



# Technical Policy Guidance for DAB Multiplex Licensees

Publication date:

1 July 2014



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## Section 1

# Introduction

- 1.1 This document is intended to give supplementary guidance to the technical provisions of individual licences awarded to radio multiplex licensees<sup>1</sup>. It outlines what Ofcom expects to be its general approach in applying some of the provisions of the Digital Radio Technical Code, and in the approval of transmission proposals. Licensees should note that Ofcom cannot restrict in advance the way in which it will exercise its discretion, so it may be that Ofcom will take a different approach to the one outlined in this guidance in a particular case.
- 1.2 The areas of activity addressed in this document are:
- Multiplex technical management;
  - Approval of transmitter proposals;
  - Planning standards.
- 1.3 The document also provides commentary on other aspects of the Digital Radio Technical Code.

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<sup>1</sup> This covers radio multiplex licences awarded under the Broadcasting Act 1996 (as amended), and the associated licences awarded under the Wireless Telegraphy Act 2006 to the radio multiplex licensees.

## Section 2

# Multiplex technical management

## Background

As well as the general duties applicable to all areas of Ofcom's work that are set out in section 3 of the Communications Act 2003, Ofcom also has duties and powers that relate specifically to radio multiplex licensing.

Ofcom has a wide discretion to include in radio multiplex licences such conditions as appear to Ofcom to be appropriate having regard to any duties that Ofcom or the licensee has under the Broadcasting Acts of 1990 and 1996 or the Communications Act 2003 (section 43(1)(a) of the Broadcasting Act 1996). Ofcom also has a specific power to include conditions enabling Ofcom to supervise and enforce technical standards in connection with the provision of the licensed service (section 43(1)(b) Broadcasting Act 1996).

Section 54 of the Broadcasting Act 1996 requires Ofcom to secure particular aims by imposing appropriate conditions in radio multiplex licences. One of the things that Ofcom is required to secure is that the signals carrying the radio multiplex service attain high standards in terms of technical quality and reliability throughout so much of the area or locality for which the service is provided as is for the time being reasonably practicable (section 54(1)(g) of the Broadcasting Act 1996).

## Audio characteristics

- 2.1 Ofcom believes that whether a digital sound programme service is broadcast in stereo or mono is an important characteristic of that service, and as such any variations to these characteristics must be considered in accordance with the requirements of section 54(6A) or (6B) of the Broadcasting Act 1996.
- 2.2 We recognise that radio multiplex licensees require flexibility in how they allocate capacity, and do not seek to restrict this. In the vast majority of cases, the broadcaster and/or multiplex operator will be best placed to determine the characteristics of the services they are providing. We do not accept, however, that left to itself, the market will necessarily reflect the interests of consumers.
- 2.3 As a matter of general policy, Ofcom is likely to refuse a request for a change in audio characteristics only in cases where the capacity freed-up by the change is to be allocated to services which, in Ofcom's view, would not be in the best interests of citizens and consumers. Such an example may be where a multiplex licensee using its full capacity for stereo radio services proposes to reduce these radio services to mono, in order to allocate the permitted 30% data capacity to provide, for example, a closed user group service, and where we judge this would not be in the public interest.
- 2.4 We believe that such a move would generally (in respect of a national radio multiplex licence) unacceptably diminish the capacity of the programme services provided under that licence to appeal to a variety of tastes and interests, or would generally (in respect of a local radio multiplex licence) unacceptably narrow the range of programmes available by way of digital sound programme services in the area. The policy is therefore designed to ensure that the multiplex as a whole – not an individual service – continues to cater for the overall tastes and interests of listeners.

## Section 3

# Approval of transmitter proposals

- 3.1 The location and characteristics of individual transmitters of a multiplex need to be agreed by Ofcom before a licence can be issued. The constraints applying to this decision are set out within the licence advertisement. These constraints are generally framed in relation to the avoidance of:
- 3.1.1 interference to other users (elsewhere in the UK and abroad) which use the same frequency;
  - 3.1.2 coverage beyond the licensed area; and
  - 3.1.3 interference to other multiplexes in the same area.
- 3.2 Section 4 provides further information on the first two points. This section provides guidance on Ofcom's approach to dealing with the third mechanism.

