



Public Sector Spectrum Release

Amateur use of 2310 to 2450 and 3400 to 3475 MHz
(including notice of proposed licence variation to be
made in 2015)

Statement

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Contents

Section		Page
1	Executive Summary	1
2	Introduction and background	2
3	Use of the release bands	8
4	Use of the adjacent bands	16
5	Guidance to protect MoD systems using 2310 to 2400 MHz	32
6	Availability of 2300 to 2302 MHz for amateur use	37
7	Next Steps	38
Annex		Page
1	Guidance to protect MoD systems using the 2.3 GHz band	39
2	Advice on protecting adjacent mobile broadband uses	48

Section 1

Executive Summary

- 1.1 In June 2013 we consulted on the use of spectrum licenced to radio amateurs which the Ministry of Defence (MoD) plan to release for new civil uses.¹ Specifically, this includes 40 MHz of radio spectrum from 2350 to 2390 MHz and a further 150 MHz from 3410 to 3600 MHz.^{2 3}
- 1.2 This statement:
- i) sets out the results of our consultation and the future use of the release and adjacent spectrum bands by licenced radio amateurs; and
 - ii) sets out additional protection requirements that need to be implemented immediately as a result of the MoD's new and changing operational use. We have agreed with the MoD that these requirements can be achieved by issuing guidance to amateurs. This guidance is set out in Annex 1 and comes into effect immediately. As required under the terms of the Amateur Radio Licence not to cause undue interference, amateurs must follow this guidance.
- 1.3 As a result of our consultation we have decided that we will:
- i) remove from the Amateur Radio Licence the bands 2350 to 2390 and 3410 to 3475 MHz. This statement provides 12 months' notice from the date of publication that the licence will be varied to remove these bands;
 - ii) retain amateur access to the bands 2310 to 2350; 2390 to 2400 and 3400 to 3410 MHz and put in place a procedure to enable us to remove these frequencies quickly should harmful interference arise in the future (to other uses in the release and adjacent bands).
- 1.4 Given the scope of the changes outlined in this statement it provides an opportunity to carry out a more general review of the amateur licence document to introduce improvements. We will consult separately on these changes. However, in order to reduce the administrative burden on both amateurs and Ofcom we plan to implement all changes at the same time.⁴
- 1.5 We are making available 2300 to 2302 MHz for amateurs to use. This requires a Notice of Variation (NoV) to the standard Amateur Radio Licence.⁵ Further details about this arrangement are set out in Section 6.
- 1.6 To facilitate communication about any information related to future changes to the use of 2310 to 2350 MHz, we request users of this band to provide information as set out in Section 5.

¹ 'Public Sector Spectrum Release: Amateur use of 2310 to 2450 and 3410 to 3600 MHz' ("the consultation")

² <https://www.gov.uk/government/news/mod-to-auction-off-radio-spectrum>

³ UK Broadband currently hold a licence for 40 MHz of spectrum between 3410 and 3600 MHz

⁴ None of the changes to the Amateur Radio Licence other than the decision set out in this statement involve removing spectrum access.

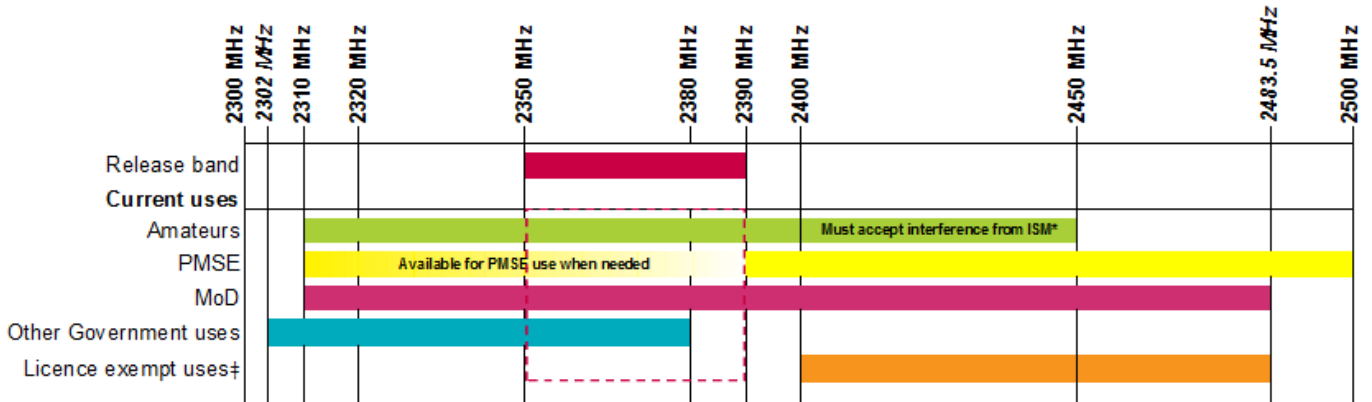
⁵ Amateurs holding a Full Amateur Radio Licence can undertake additional uses which would not be possible under the standard terms of the licence. This is achieved with the grant of an individual Notice of Variation (NoV) to the licence.

Section 2

Introduction and background

2.1 The Ministry of Defence (MoD) plan to release 40 MHz of radio spectrum from 2350 to 2390 MHz and a further 150 MHz from 3410 to 3600 MHz for new civil uses.^{6 7} An illustration of these bands and their current use is set out at Figures 1 and 2.

Figure 1: Current use of 2300 to 2500 MHz

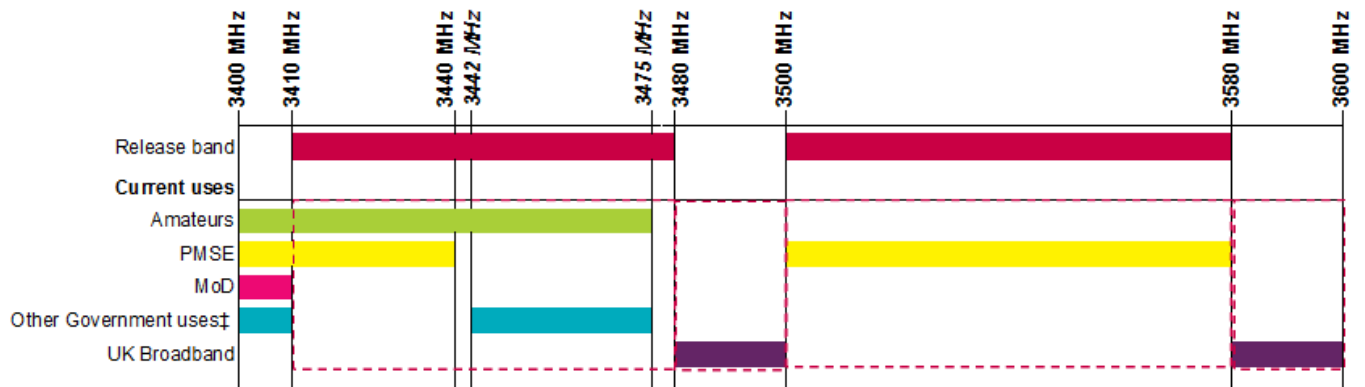


Source: UK FAT 2013

* 2400 to 2450 MHz may also be used by the amateur satellite service

‡ 2400 to 2500 MHz is designated for Industrial, Scientific and Medical (ISM) applications

Figure 2: Current use of 3400 to 3600 MHz



Source: UK FAT 2013

‡ 3400 to 3410 MHz is likely to see increased use by other Government departments with agreement from the MoD

2.2 Table 1 sets out the terms used in this document to describe the frequency bands under discussion and their relevance in this statement.

⁶ <https://www.gov.uk/government/news/mod-to-auction-off-radio-spectrum>

⁷ UK Broadband currently hold a licence for 40 MHz of spectrum between 3410 and 3600 MHz

Table 1: Terms used in this document to describe the frequency bands under discussion and their significance

Term used	Frequency band	Significance
<i>From the current Amateur Radio Licence</i>		
“the 2300 MHz amateur band”	2310 to 2400 MHz	Included in the current Amateur Radio Licence as a band amateurs have access to
“the 2400 MHz amateur band”	2400 to 2450 MHz	
“the 3400 MHz amateur band”	3400 to 3475 MHz	
<i>The release bands</i>		
“the 2.3 GHz release band”	2350 to 2390 MHz	The MoD plans to release these bands for new civil uses* The consultation proposed these bands should be removed from the amateur licence.‡ This statement sets out guidance for amateurs using 2350 to 2390 MHz with immediate effect.
“the 3.4 GHz release band”	3410 to 3600 MHz	
<i>The adjacent bands</i>		
	2310 to 2350 MHz	Amateurs currently have access to this spectrum. These are the frequencies we proposed in the consultation would be subject to quick removal if harmful interference is confirmed as arising from amateur use. This statement sets out guidance for amateurs using 2310 to 2350 MHz with immediate effect.
	2390 to 2400 MHz	
	3400 to 3410 MHz	

‡ The consultation proposal was to vary the Amateur Radio Licence to remove 3410 to 3475 MHz, which is the portion of the 3400 amateur band which overlaps with the MoD’s 3.4 GHz release band.

* 40 MHz between 3410 and 3600 MHz is already under civil licence to UK Broadband

Citizen and consumer benefit

- 2.3 The MoD’s plans are part of a Government commitment to release 500 MHz of spectrum by 2020. This commitment to opening up spectrum for new civil uses is based on growing demand from UK consumers for spectrum hungry devices such as smartphones and tablets. Use of mobile data more than doubled in the 18 months to January 2012. More than half of adults (51%) now own a smart phone, almost double

the proportion two years ago (27%).⁸ At the same time, tablet ownership more than doubled between 2012 and 2013, rising from 11% of homes to 24%. The average household now owns more than three types of internet enabled device, with one in five owning six or more. In order to provide these services suitable spectrum needs to be available.

- 2.4 An award for 4G fixed and mobile services would provide benefits for UK citizens and consumers as take up of connected devices such as mobiles and tablets increases.⁹ Indeed, the 2.3 and 3.4 GHz bands are identified in Ofcom's 'mobile data strategy' as having the potential to support even better mobile data services for citizens and consumers in the coming years.¹⁰
- 2.5 Now that the MoD and other government uses are being moved from the release bands, the plan is to release by award 40 MHz of radio spectrum from 2350 to 2390 MHz and a further 150 MHz from 3410 to 3600 MHz for new civil uses. The MoD's plans have been set out in various consultations and announcements over several years.¹¹

About the spectrum proposed for release

- 2.6 The European Conference of Postal and Telecommunications Administrations (CEPT) working group ECC FM52 is developing plans to harmonise 2300 to 2400 MHz for use by future mobile/fixed communications networks (MFCN).
- 2.7 A 2008 European Commission decision aimed to harmonise the 3400 to 3800 MHz band for terrestrial systems capable of providing electronic communications services such as mobile and fixed broadband.¹² From January 2012 Member States were required to make the 3400 to 3800 MHz band available for this use on a non-exclusive basis (i.e. current uses of the band, not covered by this decision, did not need to be removed from the band but Member States cannot allow future use by services that do not qualify as "terrestrial electronic communications networks".)
- 2.8 Harmonisation of spectrum is valuable as closer integration between countries means equipment works across borders. This is convenient for consumers and valuable for commercial operators when economies of scale are created allowing one product to be sold in several markets.
- 2.9 The award will be technology neutral but given the ongoing moves towards pan-European harmonisation of spectrum and following responses to our Call for Inputs in 2013,¹³ we expect the bands will attract interest from Mobile Network Operators looking to use the spectrum for 4G or Long Term Evolution (LTE) mobile technology, for example building capacity in networks.¹⁴

⁸ <http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr13/uk/>

⁹ <http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr12/uk/>

¹⁰ http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-data-strategy/summary/MDS_Condoc.pdf

¹¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/77429/Spectrum_Release.pdf; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/35937/dsm_consultation_report.pdf; http://stakeholders.ofcom.org.uk/binaries/consultations/3_4ghz/summary/3_4ghz.pdf

¹² 2008/411/EC (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:144:0077:0081:EN:PDF>)

¹³ <http://stakeholders.ofcom.org.uk/consultations/2.3-3.4-ghz/>

¹⁴ As it is likely that the released MoD spectrum will be used for wireless broadband using 4G LTE or LTE advanced, the initial technical analysis was conducted on this basis.

The 2300 and 3400 MHz amateur bands

- 2.10 Amateur licences authorise use of both the 2300 MHz and 3400 MHz band on a secondary basis.
- 2.11 This secondary status means amateurs operate on the basis that they should not cause harmful interference to others and can expect no protection from interference themselves from primary licensed users (non-interference/non-protection)¹⁵.
- 2.12 The non-interference/non-protection convention of amateurs' secondary access also applies to adjacent frequencies. Therefore in the technical analysis of the consultation we considered the impact of amateur use to LTE but not the impact of LTE to amateurs.

