Application for a variation to 3G licences (and consequent proposal to vary draft 2GHz MSS/CGC Base station licences)

Consultation

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Contents

Section 1

Executive Summary

1.1 Vodafone (UK) Limited has submitted a request to Ofcom to vary its Wireless Telegraphy Third Generation Mobile Licence (3G) to increase the permitted power limits. The request has been discussed with other 3G licensed operators, all of whom have indicated that they would support the proposal and would like to benefit from the same condition being applied across the licence class. We are therefore consulting on the variation of all five existing 3G licences, rather than on the variation of Vodafone's licence alone.

1.2 In our July 2009[1] Statement on authorisation of terrestrial mobile networks as a complement to mobile satellite systems operating in the frequency bands 1980 – 2010 MHz and 2170 – 2200 MHz (referred to as complementary ground component, CGC or, in this case, '2 GHz MSS/CGC'), we noted that any change to the permitted power limits for 3G base stations would also be relevant for 2 GHz MSS/CGC base stations. We are therefore also considering applying the higher power limit to CGC base station licences.

1.3 In assessing the proposal, Ofcom has taken into consideration likely developments in 3G engineering and is consequently suggesting that an increase to 68dBm EIRP, rather than the requested 65dBm would be appropriate (as compared with the current limit of 62dBm) in order to remove the potential need for further consultation in the near future.

1.4 This document assesses the request and in doing so:

- provides background information on the 3G and the 2 GHz MSS/CGC licences;
- sets out Ofcom's statutory and policy framework;
- considers the engineering effects of increased power levels, including the potential for interference to other users; and
- considers the request in light of Ofcom's statutory and other legal duties.

1.5 The main points of our pre-consultation assessment are that:

- increasing the power limits should not change the practical usability of adjacent spectrum to any significant extent due to increased interference (e.g. to PMSE wireless cameras); and
- it would be appropriate to offer the variation, if granted, to all five 3G licensees and to incorporate the higher power limit in future 2 GHz MSS/CGC base station licensees.

1.6 The request did not ask for changes to the out-of-band or spurious emissions limits for 3G bases stations and we are specifically not consulting on allowing higher limits for these. If the variation is allowed, we suggest that these limits are capped at their current levels.

[1] http://www.ofcom.org.uk/consult/condocs/cgcs2/statement/2ghzstatement.pdf

1.7 Ofcom wishes to make clear that we have not reached a decision on these matters and is seeking stakeholders' views on the request and on our pre-consultation assessment. We will carefully consider any arguments and comments made in response to this consultation before reaching a final decision.

1.8 We are asking stakeholders to consider the following questions when responding to this consultation:

Are there any reasonable grounds why Ofcom should not grant the request to vary the five Wireless Telegraphy Third Generation Mobile Licences by increasing the permitted maximum in-band EIRP to 68dBm as soon as practicable? If so, please explain your reasoning for this.

Are there any reasonable grounds why Ofcom should not also apply the increased permitted maximum in-band EIRP to future 2 GHz MSS/CGC licences? If so, please explain your reasoning for this.

Section 2

Introduction

2.1 This document consults on Ofcom's consideration of a request from 3G operators to vary their 3G licences. Vodafone submitted a request to Ofcom on 19 November 2008 to vary its licence to increase the allowed power levels. Subsequently, following discussion with the four other 3G licensees, (Telefónica O2, Orange, Hutchison 3G and T-Mobile), they too have asked to be included in the variation request. Although the variation request was submitted in late 2008, we subsequently agreed with the 3G operators, once the Digital Britain process got underway, that we would delay consideration of its variation request for reasons of resource prioritisation.

2.2 Ofcom noted a similar power request in the responses to its consultation on authorisation of 2 GHz MSS/CGC base stations and noted the future possibility for such a variation in our July 2009 Statement on 2 GHz MSS/CGC base station licence terms and conditions

2.3 The background to the request is discussed separately in Annex 6.

Ofcom's approach to spectrum management

2.4 Our general approach to spectrum management has been set out in a number of documents, including:

- the Spectrum Trading consultation document published in November 2003 ('Trading Consultation Document') and Statement published in August 2004 ('Trading Statement')[2]; and
- the Spectrum Liberalisation consultation document published in September 2004 ('Liberalisation Consultation Document') and Statement published in January 2005 ('Liberalisation Statement')[3].
- the Spectrum Framework Review consultation document published in November 2004 ('SFR') and Statement published in June 2005 ('SFR Statement')[4;]

Ofcom's liberalisation policy

2.5 Ofcom's general policy is to set technical restrictions that are the minimum necessary to provide adequate protection against harmful interference. This is because optimal use of the radio spectrum is more likely to be secured if users decide, rather than Ofcom dictates, what technology to use or service to provide in a particular frequency band. Imposing the minimum necessary constraints will increase users' flexibility and freedom to respond to changing conditions and to make best use of the valuable spectrum resource.

2.6 In our Spectrum Liberalisation Guidance Notes[5] we provided information on the procedures for reducing or removing licence restrictions on spectrum use. We said

[2] http://www.ofcom.org.uk/consult/condocs/spec_trad/
[3] http://www.ofcom.org.uk/consult/condocs/liberalisation
[4] http://www.ofcom.org.uk/consult/condocs/sfr

that some requests for complex or novel variations might require detailed analysis, consultation with third parties and international co-ordination. In some cases Ofcom may find that liberalisation raises concerns about spectrum efficiency and competition that need to be addressed through regulatory intervention. One such case may be the liberalisation of 2G spectrum licences.

2.7 Ofcom has previously consulted on the general subject of the "Application of spectrum liberalisation and trading to the mobile sector[6]" and in February 2009 issued a further consultation on the topic[7] which closed on 1 May 2009. Subsequently, the Government's report "Digital Britain"[8] which was published following the interim report of the Independent Spectrum Broker (ISB) also considered the future policy for spectrum licences, including 3G. The Government is currently consulting[9] on a draft Direction to Ofcom to implement the recommendations of the ISB's final report.

2.8 The difference between the subject matter of those consultations and this request by the 3G operators to increase the permitted power limits in their licences is that the wider consultations are on longer-term general principles concerning the overall rights and obligations conferred by spectrum licences; the current request concerns a specific technical / engineering matter that it wishes to be addressed in the course of operational business.

Matters covered in this document

2.9 This document is structured as follows:

- Section 3 sets out background to the 3G licences, the current permitted power levels and the basis under which they were set and our consideration of the variation request;
- Section 4 sets out background to the 2 GHz MSS/CGC Base station licences;
- Section 5 sets out our statutory duties and explains our approach to spectrum liberalisation and the variation of licences;
- Section 6 sets out our assessment of the potential for interference from increasing the maximum permissible power level in the 3G operators' licences;
- Section 7 sets out our assessment against our statutory and other legal duties of the variation of 3G licences to permit a higher in-band power level.
- The annexes include a template copy of the current 3G licence (which is common to all operators), including the proposed changes to it if the variation is made and an impact assessment and the background to the variation.

[5] http://www.ofcom.org.uk/radiocomms/ifi/trading/libguide/

[6] See http://www.ofcom.org.uk/consult/condocs/liberalisation
[7] See http://www.ofcom.org.uk/consult/condocs/spectrumlib/
[8] See http://www.culture.gov.uk/what_we_do/broadcasting/5631.aspx
[9] See http://www.berr.gov.uk/consultations/page53062.html

Section 3

Background information on 3G Licences

3.1 This section describes the regulatory position on the 3G licences and the spectrum bands whose use they authorise.

3G – international and UK regulatory position

3.2 Decision 128/1999/EC of the European Parliament and of the Council of 14th December 1998 on the co-ordinated introduction of a third-generation mobile and wireless communications system (UMTS) in the Community (the "UMTS Decision") was intended to facilitate the rapid and co-ordinated introduction of compatible UMTS networks and services in the European Community on the basis of internal market principles and in accordance with commercial demand. It required Member States to establish an authorisation system for UMTS no later than 1st January 2000

3.3 In April 2000, the Radiocommunications Agency of the UK Department of Trade and Industry, auctioned five spectrum packages for third generation mobile communications which are held by the five current mobile network operators, Hutchison 3G, Telefónica O2, T-Mobile, Orange and Vodafone.

3.4 These spectrum packages are in the frequency ranges 1900 – 1980MHz and 2110 – 2170MHz. Details of the technical standards and spectrum for 3G are given at Appendix A to the 3G Information Memorandum[10].

3.5 The maximum power levels in the original licences were set with reference to the radio equipment that was being developed commercially at that time. 3G standards and technology have evolved significantly since then and the base stations that are now commercially available are able to utilise higher powers than older models.

3.6 In section 2.2.11 of the Information Memorandum for the 3G Auction[11] it was stated that:

"...In the light of operational experience and in line with further developments in the 3G standards, it may subsequently be found that one or more of the emissions limits stipulated in the WT Act Licences are too stringent. ... If it is subsequently felt by the RA and licensees that the limits may be relaxed, they will be."

3.7 It has been noted that other European countries (such as Finland, Sweden, Germany and France) do not place any specific per carrier limits on radiated power in operator licences and that adjacent channel interference does not appear to have been experienced.

3.8 According to information from the 3G operators, it is not envisaged that the power would be employed at all transmitter sites, indeed current cellular planning methodology usually results in transmitters being run at less than the maximum permitted level. Vodafone has told Ofcom that permitting a higher maximum licensed power would enable it (and other operators) to optimise their networks allowing the

[10] See http://www.ofcom.org.uk/static/archive/spectrumauctions/3gindex.htm
[11] See http://www.ofcom.org.uk/static/archive/spectrumauctions/3gindex.htm

flexibility to serve more effectively a wider area and community with better in-building penetration.

3.9 It will remain a requirement for all installations to comply with the maximum permitted emission levels set by the International Committee for Non-Ionising Radiation Protection (ICNIRP). Ofcom's measurement of representative samples of cellular base stations[12] has demonstrated that, even in the vicinity of cellular masts, measurements are consistently found to be below, and in the majority of cases very significantly below, these levels. The size of power increase being proposed in this consultation is unlikely to affect significantly this position in relation to ICNIRP.

[12] See http://www.ofcom.org.uk/sitefinder/audit_info

Section 4

Background information on 2 GHz MSS/CGC Base station Licences

2 GHz Land Mobile Satellite Services Background

4.1 The European Commission has adopted Decisions related to the authorisation of new mobile satellite services (MSS) in the 2 GHz MSS bands (1980-2010 MHz and 2170-2200 MHz). These allow the operation of terrestrial mobile networks to provide services on the ground that are complementary to the MSS operation. These are known as the MSS Complementary Ground Component (2 GHz MSS/CGC), or CGC for short.

4.2 The first, an RSC Decision 2007/98/EC, harmonised use of radio spectrum in the 2 GHz frequency bands for the implementation of systems providing MSS. Decision 626/ 2008/EC was adopted jointly by the European Parliament and Council and provides a process for the selection and authorisation of systems providing mobile satellite services (MSS). The third Decision 2009/449/EC completed this process under which two MSS operators – Inmarsat Ventures Limited and Solaris Mobile Limited – have been selected and will be authorised in accordance with national procedures.

4.3 In preparation for the licensing of these new services within the UK, we consulted on a number of issues including the power limit for the CGC base stations. In the second consultation of 3 November 2008, it was proposed that the limit should be 61dBm/5MHz EIRP. Some responses to that consultation proposed higher powers for CGC base stations, up to 69 dBm/5MHz EIRP. Ofcom's Statement on the licensing of 2 GHz MSS/CGC of 17 July 2009[13] noted at the time that this was significantly above the existing limits of 3G operations in adjacent bands and, as such, could cause difficulties of asymmetric co-ordination with adjacent users and therefore we were unable to agree with this proposal at that time. However we indicated that in responding to a request to raise the EIRP level for 3G mobile networks we would consider the requests together.