### Adjacent channel interference and blocking

- 3.3 In considering applications by a licensee for a new transmitter site Ofcom will consider whether and to what extent this would lead to 'hole punching' in the coverage of other multiplexes on adjacent-channel frequencies serving the same area.
- 3.4 Ofcom organises and chairs a group, the Joint Planning for Radio Group (JPRG) representing all its digital radio multiplex licensees<sup>2</sup>, which it uses to develop its policies on digital radio spectrum management.
- 3.5 Management of Adjacent Channel Interference (ACI) has in the past been achieved through two measures:
- 3.5.1 a memorandum of understanding between Ofcom and industry that sets out the basis upon which ACI impacts were assessed; and
  - 3.5.2 a list of transmitter sites and associated characteristics<sup>3</sup> (known as the Reserved Assignments List or RAL) which and within which any licensee may expect to be able to secure Ofcom's agreement to develop, subject to compliance with all other requirements of the licence.
- 3.6 Ofcom has discussed roll-out plans with the commercial DAB multiplex operators and the BBC through the Ofcom-chaired Joint Planning for Radio Group (JPRG). All of the participants have indicated a desire to move to a more streamlined approach to dealing with ACI. The fundamental principle agreed by the JPRG members is that the multiplex operators be given freedom to coordinate their roll out plans and manage the impact of ACI that might arise from new transmitter sites through liaison amongst themselves.

<sup>2</sup> a representative of each of the companies which have a majority shareholding, and their transmission contractors, and the BBC.

<sup>3</sup> except that a unique frequency is in many cases not specified

- 3.7 Ofcom will consider proposals, taking into account the potential impact upon listeners where ACI is predicted to occur. If the DAB multiplex operators are unable to come to agreement on a proposed site, the final decision will be made by Ofcom.
- 3.8 We have therefore agreed with industry that the previous Memorandum of Understanding be dissolved and to adopt the processes detailed below for dealing with the potential impact of ACI. The DAB transmitters currently in use form the basis of a new list of Reference Sites that contains details of the transmitters already in service and a list of those anticipated to be built to expand coverage of the national and local multiplexes. The list of Reference Transmitters will be available on Ofcom's website.

### **General Principles**

- 3.9 The following steps are to be undertaken by all operators wishing to implement a transmitter, prior to seeking Ofcom consent.
- 3.10 All operators should endeavour to:
- 3.10.1 share existing sites wherever practicable;
  - 3.10.2 minimise any additional interference to other multiplexes;
  - 3.10.3 where reasonably possible ensure that sites can be used by other operators should they wish to do so;
  - 3.10.4 engage in studies in order to investigate and resolve differences between the proposed and actual impact of transmitter implementations; and
  - 3.10.5 contact and liaise with national and local multiplex operators in order to:
    - i) inform them of the likely impact of the proposal;
    - ii) to inform them of a possible source of future interference;
    - iii) enable them to implement the site in order to minimise ACI; and
    - iv) gain their agreement to use of the site.

### **Approval of transmitter proposals**

- 3.11 Copies of agreements (or otherwise) obtained under 3.10.5 should be forwarded to Ofcom.
- 3.12 Ofcom will have final approval of all site proposals before they can be brought into service. In considering operators' proposals Ofcom will also take into account the interests of consumers.

### **Procedure for assessing the impact of adding a DAB multiplex to an existing transmission site**

- 3.13 Figure 1 below illustrates the process for giving consideration to a proposal to add a multiplex to an existing DAB transmission site. The process is also described below. In all cases the impact on both household and road coverage will be calculated.

### The 'A' calculation: The interference from the proposed transmitter

- 3.14 The potential interference caused to the coverage of all national multiplexes should be calculated.
- 3.15 The potential interference caused to the coverage of all local multiplexes in the vicinity of the site should be calculated. Only the household and road coverage within the licensed area of the victim service(s) will be taken into account.

