider when determining auction formats for the award of spectrum (Section 7);
- options of auction formats for auctioning the available spectrum (Section 7); and
- proposed technical and regulatory conditions that would be specific to the wireless telegraphy licences that would be awarded to allow use of the available spectrum (Section 8).

1.2 As explained in the consultation document, Ofcom's main objective in this award is to promote the optimal use of the electro-magnetic spectrum, particularly in the 1452 – 1492 MHz frequency band. The proposals in the consultation document (and in this discussion document) are intended to secure that objective.

1.3 The proposed technical conditions in the March 2006 consultation document were intended to be the minimum necessary to a) ensure compliance with international agreements; and b) ensure effective use of the licensed frequencies, controlling interference between different licensed services.

1.4 For the 1452-1479.5 MHz sub-band this included:

- effective limits based on the Maastricht 2002 Special Arrangement;

[1] "Award of available spectrum: 1452-1492 MHz", Ofcom, 31 March 2006, http://www.ofcom.org.uk/consult/condocs/1452-1492/

- an out-of-block spectrum emission mask; and
- a proposal for an industry code of practice on engineering coordination to control adjacent-channel interference.

1.5 An extract from Section 8 of the consultation document that discusses the technical licence condition for 1452-1479.5MHz is included at annex 5.

Developments since the consultation document

1.6 For the 1452-1479.5 MHz sub-band the consultation asked the specific question, "Do you agree with the proposals for an industry code of practice on engineering coordination to control adjacent-channel interference?"

1.7 Although many respondents to this question agreed with the concept of an industry code of practice, many felt that there could be problems with the approach in practice as it could create unquantifiable risks. The central views could be summarised as saying that the approach would mean that bidders would not know at the time of auction what services would be in the adjacent spectrum. As a result it would be difficult to assign a value to a spectrum block prior to the auction as the extent and the ways that block could be used would be unknown. This uncertainty would have to be reflected in their bids and therefore the spectrum would not be allocated efficiently in the primary market.

1.8 Arqiva stated that "Not knowing the uses which the rest of the band is likely to be used for makes an investment case for bidding for some of this spectrum more difficult. There may be requirement to cap ERP and to use approved sites, requirements which may not be part of bidder's business plans and consequently, may render licensees' proposed services non viable."

1.9 A number of other respondents (e.g. ASMS, Digital One, BT, Intellect) simply noted that the approach would be difficult to carry out if there were different technologies in adjacent spectrum which would cause uncertainty.

1.10 If an industry code of practice could not be agreed the BBC wanted Ofcom to be responsible for "instigating, implementing and enforcing a regulatory code of practice to control ACI"

1.11 NGW felt that the issues raised by different technologies, trading and liberalisation could be "managed or minimised by careful and co-ordinated network design and / or through tighter control of receiver specification".

1.12 ESOA felt that the usage rights as currently defined were not clear enough and that the consultation did not explain how it would clarify those rights. Alcatel wanted each licensee to be provided with clear technical guidelines. In addition ONDAS, Fuba automotive, Mecel AB and Grundig Car InterMedia Systems felt that the measures laid out in the Maastricht and Wiesbaden Plans were sufficient and that no further code was required.

1.13 Orange suggested that Ofcom needed "to provide a clear time frame for the establishment and implementation of spectrum user rights and build an appropriate framework for this spectrum award".

1.14 On 1st November 2006, Ofcom published a note[2] on next steps arising from its consultation[3] on Spectrum Usage Rights (SURs). The note stated:

> "Ofcom accordingly proposes to focus further work on developing specific proposals for SURs on one or more forthcoming spectrum awards. Detailed proposals for the terms of possible SURs will be developed and presented alongside those for the more conventional spectrum mask approach, as part of the planned consultation process for these awards. It is likely that either or both of the 1452-1492MHz or 2500-2690MHz awards will present a suitable opportunity."

Accordingly, this discussion document includes consideration of the form of SURs which would be suitable for 1452 – 1492 MHz frequency band.

Purpose of this discussion document

1.15 In this document, Ofcom has laid out a number of alternative approaches to the technical conditions associated with the award of the 1452-1479.5MHz sub band. These proposals are designed to address a number of the technical issues raised by the respondents.

1.16 At this point this document does not seek to fully address all of the points made by respondents to the original consultation or to revisit the other areas relevant to the award of the available spectrum which were addressed in the consultation document, e.g. options for packaging the available spectrum or auction design. As such this document should be read in conjunction with the consultation document. In addition Ofcom is simultaneously publishing a sister document that is looking at auction design for the award of this spectrum. Ofcom's decision on all of these issues will be set out in its Statement on this award expected in the summer of 2007.

1.17 With any set of technical conditions there is a trade off between flexibility and thereby encouraging a wider range of services and technologies and giving the market greater certainty, but potentially reducing the flexible use of the spectrum. The conditions in the March 2006 consultation were closer to the former while the consultation responses suggested a preference for the latter. In addition the consultation responses raised a number of concerns that the proposed approach may not lead to an efficient allocation of the spectrum and as such may not fulfil Ofcom's statutory duties. The revised technical conditions proposed in this document are designed to give the market sufficient certainty while not unduly inhibiting alternative technologies.

1.18 In this document Ofcom is laying out four proposals for the technical conditions of this band:

- Proposal 1 – A spectrum mask approach based on an augmented Maastricht mask, as referred to in the consultation document.
- Proposal 2 – A spectrum mask approach based on the ETSI critical mask
- Proposal 3 – A SURs approach based on an augmented Maastricht mask

[2] http://www.ofcom.org.uk/consult/condocs/sur/next_steps2/
[3] http://www.ofcom.org.uk/consult/condocs/sur/sur/

- Proposal 4 – A SURs approach based on the ETSI critical mask

1.19 The technical conditions as they relate to SURs are laid out in detail in section 3 and Annex 6, however a few points are worth drawing out

- At this stage the proposal from the original consultation to have an industry agreed code of practice to deal with Adjacent Channel Interference remains
- Users of the spectrum still have the ability to negotiate with other users in the band if they require different usage rights

1.20 It should be noted that the technical rights of use of this band are still subject to all relevant international arrangements including EU harmonisation measures. As laid out in Ofcom's statement in October 2006[4], the Radio Spectrum Committee (RSC) has requested the European Conference of Postal and Telecommunications Administrations (CEPT) to make an assessment of the technical regulatory conditions and to recommend relevant provisions that can be made within the framework of the Maastricht 2002 Special Arrangement to allow a range of mobile multimedia technologies, in addition to T-DAB, to use the band. Following consideration of this report, one possible outcome could be that RSC will seek to develop an EC Decision regarding future use of the 1452-1479.5 MHz band which, if adopted, would be binding on the UK and other Member States. As such there is a possibility that the international conditions associated with the band may change.

1.21 Ofcom would welcome comments or views on any aspect of this discussion document by 12 April 2007 In particular on the following question:

Do stakeholders have any comments on the technical proposals made in this document or have any other comments on the contents of this document?

Structure of this discussion document

1.22 Section 2 of this discussion document summarises the proposed licensing options and the reasons for considering them. Section 3 explains the key features of a SURs-based approach to the technical conditions. Section 4 summarises the next steps.

1.23 Annex 1 sets out the process for responding to this discussion document, with Annex 2 setting out Ofcom's consultation principles. Annex 3 contains a consultation coversheet, with Annex 4 setting out the question to which Ofcom is seeking stakeholders' responses. Annex 5 is an extract from section 8 from the consultation document, which described the technical conditions as proposed in that document. Annex 6 describes in detail the SURs for the award and describes the assumptions used to calculate them. Annex 7 describes the assumptions and inputs used in the SUR modelling tool.

[4] http://www.ofcom.org.uk/radiocomms/spectrumawards/awardspending/award_1452/intupdate/

Section 2

Options for licensing conditions to control interference

2.1 On the 31st March 2006 Ofcom published its consultation of the award of available spectrum in the band 1452 – 1492 MHz. In that consultation Ofcom proposed an industry Code of Practice in order to deal with adjacent channel interference problems.

2.2 Another method of dealing with adjacent channel interference would be to develop an Ofcom imposed engineering coordination process. It is likely that this would be an approach such as a "first in" priority system such as frequency or geographic separation whereby the licensee who implements their service first in an area would be protected from the implementation of subsequent services.

2.3 Ofcom does not believe that an imposed engineering coordination process would provide for efficient use of the spectrum and satisfy Ofcom's general policy to set technical restrictions that are the minimum necessary to provide adequate protection against harmful interference. Imposing the minimum necessary constraints will increase the users' freedom to respond to changing conditions to make best use of the valuable spectrum resource. It will also allow the market, not the regulator, to make the best decisions about its own needs.

2.4 In order to address concerns raised by stakeholders regarding an industry code of practice and provide for more certainty regarding possible interference, Ofcom is seeking comments from stakeholders on the following four proposals for technical licence conditions in the proposed award:

1. **Proposal 1 – A spectrum mask approach based on an augmented Maastricht mask:** A spectrum mask approach as proposed in the original consultation document where the spectrum mask is based on an extension to the Maastricht plan. This is specified in "ETSI TR 101 496-3 v1.1.2, Figure 5.13" and is the mask that was used in the March 2006 consultation document. This mask is reproduced at figure 1. The relevant mask is the 'critical areas' one.

2. **Proposal 2 – A spectrum mask approach based on the ETSI critical mask:** A spectrum mask approach as in proposal 1 except that the spectrum mask is based on the spectrum mask for 'VHF-band transmitters in critical areas for adjacent channel interference' as specified in "ETSI EN 300 401 V1.4.1, Figure 92" ('the ETSI critical mask'). This mask is reproduced at figure 2.

3. **Proposal 3 – A SURs approach based on an augmented Maastricht mask:** A SURs approach where the spectrum mask is specified in" ETSI TR 101 496-3 v1.1.2, Figure 5.13". This mask is reproduced at figure 1.

4. **Proposal 4 – A SURs approach based on the ETSI critical mask:** A SURs approach where the spectrum mask is specified in "ETSI EN 300 401 V1.4.1, Figure 92". This mask is reproduced at figure 2.

Figure 1: Augmented Maastricht Spectrum Mask

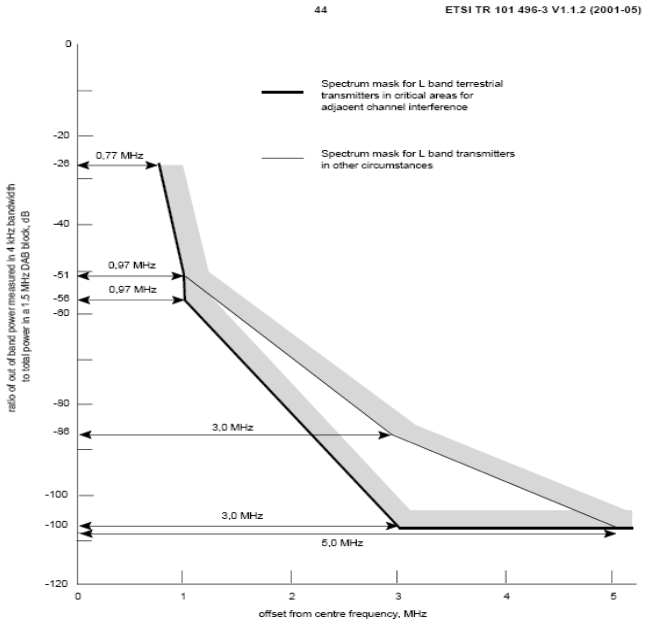


Figure 5.13: L-Band spectrum mask

Source: ETSI TR 101 496-3 v1.1.2, Figure 5.13

Figure 2: ETSI critical mask

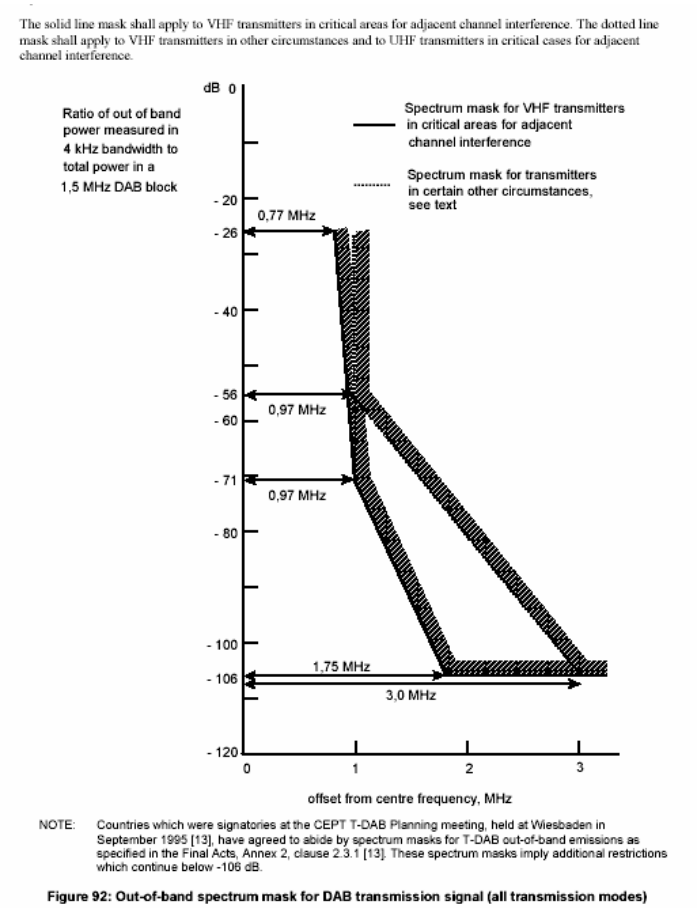


Figure 92: Out-of-band spectrum mask for DAB transmission signal (all transmission modes)

Source: ETSI EN 300 401 V1.4.1, Figure 92

2.5 In proposing these four alternatives, Ofcom is seeking to achieve an appropriate balance between greater certainty regarding the possibility of interference between licensees and allowing the maximum flexibility for licensees to be able to use the spectrum for the widest variety of uses.

2.6 The augmented Maastricht plan's spectrum mask is an appropriate means of providing protection between systems deployed in geographically separated areas, however it may not yield acceptable interference protection for network deployments which are geographically overlapping without close coordination. Hence a tighter spectrum mask may be desirable. With a tighter mask, interference is still possible, but the probability of such interference occurring in an uncoordinated deployment should be substantially reduced. The ETSI critical mask has been proposed as an appropriate basis to achieve this objective while not placing excessive constraints on equipment performance.

2.7 Even with this tighter spectrum mask, interference may still occur to receivers close to adjacent channel transmitters. This can be controlled via further coordination between licensees via an appropriate Code of Practice.

2.8 A spectrum mask alone, however, does not provide certainty regarding the aggregate levels of interference which may be experienced and this is being addressed via the introduction of options 3 and 4, based on spectrum usage rights. Spectrum usage rights and their advantages were discussed in the consultation "Spectrum Usage Rights. Technology and usage neutral access to the radio spectrum", published 12th April 2006, http://www.ofcom.org.uk/consult/condocs/sur. This consultation sets out the principles of SURs and the benefits they bring to realising Ofcom's policy to allow for the most flexible and efficient use of the spectrum.

2.9 In this spectrum band Ofcom is not planning to make additional proposals regarding co-channel interference within the UK as any frequency block would only have one owner after the primary award. At an international level there are arrangements in place with our neighbours that address co-channel interference, particularly the Maastricht 2002 Special Arrangement and the ITU Radio Regulations. If, through trading in the secondary market, a block was split within the UK any co-channel interference issues that could rise would need to be resolved between the seller and buyer of the particular spectrum block(s).

2.10 For adjacent channel interference (out-of-band emissions, OOB) the SUR consultation document states that the preferred approach to manage interference caused by OOB emissions is the use of OOB Power Flux Density (PFD) masks. This approach introduces a method to manage OOB emissions in an area by defining the maximum aggregate PFD of OOB emissions at a given height that can be expected for a given percentage of time at a number of locations in an area. The OOB mask would be defined by:

- the OOB PFD at any point up to a height H m above ground level should not exceed X dBW/m^2/MHz at more than Z% of locations in any area A km^2.

2.11 The benefits of such an approach include:

- it gives a good idea of the level of interference that services in adjacent bands could experience;

- it allows flexible deployment without needing coordination;

- it allows for technology and service neutrality, providing the limits defined in the OOB PFD mask are not exceeded by the proposed technology or service;

- it would not be possible to dramatically increase density of transmitters without reducing the transmitted power (without entering negotiation), as it would increase the level and locations of interference;

- it would not be possible to make significant change to system operation which would increase the defined OOB PFD limits (without entering negotiation);

- users could negotiate the changes to the OOB PFD limits to provide greater flexibility in service deployment.

2.12 Ofcom recognise that this approach would allow locally high levels of interference and gives no information about where this could be expected, only probabilities. Ofcom believe that this method provides an appropriate balance between over-specification of detail and interference management, enabling flexibility of spectrum use and enhancing spectrum efficiency.

2.13 In comparing spectrum masks and SURs, the following considerations apply:

- Licence restrictions defined by SUR parameters directly specify the aggregate emissions that can be radiated in neighbouring locations and frequency bands. This provides clarity over expected interference whilst allowing flexibility in terms of their use of the spectrum.

- With spectrum masks a neighbouring licensee will know the maximum power that another licensee can transmit from any single site but they cannot know for sure how many sites will be deployed. Neighbouring users are only protected against harmful interference indirectly

- SURs will control transmitter density for a given interference power, whereas masks alone will not, aside from the restrictions imposed via international obligations. A licensee may trade off power radiated from individual transmitters against transmitter density.