4.4 We therefore propose in this consultation document that if the request for an increase in 3G base station power is granted, we will also similarly vary the proposed terms and conditions for in-band power for CGC base station draft licences developed by Ofcom in its July 2009 consultation statement. When granted, these licences would then authorise maximum powers comparable to those authorised by 3G licences.

[13] http://www.ofcom.org.uk/consult/condocs/cgcs2/statement/2ghzstatement.pdf

Section 5

Ofcom's duties and functions and spectrum liberalisation

5.1 This section provides a brief overview of the main UK and European Union (EU) legislative provisions relevant to wireless telegraphy licensing and to the requested variation. It does not provide a comprehensive statement of all legal provisions which may be relevant to Ofcom's functions and to wireless telegraphy licensing.

5.2 This section also explains Ofcom's approach to spectrum liberalisation.

Ofcom's general duties

5.3 Section 3 of the Communications Act 2003 (the '2003 Act') states the general duties of Ofcom. Under section 3(1) it is the principal duty of Ofcom in carrying out its functions:

- 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.

In doing so, Ofcom is required to secure (under section 3(2)):

- the optimal use for wireless telegraphy of the electro-magnetic spectrum;
- the availability throughout the UK of a wide range of services;
- the availability throughout the UK of a wide range of TV and radio services which (taken as a whole) are both of high quality and calculated to appeal to a variety of tastes and interests;
- the maintenance of a sufficient plurality of providers of different television and radio services;
- the application in the case of all television and radio services of standards that provide adequate protection to members of the public from the inclusion of offensive and harmful material, unfair treatment in programmes and unwarranted infringement of privacy;

and to have regard to certain matters which include:

- principles of better regulation (section 3(3));
- the desirability of promoting competition (section 3(4)(b));
- the desirability of encouraging investment and innovation (section 3(4)(d));
- the desirability of encouraging availability and use of broadband services throughout the UK (section 3(4)(e));

- the different needs and interests of persons in different parts of the UK (section 3(4)(l)).

5.4 The management of the UK radio spectrum is governed by the European Communications Directives, which aim to harmonise the regulation of electronic communications networks and services throughout the EU. Section 4 of the 2003 Act requires Ofcom when carrying out its spectrum functions to act in accordance with the "six Community requirements" set out in that section when managing the wireless spectrum in the UK:

- The requirement to promote competition (section 4(3));
- The requirement to secure that Ofcom's activities contribute to the development of the European internal market (section 4(4));
- The requirement to promote the interests of all persons who are citizens of the EU (section 4(5));
- The requirement to act in a technology neutral way (section 4(6));
- The requirement to encourage to such extent as appropriate the provision of network access and service interoperability (section 4(7)); and
- The requirement to encourage such compliance with international standards as is necessary for (a) facilitating service interoperability; and (b) securing freedom of choice for the customers of communications providers (sections 4(9) and (10)).

Ofcom's duties when carrying out its spectrum functions

5.5 In carrying out its spectrum functions it is the duty of Ofcom (under section 3 of the Wireless Telegraphy Act 2006 (the '2006 Act') to have regard in particular to:

- the extent to which the spectrum is available for use or further use, for wireless telegraphy;
- the demand for use of that spectrum for wireless telegraphy; and
- the demand that is likely to arise in future for the use of that spectrum for wireless telegraphy.

It is also the duty of Ofcom to have regard, in particular, to the desirability of promoting:

- the efficient management and use of the spectrum for wireless telegraphy;
- the economic and other benefits that may arise from the use of wireless telegraphy;
- the development of innovative services; and
- competition in the provision of electronic communications services.

5.6 Where it appears to Ofcom that any of its duties in section 3 of the 2006 Act conflict with one or more of its general duties under sections 3 to 6 of the 2003 Act, priority must be given to its duties under the 2003 Act.

Ofcom's spectrum functions

5.7 Ofcom's powers to carry out these functions are set out in the 2006 Act. In summary Ofcom has the following powers:

- Section 8(1) of the 2006 Act gives Ofcom the power to grant licences to establish or use a wireless telegraphy station and to install or use wireless telegraphy apparatus. Ofcom has a general discretion under this provision to decide how to award a licence, including for example whether to use an auction mechanism (provisions in respect of which are set out in section 14 of the Act);

- Section 9 of the 2006 Act gives Ofcom the power to grant wireless telegraphy licences subject to such terms as Ofcom thinks fit;

- Schedule 1(6) of the 2006 Act gives Ofcom a general discretion to revoke or vary any wireless telegraphy licences by serving a notice in writing on the licence holder or by way of general notice to licensees in a class.

5.8 Ofcom has duty (set out section 9(7) of the 2006 Act which reflects Article 6 of the EU Authorisation Directive 2002/20/EC) to ensure that wireless telegraphy licence conditions are objectively justified in relation to networks and services to which they relate, non-discriminatory, proportionate and transparent. Ofcom considers that this obligation is ongoing and must be assessed against market circumstances and the state of technology development at the time.

5.9 Ofcom therefore has broad discretion under Schedule 1(6) of the 2006 Act to agree to vary licences but legal rules operate to limit that discretion. These legal rules include the following, in summary:

- UK obligations under EU law or international agreements where use of spectrum has been harmonised: Ofcom will not agree to remove restrictions from licences or other changes that would conflict with the UK's obligations under international law. This includes changes in use or technology that would contravene binding Community measures, such as directives or harmonisation measures adopted under the Radio Spectrum Decision (676/2002/EC) and ITU Radio Regulations;

- Ofcom must comply with any direction from the Secretary of State under section 5 of the 2003 Act or section 5 of the 2006 Act;

- Ofcom must act in accordance with its statutory duties, including the duty to ensure optimal use of the spectrum, the duty mentioned in paragraph 4.7 and obligations under the Authorisation Directive;

- General legal principles, which include the duties to act reasonably and rationally when making decisions and to take account of legitimate expectations;

- Specifically with regard to certain Wireless Telegraphy Act licences, including Third Generation Mobile, that are granted to communications service providers, the power to revoke or vary may be fettered, except in certain circumstances including at the request or with the consent of the licensee.

Spectrum liberalisation

5.10 The radio spectrum is a finite resource of considerable economic and social value. Ofcom where possible is moving to market-based mechanisms, including trading and

liberalisation, that empower spectrum users to take more decisions on spectrum. Ofcom believes that this is likely to lead to optimal use of the radio spectrum.

5.11 Liberalisation, the removal or reduction of restrictions in licences, is central to this approach to spectrum management. Together with incentive pricing, auctions and spectrum trading, it makes spectrum available on a more flexible and dynamic basis for new wireless applications. It is also consistent with Ofcom's aim to deregulate or simplify regulation wherever possible.

5.12 The Liberalisation Consultation Document made clear that Ofcom has no intention of allowing an interference free-for-all to develop and would continue to investigate and resolve interference, although users would be expected to assume greater responsibility for planning their use of spectrum in accordance with the enhanced freedom that liberalisation would give them. The Document also explained the other constraints within which liberalisation would operate, including the legal rules described above that limit Ofcom's discretion to vary licences.

5.13 In considering requests for the variation of individual licences the factors that Ofcom will take into account include:

- impact on spectrum users in adjacent bands;
- benefits for consumers and citizens;
- optimal spectrum use;
- impact on competition;
- objective justification for licence conditions; and
- legal considerations that limit Ofcom's discretion to vary licence conditions.

Section 6

The potential engineering effects increasing the maximum power levels for 3G and 2 GHz MSS/CGC Base stations

6.1 This section sets out Ofcom's provisional conclusions on the licence variation that has been requested and the engineering effects that would follow from increasing the power levels in 3G licences and in the prospective 2 GHz MSS/CGC licences, including the potential for impact on users in adjacent bands.

The request

6.2 The 3G licences (and prospective 2 GHz MSS/CGC licences) authorise network operators to establish, install and use radio transmitting and receiving stations and/or radio apparatus as described in the licence schedule (the 'Radio Equipment'). The licences[14] currently permit 3G base stations to transmit up to a maximum of 62dBm EIRP. It has been requested that this limit be increased to 65dBm EIRP to make the most effective use of currently available base station technology.

6.3 Ofcom understands that 65dBm represents the current practical limit of available 3G products, under standard assumptions about base station antenna gain and amplifier performance. It is likely that technology will further develop in future. We are therefore consulting on proposals to increase the base station power limits in the 3G licences and in the prospective CGC base station licences to 68 dBm EIRP in order to remove the need for further, unnecessary, consultations. We believe this higher limit would be justified on the basis of our technical analysis which demonstrates that it will make no practical difference to the operation of equipment in adjacent bands (wireless cameras) as a consequence of increased interference.

6.4 According to information from the 3G operators, it is not envisaged that the higher power would be employed at all transmitter sites. Indeed current cellular planning methodology usually results in transmitters being run at less than the maximum permitted level, which also prolongs their serviceable lifetime. Vodafone has told Ofcom that permitting a higher maximum licensed power would enable it (and other operators) to optimise their network, allowing the flexibility to serve more effectively a wider area and community with better in-building penetration.

Adjacent spectrum users

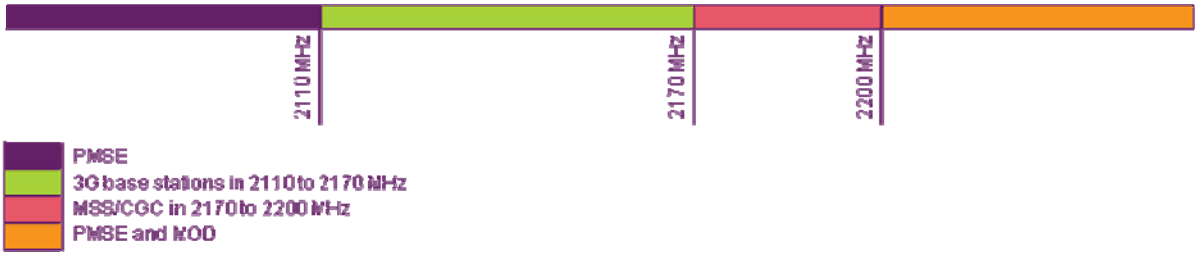
6.5 We are not proposing to change the limits in the 3G licences and prospective 2 GHz MSS/CGC licences on emissions in the out of band and spurious domains. However, it is still possible that there could be an impact from increased in-band 3G power levels on adjacent users outside the 3G and CGC bands due to the selectivity of their receivers.

6.6 The 3G base stations transmit in the 2110 to 2170 MHz band and prospective CGC base stations will transmit in the 2170 to 2220 MHz band. We therefore need to

14 http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/broadband/cellular/3g/3g_licence_temp.pdf

consider the potential implications for adjacent users at the 2110 MHz and 2200 MHz boundaries as illustrated below in Figure 1.

Figure 1. Spectrum Adjacencies for the bands from 2110-2200 MHz



6.7 PMSE is the adjacent use at each of these boundaries and the implications of increased 3G and CGC base station power limits on adjacent PMSE use has therefore been the main focus of our analysis, as summarised below.

6.8 Ministry of Defence (MOD) also use the band above 2200 MHz. The protection of this MOD use from prospective CGC use below 2200 MHz was addressed in the second consultation and statement on proposals for authorisation of 2 GHz MSS CGC[15]. The main issue in this context is related to out of band and spurious emissions and we are not proposing to change these. The proposed increase to the in-band CGC power limit is expected to have minimal effect.