### The 'B' calculation: The interference from the existing transmitter(s)

- 3.16 The existing interference caused to the coverage of all national multiplexes should be calculated using the method agreed by the JPRG.
- 3.17 The existing interference caused to the coverage of all local multiplexes in the vicinity of the site should be calculated. Only the household and road coverage within the licensed area of the victim service(s) will be taken into account.
- 3.18 If the impact of the existing site on each of the existing multiplexes is greater than the impact from the proposed one, site implementation will normally be allowed.

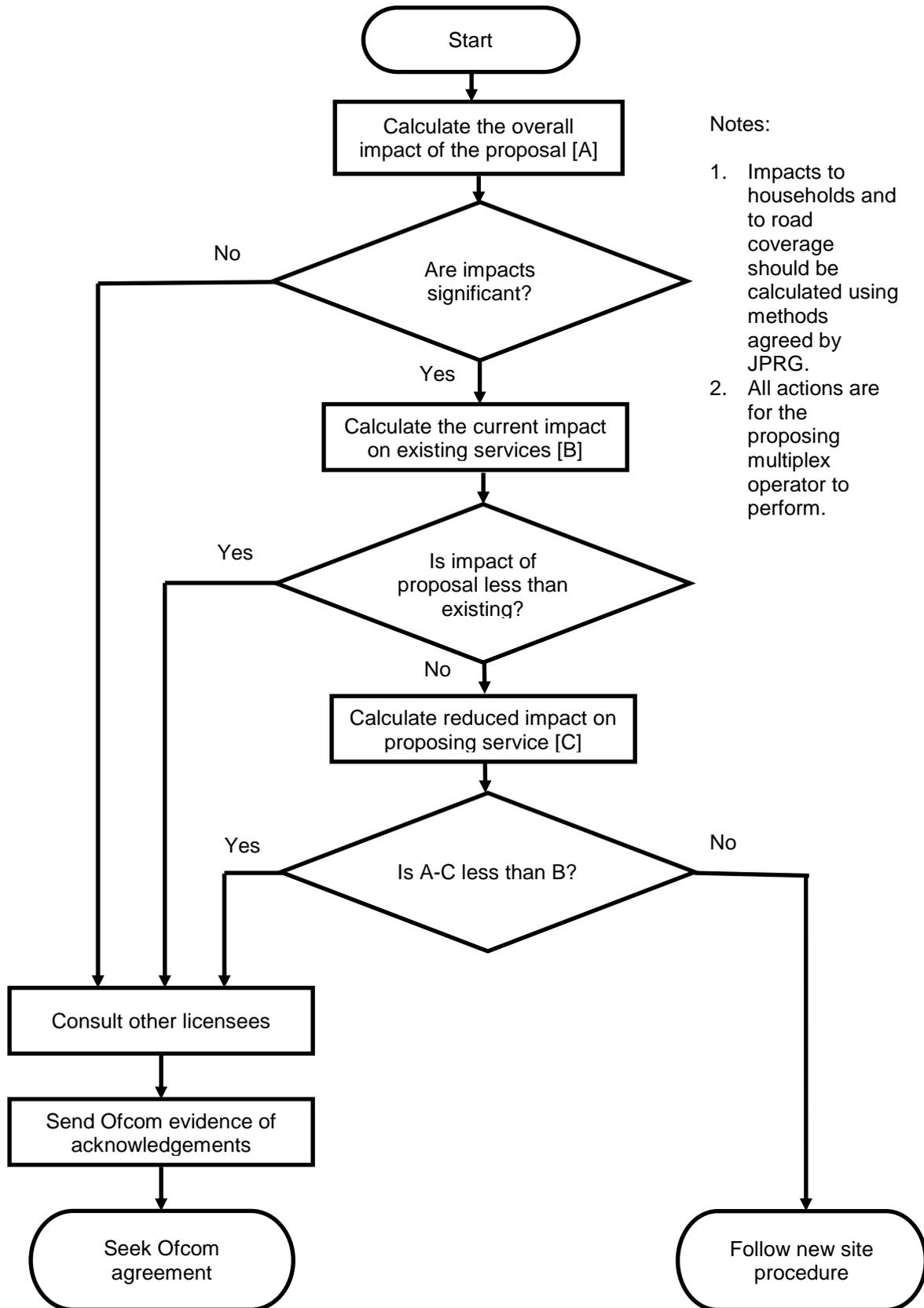
### The 'C' calculation: The reduced impact on the proposing service