2.14 Further details of the SURs are given in Annexes 6 and 7. Details of the spectrum mask approach from the original consultation are given in Annex 5. In all of the proposals licensees would have to respect any relevant international arrangements

2.15 The four options for licence conditions are summarised in figure 3 below.

Figure 3: Summary of the options for licence conditions

Options for Licence Conditions	**Reduced Interference** →	
Increased flexibility ↓	Option 1: Spectrum Mask extended from Maastricht Plan (Figure 1)	Option 2: Critical Spectrum Mask from Figure 2
	Option 3: Spectrum Usage Rights extended from Maastricht Plan (Figure 1)	Option 4: Spectrum Usage Rights extended from Figure 2

Section 3

Proposed spectrum usage rights for licensees of 1452-1492 MHz

Introduction

3.1 Ofcom published a consultation document on Spectrum Usage Rights (SURs)[5] in April 2006 and received a range of responses. These were summarised in a note on the next steps for SURs that was published in July 2006[6]. In November 2006, Ofcom published a further note[7] on the future of SURs which indicated that Ofcom would focus further work on developing specific proposals for SURs in one or more forthcoming spectrum awards and that detailed proposals for the terms of possible SURs would be developed and presented. Proposals have been published for consultation on application of SURs to the 2500-2690 MHz, 2010-2025 MHz and 2290-2300 MHz spectrum award[8] (the 2.6 GHz consultation). The proposals outlined in this document are for the possible application of SURs to the 1452 – 1492MHz band.

3.2 This document builds on the concept of SURs and the definition of SUR parameters as described in the April 2006 SUR consultation document.

3.3 This section is structured as follows. Firstly we provide a brief outline of SURs and the parameters which define an SUR based licence. We then outline at a high level some of the key issues pertaining to defining SURs for the 1452-1492 MHz band. Annex 6 presents candidate SUR parameters for the 1452-1492 MHz band and gives detail of the assumptions and methodology. Detailed modelling assumptions are presented in Annex 7.

Definition of SUR parameters

3.4 Traditionally licence restrictions have been specified in terms of either technology restrictions, usage restrictions or transmitter emission mask restrictions. As described in the SUR consultation document, transmitter emission mask restrictions on spectrum use protect neighbouring users against harmful interference indirectly. However licence restrictions defined by SUR parameters directly specify the emissions that a licence holder may radiate in neighbouring locations and frequency bands. This gives licensees more clarity over the interference they can expect and more flexibility in terms of use of their spectrum. In addition, conversely to transmitter emission mask restrictions, SUR parameters account for the density of deployment of transmitters by a licensee.

3.5 Licenses based on SURs consist of the following parameters:

- In-band power flux density (in-band PFD)

[5] Spectrum Usage Rights, Ofcom Consultation, April 2006
[6] http://www.ofcom.org.uk/consult/condocs/sur/next_steps/
[7] http://www.ofcom.org.uk/consult/condocs/sur/next_steps2/
[8] Award of available spectrum: 2500-2690 MHz, 2010-2025 MHz and 2290-2300 MHz, Ofcom Consultation, December 2006

- Out-of-band power flux density (out-of-band PFD)

- Geographical interference based on the aggregate power flux density at a boundary

3.6 A fourth parameter, the Indicative Interference Level (IIL), will also be included on an SUR licence. This parameter gives an indication of the anticipated interference levels expected in a channel based on the transmit rights of its adjacent neighbours. While this parameter is indicative because of the probabilistic nature of propagation and the fact that there may be other sources of noise, such as Electro-Magnetic Compatibility (EMC), it should be a useful guide for stakeholders to gauge their expected levels of interference.

3.7 As the detailed application of SURs to these bands has been developed, it has been concluded that slight modifications to the definitions of SUR terms, as set out in the SUR consultation document, would be advantageous. As described in the 2.6GHz consultation, the in-band PFD and out-of-band PFD are defined as follows:

- The average out-of-band PFD at a height H m above ground level should not exceed X_2 dBW/m^2/MHz at more than Z% of locations in any area A km^2.

- The average in-band PFD at a height H m above ground level should not exceed X_3 dBW/m^2/MHz at more than Z% of locations in any area A km^2.

3.8 Given that the IIL is based on the out-of-band PFD, it follows that the IIL is defined by

- The average PFD received from other spectrum users at a height H m above ground level should not exceed X_4 dBW/m^2/MHz at more than Z% of locations in any area A km^2.

3.9 As explained in the 2.6 GHz consultation we assume that the in-band and out-of-band PFD and the IILs should not be exceeded at more than 50% of locations in the measurement area. This means the parameter value Z in the SUR restrictions is set to 50%.

SURs for the 1452-1492 MHz sub-band

3.10 In this section we give an overview of the key issues which have been taken into consideration in deriving SURs. Further details on the derivation of SUR parameter values are contained in Annexes 6 and 7.

3.11 Based on Ofcom's market assessment (as summarised in Section 2 of the original consultation), likely uses for the 1452-1479.5 MHz sub-band include mobile multimedia services based on DVB-H (Digital Video Broadcasting - Handheld) or T-DMB (Terrestrial – Digital Multimedia Broadcasting) technologies among others. In line with the Maastricht Plan, T-DAB services will be used as a basis to calculate the SUR parameters for the 1452-1479.5 MHz sub-band. However, this does not preclude other technologies from using this sub-band in the UK provided the aggregate level of potential interference into neighbouring countries does not exceed the limits set in the Plan. The international restrictions are described in annex 6 of this document.

3.12 For the 1479.5-1492MHz sub-band we assume S-DAB related technical parameters. It is noted that the initial SUR parameters which are set for a spectrum award can be

subsequently changed by appropriate negotiations between relevant parties as described in Section 5 of the SUR consultation document.

3.13 Specifying licences in SUR terms should provide additional certainty over the original proposals for this band in that interference levels will be directly specified. This will enable an understanding of what interference a spectrum user may expect to receive, whilst maintaining usage neutrality within the specified restrictions.

3.14 Since UK wide licences rather than regional licences are proposed for the 1452-1492MHz spectrum award, geographical interference parameters are not set in the SURs. Geographical interference limits related to interference across national boundaries covered by the Maastricht agreement have been discussed in the 1452-1492MHz award consultation[9]. These are discussed in Annex 6.

1452 – 1479.5 MHz band

3.15 SURs for the 1452-1479.5 sub-band assume 16 channels of approximately 1.7MHz. These are shown in Table 1 of Annex 6. There are no guard bands assumed between these channels. If it was desired that the spectrum be utilised for broad-band services, for example DVB-H, then SURs for multiple channels could be aggregated together, for example 3 channels could provide a bandwidth of 5.1MHz.

3.16 As has been noted in previous work[10], the upper two of the 16 channels, referred to as LO and LP in the Maastricht Plan, require additional restrictions to prevent interference to the neighbouring 1479.5-1492 MHz band. In the case of channel LP this restriction is severe and likely to limit its usage.

3.17 A issue which has been raised as possibly affecting this band is the rejection of neighbouring transmissions in a terminal receiver, the so called “hole punching” problem. One means by which this can be alleviated is through restrictions on the out-of-band emissions that may be made. As discussed above in section 2, there is more than one possible mask that could be assumed. We have determined SURs for both proposals 3 and 4 described in section 2. The results of this and the approach in determining SURs are outlined in detail in Annex 6.

3.18 All SUR values presented are indicative, based on initial calculations. The licensing emission restrictions specified in the final award may be different to the SUR restrictions presented here for discussion.

1479.5 - 1492 MHz band

3.19 In deriving SUR parameters for the 1479.5 – 1492 MHz sub-band we have assumed an award of a single spectrum block, (as proposed in the original consultation), resulting in a single SUR covering the sub-band.

3.20 Protection of S-DAB service performance from T-DAB transmissions at the lower band edge is proposed, by restricting the in-band emissions allowed in channels LO and LP.

3.21 In establishing SUR emission restrictions for this sub-band we have considered present and future likely use of the band. At present the only satellite network

[9] Award of available spectrum: 1452-1492 MHz, Ofcom Consultation, April 2006, Section 5
[10] “International interference analysis for future use of 1452-1492MHz range”, Section 5.2, Analysys Mason, March 2006

providing commercial S-DAB services over Europe in the 1479.5 – 1492 MHz band is Worldspace. However it is possible that an operator could in the future launch a system with different transmit powers or use alternative architectures. Two other systems were therefore considered namely Global Radio (also proposed at L-band though not operational) and Sirius (at a higher frequency but operational). From consideration of these systems a generic S-DAB reference system was defined as the basis from which to determine SUR emission restrictions.

3.22 Resultant SUR restrictions and further details on their derivation and assumptions made are contained in Annex 6.

Section 4

Next steps

4.1 This consultation, published on the 15 February 2007, lasts for an 8 week period. The closing date for responses is 12 April 2007. The consultation is shorter than Ofcom's standard 10 week period as Ofcom has already consulted on the technical aspects of the award of the 1452 – 1492 MHz frequency band. See Annex 1 for details of how to respond to this consultation.

4.2 Ofcom will carry out a stakeholder event in to explain further the issues that have been raised in this discussion document. Invitations to this event will be sent out in due course, and details will be posted on the Ofcom website at http://www.ofcom.org.uk/radiocomms/spectrumawards/awardspending/award_1452/.

4.3 Ofcom expects to release a statement detailing its final proposals for this spectrum award, together with draft regulations and an Information Memorandum, in the summer of 2007.

4.4 An award would then be planned to take place in the autumn of 2007.

4.5 This timetable is subject to a number of external factors beyond Ofcom's control, in particular international issues as indicated in Ofcom's "Update on international developments and the timetable for the 1452 – 1492 MHz award" in October 2006[11], and so may be amended during the course of the award process.

4.6 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

[11] http://www.ofcom.org.uk/radiocomms/spectrumawards/awardspending/award_1452/intupdate/

Annex 1

Responding to this discussion document

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 12 April 2007**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at http://www.ofcom.org.uk/consult/condocs/1452tech/howtorespond/form as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger responses - particularly those with supporting charts, tables or other data - please email anirban.roy@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A1.4 Responses may alternatively be posted to the address below, marked with the title of this document.

Anirban Roy
3rd Floor
Spectrum Markets Team
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.6 It would be helpful if your response could include direct answers to the question asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views.

Further information

A1.7 If you want to discuss the issues and questions raised in this document, or need advice on the appropriate form of response, please contact Anirban Roy on 020 7783 4677

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt (when respondents confirm on their response coversheet that this is acceptable).

A1.9 All comments will be treated as non-confidential unless respondents specify that part or all of the response is confidential and should not be disclosed. Please place any confidential parts of a response in a separate annex so that non-confidential parts may be published along with the respondent's identity.

A1.10 Ofcom reserves its power to disclose any information it receives where this is required to facilitate the carrying out of its statutory functions.

A1.11 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use in order to meet its legal requirements. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Ofcom's consultation processes

A1.12 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.13 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.14 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Vicki Nash, Director Scotland, who is Ofcom's consultation champion:

Vicki Nash
Ofcom
Sutherland House
149 St. Vincent Street
Glasgow G2 5NW

Tel: 0141 229 7401
Fax: 0141 229 7433

Email vicki.nash@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened version for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will normally allow ten weeks for responses to consultations on issues of general interest. Ofcom has allowed 8 weeks for response to this discussion document as Ofcom has previously consulted on the technical aspects of the award of the 1452-1492 MHz band.

A2.6 There will be a person within Ofcom who will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organizations interested in the outcome of our decisions. This individual (who we call the consultation champion) will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why. This may be because a particular issue is urgent. If we need to reduce the amount of time we have set aside for a consultation, we will let those concerned know beforehand that this is a 'red flag consultation' which needs their urgent attention.

After the consultation

A2.8 We will look at each response carefully and with an open mind. We will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency, we will publish all [consultation] responses in full on our website, www.ofcom.org.uk, unless a respondent specifies that all or part of their response is confidential. We will also refer to the contents of a response when explaining our decision, without disclosing the specific information that you wish to remain confidential.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality by allowing you to state very clearly what you don't want to be published. We will keep your completed coversheets confidential.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.

A3.5 Please put any confidential parts of your response in a separate annex to your response, so that they are clearly identified. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your coversheet only so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

What do you want Ofcom to keep confidential?

Nothing	☐	Name/contact details/job title	☐
Whole response	☐	Organisation	☐
Part of the response	☐	If there is no separate annex, which parts?	

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response. It can be published in full on Ofcom's website, unless otherwise specified on this cover sheet, and I authorise Ofcom to make use of the information in this response to meet its legal requirements. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name Signed (if hard copy)

Annex 4

Consultation question

A4.1 The key proposals for this consultation are described in this document. We would welcome views on any aspect of this document by 12 April 2007, in particular on the following question

Do stakeholders have any comments on the technical proposals made in this document or have any other comments on the contents of this document?

Annex 5

Regulatory conditions, rights and obligations

Introduction

A5.1 This annex is an extract from section 8 from the March 2006 consultation document, which described the technical conditions as proposed in that document. All references are to that document.

Introduction

A5.2 This section sets out the proposed technical and regulatory conditions specific to the wireless telegraphy licences that Ofcom proposes to award for use of the 1452 - 1492 MHz band. The underlying principle has been to keep restrictions on the use of the band to the minimum necessary for efficient use of the spectrum and the avoidance of undue interference. This is consistent with Ofcom's preferred approach for technology and service neutrality, enabling users to make better use of the spectrum and to introduce a wider range of services and technologies (see section 4). Responses to the SFR:IP relevant to licence conditions are also addressed at Annex 5.

A5.3 As has been described in section 5, the international arrangements that apply to the sub-band 1452-1479.5 MHz are different to those that apply to the sub-band 1479.5-1492 MHz. As a result, some of the technical licence conditions that will apply vary between the two sub-bands and these are described below. After a description of the respective technical licence terms in each sub-band, this section also sets out the more general licence terms (tenure in minimum term, spectrum trading and liberalised use).

A5.4 A draft licence including the proposed licence conditions including further details on the transmission rights can be found in annex 6.

1452 – 1479.5 MHz: Allowable Technical Characteristics of the Service

A5.5 The licence is based on rights to transmit within the specified frequency ranges subject to compliance with the technical conditions detailed in annex 6. These conditions are predominantly international and explicit within the frequencies licensed, and of a part-technical, part-procedural nature in respect of frequencies adjacent to those licensed. The conditions are based on controlling the technical consequences of transmissions for other spectrum users rather than being intrinsic to the transmissions themselves.

A5.6 The conditions of these licences will not restrict use to broadcasting or any other application. However, since this band is allocated internationally to broadcasting (albeit with flexibility), there is no intrinsic limit to the allowable radiated power from any given transmitter, nor the height at which radiating antennas may be sited. However, effective limits will accrue from:

- the external constraints described in Section 5 and Annex 6, notably international limits derived from the Maastricht 2002 Special Arrangement, and the controls on adjacent-channel interference within the UK

- the design principles of networks deployed by licensees, to avoid interference between different transmitters using the same and adjacent frequencies.

A5.7 As described in section 5, the UK's access to the frequency range 1452 to 1479.5 MHz is affected by an arrangement made at Maastricht in 2002 by the CEPT administrations. This arrangement and the associated Plan is available at the website of the Plan Management Body, the ERO[12]. This is the basis of the technical conditions proposed in annex 6 which are constructed to allow for maximum flexibility of implementation by using international rights to the maximum extent, should licensees need/wish to do this. Part 1 of the Maastricht Plan (allotments originally established before 2002) refers to French allotments which are subject to a special arrangement between the UK and France and is not relevant to this licensing process. It governed the procedures needed to protect private fixed link services in the UK, which will not be using the band after March 2007.

A5.8 As described in Section 5, the Maastricht 2002 Special Arrangement is an 'allotment plan'. The plan allows for defined rights of implementation, but with significant flexibility about how these rights are used, notably in respect of where transmitters are placed. The Plan consists of defined geographical areas to each of which rights are attributed to use one of 16 standard frequencies (termed 'frequency blocks') from the range 1452 to 1479.5 MHz. Each of the 16 blocks is separated by a guard band. Figure 5 in Section 5 illustrates the allotments in the UK. Each country which is a signatory to the Special Arrangement is similarly split into a number of allotments.

A5.9 The Special Arrangement sets the rules which govern procedures and criteria for implementing transmitters without the need for explicit coordination between countries. Proposed implementation beyond these defined rights requires coordination between countries, with no presumption of acceptance by the countries with which coordination is sought. The following provides an outline of the procedure for deciding if coordination is necessary:

- A series of test points is associated with each allotment; this is a combination of:

  - the corners of all other allotments sharing the same frequency;

  - a locus of points generated by the geometry of the allotment and the predicted decay of signal strength from a standard hypothetical reference network of transmitters.

- The cumulative field strength of the proposed real network of transmitters is calculated at each test point

- if this cumulative field strength exceeds a certain threshold then coordination is needed with the those countries touched by the test point concerned or who lie along a line from the test point to a point where the threshold is reached (i.e. if the network is too powerful it potentially affects additional countries).

[12] http://www.ero.dk/Maastricht-e

A5.10 It should be stressed that the above is a high level outline of the procedure, the Special Arrangement sets out the full description.

A5.11 As indicated, Ofcom is not proposing to restrict use of the spectrum to transmissions which fall exactly within the spectrum blocks defined by the Maastricht 2002 Special Arrangement. This raises two issues:

- how to deal with systems with a bandwidth narrower than a Maastricht block; and
- how to deal with systems with a bandwidth wider than a Maastricht block.

A5.12 For a narrower bandwidth system, Ofcom proposes use of a spectrum mask concept: the aggregate of all transmissions within the T-DAB bandwidth should fall within a T-DAB spectrum mask. The field strength threshold used as the trigger for international coordination under Maastricht would be scaled in proportion to the ratio of the system bandwidth and the Maastricht block width. For example: if a system utilises 100 kHz channels the threshold would be reduced by the equivalent of 10 x log (100/1500) = - 12 dB. So, if the threshold defined by Maastricht is 41 dBμV/m then the equivalent threshold for coordination would be 29 dBμV/m. Ofcom will need to secure the agreement of neighbouring countries to this approach, in order to avoid that each transmitter, even of a narrower bandwidth, is treated as being of the full T-DAB bandwidth.

A5.13 For a wider bandwidth system Ofcom proposes that the field strength calculation is based on the transmission power across each 1.5 MHz Maastricht block. This means that the actual profile of the transmitted power within its nominal bandwidth needs to be considered rather than necessarily assuming that it is evenly distributed across this bandwidth.

A5.14 Each transmitter will need to be attributed to an allotment area, but there is no intrinsic requirement for it to lie within it, provided the test point criteria are satisfied.