The consultation

- 2.13 In June 2013 we published a consultation, 'Public Sector Spectrum Release: Amateur use of 2310 to 2450 and 3410 to 3600 MHz' ("the consultation").
- 2.14 The proposals made were based on our analysis of the potential for LTE to coexist with amateurs in the release band and our understanding of the risk of interference from amateur operation in the adjacent bands to LTE in the release bands.
- 2.15 Our analysis showed that large separation distances (up to 65 km) may be required between amateurs and LTE base stations in order to protect the LTE base station from harmful interference when the same spectrum is used by both systems. The separation required to protect amateur TV repeater locations from harmful interference from an LTE base station could be up to 90 km.
- 2.16 Our analysis showed that there are instances where there is a risk of interference from adjacent channel amateur use to LTE systems. The results indicate that it could be sensible for amateurs to apply additional mitigation techniques such as a reduction of transmit power, additional filtering and/or a frequency separation to avoid causing harmful interference to LTE systems that are nearby in location.
- 2.17 We believe that due to the low numbers of amateur users in the band, the intermittent nature of some transmissions and careful operation by the amateurs that adjacent channel use could continue with limited risk.
- 2.18 This means there would be a high risk of harmful interference if amateur and LTE use were to coexist in the release bands. As we do not believe that amateurs could practically coexist with new uses, we proposed varying the Amateur Radio Licence to remove access to the release bands.
- 2.19 We therefore consulted on proposals to make changes to the Amateur Radio Licence which if implemented would:
 - i) remove the frequencies of the release bands from the licence.

¹⁵ The meaning of secondary access is not defined in the current amateur licence. However, the former Amateur Radio Licence terms and conditions booklet provided that amateurs using bands allocated on a secondary basis were "required not to cause undue interference to stations of a primary or permitted service to which frequencies are already assigned or to which frequencies may be assigned at a later date" (http://www.ofcom.org.uk/static/archive/ra/publication/ra_info/br68r11/br68.htm). See also clause 7(3) of the Amateur Radio Licence (<https://services.ofcom.org.uk/amateur-terms.pdf>)

- ii) We also set out three options for the adjacent bands and recommended option two which if implemented would retain amateur access to the adjacent bands and:
- iii) introduce a procedure to enable removal of additional frequencies (i.e. the adjacent bands) quickly if harmful interference were to arise in the future. This was based on our technical analysis and assessment of the risk of amateurs causing harmful interference to other systems.

Responses to the consultation

- 2.20 The consultation responses were grouped into themes and counted according to the frequency of each answer. Where more than one theme was raised in an answer each theme was counted meaning that some questions have more than 110 responses. Non-confidential responses are available on our website.¹⁶
- 2.21 In addition to the 110 consultation responses we received from amateurs and others, we also received confidential evidence from the MoD in respect of their evolving plans for system remediation ahead of the planned award.
- 2.22 In line with the evidence provided, the MoD has directed Ofcom on national security grounds to protect MoD systems at three sites and we have developed guidance for amateurs which recognise the MoD's increased operational requirements in these bands and the MoD's requirements for a low risk of interference to its uses. Further information about this guidance is set out in Section 5 and Annex 1.

The role of Ofcom

- 2.23 Since the consultation the MoD has announced that it will release the spectrum bands 2350 to 2390 and 3410 to 3600 MHz¹⁷ to Ofcom to award.¹⁸ Having considered this in line with our duties we are clear that this does not change the positions set out in our consultation with regards to continued amateur use in either the release or adjacent bands.
- 2.24 Amateur use of the 2300 MHz and 3400 MHz band has been agreed by the MoD but it is administered by Ofcom. Ofcom is responsible for the authorisation of use of amateur radio in the UK, however the MoD is responsible for managing its uses in these bands.
- 2.25 The MoD is a Crown body and, as a result, it has no requirement to hold a WT Act licence issued by Ofcom in order to use spectrum.
- 2.26 Ofcom, as the UK spectrum regulator, has to take account of a number of factors in undertaking its statutory duties. Our duties include the need to ensure optimal use of spectrum – and our principal duties are to UK citizens and consumers.
- 2.27 Ofcom has powers to change the use of radio spectrum where this is in the best interests of UK citizens and consumers and/or in line with other domestic or international decisions. Changes may result in more spectrum being made available to a particular use (e.g. radio amateurs) or they may result in the loss of some spectrum.

¹⁶ <http://stakeholders.ofcom.org.uk/consultations/public-sector-spectrum-release/?showResponses=true>

¹⁷ 40 MHz between 3410 and 3600 MHz is already under civil licence to UK Broadband.

¹⁸ <https://www.gov.uk/government/news/ofcom-to-manage-release-of-mod-radio-spectrum>

- 2.28 Before undertaking such changes we must take into account our duties under the Communications Act 2003, the Wireless Telegraphy Act ('WT Act') itself and under applicable EU legislation, including the Authorisation Directive¹⁹ and the Framework Directive²⁰.
- 2.29 Section 3 of the Communications Act 2003 provides that our principal duties are:
- to further the interests of citizens in relation to communications matters; and
 - to further the interests of consumers in relevant markets, where appropriate, by promoting competition.
- 2.30 In fulfilling these duties, we are required to secure, among other things, the optimal use of the spectrum for wireless telegraphy, and the availability throughout the UK of a wide range of electronic communication services. We must have regard to the different needs and interests of everyone who may wish to use the spectrum for wireless telegraphy.

Structure of this document

- 2.31 This statement explains the decisions we have taken to make changes to the Amateur Radio Licence which will:
- a) remove certain frequencies from the licence (i.e. 2350 to 2390 MHz and 3410 to 3475 MHz);
 - b) maintain some access for amateurs to adjacent bands (i.e. 2310 to 2350 MHz; 2390 to 2400 MHz and 3400 to 3410 MHz) and
 - c) provide guidance to amateurs on avoiding interference to other uses.
- 2.32 We also set out our intention to make 2300 to 2302 MHz available to amateurs via a NoV and describe how these changes will be implemented and the timetable which we must follow.

¹⁹ Directive 2002/20/EC on the authorisation of electronic communications networks and services, as amended by Directive 2009/140/EC

²⁰ Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services, as amended by Directive 2009/140/EC.

Section 3

Use of the release bands

3.1 In the consultation we set out proposals to vary the amateur radio licence to remove access to the release bands (i.e. 2350 to 2390 MHz and 3410 to 3475 MHz). The answers received relating to these proposals and our decision are set out in this section.

Proposal to remove the release bands

3.2 Our technical analysis showed coexistence between amateurs and new uses would not be possible due to a requirement for large separation distances between the amateurs and new uses that have national licenses. The proposal to remove the release bands was therefore based on:

- i) our belief that the benefit to UK citizens and consumers would be greater from the MoD's release of spectrum in the 2.3 and 3.4 GHz release bands than from retaining the current amateur use.

3.3 This was based on our:

- i) understanding of the current uses of the release band; and our
- ii) understanding of the consequences of removing the release bands.

Current uses in the release bands

3.4 Amateurs may use the release band spectrum for any purpose provided they operate within the terms specified in their licence. This is a valued characteristic of the amateur licence as it enables experimentation with different uses in any frequency band on the amateur licence. However, this characteristic means we cannot be sure of the location, number or type of use in each band.

3.5 In order to consider the uses we therefore used the Radio Society of Great Britain's (RSGB) band plan for amateur use as an indication of type and spoke to amateur users of the bands themselves.

3.6 We also asked a question in our consultation about current uses of the release band in order to ensure we understood the impact of removing the release band from the Amateur Radio Licence and to consider coexistence implications.

Q2. Are there current uses in the release bands other than those detailed in RSGB's band plan and discussed in section 3 of the consultation?

Consultation responses

3.7 Seventy-three respondents agreed that we had identified the current types of use in the release bands in the consultation. Only six identified other uses, several of which were actually identified or had similar characteristics to those identified in our consultation.

Table 2: current uses in the release bands

Response	Number of respondents
No (inc. not that I know of, none that I am aware of, not to my knowledge)	73
n/a (inc. no comment, did not answer the question, not known)	18
Could be/could be in the future	8
answer did not address the question asked ²¹ (e.g. expresses disappointment that amateurs might lose access to part of the band used for amateur TV)	2
should be possible for amateurs to co-exist with commercial users in the release bands ²²	1
Yes (specific uses given)	6

Could be/could be in the future

3.8 Eight respondents said there could be other users in that band (but did not state what these were) or noted that there could be other uses in the future. In considering coexistence issues, we can only look at new planned uses versus existing uses so we have not given any consideration to coexistence of new uses in the release band with potential future amateur developments.

Yes (specific uses given)

3.9 The following applications²³ were not specifically identified in our consultation:

- Amateur research, development and testing (including testing of microwave technology)
- Emergency Communications provided by Radio Amateurs, e.g. voice, video and data links, in the case of a regional or national emergency.

3.10 We believe that while these applications of amateur uses were not specifically addressed in the consultation, the technical characteristics of these uses were covered by similar uses in the coexistence analysis. For example, emergency communication (video and audio links) were covered by our technical analysis of amateur TV (video) and narrow band (audio) systems.

²¹ Of note: in several instance where discussing results we have said 'answer given did not address the question asked'. In these instances where applicable we have considered the response given elsewhere. Where evidence has not been provided to support a response this has been noted.

²² Evidence not provided

²³ By application of use we mean the end result or intention of a particular transmission (e.g. the use of audio links can be applied to provide communication links in emergency situations, or it can be used for amateurs to hold informal one-to-one conversations)

Ofcom's response

3.11 No applications or uses were identified by the consultation that challenged our belief that potential benefits for citizens and consumers from the release are greater than the benefit of the current amateur use. We also think that our preliminary view in the consultation with regards to withdrawing amateur use remains valid as there were no amateur uses identified that we believe could coexist with new uses in the release bands.

Benefits for UK consumers and citizens

3.12 From our understanding of amateur usage of the release band going into the consultation we said we believed it was likely that the benefits to UK consumers and citizens would be greater from the release than from retaining only the current amateur use. This means that we must withdraw authorisation to use of this spectrum from amateurs if coexistence between amateurs and new uses were not possible. We asked whether respondents agreed with this statement.

Q1. Do you agree that it is likely that the benefits to UK consumers and citizens will be greater from the MoD's release of spectrum in the 2.3 and 3.4 GHz release bands than from retaining the current amateur use?

Consultation responses

3.13 Many respondents (54) agreed with that it was likely that the benefits to UK consumers and citizens would be greater from the MoD's release of spectrum in the 2.3 and 3.4 GHz release bands than from retaining the current amateur use.

Table 3: benefits for UK consumers and citizens

Response	Number of respondents
Yes	54
No	24
n/a	4
Unfair comparison/not a valid question	17
Not conclusive	12

Agreed

3.14 Of those that agreed, almost half (24) did so reluctantly stating it was difficult to argue against such a statement or that amateurs could co-exist. Other respondents (7) noted they agreed only if those that are awarded the spectrum, use it.

Disagreed

3.15 Fewer respondents (24) disagreed. By far the most frequently cited reason (8 responses) for rejecting this statement was the claim that it would do damage to work

done by amateurs and the development of understanding and skills which also contributes to citizen and consumer benefit.

- 3.16 We have considered this response but believe that the remaining spectrum, which includes spectrum in the 2.3 and 3.4 GHz bands, provides continued opportunity for amateur use and experimentation.
- 3.17 Other reasons given for disagreement included the impact on the 2400 MHz band and Wi-Fi. This issue is being considered as part of the PSSR coexistence consultation.²⁴
- 3.18 Another respondent disagreed, as the amateur satellite service uses “need to access low noise floor spectrum” and there is an allocation of 2400 to 2450 MHz to amateur satellite services in ITU regions 1 and 2. We are not suggesting any change to the 2400 to 2450 MHz spectrum where amateur satellite services are operating. We understand that this is a noisy band already and the continued take up of Wi-Fi and other licence exempt devices in the 2.4 GHz band in the UK around the world in the same band may impact the noise floor in addition to increased use for mobile broadband.
- 3.19 One respondent pointed out that once sold it will be difficult for MoD (or other government departments) to gain access to the spectrum again (as was required during the Olympics). We have considered this response but believe this is an issue for Government to consider.
- 3.20 Others claimed there is sufficient spectrum available to consumers and that it would benefit commercial interests more than consumer ones. As noted above, there is increasing demand by consumers for mobile data and this is facilitated by spectrum access. Our recent Mobile Data Strategy sets out the benefits of meeting the growing demand for mobile data services could bring to consumers, and to the UK economy more generally.²⁵
- 3.21 Other reasons included fears that the band would be used by technologies which are not making efficient use of spectrum or are making less efficient use of spectrum than amateurs are.

Unfair comparison

- 3.22 Fifteen respondents said that they felt the comparison was not valid. Several reasons were provided to back up this claim including the assertion that Ofcom was overlooking benefits provided by amateurs such as developing skills and new technologies which could not be quantified. Respondents also raised concerns with whether we should compare primary and secondary uses.

Other responses

- 3.23 Twelve respondents said they were unsure, citing dependencies on what new uses were. For example, saying that it was dependent on which services the spectrum was used for or that their response would be influenced by whether spectrum was used for technologies which could use spectrum more efficiently (i.e. if the spectrum was used by a technology that was not making efficient use of spectrum they would not agree with our statement).

²⁴ <http://stakeholders.ofcom.org.uk/consultations/pssr-2014/>

²⁵ http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-data-strategy/summary/MDS_Condoc.pdf

Ofcom's response

- 3.24 We received no evidence that disproves our assertion that the benefits to consumers and citizens following the MoD's remediation from the release band will be greater from new uses than from the current amateur use.

