

---

## Protecting passive services at 23.6-24 GHz from future 26 GHz uses

---

Redacted for publication (redactions marked with [X])

**STATEMENT:**

Publication date: 4 July 2022

# Contents

---

## Section

1. Overview	3
2. Introduction	4
3. Summary of responses to the December consultation	11
4. Our decision and implementation	23

## Annex

A1. Illustrative example of mixed overlapping channels	29
A2. Respondents	32
A3. Legal framework	33

# 1. Overview

The 26 GHz band has been identified to help deliver 5G services to people and businesses. Its use will complement the 5G services already being rolled out in other bands (e.g. in 3.4-3.8 GHz). It can offer much greater bandwidth than existing 5G bands allowing the delivery of extremely high-speed services – but, being higher in frequency, its coverage is likely to be limited in comparison. We would like to make the 26 GHz band available as soon as possible as part of our proposals to enable new uses of mmWave spectrum.

However, there is a risk that new services in 26 GHz could interfere with sensitive uses in the nearby 24 GHz band. The 24 GHz band is used by both radio astronomers to help develop our understanding of the universe, and by climate/weather scientists to make measurements used for weather forecasting and provide vital input to studies on climate change.

We want to ensure that, when making the 26 GHz band available, we minimise any impact to these 24 GHz users so that they can continue to operate without harmful interference. We consulted on proposals to achieve this in December 2021. In this document we address responses to that consultation and set out our final decision.

## What we have decided – in brief

In addition to implementing harmonised limits on out-of-band emissions, we have decided to apply additional measures to protect the Radio Astronomy and Earth Exploration Satellite Services that operate in the 24 GHz band. Our decision will apply to the following:

- a) New uses (5G and other wireless broadband technologies) that we are preparing to authorise as part of our work to enable access to the 26 GHz band, and
- b) Indoor-only Shared Access authorisations that we have already enabled in part of the 26 GHz band.

The additional measures are:

- **To protect the Earth Exploration Satellite Service**

To limit the number (within any 300 km<sup>2</sup> area) of outdoor 26 GHz base stations which can be deployed in the lowest 800 MHz of the 26 GHz band (i.e. 24.25-25.05 GHz).

- **To protect the Radio Astronomy Service**

For **outdoor 26 GHz use**, exclusion zones around the six radio astronomy sites that comprise the e-MERLIN array in which the deployment of 26 GHz base stations would not be permitted.

For **indoor 26 GHz use**, additional measures are not required. We will therefore remove the existing 1 km exclusion zones around Jodrell Bank and Cambridge radio astronomy sites from the current indoor 26 GHz Shared Access licence product.

The overview section in this document is a simplified high-level summary only. The decisions we have taken, and our reasoning are set out in the full document.

## 2. Introduction

- 2.1 On 2 December 2021 we consulted on proposals to protect the Radio Astronomy Service and the passive Earth Exploration Satellite Service that operate in the 24 GHz band from out-of-band emissions of terrestrial systems capable of providing wireless broadband electronic communications operating in the 26 GHz band (the **December consultation**).<sup>1</sup>
- 2.2 This document sets out our decisions on the proposals we made in the December consultation.

## Background

- 2.3 We are currently preparing to authorise access to the 26 GHz band (24.25-27.5 GHz) for future wireless broadband services, and published a consultation on 9 May entitled “Enabling mmWave spectrum for new uses” (the **May 2022 consultation**).<sup>2</sup> The 26 GHz band was identified on a global basis for International Mobile Telecommunications (IMT) at the 2019 World Radiocommunication Conference (WRC-19).<sup>3</sup> It was also adopted as a pioneer band for 5G in Europe and subsequently Europe established a set of harmonised technical conditions for the band,<sup>4</sup> which are now part of UK law.<sup>5</sup>
- 2.4 Access to the 26 GHz band will enable consumers to benefit from a range of connectivity needs such as mobile services, including 5G and other wireless broadband services. We have already made part of this band (24.25-26.5 GHz) available for indoor-only wireless broadband, through our spectrum sharing framework.<sup>6</sup>
- 2.5 Whilst enabling the benefits of 26 GHz uses for consumers, it is important that uses in the nearby 24 GHz band (23.6-24 GHz) are protected from interference that might be caused by out-of-band emissions from use of the 26 GHz band.
- 2.6 The 26 GHz uses that we considered in our consultation are:

---

<sup>1</sup> See Consultation: [Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#) of 2 December 2021.

<sup>2</sup> See [Ofcom’s consultation: Enabling mmWave spectrum for new uses](#) of 9 May 2022.

<sup>3</sup> The ITU [Radio Regulations](#) footnote **5.532AB** states that the frequency band 24.25-27.5 GHz is identified for use by administrations wishing to implement the terrestrial component of International Mobile Telecommunications (IMT). This identification does not preclude the use of this frequency band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. Resolution **242** (WRC-19) applies. (WRC-19).

<sup>4</sup> Commission Implementing Decision (EU) 2019/784 of 14 May 2019 on harmonisation of the 24,25-27,5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union. A consolidated text is available [here](#). This decision has been developed on the basis of studies conducted by CEPT which lead to the development of ECC Decision (18)06 on the harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the band 24.25-27.5 GHz, as amended on 20 November 2020 - <https://docdb.cept.org/document/3361>

<sup>5</sup> Decision (EU) 2019/784 and Decision (EU) 2020/590 have been incorporated part of into UK law, following Brexit, by virtue of section 3 of the EU Withdrawal Act 2018. See: <https://www.legislation.gov.uk/eudn/2019/784/contents>, and <https://www.legislation.gov.uk/eudn/2020/590/contents>.

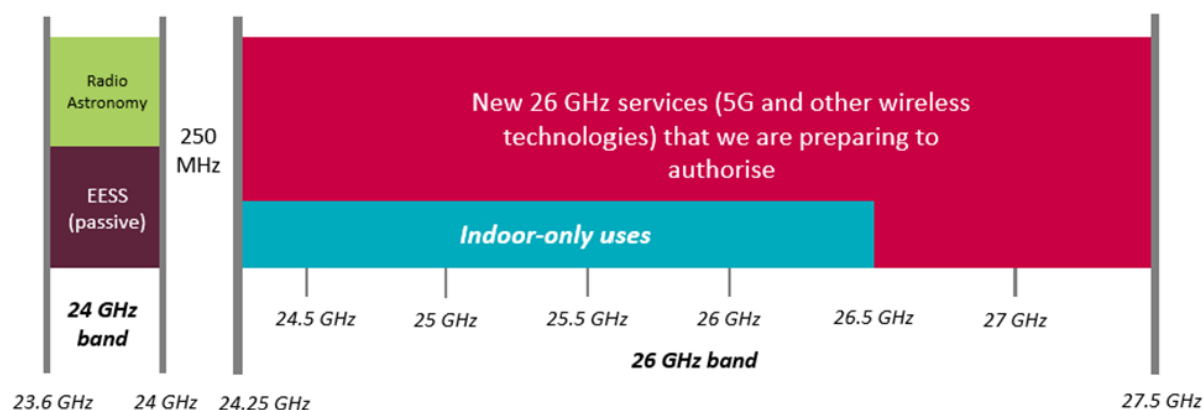
<sup>6</sup> [https://www.ofcom.org.uk/data/assets/pdf\\_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf)

- a) New wireless broadband services, including 5G mobile and other technologies that we are preparing to authorise as part of our work to enable access to mmWave,<sup>7 8</sup> and
- b) Indoor-only uses that we have enabled in part of the 26 GHz band under our Shared Assess framework.

2.7 The 24 GHz uses that we considered in our consultation have primary allocations in the Radio Regulations and are listed below and shown in Figure 1:

- a) The Radio Astronomy Service (**RAS**) and,
- b) The Earth Exploration Satellite Service (passive) (**EESS (passive)**)

**Figure 1: Uses of 24 GHz and 26 GHz covered by our December consultation**



## How the Radio Astronomy Service and Earth Exploration Satellite Service (passive) use the 24 GHz frequency band

2.8 The RAS and EESS in 24 GHz are passive (receive-only) services which take important scientific measurements. They collect naturally occurring radiation at very low power levels which means that they are very sensitive and may be susceptible to out-of-band emissions from the 26 GHz band.

### The Radio Astronomy Service

2.9 Radio astronomy is the study of radio emissions from stars, galaxies and other objects in the universe. RAS observations are used to improve our understanding of the universe and help in the investigation of cosmic phenomena. The frequencies important to radio astronomy are largely determined by the physical characteristics of extraterrestrial

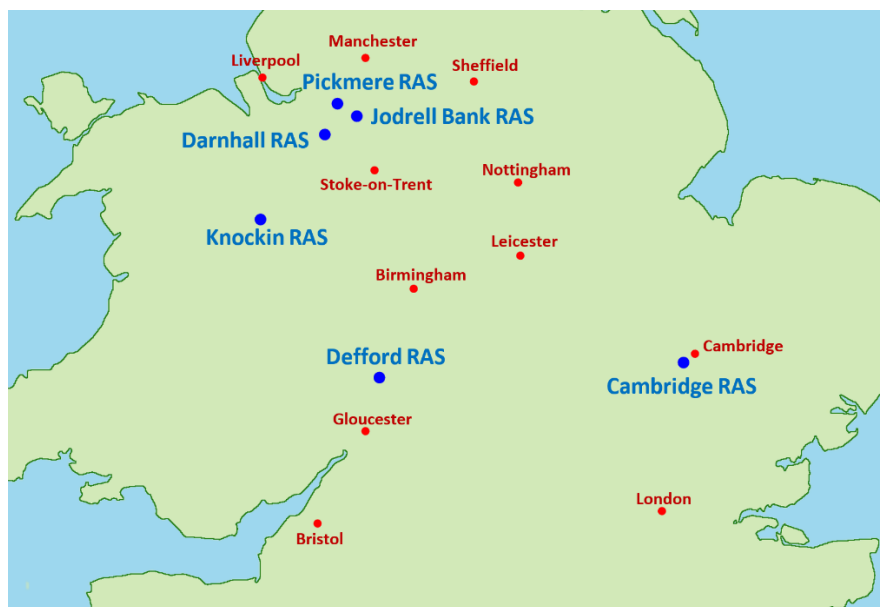
<sup>7</sup> We said that we would continue to work with Ministry of Defence to understand their current and future uses at 26 GHz and any measures needed to ensure the appropriate protection of the Radio Astronomy Service and Earth Exploration Satellite Service (passive).