Impact on PMSE

6.9 PMSE is currently subject to some interference in the channels immediately adjacent to the 3G base station spectrum below 2110 MHz. Similarly, if and when CGC stations are deployed, PMSE use will be subject to some interference in the channels immediately above 2200 MHz. This section looks at how a change in the power limits in the 3G licences (and in the prospective 2 GHz MSS/CGC licences) could be reflected in a change to the interference levels received by PMSE equipment.

6.10 Although the analysis is very similar in respect of the PMSE / 3G adjacency at 2110 MHz and the PMSE / CGC adjacency at 2200 MHz, there out some minor differences in relation to the CGC out-of-band emission limits and the frequency separation between the closest CGC and PMSE channels, and so annexes 7 and 8 summarise our analysis separately for each of these adjacencies. But the provisional conclusions are, to all intents and purposes, the same in respect of these two each adjacencies.

6.11 The assessment of the potential change in the interference from 3G and CGC into PMSE receivers summarised in these annexes uses the methodology established in previous studies[16] of interference into PMSE that were carried out in preparation for the award of spectrum at 2010 to 2025 MHz. It is based on a calculation of 3G adjacent channel leakage power ratio (ACLR) and PMSE receiver selectivity. A minimum coupling loss calculation is then used to determine whether additional isolation is needed and the necessary separation distances.

[15] http://www.ofcom.org.uk/consult/condocs/cgcs2/cgcs2.pdf
[16] http://www.ofcom.org.uk/consult/condocs/2ghzawards/masonresearch.pdf

6.12 When considering the potential impact of a higher 3G / CGC power limit, it is helpful to distinguish between:

- the first adjacent channels (centred on 2105 MHz and 2205 MHz) which are immediately adjacent to the two relevant boundaries; and
- the second adjacent channels (centred on 2095 MHz and 2215 MHz) which are once-removed from the relevant boundaries.

6.13 In the case of the first adjacent channel, our analysis indicates that PMSE receivers suffer significant interference from adjacent base stations at the current permitted power level, resulting in the need for large separation distances. Using the COST-Hata propagation model we have calculated a current minimum separation distance of 2.1km between wireless camera receivers using 2105 MHz and 3G base stations. If 3G base station power is increased to 68dBm EIRP, this distance increases from 2.1km to 2.9km.

6.14 Filtering can reduce the minimum separation distances; but the narrow frequency separation between 3G and the first adjacent PMSE channel will limit their effectiveness. With filtering in place the minimum separation distance at the current permitted 3G power limit would be 1.7km. The effect of increasing the permitted 3G power limit would be to increase this distance from 1.7km to 1.8km. These distances are an improvement over the unfiltered case but would still cause significant practical difficulties for PMSE use of this channel.

6.15 Results for PMSE / CGC adjacency at 2200 MHz were broadly similar as regards the implications of higher permitted CGC power limit: the increase in the power limit to 68dBm would increase the minimum separation distance from 2km to 2.6km without filtering, and from 1.5km to 1.6km with channel filters.

6.16 Although this analysis implies some modest diminution of the areas in which wireless cameras might be used, we understand that the wireless camera community already avoids the use of the first adjacent channel. We therefore conclude that this is likely to be of little or no practical impact.

6.17 Turning to the second adjacent channel, our analysis indicates that even at current permitted 3G / 2 GHz MSS/CGC power it would be hard to make practical use of this channel without filtering. Indeed, responses to previous Ofcom consultations have confirmed that PMSE channel filters are widely in use in this band. Without filters, the COST-Hata propagation model predicts a current minimum separation distance of 1.9km between wireless camera receivers using 2095 MHz and 3G base stations. This increases to 2.8km for the higher 3G power.

6.18 When PMSE channel filters are employed, the separation distance on the second adjacent channel is 543m at current 3G powers. At the higher 3G power limit this separation distance is increased by 4m to 547m. The practical impact of this change is likely to be minimal.

6.19 For the second adjacent PMSE channel at 2215 MHz, the minimum separation distance from a CGC macro base station in the absence of channel filtering is 1.7km at current CGC power limits and this would increase to 2.5km at the CGC higher power limit. With channel filtering the minimum separation distances are 137m at current CGC powers or 190m with increased CGC powers. In practical terms, the current minimum separation distances already present some siting difficulties for

wireless camera use but the difference due to the 3G/CGC power increase is unlikely to lead to current locations becoming unusable.

6.20 The impact of 3G and CGC base station power limits on channels further away from boundary is expected to be smaller still (although we have not sought to quantify these effects, in part because the 3G and CGC specifications and licence requirements do not provide any guidance on the level of emissions to be expected further out-of-band).

6.21 Some additional results were derived for temporary point-to-point links with receivers sited on rooftops or masts above surrounding obstructions. These links typically have high gain, but also highly directional antennas. Consequently, in the case where a 3G base station is located in the direction of highest gain of the PMSE receiver antenna, none of the assumptions in the study would result in a practical separation distance. For example, at current 3G power, with PMSE channel filtering and use of the second adjacent channel, the separation distance is calculated to be over 18km. Given this high starting point, any increase in this distance is unlikely to lead to a practical deterioration in the usability of the channel for this application.

Conclusions on impact on adjacent users

6.22 The main consideration in relation to the proposed increase in 3G and CGC base station permitted power limits is the impact on adjacent use by PMSE wireless cameras below 2110 MHz and above 2200 MHz. Our conclusion from the analysis presented in Annex 7 and Annex 8, and summarised above, is that the increase in these 3G and CGC base station permitted power limits would have little impact on the use that PMSE can make of adjacent bands in practice.

Section 7

Assessment of the request for a licence variation

7.1 This section sets out our assessment, in the light of our statutory and other legal duties, of the request for a licence variation by increasing the permitted power levels in 3G licences. Our conclusion is that granting an increase in the base station power limits to 68 dBm would not change the current practical usability of adjacent spectrum and we consider that it is appropriate to offer the variation to all five 3G licensees and to 2 GHz MSS/CGC licensees.

Potential benefits for consumers

7.2 Vodafone states that using an increased transmission power significantly improves the coverage and provides deeper in-building penetration of networks and that the capacity for data services and for speech services can also be improved.

7.3 We have considered the statement made by Vodafone alongside our understanding of 3G technology. In 3G systems, particularly when high speed packet access (HSPA) is in use, the data rate delivered to mobile terminals is highly dependent on the signal quality and strength seen by the mobile terminal. Received signal strength decreases as the distance to the base station increases and with obstructions on the signal path, so increasing the transmission power at individual sites should indeed lead to improvements to consumer data rates across wider areas and inside buildings.

7.4 On this basis, we consider the licence variation may facilitate the creation of benefits to consumers.

Optimal use of spectrum

7.5 The imposition of maximum power levels in 3G Licences was set with reference to the capability of equipment then available, some 10 years ago. We are aware that some other European countries do not set any such limit in their licences. While we believe that maintaining a limit can be justified in order to avoid interference to neighbouring spectrum users, it should not unnecessarily constrain the licensees' ability to utilise currently available transmission equipment efficiently.

Impact on competition and discrimination

7.6 We consider that the licence variation should apply equally to all 3G operators and thus competition and discrimination issues do not arise. A similar observation applies in respect of prospective CGC operators.

7.7 We note that it is always open to operators of services in any bands to seek a licence variation and that our ability to consider or grant such variation is usually dependent on local conditions within or adjacent to the spectrum used. We therefore believe that granting this variation neither prejudices nor supports any future request for an increase in power for any other radio service.

Timing of the licence variation

7.8 We can see no reason why the variation should not be applied as soon as possible. We therefore propose, subject to the responses to this consultation, to issue a statement and, if appropriate, the variation, shortly after the close of the consultation period.

7.9 We can see no reason why the same power limit should not be applied to the CGC base station licences and their appropriate interface requirement, when these CGC licences are requested. The IR document covering the 2 GHz MSS/CGC base stations will not be finalised until we've concluded this consultation process

Objective justification for licence conditions

7.10 As mentioned in Section 5, we have a statutory duty (in section 9(7) of the 2006 Act) to ensure that licence conditions are objectively justified in relation to networks and services to which they relate, non-discriminatory, proportionate and transparent. We consider that this obligation is ongoing and must be assessed against the state of technology development at the time and market circumstances. As discussed above, we do not feel that the currently licensed maximum power remains objectively justified and therefore consider that we should grant the requested variation.

International obligations

7.11 Ofcom must comply with UK obligations under EU law or international agreements where use of spectrum has been harmonised. We consider that to grant the variation would be consistent with UK obligations.

Direction from the Secretary of State

7.12 Ofcom must comply with any direction from the Secretary of State under section 5 of the 2003 Act and section 5 of the 2006 Act. No such direction has been made relating to third generation mobile licences, although the Government is currently consulting on a draft direction to Ofcom to implement its proposed Wireless Radio Spectrum Modernisation Programme, we consider that the issues being considered there are not conflicted or prejudiced by the grating of this variation.

Conclusions

7.13 Our provisional view (which is the subject of this consultation process) is that:

- technology has changed and developed since the initial setting of a maximum licensed power and there is new equipment on the market that is capable of using increased powers more effectively;
- operators wish to deploy the latest available technology to provide services that deliver services efficiently to their customers;
- as discussed in section 6, any increase in detrimental impacts on spectrum quality for others in neighbouring bands, are unlikely in practice to change those effects already being experienced by PMSE users;
- there is therefore no spectrum management reason for not increasing the power levels in 3G and 2 GHz MSS/CGC licences to 68dBm EIRP.

Are there any reasonable grounds why Ofcom should not grant the request to vary the five Wireless Telegraphy Third Generation Mobile Licences by increasing the permitted maximum in-band EIRP to 68dBm as soon as practicable? If so, please explain your reasoning for this.

Are there any reasonable grounds why Ofcom should not also apply the increased permitted maximum in-band EIRP to future 2 GHz MSS/CGC licences? If so, please explain your reasoning for this.

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on Friday 19 March 2010**

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

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

A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Cliff Mason
Spectrum Markets Team
Riverside House 03:112
2A Southwark Bridge Road
London SE1 9HA

Fax: 020 7783 4303

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

A1.6 It would be helpful if your response could include a direct answer to the question asked in this document, stated at Annex 4. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Steve Green on 020 7783 4384.

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A1.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A1.11 Following the end of the consultation period, Ofcom intends to publish a statement in Spring 2010

A1.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Ofcom's consultation processes

A1.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.14 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Vicki Nash, Director Scotland, who is Ofcom's consultation champion:

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

Tel: 0141 229 7401
Fax: 0141 229 7433

Email vicki.nash@ofcom.org.uk

Annex 2

Ofcom's consultation principles

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

Before the consultation

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

During the consultation

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

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

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

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

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

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing ☐

Whole response ☐

Part of the response ☐

Name/contact details/job title ☐

Organisation ☐

If there is no separate annex, which parts?

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

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

Name

Signed (if hard copy)

Annex 4

Consultation questions

Are there any reasonable grounds why Ofcom should not grant the request to vary the five Wireless Telegraphy Third Generation Mobile Licences by increasing the permitted maximum in-band EIRP to 68dBm as soon as practicable? If so, please explain your reasoning for this.

Are there any reasonable grounds why Ofcom should not also apply the increased permitted maximum in-band EIRP to future 2 GHz MSS/CGC licences? If so, please explain your reasoning for this.

Annex 5

Impact Assessment

Introduction

A5.1 The analysis presented in this annex represents an impact assessment, as defined in section 7 of the Communications Act 2003 (the Act).

A5.2 Consistent with Ofcom's guidelines[17] on the use of impact assessments, this analysis:

- defines the issue being considered and identifies the citizen/ consumer interest;
- defines the policy objective;
- identifies and assesses the options and identifies the impacts on stakeholders; and
- assesses the impact on competition.