- 3.19 The proposed transmitter will normally reduce the impact of the existing one on the proposing multiplex. Calculate the number of households and roads that will no longer suffer from adjacent channel interference. In many cases this value will be similar to that calculated for 'B' above.
- 3.20 If the proposed site rectifies the existing adjacent channel hole and does not cause a significant increase in ACI to the remaining multiplex(es) that are not co-sited it will normally be allowed.
- 3.21 Otherwise the proposing multiplex operator should consider ameliorating actions including the provision of a hole filling relay.

### Liaison with other multiplex operators

- 3.22 Even where the impact on other multiplexes is low, the proposing multiplex operator should inform other multiplexes of the intention to bring a new transmitter site into operation prior to seeking Ofcom consent. The proposing multiplex operator should provide Ofcom with evidence that appropriate consultation has taken place when submitting an application for consent.

Figure 1 – Existing site procedure



## **Procedure for assessing the impact of adding a DAB multiplex to a new transmission site**

### General requirements

- 3.23 Operators who wish to implement new sites should endeavour to adopt the following principles:
- 3.23.1 to minimise the interference to other multiplexes;
  - 3.23.2 where reasonably possible, to ensure that the site can be used by other operators should they wish to do so; and
  - 3.23.3 to contact all national and any local multiplex operators in order to gain their agreement to the use of the site and to inform them of a possible source of future interference.
- 3.24 Copies of agreements reached with the other multiplex operators under 3.22.3 should be forwarded to Ofcom.
- 3.25 Figure 2 illustrates the process for giving consideration to a proposal to add a multiplex to a transmission site not used for DAB. The process is also described below. In all cases the impact on both household and road coverage will be calculated.

### ACI calculation: the interference from the proposed transmitter

- 3.26 The interference caused to the coverage of all national multiplexes should be calculated using the method agreed by the JPRG.
- 3.27 The interference caused to the coverage of all local multiplexes in the vicinity of the site should be calculated. Only the household and road coverage within the licensed area of the victim service(s) will be taken into account.

