
Electromagnetic field (EMF) measurements near 5G mobile phone base stations

Summary of measurement results for April to October
2021

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1. Overview

This report contains the results of 38 EMF measurement surveys undertaken near 5G-enabled mobile base stations between April and October 2021¹.

These surveys are part of our ongoing program of measurements to verify that 5G-enabled mobile base stations remain within the limits in the ICNIRP Guidelines for the protection of the general public². This program of measurements commenced in 2020. All 2020 measurement results were published in our [1 March 2021 technical report](#).

What we have found – in brief

Our measurement results between April and October 2021 have shown that:

- The measured EMF levels from 5G-enabled mobile phone base stations are well within the levels identified in the ICNIRP Guidelines, with the highest level being approximately 0.87% of the ICNIRP general public reference levels;
- The contribution of 5G to the total emissions level observed is currently low – the highest level we observed in the band currently used for 5G was just 0.04% of the ICNIRP general public reference levels.

The highest level we have recorded across all surveys undertaken to date is approximately 7.1% of the ICNIRP general public reference levels, with the next highest level being 1.5%³. The highest level we have seen for the 5G contribution to the total emissions level at a mobile base station is 0.04% of the ICNIRP general public reference levels.

- 1.1 Ofcom has been carrying out radio frequency electromagnetic field (EMF) measurements near mobile phone base stations for many years.⁴ These measurements have consistently shown that EMF levels near mobile phone base stations are well within the internationally agreed levels published in the ICNIRP Guidelines.
- 1.2 While all the frequency bands now in use by mobile phone base stations have been used for various services for many years, our EMF measurements prior to 2020 did not include the specific frequency bands now being rolled out by the mobile operators for 5G. We commenced a new program of EMF measurements in 2020 which has focused on 5G-enabled mobile phone base stations. All of the [individual measurement reports](#) which form the basis of this (and previous) summary reports have been published on our website.

¹ No measurements were undertaken between December 2020 and March 2021 due to Covid-19 restrictions.

² Guidelines for limiting EMF exposure that will provide protection against known adverse health effects are published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). ICNIRP is formally recognised by the World Health Organization (WHO). The measurements in this report were carried out with reference to the 1998 ICNIRP Guidelines, which are available on the ICNIRP website.

³ These measurement results were included in our [1 March 2021 technical report](#).

⁴ Ofcom inherited a programme of EMF measurements started by its predecessor, the Radiocommunications Agency (one of the five regulators whose duties were subsumed by Ofcom when it was created).

- 1.3 In the UK, the UK Health Security Agency (UKHSA) leads on public health matters associated with radiofrequency electromagnetic fields, or radio waves, and has a statutory duty to provide advice to Government on any health effects that may be caused by EMF emissions⁵. On 5G, the UKHSA's view is that *'the overall exposure is expected to remain low relative to guidelines and, as such, there should be no consequences for public health'*.⁶
- 1.4 The deployment of 5G networks and the take-up of 5G services is still at an early stage. We will continue to undertake EMF measurements to monitor the overall trends in the long term. This will include measurements in new areas and repeat measurements at a number of the locations which we have already visited. We will continue to publish these measurements on our website as they become available.

⁵ The Scottish Government set out its position on 5G and public health in a [statement](#) published alongside its [5G strategy](#) in August 2019. This noted that "the advice provided by PHE [now UKHSA] is fully endorsed by the Chief Medical Officer for Scotland". Public Health Wales notes on its [website](#) that "specialist radiation protection information and advisory services are provided in Wales by Public Health England's [now UKHSA's] Centre for Radiation, Chemical and Environmental Hazards (CRCE)".

⁶ See gov.uk, [Mobile phone base stations: radio waves and health](#), 27 August 2021.