1452-1479.5 MHz: Out-of-Block Spectrum Emission Mask

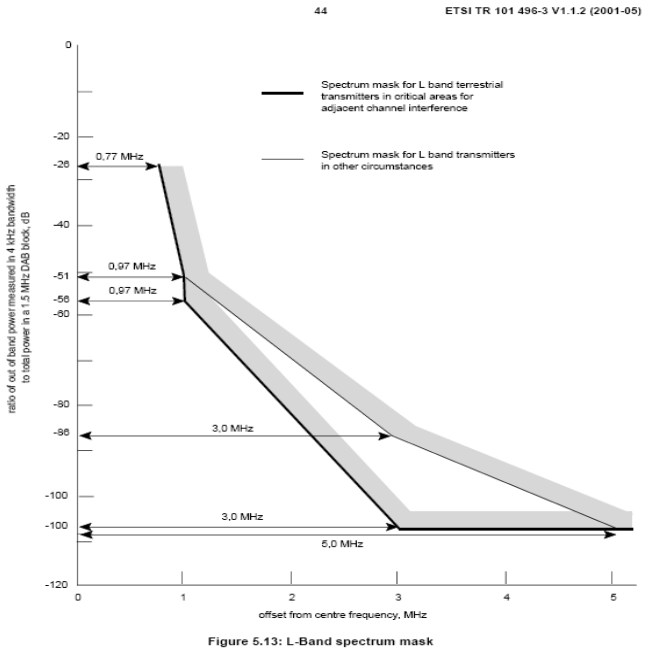
A5.15 The application of a common spectrum mask to each transmitter, irrespective of its radiated power, enables its characteristics to be predictable in frequency management. This will avoid a disproportionate burden on other spectrum users in adjacent frequencies in assessing the impact of new transmitters, within the frequency clearance processes.[13]

A5.16 Ofcom is not proposing to specify a maximum radiated transmission power, since (a) such a provision is not generally applied in broadcasting bands, and (b) the impact of out-of-band emissions is highly contextual (i.e. how close to the site is the potential adjacent/out-of-band incompatibility?). Nor is Ofcom proposing an equivalent outcome-based provision for an absolute out-of-band field strength within a specified bandwidth. Any realistic transmission for the broadcasting-topology networks which are one of the candidate users of this band would require powers in excess of the maxima which would avoid the potential for adjacent-channel interference. This also implies that alternative measures to a blanket power limit would be necessary.

[13] This refers to: the site clearance process applied to all transmitters above certain metrics of significance [17 dBW e.r.p.; above 30m aerial height above ground]; the exemption to this for lower power transmitters; and the processes which would be agreed between licensees within the 1452-1492MHz Band to control adjacent-channel interference.

A5.17 The spectrum mask for a given T-DAB channel is specified in the Maastricht Plan. Figure 22 below is taken from the T-DAB specification. Licensees will be expected to implement the 'critical' mask, although the standard variant may be implemented by mutual agreement with the licensee with rights to the adjacent frequency (as discussed further below). Where a licensee holds a licence covering two or more adjacent frequency blocks, the mask from a given transmitter will only apply at the lower edge of the lowest frequency, and the highest edge of the highest one.

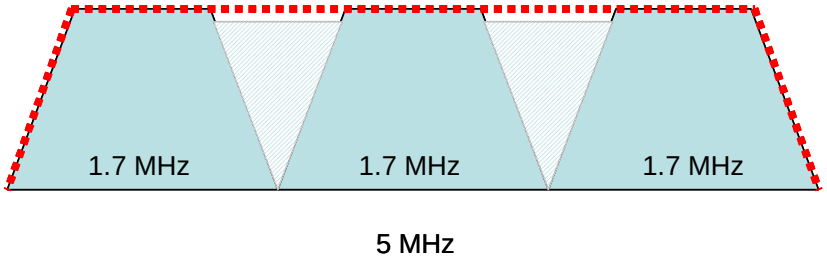
Figure 22: Standard T-DAB Channel Spectrum Mask



Source: ETSI

A5.18 It should be noted that implementation of technologies with wider bandwidths than the blocks defined in the Maastricht 2002 Special Arrangement is possible but that the conditions of use of the spectrum that falls within the guard bands is not specified (see Figure 23). This means that for the guard bands the Maastricht Plan does not confer any protection from interference caused by use in other countries, and the right of implementation is not clarified within the Maastricht Plan.

Figure 23: Spectrum mask for three aggregated lots

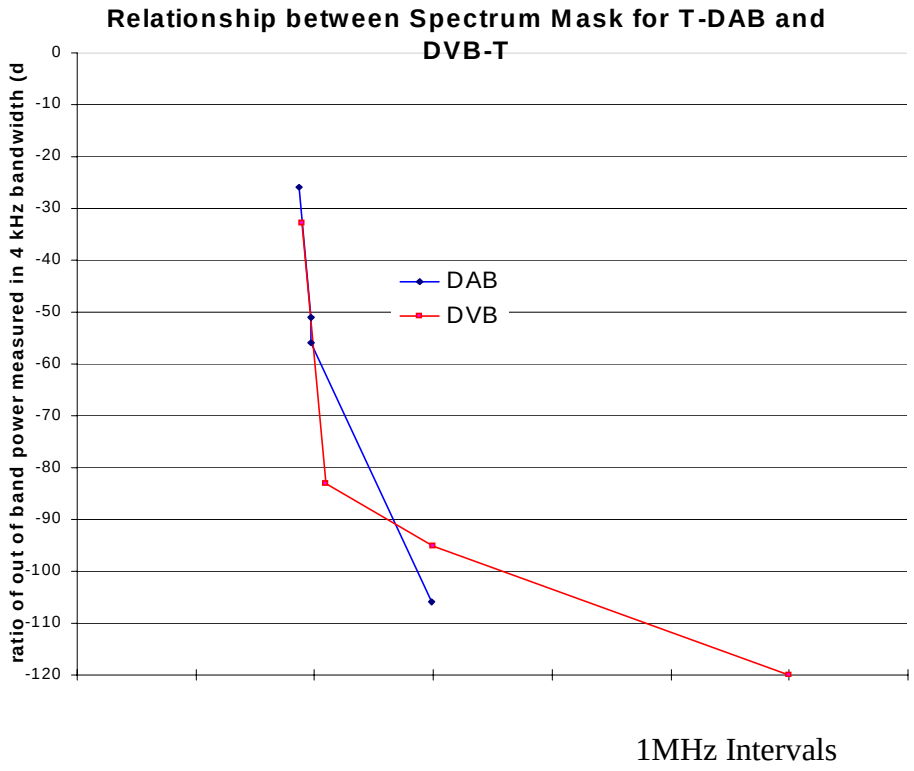


Source:Ofcom

A5.19 One example of a technology requiring a wider bandwidth is a DVB variant with a 5MHz bandwidth. This would require three contiguous T-DAB frequency blocks. There is a slight difference in the shape of the spectrum mask between the two

systems (see Figure 24 below), and in this case additional filtering (compared with the usual DVB mask) is likely to be needed.

Figure 24: Comparison of the band-edge masks of DAB and DVB



Source: Ofcom

1452-1479.5 MHz: Engineering coordination of transmitter location between users

A5.20 The implementation of a new service on an adjacent channel[14] and in the same geographical area as an existing service, risks causing a zone of interference to the existing service around the transmitter of the new service. The new service is effectively 'punching a hole' in the coverage of the existing service. The extent of this 'zone of interference' can range over a significant amount of spectrum either side of the transmitting network.

A5.21 Several technical solutions are available that can help licensees deal with this adjacent channel interference problem, such as:

- Deploying receivers that have better receiver characteristics;
- Turning down the power of interfering signal;
- Turning up the power of originating signal;
- Engineering coordination of transmitter sites; or

[14] the extent of adjacency which is relevant will depend on the characteristics of the 'victim' system and its receivers; for example with T-DAB, five or more adjacent blocks can be relevant.

- Deploying compensating transmitters for the effected service.

A5.22 Each of these solutions places different constraints on the licensee's ability to implement a transmission network.

A5.23 There are several regulatory mechanisms available to Ofcom to deal with this adjacent channel interference problem. Such regulatory mechanisms can range from:

- No regulations;
- Industry-defined code of practice;
- Ofcom-imposed engineering coordination process; or
- Independent third party coordinates.

A5.24 There is also a choice between an emphasis on pre-implementation coordination or approval, and post-hoc reaction procedures to notification/complaint of interference. The latter would put the burden of risk and predictive analysis onto the party causing the interference

A5.25 **No regulations**. No regulation is not a particularly attractive option. It would allow a free for all where licensees could install transmitters without regard to their effect on the coverage of existing systems. It is likely that the effect of 'punching holes' in the service area of existing system described above would be a real and growing problem. Without a mechanism in place to exchange information it is unlikely that licensees could effetely mitigate against the problem.

A5.26 **Industry-defined code of practice**. It could be argued that if this was a real problem, it would be likely that licensees would voluntarily develop a procedure to coordinate amongst themselves. Such an industry developed coordination procedure (or code of practice) may well be able to resolve the problem. However, it would only take one licensee to fail to cooperate for the system to fall apart. Without at least the threat of regulatory action if the industry developed code of practice fails to work effectively there may be little the other licensees can do to make an uncooperative licensee cooperate.

A5.27 **Ofcom-imposed engineering coordination process**. Were Ofcom to impose a coordination procedure it is unlikely that it could develop one that was as effective as something that industry could design for itself. It is likely that Ofcom would fall back on a relatively unsophisticated approach such as a first in priority system where the licensee who rolls out a service in a particular area first would have priority over subsequently installed systems. These subsequently installed systems would effectively have to protect existing installed systems.

A5.28 **Independent third party coordinates.** A process where a third party is responsible for coordination may provide a workable solution but there are still questions about who this third party will be? What power will they have to compel licensees to abide by their decisions and how they are funded?

A5.29 Ofcom proposes to impose on the licensees within the scope of this award a general obligation to mutually coordinate their transmitters on a best endeavours basis and to negotiate in good faith where interference occurs.

A5.30 In principle, Ofcom proposes to allow licensees to manage the engineering coordination process amongst themselves. There may be a need for licensees to exchange information on the location and characteristics of transmitters and to come to arrangements on siting of transmitters and power levels, etc. Exactly what information is exchanged (if any) and how this is managed should be left up to the industry to agree. The arrangement relating to this engineering coordination should be formalised by the establishment of an industry Code of Practice.

A5.31 Ofcom proposes to require all licensees to agree such a Code of Practice within 6 months after the licences are awarded. The Code should deal with the procedural and technical issues with managing engineering coordination. This Code of Practice will need to set out clearly defined principles which will allow the licensees and Ofcom to judge whether an individual licensee is complying with the Code.

A5.32 The objective of the Code should be to promote efficient use of the Spectrum Bands so that, as far as possible, systems are deployed in a manner that will allow services to be deployed alongside each other (e.g. in neighbouring spectrum). In developing the Code, Ofcom would expect that, as a minimum, the following principles should be considered:

- Efficient frequency use of the spectrum;
- Possible conditions on limiting transmission powers to that just necessary to effectively provide service;
- Selection of sites in a manner that will minimise the probability of mutual interference; and
- Identifying the type of information that needs to be communicated between licensees and the arrangements for its exchange.

A5.33 Mitigation techniques such as automatic power control and dynamic frequency selection may be suitable for certain applications and may be considered for inclusion in the Code of Practice, particularly where they can be implemented on a technology neutral basis.

A5.34 Licensees should be aware that the Code, and the activities of the licensees in connection with engineering coordination, need to comply with the requirements of competition law and any other relevant legal requirements.

A5.35 The proposed licence will also give Ofcom the power to impose an engineering coordination procedure if necessary (e.g. where licensees either fail to agree the Code or where it is clear that the objective sought by the Code is not being achieved either through lack of cooperation or shortcomings in the Code itself).

A5.36 As a matter of policy, Ofcom will not have a role in resolving individual engineering coordination disputes. Ofcom will only become directly involved where the objectives sought by the Code of Practice are clearly not being secured. Such involvement will be limited to the imposition by Ofcom of a Code of Practice setting out a relevant engineering coordination procedure rather than the micro-management of individual coordination requests. Where a licensee fails to abide by a Code of Practice that has been imposed by Ofcom, this will be treated like any other breach of licence conditions

Summary of technical licence terms: 1452-1479.5 MHz

A5.37 The main technical conditions in the draft licence in this frequency range are based on four requirements.

- Limits will apply to the aggregate field strength which may be produced (within a specified frequency bandwidth) at specified locations outside the UK by the transmitters established under the licence.
- No individual technical system will be specified, but adherence will be required to a spectrum mask. This mask will be based on the T-DAB (digital radio) standard and a standard channelling plan. Where a licensee holds licences for adjacent T-DAB channels, transmissions can span all of those channels, including in the guard bands between them, subject to international co-ordination.
- Undue interference must be avoided to services using adjacent channels, e.g. by interference to mobile receivers using one channel near to transmitter sites using adjacent channels. Therefore, licensees will be under an obligation to create and agree a code of practice on engineering coordination
- The usual procedures of site clearance at each transmitter site will apply. This is to give other radiocommunications users the chance to anticipate and object to potential local incompatibilities in the vicinity of a transmitter; however, low power transmissions (below 50W e.r.p., do not require site clearance).

A5.38 In relation to the second of these conditions, the present European agreement for use of this frequency range does not define rights of implementation, nor of protection from interference in the guard bands between T-DAB channels; the agreement did not anticipate use of the band by systems of wider bandwidth than DAB. Ofcom proposes to attempt to establish bilateral agreements with countries neighbouring the UK to clarify the position prior to the auction, in order to increase the technological neutrality of the process. It will not be practicable to commence this dialogue until the late summer/early autumn of 2006, and the process may take several months[15].

A5.39 Further details of the transmission rights and the technical analysis on which they are based are set out in annex 6.

Summary of technical licence terms: 1479.5-1492 MHz

A5.40 The main technical conditions attached to this licence are similar in principle to those in the range 1452 to 1479.5 MHz.

- Limits will apply to the aggregate field strength which may be produced (within a specified frequency bandwidth) at specified locations outside the UK by the transmitters established under the licence.
- No individual technical system will be specified, but generic limits will apply to emissions into adjacent bands.

[15] The administrations of neighbouring countries are preoccupied with a major broadcasting conference, the 'RRC06' until then. The RRC 06 does not affect the L-Band, but it may set a precedent with respect to the principle of combining rights to adjacent DAB channels.

- More specific limits and conditions may need to be applied to ensure that undue interference is avoided to services using adjacent channels, e.g. by interference to mobile receivers using one channel near to transmitter sites using adjacent channels.

- The usual procedures of site clearance at each transmitter site will apply. This is to give other radiocommunications users the chance to anticipate and object to potential local incompatibilities in the vicinity of a transmitter; however, low power transmissions (below 50W e.r.p., do not require site clearance).

A5.41 However, the principal considerations in designing use of spectrum within this frequency range are that

- the UK currently has no defined rights of terrestrial transmission within this range, transmission rights are in practice limited by the requirements to protect satellite sound broadcast reception in neighbouring countries;

- a satellite service provider holding a licence for use of this spectrum range within the UK may seek protection of its service within the UK from interference from terrestrial transmitters in neighbouring countries to the extent that the satellite service is registered and able to demand protection within the ITU framework; and

- a satellite service provider holding a licence for use of this spectrum range within the UK will have to take into consideration the possible impact on its service within the UK of interference from terrestrial transmitters operating in the band 1452- 1479.5 MHz.

A5.42 The protection requirements of neighbouring countries' registered (though not yet in service) satellite broadcast systems can be assessed from the system-individual filings made to the International Telecommunications Union. It should also be noted that a US filed satellite, AFRIBSS is notified and is operating in the band with coverage in the UK and neighbouring countries. This implies a need for detailed and bespoke calculations related to the system which a prospective applicant for the UK licence in this frequency range would wish to implement. However, the practical consequence of this is expected to limit the ability to implement broadcast network implementation topologies (see section 5) across much of the UK.

A5.43 The Maastricht Plan makes assumptions regarding the receive field strength for the satellite signal based on one particular system; it may be convenient to use this as an approximate basis for establishing the technical constraints required to protect satellite receivers. However, it must be recognised that there is no agreement regarding the type of equipment used to receive the broadcast satellite signals and the interference criteria are those that are set by the characteristics registered in the ITU filing and the relevant recommendations on protection and interference. Reference sources for these, along with filing information and known satellite operators are provided in Annex 6.

A5.44 If a licence holder is the cause of interference to an ITU registered satellite network, he must cease the transmission causing interference irrespective of holding a licence that allows for the transmission.

Summary of technical licence terms: 1479.5-1492 MHz

A5.45 The main technical conditions attached to this licence are similar in principle to those in the range 1452 to 1479.5 MHz.

- Limits will apply to the aggregate field strength which may be produced (within a specified frequency bandwidth) at specified locations outside the UK by the transmitters established under the licence.
- No individual technical system will be specified, but generic limits will apply to emissions into adjacent bands.
- More specific limits and conditions may need to be applied to ensure that undue interference is avoided to services using adjacent channels, e.g. by interference to mobile receivers using one channel near to transmitter sites using adjacent channels.
- The usual procedures of site clearance at each transmitter site will apply. This is to give other radiocommunications users the chance to anticipate and object to potential local incompatibilities in the vicinity of a transmitter; however, low power transmissions (below 50W e.r.p., do not require site clearance).

A5.46 However, the principal considerations in designing use of spectrum within this frequency range are that

- the UK currently has no defined rights of terrestrial transmission within this range, transmission rights are in practice limited by the requirements to protect satellite sound broadcast reception in neighbouring countries;
- a satellite service provider holding a licence for use of this spectrum range within the UK may seek protection of its service within the UK from interference from terrestrial transmitters in neighbouring countries to the extent that the satellite service is registered and able to demand protection within the ITU framework; and
- a satellite service provider holding a licence for use of this spectrum range within the UK will have to take into consideration the possible impact on its service within the UK of interference from terrestrial transmitters operating in the band 1452- 1479.5 MHz.