<sup>8</sup> Existing allocations between 24-26.5 GHz were not within the scope of our considerations: short range devices (21.6-27 GHz); Programme Making and Special Events (24.25-25 GHz); Fixed Links (24.5-26.5 GHz); Earth Stations of the Earth Exploration Satellite Service and Space Research Service (25.5-26.5 GHz).

radiation and fundamental physical constants. This means that radio astronomers, unlike some other radio users, may have little choice about the frequencies they use.

- 2.10 Measurements taken in the 24 GHz band are important for answering a range of scientific questions; for example, ammonia (NH<sub>3</sub>) line studies help identify the distribution of ammonia in the galaxy which is important for the understanding of interstellar chemistry. These measurements are undertaken from six RAS sites (see Figure 2) that operate together as a radio telescope array called e-MERLIN.<sup>9</sup>
- 2.11 The e-MERLIN array makes observations across a wide range of frequencies helping to answer many important scientific questions regarding the universe including how galaxies and planets evolve. It is a key component of a global network of radio astronomy facilities comprising the world's largest VLBI<sup>10</sup> network and is complementary to the capability of the Square Kilometre Array (SKA<sup>11</sup>) in which the UK is investing around £300M over the next 10 years. Radio astronomy research in the UK is funded by the Science and Technology Facilities Council (STFC).<sup>12</sup>

**Figure 2: Map showing location of e-MERLIN RAS sites (shown in blue)**



### The Earth Exploration Satellite Service (passive)

- 2.12 A key use of the EESS (passive) is to provide information for studies of climate change and weather forecasting/warnings for national and global applications. The frequency bands used are determined by physics (e.g. to coincide with certain molecular absorption

---

<sup>9</sup> e-MERLIN is the UK's national interferometer radio telescope array operated by Jodrell Bank for the Science and Technology Council (STFC).

<sup>10</sup> Very-long-baseline interferometry (VLBI)

<sup>11</sup> The Square Kilometre Array (SKA) jointly funded intergovernmental project to build world's most powerful radio astronomy facilities in Australia and South Africa with headquarters in the UK.

<sup>12</sup> STFC is part of UKRI (UK Research and Innovation) a non-departmental public body sponsored by the Department for Business, Energy and Industrial Strategy (BEIS).

frequencies) which means that, unlike some other radio uses, there is little choice about the frequencies used. Measurements in various frequency bands are needed collectively to inform climate studies and weather forecasting, and the continuity of observations over a long timescale is essential.

- 2.13 The 24 GHz band is used to measure sea and land surface temperature and the water vapour content of the atmosphere. This band is important as it coincides with an important water absorption frequency, and by measuring close to this frequency, information on water vapour in the atmosphere can be gained.

## Harmonised limits on out-of-band emissions

- 2.14 As set out at Annex A3, in 2019 a European Commission Decision harmonised the essential technical conditions for the use of 26 GHz band (the “**26 GHz Decision**”).<sup>13</sup> In particular, these harmonised conditions include limits on out-of-band emissions from future deployments in the 26 GHz band to ensure the protection of RAS and EESS (passive) in the 24 GHz band. For ease of reference, we refer to these limits as the “**harmonised limits on out-of-band emissions**” in the remainder of this document. These limits are described in more detail in paragraphs 2.15-2.19 below.
- 2.15 We are required by UK law<sup>14</sup> to implement the harmonised limits on out-of-band emissions in (i) any new spectrum access licences authorising use of 26 GHz spectrum, and (ii) the existing indoor-only Shared Access licence product for 26 GHz spectrum.<sup>15</sup>
- 2.16 We are also required to ensure that deployments in the 26 GHz band appropriately protect other spectrum users operating in the same band or adjacent bands.<sup>16</sup> We therefore considered whether we should implement any measures in addition to the harmonised limits on out-of-band emissions to ensure the protection of RAS and EESS (passive) use in the 24 GHz band.
- 2.17 In our December consultation, we considered whether it would be appropriate to apply additional measures to (i) the new 26 GHz uses that we are preparing to authorise as part of our proposals to enable access to mmWave spectrum,<sup>17</sup> and (ii) indoor-only uses of the 26 GHz band that we have already enabled through our spectrum sharing framework. We said that our proposals would not apply to other existing uses of the 26 GHz band.<sup>18</sup>
- 2.18 In our December consultation, we said we would revise the current limits on out-of-band emissions set out in the 26 GHz indoor-only Shared Access licence, and include these limits in any new 26 GHz licences.

---

<sup>13</sup> An unofficial consolidated version of Decision 2019/784, as amended by Decision 2020/590, is available [here](#).

<sup>14</sup> Decision 2019/784 and Decision 2020/590 continue to be part of UK law, following Brexit, by virtue of section 3 of the EU Withdrawal Act 2018. See: <https://www.legislation.gov.uk/eudn/2019/784/contents>, and <https://www.legislation.gov.uk/eudn/2020/590/contents>.

<sup>15</sup> Shared Access licensing: <https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/shared-access>

<sup>16</sup> Articles 2 and 3 of Decision 2019/784, as amended by Decision 2020/590.

<sup>17</sup> See [Ofcom's consultation: Enabling mmWave spectrum for new uses](#) of 9 May 2022.

<sup>18</sup> Short range devices (21.6-27 GHz); Programme Making and Special Events (24.25-25 GHz); Fixed Links (24.5-26.5 GHz); Earth Stations of the Earth Exploration Satellite Service and Space Research Service (25.5-26.5 GHz).

2.19 The harmonised limits on out-of-band emissions are shown in Table 1 below.

**Table 1: Harmonised limits on out-of-band emissions**

	Base stations			Terminal stations		
	Frequency range	Maximum TRP <sup>19</sup>	Measurement bandwidth	Frequency range	Maximum TRP	Measurement bandwidth
<b>Initial limit</b> (before 1 January 2024)	23.6-24 GHz	-33 dBW	200 MHz	23.6-24 GHz	-29 dBW	200 MHz
<b>Final limit</b> (from 1 January 2024)	23.6-24 GHz	-39 dBW	200 MHz	23.6-24 GHz	-35 dBW	200 MHz

## What we proposed in our December consultation

### To protect the Radio Astronomy Service use at 24 GHz

#### Outdoor 26 GHz use

2.20 In addition to the harmonised limits on out-of-band emissions, we proposed to implement exclusion zones in which we would not permit any outdoor 26 GHz deployments. These exclusion zones would protect the six e-MERLIN radio astronomy sites<sup>20</sup> as shown in Table 2 below.

**Table 2: Exclusion zones around all six e-MERLIN RAS sites**

	Radii of exclusion zones (km)	
	Frequency range 24.25-25.05 GHz	Frequency range 25.05-27.5 GHz
<b>Before 1 January 2024</b>	<b>4.5 km</b>	<b>1.5 km</b>
<b>From 1 January 2024</b>	<b>2.5 km</b>	<b>1 km</b>

<sup>19</sup> TRP (Total radiated power) is a measure of how much power a composite antenna radiates. It equals the total conducted power input into the antenna array system less any losses in the antenna array system. TRP means the integral of the power transmitted in different directions over the entire radiation sphere as shown in the formula:

$$TRP \stackrel{def}{=} \frac{1}{4\pi} \int_0^{2\pi} \int_0^\pi P(\vartheta, \varphi) \sin(\vartheta) d\vartheta d\varphi$$

where  $P(\vartheta, \varphi)$  is the power radiated by an antenna array system in direction  $(\vartheta, \varphi)$  given by the formula:

$$P(\vartheta, \varphi) = P_{Tx} g(\vartheta, \varphi)$$

where  $P_{Tx}$  denotes the conducted power (measured in Watts), which is input into the array system, and  $g(\vartheta, \varphi)$  denotes the array systems directional gain along the  $(\vartheta, \varphi)$  direction.

<sup>20</sup> Cambridge (TL 39400 54000); Darnhall (SJ 64275 62265); Defford (SO 90200 44700); Jodrell Bank (SJ 79650 70950); Knockin (SJ 32855 21880); Pickmere (SJ 70404 76945).

### Indoor-only 26 GHz use

- 2.21 Indoor-only Shared Access 26 GHz licences are currently not available within 1 km of the Jodrell Bank and Cambridge RAS sites. We proposed to remove this restriction on the basis that (i) single dish measurements are not taken at these sites in the 24 GHz band, and (ii) our analysis showed that exclusion zones are not necessary to protect the six e-MERLIN sites from indoor use in the 26 GHz band.
- 2.22 We also said we would revise the current limits on out-of-band emissions set out in the indoor-only Shared Access 26 GHz licence product and replace them with the harmonised limits on out-of-band emissions.
- 2.23 We proposed to take any implementation action following our statement, including:
- i) varying any current indoor-only Shared Access 26 GHz licences;
  - ii) amending the relevant conditions in the Shared Access licence product for 26 GHz and related documents.