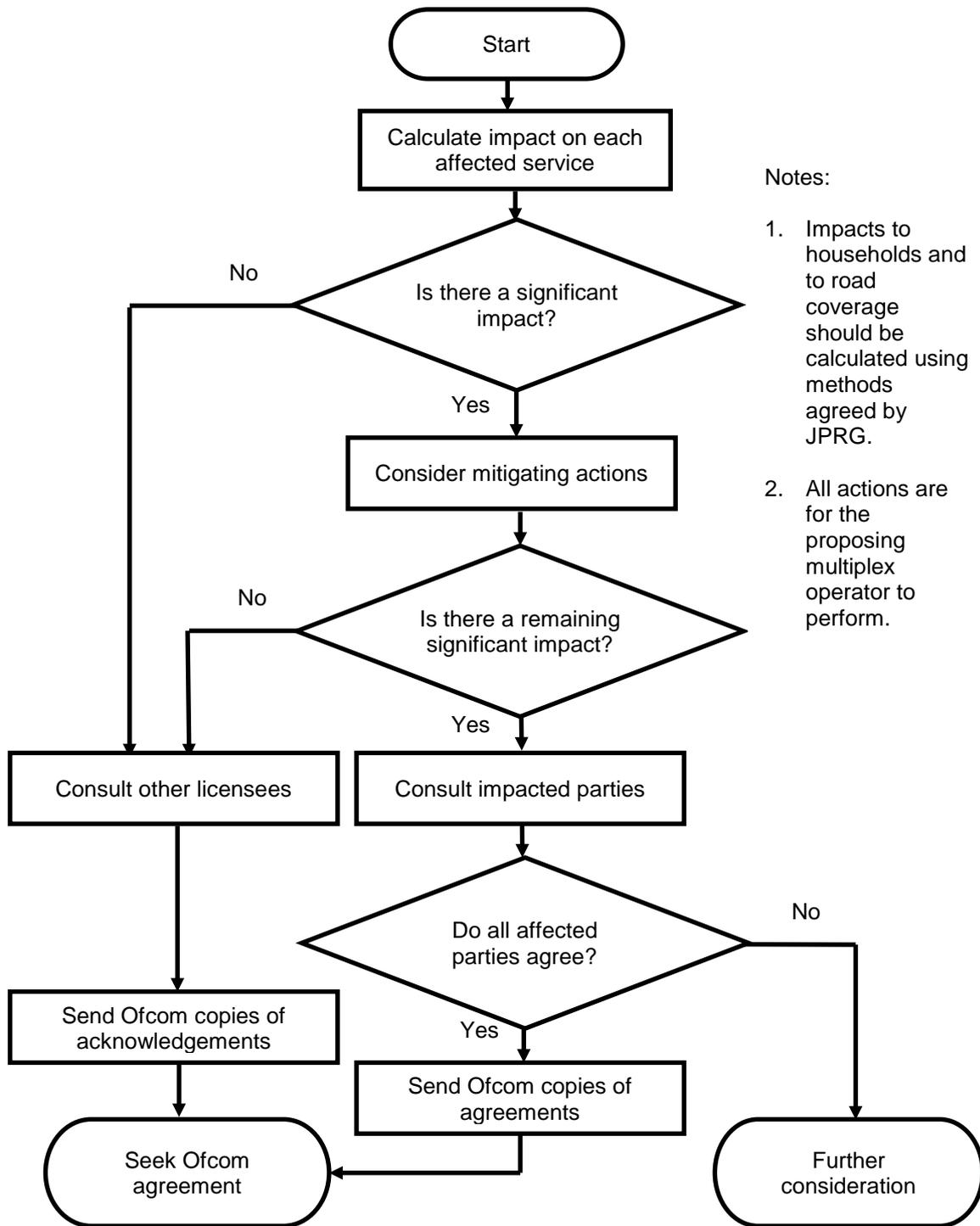
### Assessment of impact

- 3.28 If the interference to victim services is not significant the proposer should seek Ofcom agreement.
- 3.29 If the interference is significant the proposer should:
- 3.29.1 reconsider the application; and
  - 3.29.2 propose ameliorating actions which may include the provision of a 'hole filling' relay.

### Liaison with other multiplex operators

- 3.30 Even where the impact on other multiplexes is low, the proposing multiplex operator should inform other multiplexes of the intention to bring a new transmitter site into operation prior to seeking Ofcom consent. The proposing multiplex operator should provide Ofcom with evidence that appropriate consultation has taken place when submitting an application for consent.

Figure 2 – New site procedure



## Section 4

# Planning Standards: wanted coverage and interference protection

- 4.1 In assessing licence applications, Ofcom has to take a number of statutory criteria into account in deciding whether and to whom to award a multiplex licence. One of these is the extent of coverage provided.
- 4.2 Ofcom assesses the extent of coverage delivered in terms of two modes of reception; 'mobile' and 'portable indoor', at each 100m x 100m square of territory within the licence area. All coverage assessment will be carried out on the basis of level 3 error protection being used, specifically unequal error protection level 3 or UEP-3.
- 4.3 The methods and thresholds used to produce the coverage predictions were developed as part of the work carried as part of the Government's Digital Radio Action Plan<sup>4</sup>, the purpose of which was 'to provide the information to allow for a well-informed decision by Government on whether to proceed with a radio switchover'.
- 4.4 Ofcom was asked to chair a DAB coverage and spectrum planning group to determine the current level of FM coverage and develop a range of options to increase DAB coverage to match FM. The assumptions and thresholds were published in our May 2012 Report to Government on DAB Coverage Planning<sup>5</sup>.
- 4.5 The assumptions are also summarised as below:

### Mobile Coverage

- 4.6 Coverage in a mobile environment will be assessed in terms of the number of kilometres and percentage of 'A' roads and motorways within the licence area that receive a field strength of at least 54 dB( $\mu$ V/m) at 10m above ground level. The derivation of this field strength is given in Table 1 below.