A5.47 The protection requirements of neighbouring countries' registered (though not yet in service) satellite broadcast systems can be assessed from the system-individual filings made to the International Telecommunications Union. It should also be noted that a US filed satellite, AFRIBSS is notified and is operating in the band with coverage in the UK and neighbouring countries. This implies a need for detailed and bespoke calculations related to the system which a prospective applicant for the UK licence in this frequency range would wish to implement. However, the practical consequence of this is expected to limit the ability to implement broadcast network implementation topologies (see section 5) across much of the UK.

A5.48 The Maastricht Plan makes assumptions regarding the receive field strength for the satellite signal based on one particular system; it may be convenient to use this as an approximate basis for establishing the technical constraints required to protect satellite receivers. However, it must be recognised that there is no agreement regarding the type of equipment used to receive the broadcast satellite signals and

the interference criteria are those that are set by the characteristics registered in the ITU filing and the relevant recommendations on protection and interference. Reference sources for these, along with filing information and known satellite operators are provided in Annex 6.

A5.49 If a licence holder is the cause of interference to an ITU registered satellite network, he must cease the transmission causing interference irrespective of holding a licence that allows for the transmission.

Annex 6

SUR derivation for 1452-1492 band

Introduction

A6.1 This annex presents the SURs proposed for this spectrum award and describes the assumptions used to calculate them. The implementation details of SURs assumed here are the same as those described in Annex 11 of the 2.6GHz spectrum award consultation[16] and are not reproduced here. We have used the Visualyse tool, described in Annex 12 of the 2.6 GHz consultation document, to generate the expected in-band PFD for the services of interest. In the future, Ofcom intends to make publicly available a modified version of its Generic Radio Modelling Tool (GRMT) for such calculations.

A6.2 All SUR values presented here are indicative, based on initial calculations. Emission restrictions specified in the final award may be different to the SUR restrictions presented here for discussion. SUR values are presented for the two different spectrum mask cases of proposals 3 and 4, as described in section 2. SUR parameters for proposal 4 are presented below, alongside the methodology and assumptions we have made in derivation of SURs. SUR values for proposal 3 are then presented at the end of this annex in paragraphs A6.52 to A6.54.

Current and Adjacent Use of the 1452-1492 MHz band

A6.3 The spectrum between 1452 and 1492 MHz is currently being used for fixed links and Programme Making and Special Events (PMSE). Notice has been given to these users as discussed in the consultation document[17] and subsequently in the statement on Ofcom's website[18]. For the purposes of definition of SUR licences it is assumed that the spectrum awarded is clear of any legacy users.

A6.4 Adjacent uses to the 1452 – 1492 MHz spectrum band are fixed links below 1452 MHz and fixed links and PMSE above 1492 MHz.

A6.5 PMSE operates in the band 1517 – 1525MHz. Harmful interference from this band into the 1452-1492 MHz band is considered unlikely and is not included in SUR analysis.

A6.6 Fixed services operate in the 1427-1450 MHz and 1492 – 1517 MHz bands. Ofcom has undertaken analysis of the likely interference from fixed services into the 1452-1497.5 MHz band which suggests the risk of harmful interference is low. This is discussed further when presenting IILs for channel LA below.

A6.7 In deriving SURs for the lower boundary channel LA at the bottom of the 1452-1479.5 MHz sub-band, no specific protection to the Fixed link services (1427-1452 MHz) over and above the ETSI spectrum mask is assumed.

[16] Award of available spectrum: 2500-2690 MHz, 2010-2025 MHz and 2290-2300 MHz, Ofcom Consultation, December 2006

[17] Award of available spectrum: 1452-1492 MHz, Ofcom Consultation, April 2006, paras 2.10 – 2.15

[18] http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/information/

1452-1479.5 MHz sub-band

A6.8 Based on Ofcom's market assessment (as summarised in Section 2 of the original consultation), likely uses for the 1452-1479.5 MHz sub-band include mobile multimedia services based on DVB-H (Digital Video Broadcasting - Handheld) or T-DMB (Terrestrial – Digital Multimedia Broadcasting) technologies among others.

A6.9 The Maastricht Plan outlines a T-DAB allotment plan for the 1452-1479.5 MHz sub-band allocating channels to small allotment areas spread across the UK. As a signatory to the Maastricht Plan, Ofcom will respect the international coordination agreements laid out in the Plan. However as highlighted in the original 1452 consultation document[19], Ofcom intends to award licences in the sub-band at a UK-wide level. The onus is on the licensee to ensure that international restrictions on the use of the 1452-1479.5 MHz sub-band in terms of aggregate level of interference to neighbouring countries are respected. Appropriate network deployment and use of directional antennas may be required.

A6.10 In line with the Maastricht Plan, T-DAB services will be used as a basis to calculate the SUR parameters for the 1452-1479.5 MHz sub-band. However, this does not preclude other technologies from using this sub-band in the UK provided the aggregate level of potential interference into neighbouring countries does not exceed the limits set in the Plan. The international restrictions are described later in this Annex

A6.11 The SUR parameters for the 1452-1479.5 MHz sub-band are based on a spectrum packaging option where the sub-band is divided into sixteen 1.7 MHz lots. Spectrum packaging options for this sub-band have been outlined in the 1452-1479.5MHz spectrum award consultation document and will not be discussed here.

A6.12 The Maastricht Plan divides the 1452-1479.5 MHz sub-band into sixteen 1.536 MHz T-DAB channels with guard bands of 0.176 MHz. Exceptionally the guard bands at the 1452 MHz and 1479.5 MHz band edges are 0.192 MHz and 0.092 MHz respectively.

A6.13 In principle in an SUR framework, there is no need for guard bands as a means of protection to or from adjacent channels. For the purpose of calculating the SUR parameters for the 1452-1479.5 MHz sub-band, the following assumptions are made:

- Each approximate 1.7 MHz of spectrum will be treated as a single block and guard bands will not be specified. Channels LB to LO are assumed to be 1.712 MHz wide. The boundary channels LA is 1.816 MHz wide (i.e. a T-DAB channel of 1.536 MHz plus the lower guard band of 0.192 MHz with the 1452 MHz band edge, plus half of the upper guard band of 0.176 MHz). The boundary channel LP is 1.716 MHz wide (i.e. a T-DAB channel of 1.536 MHz, with half of the guard band of 0.176 MHz on the lower side and the upper guard band of 0.092 MHz). This is shown in Table A6.1. The slight difference in channel widths of LA and LP to the other 14 channels results in them having slightly different channel centres to those of the Maastricht Plan.

- The in-band PFD of channels LA to LP is identical to the in-band PFD - specified with a reference bandwidth of 1 MHz, i.e. in units of dBW/m^2/MHz – of a 1.536 MHz T-DAB channel. This implies that channels LA to LP could in principle

[19] Award of available spectrum: 1452-1492 MHz, Ofcom Consultation, March 2006

operate at a higher total power than a 1.536 MHz T-DAB channel although at the same power density per MHz. In practice, the need to roll off transmissions may result in power levels in line with those of a 1.536MHz channel. The onus is on the licensee to ensure that international restrictions on use of the 1452-1479.5 MHz sub-band are respected.

- The out-of-band PFD is derived from the in-band PFD and the appropriate spectrum mask. Two spectrum masks have been considered in determining SURs, in line with the four proposals made in section 2 of this document:

    - Proposal 3: An SURs approach based on an augmented Maastricht mask. A SURs approach where the spectrum mask is specified in ETSI TR 101 496-3 v1.1.2, Figure 5.13.

    - Proposal 4: A spectrum mask approach based on the ETSI critical mask. A spectrum mask approach where the spectrum mask used is based on the spectrum mask for 'VHF-band transmitters in critical areas for adjacent channel interference' as specified in ETSI EN 300 401 V1.4.1, Figure 92 ('the ETSI critical mask').

- In the following sections out-of-band PFD restrictions and IILs based on the latter case, proposal 4, are presented. SUR parameters for proposal 3 are presented at the end of this annex in paragraphs A6.52 to A6.54. (Note In-band SUR restrictions are independent of the spectrum mask assumed).

- As guard bands are not considered, the out-of-band PFD of channels LA to LP is specified from the channel edge. This is discussed further in the section on out-of-band restrictions below.

- We note that some out-of-band PFDs and IILs quoted below are likely to be well below the noise floor. We have left these in for clarity in the calculations at this point, however we would expect to remove unnecessary restrictions which are well below the noise floor in any licence.

Table A6.1: Channel plan assumed for 1452 – 1479.5 MHz sub band

Channel	Bottom (MHz)	Top (MHz)	Width (MHz)	Centre (MHz)
LA	1452	1453.816	1.816	1452.908
LB	1453.816	1455.528	1.712	1454.672
LC	1455.528	1457.24	1.712	1456.384
LD	1457.24	1458.952	1.712	1458.096
LE	1458.952	1460.664	1.712	1459.808
LF	1460.664	1462.376	1.712	1461.52
LG	1462.376	1464.088	1.712	1463.232
LH	1464.088	1465.8	1.712	1464.944
LI	1465.8	1467.512	1.712	1466.656
LJ	1467.512	1469.224	1.712	1468.368
LK	1469.224	1470.936	1.712	1470.08
LL	1470.936	1472.648	1.712	1471.792
LM	1472.648	1474.36	1.712	1473.504
LN	1474.36	1476.072	1.712	1475.216
LO	1476.072	1477.784	1.712	1476.928
LP	1477.784	1479.5	1.716	1478.642

In-band PFD restrictions

A6.14 To determine the in-band PFD SUR restriction, a number of assumptions need to be made. Calculations have been made on the assumption that a specified minimum signal level is to be provided across the licence area, in line with the Maastricht plan, and based upon a T-DAB reference network from the Maastricht plan. Full details of the modelling assumptions are provided in Annex 7. Simulation has suggested in-band PFD SUR restriction of -80.3dB dBW/m^2/MHz be specified.

A6.15 In the case of a T-DAB deployment, this level would allow 99% outdoor mobile coverage service provision for a mobile terminal height of 1.5m.

A6.16 This in-band restriction would be valid for channels LA – LN.

A6.17 According to the Maastricht Plan, the channels at the top of the 1452-1479.5 MHz sub-band may be required to offer some protection to S-DAB services operating in the 1479.5-1492 MHz sub-band. Channels LO and LP are assumed to be subject to a restricted in-band power to reduce interference into the 1479.5-1492 MHz sub-band, in line with analysis presented earlier[20]. This analysis suggested a 7.5dB and 55.6dB additional restriction be applied to channels LO and LP respectively to protect S-DAB services in the upper sub-band. Hence the in-band PFD of channel

[20] "International interference analysis for future use of 1452-1492MHz range", Section 5.2, Analysys Mason, March 2006

LO and LP is the same as channels LA-LN, but with additional attenuations of 7.5 dB and 55.6 dB respectively.

A6.18 Resultant in-band PFD restrictions for each channel are given in Table A6.2.

A6.19 These PFD levels should not be exceeded at more than 50% of locations in a test measurement area within the licence coverage area. In general SUR parameters have been calculated assuming a measurement area in an urban environment which potentially represents the highest levels of in-band and out-of-band PFD due to the high transmitter deployment density. In this instance, the basis of the in-band restriction is provision of a minimum service level across the UK, hence the measurement area can be assumed to be in any region of the UK.

A6.20 Where practicable, the measurement area, A, is also set to cover around 10 ‘cells’ in order that any measurements made are not unduly biased by specific cell placement. A ‘cell’ is assumed to be the coverage area of a transmitter.

A6.21 The in-band and out-of-band PFD are defined as the average values measured over a period of time sufficiently long to eliminate effects such as fading and the transmission cycle times. This is likely to be of the order of several minutes. The justification for defining the SUR parameters in terms of an average PFD is that it captures variations in time due to rapidly fluctuating propagation effects, transmit equipment time variability such as transmit power control, and other effects such as vehicle movement. It is not intended to capture long term propagation effects such as the occurrence of ducting.

Table 6.2: In-band SUR restrictions for the 1452 – 1479.5 MHz sub band. These should not be exceeded at more than 50% of locations over the measurement area.

Channel	Centre (MHz)	Average in-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
LA	1452.908	-80.3
LB	1454.672	-80.3
LC	1456.384	-80.3
LD	1458.096	-80.3
LE	1459.808	-80.3
LF	1461.52	-80.3
LG	1463.232	-80.3
LH	1464.944	-80.3
LI	1466.656	-80.3
LJ	1468.368	-80.3
LK	1470.08	-80.3
LL	1471.792	-80.3
LM	1473.504	-80.3
LN	1475.216	-80.3
LO	1476.928	-87.8
LP	1478.642	-135.9

Out-of-band PFD restrictions

A6.22 The out-of-band PFD is derived from the in-band PFD and the appropriate spectrum mask. Two spectrum masks have been considered in determining SURs as described in section 2:

- Proposal 3: An SURs approach based on an augmented Maastricht mask. A SURs approach where the spectrum mask is specified in ETSI TR 101 496-3 v1.1.2, Figure 5.13.

- Proposal 4: A spectrum mask approach based on the ETSI critical mask. A spectrum mask approach where the spectrum mask used is based on the spectrum mask for 'VHF-band transmitters in critical areas for adjacent channel interference' as specified in ETSI EN 300 401 V1.4.1, Figure 92 ('the ETSI critical mask').

A6.23 Here we present the out-of-band PFD values derived for proposal 4, as described in section 2 above.

A6.24 Because no guard bands are assumed in the SURs, the ETSI mask is applied at the edge of SUR channel bandwidth. For example in the case of channel LH, the upper boundary of the in-band SUR is at 1465.8MHz. The out-of-band mask has

been assumed to apply from here, as shown in Figure A6.1, derived from the appropriate ETSI mask.

A6.25 The out-of-band PFD restrictions extend to a frequency offset of 5 MHz from the channel centre frequency. We assume that the out-of-band emissions beyond this frequency offset are insignificant. As the out-of-band PFD changes rapidly over 1 MHz, the out-of-band PFD is specified in smaller increments of 200 kHz.

A6.26 Resultant in-band PFD restrictions for each channel are given in Tables 3 – 6 as a series of restrictions over successive 200kHz intervals from the centre of the channel. These PFD levels should not be exceeded at more than 50% of locations in a test measurement area within the licence coverage area.

A6.27 Out-of-band emissions for channels LO and LP are subject to the attenuations of 7.5 dB and 55.6 dB respectively to protect S-DAB services as discussed in paragraph A6.17.

Figure A6.1: Application of ETSI mask to derive SUR out-of-band restrictions, for the case of a 1.712MHz channel (corresponding to channels LB – LO from the Maastricht Plan).

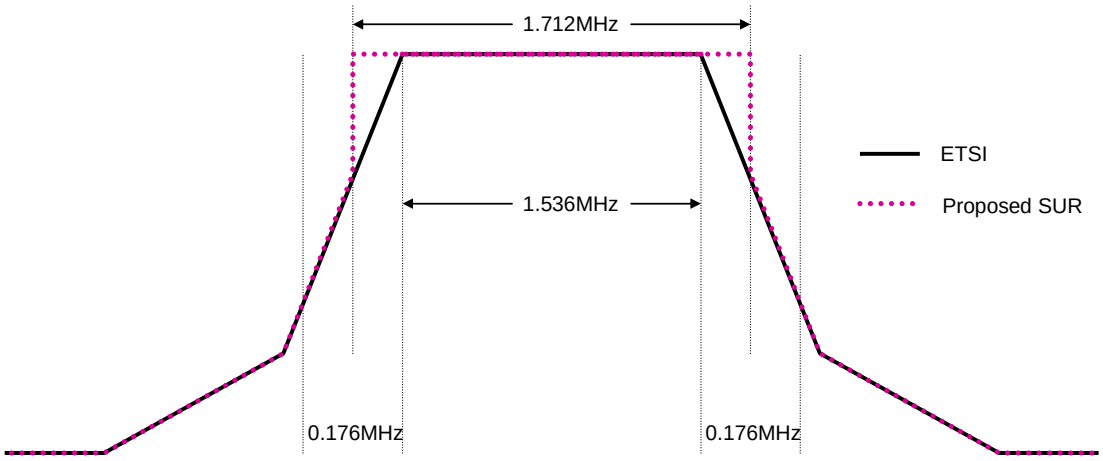


Table A6.3: Out-of-band SUR restrictions for channel LA for proposal 4. These should not be exceeded at more than 50% of locations over the measurement area.

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
0.908	1.108	-120
1.108	1.308	-135
1.308	1.508	-144
1.508	1.708	-153
1.708	1.908	-160
1.908	2.108	-160
2.108	2.308	-160
2.308	2.508	-160
2.508	2.708	-160
2.708	2.908	-160
2.908	3.108	-160

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
3.108	3.308	-160
3.308	3.508	-160
3.508	3.708	-160
3.708	3.908	-160
3.908	4.108	-160
4.108	4.308	-160
4.308	4.508	-160
4.508	4.708	-160
4.708	4.908	-160
4.908	5.000	-160

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Table A6.4: Out-of-band SUR restrictions for channels LB - LN for proposal 4. These should not be exceeded at more than 50% of locations over the measurement area

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
0.856	1.056	-108
1.056	1.256	-132
1.256	1.456	-141
1.456	1.656	-150
1.656	1.856	-159
1.856	2.056	-160
2.056	2.256	-160
2.256	2.456	-160
2.456	2.656	-160
2.656	2.856	-160
2.856	3.056	-160
3.056	3.256	-160
3.256	3.456	-160
3.456	3.656	-160
3.656	3.856	-160
3.856	4.056	-160
4.056	4.256	-160
4.256	4.456	-160
4.456	4.656	-160
4.656	4.856	-160
4.856	5.000	-160

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Table A6.5: Out-of-band SUR restrictions for channel LO for proposal 4. These should not be exceeded at more than 50% of locations over the measurement area.