The citizen and/or consumer interest

A5.3 This document consults on Ofcom's consideration of a request from 3G operators to vary their 3G licences. Vodafone submitted a request to Ofcom on 19 November 2008 to vary its licence to increase the allowed power levels. Subsequently, the four other 3G licensees, Telefónica O2, Orange, Hutchison 3G and T-Mobile have asked to be included in the variation request.

A5.4 Vodafone has told Ofcom that permitting a higher maximum licensed power would enable it (and other operators) to optimise their networks allowing the flexibility to serve more effectively a wider area and community with better in-building penetration.

A5.5 in our July 2009 Statement on authorisation of 2 GHz MSS/CGC base stations we noted that any change to the permitted power limits for 3G base stations would also be relevant for CGC base stations, otherwise, asymmetric conditions would occur at the relevant band edges at 2170 MHz. We are therefore considering this potential variation for the planned CGC base station licences.

Ofcom's policy objective

A5.6 Ofcom has a principal duty 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. Further, in securing this principal duty Ofcom is required to secure the optimal use of the spectrum for wireless telegraphy. Therefore, the objective of the policy is maximise the likelihood that the spectrum is used optimally, to generate economic benefits and to promote innovation and competition, thus ultimately creating benefits to consumers by reducing restrictions on spectrum use.

[17] http://www.ofcom.org.uk/consult/policy_making/guidelines.pdf

Options considered

A5.7 Ofcom could decide not to grant the variation and maintain the current licence conditions. This would deny the possibility of using the higher powers requested which is likely to result in a sub-optimal choice of technological deployments and services (with a consequent reduction of benefits from spectrum use).

A5.8 If Ofcom grants the variation, it will need to determine that this is objectively justified and that any effects to adjacent or other spectrum users are given appropriate consideration.

Analysis of the different options

A5.9 Maintaining the status quo could only be justified if these forgone benefits were more than outweighed by the need to avoid undesirable outcomes such as impairing competition or creating the risk of an unacceptable level of interference.

A5.10 It is arguable that the current limit in the licences, with the development of technology over time, has ceased to be relevant and that it is no longer objectively justified.

A5.11 Ofcom has considered the potential effects on adjacent PMSE channels. While the level of emissions into the first two PMSE channels adjacent to 3G spectrum will rise, we believe that in practice this has no adverse effect on PMSE services.

A5.12 This is because PMSE must use filtering at present to make effective use of these channels and this will remain the case. Filters that enable PMSE use at present should equally permit comparable use at the raised power levels.

The preferred option

A5.13 Ofcom has concluded from the analysis presented in the main text of this consultation document that it does not consider maintaining the status quo would be justifiable, since granting more flexibility in the use of spectrum will on balance be beneficial.

A5.14 Ofcom's preferred option is therefore to grant the variation as soon as practicable.

Annex 6

Background to the variation request

A6.1 Vodafone's initial request was made on 19 November 2008.

A6.2 The proposal was discussed with the other 3G operators, Telefónica O2, Orange, Hutchison 3G and T-Mobile early in 2009. All operators agreed this should be taken forward as an industry-wide request.

A6.3 A statement on the licensing of 2 GHz MSS/CGC was published on 17 July 2009. We indicated that in that statement that in the event of a request to raise the EIRP level for 3G mobile networks, we would consider the requests together.

A6.4 We are therefore consulting on the proposal to apply the higher power limit to both 3G and 2GHz MSS/CGC base station licences

Annex 7

Analysis of interference from 3G to PMSE

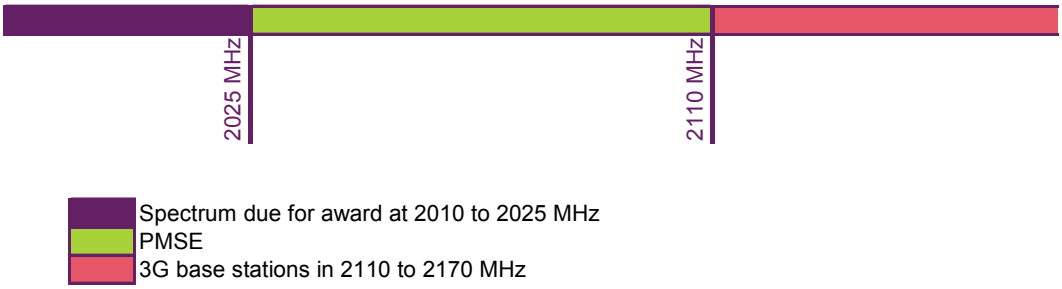
Introduction

A7.1 This annex presents an assessment of the potential impact on neighbouring spectrum users outside the 3G band arising from as a result of an increase in the maximum in-band EIRP limits in the 3G licences. The analysis is based on the methodology established during the preparation for the award of spectrum at 2.6 GHz and 2010 MHz.

Spectrum adjacencies

7.14 PMSE uses the 2025 to 2110 MHz band and the adjacency between PMSE use and macrocell base station use.at the 2110 MHz boundary, which is of relevance to the licence variation request in this consultation, has similarities with the equivalent adjacency at the 2025 MHz boundary, as shown in figure A1.

Figure A1. Spectrum boundaries of lower 2 GHz PMSE band



A7.2 Ofcom previously analysed the coexistence of mobile and PMSE during the development of technical licence conditions for the 2010 to 2025 MHz band. The statement[18] on the "Award of available spectrum: 2500-2690 MHz, 2010-2025 MHz", (the "2.6 GHz Statement") outlines the methodology and we decided to base our analysis for the 2110 MHz boundary on that methodology.

A7.3 In addition, we considered the information provided in responses[19,20] to the Ofcom consultations[21,22] on 2.6 GHz and 2010 MHz that dealt with PMSE adjacencies, since these had information about the experience of PMSE use of the 2025 to 2210 MHz spectrum.

PMSE channel plan

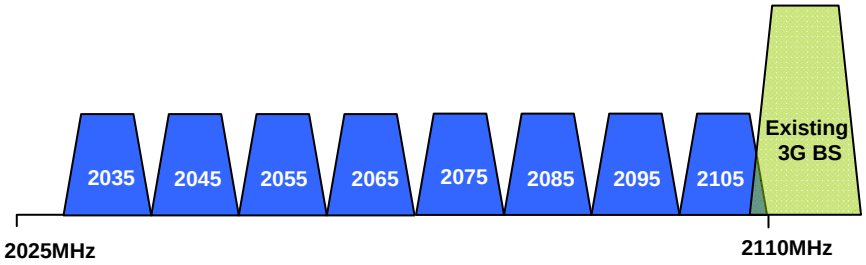
A7.4 PMSE equipment uses a receiver bandwidth of 8 MHz with channels centred on the following frequencies:

[18] http://www.ofcom.org.uk/consult/condocs/2ghzrules/statementim/statement/
[19] http://www.ofcom.org.uk/consult/condocs/2ghzawards/responses/
[20] http://www.ofcom.org.uk/consult/condocs/2ghzdiscuss/responses/
[21] http://www.ofcom.org.uk/consult/condocs/2ghzawards/
[22] http://www.ofcom.org.uk/consult/condocs/2ghzdiscuss/

Lower 2 GHz band PMSE band: equipment centre frequencies (MHz)							
2035	2045	2055	2065	2075	2085	2095	2105

A7.5 Comments from PMSE users to the Ofcom discussion document on the 2.6 GHz and 2010 MHz award indicated that use of the 2105 MHz channel is problematic, as shown in figure A2.

Figure A2. Illustration of current interference into PMSE (source: JFMG)



A7.6 For this analysis we considered the effects on the two uppermost PMSE channels.

3G channel plan

A7.7 The nearest 3G licence to the 2110 MHz boundary is for the block of spectrum from 2110.3 to 2124.9 MHz. The licence does not specify centre frequencies but for this analysis we have assumed that the first 3G base station centre frequency is as close to the lower boundary as possible. In line with Decision ECC/DEC/(06)01[23] this would put the channel on a centre frequency of 2112.8 MHz.

A7.8 We have confined our analysis to the emissions from the closest 3G channel to the band edge. There are three reasons for this:

- The emissions limits in the 3G licence apply from the edge of the block, i.e. they apply from 2110.3 MHz, regardless of the carrier frequency in use;
- Results are likely to be similar to, and no worse than, those from emissions at 2112.8 MHz into both the first and second adjacent PMSE channels; and
- We were not able to make any assumptions about the degree of usage of the different carrier frequencies within this licence block, so even if results were better for the second or third carrier than for 2112.8 MHz, we could not give guidance on which of the three represented the more likely scenario.

Technical characteristics of PMSE equipment

A7.9 Table A1 shows the parameters used in the study in the 2.6 GHz Statement for four different PMSE receivers for antenna gain, maximum permitted interference level and adjacent channel selectivity (ACS) for separations of 7.5 MHz and 12.5 MHz between the centre frequencies of PMSE and 3G. These were taken from Table 13 of the 2.6 GHz Statement.

[23] http://www.erodocdb.dk/Docs/doc98/official/Word/ECCDEC0601.DOC

Table A1. PMSE receiver parameters

PMSE receiver	Antenna gain (dBi)	Interference level (dBm)	ACS (dB) Baseline at 7.5 MHz carrier separation	ACS (dB) With receiver channel filter at 12.5 MHz carrier separation
Wireless camera 1W	0	-107	46	86
Portable/mobile links	8	-107	46	86
Airborne links	8	-107	46	86
Temp point to point	20	-107	46	86

A7.10 The ACS of 46dB represents the standard selectivity of PMSE equipment. The higher ACS of 86dB would require the use of an additional receiver filter. As such, we considered it unreasonable to assume that 40dB additional filtering could be achieved for the first adjacent channel. However, as a result of comments from PMSE users, we also considered an ACS of 60dB. Therefore, for the PMSE channel at 2105 MHz, we restricted the analysis to the baseline 46dB ACS and also provided a limited set of results for an enhanced ACS of 60dB.

A7.11 For the second PMSE channel, at 2095 MHz, we included the ACS values of 46dB, and 86dB, as in the 2.6 GHz Statement in our analysis and also provided a limited set of results for an ACS of 60dB.

A7.12 The parameter values for airborne links are identical to those for portable and mobile links. However, since the path would be line of sight we would run into the issue encountered in previous work on calculating separation distances. The distances that emerged would be highly sensitive to assumptions about the antenna patterns (particularly in the vertical plane), downtilt and directions of maximum gain. Therefore, as with the 2.6 GHz statement, we did not calculate separation distances for this application. However, because antenna gain is lower than on temporary point to point links, isolation requirements will result in lower line-of-sight distances than that scenario.

3G parameters

Licence requirements

A7.13 The 3G licences contain a maximum EIRP per carrier, a maximum EIRP per MHz and out of block emission limits. These limits are specified in different ways:

- The maximum EIRP is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna. The maximum EIRP in any direction from the base-station must not be above this limit.

- The EIRP per MHz is defined as the sum of the EIRP radiated by all transmitted carriers in any given direction within any contiguous 5 MHz block within an operator's spectrum allocation, divided by 5. In practice, for the limits in the licence, this is a less stringent requirement than the maximum EIRP per carrier for any bandwidth greater than 2.5 MHz (3G uses a nominal 3.84 MHz bandwidth). The licence specifies that the more stringent of these two is the requirement that applies.

- The maximum permitted level of out of block emissions is the maximum power, integrated over the corresponding measurement bandwidth that may be supplied by the transmitter to the antenna feeder line.