### Single dish

- 2.24 We said that in theory, two of the radio astronomy sites included in the e-MERLIN network (the ones located in Jodrell Bank and Cambridge) could also potentially be used for taking single dish measurements in the 24 GHz band.
- 2.25 We proposed not to implement any additional measures for protecting single dish measurements. This was because no single dish measurements were being taken in the 24 GHz band and it was unclear how important such measurements might be in the future. In relation to outdoor 26 GHz deployments, we also took into account the risk that any additional measures could disproportionately restrict future 26 GHz uses, given they would likely extend to several tens of kilometres.

## To protect Earth Exploration Satellite Service (passive)

- 2.26 In addition to the harmonised limits on out-of-band emissions, we proposed the following measures to protect EESS (passive):
- a) In 24.25 GHz-25.05 GHz we proposed to limit the number of 26 GHz outdoor base stations that could be deployed in any 300 km<sup>2</sup> area of the UK; and
  - b) In 25.05-27.5 GHz our view was that no additional measures would be necessary to protect EESS (passive) and so we did not propose to limit the number of base stations that could be deployed in any area in this remaining 2.45 GHz portion of the 26 GHz band.

## Impact Assessment

- 2.27 The analysis presented in our December consultation represented an impact assessment as defined in section 7 of the Communications Act 2003. Impact assessments provide a valuable way of assessing different options for regulation. They form part of best practice

policy making.<sup>21</sup> In particular, in addition to their likely impact on citizens and consumers, we have considered the impact of our proposals on existing and future users of the relevant frequencies, including adjacent bands.

- 2.28 We have also given careful consideration to whether our decisions will have a particular impact on persons sharing protected characteristics (broadly including race, age, disability, sex, sexual orientation, gender reassignment, pregnancy and maternity, marriage and civil partnership, and religion or belief in the UK, and in Northern Ireland also dependants and political opinion), and in particular whether they may discriminate against such persons or impact on equality of opportunity or good relations. This assessment helps us comply with our duties under the Equality Act 2010 and the Northern Ireland Act 1998.<sup>22</sup> We do not consider that our decisions have equality implications under the 2010 Act or the 1998 Act.

## Structure of this document

- 2.29 The remainder of this document is structured as follows:
- i) **Section 3** summarises responses that we have received and our response to them.
  - ii) **Section 4** sets out our decisions and how we will implement them.
  - iii) **Annex 1** provides an illustrative example of mixed overlapping channels
  - iv) **Annex 2** provides a list of respondents to our consultation.
  - v) **Annex 3** sets out the legal framework for the decisions set out in this statement.

---

<sup>21</sup> For more information on our approach to impact assessments, see the [guidelines](#).

<sup>22</sup> Further detail is given in section 149 of the Equality Act 2010 and section 75 of the Northern Ireland Act 1998.

## 3. Summary of responses to the December consultation

- 3.1 We received seven responses<sup>23</sup> to the December consultation. One respondent requested for the name of their organisation to be kept confidential. This section summarises the comments that we received and sets out our response to them.

### Responses to our proposals for protecting the Radio Astronomy Service

#### Comments received in response to our proposed exclusion zones for future outdoor use of 26 GHz

##### Consultation question 1

For future outdoor use of 26 GHz, do you agree that the proposed exclusion zones will provide appropriate protection to the 6 radio astronomy sites? If not please explain your reasons for this providing any supporting evidence.

##### Comments received

- 3.2 Three respondents<sup>24</sup> commented on this question.
- 3.3 BT and Vodafone agreed with our proposals. BT agreed that the proposed exclusion zones around the six radio astronomy sites would give adequate protection to radio astronomy and would be a proportionate measure. It also commented that the limitations these present for 5G deployment are relatively minor given their size and specific locations.
- 3.4 A confidential respondent [X], provided comments on the following issues:
- a) **Protection of single dish use at all six RAS sites** – The confidential respondent commented that while single dish use is not its current priority, Ofcom should consider protection of all six observatory sites for single dish use. It indicated that the Jodrell Bank site was used for single dish measurements for a range of frequencies and would continue to do so, for independent observations and to support e-MERLIN network observations. It further added that with new technological developments, there will be increasing applications for single dish measurements and that all e-MERLIN sites are equipped with single dish antennas and could be used in single dish mode in the future. It said it recognised that protecting all six e-MERLIN sites to the appropriate level for single dishes would have a significant impact on potential deployment of 26 GHz equipment, given the size of the exclusion zones, but said that nonetheless Ofcom

---

<sup>23</sup> See Annex 2 for the list of respondents. Non confidential responses are published on our website [here](#)

<sup>24</sup> BT, Vodafone, and one confidential respondent [X]

should consider “applying the standard and accepted (single dish) Recommendation ITU-R RA.769 level of protection to UK radio telescopic sites, especially since 23.6-24.0 GHz is a fully passive (5.340) band”.

- b) Type of measurements taken by RAS observatories and the protection level used in Ofcom’s analysis** – The confidential respondent said that the 23.6-24.0 GHz band is often used for continuum<sup>25</sup> observations and there is clear justification for using the continuum threshold as given in Recommendation ITU-R RA.769-2.<sup>26</sup>

The confidential respondent disagreed with the protection levels we used in our analysis to assess the out-of-band interference that would be received at the six RAS sites. It commented that the protection levels we used were “c 40 dB more relaxed” than the protection levels given in Recommendation ITU-R RA.769-2. Its view is that the protection level we used in our analysis of -168 dBW/250 kHz applied to 22 GHz (bands listed in Radio Regulations 5.149<sup>27</sup>) rather than 24 GHz which is listed in the passive footnote 5.340 of the Radio Regulations, in which no emissions are permitted.

- c) Updated information on locations of RAS sites** – The confidential respondent provided the locations shown in Table 3 for the relevant RAS sites and noted that the position of the Jodrell Bank Mark II telescope should be updated.

**Table 3: Location of the RAS stations provided in the confidential consultation response**

Observatory name	Easting	Northing
Jodrell Bank Mark II telescope	379817	370806
Cambridge	539423	254028
Darnhall	364278	362263
Defford	390201	244700
Knockin	332854	321877
Pickmere	370407	376953

- d) Aggregate vs single entry analysis** – The confidential respondent disagreed with the scenario used by Ofcom to assess the out-of-band interference to RAS sites. In its view, the exclusion zones for outdoor transmitters should be calculated based on the aggregate effect of 26 GHz interferers rather than a single 26 GHz interferer.

<sup>25</sup> which means that measurements are taken over a wide bandwidth

<sup>26</sup> Protection criteria used for radio astronomical measurements

<sup>27</sup> Radio Regulations footnote that lists the 22 GHz band and not the 24 GHz band where administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference.

## Our response

3.5 Our response to the specific points in the confidential respondent's response is:

- a) **Protection of single dish use at all six RAS sites** – We disagree with the confidential respondent's view that all RAS sites should be protected for single dish use. This is because, as indicated in its response, taking single dish measurements is not a priority for this band. We also note the confidential respondent's comments that all six RAS sites are equipped with single dish antennas, that they take single dish measurements for a range of frequencies, and that technological developments could increase the likelihood of single dish measurements being taken using the 24 GHz band in future. However, the confidential respondent did not provide any evidence in support of these points or on the specific need to do this using frequencies in the 24 GHz band, nor did it make clear how or why such measurements might be important in the future. In order to protect single dish use at all e-MERLIN sites, protection zones for outdoor 26 GHz deployments would need to extend to several tens of kilometres around each RAS site. For indoor-only 26 GHz deployments, single dish exclusion zones would be smaller but they would still need to be a few kilometres. We therefore remain of the view that it would be disproportionate to protect RAS sites for single dish use.
- b) **Type of measurements taken by RAS observatories and the protection level used in Ofcom's analysis** – In determining the appropriate protection level to use in our assessment of the compatibility between RAS at 24 GHz and future use of 26 GHz we have taken into account a number of factors including:
  - i) Currently, measurements at 24 GHz are carried out by the e-MERLIN array.
  - ii) Grants of recognised spectrum access (RSA), whilst not placing a requirement on us to protect RAS against out-of-band emissions, nonetheless provide a useful reference when determining appropriate protection levels.<sup>28</sup>
  - iii) The grants of RSA for Defford, Knockin, Darnhall and Pickmere, specify a protection level of -168 dBW/250 kHz for the 23.6-24 GHz band. These sites are constituents of the e-MERLIN array and, in our view, this protection level is appropriate for the protection of e-MERLIN as a whole including Jodrell Bank and Cambridge.<sup>29</sup>

We further clarify that the protection of UK RAS observations at 24 GHz from 26 GHz uses is a national matter. We disagree with the confidential respondent in relation to the application of Recommendation ITU-R RA.769 for protection levels for 24 GHz. This is not a mandatory recommendation that applies to the UK for the protection of the e-MERLIN network. We also clarify that footnotes RR 5.149 and RR 5.340 to Article 5 of

---

<sup>28</sup> The grants of RSA for radio astronomy provide that Ofcom will not authorise transmissions on the same frequencies that RSA is recognised as using unless certain conditions are met to protect radio astronomy use from harmful interference. They do not place obligations on Ofcom with respect to out-of-band emissions from transmissions outside these frequencies.

<sup>29</sup> Note, the grants of RSA for Jodrell Bank and Cambridge specify a different protection level. However, each constituent of the e-MERLIN array requires the same level of protection, hence we have used -168 dBW/250 kHz for all six e-MERLIN sites.

the Radio Regulations<sup>30</sup> do not explicitly set protection levels for the radio astronomy service.

We note the confidential respondent's comment that the band is often used for continuum measurements. However, we do not agree that we should use the continuum protection threshold as referred to by the confidential respondent. This is because, as explained above, we have used the appropriate protection level for the protection of e-MERLIN.