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
0.856	1.056	-116
1.056	1.256	-140
1.256	1.456	-149
1.456	1.656	-158
1.656	1.856	-166
1.856	2.056	-168

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
2.056	2.256	-168
2.256	2.456	-168
2.456	2.656	-168
2.656	2.856	-168
2.856	3.056	-168
3.056	3.256	-168
3.256	3.456	-168
3.456	3.656	-168
3.656	3.856	-168
3.856	4.056	-168
4.056	4.256	-168
4.256	4.456	-168
4.456	4.656	-168
4.656	4.856	-168
4.856	5.000	-168

Table A6.6: Out-of-band SUR restrictions for channel LP for proposal 4. These should not be exceeded at more than 50% of locations over the measurement area.

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
0.858	1.058	-164
1.058	1.258	-188
1.258	1.458	-197
1.458	1.658	-206
1.658	1.858	-214
1.858	2.058	-216
2.058	2.258	-216
2.258	2.458	-216
2.458	2.658	-216
2.658	2.858	-216
2.858	3.058	-216
3.058	3.258	-216
3.258	3.458	-216
3.458	3.658	-216
3.658	3.858	-216
3.858	4.058	-216
4.058	4.258	-216
4.258	4.458	-216
4.458	4.658	-216
4.658	4.858	-216
4.858	5.000	-216

IILs

A6.28 IILs for each channel have been calculated using the out-of-band emission restrictions from two neighbouring channels above and two neighbouring channels below in frequency. So, for example, IILs for channel LD would include emissions from channels LA, LB, LE and LF. Emissions from further channels are assumed negligible.

A6.29 Here we present the IILs based resulting from out-of-band PFD values derived for proposal 4, as described in section 2 above.

A6.30 At boundaries, IILs also include emissions from other use. At the lower sub-band boundary fixed service out-of-band emissions have been included in the IIL, though the impact of these is considered small. At the upper sub-band boundary S-DAB out-of-band emissions have been included in the IILs for channels LO and LP. Again, the likely impact of these is considered to be small, particularly given the additional restrictions on these channels for protection of S-DAB services.

A6.31 As the IILs are expected to vary significantly over the channel bandwidth, they are specified in smaller increments of 200 kHz.

A6.32 Table A6.7 summarises the IILs for each channel.

Table 7: IILs for channels LA – LP for proposal 4. These should not be exceeded at more than 50% of locations over the measurement area.

Channel LA			Channels LB – LP		
Lower frequency limit from centre frequency (MHz)	**Upper frequency limit from centre frequency (MHz)**	**Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)**	**Lower frequency limit from centre frequency (MHz)**	**Upper frequency limit from centre frequency (MHz)**	**Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)**
-0.908	-0.700	-140	-0.856	-0.700	-107
-0.700	-0.500	-140	-0.700	-0.500	-130
-0.500	-0.300	-140	-0.500	-0.300	-139
-0.300	-0.100	-140	-0.300	-0.100	-148
-0.100	0.100	-140	-0.100	0.100	-153
0.100	0.300	-140	0.100	0.300	-148
0.300	0.500	-139	0.300	0.500	-139
0.500	0.700	-136	0.500	0.700	-130
0.700	0.908	-129	0.700	0.856	-107

Channel LN			Channel LO		
Lower frequency limit from centre frequency (MHz)	**Upper frequency limit from centre frequency (MHz)**	**Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)**	**Lower frequency limit from centre frequency (MHz)**	**Upper frequency limit from centre frequency (MHz)**	**Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)**
-0.856	-0.700	-107	-0.856	-0.700	-106
-0.700	-0.500	-130	-0.700	-0.500	-112
-0.500	-0.300	-139	-0.500	-0.300	-112
-0.300	-0.100	-148	-0.300	-0.100	-112
-0.100	0.100	-155	-0.100	0.100	-112
0.100	0.300	-153	0.100	0.300	-112
0.300	0.500	-146	0.300	0.500	-112
0.500	0.700	-138	0.500	0.700	-112
0.700	0.856	-115	0.700	0.856	-112

Channel LP

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)
-0.858	-0.700	-103
-0.700	-0.500	-103
-0.500	-0.300	-103
-0.300	-0.100	-103
-0.100	0.100	-103
0.100	0.300	-103
0.300	0.500	-103
0.500	0.700	-103
0.700	0.858	-103

A6.33 The IIL for channel LA takes into account interference from fixed services in the 1427-1450MHz band. Simulation has determined the 50% of locations mean PFD level contribution into channel LA to be -140.8dBW / m^2 / MHz. The derivation of this value is outlined in Annex 7

A6.34 It should be noted that the directional nature of the Fixed Services (FS) networks means there can be significant variation in PFD levels. For example the highest PFD level into the nearest DAB channel LA at 1.5m was predicted to be -81.8 dBW / m^2 / MHz, though this was only calculated at a single point. This represents a case where a DAB signal is being received at close proximity to a FS transmitter.

A6.35 However there are likely to be only a handful of FS transmitters in the adjacent band within a measurement area. Around these transmitters there is likely to be higher levels of PFD but the precise locations will depend upon the actual deployments of FS links in channels adjacent to the 1452 – 1 492 MHz band.

A6.36 The results above did not include the effects of terrain or clutter. This approach was taken as it ensures the PFD levels generated are worst case and generally applicable rather than depending upon the location selected. Further detail on the modelling is available in Annex 7.

International restrictions

A6.37 The geographical limits on interference that will apply in the 1452-1479.5 MHz are defined in the Maastricht Plan. We do not propose to restate these in SUR terms. These restrictions pertain to:

- Co-channel and adjacent channel interference restrictions within the 1452-1479.5 MHz sub-band

    - *'The maximum permissible equivalent field strength for co-block interference at the contour of an allotment area is given by 41 dB uV/m'*. This is based on a minimum median equivalent field strength of 69 dB uV/m (valid at 10m and for 99% of locations), a co-block protection ratio of 10 dB and a propagation correction of 18 dB.

- *'The maximum permissible equivalent field strength for adjacent block interference at the contour of an allotment area is given by 81 dB uV/m'*. This is based on a minimum median equivalent field strength of 69 dB uV/m (valid at 10m and for 99% of locations), a co-block protection ratio of -30 dB and a propagation correction of 18 dB.

- Interference restrictions to services operating in bands adjacent to the one under consideration.
  - For the case of services in the 1452-1479.5 MHz sub-band being interfered by services in adjacent bands, the maximum allowable field strength of the interfering signal for a range of services is listed in Section 4.2.1 of Annex 2 of the Maastricht Plan.
  - For the case of services in the 1452-1479.5 MHz sub-band interfering with services in adjacent bands, the maximum allowable field strength of the interfering signal is listed in Section 4.2.2 of Annex 2 of the Maastricht Plan.

A6.38 In case the above restrictions are not met, the Maastricht Plan requires coordination between countries. The procedure for deciding if coordination is necessary, is outlined as follows:

- A series of test points is associated with each allotment; this is a combination of:
  - The corners of all other allotments sharing the same frequency
  - A locus of points generated by the geometry of the allotment and the predicted decay of signal strength from a standard hypothetical reference network of transmitters.
- The cumulative field strength of the proposed real network of transmitters is calculated at each test point.
- If this cumulative field strength exceeds a certain threshold then coordination is needed with those countries touched by the test point concerned or which lie along a line from the test point to a point where the threshold is reached.

A6.39 A full description of the coordination procedure is given in the Maastricht Plan.

1479.5-1492 MHz sub-band

A6.40 SURs will be derived for the 1479.5-1492 MHz sub-band using S-DAB services as a basis for technical parameters. This does not preclude other technologies from using this sub-band in the UK provided the aggregate levels of interference meet the SUR restrictions and international obligations. However the restrictions are likely to place constraints on other services which could be deployed.

A6.41 For the purpose of calculating SUR parameter values for this sub-band, we assume the 1479.5-1492 MHz is to be awarded as one block as shown below.

Channel	Bottom (MHz)	Top (MHz)	Width (MHz)	Centre (MHz)
LA	1479.5	1492	12.5	1485.75

In-band PFD

A6.42 In establishing SUR emission restrictions we have considered present and future likely use of the band. At present the only satellite network providing commercial S-DAB services over Europe in the 1479.5 – 1492 MHz band is Worldspace. However it is possible that an operator could in the future launch a system with different transmit powers or use alternative architectures. Two other systems were therefore considered namely Global Radio (also proposed at L-band though not operational) and Sirius (at a higher frequency but operational). A generic S-DAB reference system was defined that was consistent with these networks to determine SUR emission restrictions.

A6.43 For S-DAB services in the 1479.5-1492 MHz sub-band we assume the signal level to be relatively uniform across the service area. Simulations therefore model only a single point. Further details of modelling assumptions are given in Annex 7.

A6.44 An in-band PFD restriction of -96.7dBW/m^2/MHz has been calculated based on the generic reference system. This proposed limit should not be exceeded in more than 50% of locations within a measurement area.

Out-of-band PFD

A6.45 Interference protection to adjacent channels is based on the attenuation as specified by ITU-R Rec. SM.1541. The out-of-band PFD is therefore determined from the in-band PFD and the attenuation as specified by ITU-R Rec. SM.1541. The out-of-band emissions beyond 250% of the generic reference S-DAB channel bandwidth (assumed to be 2.5MHz, see Annex 7) from the centre frequency are assumed to be negligible.

A6.46 For indicative purposes the OOB PFD emissions expected in T-DAB channels LO and LP are given as -104 dBW/m^2/MHz and -112dBW/m^2/MHz. Detail on calculation of these values is given in Annex 7.

A6.47 It is noted that in the case of S-DAB services, the in-band and out-of-band PFD at 1.5m are assumed to be applicable at 10m. This is because free space path loss is likely to be the dominant factor and the difference in height is insignificant compared to the orbital distance of the satellite.

A6.48 Table A6.8 shows the resultant out-of-band PFD restrictions in SUR terms for the 1479.5-1492MHz band, quoted at 200kHz intervals from the channel edges at 1479.5MHz and 1492MHz.

Table 8: Out-of-band SUR restrictions for the 1479.5 – 1492 MHz sub-band. These PFD values should not be exceeded at more than 50% of locations over the measurement area.

Inner offset from channel edge (MHz)	Outer offset from channel edge (MHz)	Out-of-band PFD
0.000	0.200	-97.000
0.200	0.400	-99.000
0.400	0.600	-101.000
0.600	0.800	-102.000
0.800	1.000	-104.000
1.000	1.200	-105.000
1.200	1.400	-106.000
1.400	1.600	-107.000
1.600	1.800	-108.000
1.800	2.000	-109.000
2.000	2.200	-110.000
2.200	2.400	-111.000
2.400	2.600	-111.000
2.600	2.800	-112.000
2.800	3.000	-113.000
3.000	3.200	-114.000
3.200	3.400	-114.000
3.400	3.600	-115.000
3.600	3.800	-115.000
3.800	4.000	-116.000
4.000	4.200	-116.000
4.200	4.400	-117.000
4.400	4.600	-117.000
4.600	4.800	-118.000
4.800	5.000	-118.000
5.000	5.200	-119.000
5.200	5.400	-119.000
5.400	5.600	-120.000
5.600	5.800	-120.000
5.800	6.000	-120.000
6.000	6.250	-121.000

IILs

A6.49 IILs for the bottom of the 1479.5-1492MHz can be calculated by summing the contributions of the PFD emissions from adjacent channels in the lower sub-band. The top two T-DAB channels, LO and LP are assumed to contribute to the IIL. Resultant IILs are very low, reflecting the protection restrictions applied to these channels.

A6.50 The IIL at the top end of the 1479.5-1492MHz are assumed to be contributed to by the adjacent fixed services band. This is discussed in further detail in Annex 7. Again, expected levels of interference are very low, an IIL of -146.7 dBW/m^2/MHz has been calculated for the upper 2.5MHz of the sub-band.

A6.51 IILs for the 1479.5-1492MHz sub-band are presented in Table A6.9.

Table A6.9: IILs for the 1479.5-1492 MHz sub-band, quoted at 2.5MHz intervals. These PFD values should not be exceeded at more than 50% of locations over the measurement area.

Lower frequency limit (MHz)	Upper frequency limit (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)
1479.5	1482.0	-167
1482.0	1484.5	-167
1484.5	1487.0	-167
1487.0	1489.5	-167
1489.5	1492.0	-146

Derived SUR parameters for proposal 3, the "augmented Maastricht mask"

A6.52 In this section we present the derived SUR parameter values for the ETSI mask "L-band transmitters in critical areas for adjacent channel interference". This is proposal 3: "An SUR approach based on an augmented Maastricht mask", suggested in section 2. This is the mask that was assumed in the March 2006 consultation document. The emission restrictions in this mask are less stringent than those presented in Tables A6.3 – A6.6 above. An implication of these less stringent restrictions is that the IILs presented here are higher than those in Table A6.7 in some instances.

A6.53 In-band SUR restrictions are identical to the case presented above in Table 2, and are not repeated here.

A6.54 Tables A6.10 – A6.14 present the out-of-band PFD restrictions and IILs for this alternative mask. Figures A6.2 and A6.3 compare the out-of-band PFD restrictions and IILs for the two mask cases.

Table A6.10: Out-of-band SUR restrictions for channel LA for proposal 3. These should not be exceeded at more than 50% of locations over the measurement area.

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
0.908	1.108	-104
1.108	1.308	-116
1.308	1.508	-120
1.508	1.708	-125
1.708	1.908	-130
1.908	2.108	-135
2.108	2.308	-140
2.308	2.508	-145
2.508	2.708	-150
2.708	2.908	-155
2.908	3.108	-159
3.108	3.308	-160
3.308	3.508	-160
3.508	3.708	-160
3.708	3.908	-160
3.908	4.108	-160
4.108	4.308	-160

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
4.308	4.508	-160
4.508	4.708	-160
4.708	4.908	-160
4.908	5.000	-160

Table A6.11: Out-of-band SUR restrictions for channels LB - LN for proposal 3. These should not be exceeded at more than 50% of locations over the measurement area..

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
0.856	1.056	-98
1.056	1.256	-114
1.256	1.456	-119
1.456	1.656	-124
1.656	1.856	-129
1.856	2.056	-134
2.056	2.256	-139
2.256	2.456	-144
2.456	2.656	-149
2.656	2.856	-154
2.856	3.056	-159
3.056	3.256	-160
3.256	3.456	-160
3.456	3.656	-160
3.656	3.856	-160
3.856	4.056	-160
4.056	4.256	-160
4.256	4.456	-160
4.456	4.656	-160
4.656	4.856	-160
4.856	5.000	-160

Table A6.12: Out-of-band SUR restrictions for channel LO for proposal 3. These should not be exceeded at more than 50% of locations over the measurement area.

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
0.856	1.056	-105
1.056	1.256	-122
1.256	1.456	-127
1.456	1.656	-132
1.656	1.856	-137
1.856	2.056	-142
2.056	2.256	-146
2.256	2.456	-151
2.456	2.656	-156
2.656	2.856	-161
2.856	3.056	-166
3.056	3.256	-168

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
3.256	3.456	-168
3.456	3.656	-168
3.656	3.856	-168
3.856	4.056	-168
4.056	4.256	-168
4.256	4.456	-168
4.456	4.656	-168
4.656	4.856	-168
4.856	5.000	-168

Table A6.13: Out-of-band SUR restrictions for channel LP for proposal 3. These should not be exceeded at more than 50% of locations over the measurement area.

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average out-of-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
0.858	1.058	-154
1.058	1.258	-170
1.258	1.458	-175
1.458	1.658	-180
1.658	1.858	-185
1.858	2.058	-190
2.058	2.258	-195
2.258	2.458	-200
2.458	2.658	-204
2.658	2.858	-209
2.858	3.058	-214
3.058	3.258	-216
3.258	3.458	-216
3.458	3.658	-216
3.658	3.858	-216
3.858	4.058	-216
4.058	4.258	-216
4.258	4.458	-216
4.458	4.658	-216
4.658	4.858	-216
4.858	5.000	-216

Table A6.14: IILs for channels LA - LP for proposal 3. These should not be exceeded at more than 50% of locations over the measurement area.

Channel LA			Channels LB – LM		
Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)	Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)
-0.908	-0.700	-140	-0.856	-0.700	-97
-0.700	-0.500	-139	-0.700	-0.500	-113
-0.500	-0.300	-138	-0.500	-0.300	-118

Channel LA

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)
-0.300	-0.100	-135
-0.100	0.100	-131
0.100	0.300	-127
0.300	0.500	-122
0.500	0.700	-117
0.700	0.908	-112

Channels LB – LM

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)
-0.300	-0.100	-123
-0.100	0.100	-125
0.100	0.300	-123
0.300	0.500	-118
0.500	0.700	-113
0.700	0.856	-97

Channel LN

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)
-0.856	-0.700	-97
-0.700	-0.500	-113
-0.500	-0.300	-118
-0.300	-0.100	-123
-0.100	0.100	-127
0.100	0.300	-129
0.300	0.500	-125
0.500	0.700	-121
0.700	0.856	-104

Channel LO

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)
-0.856	-0.700	-97
-0.700	-0.500	-109
-0.500	-0.300	-111
-0.300	-0.100	-111
-0.100	0.100	-112
0.100	0.300	-112
0.300	0.500	-112
0.500	0.700	-112
0.700	0.856	-112

Channel LP

Lower frequency limit from centre frequency (MHz)	Upper frequency limit from centre frequency (MHz)	Average PFD at a height 1.5m above ground level from other interferers (dBW/m^2/MHz)
-0.858	-0.700	-101
-0.700	-0.500	-103
-0.500	-0.300	-103
-0.300	-0.100	-103
-0.100	0.100	-103
0.100	0.300	-103
0.300	0.500	-103
0.500	0.700	-103
0.700	0.858	-103

Figure A6.2 Out-of-band PFD restrictions and IILs for channels LA – LP for proposal 4, the mask based on the ETSI "VHF transmitters in critical areas for adjacent channel interference" mask. An indication of background noise levels (kTB) is also given for information.