2. Background

- 2.1 In March 1999, the Chairman of the National Radiological Protection Board (NRPB, now part of the UK Health Security Agency) was asked by the Minister for Public Health to set up an independent expert working group to assess the current state of research into possible health risks from mobile phones. The Independent Expert Group on Mobile Phones (IEGMP) was set up in April 1999 and was chaired by Sir William Stewart.
- 2.2 The IEGMP published its report in May 2000 (the Stewart Report), recommending the establishment of an independent audit of EMF emissions from mobile base stations.⁷ In response to this report, the Government commissioned the Radiocommunications Agency (RA) to implement a national measurement programme to ensure that emissions from mobile phone base stations did not exceed the levels identified in the ICNIRP Guidelines for general public exposure. Ofcom has continued this programme since its establishment in 2003.
- 2.3 In 2012, this activity switched from a proactive to a reactive programme. From this date onwards, Ofcom has continued to conduct EMF exposure measurements on request. This is provided as a free service to qualifying schools and hospitals (i.e. those that do not benefit financially from base stations installed on their property). More information about [Ofcom's EMF exposure measurement surveys](#) and the [results of all measurements published to date](#) are available on our website.
- 2.4 In recent years, the number of requests for EMF exposure measurements has been declining. However, the introduction of 5G has seen a renewed interest in the potential impact of radio waves on health and Ofcom has received an increasing number of queries about the safety of 5G deployments.

⁷ IEGMP, [Mobile Phones and Health](#), 2000 (archived 10 September 2010).

3. High-level methodology

- 3.1 In this section we set out the high-level methodology we have used to measure general public exposure to EMF near 5G-enabled mobile base stations.
- 3.2 We have measured the EMF exposure level at selected test locations using a field strength analyser with an isotropic probe following a procedure based on the in-situ RF exposure measurement method set out in section B.3.1.2 of IEC 62232:2017⁸.
- 3.3 The power density reference levels from the ICNIRP Guidelines for general public exposure (applicable to mobile phone frequencies) are as follows:

Frequency range	Power density (W m ⁻²)
400 – 2,000 MHz	$f/200^*$
2 – 300 GHz	10

*where f is the frequency in MHz

- 3.4 The measurements were conducted over the individual frequency bands used for mobile base station (downlink) transmissions as well as across all other frequency bands between 420 MHz to 6 GHz.

Table 3.1: Frequency bands covered by the measurements presented in this report

Frequency band	Frequency range	Technology ⁹
700 MHz	738-788 MHz	4G, 5G
800 MHz	791-821 MHz	4G
900 MHz	925-960 MHz	2G, 3G, 4G
1400 MHz	1452-1492 MHz	4G (Supplementary downlink)
1800 MHz	1805-1880 MHz	2G, 4G
1900 MHz	1900-1920 MHz	4G
2100 MHz	2110-2170 MHz	3G, 4G
2300 MHz	2350-2390 MHz	4G
2600 MHz TDD	2570-2620 MHz	4G
2600 MHz FDD	2620-2690 MHz	4G
3.4 GHz	3410-3680 MHz	5G, 4G
3.8 GHz	3680-4200 MHz	Various
Others ¹⁰		