Consequences of removing the release bands

- 3.25 In the consultation we considered the consequences of removing the release bands from the amateur licence. Specifically, these consequences were: the loss of use of 40 MHz in the 2300 MHz amateur band (out of a current 90 MHz) and 65 MHz in the 3400 MHz amateur band (out of a current 75 MHz). We considered the current use of this spectrum as set out in the RSGB's band plan and as a result of our conversations with individual amateurs and representative groups.
- 3.26 We acknowledged the benefits of amateur activity but indicated that we believed that the majority of these benefits, could continue to be realised in the remaining spectrum available to amateurs. We remain of this view.

Q3. Are there further consequences of removing the release bands from amateur licences that have not been considered in our analysis?

Consultation responses

- 3.27 Stakeholders, on the whole, agreed with our assessment. Of the 110 responses received to this question over half (57) agreed that the consequences had been addressed in our analysis and 10 respondents skipped this question or wrote 'no comment'.

Table 4: consequences of removing the release bands

Response	Number of respondents
No (inc. not that I am aware of)	57
N/a	8
No comment	2
answer did not address the question asked	3
Yes <ul style="list-style-type: none"> - loss of spectrum for experimentation; future experimentation; loss of opportunities; loss of skills/education (inc. other societal benefits not specified) (14) - loss of spectrum for Amateur TV (ATV)/wideband/spread spectrum/for other amateur uses (inc. could have missed uses not on bandplan) (23) - financial cost to amateurs (inc. amateurs have invested in these bands; compensation should be considered; equipment will be made obsolete) (14) - other reasons given (4) 	43

Loss of spectrum for experimentation

- 3.28 Fourteen respondents noted the loss of spectrum for experimentation, future experimentation or loss of opportunities.
- 3.29 We have considered this response but believe that the remaining spectrum, which includes spectrum in the 2.3 and 3.4 GHz bands, provides continued opportunity for amateur use and experimentation.

Wide band use (Amateur TV) and other amateur uses

- 3.30 Twenty-three respondents pointed to loss of spectrum for amateur television, wideband or other known uses. We acknowledged in our analysis the impact on amateur television, noting there were five TV repeaters either transmitting or receiving in the release bands and other users that would be impacted.
- 3.31 One respondent also pointed out there could be uses missed by the RSGB's band plan. A handful of respondents pointed out other uses in these bands. These uses were: TV from international space station; amateur radio astronomy; microwave and high speed data uses.
- 3.32 Again we have considered this response but believe that the remaining spectrum, which includes spectrum in the 2.3 and 3.4 GHz bands, provides continued opportunity for amateur use and experimentation. At present amateurs have access to several different bands across the spectrum. We acknowledge that these bands have various uses depending on each band's propagation properties and available bandwidth. However, we understand that other bands are already being used for most of the activities currently taking place at 2.3 and 3.4 GHz. Wide band and

amateur TV activities could continue in other bands in most parts of the UK, if users were to migrate to more spectrally efficient modes, for example, those that utilise digital technologies.

- 3.33 Furthermore, as discussed in paragraphs 2.3 to 2.5 now that the MoD and other government uses have been or are in the process of being moved from the release bands, we believe it is likely that the benefits to UK consumers and citizens will be greater from the MoD's release than from retaining only the current amateur use.

Financial cost to amateurs

- 3.34 Fourteen respondents said there was a financial cost to amateurs and that amateurs should be compensated for this loss.
- 3.35 The MoD is the primary user of the release bands. For several years the Government has undertaken work looking at which spectrum could be released and likely candidate bands including 2.3 GHz and 3.4 GHz have been discussed in many consultations and statements. For example, the possibility of the MoD releasing spectrum between 3400 and 3600 MHz and the impact this would have on amateurs was raised in a 2008 MoD consultation '*An Implementation Plan for Reform*'.²⁶ The subsequent statement also indicated the MoD's intention to review the 2.3 GHz band for potential release.²⁷
- 3.36 The MoD previously signalled its intent to request a grant of Recognised Spectrum Access (RSA) for the 3.4 GHz band. We consulted on this request and in our subsequent statement said that amateur access could continue in the frequencies from 3400 to 3475 MHz. As we explained in the June 2013 consultation, since that time the ongoing harmonisation work in Europe and more recent MoD plans suggest that fixed and mobile 4G usage may be more widespread than previously assumed. We therefore stated that we believed amateurs had been aware of the MoD's plans and associated uncertainty for several years. We also noted that this uncertainty had been reflected in the RSGB's band plan which has noted 3.4 GHz is 'subject to regulatory change'. Notwithstanding our previous statements, we therefore believe that amateurs have therefore long been aware of the potential that they would lose access (or have reduced access) to some or all of the 2.3 and 3.4 GHz bands.
- 3.37 Furthermore, amateurs will have at least 12 months to re-plan their uses in the release bands.²⁸ We believe 12 months to be reasonable notice for removing the release bands. With 12 months' notice we do not consider there are any grounds for claims of compensation as a result of the removal of these bands from the amateur licence.

Other consequences

- 3.38 Four respondents stated other consequences of removing the release bands. These consequences included the claim that removing the release bands would require changes to the exam taken by amateurs. These changes will be considered by the examination committee.

²⁶ [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/35937/dsm_consultation_report.p
df](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/35937/dsm_consultation_report.pdf)

²⁷ <https://www.gov.uk/government/consultations/uk-defence-spectrum-management>

²⁸ Subject to the guidance set out in Annex 1

- 3.39 Another respondent said there would need to be changes to the specifications for NoVs. These changes will be considered as part of the general review of the amateur licence document.
- 3.40 One respondent said a consequence of removing the release bands would be the impression that we give into commercial pressures to the detriment of minority uses such as amateur radio. Ofcom makes decisions against our duties and, as set out in paragraph 3.32, we believe that the remaining spectrum provides continued opportunity for amateur experimentation.

Ofcom's response

- 3.41 We therefore believe our assessment of the current uses of the band with regards to coexistence and the potential for current uses to coexist post release is accurate.

Decision

- 3.42 We have considered the current uses in the release band as well as the consequences of removing the release band and concluded that the benefits to consumers and citizens following the MoD's remediation from the release band will be greater from new uses than from the current amateur use. We have therefore decided to vary the Amateur Radio Licence to remove the release bands, giving amateurs a minimum of 12 months' notice to re-plan their activities.

Section 4

Use of the adjacent bands

- 4.1 In the consultation we set out three scenarios for the adjacent bands (i.e. 2310 to 2350 MHz, 2390 to 2400 MHz and 3400 to 3410 MHz).²⁹ The responses received relating to these proposals and our decision are set out in this section.
- 4.2 We conducted technical analysis to assess the interference issues to help inform whether amateurs were able to remain in the adjacent bands. In considering amateur access in the future, we reviewed current use as detailed in RSGB's band plan and spoke to amateur users of the bands themselves.
- 4.3 Our technical analysis was based on the premise that amateur use would be able to continue providing there was not a risk of amateurs in the adjacent bands causing harmful interference into the release band. We also highlighted the uncertainty around increasing future use of the adjacent bands by other uses. In the consultation we noted that continued amateur use would be on a non-interference, non-protection basis, so if there were interference problems in the future then these would be resolved by the usual regulatory mechanisms. (e.g. closing down or imposing restrictions on individual stations). However, we wanted to be clear that if we needed to remove access to all amateurs on interference grounds the period of notice would be three months
- 4.4 Our preferred option in the consultation was for amateurs to retain access to the adjacent bands with clarification of the notice period required in the case of interference.
- 4.5 This recommendation was made based on our technical analysis with the understanding that amateurs would follow the proposed mitigation measures summarised at Annex 2.
- 4.6 In addition to our assessment of the technical analysis, we noted there was also uncertainty with regard to potential future increased usage by the MoD, other government departments (OGDs) and/or Programme Making and Special Events (PMSE) in these bands.

Consequences of removing access to the adjacent bands

- 4.7 In the consultation we set out the option to remove access to the adjacent bands from amateur licences if necessary. We made it clear this option was not preferred but asked what the consequences of removal would be.

Q4: There is an option (although not preferred) to remove access to the adjacent bands from amateur licences. What are the consequences of removing access to the adjacent bands from amateur licences?

- 4.8 We asked this question because we noted it was likely that future use in the adjacent bands was likely to increase. We aimed to determine the impact to amateurs if it was necessary to remove the adjacent bands. We acknowledge that although amateurs

²⁹ There are no proposals to vary access to the 2400 MHz amateur band (i.e. 2400 to 2450 MHz) but it may be good practice for users to follow the recommendations in Annex 2 such as the use of good filters for wide band systems.

have access to a number of other bands the propagation properties of the adjacent bands are valued by amateurs and therefore to remove all access would have an impact to the community and could render some current activities unviable.

Consultation responses

4.9 The most frequently cited implication of removing the adjacent bands were:

- loss of scientific knowledge/knowledge beyond the amateur community
- loss of investment in equipment for amateurs/incurred additional costs of amateurs
- damage to the amateur community (including the development of the amateur community in the future)
- loss of opportunity for experimenting not available else in the spectrum (including require internationally harmonised spectrum; retaining access to adjacent bands solves problem; propagation characteristics; would prevent ATV continuing)

Table 5: Consequences of removing access to the adjacent bands

Response	Number of respondents
loss of scientific knowledge/knowledge beyond the amateur community	54
loss of investment in equipment for amateurs/incurred additional costs of amateurs	53
damage to the amateur community (inc. the development of the amateur community in the future)	51
loss of opportunity for experimenting not available else in the spectrum (inc. require internationally harmonised spectrum; retaining access to adjacent bands solves problem; propagation characteristics; would prevent ATV continuing)	53
n/a (inc. No comment and don't know)	8
None	1
answer did not address the question asked (inc. made suggestions for alternative ways to organise the band/s)	7

Loss of scientific knowledge

4.10 Fifty four respondents pointed to a loss of scientific knowledge that could be gained by future amateur use of the adjacent bands which would be lost if this use was taken away.

4.11 Evidence provided to back up this claim took two main forms: personal examples that amateur radio provided a background in technical expertise and specific examples of

amateurs developing solutions to technical problems (e.g. “the development of Aircraft Reflection techniques and the use of Digital weak signal communication modes like WSJT to cope with rainscatter and other tropospheric propagation phenomena encountered at these frequencies.”)

- 4.12 Other amateurs also connected the evidence to benefits for UK industry and the Government’s skills agenda (e.g. “[a]s well as opportunities for self-training in the field of RF engineering where the UK has a shortage of skilled people, there are great possibilities for outreach projects to interest school children as well as university students in careers in electronic engineering.”)
- 4.13 Other respondents provided general evidence for these claims (e.g. amateurs that use these bands will often work professionally as engineers; equipment for this band is relatively inexpensive allowing many to use it; Research by the amateur community has often been a precursor to commercial developments in this and other parts of the spectrum).
- 4.14 We have considered these responses but note that much of the adjacent bands will remain available for amateur experimentation.

Cost to amateurs as a result of loss of investment in equipment

- 4.15 Fifty-two respondents cited the cost to amateurs resulting from the loss of equipment as a consequence of losing access to the adjacent bands.
- 4.16 As noted previously in respect of the release band, the MoD is the primary user of this spectrum and amateurs have long been aware of the potential that they would lose access (or have reduced access) to some or all of these bands.
- 4.17 Ofcom has powers to change the use of radio spectrum where this is in the best interests of UK citizens and consumers and/or in line with other domestic or international decisions. Changes may result in more spectrum being made available to a particular use (e.g. radio amateurs) or they may result in the loss of some spectrum. As noted above we received no evidence that disproved our assertion that the benefits to consumers and citizens following the MoD release would be greater from new uses than from the current amateur use.

Damage to the amateur community

- 4.18 Forty-eight respondents cited damage to the amateur community as a consequence of removing the adjacent bands. Reasons given were: access to this part of the spectrum is a relatively easy way for amateurs to experiment and removal will discourage future potential amateurs from getting involved in the hobby. No further evidence was provided as to why this might damage the community.
- 4.19 We have considered these responses but believe that the remaining spectrum provides continued opportunity for amateur use and experimentation.
- 4.20 One respondent cited damage to the community from interruption of experimentation with “long range forward scatter from aircraft (essentially bi-static radar)”. The respondent noted that this was “a currently funded research topic” but did not provide further information.
- 4.21 Since the adjacent bands will continue to be available for amateur use we believe this research will be able to continue, although, as previously noted, amateurs should

be aware that primary use of the 2310 to 2350 MHz band is likely to increase in the future.

Loss of opportunity for experimenting not available else in the spectrum

- 4.22 Forty-eight respondents pointed out that the loss of adjacent bands would mean that “no amateur operation would be permitted between 1.3 GHz and 5.7 GHz” which would have implications for experimenting with the propagation characteristics specific to that range.

Ofcom’s response

- 4.23 In line with our duties we are required to consider citizen and consumer interest as well as optimal use of spectrum. This will often involve balancing competing demands on spectrum. In this instance we are not planning to remove access to spectrum at this time.

Additional uses of the adjacent bands?

- 4.24 In the consultation we set out current uses of the adjacent bands and asked whether there were further uses that we had not identified in order to consider the implication of removing some or all of the adjacent bands if that was deemed necessary as well as to consider potential coexistence issues.