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<sup>4</sup> Government's Digital Radio Action Plan:  
[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/270375/Digital\\_Radio\\_Action\\_Plan\\_v10\\_5.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/270375/Digital_Radio_Action_Plan_v10_5.pdf)

<sup>5</sup> DAB Coverage Planning – Report to Government 2 May 2012 :  
[http://stakeholders.ofcom.org.uk/binaries/broadcast/radio-ops/coverage/DAB\\_Statement.pdf](http://stakeholders.ofcom.org.uk/binaries/broadcast/radio-ops/coverage/DAB_Statement.pdf)

**Table 1: Derivation of Minimum Median Field Strength for In-Car Reception**

<b>UEP</b>		<b>3</b>
Noise bandwidth	(MHz)	1.5
Thermal noise	(dBm)	-112.22
Required C/N	(dB)	8.4
Receiver noise figure	(dB)	7
Rayleigh implementation margin	(dB)	4.6
Minimum receiver signal level	(dBm)	-92.2
Frequency	(MHz)	220
Wavelength	(m)	1.36
Receiving antenna gain	(dBi)	-2.9
Required field strength	(mV/m)	54.6
Required field strength	(dB $\mu$ V/m)	34.7
Height Gain	(dB)	10
Required percentage of locations	(%)	99
Inverse Normal function	For 99% locations	2.33
Outdoor Location Variation	(dB)	4.0
Additional field strength required	(dB)	19.3
Minimum Median Field Strength	(dB $\mu$ V/m)	54.0

### Indoor coverage

4.7 To define coverage to portable receivers within an indoor environment account will be taken of the penetration loss of the building type around the reception point. This will be considered to be either suburban or dense urban and the losses for each category are given in Table 2 below.

**Table 2: Building Penetration Loss**

<b>Building Type</b>	<b>Median Penetration Loss (dB)</b>	<b>Standard Deviation of Penetration Loss (dB)</b>
<b>Suburban</b>	8	4.4
<b>Dense Urban</b>	15	5

4.8 Indoor coverage will be assessed in terms of the number of households within the licence area that receive a field strength of at least between 63 and 68 dB $\mu$ /m in suburban areas and 70 and 75 dB( $\mu$ V/m) in a dense urban area. The lower of these pairs indicate a useful service and the latter a robust one. These signals are being received at 10m above ground level. The derivation of these field strengths is given in Table 3 below.