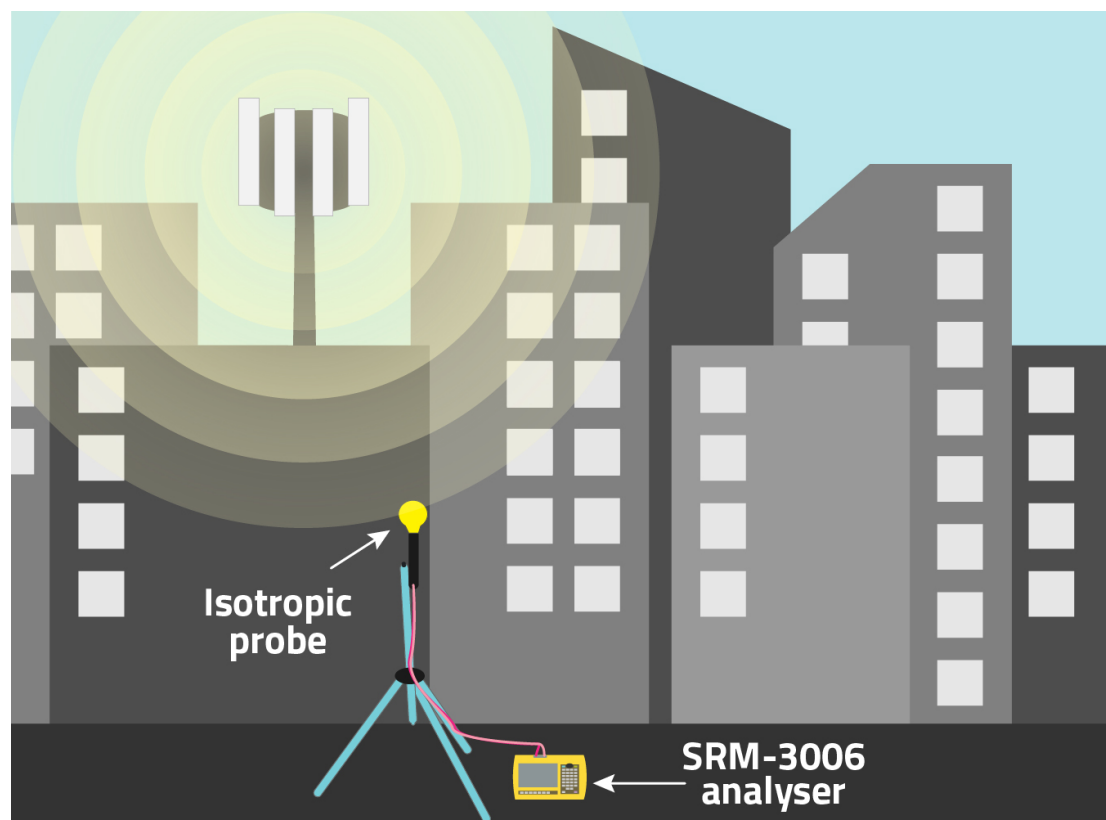
⁸ International Electrotechnical Commission, *IEC 62232:2017: Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure*, 23 August 2017.

⁹ Note: this is an indication of the type of technologies typically deployed in these bands. Not all frequency bands and technologies will be in use in any one location.

¹⁰ All other frequencies between 420 MHz and 6 GHz.

3.5 We used a [field strength analyser \(Narda SRM-3006\)](#), connected to an isotropic electric field (E-field) probe, to carry out the measurements. As illustrated in Figure 3.1 below, the probe is mounted on a tripod at a height of 1.5m above ground level. The use of an isotropic probe means that the measurement result is not affected by the direction of signal arrival and the polarisation of the measured field.

Figure 3.1: Narda SRM-3006 field strength analyser connected to an isotropic E-field probe mounted on a tripod 1.5m above ground level



3.6 The SRM-3006 analyser together with the probe has an overall operating frequency range from 420 MHz to 6 GHz. This is sufficient to cover all the frequency bands currently used for mobile phone base station transmissions.

3.7 For the measurements reported here, the SRM-3006 was set to its Safety Evaluation mode. In this mode, the analyser automatically adjusts its resolution bandwidth to 5 MHz and its frequency step size to 2.5 MHz and repeatedly sweeps across all frequencies from 420 MHz to 6 GHz at a rate of approximately 1 sweep per second. At each frequency step the analyser measures the root mean square (rms) field strength. As specified in the 1998 ICNIRP Guidelines, the measurements at each location are averaged over a six minute period.

3.8 The SRM-3006 reports the exposure level as a percentage of a selected safety standard limit (e.g. the levels from the ICNIRP Guidelines). Exposure levels are reported for each individual frequency band and the total EMF emission level across all bands measured (420 MHz – 6 GHz) is also reported.

4. Summary of test results

- 4.1 The measurements in this report were carried out at 38 locations across England, Scotland, Wales and Northern Ireland between April and October 2021.
- 4.2 The map below shows the towns and cities where we conducted the measurements in this report.