Q5. Are there current uses in the adjacent bands other than those detailed in the RSGB’s band plan and discussed in section 3?

Consultation responses

- 4.25 The majority of respondents from the amateur community (67) agreed that we had identified the current uses of the adjacent bands in our consultation document. Thirteen respondents did not answer the question or said no comment and five provided answers that did not address the question asked.

Table 6: Additional uses of the adjacent bands?

Response	Number of respondents
no/not to my knowledge (inc. mention of uses detailed in RSGB's band plan and discussed in section 3)	67
international uses	17
amateur radar/tracking aircraft	7
answer did not address the question asked	5
N/A; No comment	13
Investigating propagation mechanisms/marginal propagation	11
Other uses	5

4.26 As Table 6 details, the majority of respondents detailed uses in the adjacent band which we are already aware of and were taken into account in the consultation.

4.27 Other uses have been highlighted however we modelled similar systems in our consultation, for example:

- telemetry and APRS linking projects, which tends to be adapted Wi-Fi equipment, we modelled in our consultation document as data links;
- scattering signals from space objects, these systems are similar to EME systems that we modelled;
- We modelled three different types of wide band modulation systems, these were data links, analogue TV equipment, and digital TV equipment.

International uses

4.28 A number of respondents (17) also raised the importance of 2319 to 2322 MHz as a range that works across Europe and is highly desirable for this reason. One respondent added that because these frequencies are widely used internationally it is likely that “legitimate amateur activity from neighbouring countries could still lead to interference events”.

4.29 We do not believe this is a significant concern. However, if this were to be an issue in practice we note that amateurs are secondary to fixed and mobile use in the UK Frequency Allocation Table (FAT)³⁰. The principles of the International Telecommunication Union’s (ITU) definition of primary and secondary status are used to consider cross border spectrum interference and protection issues. In the ITU’s definition of secondary status it states: stations shall not cause harmful interference to stations of a primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date. Therefore there is

³⁰ http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-information/UKFAT_2013.pdf

a mechanism via the ITU for dealing with such cases of interference should they arise.

Investigating marginal propagation

- 4.30 Ten respondents noted that an application of uses³¹ was to investigate marginal propagation. We have considered this response but note that much of the adjacent band will remain available for amateur experimentation of these properties.

Amateur radar

- 4.31 Seventeen respondents cited development of amateur radar and use of these frequencies for aircraft tracking. Again, we have considered this response but note that much of the adjacent band will remain available for this use.

Ofcom's response

- 4.32 We acknowledge the work of amateurs in these bands and the impact a total loss of access would have to activities such as amateur TV. Wherever possible Ofcom has sought to maintain amateur access to the adjacent bands.

Mitigations to prevent amateurs causing interference into LTE

- 4.33 In the consultation we set out a number of mitigation measures (summarised at Annex 2) based on our technical analysis which we said amateurs may want to consider in order to comply with the terms of the Amateur Radio Licence not to cause interference to adjacent users.
- 4.34 We asked if there were additional measures that would provide demonstrable proof that amateurs in the adjacent bands would not cause interference into LTE in the release bands in order to draw on the expertise of amateurs themselves. We wanted to see if there were effective solutions that could be shared with the community to provide comfort to both amateurs (that they would be operating within their licence conditions) and new users that interference from amateurs would not cause a problem.

Q6. Are there additional mitigation measures which would provide demonstrable proof that amateurs would not cause interference into LTE in the release bands following the release?

Consultation responses

- 4.35 This question elicited a number practical suggestions from stakeholders. These are discussed below. In addition 17 respondents responded that they were not aware of any or declined to answer the question and four respondents said demonstrable proof could not be provided.

³¹ As previously noted, by application of use we mean the end result or intention of a particular transmission (e.g. the use of audio links can be applied to provide communication links in emergency situations, or it can be used for amateurs to hold informal one-to-one conversations)

Table 7: Mitigations to prevent amateurs causing interference into LTE

Response	Number of respondents
Working with specialist clubs groups (inc. amateurs already work with clubs/groups) / Technical assurance/help by interest groups such as BATV, UK Microwave group is currently available or could take a more active role	i) 44
Efficient filtering	39
Amateurs have experience and expertise to deal with the situation if problems arise	38
Careful / proper band planning	19
Operators should make sure LTE is protected from other users	17
Not aware of any, N/A, none (inc. did not answer question)	17
Testing/availability of test equipment	14
Need to know information on LTE systems	11
Guidance to amateurs (inc. specifying adjacent channel power limits)	9
Cannot provide demonstrable proof	4
Spectrum efficient / power efficient coding techniques	4
Could use spectrum analysers / an amateur can listen to the frequency before they transmit	3
Licence already has sufficient powers	3
We require quiet frequencies to transmit, so this will limit the risk of interference. Risk is both directions so this will limit the problem in practice	3
Other	11

Working with specialists clubs and groups

- 4.36 The most frequently cited response was working with specialists clubs and groups. Respondents gave examples of how this has assisted the community in the past as well as plans to do so in the future. For example “[a]s chair of BATC I can add that we are also planning a series of articles in our in-house publications, CQ-TV covering the practical aspects of filtering and reduction of problems and the construction filters. Equipment and filter testing will also become a major focus of the hands on workshops at the roundtables organised regularly by BATC.” One respondent suggested Ofcom provide funding for this work.

- 4.37 We welcome amateurs sharing information and best practice. However we do not believe it would be appropriate to provide funding to amateurs to undertake this work.

Efficient filtering

- 4.38 Thirty-nine respondents cited efficient filtering as an additional mitigation measure.
- 4.39 Efficient filtering is a measure we recommend amateurs taking in order to coexist with LTE (and others) in the release and adjacent bands. For further information on the performance of LTE systems assumed in our modelling, see Annex 2.

Amateur experience

- 4.40 Thirty-eight respondents said amateurs have the experience and expertise to prevent problems and/or to deal with the situation if problems arise. For example, “[w]e have the expertise to design additional filtering and minimise energy on adjacent channels. Indeed many amateur radio and tv repeaters only work because of the technical attention to detail - to have noisy transmitters or broadband receivers would mean our kit just wouldn't work in the field.”
- 4.41 We have considered the evidence provided about the level of expertise of amateurs using the adjacent bands and have factored this into our decision making with regards to allowing adjacent band access to continue.

Careful band planning

- 4.42 Nineteen respondents cited careful or proper band planning as a way of proving proof that amateurs would not cause interference into LTE in the release bands following the release.
- 4.43 We have considered the usefulness of careful band planning and the potential to specify particular uses and we have weighed these benefits against the importance amateurs place on experimentation.
- 4.44 We have concluded that the benefits of prescriptive band planning are outweighed by the beneficial aspects of the amateur licence. Further we note that not all amateurs choose to follow the band plans as set out by RSGB.

Operators should make sure LTE is protected

- 4.45 Seventeen respondents stated that operators in the release band should make sure LTE is protected from amateur use in the adjacent bands. This could mean that amateurs felt LTE was overly sensitive to interference from adjacent uses (i.e. LTE would be picking up signals from the adjacent band amateurs use) or that LTE should have improved filters to protect from signals entering the release bands from adjacent uses.
- 4.46 We have considered respondents' concerns however, conditions for new use in the release band will be in line with internationally agreed technical standards. We therefore do not believe that imposing more restrictive conditions on new LTE uses in order to protect adjacent use would be appropriate.
- 4.47 We are currently consulting on the technical conditions to be licensed within the adjacent bands 2350 to 2390 MHz and 3410 to 3600 MHz. These are summarised

within Figure 13.2 of our Consultation document 'Technical coexistence issues for the 2.3 and 3.4 GHz award'³².

Testing/Need to know information on LTE systems

- 4.48 Fourteen respondents said the ability to test equipment would assist in reducing the risk of interference. A further eleven respondents said having further information on LTE systems would assist in amateurs not causing harmful interference to LTE in the release band.
- 4.49 We have considered whether further testing would be useful but believe that the testing already undertaken alongside the information about LTE systems set out in the consultation Annex 6 is sufficient at this time.

Guidance to amateurs

- 4.50 Nine respondents said that issuing guidance to amateurs would help. We have considered whether formal guidance to avoid amateurs causing harmful interference to LTE would be appropriate but believe that the approach we proposed in the consultation provides greater flexibility to amateurs.

Spectrum efficient/power efficient coding techniques

- 4.51 Four amateurs said that coding of signals would assist amateurs in not causing harmful interference into LTE in the release band. One respondent cited evidence from amateurs ensuring their transmitters were improved to coexist with transmitters in the 1950s.
- 4.52 We acknowledge that this could be a useful option for amateurs to consider. If amateurs have power efficient coding techniques that would limit power into the adjacent bands and limit the risk of interference we welcome the adoption of these techniques.

Use of spectrum analysers

- 4.53 Three respondents pointed to the use of spectrum analysers as a tool to assist amateurs in not causing harmful interference into LTE in the release band. We acknowledge that this would be a useful option for amateurs to consider but do not see it would be practical or necessary to mandate this use for all amateurs using the spectrum.

Licence already has sufficient powers

- 4.54 Three respondents said the licence already has sufficient powers. We agree which is why in the consultation we set out suggestions for amateurs using the release band to avoid causing harmful interference into LTE, rather than proposing guidance or changes to the Amateur Radio Licence.

³² <http://stakeholders.ofcom.org.uk/binaries/consultations/pssr-2014/summary/pssr.pdf>

Quiet frequencies required to transmit

- 4.55 Three respondents said quiet frequencies are required to transmit which will limit the risk of interference in practice as amateurs would not want to transmit if there was a risk of their signal being interfered with.

Ofcom's response

- 4.56 We have decided not to impose or specifically recommend additional mitigation measures over those made in Annex 6 of the consultation and summarised in Annex 2. However we recognise there are good suggestions put forward in response to our consultation, summarised above, which may be helpful to limit the risk of causing interference. We suggest that amateurs use suitable judgement to decide what is appropriate.

Licence changes to lower interference risk?

- 4.57 In the consultation we proposed making changes to the Amateur Radio Licence in Table B 'Intermediate Licence Parameters' and in Table C 'Full Licence Parameters' to remove the release bands and retain the adjacent frequencies.
- 4.58 This means the row 2310-2400 and the row 3400-3475 would be amended with the terms and conditions as set out in Figure 3.
- 4.59 We also proposed to insert the following text as a new paragraph to the Amateur Radio Licence terms and conditions, Section 2, Clause 4(6):

"In relation to the following bands:

a) 2310 to 2350 MHz

b) 2390 to 2400 MHz

c) 3400 to 3410 MHz

Ofcom may vary this licence for reasons related to interference management after first giving reasonable notice of three months."

- 4.60 We asked whether there additional licence changes that would assist amateurs in lowering the risk of causing harmful interference to new users.

Q9. Are there additional changes to the Amateur Radio Licence which would assist amateurs in lowering the risk of causing harmful interference to new uses?

- 4.61 We asked this question in order to determine whether additional licence changes would be helpful to either amateurs or to new uses in the release bands.

Consultation responses

- 4.62 Instead of suggesting additional licence changes, many responses to this question instead provided general suggestions. These are discussed below along with the specific suggestions that were made.

Table 8: Licence changes to lower interference risk?

Response	Number of respondents
Licence already contains power to control interference	40
No and n/a	29
Limit power	13
answer did not address the question asked	12
Guidelines (inc. Database so we know where others are operating)	7
Limit spurious emissions/OOB emissions	4
Involve RSGB	4
Good design of equipment	3
Other (i.e. only one or two responses)	13

No changes apparent

- 4.63 The most frequently given response indicated that amateurs felt the licence already contained powers to control interference. Indeed, the first set of changes we suggested are in line with the existing licence conditions for other amateur bands.
- 4.64 With regards to the additional text proposed for Section 2, Clause 4(6), we have considered whether only the changes to tables B and C are sufficient. However, we have decided that it is not unreasonable to clarify the notice required for future amateur use to cease if it transpires that amateurs cause interference to other uses in the release or adjacent bands in the future.

Limit power

- 4.65 We note that thirteen respondents suggested limiting power as a means to assist amateurs in lowering the risk of causing harmful interference to new uses.
- 4.66 We have not proposed any additional restrictions to the power requirements in the 2310 to 2350 MHz band. However, we expect amateurs to take responsibility in minimising the risk of interference to other systems. This could include limiting the power used, considering the out-of-band emissions, and/or considering whether the frequency is in use within the area for other systems.
- 4.67 This means amateurs farther away may still be able to operate at higher power levels without causing interference to LTE. We believe that the guidance and information issued provides protection to amateurs and we do not think the risk is sufficient to justify lower power levels.
- 4.68 Amateurs are strongly encouraged to consider the risk of interference of their transmissions. The annex of our initial consultation document provides some detailed

calculations on the potential impact of amateur systems highlighted to us and the risk of interference to LTE systems³³. This study could be used by amateurs to help them understand the risk of interference of their transmissions. We would encourage RSGB or other amateurs to give support to the community, for example in the form of advice or support to help minimise any risk in advance of interference happening.