**Table 3: Derivation of Minimum Median Field Strength for Indoor Reception**

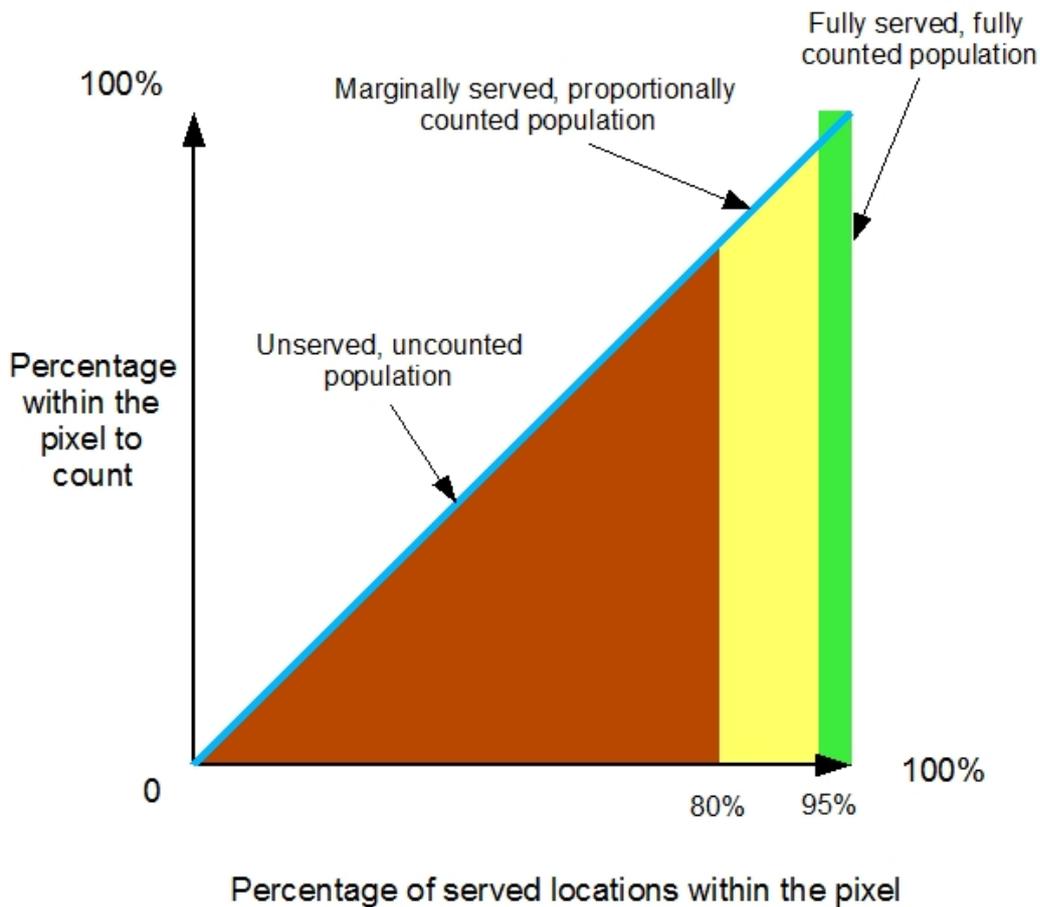
UEP		3			
Reception environment		Suburban		Dense Urban	
Reception quality		Useful	Robust	Useful	Robust
Noise bandwidth	(MHz)	1.5	1.5	1.5	1.5
Thermal noise	(dBm)	-112.22	-112.22	-112.22	-112.22
Required C/N	(dB)	8.4	8.4	8.4	8.4
Receiver noise figure	(dB)	7	7	7	7
Rayleigh implementation margin	(dB)	4.6	4.6	4.6	4.6
Minimum receiver signal level	(dBm)	-92.2	-92.2	-92.2	-92.2
Frequency	(MHz)	220	220	220	220
Wavelength	(m)	1.36	1.36	1.36	1.36
Receiving antenna gain	(dBi)	-8.1	-8.1	-8.1	-8.1
Linear Gain		0.155	0.155	0.155	0.155
Required field strength	(mV/m)	99.4	99.4	99.4	99.4
Required field strength	(dB $\mu$ V/m)	39.9	39.9	39.9	39.9
Building Penetration Loss	(dB)	8	8	15	15
Height Gain	(dB)	10	10	10	10
Required percentage of locations	(%)	80	95	80	95
Inverse Normal function		0.84	1.64	0.84	1.64
Outdoor Location Variation	(dB)	4.0	4.0	4.0	4.0
Building Penetration Loss SD	(dB)	4.4	4.4	5.0	5.0
Composite Location variation	(dB)	5.95	5.95	6.4	6.4
Additional field strength required	(dB)	23.0	27.8	30.4	35.5
Minimum Median Field Strength	(dB $\mu$ V/m)	62.9	67.7	70.3	75.4

4.9 In addition a cut-off and proportional method of coverage counting will be used to calculate the total population that receives a DAB service. This will be assessed using the predicted percentage of locations for each pixel as detailed in Table 4 and Figure 3 below

**Table 4: Proportional counting thresholds**

Percentage of pixel locations served	Percentage of pixels population considered served
95% or greater	100%
80% to 94% inclusive	Between 80% and 94% in proportion to locations served <sup>6</sup>
79% or fewer	0

**Figure 3: Diagrammatic representation of the proportional counting thresholds**



4.10 In all cases the 100m x 100m square must also be (calculated to be) adequately free from interference. These assumed values for wanted coverage are taken as the basis of Ofcom’s interference protection practice (see section below).