A7.14 This analysis assumes that the out of block emission limits would be kept at the present levels if the in-block EIRP were increased. If any proposals to change the out of block limits emerged, these would need to be the subject of a separate analysis.

A7.15 Tables A2 and A3 show the EIRP and out of block emission limits in the 3G licences.

Table A2. 3G maximum permissible EIRP (current limits)

Maximum EIRP per carrier	Maximum EIRP per MHz
62dBm	58dBm/MHz

Table A3. 3G out of block emission limits

Offset from edge of block	Maximum permitted level	Measurement bandwidth
0 to 0.2 MHz	-14dBm	30 kHz
0.2 to 1.0 MHz	-14 - 15(Δf - 0.2)dBm	30 kHz
Beyond 1.0 MHz	-13 dBm	1 MHz
Where Δf is the frequency offset in MHz from the edge of the block		

A7.16 The impact of the different ways the limits are specified is that for this study we need to make an assumption about the antenna gain and feeder loss in order to be able to calculate the level of radiated emissions outside the licence block (see paragraph A7.22).

3G specification requirements

A7.17 The licensed out of block emission limits align with the base station out of band emission requirements in 3GPP Technical Specification 25.104. The same specification also defines the spurious emission limits that apply from a frequency 10 MHz below the base station operating band. Table A4 shows the Category B limits in clause 6.6.3.1 of this specification.

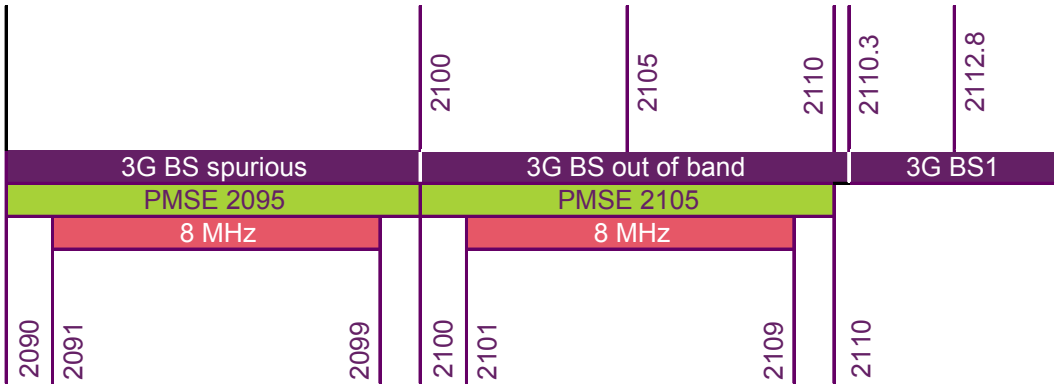
Table A4. Spurious emission limits for 3G base stations

Band	Maximum Level	Measurement Bandwidth	Note
9 kHz ↔ 150 kHz	-36 dBm	1 kHz	Note 1
150 kHz ↔ 30 MHz	-36 dBm	10 kHz	Note 1
30 MHz ↔ 1 GHz	-36 dBm	100 kHz	Note 1
1 GHz ↔ F_{low} - 10 MHz	-30 dBm	1 MHz	Note 1
F_{low} - 10 MHz ↔ F_{high} + 10 MHz	-15 dBm	1 MHz	Note 2
F_{high} + 10 MHz ↔ 12.75 GHz	-30 dBm	1 MHz	Note 3
NOTE 1: Bandwidth as in ITU-R Recommendation SM.329 [1], s4.1 NOTE 2: Limit based on ITU-R Recommendation SM.329 [1], s4.3 and Annex 7 NOTE 3: Bandwidth as in ITU-R Recommendation SM.329 [1], s4.1. Upper frequency as in ITU-R SM.329 [1], s2.5 table 1			
Key: F_{low}: The lowest downlink frequency of the operating band F_{high}: The highest downlink frequency of the operating band			

A7.18 In the specification, the operating band is defined as starting at 2110 MHz, therefore the spurious emissions limit of -30dBm/MHz applies below 2100 MHz, i.e. in the second PMSE channel.

A7.19 Figure A3 illustrates the boundaries between the different limits and how they sit alongside the PMSE channels.

Figure A3. Applicable emission limits



A7.20 The combination of the out of block limits in the 3G licence and the spurious emission limits in the equipment specification provides a continuum of limits running from the edge of the 3G band, down into the spectrum used by PMSE.

A7.21 As with the out of block emission limits, the spurious emission limits are specified in absolute terms and would be kept at this level regardless of any change in the maximum permitted EIRP.

Antenna gain

A7.22 To maintain consistency with the study in the 2.6 GHz Statement we assumed a value of 18dBi for antenna gain and feeder loss. For the two values of 3G EIRP that we studied, and the assumption of 18dBi antenna gain, the in-block power levels supplied by the base station transmitter to the antenna feeder line are shown in table A5.

Table A5. Base station power into antenna

Scenario	Maximum EIRP (dBm)	Antenna gain (dBi)	Base station power (dBm)
Current 3G licence	62	18	44
Increased maximum EIRP limit	68	18	50

Methodology

A7.23 The basic methodology for the study is to use a minimum coupling loss calculation to find the isolation needed between the 3G base station transmitter and the PMSE receiver to meet the interference limits in Table A1. This is then converted to a minimum separation distance.

A7.24 Adjacent channel leakage power ratio and adjacent channel selectivity are combined to give an adjacent channel interference ratio (ACIR) according to the following equation:

$$ACIR^{-1} = ACLR^{-1} + ACS^{-1}$$ (for ACIR, ACLR and ACS as linear ratios)

A7.25 The required isolation is calculated according to the following equation:

$$isolation = P_{INT} + G_{VICT} + G_{INT} - (S_{VICT} - C/I_{VICT}) - ACIR$$

Where all parameters are in dB and

P_{INT} is the maximum transmit power of the interferer
G_{VICT} is the gain of the victim antenna (including feeder loss)
G_{INT} is the gain of the interferer antenna (including feeder loss)
S_{VICT} is the sensitivity of the victim
C/I_{VICT} is the protection ratio of the victim
ACIR is total interference power affecting a victim receiver relative to the interferer's carrier power

A7.26 The parameter $(S_{VICT} - C/I_{VICT})$ equates to the permissible interference level at the receiver, given in Table A1.

Propagation models

A7.27 The PMSE study in the 2.6 GHz Statement used the outdoor pedestrian propagation model in Recommendation ITU-R M.1225, except for airborne links where it used a free space propagation model. The ITU-R M.1225 model estimates the propagation loss between isotropic antennas expressed as the sum of free space loss, a diffraction loss from rooftop to the street, and the reduction due to multiple screen diffraction past rows of buildings.

A7.28 We have used the same propagation models in the present study, with the losses adjusted for a frequency of 2110 MHz. Table A6 shows values for propagation loss for distances between 10m and 1000m.

Table A6. Recommendation ITU-R M.1225 propagation loss (frequency 2110 MHz)

Distance (m)	10	50	100	500	1000
Propagation loss (dB)	68.7	96.7	108.7	136.7	148.7

A7.29 In addition, we have also considered propagation according to the COST-Hata model. This model is given by the equation for basic transmission loss L_b

$$L_b = 46.3 + 33.9 \log f - 13.82 \log h_{bs} - a(h_{mobile}) + (44.9 - 6.55 \log h_{base}) \log d + C$$

where

$$a(h_{mobile}) = (1.1 \log f - 0.7)\, h_{mobile} - (1.56 \log f - 0.8)$$

and

f	frequency (MHz)
h_{base}	base station height (m)
d	distance (km)
h_{mobile}	mobile station height (m)

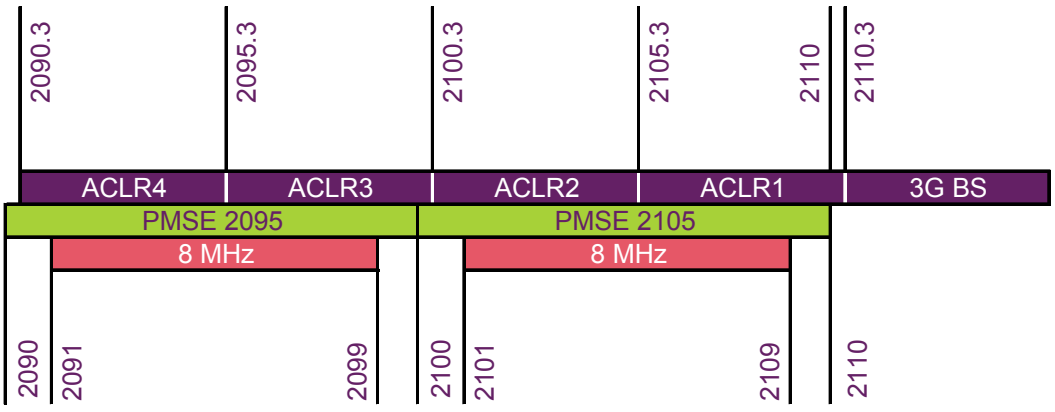
A7.30 We assumed a mobile or CGC base station height of 30m and a PMSE receiver height of 10m in the COST-Hata analysis.

A7.31 Temporary point to point link antennas may be mounted on rooftops and masts, which would take them outside the validity range of the COST-Hata model, which has a maximum receiver height of 10m. For these receivers we used a free space path loss model in the sections of this annex dealing with the COST-Hata analysis.

Adjacent channel interference ratios

A7.32 Figure A4 illustrates how the ACLR values in the 3G specification apply in the 5 MHz blocks immediately adjacent to the 3G spectrum. The ACLR values are specified for a receiver bandwidth of 3.84 MHz and do not line up exactly with any of the PMSE receiver bandwidths. This is due to the 0.3 MHz offset between the 2110 MHz frequency and the edge of the licence block, the 1 MHz offset due to the 8 MHz PMSE receiver being centred in a 10 MHz channel, and the difference in bandwidth between the 8 MHz PMSE receiver and the 3.84 MHz measurement bandwidth for 3G ACLR.

Figure A4. Frequency boundaries of 3G ACLR limits



A7.33 It was therefore necessary to derive values for ACLR within the PMSE receiver bandwidth. We calculated the ACLR by integration under the 3G emissions mask and spurious emission limits. Tables A7 and A8 show the values calculated for ACLR for the first and second adjacent channels.

Table A7. Calculated ACLR for 62dBm EIRP

PMSE channel	3G EIRP (dBm)	3G antenna gain (dBi)	3G base station power (dBm)	3G power emitted in PMSE receiver channel (dBm)	3G ACLR (dB)
2105 MHz	62	18	44	-4.0	48.0
2095 MHz	62	18	44	-21.0	65.0

Table A8. Calculated ACLR for 68dBm EIRP

PMSE channel	3G EIRP (dBm)	3G antenna gain (dBi)	3G base station power (dBm)	3G power emitted in PMSE receiver channel (dBm)	3G ACLR (dB)
2105 MHz	68	18	50	-4.0	54.0
2095 MHz	68	18	50	-21.0	71.0

A7.34 Using the values of 46dB, 60dB and 86dB for adjacent channel selectivity, we can derive adjacent channel interference ratios for each of these scenarios. Table A9 shows the values. We did not consider it realistic to assume 86dB ACS in the first adjacent channel, so we did not calculate ACIR values for that scenario.