Ofcom's response

- 4.69 After consideration we have decided that further formal changes to the licence (other than those set out in the consultation) would not add to the protection of LTE use in the release band and formal changes to the licence would not remove a risk of interference to LTE systems. Formal changes to the licence conditions, however, could set some limitations on the amateur use, in circumstances where the risk of interference to LTE was minimal. We note that the current amount of interference cases from amateurs across all bands is quite low. This band has a relatively low number of amateur users compared to other bands, and it has been indicated to us that those amateurs who tend to use this band generally have a high level of expertise. Therefore we expect amateurs who use this spectrum to take responsibility for minimising the risk of interference to LTE systems as well as other uses.
- 4.70 Should there be isolated interference problems, we will:
- first to seek a remedy with the amateur(s) whose station(s) were causing the interference.
 - if for example the number of amateurs causing interference to other users in the release or adjacent bands in our view increases sufficiently from the current number and we anticipate this may cause a general problem, we may then consider further action to vary all amateur licences to remove the adjacent band in question completely. In that case, we would give three months' notice of this decision.

Proposed process following cases of reported interference

- 4.71 In the consultation we set out a process for varying an individual's Amateur Radio Licence and, if necessary, the Amateur Radio Licence for all amateurs if dealing with the number of individual reported cases became too onerous. We proposed that if taking this step were necessary, we would provide a 'reasonable notice' period under the licence terms and conditions of three months. This was not only to provide clarification for amateurs but also for primary users and LTE operators.
- 4.72 This process was set out not as a first step, but as something we would consider on after we had followed the steps set out in paragraph 4.70.
- 4.73 We were clear in the consultation that this notice period would apply only to the case of Ofcom exercising powers under Section 2, Clause 4 of the licence in the case of the adjacent bands (i.e. it would not apply to instances where we would remove/vary the licences under Schedule 1, paragraph 8 (5) of the WT Act). We asked whether stakeholders agreed with our proposed process.

Q7. Do you agree with the proposed process for varying licences following cases of reported interference and our proposal to vary licences should dealing with the number of reported cases become too onerous?

³³ <http://stakeholders.ofcom.org.uk/binaries/consultations/public-sector-spectrum-release/summary/condoc.pdf>

Consultation responses

4.74 Sixteen respondents agreed with our proposed process. Eight did not answer and four gave an answer that did not address the question. Ninety-seven respondents disagreed or tended to disagree (expressed reservations) in their response as discussed in paragraphs 4.75 to 4.84.

Table 9: proposed process following cases of reported interference

Response	Number of respondents
Yes	16
N/a	8
answer did not address the question asked	4
No	24
Tend to disagree	73
Of nos and tend to disagrees: <ul style="list-style-type: none"> • other organisations should be involved (i.e. RSGB, BATC, etc) = 40³⁴ • Licence conditions are enough (inc. Ofcom has enough powers already) = 29³⁵ • potential for manipulation (e.g. by MNOs) = 17³⁶ • unclear criteria for removal (inc. Proposals are too broad) = 20³⁷ • process needs to involve both parties = 5³⁸ • amend amateur bandplan = 1 • Not convinced there will be sufficient resources to effectively police this = 1 	

Licence conditions are sufficient

4.75 Twenty-nine respondents said they disagreed because they thought the licence conditions as they stood were sufficient. We agree that the licence conditions as they stand would allow removal with an unspecified reasonable notice period but nevertheless want to provide clarity to amateurs about the notice period in the case of harmful interference.

RSGB should be involved

4.76 A number of respondents argued that RSGB should be involved before a licence variation exercise was put in place for all amateurs. We note that RSGB does not represent all radio amateurs but affiliated amateurs who were approached by Ofcom

³⁴ Three respondents who agreed with the proposals also raised this as a concern

³⁵ One respondent who agreed with the proposals also raised this as a concern

³⁶ One respondent who agreed with the proposals also raised this as a concern

³⁷ One respondent who agreed with the proposals also raised this as a concern

³⁸ Two respondents who agreed with the proposals also raised this as a concern

about reported interference problems would be (as they are currently) free to involve RSGB (in its own right or via AROS³⁹) in finding a solution, since the first step of the process is to work with individual amateurs. Further we would encourage RSGB or other amateurs who resolved such issues to publicise the outcome for the benefit of other amateurs using the band.

Unclear criteria for removal

- 4.77 Other concerns raised included the claim the proposals were too broad or the criteria were unclear.
- 4.78 As set out in the consultation invoking the three month reasonable notice period in the case of harmful interference would be the last step in the process. First, Ofcom would take steps to work with an individual licence holder to correct the problem (e.g. through use of lower transmitter power) in line with our current procedures.
- 4.79 However, dealing with a large number of interference cases or an aggregated problem of interference from amateur stations, generally, on an individual basis could take considerable time and resources. We therefore set out the number of cases of reported interference across all amateur bands (between four and 14 per year)⁴⁰ and noted that if there were an increase in reported issues in these bands we might seek to restrict or remove access to the adjacent bands with a reasonable notice period of three months. This could be persistent harmful interference from one or two stations or more widespread interference from general aggregate use.

Potential for manipulation by Mobile Network Operators (MNOs)

- 4.80 Additionally, many respondents were concerned that there would be an opportunity for manipulation (e.g. MNOs could falsely claim interference). However, the process as set out does not allow for such manipulation. Interference can be reported, but before becoming a 'case' of interference it must first pass engineering triage, and if passed, it is then investigated in an attempt to find the source of the problem. There is therefore no scope for false reports of interference to be counted 'against' amateurs in an attempt to remove additional spectrum.

Other responses

- 4.81 Other responses given included the suggestion that the process needs to involve both parties (i.e. amateurs and Ofcom). As explained in paragraph 4.70, Ofcom will engage with individual amateurs before considering further action to vary all amateur licences to remove the adjacent band in question completely.
- 4.82 One respondent suggested amending the amateur bandplan. Ofcom does not maintain a bandplan for amateurs and it will be for the RSGB and other amateur groups to consider future amends to their plans.
- 4.83 One respondent raised concerns that there would not be sufficient resources to effectively police our proposed process. We have considered this response but

³⁹ AROS is the Amateur Radio Observation Service. It's the first port of call for complaints about amateur abuse and interference. The object is for the hobby to resolve complaints itself, be that complaints about or by amateurs. See <http://rs.gb.org/main/operating/amateur-radio-operating-service>. Our interaction with AROS is explained at <http://licensing.ofcom.org.uk/radiocommunication-licences/amateur-radio/guidance-for-licensees/licence-misuse-licence/information>

⁴⁰ Each year between 2010 and 2012 we received between four and 14 cases of interference where amateurs had caused interference to other spectrum users (Source: Ofcom database. Cases of reported interference)

believe that the process is reasonable from a resource allocation perspective and we will be able to carry this out if required.

Ofcom's response

4.84 After considering stakeholders' concerns we have decided to adopt our proposal to provide clarity to amateurs about the notice period required in the case of removing the release bands from all amateur licences for reasons of interference management. This clarification will be provided by adding a new paragraph to the Amateur Radio Licence as set out in paragraph 4.59 of this statement.

Our preferred option in consultation

4.85 In the consultation we set out three options for the adjacent bands. There were:

- i) Remove access to the adjacent bands
- ii) Retain access to the adjacent bands on the current terms but with clarification of the notice period required for future amateur use to cease if amateurs cause interference to other users in the release band or the adjacent band
- iii) Restrict amateur access to a smaller part of one or more adjacent bands.

4.86 Our preference was for option two. That is for amateurs to retain access to the adjacent bands with clarification of the notice period required in the case of interference. We asked in the consultation if respondents agreed with our preferred option.

Q8. Do you agree with our preferred option?

Table 10: Our preferred option

Response	Number of respondents
Yes	25
Reluctant yes <ul style="list-style-type: none"> - Suggested allowing use of 2300 to 2310/suggested solutions which maintain international allocations (9) - Want to maintain analogue TV/wideband uses (11) - Before variations applied, conversations with RSGB required (2) - Concern about the process (5) 	52
Other <ul style="list-style-type: none"> - Would prefer to find way where both new and existing users can coexist - Before variations applied, conversations with RSGB required 	2
No	16
n/a	9
answer did not address the question asked	1

4.87 Responses to question 7 notwithstanding, an overwhelming majority (82) respondents agreed, or reluctantly agreed with the preferred option for the adjacent bands. In contrast only 16 respondents disagreed.

Decision

4.88 Despite many not agreeing that a clarification of the notice period was required, a majority of respondents agreed (or reluctantly agreed) with our preferred option for amateurs to retain access to the adjacent bands with clarification of the notice period required in the case of interference to other users in the release or adjacent bands.

4.89 Amateurs argued that the licence already contained provisions for reasonable notice and therefore specifying the notice period of three months as proposed in the consultation was not necessary. We have considered these responses but, given the additional clarity that it gives licensees, we do not think that specifying this period is unreasonable.

4.90 We have therefore decided that, if amateur use in the adjacent bands must cease, the Amateur Radio Licence will be varied in line with the preferred option but with the addition of modifications as a result of representations from the MoD as set out in Section 5.

Section 5

Guidance to protect MoD systems using 2310 to 2400 MHz

- 5.1 In addition to the responses from radio amateurs, we also received representations from the MoD concerning its band plan for both the release and adjacent bands (i.e. the new location of systems remediated as a result of the 2.3 and 3.4 GHz release and the placement of new planned systems). The MoD's remediation programme is the replanning of its spectrum uses to support the release. This means there may be some impact on sharing arrangements with other users of spectrum.
- 5.2 The MoD is moving systems into the release band (in the short term) and the adjacent bands and increasing existing use as a result of its remediation programme required to clear 2350 to 2390 MHz.
- 5.3 We have received evidence from the MoD as a result of its new and changing operational uses and it has directed us to take appropriate measures to protect its systems. We have agreed with the MoD that appropriate measures are for us to issue guidance to amateurs to help them comply with their licence obligations not to cause harmful interference. These measures apply immediately. For some amateurs this guidance will mean time based geographic restrictions on use of the 2310 to 2390 MHz band in order to protect primary use which are MoD uses.
- 5.4 This section sets out information about the amateur licence and goes on to detail the implications of new/changing MoD use for amateurs operating in both the 2350 to 2390 MHz band (between now and when this spectrum is withdrawn from use) and the 2310 to 2350 MHz adjacent band. There is no proposed additional guidance for 2390 to 2400 MHz or 3400 to 3410 MHz.

Context for amateur licences

- 5.5 Amateurs share the 2300 MHz band with other uses (i.e. the MoD, OGDs, and from time to time PMSE). Amateur licences authorise use of the 2300 MHz band on a secondary basis. This secondary status means amateurs operate on the basis that they should not cause harmful interference to others and can expect no protection from interference themselves from primary licensed users (non-interference/non-protection).
- 5.6 As noted in the consultation, the non-interference/non-protection convention of amateurs' secondary access also applies to adjacent frequencies. This means that amateur access to adjacent frequencies is also threatened if there is potential for harmful interference to use in the release bands or to other uses in the adjacent bands. These uses could be a new primary licensee or other primary and secondary uses (e.g. the MoD, other Government departments, and PMSE).
- 5.7 Now that the MoD has confirmed its operational requirements between 2310 and 2390 MHz, Ofcom is issuing the guidance below to amateurs in order to limit the risk of interference to MoD systems.
- 5.8 We acknowledge that clauses in the current Amateur Radio Licence mean that if interference were caused to MoD systems by amateurs, we could take remedial compliance action in respect of the amateur station(s) concerned. However, the MoD

is clear that many of its activities are important and resource-intensive and there would be significant implications were its systems to be affected by any interference. Consequently, relying solely on taking remedial enforcement after interference occurs would not be acceptable. Having conducted technical analysis into the possible risk of interference, the MoD is therefore keen to reduce the risk of interference to its systems. The MoD therefore requires us to provide details of preventative restrictions in the form of guidance to avoid interference occurring (although we note that compliance with the guidance does not absolve amateurs of their wider responsibility not to cause harmful interference to other uses). This information is the guidance set out at Annex 1.

- 5.9 If amateurs adhere to this guidance, we believe that the risk of interference to these crucial MoD systems is manageable (although we note that compliance with guidance does not absolve amateurs of their responsibilities not to cause harmful interference to other uses).
- 5.10 Amateurs are required to comply with the guidance on the basis of the terms of the Amateur Radio Licence which state that amateurs operate on the basis that they should not cause harmful interference to others (including primary uses).
- 5.11 When the amateur licence variation takes place this will be clarified in the licence. Additionally, as set out in Figure 3 clauses will be added noting that the adjacent bands are 'available on the basis of non-interference to other services inside or outside the UK'.

Figure 3: Proposed amendments in tables B and C of the amateur licence

Frequency Bands (in MHz)	Status of allocations in UK to the Amateur Service
2310-2350	Secondary. Available on the basis of non-interference to other services inside or outside the UK
2390-2400	Secondary. Available on the basis of non-interference to other services inside or outside the UK
3400-3410	Secondary. Available on the basis of non-interference to other services inside or outside the UK

MoD use in 2350 to 2390 MHz release band

- 5.12 The MoD's plans include use of the 2.3 GHz release band from April 2014 until the award in certain geographical areas.