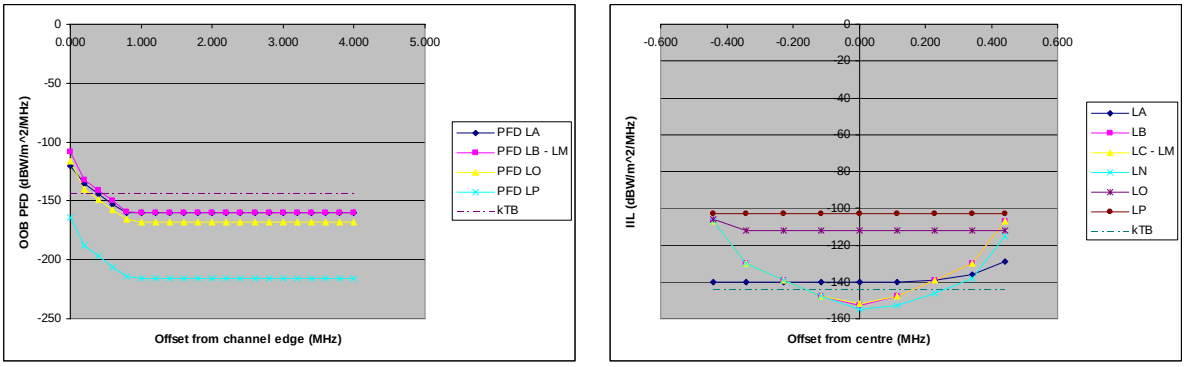
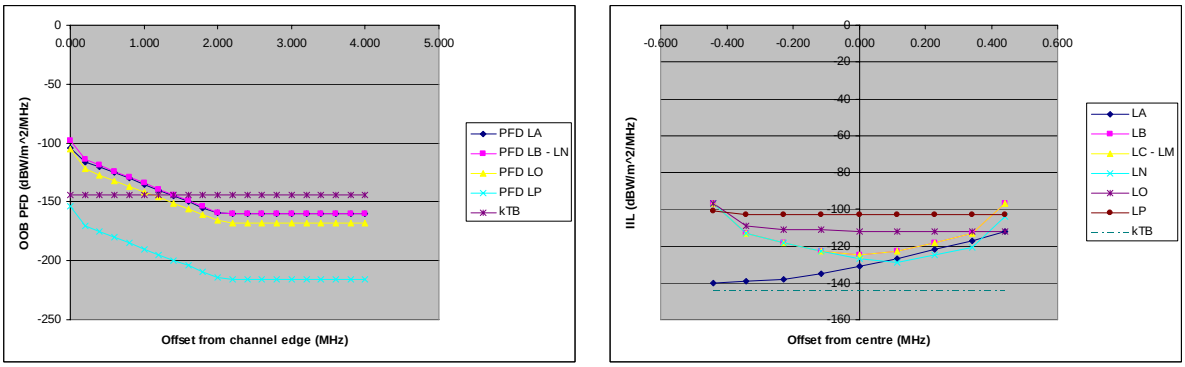


Figure A6.3 Out-of-band PFD restrictions and IILs for channels LA – LP for proposal 3, the "augmented Maastricht mask". An indication of background noise levels (kTB) is also given for information.



Annex 7

Assumptions and inputs used in the SUR modeling tool

Introduction

A7.1 In this section we adopt the modelling methodology described in Annex 12 of the 2.6 GHz consultation document[21], modified with appropriate system parameters, deployment assumptions and propagation models for this spectrum band.

A7.2 SUR parameter values have been derived through modelling using the Visualyse tool, described in detail in the 2.6 GHz consultation document.

A7.3 Modelling assumptions are presented first for simulation of T-DAB services in the 1452-1479.5 MHz sub-band, followed by those assumed for S-DAB services in the 1479.5-1492 MHz sub-band. Finally assumptions for calculating the likely interference that can be expected in the 1452 – 1492 MHz band from fixed services are presented.

T-DAB

A7.4 The key parameters assumed to derive the T-DAB PFD values are given in Table A7.1.

[21] Award of available spectrum: 2500-2690 MHz, 2010-2025 MHz and 2290-2300 MHz, Ofcom Consultation, December 2006

Table A7.1: Key T-DAB parameters

Field	Value	Comments
Carrier bandwidth	1.536 MHz	From T-DAB frequency plan table above
Channel bandwidth	1.712 MHz	From T-DAB frequency plan table above
Centre frequency	1 470.080	Nearest frequency to the 1 470 MHz used in Maastricht Annex 2
Service type	Outdoor Mobile 99 % locations	Implies: - Minimum field strength of 46 dBμV/m at h = 1.5m for 50% locations and 50% of time - 13 dB correction from 50% to 99% of locations - 10 dB of height correction from 1.5 m to 10m
Minimum field strength required at 10 m for 50% of the time and locations	69 dBμV/m	From Maastricht Annex 2 assuming service type described above
Antenna pattern	Isotropic	Mobile user
Antenna height	10m	Reference height consistent with assumptions above
Reference network	One	Note comments below regarding EIRP
Transmitter separation	15 km	Appropriate for reference network one
Propagation Model	ITU-R Rec.P.1546-2	More recent version of the model in ITU-R Rec.370. Assumed path 100% over land and calculated at 50% of time and 50% locations given adjustments above.

A7.5 The parameters were collected from the following sources:

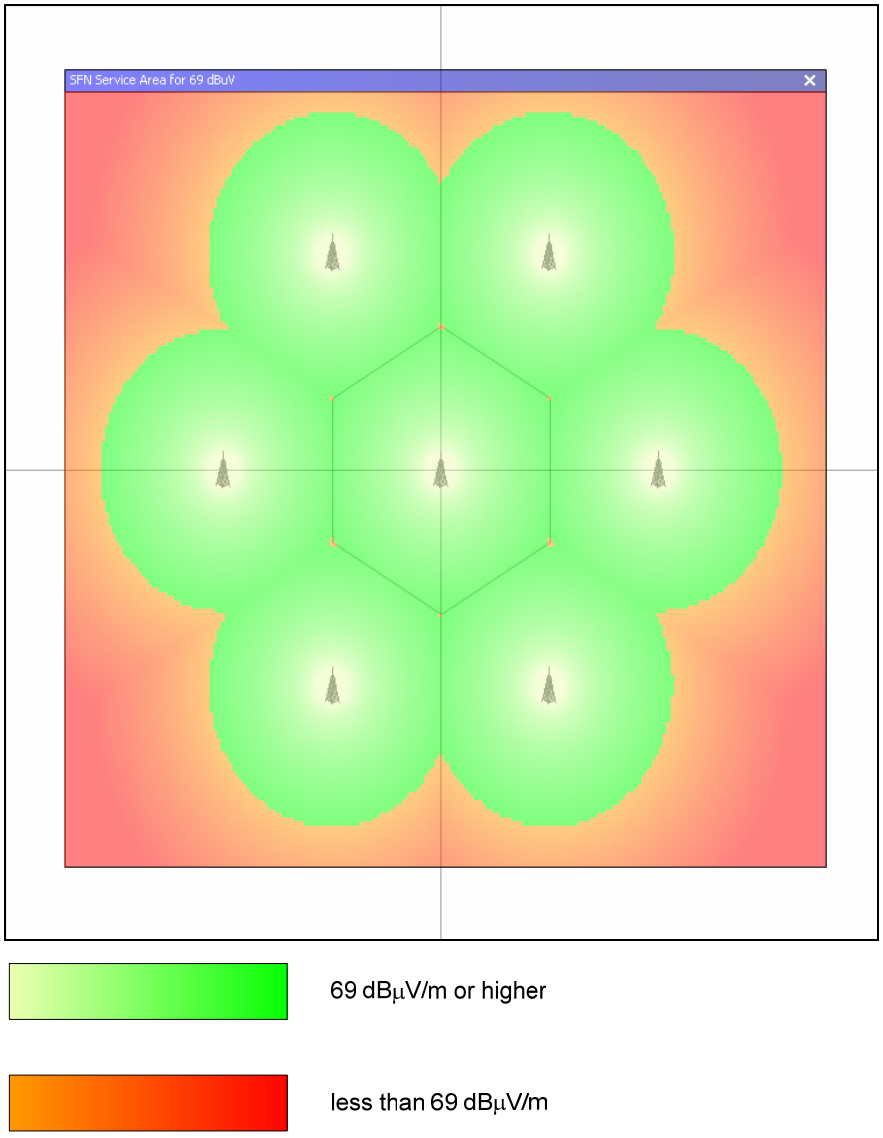
- Final Acts of the CEPT T-DAB Planning Meeting (4) Maastricht, 2002 – Annex 2: Technical Bases for T-DAB Planning
- International interference analysis for future use of 1452-1492MHz range, Final Report for Ofcom, Analysys & Mason

A7.6 Reference network one, as specified in the Maastricht plan, has a reference power of 1 kW. However analysis suggested it would not be feasible to achieve the minimum field strength of 69 dBμV/m across the service area – rather this power would be appropriate for a fixed receiver. A figure of 37dBW, or 5kW, has been

assumed, in line with the earlier analysis of international interference issues undertaken and presented alongside our earlier consultation[22].

A7.7 Figure A7.1 below shows the field strength derived across the reference network using the assumptions above.

Figure A7.1: Field strength of strongest transmitter across the reference network area



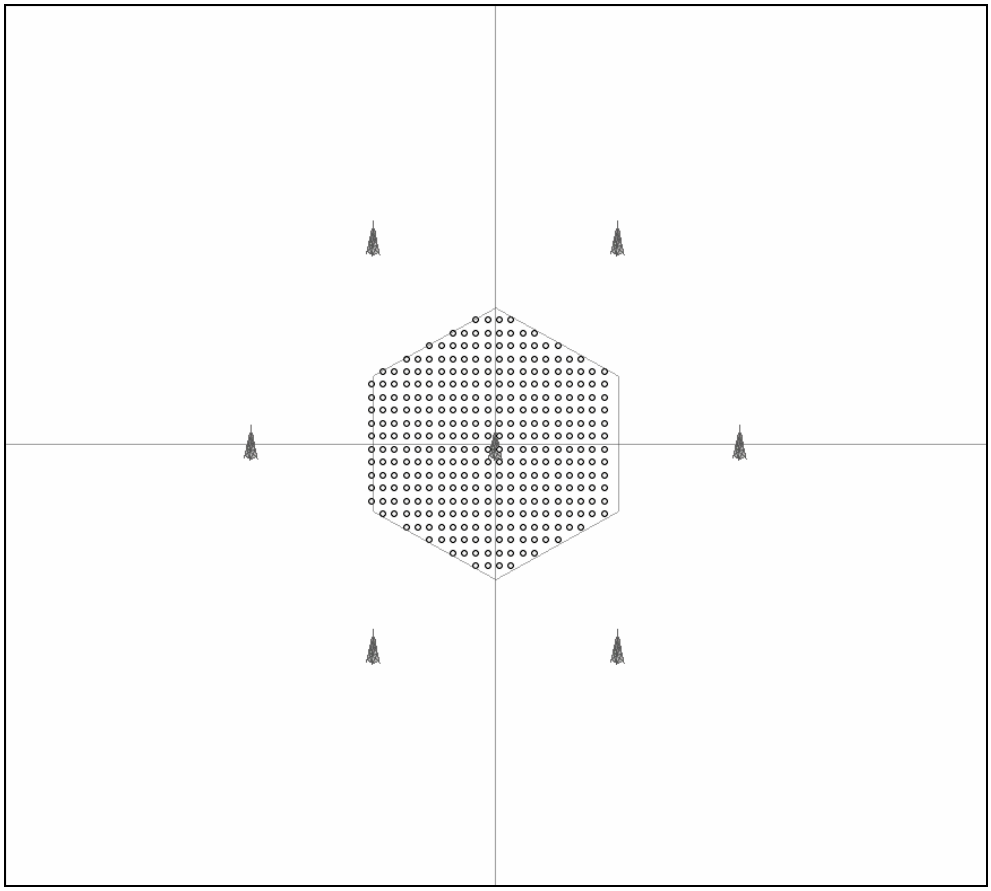
A7.8 It can be seen that the selected EIRP would just provide the required field strength across the reference network area.

A7.9 The scenario was modelled using the reference network one as configured above. The measurement area and other simulation parameters for the T-DAB case are given by:

[22] "International interference analysis for future use of 1452-1492MHz range", Section 5.2, Analysys Mason, March 2006

- Measurement area: 1 hexagonal cell (i.e. 195 km^2).
- Number of measurement points: 330 measurement points deployed on a regular grid across the central area as in Figure A7.2. At each of the test points the PFD was measured at 1.5 m.
- Although only a single cell is simulated, PFD values are taken at evenly spaced values across the cell. It is assumed that the resultant 50% of locations PFD will not be significantly different to that measured across an area covering a number of cells.

Figure A7.2: Deployment of T-DAB test points



A7.10 Based on the above inputs and assumptions, the median 50 % of locations in-band PFDs are as follows:

Measurement height (m)	1.5	10
In-band PFD (dBW/m^2/MHz)	-80.3	-70.3

A7.11 The out-of-band PFD is calculated by applying the appropriate spectrum mask to the 1.5m height in-band PFD restriction.

S-DAB

System parameters

A7.12 At present the only satellite network providing commercial S-DAB services over Europe in the 1479.5 – 1492 MHz band is Worldspace[23]. However it was considered that this network should not be the sole source of system parameters as it is possible that an operator could in the future launch a system with different transmit powers or use alternative architectures.

A7.13 Two others were therefore considered namely Global Radio (also proposed at L-band though not operational) and Sirius (at a higher frequency but operational).

A7.14 Hence three example S-DAB networks were considered, with parameters collected from the following sources:

- ITU-R Database of Space Radiocommunications Stations (SRS)
- ITU-R Rec. SM.329: Spurious Emissions
- ITU-R Rec. SM.1541: Unwanted emissions in the out-of-band domain
- FCC: Application for Authority to Launch and Operate Sirius FM-5, a geostationary satellite to provide satellite digital audio radio services

A7.15 Table A7.2 shows the key system parameters for the three S-DAB networks mentioned above.

[23] See http://www.worldspace.com/

Table A7.2: Example S-DAB system parameters

System	Worldspace	Global Radio	Sirius
Data source	ITU SRS	ITU SRS	FCC Application
Frequency (MHz)	1,479.5	1,479.5	2,322.3
Orbit type	GEO	HEO	GEO
Longitude (deg)	21E	n/a	96W
Range (km)	38,376.0 (1)	67,632.0 (2)	35,147.5 (3)
ITU Satellite ID	AFRIBSS	GLOBAL RADIO	n/a
ITU Beam	SD1R	LUKR	n/a
Peak gain (dBi)	30	37.3	n/a
Group ID	104615326	101682878	n/a
Designation of emission	2M60G7E--	1M60X1W--	4M50G7E
Maximum power (dBW)	29.8	35.5	n/a
Peak eirp (dBW)	59.8	72.8	71.0
Spreading loss (dB) (4)	162.7	167.6	161.9
Rec. P.676 losses (dB) (5)	0.07	0.07	0.07
Bandwidth (MHz)	2.5 (6)	1.5625 (6)	4.5
Reference bandwidth (MHz)	1	1	1
Bandwidth adjustment (dB)	4.0	1.9	6.5
PFD (dBW/m^2/MHz)	-107.0	-96.8	-97.5

Notes:

(1): Distance to test point at same longitude and latitude = 50° N.

(2): Derived from apogee radius = 74,010 km and earth radius = 6378 km.

(3) Derived from propagation loss.

(4): Spreading loss = $10.\log_{10}(4¶d^2)$ and is the PFD equivalent of free space path loss in ITU-R Rec. P.525.

(5): ITU-R Rec. P.676 includes attenuation due to atmospheric gases.

(6) The bandwidth used was slightly less than that defined in the designation of emission as it was assumed that there would be an integer number of channels within the 12.5 MHz

A7.16 It was noted that the PFD of Global Radio and Sirius was higher than that of Worldspace, which would allow them to provide a service with greater margins (e.g. to compensate for foliage loss) or additional channels.

A7.17 A generic S-DAB network was defined that was consistent with the networks described above as in Table A7.3.

Table A7.3: Reference S-DAB system parameters

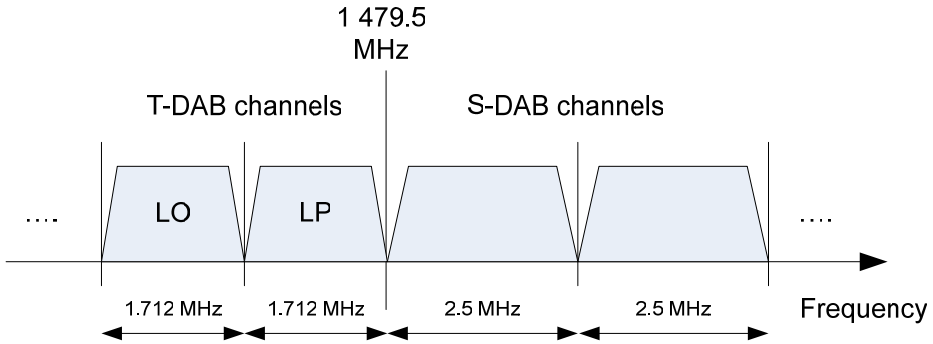
Frequency (MHz)	1,479.5
Orbit type	GEO
Longitude (deg)	0 E
Range (km)	38,376.0
Peak gain (dBi)	37.0
Maximum power (dBW)	33.0
Peak eirp (dBW)	70.0
Spreading loss (dB)	162.7
Rec. P.676 losses (dB)	0.07
Bandwidth (MHz)	2.5
Reference bandwidth (MHz)	1
Bandwidth adjustment (dB)	4.0
PFD (dBW/m^2/MHz)	-96.7

A7.18 This reference S-DAB system was then used to derive PFD levels both in-band and in adjacent T-DAB channels. As the satellite system is designed to provide near isoflux coverage, it was only necessary to use a single test point which was assumed to be located at 50°N, 0°E.

Out-of-band PFD

A7.19 The top 12.5 MHz of the 1450 – 1492 MHz band, which is currently assigned for use by S-DAB systems, is adjacent to T-DAB channels LO and LP. The channel plan is shown in the figure A7.2 below which assumes the 2.5 MHz channel bandwidth assumed for the reference satellite network described above.

Figure A7.2: T-DAB and S-DAB channels around 1479.5 MHz



A7.20 The centres of the two following channels are offset in frequency from the edge of the S-DAB part of the band as in table A7.4.