Table A9. Adjacent channel interference ratio for each scenario

PMSE channel	3G EIRP (dBm)	3G ACLR (dB)	ACIR (dB)		
			46dB PMSE ACS	60dB PMSE ACS	86dB PMSE ACS
2105 MHz	62	48.0	43.9	47.7	-
	68	54.0	45.4	53.0	-
2095 MHz	62	65.0	45.9	58.8	64.9
	68	71.0	46.0	59.7	70.8

A7.35 We can see from these values that at 2095 MHz and 86dB ACS, 6dB increase in power is accompanied by 5.9dB increase in ACIR. Therefore the increase in isolation requirement at the receiver is 0.1dB. In contrast, at 2105 MHz with 46dB ACS, there is only 1.5dB increase in ACIR so there is a requirement for 4.5dB increase in isolation.

Results for PMSE channel centred on 2105 MHz

Recommendation ITU-R M.1225 propagation model

A7.36 Tables A10 and A11 follow the layout of results in the 2.6 GHz Statement and provide the results for the immediately adjacent channel at the 2110 MHz boundary with PMSE ACS of 46dB. Table A10 is described as the baseline case because it represents the current situation with 3G power at 62dBm EIRP. Table A11 shows the impact of a 6dB increase in 3G base station EIRP. Negative values represent a margin compared to the calculated isolation requirement and positive values represent cases where, at the distance considered, some additional isolation is required. The separation distances assume that the path between the interferer and victim lies in the direction of maximum gain of both antennas.

A7.37 In common with the 2.6 GHz Statement and the Engineering Study Phase 2 Report we did not calculate separation distances for interference to airborne links. As explained in Annex B to the Engineering Study Phase 2 Report, any results would have been sensitive to assumptions we made about the vertical radiation patterns

and downtilt of 3G base station antennas, as well as the gain pattern of the airborne receiver.

Table A10. Baseline case: interference from 62dBm EIRP 3G into adjacent PMSE at 2105 MHz

Interferer	Victim	Additional isolation or margin					Separation (m)
		10m	50m	100m	500m	1000m	
FDD BS 7.8 MHz separation	Wireless camera 1W	56.4	28.4	16.4	-11.6	-23.6	257
	Portable/mobile links	64.4	36.4	24.4	-3.6	-15.6	408
	Airborne links	74.2	60.2	54.2	40.2	34.2	Note 1
	Temp point to point	76.4	48.4	36.4	8.4	-3.6	813
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

Table A11. Interference from 68dBm EIRP 3G into adjacent PMSE at 2105 MHz

Interferer	Victim	Additional isolation or margin					Separation (m)
		10m	50m	100m	500m	1000m	
FDD BS 7.8 MHz separation	Wireless camera 1W	60.9	33.0	20.9	-7.0	-19.1	333
	Portable/mobile links	68.9	41.0	28.9	1.0	-11.1	528
	Airborne links	78.7	64.7	58.7	44.7	38.7	Note 1
	Temp point to point	80.9	53.0	40.9	13.0	0.9	1054
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

A7.38 Between tables A10 and A11 there is some increase in the additional isolation requirement. In the cases of portable links at 500m separation from the 3G base station and point to point links at 1000m separation from the 3G base station this has changed from a margin to a requirement for additional isolation. The distances below 500m that are currently problematic for PMSE remain so with the elevated 3G EIRP.

A7.39 The separation distances in table A11 represent a 30% increase in distance above those in table A10.

COST-Hata propagation model

A7.40 Table A12 sets out the results for the immediately adjacent channels at the 2110 MHz boundary. For each PMSE receiver we derived a separation distance using 46dB selectivity to represent standard equipment and 60dB to represent either higher performance equipment or use of additional receiver filtering. We derived separation distances based on the current 3G EIRP of 62dBm and an increased EIRP of 68dBm and then calculated the increase in separation distance as a percentage of the current distance. The distances are expressed in metres for wireless cameras and portable/mobile links, and in kilometres for free space propagation of interference into temporary point to point links.

Table A12. Increase in separation distances between 3G and adjacent PMSE

PMSE receiver	Propagation model	PMSE ACS (dB)	Separation distance		Difference
			3G power: 62dBm EIRP	3G power: 68 dBm EIRP	
Wireless camera 1W	COST-Hata	46	2154m	2892m	34%
		60	1676m	1754m	5%
Portable/mobile links	COST-Hata	46	3634m	4879m	34%
		60	2827m	2960m	5%
Temp point to point	Free space	46	204km	343km	68%
		60	131km	142km	8%

A7.41 A general comment on these results is that the difference in separation distance is dependent on the rate at which the propagation model predicts that the loss increases with distance. Loss in the Cost-Hata model increases at a rate of (44.9 - 6.55 log h_{base}) log d, or about 35 log d for base station height of 30m whereas free space loss increases at a rate of 20 log d. This is why the increases are the same for wireless cameras and portable/mobile links, and greater for temporary point to point links.

A7.42 We can see from these results that improving the selectivity can reduce the difference that is caused by a power increase within the 3G band. However it is apparent that the separation distances still remain large by comparison with the normal assumptions for the distance between base stations. The separation distances predicted for temporary point to point links with free space propagation do not take account of the curvature of the Earth. Taking into account that there will be very few, if any, possible locations that could guarantee such separation distances to the nearest 3G base station, these would therefore appear to be very conservative estimates. This is discussed further in paragraph A7.54.

A7.43 We are aware that responses to previous Ofcom consultations from PMSE users have indicated that they find this channel very difficult to use because of the interference levels, and the figures in tables A7 and A9 bear this out.

Results for PMSE channel centred on 2095 MHz

Recommendation ITU-R M.1225 propagation model

Results without additional receiver filter (46dB ACS)

A7.44 This set of results considers the impact of a 3G power increase on the use of the second adjacent PMSE channel, centred on 2095 MHz. The first results take the case of PMSE equipment without any additional receiver filtering, so its ACS is 46dB. Table A13 shows the current additional isolation requirements or margins while table A14 shows how these would change if the 3G base station power is increased to 68dBm EIRP.

Table A13. Baseline. 62dBm, no additional PMSE receiver filter

Interferer	Victim	Additional isolation or margin					Separation (m)
		10m	50m	100m	500m	1000m	
FDD BS 17.8 MHz separation	Wireless camera 1W	54.3	26.4	14.3	-13.6	-25.7	228
	Portable/mobile links	62.3	34.4	22.3	-5.6	-17.7	362
	Airborne links	72.1	58.1	52.1	38.1	32.1	Note 1
	Temp point to point	74.3	46.4	34.3	6.4	-5.7	721
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

Table A14. Increased power 68dBm EIRP, no additional PMSE receiver filter

Interferer	Victim	Additional isolation or margin					Separation (m)
		10m	50m	100m	500m	1000m	
FDD BS 17.8 MHz separation	Wireless camera 1W	60.3	32.3	20.3	-7.7	-19.7	321
	Portable/mobile links	68.3	40.3	28.3	0.3	-11.7	509
	Airborne links	78.1	64.1	58.1	44.1	38.1	Note 1
	Temp point to point	80.3	52.3	40.3	12.3	0.3	1017
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

A7.45 The results are very similar to those for the PMSE channel at 2105 MHz. This is because the only input assumption that has changed is the ACLR, which is 17dB higher due to the change from out of band emission limits at 13dBm/MHz to spurious emission limits at 30dBm/MHz. The nature of the ACIR calculation means that this becomes a 2dB ACIR increase for 62dBm EIRP base stations and 0.4dB increase for 68dB EIRP base stations. It is possible that PMSE receivers might offer selectivity improvements for this greater frequency separation, even without additional filters. However, in the absence of other information, we used the same ACS for 17.8 MHz separation as for 7.8 MHz separation.

A7.46 For this case the 500m result for portable/mobile links and the 1000m result for temporary point to point links have changed from excess margins to requirements for additional isolation. For all cases, the separation distance has increased by 41%.

Addition of PMSE receiver filter (86dB ACS)

A7.47 The next set of results in this annex considers the use of additional receiver filtering at the PMSE side, increasing its adjacent channel selectivity to 86dB. Table A15 shows the situation with the current 3G base station EIRP and table A16 shows the impact of increasing the EIRP to 68dBm.

Table A15. Results with additional PMSE receiver filter: interference from 3G at 62dBm EIRP

Interferer	Victim	Additional isolation or margin					Separation (m)
		10m	50m	100m	500m	1000m	
FDD BS 17.8 MHz separation	Wireless camera 1W	35.3	7.4	-4.7	-32.6	-44.7	76
	Portable/mobile links	43.3	15.4	3.3	-24.6	-36.7	121
	Airborne links	53.1	39.2	33.1	19.2	13.1	Note 1
	Temp point to point	55.3	27.4	15.3	-12.6	-24.7	242
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

Table A16. Results with additional PMSE receiver filter: interference from 3G at 68dBm EIRP

Interferer	Victim	Additional isolation or margin					Separation (m)
		10m	50m	100m	500m	1000m	
FDD BS 17.8 MHz separation	Wireless camera 1W	35.4	7.5	-4.6	-32.5	-44.6	77
	Portable/mobile links	43.4	15.5	3.4	-24.5	-36.6	122
	Airborne links	53.2	39.3	33.2	19.3	13.2	Note 1
	Temp point to point	55.4	27.5	15.4	-12.5	-24.6	243
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

A7.48 These results are a significant improvement over those from the previous sections. With the baseline 62dBm EIRP, 100m separation from a 3G base station has become feasible for wireless camera use. In general, calculated separation distances are one third or less of those required without additional filtering, even where 68dBm is compared with 62dBm (the separation distances in table A13 are about 30% of those in table A7).

A7.49 The ACS improvement that flows from additional filtering has had a significant impact on this scenario. Without additional filtering, ACS and ACLR are at similar levels, so improvements in 3G transmitter filtering are not fully reflected in the ACIR seen at the PMSE receiver. Table A6 shows that when the ACS is about 15 to 20dB higher than the ACLR, most but not all of the increase in ACLR translates to an increase in ACIR; 6dB improvement in ACLR results in 5.9dB improvement in ACIR. As a result, the sum of EIRP and ACIR is marginally higher in the second case so there are some minor differences in the results in tables A12 and A13. As far as the PMSE receiver is concerned, most of the interference contribution in this scenario comes from the out of band emissions and spurious emissions from 3G, which are kept at their current levels. The high level of ACS means the contribution from in-band 3G power is negligible.

COST-Hata propagation model

A7.50 For the analysis using the COST-Hata propagation model we have used three values of ACS: 46dB, representing standard equipment; 60dB, representing improved equipment; and 86dB, representing the use of additional receiver filters. We calculated a separation distance for each type of PMSE equipment for 3G EIRP of 62dBm and 68dBm and the difference between them. Differences are presented as a percentage of the original distance. Table A17 summarises the results. The distances are expressed in metres for wireless cameras and portable/mobile links, and in kilometres for temporary point to point links. As in the previous COST-Hata analysis we used free space propagation loss for temporary point to point links, because we wanted to consider the case where the height of the receiver was above the 10m limit of applicability of the COST-Hata model.

Table A17. Increase in separation distances between 3G and PMSE for second adjacent PMSE channel

PMSE receiver	Propagation model	PMSE ACS (dB)	Separation distance		Difference
			3G power: 62dBm EIRP	3G power: 68 dBm EIRP	
Wireless camera 1W	COST-Hata	46	1880m	2775m	48%
		60	811m	1135m	40%
		86	543m	547m	1%
Portable/mobile links	COST-Hata	46	3171m	4682m	48%
		60	1369m	1915m	40%
		86	917m	923m	1%
Temp point to point	Free space	46	161km	319km	99%
		60	37km	66km	81%
		86	18.1km	18.3km	1%

A7.51 It should be noted that the separation distances predicted for temporary point to point links with free space propagation do not take account of the curvature of the Earth.