- c) **Locations of RAS sites** - We have considered the data that the confidential respondent provided on the location of the e-MERLIN sites. The difference between the locations provided in its response and those set out in the RSA (on which we based our analysis) are minimal. Nevertheless, we have re-run our analysis using the locations provided in its response, which has confirmed that the exclusion zone definition that we proposed in our consultation would still provide adequate protection to the RAS sites. This is because there are only minimal or no differences in the pattern of impact areas calculated around RAS sites with updated locations as compared to the results presented in Annex 2 of the December consultation. Moreover, the exclusion zones we proposed were rounded up to the nearest 0.5 km to simplify their implementation and because of this, the impact areas for the revised locations are still within the original exclusion zones. We therefore do not consider that it is necessary to update the national grid reference (NGR) locations around which we defined exclusion zones in our December consultation.
- d) **Aggregate vs single entry analysis** – In light of the confidential respondent's comments, we clarify that our analysis of a single-interferer at each and every azimuth direction around the RAS station is considered to be a worst-case scenario. The scenario we considered is a situation where the direction of transmission of a 5G base station is pointing directly at the RAS station in azimuth with very high antenna gain (or directivity) because it is delivering data to a terminal station along that same azimuth. We consider this scenario to be more conservative than if we had considered the case of multiple 5G base stations in aggregate, as suggested by the confidential respondent. Although it is possible that a situation could arise where the main beams of multiple 5G base stations are instantaneously pointing directly at the RAS station on the same frequency from different directions, we consider that this situation will occur very rarely in practice. For example, 5G base stations in this frequency range are likely to use "beamforming" antennas which dynamically alter the direction of transmission towards the terminal they are serving, which requires them to constantly change the direction of their main beams as they deliver data to different terminals in different locations. In our view, there is very low probability that the directions of transmission from base stations in multiple locations would simultaneously converge on the RAS station.

---

<sup>30</sup> <https://www.itu.int/en/publications/ITU-R/pages/publications.aspx?parent=R-REG-RR-2020&media=electronic>

## Comments received in response to our proposal to remove existing exclusion zones for indoor use of 26 GHz

### Consultation question 2

For indoor use of 26 GHz, do you agree that additional measures are not needed to protect radio astronomy sites and that we should remove the existing 1 km exclusion zone around Jodrell Bank and Cambridge from the current 26 GHz indoor-only shared access licence product? If not, please explain your reasons for this providing any supporting evidence.

### Comments received

- 3.6 Three respondents<sup>31</sup> commented on this question.
- 3.7 BT agreed that additional constraints on indoor 26 GHz deployments are not required to protect RAS sites. Vodafone also supported our proposals, while calling for clarity on the definition of indoor usage, although it did not believe there would be any practical impact for the specific RAS sites listed in the consultation.
- 3.8 A confidential respondent [REDACTED] commented that the same general points that it had raised in response to question 1 applied here, however, they would be less severe due to power output and building loss.

### Our response

- 3.9 Our response to comments made by the confidential respondent in response to question 1 also apply to this question. We therefore disagree, for those reasons, that the 1 km exclusion zone should remain.
- 3.10 We note Vodafone's request for clarity about the definition of 'indoor' use. In line with the definition of "indoors" set out in our low power Shared Access licence product - in this context "indoors" means inside premises which have a ceiling or a roof; and except for any doors, windows or passageways, are wholly enclosed.<sup>32</sup>

---

<sup>31</sup> BT, Vodafone and one confidential respondent [REDACTED]

<sup>32</sup> See Ofcom's [Shared Access licence guidance document](#), paragraph 3.8.

## Responses to our proposals for protecting Earth Exploration Satellite Service (passive)

### Comments received in response to our proposal to limit the number of 26 GHz base stations using 24.25-25.05 GHz

#### Consultation question 3

Do you agree with our proposal to limit the number of 26 GHz base stations in 24.25-25.05 GHz to protect EESS (passive) use at 24 GHz? If not, please explain your reasons for this providing detailed supporting evidence.

#### Comments received

- 3.11 We received six responses to our proposals to protect EESS (passive).<sup>33</sup>
- 3.12 BT and Vodafone agreed with Ofcom's analysis and the proposal to limit the number of 26 GHz base stations in 24.25-25.05 GHz to protect EESS (passive) use at 24 GHz.
- 3.13 UK Space Agency (**UKSA**), European Centre for Medium Range Weather Forecasts (**ECMWF**), Met Office, the European Organisation for the Exploitation of Meteorological Satellites in a joint response with the European Space Agency (**EUMETSAT and ESA**) highlighted the need to limit the number of base stations and their out-of-band emissions, but expressed concerns about whether the proposed measures would offer sufficient protection to EESS (passive) at 24 GHz.
- 3.14 UKSA agreed that limiting the number of base stations in order to protect EESS (passive) from their out-of-band emissions would be beneficial, however they commented that the "compromise limit" of -33 dBW/200 MHz reducing to -39 dBW/200 MHz by 2027 agreed at WRC-19 was not supported by the EESS (passive) community. To address this, UKSA said that immediately after WRC-19 "we agreed within the UK that the more stringent limits would apply from 2024 rather than 2027" as later agreed by CEPT. The UKSA response further commented that this would help mitigate the problem to an extent, but given the sensitivity of this data, they would still prefer that UK deployments strive to meet the more stringent -42 dBW/200 MHz limits from the outset as far as possible and this would mean further reducing the number of base stations deployed in some areas including further mitigation such as reducing base station maximum radiated power.
- 3.15 ECMWF commented that "the calculations in the EESS community" showed a higher level of protection (-42 dBW/200 MHz) than agreed at WRC-19 (-39 dBW/200 MHz) is needed and supported all efforts to afford more protection to the EESS band.

---

<sup>33</sup> We received comments from: BT, the Met Office, Vodafone, the European Centre for Medium-Range Weather Forecasts (ECMWF), UK Space Agency (UKSA), and the European Organisation for the Exploitation of Meteorological Satellites and the European Space Agency (EUMETSAT, ESA).

- 3.16 Three respondents provided additional information about the importance of the 24 GHz band for passive operation of EESS. ECMWF referred to increased use of microwave imager data over land in line with the "all-sky all-surface strategy" which it said increases the importance of the imager bands such as 24 GHz over land above the value they had at WRC-19. Met Office said that although it does not currently use data from observations made in this band over land areas, its use is an active area of research which could unlock additional benefits from existing measurements. In this respect, Met Office stated that its own studies have shown that even with the proposed limits, out-of-band emissions over land would make this 24 GHz band data unusable over land and would have the potential to degrade the quality of data over coastal areas. EUMETSAT and ESA provided details about several operated or planned satellite missions within the band.
- 3.17 We note that ESA and EUMETSAT fully supported the comments in the responses of UKSA, UK Met Office and ECMWF, and ECMWF said that they had seen and endorsed the comments submitted by the Met Office, UKSA and ESA.

### Our response

- 3.18 In relation to the comments expressing preference for more stringent limits on out-of-band emissions than the ones proposed, it should be noted that the initial and final base station limits of -33 dBW/200 MHz<sup>34</sup> and -39 dBW/200 MHz<sup>35</sup>, respectively, were agreed at WRC-19 and were subsequently incorporated into the harmonised limits on out-of-band emissions. Ofcom is required to implement these limits. We note that no additional calculations or supporting technical analysis was provided in any response to evidence the need for tighter restrictions to limit the number of base stations. Our analysis shows that the combination of the harmonised limits on out-of-band emissions and our limit on the number of base stations deployed in any 300 km<sup>2</sup> area in the lowest 800 MHz of the 26 GHz band, ensures the protection of EESS (passive) – thus, even if we were not bound by UK law to implement the limits agreed at WRC-19, we do not see a case to consider tighter out-of-band limits.
- 3.19 On ECMWF's comment that "the calculations in the EESS community" showed a higher level of protection (-42 dBW/200 MHz) than agreed at WRC-19, we clarify that this was Europe's original proposal to WRC-19. However, the agreement at WRC-19 included that countries would avoid deploying high density mobile systems in the bands immediately below 23.6 GHz thus allowing the removal of a 3 dB apportionment factor that had been included in calculations that lead to the -42 dBW/200 MHz value.<sup>36</sup> As explained in 2.15 the limits we are implementing are now part of UK law.
- 3.20 We have considered the Met Office's comment on the effect of out-of-band emissions on the usability of data collected by EESS (passive) over land areas, however, we note that our analysis shows that our proposed measures to limit the number of outdoor base stations

---

<sup>34</sup> with an initial Terminal Station Limit: -29 dBW/200 MHz

<sup>35</sup> with a final Terminal Station Limit: -35 dBW/200 MHz

<sup>36</sup> See [Radio Regulations](#) Resolution 242, recognising f)

within any 300 km<sup>2</sup> area in the lowest 800 MHz of the 26 GHz band will protect EESS (passive) over land or sea. No studies or detailed supporting evidence were provided by Met Office, or other respondents, to suggest otherwise.

## Comments on our technical analysis and other issues raised

### Consultation question 4

Do you agree with the technical analysis set out in Annex 2? If not, please explain your reasons for this providing detailed supporting evidence.

- 3.21 We note that the confidential respondent's comments on the impact to RAS and our response to these is covered in paragraph 3.5 of this statement.