Figure 4.1: Towns and cities where we conducted measurements – April to October 2021



- 4.3 Figure 4.2 shows the highest average exposure level that we recorded at each location. Table 4.1 on page 11 shows the same data in tabular form. The exposure levels are expressed as a percentage of the reference levels for general public exposure in the 1998 ICNIRP Guidelines¹¹. The chart presents two measured levels:
- a) the exposure level measured across all mobile frequency bands; and

¹¹ All figures below (or equal to) 100% are considered as being within the recommended exposure limits.

- b) the exposure level for the 5G frequency band (currently, 5G is deployed in the 3.4-3.6 GHz band).

Figure 4.2: Highest recorded average exposure levels – April to October 2021

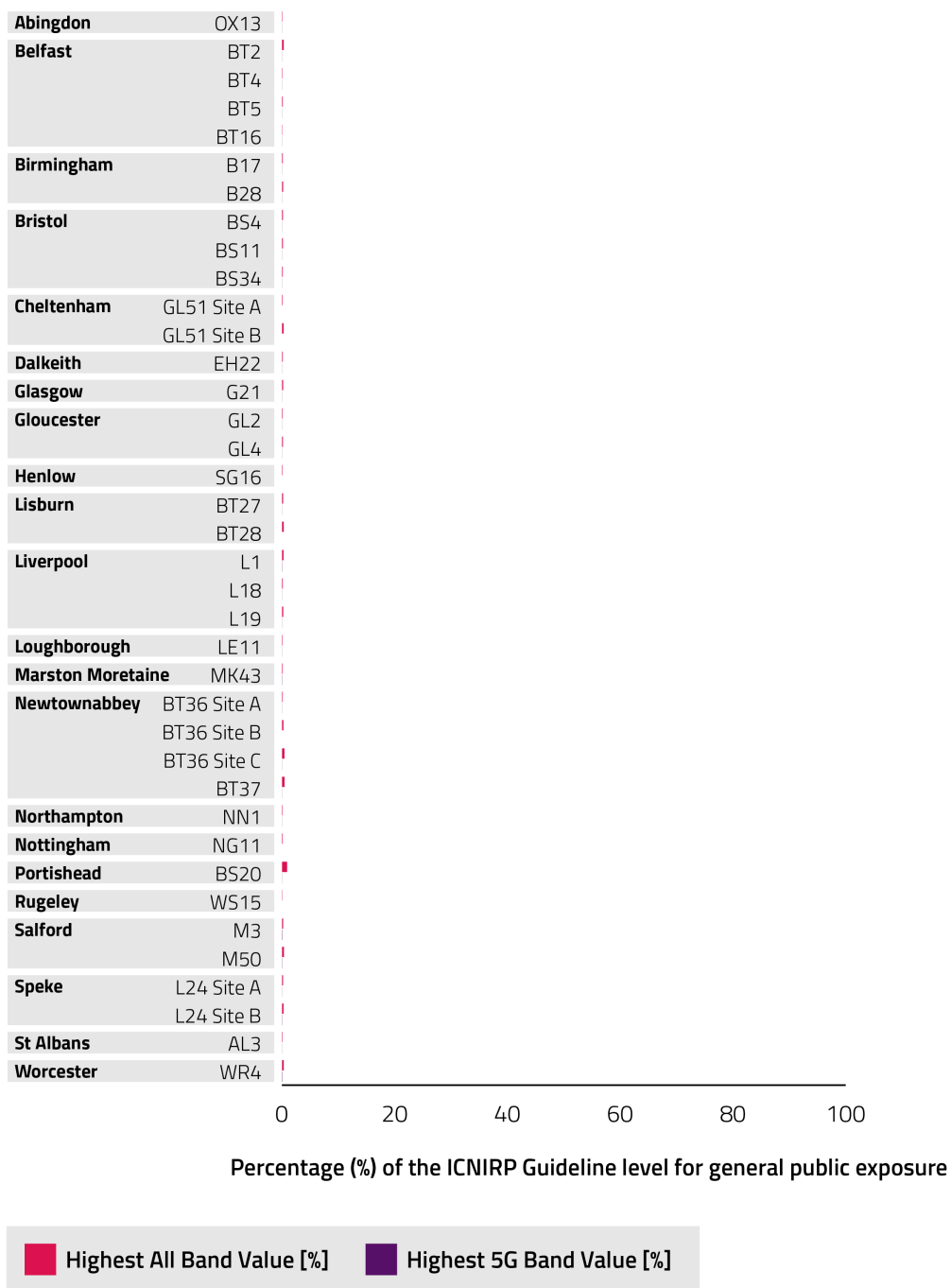


Table 4.1: Highest average exposure levels – April to October 2021¹²

City	Location	Highest All Band Value [%]*	Highest 5G Band Value [%]*
Abingdon	OX13	0.0645	0.0024
Belfast	BT2	0.2922	0.0031
	BT4	0.0555	0.0005
	BT5	0.1197	0.0046
	BT16	0.0335	0.0003
Birmingham	B17	0.1173	0.0091
	B28	0.1889	0.0095
Bristol	BS4	0.1112	0.0058
	BS11	0.1523	0.0027
	BS34	0.1527	0.0002
Cheltenham	GL51 (A)	0.0937	-
	GL51 (B)	0.2662	-
Dalkeith	EH22	0.1099	0.0082
Glasgow	G21	0.1769	0.0102
Gloucester	GL2	0.0955	0.0038
	GL4	0.1442	0.0064
Henlow	SG16	0.0714	-
Lisburn	BT27	0.1751	0.0003
	BT28	0.2836	-
Liverpool	L1	0.2582	0.0205
	L18	0.1069	0.0054
	L19	0.2076	0.0046
Loughborough	LE11	0.0809	0.0136
Marston Moretaine	MK43	0.1022	0.0184
Newtownabbey	BT36 (A)	0.0906	0.0103
	BT36 (B)	0.2266	-
	BT36 (C)	0.4047	0.0048
	BT37	0.4309	0.0028
Northampton	NN1	0.0834	0.0009
Nottingham	NG11	0.0935	-
Portishead	BS20	0.8668	0.0002
Rugeley	WS15	0.0423	-
Salford	M3	0.1872	0.0444
	M50	0.3281	0.0251
Speke	L24 (A)	0.1727	0.0046
	L24 (B)	0.2544	0.0164
St Albans	AL3	0.0799	0.0073
Worcester	WR4	0.2796	0.0345