A7.52 With 46dB ACS we can see that the lower 3G emissions into this PMSE channel are not reflected in significant improvements in separation distance compared with table A9, even at the baseline 3G power of 62dBm EIRP. This is exactly what we should expect because table A6 shows that 17dB lower emissions (represented by an ACLR change from 48dB to 65dB) only result in a 2dB improvement in ACIR (from 43.9dB to 45.9dB).

A7.53 The use of additional filtering to bring ACS to 86dB has again had a significant impact on this scenario. When the ACS is about 15 to 20dB higher than the ACLR, most but not all of the increase in ACLR translates to an increase in ACIR; 6dB improvement in ACLR results in 5.9dB improvement in ACIR. As far as the PMSE receiver is concerned, most of the interference contribution in this scenario comes from the out of band emissions and spurious emissions from 3G, which are kept at their current levels. The high level of ACS ensures that the additional contribution from the increase in in-band 3G power is negligible.

A7.54 The values for separation distance between 3G base stations and temporary point to point links look very high, even for the baseline case of current 3G power levels. If these channels are currently in use for such links, a possible explanation may be down to one or more of the following factors: the propagation path from 3G base stations to the PMSE receiver may have greater loss than predicted by the free space model; the PMSE link may be able to function in the presence of more desensitisation from 3G than we have assumed; or the PMSE receiver antenna gain towards the 3G base station may be lower than we have assumed. At 86dB ACS, the change in predicted separation distance as a result of an increase in 3G power is still 1%.

A7.55 We have not provided results for PMSE channels below 2095 MHz. As table A1 showed, the general spurious emissions limit stays at -30dBm/MHz from 2100 MHz down to 1 GHz, even though we would expect the emissions to continue to decrease as the separation from the centre frequency increases. In the absence of more realistic values for 3G emission levels, we could only assume the flat spectrum mask given in the standards. Additional theoretical studies on the PMSE channels below 2095 MHz would therefore be using identical input assumptions to those used in studying the second PMSE channel.

Use of the 2095 MHz and 2105 MHz channels by PMSE

A7.56 Ofcom consultations on the award of spectrum at 2.6 GHz and 2010 MHz considered the adjacency with the 2030 to 2110 MHz PMSE spectrum. We received responses from the BBC, ITN and JFMG. Common themes in these responses were:

- Compatibility difficulties with adjacent 3G base stations causing problems for the two adjoining PMSE channels (2095 MHz and 2105 MHz).
- Broadcasting organisations attempting to use 2105 MHz operationally, but having to abandon these attempts because of loss of receiver sensitivity. The source of the desensitisation of the receivers is out of band transmitters such as those operating the 3G network.

A7.57 There is a consistent view that use of the channel at 2105 MHz is very problematic, while 2095 MHz also presents difficulties.

A7.58 PMSE users have indicated in responses[19] to previous Ofcom consultations that receiver filters are already heavily in use, but they restrict the flexibility of equipment to move between channels. JFMG commented that "the potential benefit of using adjacent channel filters has been shown to be marginal when used with well engineered PMSE receivers", while one JFMG study[24] indicated that some wireless camera receivers are very vulnerable to interference from 3G masts.

A7.59 It is possible that the comment about the marginal benefit of additional filters related particularly to the difficulty of achieving improvements within the 1.3 MHz separation between the edges of the 2105 MHz PMSE channel and the first 3G channel. Both the BBC and JFMG drew attention to the difficulty of using the PMSE channel at 2105 MHz. The BBC indicated that it has attempted to use 2095 MHz, but had to abandon this due to the substantial levels of interference experienced, and that it understood that ITN similarly attempted to use 2105 MHz, but abandoned this for similar reasons.

Conclusions for 3G and PMSE

A7.60 The current situation in the PMSE channel at 2105 MHz is difficult due to the levels of power transmitted from the first channel within the adjacent 3G licence block. It is currently very challenging to provide significant rejection of these signals in the available 1.3 MHz for the types of transportable and mobile application used for PMSE in this band. Use of the PMSE channel at 2105 MHz would remain problematic whether or not the 3G operators' power was increased but, as a guideline, where separation distances between PMSE use in this channel and 3G base stations are currently necessary, these distances would be about 35% longer, assuming 46dB ACS, or 5% longer if 60dB ACS is feasible. If there are locations in the UK that are able to use 2105 MHz for temporary point to point links with receivers sited on rooftops or masts that are well above surrounding clutter, the necessary separation distance for the case of free space paths would increase by 70%. If it is possible to provide equipment with adjacent channel selectivity of 60dB, that equipment would instead see an 8% increase in necessary separation distances.

[24] *How Green are today's Digital Wireless Cameras?* http://www.jfmg.co.uk/pages/Docs/Wireless%20Cameras.pdf

A7.61 For the PMSE channel at 2095 MHz, the frequency separation from 3G provides sufficient space for additional filtering to increase the selectivity against signals above 2110 MHz so that the interference contribution from the 3G in-band emissions becomes negligible compared to the 3G out of band emissions. PMSE receivers that deploy such filtering would therefore be unaffected by 6dB power increases at existing 3G sites in their vicinity and new 3G sites at 68dBm EIRP would have no greater impact than new 62dBm EIRP 3G sites.

A7.62 We conclude that an increase in 3G power from 62dBm EIRP to 68dBm EIRP could be managed without adverse interference impact on PMSE in the channels below 2100 MHz, provided that additional receiver filters were implemented on PMSE equipment. For the PMSE channel above 2100 MHz, the number of locations where this channel could be used without the application of additional mitigation measures would be reduced.

Annex 8

Analysis at the boundary between CGC and PMSE

Introduction

A8.1 This annex presents an analysis of the interference from base stations of a 2 GHz MSS/CGC at 2200 MHz into PMSE.

A8.2 MSS networks in Europe have not yet deployed 2 GHz MSS/CGC so it is necessary to make some assumptions about their characteristics. We anticipate that a 2 GHz MSS/CGC system is likely to resemble a 2 GHz terrestrial mobile system utilising a number of base stations to provide connectivity within major urban areas as well as areas with lower population density. Ofcom's 2 GHz MSS/CGC statement and second consultation of 3 November 2008 set out CGC base station power limits that were aligned to the current 3G EIRP limits. However, as noted earlier in this document, some of the responses to that consultation proposed higher powers for CGC base stations. The analysis in this annex therefore follows the approach in Annex 7 of determining the impact of such a power increase compared with the situation under current CGC base station licence power limits.

A8.3 The boundary between the base stations of a 2 GHz MSS/CGC at 2200 MHz and PMSE is broadly comparable with the 2110 MHz boundary between 3G and PMSE. The emission masks in the Ofcom consultation on CGC are very close in shape to those derived for the 3G emissions for the first adjacent channel but the emissions into channels beyond this are more restricted. Since the CGC emission limits are specified in EIRP we do not need to make assumptions about antenna gain and feeder loss for the study. While we have no concrete indication about the deployment plans of CGC networks, for the purposes of this study we can assume that they would look like 3G networks. We therefore used the same methodology as for the 3G to PMSE study, i.e.

- Use of adjacent channel interference ratio as outlined in A7.24
- Use propagation models as described in A7.27 and A7.31.

Technical characteristics of PMSE equipment

A8.4 PMSE equipment in the band above 2200 MHz uses a receiver bandwidth of 8 MHz with channels centred on the following frequencies:

Upper 2 GHz band PMSE band: equipment centre frequencies (MHz)								
2205	2215	2225	2235	2245	2255	2265	2275	2285

A8.5 JFMG indicates[25] the usage as low power links and wireless cameras. The maximum power is 0 dBW ERP. We used the values for antenna gain, maximum permitted interference level and adjacent channel selectivity (ACS) given in table A1 (taken from Table 13 of the 2.6 GHz Statement) for wireless camera receivers, portable/mobile links and temporary point to point links. In common with the

[25] http://www.jfmg.co.uk/pages/equip/Video/2ghz.htm

analysis of interference from 3G, and as a result of comments from PMSE users, we also provided a limited set of results for an ACS of 60 dB. With regard to airborne links, any analysis would suffer from the issue encountered in previous work on calculating separation distances in that the distances that emerged would be highly sensitive to assumptions about the antenna patterns (particularly in the vertical plane), down-tilt and directions of maximum gain. Therefore, as with the 2.6 GHz statement, we did not calculate separation distances for this application. However, because antenna gain is lower than on temporary point to point links, isolation requirements will result in lower line-of-sight distances than that scenario.

CGC parameters

A8.6 Unlike the 3G band, the 2 GHz MSS/CGC channels have no offset from the edge of the band. They are defined on a 5 MHz raster, so the closest channel to the 2200 MHz boundary will be centred on 2197.5 MHz.

A8.7 Table A18 shows the emission mask in the Ofcom statement[26] of 17 July 2009 on the licensing of 2 GHz MSS/CGC, the "CGC Statement".

Table A18. CGC base station out of block EIRP limits

Offset from block edge	Maximum mean EIRP for out-of-block emissions
0.0 to 0.2 MHz	+3dBm/30 kHz
0.2 to 1.0 MHz	Linear from +3dBm/30 kHz to -9dBm/30 kHz
1.0 to 1.5 MHz	-9dBm/30 kHz
1.5 to 10 MHz	+4dBm/MHz
+ 10 MHz from the block edge at 2200 MHz	-38dBm/MHz

A8.8 The in-block power is specified to be 61 dBm/(5 MHz) EIRP. If this power is in a 3.84 MHz bandwidth, the maximum transmitted EIRP could be 61 + 10 log (5/3.84) = 62 dBm, i.e. the same as the maximum power currently permitted in the 3G licences.

A8.9 For the purposes of this study, we assumed that there would be the same increase in in-block power as for 3G, i.e. a 6 dB increase, taking the maximum power to 67 dBm/5 MHz. This would therefore be equivalent to 68 dBm/3.84 MHz. At the same time, we assumed no increase in out of block EIRP limits.

Calculated adjacent channel interference ratios

A8.10 The first step in calculating ACIR is to derive ACLR for CGC emissions into the PMSE channels at 2205 MHz and 2215 MHz. As with 3G ACLR, we integrated under the spectrum mask as it fell across each 8 MHz PMSE receiver bandwidth and expressed this as a ratio to the 61 dBm/5 MHz in-band power. Table A19 shows the ACLR values that we derived.

Table A19. Calculated ACLR for 61 dBm/5 MHz EIRP CGC

PMSE channel centre frequency (MHz)	CGC EIRP (dBm)	Power emitted in receiver channel (dBm)	ACLR (dB)
2205	61	13.2	47.8
2215	61	-29.0	90.0

[26] http://www.ofcom.org.uk/consult/condocs/cgcs2/statement/2ghzstatement.pdf

A8.11 Table A20 then shows the ACLR values that we derived for a 6 dB power increase.

Table A20. Calculated ACLR for 67 dBm/5 MHz EIRP CGC

PMSE channel centre frequency (MHz)	CGC EIRP (dBm)	Power emitted in receiver channel (dBm)	ACLR (dB)
2205	67	13.2	53.8
2215	67	-29.0	96.0

A8.12 Using the values of 46 dB, 60 dB and 86 dB for adjacent channel selectivity, we can derive adjacent channel interference ratios for each of these scenarios. Table A21 shows the values. We did not consider it realistic to assume 86 dB ACS for the PMSE channel at 2205 MHz, so we did not calculate ACIR values for that scenario.