<sup>6</sup> For example if the pixel is predicted to have 85% of its locations served then 85% of the population in the pixel will be considered to be served.

## Licensed areas

- 4.11 Another statutory requirement placed on Ofcom is to define for each radio multiplex an area for which a service is licensed, i.e. a 'licensed area'. Ofcom believes it is most appropriate for licensees to be responsible for network planning and delivering coverage within the minimum of constraints necessary in order to properly address statutory requirements, and the integrity of the licence award process. At the technical level Ofcom gives effect to the principle of the 'licensed area' by defining a geographical area, known as the 'licensed area', within which Ofcom will take steps to control the extent of interference to the licensed service.
- 4.12 The concept of a 'licensed area' is set out in the 1996 Broadcasting Act, in establishing the statutory criteria which Ofcom applies in its licensing of digital radio multiplex licences. In respect of local radio multiplexes, the 'licensed area' is described by Ofcom to reflect its views of what constitutes a coherent local area, consistent with the intentions of legislation, and consistent with Ofcom's statutory duties as specified in the Communications Act of 2003.
- 4.13 The relevance of the licensed area includes that it defines the area within which Ofcom will apply measures to protect the relevant service from interference to the extent practicable

## Co-channel interference

- 4.14 In calculating freedom from co-channel interference, the assumptions include that the interfering signals propagate in conditions corresponding to those believed to apply in the least favourable circumstances and which occur only over 1% of the time. A protection margin of 25 dB is applied between wanted and unwanted signals.
- 4.15 It is assumed that an area of analysis is still served if the median interfering field strength is 25dB lower than the median of the wanted signals. This margin is derived as follows:
- |        |   |       |
|--------|---|-------|
| 4.15.1 | Receiver protection ratio:                    | 10 dB |
| 4.15.2 | Planning margin for 99% location availability | 15 dB |
- 4.16 The planning margin is derived theoretically as  $(4.0 \times 2.33 \times \sqrt{2}) = 13.2$  dB, assuming both wanted and unwanted signals are Gaussian distributed with standard deviations of 4.0 dB, and have a correlation coefficient of 0. However, field tests have indicated that a margin of *15dB* provides a practical achievement of 99% availability in a number of different measurement scenarios, in other words, taking account of the fact that the standard deviation or correlation coefficients may depart from the assumed figure.
- 4.17 In applying what are general limits to the maximum allowable field strength from one area's network into the protected area of another co-channel service, some account is taken of the fact that most of the wanted service area receives a wanted signal at a significantly higher level than the lowest workable value. In general, there is a positive correlation; where unwanted signals are higher, then so are the wanted signals. Therefore, a 10 dB margin is added to the threshold of allowable interference. If maximum interference into the area is kept to this higher threshold, which tends to 'bite' first on higher, more exposed ground, then the levels in the generality of the area will be lower.

## Adjacent channel interference

- 4.18 Measures to protect reception from adjacent channel interference are only applied within the licensed areas of the services concerned (see Section 3 above).

### Note on Unequal Error Protection (UEP)

- 4.19 In order to ensure consistency when making coverage predictions, we propose that all DAB coverage assessment will be carried out on the basis of Unequal Error Protection level 3 (UEP-3) being used. We therefore propose to amend the Digital Radio Technical Code to require that unless otherwise agreed with Ofcom, all transmissions will use UEP-3 for audio and UEP- 3A for data services. The DAB+ standard does not support unequal error protection and all services are transmitted with equal error protection (EEP). Consequently Ofcom proposes that all DAB+ transmissions must use EEP-3A.
- 4.20 Where licensees apply to use UEP-1 or UEP-2, this may be agreed by Ofcom on a case by case basis. However, licensees should be aware that if at a later date the licensee wishes to reduce the level of error protection Ofcom may require that any resulting loss of coverage (and therefore listener disenfranchisement) to be mitigated.
- 4.21 As UEP-3 forms the basis of our coverage planning and interference assessment criteria unless already agreed with Ofcom, we will not allow services to reduce the UEP used below this level (i.e. to UEP- 4 or UEP-5). This is to ensure a consistent user experience and stability for the receiver market.