### Comments on the implementation margin

- 3.22 UKSA commented that it did not support using a 2 dB implementation margin by which systems typically exceed the specifications, as they said that this margin could not be guaranteed. Both UKSA and ECMWF stated that the 2 dB implementation margin had already been factored into the agreement at WRC-19 to adopt an emission limit of -39 dBW/200 MHz instead of -42 dBW/200 MHz, and therefore by incorporating it into our analysis we were 'double counting'.
- 3.23 While BT found the technical assumptions to be appropriate, it viewed them as "probably somewhat conservative". BT gave the example that the actual out-of-band emissions of 5G technology might be more than the assumed 2 dB lower than the specified values. BT noted that that ECC Report 249 discussed the issue of difference in specified and actual out-of-band emissions and how this could be considered in compatibility studies and further noted that although the report gives some examples for mobile technology, it does not have specific guidance or evidence in relation to 5G NR equipment and the 26 GHz band.

### Our response

- 3.24 As we said in our December consultation,<sup>37</sup> it is common for vendors to manufacture their base stations with a certain margin in order to ensure they meet the regulatory limit. The GSA in a submission to ECC (See ECC(18)035) proposed an implementation margin of 3 dB. We also note that no implementation margins were taken into account in the studies from CEPT administrations submitted to the ITU in preparation for WRC-19,<sup>38</sup> and so factoring an implementation margin into our analysis now does not constitute double counting. We remain of the view that assuming an average implementation margin of 2 dB is appropriate.

---

<sup>37</sup> See paragraph A2.64 of our December consultation

<sup>38</sup> See Studies A and J from Attachment 2 to Annex 3 to Task Group 5/1 Chairman's Report (document 5-1/478) - [https://www.itu.int/dms\\_ties/itu-r/md/15/tg5.1/c/R15-TG5.1-C-0478!N03-P2!MSW-E.docx](https://www.itu.int/dms_ties/itu-r/md/15/tg5.1/c/R15-TG5.1-C-0478!N03-P2!MSW-E.docx)

### Apportionment of interference from other services

- 3.25 BT also understood that the interference criterion used in the ITU/CEPT studies included apportionment of interference from other services, but if the incumbent microwave links were not present in the 26 GHz band, this may not be required.

### Our response

- 3.26 We have considered BT's comment regarding apportionment in relation to incumbent microwave links. We note that the ITU/CEPT studies did not assume interference from microwave links within the 26 GHz band.

### Comments on the level of out-of-band interference assumed for 5G base stations

- 3.27 The analysis we included in the December consultation for protection of EESS (passive) was based on a "typical" base station, and assumed that there would be a 4 dB reduction in out-of-band emission levels per 200 MHz frequency separation between the 5G base station and the EESS (passive) sensor. UKSA emphasised that it could only support the assumption of a 4 dB drop for each additional 200 MHz of frequency separation on the condition the out-of-band emission mask that defines this roll-off is a mandatory requirement. UKSA said that limits are currently defined by the level of radiation into the passive band, and that systems operating further up the band will already have factored this into their designs.
- 3.28 UKSA also stated that it did not support adopting a level of -37 dBW/200 MHz (which is a per base station out-of-band emission level) used in Ofcom's analysis for the calculation of the allowable aggregate value of emissions into the 24 GHz band from a deployment of base stations in the F8 satellite's<sup>39</sup> instantaneous field of view.
- 3.29 Met Office said that its studies confirmed a threshold of -37 dBW/200 MHz (which is the per base station out-of-band emission level used in our analysis) as acceptable for the microwave sounders operating in bands adjacent to 26 GHz. However, it said that its calculations show that if 443 base stations are within the field of view of a sensor, this would lead to a 26 dB increase in power levels, 443 times the -37 dBW/200 MHz stated limit.

### Our response

- 3.30 We have considered the UKSA's suggestion that the assumption of an average 4 dB reduction in out-of-band emission levels per 200 MHz frequency separation should be a mandatory requirement. In our view it would not be appropriate to convert an assumption about average performance (taking into account variations in network loading) across all the base stations in the satellite's field of view into a regulatory ceiling for individual equipment. In addition, introducing such a mandatory requirement would prevent us from fulfilling the legal requirement to implement the harmonised limits on out-of-band

---

<sup>39</sup> The technical characteristics of the F8 satellite sensor are defined in Recommendation ITU-R RS.1861

emissions because it would have the effect of imposing more restrictive conditions on equipment performance than those required by the harmonised limits on out-of-band emissions.

- 3.31 We note that the UKSA said it did not support a -37 dBW/200 MHz limit. In light of this we are clarifying that this value was not the proposed limit. The studies submitted to the ITU in preparation for WRC-19 used EESS (passive) sensor characteristics taken from Recommendation ITU-R RS.1861-0. In this version of the recommendation,<sup>40</sup> the most sensitive sensor was the F3 sensor, and the studies therefore were based on its protection. Subsequently, however, it was found that the F3 sensor was not actually deployed on an EESS (passive) satellite, the most sensitive sensor actually deployed was F8. The F8 sensor is 2 dB less sensitive than the F3 sensor. Taking this into account an equivalent level of out-of-band emissions per base station would be -37 dBW/200 MHz. However, we confirm that the limits we will implement are the harmonised limits on out-of-band emissions.
- 3.32 We note the Met Office has carried out calculations which it says show that if 443 base stations are within the field of view of a sensor, this would lead to a 26 dB increase in power levels. We note that these calculations assume that the harmonised limits on out-of-band emissions are the *total* interference that can be accepted by the satellite. This is not the case: the out-of-band emission limit is for a *single* base station which is needed to ensure the protection of the F8 sensor, rather than the aggregate interference level. As we explained in Annex 2 of the December consultation, given this limit applies to every base station, the aggregate interference threshold for a single 200 MHz channel in a 300 km<sup>2</sup> area for 443 base stations is -10.54 dBW/200 MHz. The value of -10.54 dBW/200 MHz is indeed 443 times -37 dBW/200 MHz, but it is the aggregate interference level rather than the interference level from a single base station. This aggregate interference level is what was then used to derive the limit for a single base station.

### Comments on the frequency range where additional measures apply

- 3.33 ECMWF questioned the frequency range to which additional measures would apply. It said that that regardless of whether a 5G base station is operating using frequencies immediately adjacent to the EESS (passive) band, or using frequencies 2 GHz away from the passive band, if the unwanted emission is -39 dBW/200 MHz, then the sensor will receive -39 dBW/200 MHz of emissions in both cases. UKSA also queried whether it was safe to disregard any contributions to out-of-band emissions from deployments operating above 25.05 GHz.

### Our response

- 3.34 We considered whether it was likely or feasible that the unwanted emissions from a 26 GHz base station into the 23.6-24 GHz band would be exactly the same regardless of

---

<sup>40</sup> Note, an updated version of the recommendation – RS.1861-1 – was published in 2021 with references to the F3 sensor removed.

whether the base station was transmitting at the band edge or at a 2 GHz frequency separation. It is reasonable to expect unwanted emissions to be lower as the frequency separation from the transmitted signal increases, and measurements we have seen of 5G base stations show that emissions reduce with increased frequency separation from the transmitted block. We concluded that it would be unrealistic to assume that base stations separated from the EESS (passive) band by 800 MHz or more would emit exactly the same level of emissions into the 24 GHz band as those at 250 MHz separation from it. The reduction of 4 dB for every 200 MHz frequency separation that we assumed for the typical base station also takes into account that this is averaged across all the base stations within the satellite's instantaneous field of view, and anything less than 100 % network loading at a base station will also result in reduced emissions. On this basis, channels from 25.05 GHz upwards would make a negligible contribution to the overall interference level received below 24 GHz. For example, a 200 MHz channel in 25.05-25.25 GHz would emit, on average, out-of-band emissions 16 dB lower than a channel at the lower edge of the band (24.25-24.45 GHz), contributing as little as 0.07 dB to the overall interference level, and even less moving up the band above 25.05 GHz.

#### Comments on neglecting contributions from indoor deployments to protect EESS (passive)

- 3.35 UKSA said that it had not been able to verify the assumption that contributions from indoor deployments can be safely neglected to protect EESS (passive) and it would like to see these assumptions confirmed by technical experts in ESA and EUMETSAT.

#### Our response

- 3.36 We remain of the view that it is unnecessary to impose additional measures on indoor 5G systems. We explained in the December consultation that EESS (passive) satellites scan the surface of the earth at an elevation angle of at least 25°, and any interference from an indoor base station towards the satellite would be significantly reduced on its path through the roof and ceiling of the building. Consequently, the contribution from 5G indoor base stations to the aggregate interference towards these satellites will be negligible in comparison with the contribution from outdoor base stations and does not require any additional measures to be imposed.

### Other issues raised

#### Review of our decisions with greater experience of mmWave uses

- 3.37 While BT supported our proposals, it proposed that Ofcom should consider the possibility of further relaxing the restrictions on 5G deployments in the future once there is a larger volume of equipment available and greater experience of 5G deployments and operation of these networks in the mmWave band.

#### Our response

- 3.38 We agree that mmWave technology is in its early stages of development and that as this technology develops, improvements could result in better out-of-band performance.

Should this occur, licensees will be able to request that Ofcom consider relaxation to the additional measures in the future if they provide evidence that it would be necessary and proportionate to do so.

### **Difference in the value of the 26 GHz band where additional measures could apply**

- 3.39 Vodafone commented that additional measures that lead to limitations on deployments in 24.25-25.05 GHz could limit deployments in some geographic areas (or, could mean that any licences authorising use of 24.25-25.05 GHz would have a reduced value). Vodafone noted that Ofcom would need to take any restrictions into account when considering the award process for the 26 GHz band.

### **Our response**

- 3.40 In our May 2022 consultation,<sup>41</sup> we proposed to make the lowest 850 MHz of the band (24.25-25.1 GHz) available for local users by extending the Shared Access licensing framework. Part of the reasoning for this was based on the additional measures in 24.25-25.05 GHz, as described in paragraphs 3.18 and 3.19 of the May 2022 consultation. We will continue to take this point into account when we make further proposals and a decision in our statement on the authorisation process for the 26 GHz band.