- 5.13 The following guidance as set out at Annex 1 and summarised below is effective immediately:
- i) amateurs are advised to note MoD usage in Boscombe Down and West Wales Airport as well as associated use areas.
 - ii) amateurs are therefore required to take such steps as may be necessary when transmitting in the direction of Boscombe Down and West Wales Airport and associated use areas of Salisbury Plain and Cardigan Bay to avoid causing interference to MoD systems.
- 5.14 This could potentially have the effect of curtailing certain types of amateur activity under general licence conditions for those operating at locations marked by grid locations in the guidance.

MoD use in the 2310 to 2350 MHz adjacent band

- 5.15 As part of the MoD's remediation plans and general use of the spectrum to which it has access, it is increasing use of the 2310 to 2350 MHz adjacent band beyond what was understood when the consultation was published in June 2013.
- 5.16 The guidance on the use of this spectrum by amateurs will also be published on our website and will be referenced in the Amateur Radio Licence following the licence variation.⁴¹
- 5.17 The guidance will impact any amateur use around three ground locations: Boscombe Down, St Kilda and Aberporth starting immediately.

Use of 2310 to 2350 MHz around St Kilda and Aberporth

- 5.18 Amateurs must tolerate some limitations on uses around each site. These limitations apply during business day daylight hours.
- 5.19 Guidance is provided for amateur operation in the form of a maximum receive power at each site. Amateurs must limit the received power at the site from each amateur location to below the thresholds specified. There is no requirement to take into account aggregate effects from other amateurs.
- 5.20 The impact of these restrictions will be dependent on the location of the amateur, the transmission activity (e.g. EME, voice or datalinks), the antenna directivity and elevation. For example, amateurs operating at a low power close to St Kilda may calculate their signal power levels will not exceed the threshold at the MoD ranges, whereas high power users further away may still need to cease operation during business day daylight hours.
- 5.21 This decision to issue guidance provides greater flexibility for amateurs than outright exclusion zones which would need to take into account high power uses and could therefore excluded other amateur activity which could take place at a lower power.
- 5.22 The MoD's assessment suggests a number of 10km grid squares are likely to be affected with amateur systems operating at two example power levels with 16dB of antenna discrimination. The assessment was carried out using ITU-R propagation

⁴¹ <http://licencing.ofcom.org.uk/radiocommunication-licences/amateur-radio/licensing-updates>

model 452-14 with 50% time, although we consider that for systems operating 24 hours a day, seven days a week a 10% time basis may be more appropriate.

5.23 Full guidance is set out at Annex 1.

Use of 2310 to 2350 MHz around Boscombe Down

- 5.24 Amateurs must note MoD usage at frequencies between 2310 and 2350 MHz in the Boscombe Down area. Relevant MoD uses at this site are typically daylight hours on business days between May and October inclusive each year.
- 5.25 Guidance is provided for amateur operation in the form of a maximum receive power at Boscombe Down. Receive power levels differ for amateurs transmitting in different parts of the band. Amateurs must limit the receive power at Boscombe Down for all three parts of the band.
- 5.26 Between daylight hours on business days between May and October (inclusive) every year amateurs wishing to use the 2310 to 2350 MHz band must:
- i) Cease/refrain from transmitting or
 - ii) Perform the necessary calculations and modifications to ensure received power at Boscombe Down from each amateur location is below the thresholds specified before transmitting.
- 5.27 Again, the impact of these restrictions will be dependent on the location of the amateur, the transmission activity (e.g. EME, voice or datalinks), the antenna direction and elevation.
- 5.28 Amateurs should note that applications for NoVs to operate TV repeaters are unlikely to be approved on most frequencies between 2310 to 2350 MHz within 50km of Boscombe Down and there may be some limitations beyond this in certain directions.

Timing of the changes

5.29 Amateurs are required to comply with this guidance with immediate effect.

Informing amateurs of the changes

5.30 We will publicise the new guidance through a variety of methods including: placing notices/articles in RadCom (RSBG's member magazine) and other amateur publications and posting a notice on our website.

Amateurs using the 2310 to 2350 MHz band

5.31 In the consultation we set out the uncertainty regarding future use of the adjacent band (including 2310 to 2350 MHz). We said the adjacent bands were currently used by the MoD as well by OGDs and PMSE and that, due to high demand for this spectrum, it was likely that existing uses would be concentrated in the adjacent bands. It is also likely that the guidance as set out above will be updated from time to time as MoD usage changes and amateurs will be required to comply with the latest version of this guidance.

- 5.32 Amateurs should note that it is also likely that use of this spectrum will increase further in the future and this could have implications for amateur use of the bands in the medium to long term.
- 5.33 In order to manage coexistence of government systems with amateurs, it would be helpful for Ofcom to understand the number and location amateurs using the 2310 to 2350 MHz band.
- 5.34 In order to facilitate communication of any information related to future changes to other uses in this band, we are therefore requesting amateurs using 2310 to 2350 MHz register their use and provide contact details by emailing pssramateurs@ofcom.org.uk providing the following information:
- Name
 - Address (and location of use)
 - Call sign
 - Location of use
 - Frequency range uses
 - Type of use
 - Regularity of use (e.g. evenings and weekends; 24/7; occasional)
 - Transmit power (ie. EIRP)

Section 6

Availability of 2300 to 2302 MHz for amateur use

- 6.1 We note that amateur narrow band users will be impacted by additional restrictions from March 2014 around three ground locations above what we consulted on in the 2013 consultation.
- 6.2 We also note several amateurs raised the potential for access to 2300 to 2310 MHz in response to the consultation. While 2302 to 2310 MHz is in use and cannot be made available for amateurs, 2300 to 2302 MHz has been considered by Ofcom for potential award but there are no plans in place at present.
- 6.3 We have therefore decided to make 2300 to 2302 MHz available to amateurs who apply for a Notice of Variation (NoV) to their Amateur Radio Licence. These NoVs would be issued for a period of three years with a set end date there would be a rolling one year notice period to withdraw access to the band during the three year notice period or NoVs would not be renewed.
- 6.4 Amateurs should note that this 2 MHz of spectrum is occasionally used by PMSE wireless cameras and amateurs holding NoVs for this spectrum may occasionally be asked to switch off if the spectrum is required for PMSE use (e.g. for a particular sporting event or a national occasion where there is heavy demand for wireless camera spectrum).

Section 7

Next Steps

- 7.1 This section sets out the next steps in the process.
- 7.2 From the publication date of this statement, Amateur Radio Licence holders will have a minimum of 12 months' notice (under the provision for reasonable notice) that access to the release bands will end and the licences will be varied to that effect.
- 7.3 In due course we will commence the formal process required to vary amateur licences to reflect our decision to remove the release band and modify the terms of access to the adjacent bands from completion of the 12 month notice period.
- 7.4 Under the WT Act we are required to provide written notice setting out the changes we intend to make to the licence. Licence holders will be provided with at least one month in which to make representations about the manner in which we have implemented the changes described in the statement to the licence (noting that this document confirms our intention to remove access to the release and modify the terms of access to the adjacent bands).
- 7.5 As provided for by the WT Act, Ofcom then has a maximum of one month to consider representations and decide whether to proceed with the variation. We shall notify licensees (through a notice published on our website) of our decision within a week of making it. Licensees will then be provided with a new licence document reflecting the new terms and conditions.

Table 11: Timetable for next steps

April 2014	Guidance issued to amateurs
April 2015	End the 12 month notice period for removal of the release bands/modification of terms of access to the adjacent bands
April 2015	Earliest date at which varied licence terms and conditions will formally come into effect
From April 2015	New licence documentation provided to licensees

- 7.6 Ofcom issues licences to amateurs for the United Kingdom as well as Crown Dependencies – Jersey, Guernsey and the Isle of Man. The process is the same for UK and Crown Dependency applicants and the licences and their terms and conditions are consistent. Although the spectrum will not be released for new uses in the same way in the Crown Dependencies or Northern Ireland, we are proposing to keep these licences consistent with those issued to UK amateurs.
- 7.7 We will also consider amending the exemption regulations that allow overseas amateurs to operate under CEPT recommendations T/R 61-01.⁴²

⁴² See <http://legislation.gov.uk/ukxi/1988/2090/made>

Annex 1

Guidance to protect MoD systems using the 2.3 GHz band

A1.1 Amateurs are required to operate in such a way as to not cause interference to other lawful uses of the spectrum. This includes MoD uses. However as part of the preparations for release of spectrum in the 2.3 GHz band, MoD has undertaken some analysis of coexistence between amateurs and their own systems. This guidance note therefore provides some information to amateurs in order to help them ensure that harmful interference is not caused to MoD uses. Compliance with this guideline does not alter the overarching conditions in the licence to not cause interference.

Guidance for use of 2350 – 2390 MHz (the 2.3 GHz release band)

A1.2 This band is due to be removed from the Amateur Radio Licence in April 2015.

A1.3 As part of the MoD remediation of systems from this band it will be making temporary use of this band with immediate effect for systems not previously operating in this spectrum.

A1.4 Therefore Amateurs are advised to note MoD usage in the following areas:

- Boscombe Down (SU 172 404)
- Salisbury Plain (airborne receive)
- West Wales Airport (SN 247 494)
- Cardigan bay (airborne receive)

A1.5 MoD usage is typically during business day daylight hours only (daylight hours as defined by sunrise to sunset in the relevant location on any given day)

A1.6 Amateurs must therefore take whatever steps may be necessary when transmitting in the direction of the two ground sites and associated use areas locations to avoid causing interference to MoD systems. The MoD has not specified a protection threshold for these locations but these are expected to be similar to those specified in the 2310 to 2340 MHz band for Boscombe Down below.

Guidance for use of 2390 to 2450 MHz (the adjacent band)

A1.7 There are no proposed restrictions in this band.

Guidance for use of 2310 to 2350 MHz (the adjacent band)

A1.8 During and after their remediation is complete, MoD will make greater use of the 2310 to 2350 MHz band than they have done previously. In particular amateurs' attention is drawn to some aeronautical telemetry uses received at the following locations (Sites):

- St Kilda (NF 094 987)
- Aberporth (SN 247 518)
- Boscombe Down (SU 172 404)

St. Kilda and Aberporth

A1.9 Relevant MoD uses at each site are typical daylight hours on business days.

A1.10 MoD calculations indicate that to protect its systems using frequencies between 2310 and 2350 MHz when the Site is in use, amateurs must limit the received power at the Sites from their stations (including temporary or mobile use) to below the thresholds specified. The Site may be in use at short notice, so amateurs need to check before transmitting to establish whether the threshold is applicable for that Site.

A1.11 Amateurs should consider the effect of the receive antenna gain at Aberporth when determining whether their signals are below the thresholds as shown in the following table (absolute gain is included within thresholds in Table 12)

Table 12: St. Kilda and Aberporth site protection thresholds

In-band communication signal		
St Kilda		
Site Protection thresholds	Threshold for Signals in the 2310 to 2350 MHz band ^[1]	-145dBm / 5 MHz
	Height	370m above mean sea level
	Time where threshold applies	Daylight hours business days
Aberporth		
Site Protection thresholds	Threshold for Signals in the 2310 to 2350 MHz band ^[1]	-147dBm / 5 MHz
	Height	143m above mean sea level
	Time where threshold applies	Daylight hours business days
Note ^[1] : The protection thresholds are defined during the 'on' period of the transmit signal and referenced to a 0dBi receive antenna Daylight hours are defined as the times between sunrise and sunset for the relevant location and time.		

Table 13. Antenna discrimination present at Aberporth

Angle from grid north (degrees)	Gain with respect to peak (dB) at Aberporth
0 to ≤ 63	0
63 < to ≤ 64	-1
64 < to ≤ 65	-3
65 < to ≤ 66	-12.5
66 < to ≤ 72	-24
72 < to ≤ 75	-30
75 < to ≤ 243	-31
243 < to ≤ 246	-30
246 < to ≤ 255	-24
255 < to ≤ 256	-12.5
256 < to ≤ 257	-3
257 < to ≤ 258	-1
258 < to ≤ 360	0

Boscombe Down

- A1.12 Relevant MoD uses at this site are typically daylight hours on business days between May and October inclusive every year.
- A1.13 MoD calculations indicate that to protect their systems from amateur narrowband systems using frequencies between 2320 and 2322 MHz and general uses between 2310 and 2340 MHz when the Site is in use, amateurs must limit the received power at the Sites from their stations (including temporary or mobile use) to below the thresholds specified.
- A1.14 We have also provided thresholds for general use in 2340 to 2350 MHz.