Table A7.4: Offset from S-DAB boundary to nearest T-DAB channels

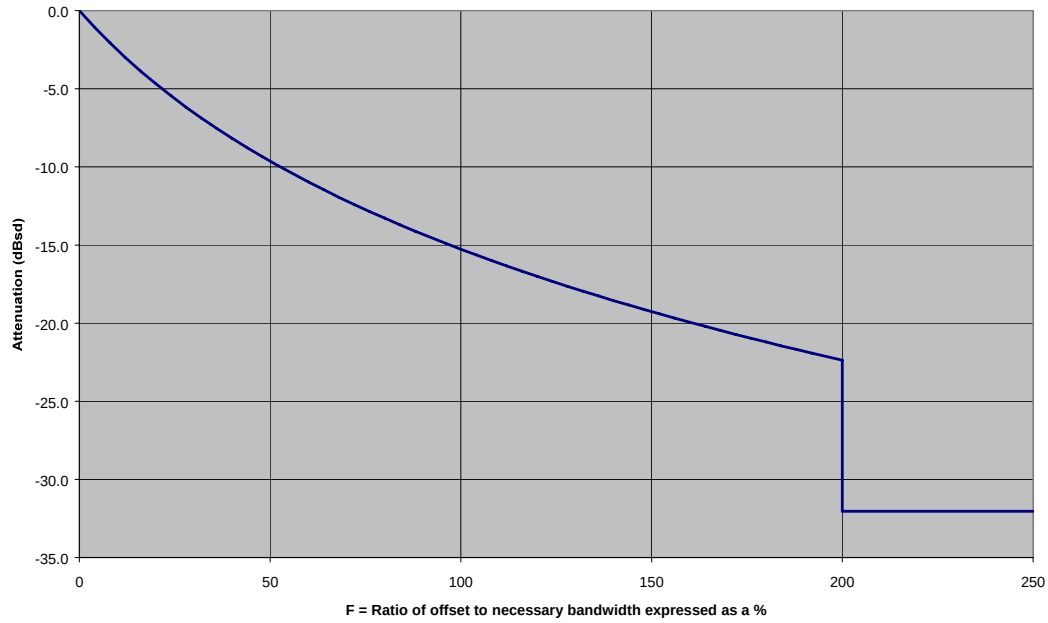
Channel	LP	LO
Frequency (MHz)	1478.640	1476.928
Offset from 1479.5 MHz (MHz)	0.860	2.572

A7.21 The emissions in the out-of-band and spurious domains for Broadcast Satellite Service (BSS) systems such as S-DAB can be derived using the following two ITU-R Recommendations:

- Out-of-band domain (from ITU-R Rec. SM.1541):
  - Attenuation = 32 log ((F/50) + 1) expressed in dBsd
    - Where: F = the frequency offset from the edge of the total assigned band expressed as a percentage of necessary bandwidth which will range from 0% to 200% at the standard spurious boundary of 250%
- Spurious domain (from ITU-R Rec. SM.329):
  - Attenuation = min{ 43 + 10log(P), 60 } expressed in dBc
  - Where: P = the transmit power and for space services this is to be measured in 4 kHz.

A7.22 Combining the two the attenuation from the edge of the last carrier is shown in figure A7.3 below.

Figure A7.3: Attenuation of reference S-DAB network emissions in the out-of-band and spurious domains



Hence the attenuation at the centre of the two adjacent T-DAB channels is as in Table A7.5.

Table A7.5: Attenuations at centre of adjacent T-DAB channels with respect to S-DAB in-band

Channel	LP	LO
Attenuation (dB)	-7.3	-15.5

A7.23 From the information above the following PFDs in Table A7.6 were derived.

Table A7.6: PFD levels in-band and in adjacent T-DAB channels

Channel	S-DAB	LP	LO
PFD (dBW/m^2/MHz)	-96.7	-104.0	-112.2

A7.24 While the PFDs were derived using a single test point the isoflux nature of the reference satellite system implies they can be assumed to be near constant over the UK. The PFD levels can also be assumed to be near constant in the time domain, and so any measurement period may be used.

A7.25 Based on the above inputs and assumptions, the in-band PFD due to a standard S-DAB channel is calculated as -96.7 dBW/m^2/MHz. Out-of-band PFD values are calculated by applying attenuations from the above mask at regular intervals.

Frequency Bands and Channels

A7.26 There are two frequency bands that are adjacent to the 1 452 – 1 492 MHz band which are used for fixed links, namely:

- Frequency band 1 350 – 1 375 paired with 1 492 – 1 517 MHz
- Frequency band 1 375 – 1 400 paired with 1 427 – 1 452 MHz

A7.27 Each of the bands has a 0.5 MHz guard band (GB) at either end, as shown in the figures A7.4 and A7.5.

Figure A7.4: Frequency band 1 350 – 1 375 paired with 1 492 – 1 517 MHz

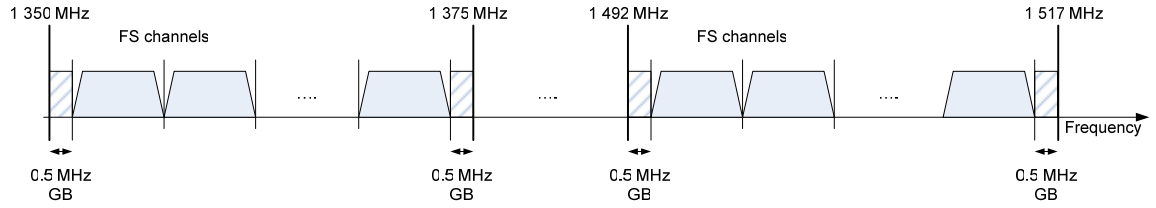
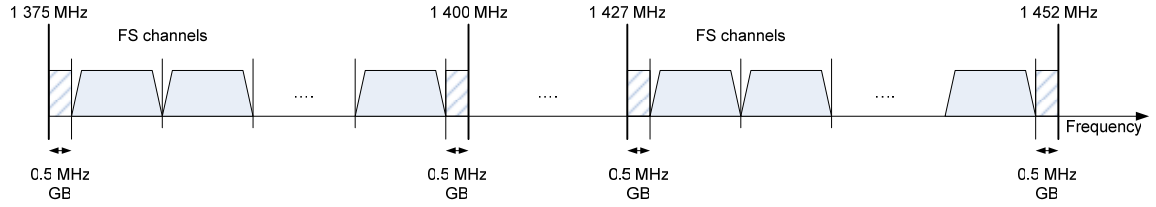


Figure A7.5: Frequency band 1 375 – 1 400 paired with 1 427 – 1 452 MHz



A7.28 CEPT Recommendation TR 13-01 gives a number of channel plans based upon bandwidths of:

- 0.025 MHz;
- 0.25 MHz;
- 0.5 MHz;
- 1 MHz;
- 2 MHz.

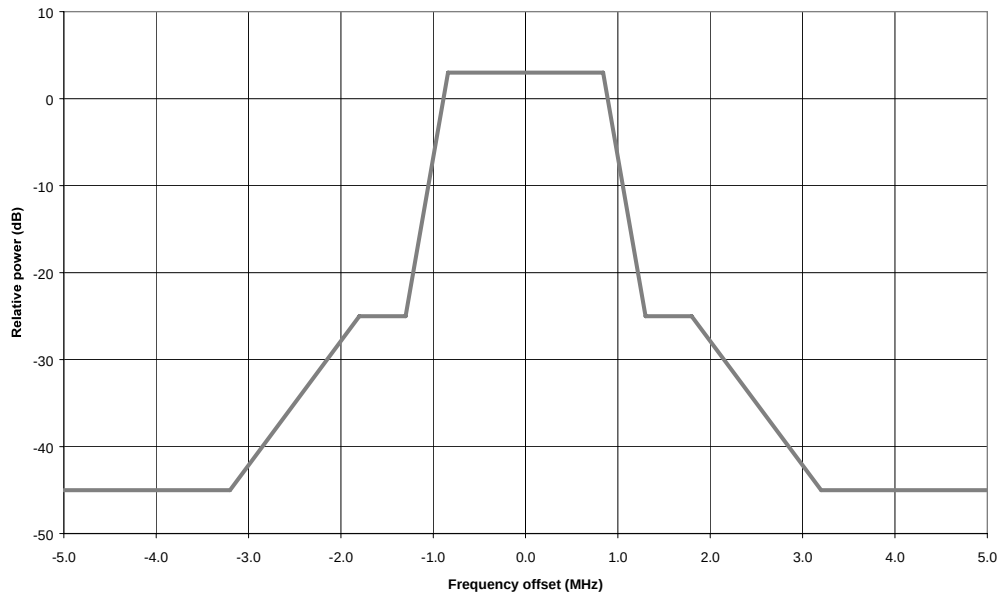
A7.29 Typically wider bandwidth carriers are more likely to generate interference into adjacent channels as they have slower roll-offs in the frequency domain. It is therefore appropriate to consider the 2 MHz carrier, and hence the centre frequencies of the two nearest channels below and above the 1 452 – 1 492 MHz are:

- Band 1 375 - 1 400 MHz paired with 1 427 - 1 452 MHz: 1450.5 MHz
- Band 1 350 - 1 375 MHz paired with 1 492 - 1 517 MHz: 1493.5 MHz

Spectrum Masks

A7.30 Spectrum masks are defined in ETSI EN 302 217, and the relevant one for the band under consideration and bandwidth of 2 MHz is shown in figure A7.6below.

Figure A7.6: Spectrum Mask for 2 MHz Bandwidth Channels



A7.31 Combining the spectrum mask with the nearest FS channel above and below, the attenuations into the 1 452 – 1 492 DAB channels can be calculated as in Table A7.7

Table A7.7: Attenuations into DAB Channels

Channel	Frequency (MHz)	Offset to 1 450.5 MHz	Offset to 1 493.5 MHz	Attenuation (dB)
LA	**1452.960**	**2.460**	**40.540**	**-34.429**
LB	1454.672	4.172	38.828	-45.000
:	:	:	:	:
LO	1476.928	26.428	16.572	n/a
LP	1478.640	28.140	14.860	n/a
LQ	1480.352	29.852	13.148	n/a
LR	1482.064	31.564	11.436	n/a
:	:	:	:	:
LV	1488.912	38.412	4.588	-45.000
LW	**1490.624**	**40.124**	**2.876**	**-40.371**

System Parameters

A7.32 The FS have a range of values for fields such as EIRP, peak gain, hop length etc. Table A7.8 below gives typical or representative values used during the simulations:

Table A7.8: FS System Parameters

Field	Value	Comments
Peak gain (dBi)	28	Gain pattern assumed to be ITU-R Rec. 699 Beamwidth derived from peak gain.
Antenna height (m)	20 60	The height of the FS transmitter can make a significant difference and so the effect of two alternatives was considered.
Azimuth (deg)	Varies	Selected quasi-random using deployment assumptions described in following section
Elevation (deg)	Varies	Pointing at receive station using deployment assumptions described in the following section. For the hops under consideration the typical elevation angle was -0.27°
EIRP (dBW)	28	Toward the top end of the range
Density (TX / 100 km square)	6	Per channel
Bandwidth (MHz)	2	Widest defined in CEPT Recommendation T/R 13-01
Frequencies (MHz)	1450.5 1493.5	Two nearest (above / below) 1 452 – 1 492 MHz band

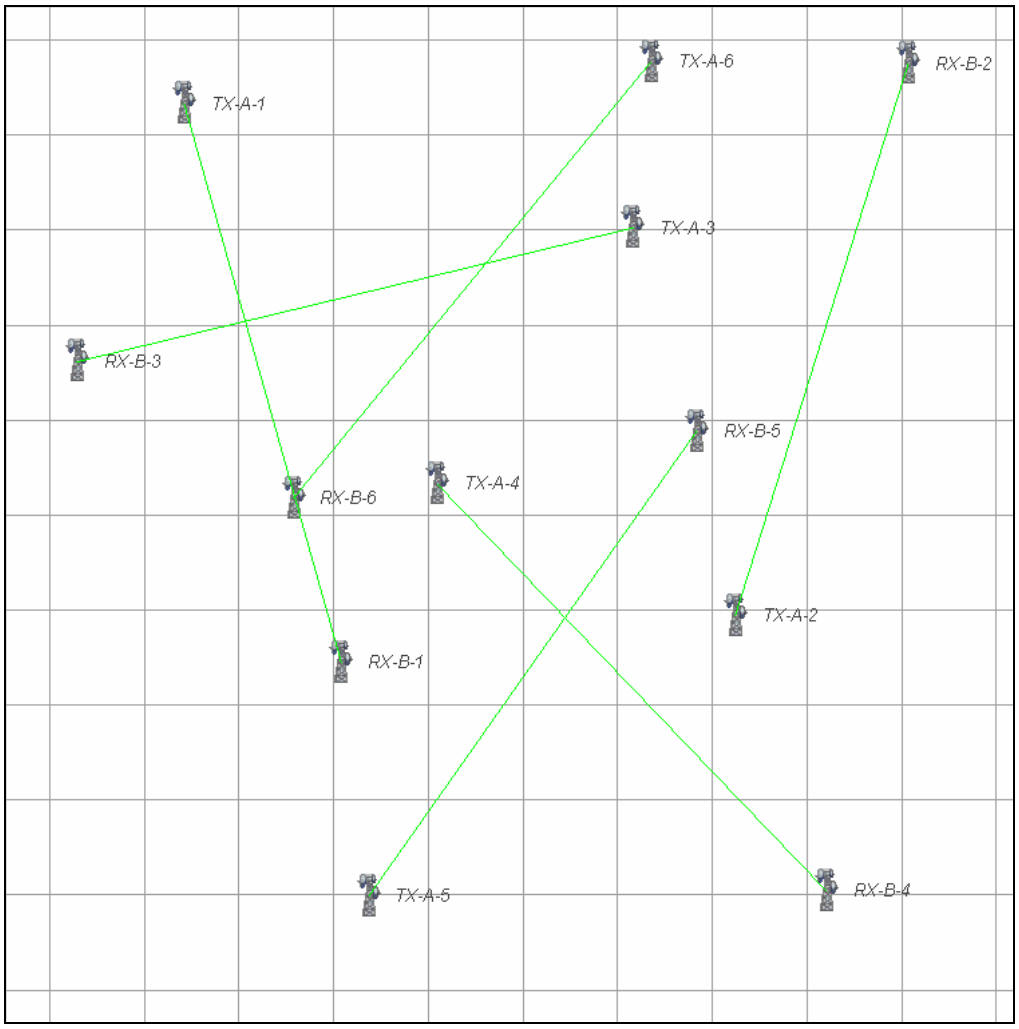
FS Locations

A7.33 A reference configuration of FS networks was derived that was consistent with the parameters in the table above and the following assignment rules:

- The target Receive Signal Level (RSL) was -119 dBW based upon Ofcom TFAC OF 46W assuming spectrum efficiency class 2 and bandwidth of 2 MHz;
- Together with the class 2 required S/N of 13.5 dB from ITU-R Rec.1101 it implied a total equivalent noise figure of 8.5 dB;
- The propagation model used for link design was free space path loss and the multi-path fade model in ITU-R Rec.P.530 with a required unavailability of 0.01% i.e. desired availability of 99.99%;
- The propagation model used for interference paths was ITU-R Rec.P.452 at the 50% of time level with a smooth Earth and $\Delta N = 45$;
- The interference threshold used to check compatibility between all of the FS links was assumed to be an aggregate I/N < -10 dB;

A7.34 Six single direction hop FS networks were deployed at random in a way that was consistent with the above criteria as shown in figure A7.7 below.

Figure A7.7: Reference FS Networks

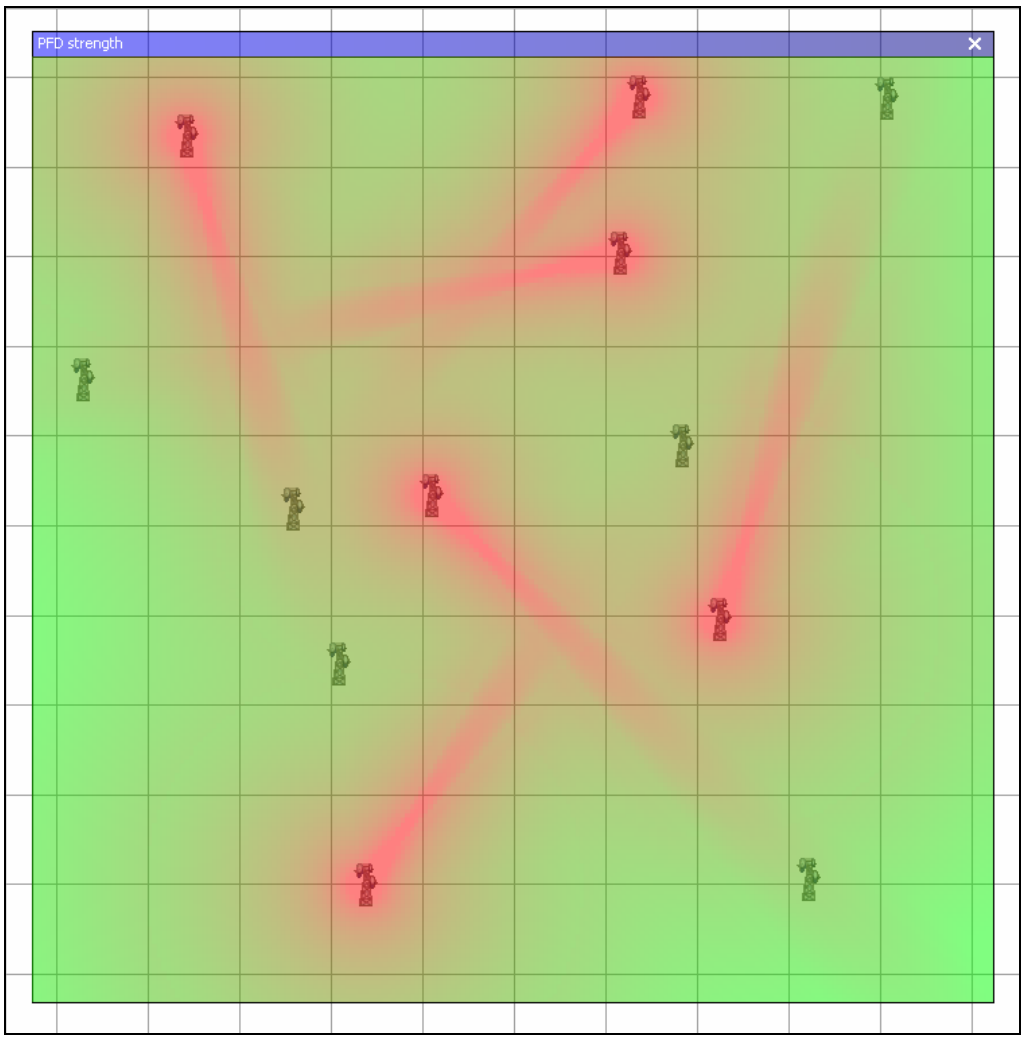


A7.35 Note that the grid lines in the figure above are spaced every 10 km and so the total area shown is 100 km by 100 km. This defined the reference test area comprising 10,000 km^2, within which test points were deployed ever 5 km, resulting in 21 x 21 = 441 predictions of PFD level per case considered.