---

<sup>41</sup> See Ofcom's consultation: [Enabling mmWave spectrum for new uses](#) of 9 May 2022.

## 4. Our decision and implementation

### Introduction

- 4.1 Having carefully considered all responses to the December consultation, in this section we detail our decision. We continue to rely on the technical analysis set out in Annex 2 to our December consultation in support of the decisions set out in this document and provide further explanation related to the protection of the EESS (passive) below.
- 4.2 In line with our Spectrum Management Strategy<sup>42</sup> and for the reasons set out in this document, we consider that our decision provides an efficient balance between the level of interference protection given to one service and flexibility for others to transmit.
- 4.3 We also explain how we will implement our decision in this section.

### 26 GHz authorisations to which our decision will apply

- 4.4 Our decision will apply to the following authorisations in the 24.25-27.5 GHz (26 GHz) band:
- a) New wireless services, including 5G mobile and other technologies that we are preparing to authorise as part of our work to enable access to the 26 GHz band and,
  - b) Indoor-only authorisations that we have enabled in part of the 26 GHz band under our Shared Access framework.<sup>43</sup>
- 4.5 We will continue to work with the Ministry of Defence to understand their current and future uses at 26 GHz and to ensure they provide the appropriate protection to the Radio Astronomy Service and Earth Exploration Satellite Service (passive) in the 23.4-26 GHz band.

### The harmonised limits on out-of-band emissions

- 4.6 The measures which we have decided to implement are additional to the harmonised limits on out-of-band emissions set out in the 26 GHz Decision, which are shown in Table 4 below.

---

<sup>42</sup> <https://www.ofcom.org.uk/consultations-and-statements/category-1/supporting-uk-wireless-future>

<sup>43</sup> Indoor-only Shared Access licences are currently available in the 24.25-26.5 GHz frequency range.

Table 4: Harmonised limits on out-of-band emissions

	Base station			Terminal station		
	Frequency range	Maximum TRP <sup>44</sup>	Measurement bandwidth	Frequency range	Maximum TRP	Measurement bandwidth
<b>Initial limit</b> (before 1 January 2024)	23.6-24 GHz	-33 dBW	200 MHz	23.6-24 GHz	-29 dBW	200 MHz
<b>Final limit</b> (from 1 January 2024)	23.6-24 GHz	-39 dBW	200 MHz	23.6-24 GHz	-35 dBW	200 MHz

## Our decision on additional measures

### To protect Radio Astronomy Service use at 24 GHz

#### e-MERLIN sites

- 4.7 The additional measures that we have decided to implement are intended to protect the following six radio astronomy sites that comprise the e-MERLIN array, with NGR locations as follows:

Jodrell Bank (SJ 79650 70950)

Cambridge (TL 39400 54000)

Darnhall (SJ 64275 62265)

Defford (SO 90200 44700)

Knockin (SJ 32855 21880)

Pickmere (SJ 70404 76945)

#### Outdoor 26 GHz use

- 4.8 For outdoor 26 GHz use, we have decided to apply exclusion zones in which the deployment of base stations operating at 26 GHz would not be permitted. These exclusion

<sup>44</sup> TRP (Total radiated power) is a measure of how much power a composite antenna radiates. It equals the total conducted power input into the antenna array system less any losses in the antenna array system. TRP means the integral of the power transmitted in different directions over the entire radiation sphere as shown in the formula:

$$TRP \stackrel{\text{def}}{=} \frac{1}{4\pi} \int_0^{2\pi} \int_0^\pi P(\vartheta, \varphi) \sin(\vartheta) d\vartheta d\varphi$$

where  $P(\vartheta, \varphi)$  is the power radiated by an antenna array system in direction  $(\vartheta, \varphi)$  given by the formula:

$$P(\vartheta, \varphi) = P_{Tx} g(\vartheta, \varphi)$$

where  $P_{Tx}$  denotes the conducted power (measured in Watts), which is input into the array system, and  $g(\vartheta, \varphi)$  denotes the array systems directional gain along the  $(\vartheta, \varphi)$  direction.

zones will comprise circular areas around the six e-MERLIN sites, centred on the NGR locations listed in paragraph 4.7 above with radii as shown in Table 5 below.

**Table 5: Radii of exclusion zones around all six e-MERLIN sites**

	Radii of exclusion zones (km)	
	Frequency range 24.25-25.05 GHz	Frequency range 25.05-27.5 GHz
<b>Before 1 January 2024</b>	<b>4.5 km</b>	<b>1.5 km</b>
<b>From 1 January 2024</b>	<b>2.5 km</b>	<b>1 km</b>

- 4.9 We will implement these measures when we authorise access to future outdoor uses in the 26 GHz band.<sup>45</sup>

#### Indoor-only 26 GHz use

- 4.10 We have decided that additional measures to protect the e-MERLIN array from future indoor base station deployments in the 26 GHz band are not required. We are therefore removing the existing 1 km exclusion zones around Jodrell Bank and Cambridge radio astronomy sites from the current indoor-only 26 GHz Shared Access licence product.
- 4.11 We are revising the current limits on out-of-band emissions set out in the indoor-only 26 GHz Shared Access licence product, so that they are in line with the harmonised limits on out-of-band emissions. Specifically, the limits set out in the current licence product that apply within the 23.6-24 GHz band will be replaced as follows:
- a) A total radiated power limit of -42 dBW/200 MHz on the emissions from base stations will be replaced with:
    - i) an initial total radiated power limit of -33 dBW/200 MHz for base stations brought into use before 1 January 2024; and
    - ii) a final total radiated power limit of -39 dBW/200 MHz for base stations brought into use from 1 January 2024.
  - b) A total radiated power limit of -38 dBW/200 MHz on the emissions from terminal stations will be replaced with:
    - i) an initial total radiated power limit of -29 dBW/200 MHz for terminal stations brought into use before 1 January 2024; and
    - ii) a total radiated power limit of -35 dBW/200 MHz for terminal stations brought into use from 1 January 2024.
- 4.12 Following the publication of this statement we will:

<sup>45</sup> <https://www.ofcom.org.uk/consultations-and-statements/category-1/mmwave-spectrum-for-new-uses>

- a) Update schedule 3 of the indoor-only Shared Access 26 GHz licence template with the new initial and final limits.
- b) Update all the relevant documents (Interface requirement IR 2105, OfW 590 Technical Frequency Assignment Criteria for Shared Access Radio Services and Ofcom's Shared Access guidance) to:
  - i) remove the 1 km exclusion zones around Jodrell Bank and Cambridge radio astronomy sites, and
  - ii) update the out-of-band emissions limits so that they are in line with the harmonised limits on out-of-band emissions, and
- c) vary any current indoor-only Shared Access 26 GHz licences<sup>46</sup> to update the out-of-band emissions limits so that they are in line with the harmonised limits on out-of-band emissions.

### To protect Earth Exploration Satellite Service (passive)

- 4.13 We have decided to limit the number of 26 GHz outdoor base stations that can be deployed in the lowest 800 MHz of the 26 GHz band (i.e. from 24.25 GHz to 25.05 GHz) in any 300 km<sup>2</sup> area.
- 4.14 As set out in our December consultation,<sup>47</sup> in cases where channels do not overlap, we would calculate this limit on the number of base stations using the following equation:

#### Equation 1

$$(P_{Initial} \times NBS_{Initial}) + (P_{Final} \times NBS_{Final}) \leq \text{Aggregate interference threshold (linear)}$$

Where:

$P_{Initial}$ : average base station out-of-band emission level at the initial limit:  $10^{-35/10}$  (W/200 MHz)

$P_{Final}$ : average base station out-of-band emission level at the final limit:  $10^{-41/10}$  (W/200 MHz)

$NBS_{Initial}$ : number of base stations brought into use before 1 January 2024 at the initial limit

$NBS_{Final}$ : number of base stations brought into use from 1 January 2024 at the final limit

As indicated above, the implementation margin of 2 dB is taken into account in the average base station out-of-band emission levels  $P_{Initial}$  and  $P_{Final}$ . This means that for a base station required to meet the initial limit of -33 dBW/200 MHz, we assume the average emission level to be -35 dBW/200 MHz. Similarly, for a base station required to meet the final limit of -39 dBW/200 MHz, we assume the average emission level to be -41 dBW/200 MHz.

---

<sup>46</sup> As at the date of this Statement there we have only issued one Shared Access Licence in this band.

<sup>47</sup> December consultation, paragraphs 4.15-4.17.

The aggregate interference threshold used in this equation is dependent on the channel size and is set out in Table 6.<sup>48</sup>

**Table 6: Aggregate interference threshold for different channel sizes**

Channel Size (MHz)	Aggregate Interference thresholds	
	logarithmic (dBW/200 MHz)	linear (W/200 MHz)
50	-15.20	0.0302
100	-12.66	0.0542
200	-10.54	0.0883
400	-9.08	0.1236
800	-8.44	0.1432

4.15 Paragraphs 4.17 and A2.84 to A2.86 of our December consultation describe how we would accommodate different base station deployment scenarios including mixed overlapping channel sizes. In these cases (i.e. where channels overlap and may be of mixed sizes), we said that the total interference contribution from all individual base stations operating in the lowest 800 MHz of the 26 GHz band within any 300 km<sup>2</sup> area must be lower than -8.44 dBW/200 MHz.<sup>49</sup> In line with this, in cases where channels overlap and may be of mixed sizes, we will calculate this limit on the number of base stations using the following equation<sup>50</sup>:

**Equation 2**

$$\sum_{n=1}^N I_{c\_n} \leq 0.1432 \text{ W/200 MHz}$$

Where:

$N$ : is the total number of base stations in the 300 km<sup>2</sup> area

$n$ : is the  $n^{\text{th}}$  base station

$I_{c\_n}$ : is the interference contribution from the  $n^{\text{th}}$  base station (in linear units - W/200 MHz)

Note, the aggregate interference threshold used in Equation 2 (i.e. 0.1432 W/200 MHz) is the same as the aggregate interference threshold for an 800 MHz channel from Table 6 above ( $10^{-8.44/10} = 0.1432$ ).