Table 14. Boscombe Down site protection thresholds

In-band communication signal		
	Boscombe	
Site Protection thresholds	Threshold for Signals in the 2314 to 2330 MHz band ^[1]	-129dBm / carrier
	Threshold for Signals in the 2310 to 2314 and 2330 to 2340 MHz band ^[1]	-96dBm / carrier (for systems with BW <5MHz) -96dBm / 5 MHz (for systems with BW ≥5MHz)
	Threshold for Signals in the 2340 to 2350 MHz band ^[1]	-74 dBm / carrier (for systems with BW <5MHz) -74dBm / 5 MHz (for systems with BW ≥5MHz)
	Height	15m above ground level
	Time where threshold applies	Daylight hours business days May – October inclusive
<p>Note ^[1]: The protection thresholds are defined during the 'on' period of the transmit signal and referenced to a 0dBi receive antenna</p> <p>Daylight hours are defined as the times between sunrise and sunset for the relevant location and time.</p>		

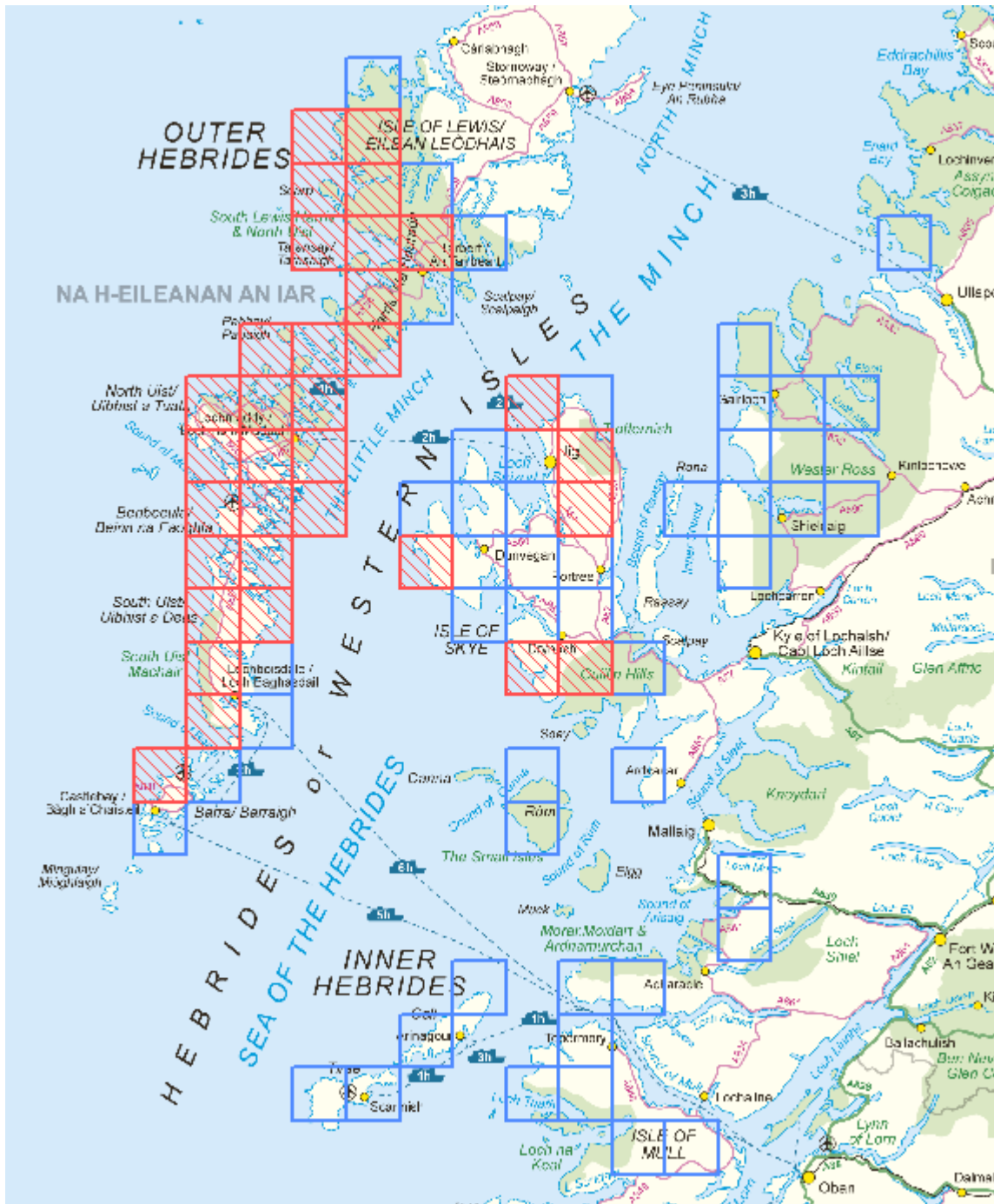
Illustration of affected areas

- A1.15 As an illustration of areas where an amateur may have to consider protecting the MoD system at St. Kilda, Aberporth or Boscombe Down when each Site is in use, two example amateur systems have been analysed (a narrow band and a lower power wider band data link transmission). Please note that the requirement applies to all amateur systems within the relevant bands. If an amateur station is operating with different parameters from those used in our analysis, then the amateur must consider whether it is appropriate to consider their signal strength incident at the MoD site (whether they are in the highlighted areas or not).
- A1.16 The MoD systems being protected are intermittent users of spectrum. The Radio Amateur systems are also typically intermittent users of the spectrum and are guided to operate at weekends and evenings when MoD systems are generally not being used. Therefore the risk of enhanced propagation conditions, such as ducting, is deemed to be low and in our analysis of impacted amateurs, ITU-R 452⁴³ has been used with a 50% time criteria.
- A1.17 However, in times of propagation lift, extra care may be needed to protect MoD systems. Therefore the use of a 10% time criterion may be more appropriate for these circumstances. If amateurs systems are transmitting more than intermittently then the use of the propagation model the use of 10% time criterion may also be more appropriate in determining if thresholds will be exceeded.
- A1.18 The examples identified are shown below:
- narrow band equipment at a transmit height of 10 m, using an EIRP of 40 dBW with 16 dB of antenna discrimination, i.e. it is pointing away from the MoD system (effective EIRP in the direction of the Site is 24 dBW) [blue and red squares];
 - data link equipment at a transmit height of 10m, using an EIRP of 17 dBW with 16 dB of antenna discrimination, ie it is pointing away from the MoD system (effective EIRP in the direction of the Site is 1dBW) [red squares only].
- A1.19 The figures below show an example where amateurs may need to consider additional mitigations in order to protect MoD systems around St. Kilda, Aberporth or Boscombe Down, based on the assumptions listed above. This is to provide an illustration of the areas where there could be restrictions in place. It is the responsibility of individual amateurs to ensure that they do not cause harmful interference irrespective of their location.

⁴³ www.itu.int/rec/R-REC-P.452/en

St Kilda

Figure 4. Illustration of land based areas around St. Kilda where mitigations are likely to be considered



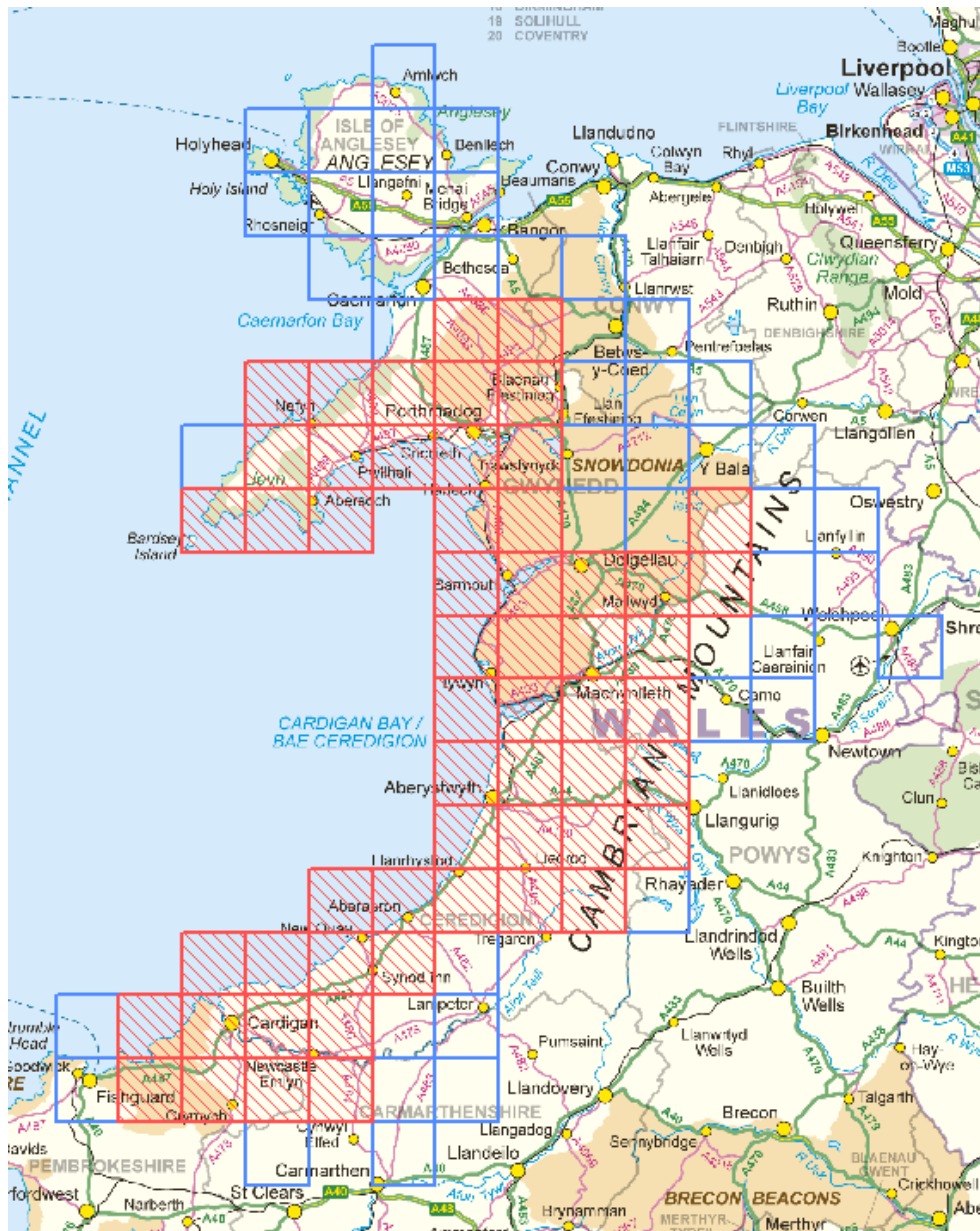
Ordnance Survey data © Crown copyright and database right 2012

A1.20 The 10Km² land based squares identified in the figure above are tabulated in the table below by the coordinates of the bottom left corner. For example the square NF60, has the bottom left hand co-ordinate of NF 600 000 and the top right hand co-ordinate of NF 700 100.

NA91	NC00	NF77	NF96	NG24	NG42	NG74	NG97	NM45
NA92	NF60	NF81	NF97	NG25	NG43	NG75	NL69	NM46
NB00	NF70	NF82	NF98	NG26	NG44	NG76	NL94	NM53
NB01	NF71	NF83	NG08	NG30	NG45	NG77	NM04	NM56
NB02	NF72	NF84	NG09	NG32	NG46	NG78	NM15	NM63
NB03	NF73	NF85	NG14	NG33	NG47	NG85	NM26	NM77
NB10	NF74	NF86	NG15	NG34	NG50	NG86	NM34	NM78
NB11	NF75	NF87	NG19	NG35	NG52	NG87	NM39	
NB20	NF76	NF95	NG23	NG36	NG65	NG95	NM44	

Aberporth

Figure 5. Illustration of land based areas around Aberporth where mitigations are likely to be considered



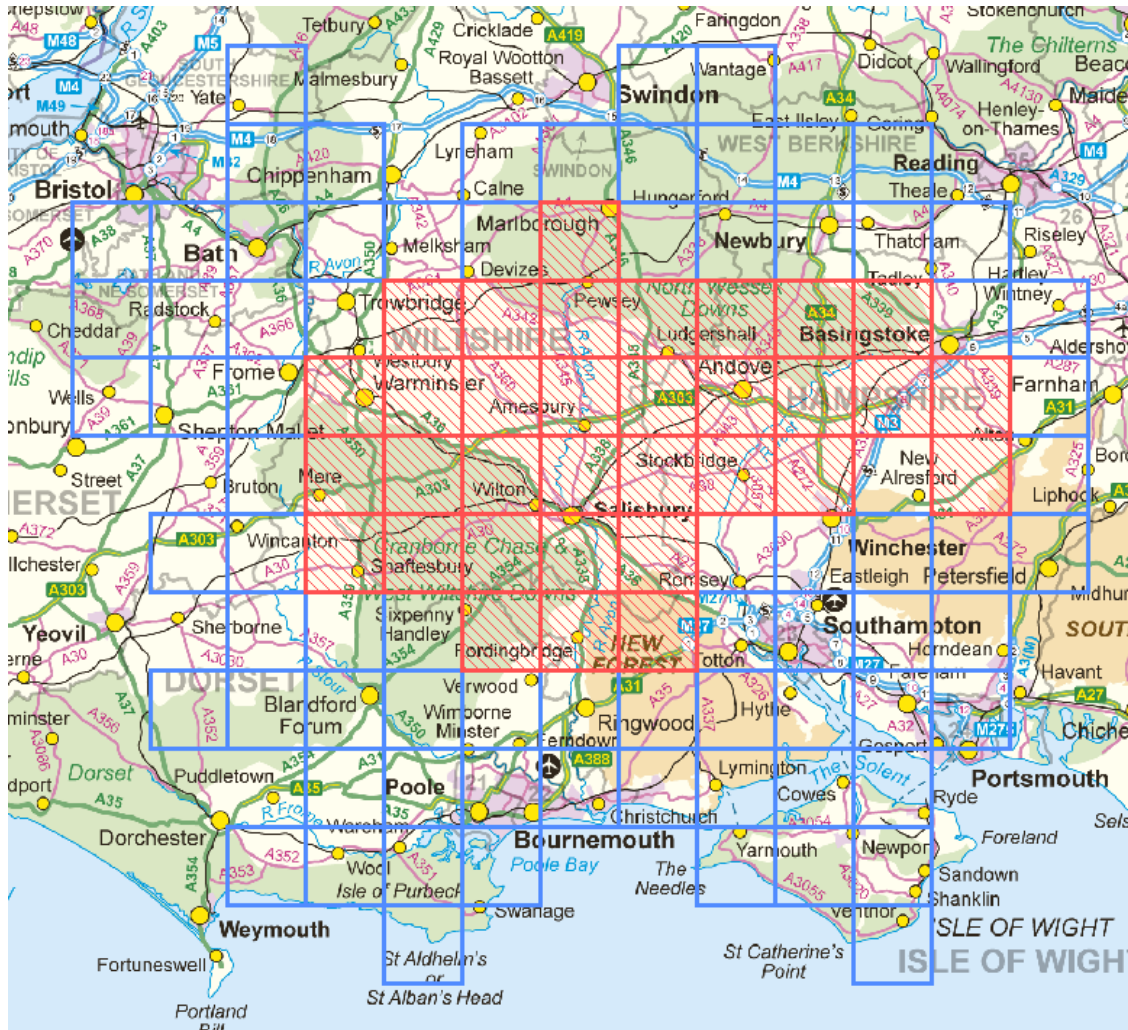
Ordnance Survey data © Crown copyright and database right 2012

A1.21 The 10Km² land based squares identified in the figure above are tabulated in the table below by the coordinates of the bottom left corner.