Table A21. Adjacent channel interference ratio for each scenario

PMSE channel	CGC EIRP (dBm/5 MHz)	CGC ACLR (dB)	ACIR (dB)		
			46 dB PMSE ACS	60 dB PMSE ACS	86 dB PMSE ACS
2205 MHz	61	47.8	43.8	47.5	-
	67	53.8	45.3	52.9	-
2215 MHz	61	90.0	46.0	60.0	84.5
	67	96.0	46.0	60.0	85.6

Propagation model

A8.13 We continued to use the outdoor pedestrian propagation model in Recommendation ITU-R M.1225 for the initial analysis involving wireless cameras, portable/mobile links and temporary point to point links and a free space propagation model for airborne links. The frequency component in the M.1225 propagation model means that there will be greater loss at this frequency for a given distance than at the 2110 MHz boundary. Table A22 shows values for propagation loss for distances between 10m and 100m at a frequency of 2200 MHz.

Table A22. Recommendation ITU-R M.1225 propagation loss (frequency 2200 MHz)

Distance (m)	10	50	100	500	1000
Propagation loss (dB)	69.3	97.2	109.3	137.2	149.3

A8.14 We also repeated the analysis using the COST-Hata propagation model for the path loss between 3G base stations and wireless cameras and portable/mobile links. Again, we assumed a CGC base station height of 30m and a PMSE receiver height of 10m. Finally, alongside the COST-Hata analysis, we derived distances for temporary point to point links above building clutter, using a free space loss model.

Results for PMSE channel centred on 2205 MHz

Recommendation ITU-R M.1225 propagation model

A8.15 Table A23 shows the baseline case for the operation of PMSE in the channel centred on 2205 MHz in the presence of a CGC base station conforming to the EIRP limits in the CGC statement. Due to the close adjacency, the PMSE receiver ACS is set at 46dB and no additional filtering is assumed.

Table A23. Baseline case: interference from 61dBm/5 MHz EIRP CGC into adjacent PMSE at 2205 MHz

Interferer	Victim	Additional isolation or margin					Separation
		10	50	100	500	1000	(m)
CGC BS 7.5 MHz separation	Wireless camera 1W	54.9	27.0	14.9	-13.0	-25.1	236
	Portable/mobile links	62.9	35.0	22.9	-5.0	-17.1	374
	Airborne links	72.9	58.9	52.9	38.9	32.9	Note 1
	Temp point to point	74.9	47.0	34.9	7.0	-5.1	747
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

A8.16 Table A24 shows the operation of PMSE in the channel centred on 2205 MHz in the presence of a 2 GHz MSS/CGC base station conforming to the out of block EIRP limits in the CGC statement but with a 6 dB increase in its in-block power.

Table A24. Increased power: interference from 67 dBm/5 MHz EIRP CGC into adjacent PMSE at 2205 MHz

Interferer	Victim	Additional isolation or margin					Separation
		10	50	100	500	1000	(m)
CGC BS 7.5 MHz separation	Wireless camera 1W	59.4	31.4	19.4	-8.6	-20.6	305
	Portable/mobile links	67.4	39.4	27.4	-0.6	-12.6	484
	Airborne links	77.4	63.4	57.4	43.4	37.4	Note 1
	Temp point to point	79.4	51.4	39.4	11.4	-0.6	966
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

COST-Hata propagation model

A8.17 Table A25 shows the required separation distance between a PMSE receiver centred on 2205 MHz and a 2 GHz MSS/CGC base station conforming to the EIRP limits in the CGC Statement, and the difference in distance if the CGC power is increase by 6 dB. Due to the close adjacency, the PMSE receiver ACS is assumed to be 46dB as a baseline or 60 dB for equipment with improved selectivity or additional filtering. The distances are expressed in metres for wireless cameras and portable/mobile links, and in kilometres for free space propagation of interference into temporary point to point links.

Table A25. Increase in separation distance for first adjacent PMSE channel above 2200 MHz

PMSE receiver	Propagation model	PMSE ACS (dB)	Separation distance		Difference
			CGC EIRP: 61dBm/5 MHz	CGC EIRP: 67dBm/5 MHz	
Wireless camera 1W	COST-Hata	46	1969m	2636m	34%
		60	1542m	1611m	5%
Portable/mobile links	COST-Hata	46	3322m	4446m	34%
		60	2601m	2719m	5%
Temp point to point	Free space	46	176km	294km	67%
		60	114km	124km	8%

A8.18 It should be noted that the separation distances predicted for temporary point to point links with free space propagation do not take account of the curvature of the Earth.

A8.19 These results are similar to, but not quite as high as, those for 3G into PMSE at 2105 MHz. They suggest that users of the 2205 MHz PMSE channel would need to take similar mitigation measures to those needed at 2105 MHz with respect to any nearby CGC base stations.

Results for the PMSE channel centred on 2215 MHz

A8.20 The second PMSE channel above 2200 MHz is centred on 2215 MHz. For this channel we calculated results for PMSE ACS values of 46 dB, representing standard equipment; and 86 dB, representing the use of additional receiver filters. We also provided a set of results for the COST-Hata analysis using these values as well as 60 dB ACS, representing enhanced equipment.

Recommendation ITU-R M.1225 propagation model

Results without additional receiver filter (46 dB ACS)

A8.21 Table A26 now shows the baseline case for the operation of PMSE in the channel centred on 2215 MHz in the presence of a CGC base station conforming to the EIRP limits in the CGC statement.

Table A26. Baseline case: interference from 61dBm/5 MHz EIRP CGC into PMSE at 2215 MHz, no additional PMSE receiver filter

Interferer	Victim	Additional isolation or margin					Separation
		10	50	100	500	1000	(m)
CGC BS 17.5 MHz separation	Wireless camera 1W	52.7	24.8	12.7	-15.2	-27.3	208
	Portable/mobile links	60.7	32.8	20.7	-7.2	-19.3	330
	Airborne links	70.7	56.7	50.7	36.7	30.7	Note 1
	Temp point to point	72.7	44.8	32.7	4.8	-7.3	658
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

A8.22 These results show an improvement in comparison to table A20 due to the reduced emissions above 2210 MHz. However, although the adjacent channel interference ratio is over 40 dB better, the change in ACIR is only 2.2 dB so the reduction in separation distance is limited to about 12%. Table A27 shows the impact of a 6 dB increase in CGC base station power.

Table A27. Increased power: interference from 67 dBm/5 MHz EIRP CGC into PMSE at 2215 MHz, no additional PMSE receiver filter

Interferer	Victim	Additional isolation or margin					Separation
		10	50	100	500	1000	(m)
CGC BS 17.5 MHz separation	Wireless camera 1W	58.7	30.8	18.7	-9.2	-21.3	294
	Portable/mobile links	66.7	38.8	26.7	-1.2	-13.3	466
	Airborne links	76.7	62.7	56.7	42.7	36.7	Note 1
	Temp point to point	78.7	50.8	38.7	10.8	-1.3	929
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

Addition of PMSE receiver filter (86 dB ACS)

A8.23 In table A28 we show the impact of adding a receiver filter, while in the presence of a CGC base station using the in-block power limit in the CGC statement.

Table A28. Results with additional PMSE receiver filter: interference from CGC at 61 dBm/5 MHz EIRP into PMSE at 2215 MHz

Interferer	Victim	Additional isolation or margin					Separation
		10	50	100	500	1000	(m)
CGC BS 17.5 MHz separation	Wireless camera 1W	14.2	-13.8	-25.8	-53.8	-65.8	23
	Portable/mobile links	22.2	-5.8	-17.8	-45.8	-57.8	36
	Airborne links	32.2	18.2	12.2	-1.8	-7.8	Note 1
	Temp point to point	34.2	6.2	-5.8	-33.8	-45.8	72
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

A8.24 Finally, table A29 shows results for the PMSE channel at 2215 MHz with a receiver filter when the CGC in block power is increased by 6 dB but out of block emissions are unchanged.

Table A29. Results with additional PMSE receiver filter: interference from CGC at 67 dBm EIRP into PMSE at 2215 MHz

Interferer	Victim	Additional isolation or margin					Separation
		10	50	100	500	1000	(m)
CGC BS 17.5 MHz separation	Wireless camera 1W	19.1	-8.8	-20.9	-48.8	-60.9	30
	Portable/mobile links	27.1	-0.8	-12.9	-40.8	-52.9	48
	Airborne links	37.1	23.1	17.1	3.1	-2.9	Note 1
	Temp point to point	39.1	11.2	-0.9	-28.8	-40.9	95
Note 1: Calculation does not account for typical pattern losses between base station and airborne PMSE receivers, as considered further in the Engineering Study Phase 2 Report							

A8.25 These results show a major improvement over the scenario without additional receiver filtering. Although there is around 30-33% increase in separation distance, the total distances are less than half of the equivalent separation distance from 3G base stations.

COST-Hata propagation model

A8.26 Table A30 shows the increase in separation distances between the current power in the CGC Statement and a potential 6 dB increase in line with that being considered for 3G. Out of band limits are assumed to be unchanged.

Table A30. Increase in separation distance at second adjacent PMSE channel

PMSE receiver	Propagation model	PMSE ACS (dB)	Separation distance		Difference
			CGC EIRP: 61dBm/5 MHz	CGC EIRP: 67dBm/5 MHz	
Wireless camera 1W	COST-Hata	46	1705m	2523m	48%
		60	683m	1010m	48%
		86	137m	190m	38%
Portable/mobile links	COST-Hata	46	2876m	4256m	48%
		60	1152m	1705m	48%
		86	232m	320m	38%
Temp point to point	Free space	46	137km	273km	100%
		60	27km	54km	100%
		86	1.62km	2.86km	77%

A8.27 It should be noted that the separation distances predicted for temporary point to point links with free space propagation do not take account of the curvature of the Earth.

A8.28 These results are broadly similar to the 3G results for ACS values of 46 dB and 60 dB. For an ACS of 86 dB, the potential combination of greatly improved receiver selectivity and the low CGC emission limits result in significantly lower separation distances than any of the other scenarios.

Conclusion for CGC and PMSE

A8.29 The interference environment at 2205 MHz will present difficulties to PMSE users at either 62 dBm EIRP or 68 dBm EIRP and is likely to require similar mitigation measures to those needed in the 2105 MHz PMSE channel. Where separation distances between PMSE use in this channel and CGC base stations become necessary, a 6 dB power increase would make these distances about 35% longer, assuming 46 dB ACS, or 5% longer if 60 dB ACS is feasible. If there are locations in the UK that are able to use 2205 MHz in the presence of CGC base stations for temporary point to point links with receivers sited on rooftops or masts that are well above surrounding clutter, the separation distance for the case of free space paths would increase by almost 70%. If it is possible to provide equipment with adjacent channel selectivity of 60 dB, that equipment would instead see an 8% increase in necessary separation distances.

A8.30 For the PMSE channel at 2215 MHz, in the scenarios where COST-Hata is representative of the propagation environments where PMSE receivers are used, the combination of the emission limits and additional receiver filtering results in a small change to the necessary separation distances for a 6 dB increase in 2 GHz MSS/CGC base station power. Temporary point to point links with receivers mounted high on rooftops appear to present a problem at current power levels. The use of additional receiver filtering could provide a significant reduction in the isolation requirement, even in the case of increased CGC power (i.e. a change from 27km separation at 60 dB ACS to 2.9km separation at 86 dB ACS) but these distances are highly dependent on the actual propagation path between the 2 GHz MSS/CGC base station and the PMSE receiver. It may not be possible to guarantee that PMSE rooftop receivers are separated from CGC base stations by these distances but as the paths become longer, there is less change of them being accurately characterised as unobstructed free space propagation.

A8.31 We conclude that an increase in CGC power from 61 dBm/5 MHz to 67 dBm/5 MHz could be managed without adverse impact on PMSE in the channels above 2210 MHz, provided that additional receiver filters were implemented on PMSE equipment. For the PMSE channel below 2210 MHz, there would be a reduction in the number of locations where this channel could be used without the application of additional mitigation measures.