<sup>48</sup> See Annex A2 of the December Consultation for information on how these were derived.

<sup>49</sup> December consultation, paragraph A2.86.

<sup>50</sup> This equation implements the approach set out in Annex 2 to the December consultation, paragraphs A2.84 to A.2.86.

When calculating the interference contribution ( $I_{c_n}$ ) of each individual base station we will take into account the average 2 dB implementation margin, the 4 dB reduction in average out-of-band emission levels per 200 MHz frequency separation from the lower band edge<sup>51</sup>, and whether the initial or final out-of-band emission limit applies for that base station.<sup>52</sup>

- 4.16 Where a base station is deployed with more than one sector<sup>53</sup> (three sectors, for example), each sector will count as a separate base station in the application of both Equation 1 and Equation 2.
- 4.17 In Annex 2 to our December consultation, we provided several examples of the application of Equation 1 and the aggregate interference thresholds in Table 6 to calculate the maximum number of 26 GHz outdoor base stations that can be deployed in the 24.25-25.05 GHz band in any 300 km<sup>2</sup> area. In Annex 1 to this document we provide a further example to illustrate how we would apply Equation 2 to calculate that maximum number in a case of mixed overlapping channel sizes. We will provide further information, as necessary, on the process we intend to follow in order to implement this approach as part of our proposals on the future authorisation of the 26 GHz band.
- 4.18 We have decided that additional measures are not required to limit the number of base stations that can be deployed in any area in the remaining 2.45 GHz portion of the 26 GHz band (i.e. 25.05-27.5 GHz).

---

<sup>51</sup> For clarity, the frequency separation is between the lower edge of the 26 GHz band (i.e. 24.25 GHz) and the lower edge of the specific channel the base station is operating on.

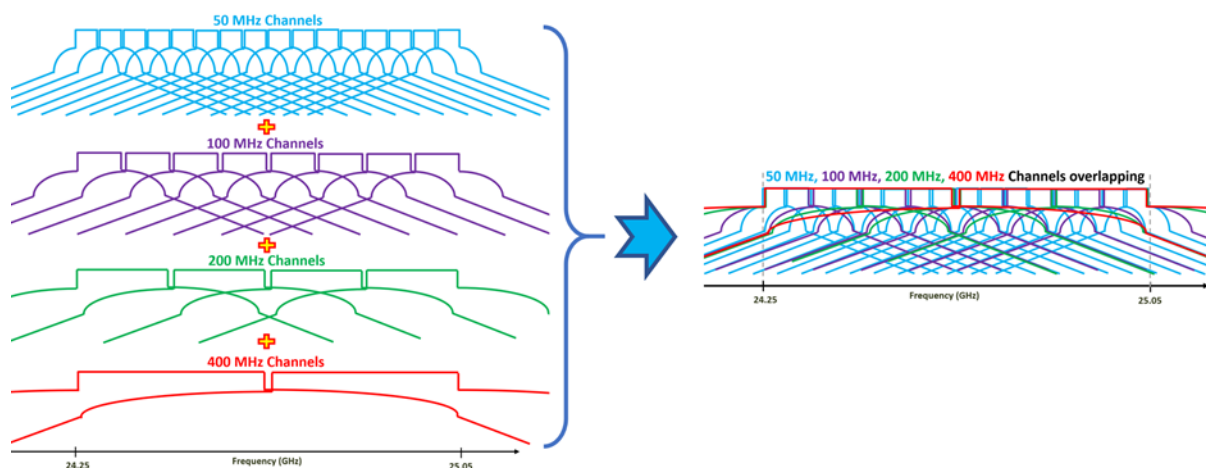
<sup>52</sup> See paragraph A2.85 of our December consultation and Annex 1.

<sup>53</sup> A base station sector is the transmitter and antenna panel providing coverage. Examples of base stations employing multiple sectors include those providing 360° coverage from a central site using three sectors of ±60° each.

# A1. Illustrative example of mixed overlapping channels

- A1.1 In Annex 2 to our December consultation, we provided several examples of application of Equation 1 (shown in section 4) to calculate the maximum number of 26 GHz outdoor base stations that can be deployed in the 24.25-25.05 GHz band in any 300 km<sup>2</sup> area. We provide below a further example to clarify how we would apply Equation 2 (shown in section 4) to calculate that maximum number in a scenario of mixed overlapping channel sizes with base station meeting the initial and final out-of-band emission limits.
- A1.2 Within any 300 km<sup>2</sup> area there could be multiple locations where frequencies in the lowest 800 MHz of the 26 GHz band are in use, and at each location one of a possible set of channel sizes (e.g. 50 MHz, 100 MHz, 200 MHz or 400 MHz) could be used, depending on the specific requirements of the users at that location. Figure A1 illustrates how different overlapping channel sizes could be arranged.<sup>54</sup>
- A1.3 It should be noted that this example uses one possible set of base station arrangements to provide an illustration and that there is a very large number of potential arrangements that could be applied in practice.

**Figure A1: Example channel arrangement in the lowest 800 MHz of the 26 GHz band**



- A1.4 As set out in Section 4, the aggregate interference threshold that we have decided to apply in the case where channels overlap (and may be of mixed sizes) in the lowest 800 MHz of the 26 GHz band is -8.44 dBW/200 MHz. In paragraphs A2.84-A2.86 of our December consultation we explained that the total interference contribution from all individual base stations operating in the lowest 800 MHz of the 26 GHz band within any 300 km<sup>2</sup> area must be less than or equal to -8.44 dBW/200 MHz.

<sup>54</sup> The flat part represents the licensed in-block power and a curve and slope represents the decrease in the level of out-of-block emissions as the frequency separation from the edge of the licensed block increases.

- A1.5 In accordance with the above, in a case of mixed overlapping channel sizes, we would calculate the maximum number of 26 GHz outdoor base stations that can be deployed in the 24.25-25.05 GHz band in any 300 km<sup>2</sup> area using Equation 2 (see section 4) – repeated for clarity as follows:

$$\sum_{n=1}^N I_{c\_n} \leq 0.1432 \text{ W/200 MHz}$$

Where:

$N$ : is the total number of base stations in the 300 km<sup>2</sup> area

$n$ : is the  $n^{\text{th}}$  base station

$I_{c\_n}$ : is the interference contribution from the  $n^{\text{th}}$  base station (linear - W/200 MHz)

Note, the aggregate interference threshold used in Equation 2 (i.e. 0.1432 W/200 MHz) is the same as the aggregate interference threshold for an 800 MHz channel from Table 6 above ( $10^{-8.44/10} = 0.1432$ ).

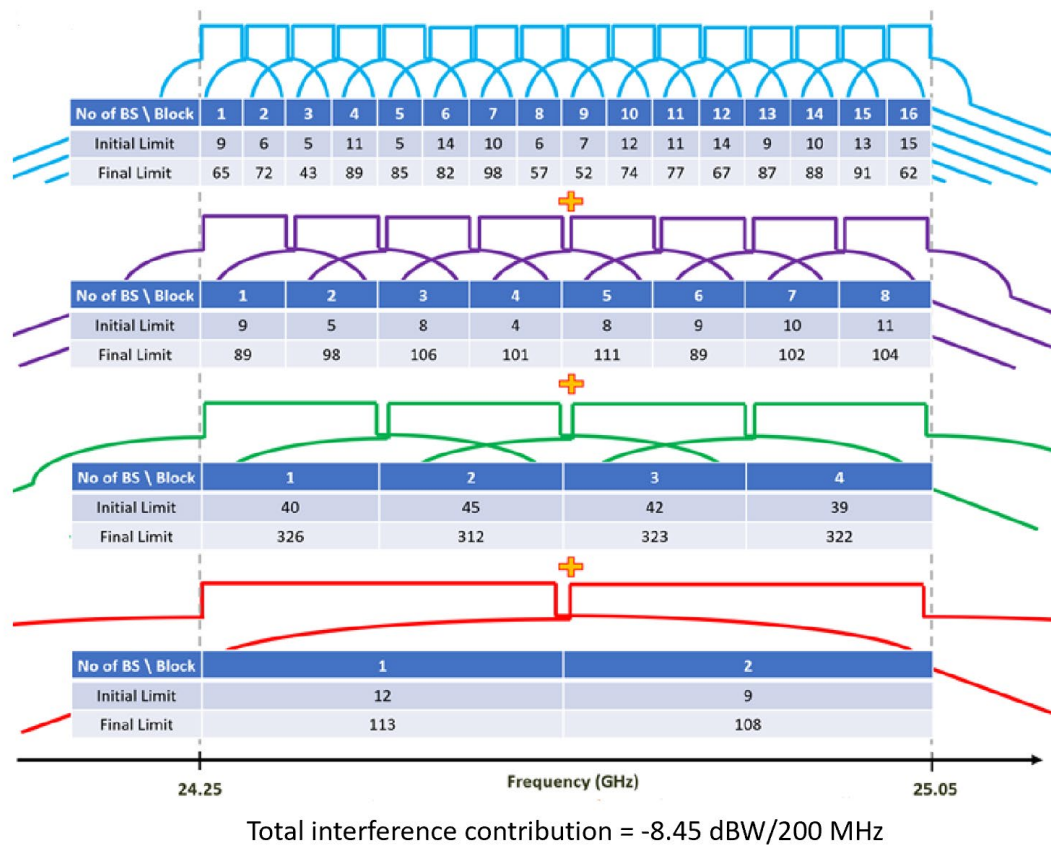
When calculating the interference contribution ( $I_{c\_n}$ ) of each individual base station we would take into account the average 2 dB implementation margin, the 4 dB reduction in average out-of-band emission levels per 200 MHz frequency separation from the lower band edge<sup>55</sup>, and whether the initial or final out-of-band emission limit applies for that base station.<sup>56</sup>