SH12	SH38	SH54	SH70	SH85	SJ20	SN33	SN56	SN86
SH13	SH43	SH55	SH71	SH90	SM93	SN34	SN57	SN87
SH22	SH44	SH56	SH72	SH91	SM94	SN35	SN58	SN88
SH23	SH45	SH57	SH73	SH92	SN03	SN36	SN59	SN89
SH24	SH46	SH58	SH74	SH93	SN04	SN42	SN66	SN99
SH27	SH47	SH60	SH75	SH94	SN13	SN43	SN67	SO09
SH28	SH48	SH61	SH76	SJ00	SN14	SN44	SN68	
SH32	SH49	SH62	SH80	SJ01	SN15	SN45	SN69	
SH33	SH50	SH63	SH81	SJ02	SN22	SN46	SN76	
SH34	SH51	SH64	SH82	SJ03	SN23	SN53	SN77	
SH36	SH52	SH65	SH83	SJ11	SN24	SN54	SN78	
SH37	SH53	SH66	SH84	SJ12	SN25	SN55	SN79	

Boscombe Down

Figure 6. Illustration of land based areas around Boscombe Down where mitigations are likely to be considered



Ordnance Survey data © Crown copyright and database right 2012

A1.22 The 10Km² land based squares identified in the figure above are tabulated in the table below by the coordinates of the bottom left corner.

ST78	ST74	ST91	SU07	SU24	SU38	SU54	SU74	SZ39
ST54	ST75	ST92	SU10	SU25	SU40	SU55	SU75	SZ48
ST55	ST76	ST93	SU11	SU26	SU41	SU56	SY78	SZ49
ST56	ST77	ST94	SU12	SU27	SU42	SU57	SY88	SZ57
ST60	ST80	ST95	SU13	SU28	SU43	SU60	SY89	SZ58
ST62	ST81	ST96	SU14	SU30	SU44	SU61	SY97	SZ59
ST64	ST82	SU00	SU15	SU31	SU45	SU62	SY98	
ST65	ST83	SU01	SU16	SU32	SU46	SU63	SY99	
ST66	ST84	SU02	SU17	SU33	SU47	SU64	SZ08	
ST70	ST85	SU03	SU20	SU34	SU50	SU65	SZ09	
ST71	ST86	SU04	SU21	SU35	SU51	SU66	SZ19	

ST72	ST87	SU05	SU22	SU36	SU52	SU72	SZ20
ST73	ST90	SU06	SU23	SU37	SU53	SU73	SZ29

Annex 2

Advice on protecting adjacent mobile broadband uses

- A2.1 The non-interference/non-protection convention of amateurs' secondary access also applies to adjacent frequencies. Therefore amateurs are required to avoid causing harmful interference to adjacent radio systems as well as other primary and secondary uses (e.g. the MoD, OGDs and PMSE).
- A2.2 This section highlights some key information from our consultation of the Amateur use of 2310 to 2450 and 3400 to 3475 MHz dated 11 June 2013:
- summary of advice given to different amateur uses to avoid causing interference to adjacent mobile broadband systems.
 - and a summary of some of modelling assumptions that were used in our analysis to protect future adjacent mobile broadband systems.
- A2.3 Our analysis showed that there are instances where there is a risk of interference from adjacent channel amateur use to LTE systems. The results indicate that it could be sensible for amateurs to apply additional mitigation techniques such as a reduction of transmit power, additional filtering and/or a frequency separation to avoid causing harmful interference to LTE systems that are nearby in location.
- A2.4 We believe that due to the low numbers of amateur users in the band, the intermittent nature of some transmissions and careful operation by the amateurs that adjacent channel use should continue with limited risk.

Summary of advice to protect LTE systems

- A2.5 Various systems were highlighted to us that typically use some of the adjacent bands to the 2310 – 2350 MHz, 2390 – 2400 MHz and 3400 – 3410 MHz. These uses may not be an exhaustive selection of future amateur use of the bands; however this provides information that may be applicable for similar systems.

Wide band systems including Amateur TV user equipment

- A2.6 The results indicated that it could be sensible for an amateur to apply additional mitigation techniques such as a reduction of transmit power, additional filtering and/or a frequency separation to avoid causing harmful interference to nearby LTE systems.
- A2.7 The measurements taken of amateur TV user equipment demonstrates the importance of filtering of user equipment, as there was a marked performance improvement of the out-of-band emissions with a filter present. Our calculations were based on the equipment that had a filter, as we are led to believe it is typical for the equipment to have a filter.
- A2.8 The results indicate that a separation of 10 MHz from the amateur TV channel centre to the LTE band edge may not be large enough to avoid causing unreasonable interference to LTE systems that are located nearby. Therefore it could be sensible for an amateur to apply additional mitigation techniques such as a

reduction of transmit power, additional filtering and/or a larger frequency separation to avoid causing harmful interference to LTE systems.

- A2.9 With suitable mitigations by the amateur such as limiting out-of-band emissions into the 2350 – 2390 MHz release band the separation distances to avoid desensitising systems can be reduced to less than a 1km.
- A2.10 It has been indicated to us, that TV user equipment is used very intermittently with peaks on activity evenings. If an amateur is transmitting 2 hours a week, they are transmitting 1.2% of the time. This intermittent use reduces the likelihood of potential interference occurring.

Narrow band communication systems including EME

- A2.11 Mitigation measures can be taken, including the use of lower amateur transmit powers or increased azimuth offsets between the antennas of the amateur and the LTE. Additional mitigation for EME systems may be achieved by the EME pointing higher than 10 degrees above the horizon and if a more directional transmitting dish is used.
- A2.12 It is an important assumption that the EME use is pointing at least 10 degrees above the horizon, as an EME antenna pointing at a lower trajectory and towards a LTE base station or user equipment would have a much higher risk of causing desensitisation.
- A2.13 It has been indicated to us that narrow band communications equipment including EME is used very intermittently with peaks on activity evenings and special events. If an amateur is transmitting 2 hours a week, they are transmitting 1.2% of the time. This intermittent use reduces the likelihood of potential interference occurring.
- A2.14 We note that the RSGB band plan on their website refers to EME potentially being used at 2390 MHz. We understand from our initial enquiries that this channel is not used in practice. We would have some concern if 2390 MHz was used for EME systems, as it is immediately adjacent to the band edge used by future LTE systems. It is likely that the selectivity of the LTE system would be more vulnerable to interference by a high power EME system on 2390 MHz with minimal frequency separation compared to the EME system at 2320 MHz with 30 MHz frequency separation.

Summary of modelling assumptions that were used in our analysis to protect future adjacent mobile broadband systems

- A2.15 Whilst new licences will ultimately be issued on a technology neutral basis, ongoing harmonisation of spectrum means it is likely that the released MoD spectrum will be used for wireless broadband such as using 4G Long Term Evolution (LTE) or LTE advanced technology and therefore based our analysis on these systems within our consultation document Amateur use of 2310 to 2450 and 3400 to 3475 MHz⁴⁴.
- A2.16 The susceptibility of LTE systems were assessed by considering the interference power needed to cause a specified desensitisation. This is a common way to calculate the potential interference effect of another system on LTE systems. The desensitisation levels represent a noise rise at the base station or user equipment so that the capacity, throughput and the maximum range of the cell are reduced.

⁴⁴ <http://stakeholders.ofcom.org.uk/binaries/consultations/public-sector-spectrum-release/summary/condoc.pdf>

A2.17 Below in Table 15 and Table 16 are the parameters we assumed for LTE base stations for our compatibility modelling.

Table 15: General parameters for LTE base stations

EIRP	61 dBm / 5 MHz
Antenna gain	18 dBi
Antenna height	20 m
Interference to cause specified 1 dB desensitisation	-108 dBm / 5 MHz (noise figure 5 dB)

A2.18 The selectivity performance requirements for wide area base stations, as defined in 3GPP TS 36.104 v11.3.1, are summarised below in Table 16.

Table 16: Selectivity parameters of LTE base station receivers

Operating band	Centre Frequency of Interfering Signal, MHz	Selectivity of base station receiver, dB
2300 – 2400 MHz	First adjacent channel	43.5
and	Beyond first adjacent channel within the operating band	52.5
3400 – 3600 MHz	> 20 MHz out of operating band (CW)	80.5

A2.19 In practice, equipment often performs better than the standard. The ACS value of 52.5 dB is specified for an LTE system being interfered with by a 5 MHz LTE system within the operating band. The LTE may be more robust to interference in practice from a lightly modulated signal that is less than 3 kHz in bandwidth, as a higher powered narrow band signal is likely to cause fewer harmonics and thus interfere with only a limited number of resource blocks than a wider band interferer and the error correction of the system may well be able to cope better.

A2.20 The 3GPP TS 36.104 v11.3.1 standard has a conformance value of 80.5 dB for CW interference \pm 20 MHz outside of the operating band (28 dB improvement over 52.5 dB). It is possible that the selectivity performance of the base station to a CW like signal, such as the emissions from the narrow band systems, may tend to the 80.5 dB value, particularly if additional filtering of the licensed band only is applied to the base station. However, this may be a more appropriate assumption for narrow band systems around 2320 MHz that are 30 MHz from the release band edge than narrow band systems around 3400.9 MHz that are only 9 MHz from the release band edge.

A2.21 ECC Report 172 states that the equipment performance can actually be much better than the standards: “In practice, it is common for infrastructure vendors to offer products with significantly better performance for various reasons such as to accommodate special sharing situations in various markets or for deployment in co-siting situations or for improving the interference behaviour in specific sites.”

A2.22 We think it is likely – based on the European work on a Licence Spectrum Access (LSA) framework designed to facilitate greater spectrum sharing in bands including the 2300 MHz band – that equipment vendors or operators may choose to have improved receiver performance of their base stations in order to facilitate greater spectrum sharing in the band.

- A2.23 It is likely that greater improvements on selectivity of base stations will be achieved with greater frequency separation from the LTE channel edge. Draft ECC Report “Least Restrictive Technical Conditions suitable for Mobile/Fixed Communication Networks (MFCN), including IMT, in the frequency bands 3400-3600 MHz and 3600-3800MHz” states, “for a macro cell base station, a ceramic filter with a bandwidth of 20 MHz can achieve 50 dB suppression within 5 MHz offset from the channel edge.” “For 100 MHz channel bandwidth, 10 MHz roll-off region is required to achieve this suppression”. Therefore it may be more appropriate to consider improvements in the performance of the selectivity of LTE systems below 2345 MHz, above 2395 MHz, and below 3405 MHz.
- A2.24 Below in Table 17 and Table 18 are the parameters assumed for LTE user equipment for our compatibility modelling.

Table 17: General parameters for LTE user equipment

Antenna gain	0 dBi
Antenna height	1.5 m
Body loss	3 dB
Interference to cause specified 3 dB desensitisation	-98 dBm / 5 MHz (noise figure 9 dB)

- A2.25 The selectivity performance requirements for user equipment, as defined in 3GPP TS 36.101 v11.3.1, are summarised below in Table 18.

Table 18: Selectivity parameters of LTE user equipment receivers

Operating band	Centre Frequency of Interfering Signal, MHz	Selectivity of user equipment receiver, dB
2300 – 2400 MHz and 3400 – 3600 MHz	First adjacent channel	33
	Beyond first adjacent channel within the operating band	45

- A2.26 It is also expected that the selectivity performance of user equipment may be better than the standards.
- A2.27 Ofcom has previously commissioned some measurements into 2.1 GHz user equipment⁴⁵. The user equipment measured performed up to 30 dB better than the standards specified.

⁴⁵ <http://stakeholders.ofcom.org.uk/binaries/consultations/2ghzregsnotice/annexes/era.pdf>