Distribution of PFD

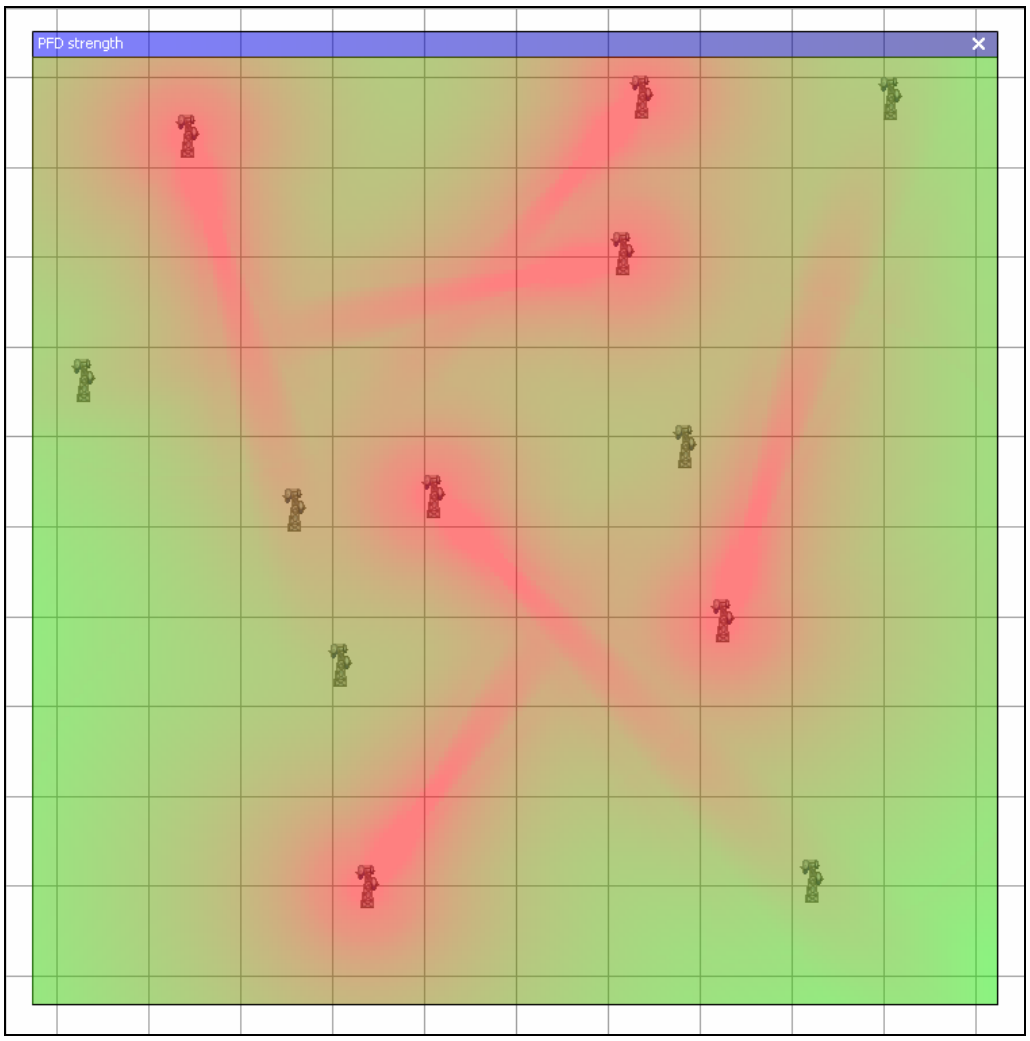
A7.36 For the above configuration of FS transmitters the aggregate PFD was calculated at a grid of test points across the test area of 100 km by 100 km. As can be seen in figure A7.8 below the locations of high PFD are either close to a transmit station or along the boresight of its antenna towards the receiver.

Figure A7.8: Distribution of PFD across Test Area FS h=20m



A7.37 As noted above, the height of the FS transmitter can make a significant difference: for comparison figure A7.9 below shows the impact of increasing it from 20m to 60m.

Figure A7.9: Distribution of PFD across Test Area FS h=60m



PFD Cumulative Distribution Functions

A7.38 From the information above a simulation was used to create cumulative distribution functions (CDFs) of PFD across the service area with variations:

- FS transmit antenna height: either 20m or 60m;
- Test point height: located at either 1.5m or 10m;
- Frequency: measured either in-band or at the centre of the nearest DAB channel;
- Band: either FS operating at 1 450.5 MHz or 1 493.5 MHz;

A7.39 There were thus two sets of four CDFs generated for each of the two FS frequency bands as shown in figures A7.10 and A7.11 below.

Results for FS Transmit Antenna Height = 20m

A7.40 The CDFs in figure A7.10 and A7.11 below shows the results assuming the FS transmit antenna is located at a height of 20m above terrain.

Figure A7.10: CDF of PFD from FS at 1 450.5 MHz in-band and into nearest DAB channel

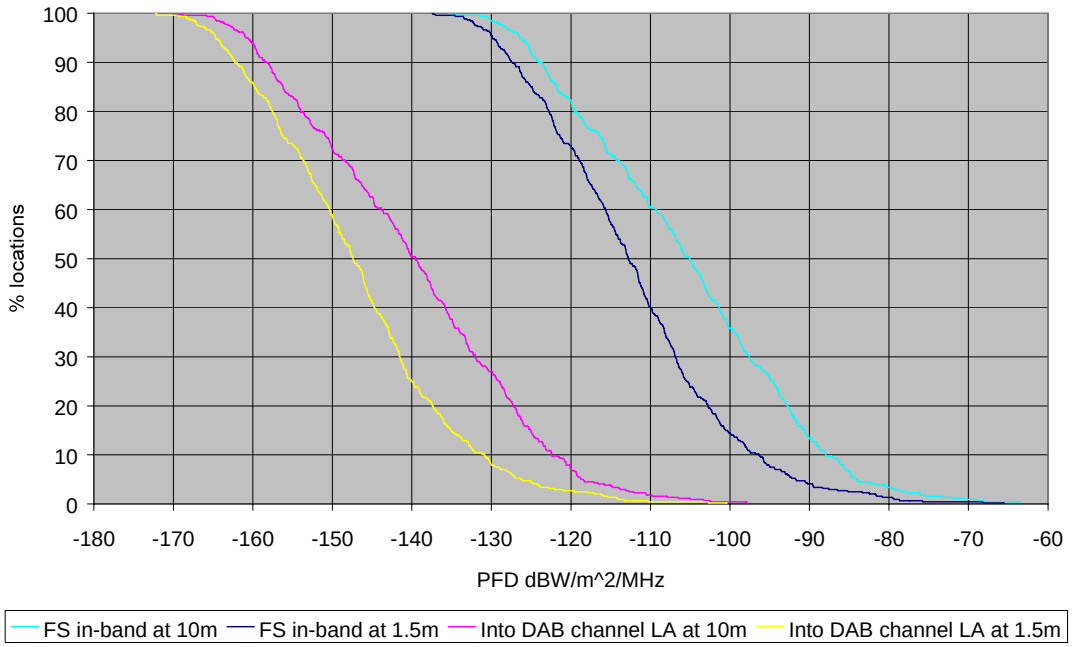
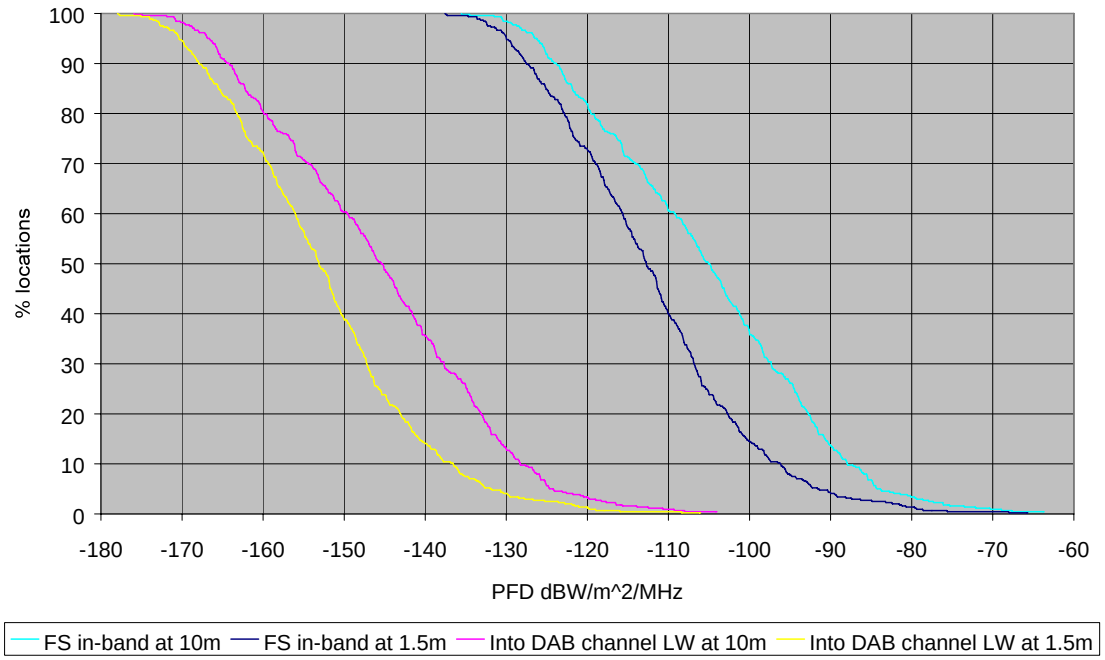


Figure A7.11: CDF of PFD from FS at 1 493.5 MHz in-band and into nearest DAB channel



A7.41 The median or 50% of locations PFDs are shown in tables A7.9 and A7.10 below.

Table A7.9: Median PFD Levels for FS at 1 450.5 MHz

Height:	1.5m	10m
In-band:	-112.8	-105.1
Into DAB channel LA:	-147.4	-139.5

Table A7.10: Median PFD Levels for FS at 1 493.5 MHz

Height:	1.5m	10m
In-band:	-112.7	-105.0
Into DAB channel LW:	-153.1	-145.4

Results for FS Transmit Antenna Height = 60m

A7.42 The CDFs in figures A7.12 and A7.13 shows the results assuming the FS transmit antenna is located at a height of 60m above terrain.

Figure A7.12: CDF of PFD from FS at 1 450.5 MHz in-band and into nearest DAB channel

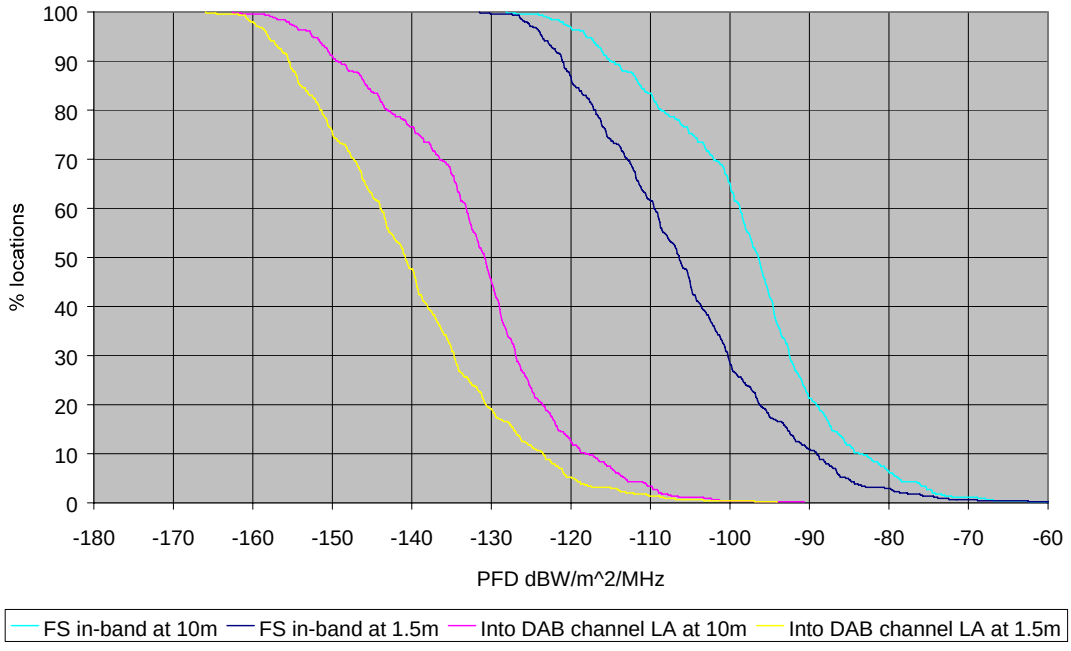
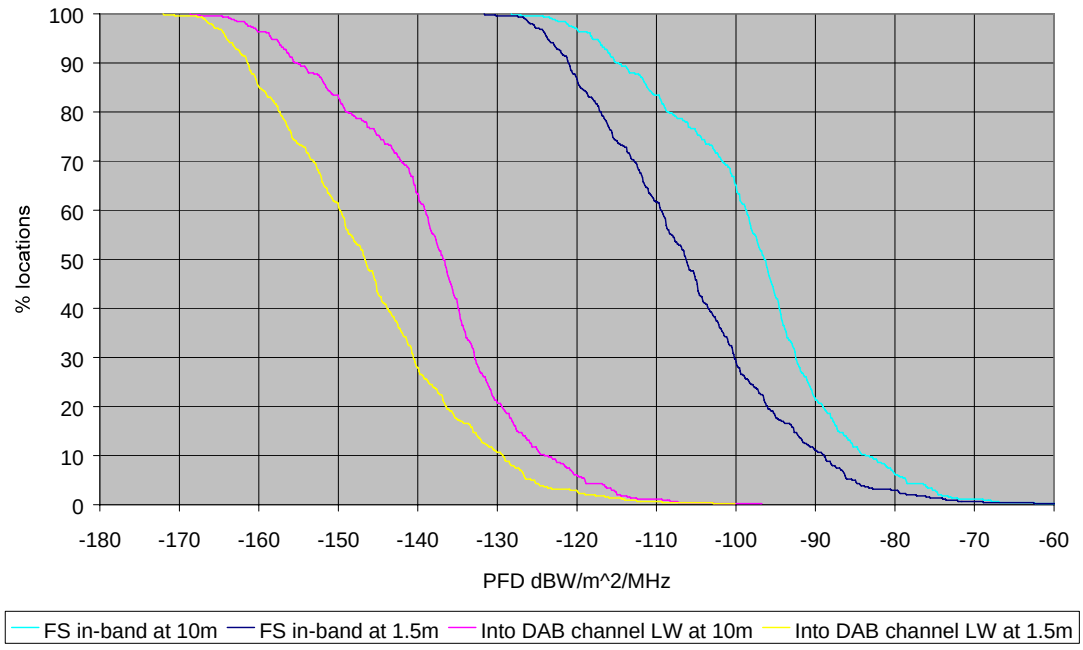


Figure A7.13: CDF of PFD from FS at 1 493.5 MHz in-band and into nearest DAB channel



A7.43 The median or 50% of locations PFDs are shown in tables A7.11 and A7.12 below.

Table A7.11: Median PFD Levels for FS at 1 450.5 MHz

Height:	1.5m	10m
In-band:	-106.4	-96.7
Into DAB channel LA:	-140.8	-131.1

Table A7.12: Median PFD Levels for FS at 1 493.5 MHz

Height:	1.5m	10m
In-band:	-106.3	-96.4
Into DAB channel LW:	-146.7	-136.8

Discussion of Results

A7.44 The following points were noted:

- The impact of the FS transmit antenna height was significant – with about median PFD levels around 8.5 dB higher when at 60m compared to 20m;
- The impact of the test point height on the median PFD level was minor – only about 0.1 dB;

- The principal difference between the results at the lower band compared to those for the higher band were due to the difference in centre frequencies and hence attenuation of power in the out-of-band domain due to the FS spectrum mask.

Impact of FS Directivity

A7.45 It should be noted that the directional nature of the FS networks means there can be significant variation in PFD levels. For example the highest PFD level into the nearest DAB channel LA at 1.5m was predicted to be -81.8 dBW / m^2 / MHz, though this was only calculated at a single point.

A7.46 However there are likely to be only a handful of FS transmitters in the adjacent band within an area of 10,000 km^2. Around these transmitters there is likely to be higher levels of PFD but the precise locations will depend upon the actual deployments of FS links in channels adjacent to the 1 452 – 1 492 MHz band.

A7.47 Note that this represents a case where a DAB signal is being received at close proximity to a FS transmitter, and so was worse for the lower height transmit antenna case of h = 20m than for a transmit height of 60m.

Impact of Terrain

A7.48 The results above did not include the effects of terrain or clutter. This approach was taken as it ensures the PFD levels generated are worst case and generally applicable rather than depending upon the location selected.

A7.49 In addition, other work done for Ofcom noted that if a set of simulations were done at a variety of locations taking into account terrain, the envelope of worst cases over all simulations tended to the smooth Earth case.