- A1.6 For example, for a base station with a channel size of 100 MHz brought into use before 1 January 2024, i.e. when the initial limit of -33 dBW/200 MHz is in force, and operating at 24.45-24.55 MHz, its interference contribution would be -39 dBW/200 MHz. This accounts for a reduction of 4 dB in the average out-of-band emissions for operating 200 MHz above the lower edge of the 26 GHz band and the 2 dB implementation margin. In linear units this would give  $I_{c\_n} = 10^{-39/10} = 0.000126 \text{ W/200 MHz}$ .
- A1.7 As another example, for a base station at the same operating frequency and channel size brought into use after 1 January 2024, i.e. when the final limit of -39 dBW/200 MHz is in force, the interference contribution would be -45 dBW/200 MHz. Again, this accounts for a reduction of 4 dB in the average out-of-band emissions for operating 200 MHz above the lower edge of the 26 GHz band and the 2 dB implementation margin. In linear units this would give  $I_{c\_n} = 10^{-45/10} = 0.0000316 \text{ W/200 MHz}$ .
- A1.8 Figure A2 illustrates how a particular example set of base station deployments at the initial and final limits with mixed overlapping channel sizes, when their interference contributions are summed (as per Equation 2), would meet the aggregate interference threshold.

<sup>55</sup> For clarity, the frequency separation is between the lower edge of the 26 GHz band (i.e. 24.25 GHz) and the lower edge of the specific channel the base station is operating on.

<sup>56</sup> See paragraph A2.85 of our December consultation

Figure A2: Example scenario of the number of base stations for mixed overlapping channel that just meets the aggregate interference threshold



## A2. Respondents

We received seven responses to our consultation. One respondent requested for the name of their organisation to be kept confidential. The names of the remaining respondents are:

- BT
- European Centre for Medium-Range Weather Forecasts (ECMWF)
- Joint response from European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the European Space Agency (ESA)
- Met Office
- UK Space Agency
- Vodafone

## A3. Legal framework

- A3.1 Ofcom's statutory powers and duties in relation to spectrum management are set out primarily in the Communications Act 2003 (the "**2003 Act**") and the Wireless Telegraphy Act 2006 (the "**WT Act**").

### Duties under the Communications Act 2003

- A3.2 Our principal duties under the 2003 Act, when carrying out our functions and exercising our powers, are to further the interests of citizens and consumers, where appropriate by promoting competition. In doing so, we are also required (among other things) to secure the optimal use of spectrum and the availability throughout the United Kingdom of a wide range of electronic communications services.
- A3.3 We must also have regard to: (i) the desirability of promoting competition in relevant markets; (ii) the desirability of encouraging investment and innovation in relevant markets; (iii) the desirability of ensuring the security and availability of public electronic communications networks and services; (iv) the different needs and interests, so far as the use of the electro-magnetic spectrum for wireless telegraphy is concerned, of all persons who may wish to make use of it; and (v) the different interests of persons in the different parts of the United Kingdom, of the different ethnic communities within the United Kingdom and of persons living in rural and in urban areas.
- A3.4 In performing our duties, we are required under section 3(3) of the 2003 Act to have regard in all cases to the principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed.
- A3.5 In carrying out certain regulatory functions, including Ofcom's spectrum management functions, section 4 of the 2003 Act requires Ofcom to act in accordance with the following requirements: a) to promote competition in communications markets; b) to promote the interests of all members of the public in the United Kingdom; c) to act in a manner which, so far as practicable, is technology neutral<sup>57</sup>; d) to encourage, to the extent Ofcom considers it appropriate, the provision of network access and service interoperability for the purpose set out in s.4(8)<sup>58</sup>; e) to encourage such compliance with certain international standards as is necessary for the purposes set out in s.4(9)<sup>59</sup>; and f) to promote

---

<sup>57</sup> According to s.4(6A) of the 2003 Act, this requirement does not apply to the imposition, in relation to a wireless telegraphy licence, of a limitation of a kind falling within section 9ZA(1) of the WT Act; or (b) the review, variation or removal of such a limitation.

<sup>58</sup> The purpose of securing: (i) efficiency and sustainable competition, (ii) efficient investment and innovation, and (iii) the maximum benefit for the customers of communications providers and of persons who make associated facilities available.

<sup>59</sup> For facilitating service interoperability, end-to-end connectivity, the changing by end-users of their communications provider, the retention by end-users of their telephone numbers after a change of communications provider; and securing freedom of choice for the customers of communications providers.

connectivity and access to very high capacity networks by members of the public and businesses in the United Kingdom.

## Duties under the Wireless Telegraphy Act 2006

- A3.6 Additionally, in carrying out our spectrum functions we have a duty under section 3 of the WT Act to have regard in particular to: (i) the extent to which the spectrum is available for use, or further use, for wireless telegraphy; (ii) the demand for use of that spectrum for wireless telegraphy; and (iii) the demand that is likely to arise in future for such use.
- A3.7 We also have a duty to have regard to the desirability of promoting: (i) the efficient management and use of the spectrum for wireless telegraphy; (ii) the economic and other benefits that may arise from the use of wireless telegraphy; (iii) the development of innovative services; and (iv) competition in the provision of electronic communications services.

## Harmonised technical conditions

- A3.8 Certain European decisions continue to have effect in domestic UK law, following Brexit, by virtue of section 3 of The European Union (Withdrawal) Act 2018. These include, in particular, the Implementing Decision issued by the European Commission in 2019 to open up the 26 GHz band for wireless broadband under harmonised technical conditions, which it then amended in 2020 (the **“26 GHz Decision”**).<sup>60</sup>
- A3.9 The 26 GHz Decision harmonises the essential technical conditions for the availability and efficient use of the 24.25-27.5 GHz frequency band (the **“26 GHz band”**) in the European Union for terrestrial systems capable of providing wireless broadband electronic communications services (Art. 1) and requires the UK (and the EU Member States) to designate and make available on a non-exclusive basis that frequency band for such systems, in accordance with the essential technical conditions in the Annex (Art. 2).
- A3.10 It also contains provisions about the co-existence between terrestrial systems for wireless broadband and other spectrum users. These provisions are particularly relevant to this statement, and they provide the basis for our decisions. In particular, the 26 GHz Decision provides that:
- a) it should be analysed at national level whether it is necessary to impose additional technical conditions to ensure appropriate co-existence with other services in the band (Art. 2);
  - b) terrestrial systems for wireless broadband must appropriately protect other spectrum users operating in the same band or adjacent bands, including certain earth exploration satellite services, radio astronomy services, space research services and satellite systems (Art. 3);

---

<sup>60</sup> An unofficial consolidated version of Decision 2019/784, as amended by Decision 2020/590, is available [here](#)

- c) fixed links may be allowed to continue to operate within the band, if the terrestrial systems for wireless broadband can co-exist with them through managed shared spectrum use (Art. 4);
- d) the number and locations of new earth stations must be determined so as not to impose disproportionate constraints on terrestrial systems for wireless broadband. Subject to market demand, the continued deployment of earth stations must be made possible for certain uses within the 26 GHz band (Art. 5); and
- e) the progress on co-existence should be monitored, and the findings reported to the European Commission to allow for a timely review of the 26 GHz Decision (Art. 7).
- f) cross-border coordination agreements should be facilitated to enable the operation of terrestrial systems for wireless broadband (Art. 6).

## Ofcom's licensing framework

- A3.11 Ofcom is responsible for authorising use of the radio spectrum. We permit the use of the radio spectrum either by granting wireless telegraphy licences under the WT Act or by making regulations exempting the use of particular equipment from the requirement to hold such a licence. It is unlawful and an offence to install or use wireless telegraphy apparatus without holding a licence granted by Ofcom, unless the use of such equipment is exempted.<sup>61</sup>
- A3.12 This document sets out our decisions on technical licence conditions to be included in licences authorising use of the 26 GHz band. Below we explain the legal framework under which we can impose conditions in spectrum licences.

### Licence conditions

- A3.13 A wireless telegraphy licence may be granted subject to such terms, provisions and limitations as Ofcom think fit (WT Act, s. 9(1)). However, this power is subject to certain constraints. In particular:
- a) the terms, provisions and limitations of a spectrum licence must not duplicate the obligations already imposed on the licensee by the general conditions set by Ofcom under section 45 of the Communications Act 2003 (WT Act, s. 9(6));<sup>62</sup> and
  - b) Ofcom may only impose terms, provisions and limitations which are: a) objectively justified in relation to the network and services to which they relate; b) not unduly discriminatory; c) proportionate to what they are intended to achieve; and d) transparent in relation to what they are intended to achieve (WT Act, s. 9(7)).
- A3.14 Section 9(4) of the WT Act sets out a non-exhaustive list of the terms, provisions and limitations that Ofcom may impose.

---

<sup>61</sup> Section 8 of the WT Act.

<sup>62</sup> The "General Conditions of Entitlement", which are available [here](#).

A3.15 Examples of the types of conditions we may impose in spectrum licences under s9 WT Act include:

- c) limitations as to the position and nature of a station (s.9(2)(a));
- d) limitations as to the apparatus that may be installed or used (s.9(3)); and
- e) terms, provisions and limitations as to strength or type of signal, as to times of use and as to the sharing of frequencies the strength or type of signal (s.9(4)(a)).