*Results which are not sufficiently above the system noise floor to record as a valid measurement are shown as a dash (-)

¹² The location names in this table contain links to the detailed measurement reports for each location which are published separately on our website.

Electromagnetic Field (EMF) measurements near 5G mobile phone base stations

- 4.4 As can be seen from Figure 4.2 and Table 4.1 above, EMF emission levels from 5G-enabled mobile phone base stations remain well within the reference levels for general public exposure in the ICNIRP Guidelines, with the highest level recorded being approximately 0.87% of the reference levels.
- 4.5 Our measurements also show that the contribution of 5G to the total emissions level observed is currently low – the highest level we observed in the band used for 5G was just 0.04% of the reference levels.
- 4.6 The measurements presented in this report show some variation between the exposure levels measured at each location. This is likely to be due, at least in part, to differences in the position of the measurement probe relative to the base station at each location. We took all measurements in publicly accessible areas, and these areas were at varying distances to the mobile phone base station serving the area. In all cases however, we sought to take measurements at locations with the highest signal strength near the base station.
- 4.7 The deployment of 5G networks and the take-up of 5G services in the UK is still underway. We will therefore continue to undertake EMF measurements to monitor the overall trends in the long term.
- 4.8 This will include repeat measurements at a number of the locations which we have already visited as well as measurements in new areas.
- 4.9 We will continue to publish the results of these measurements on our website as they become available.

5. Glossary

Term	Definition
5G	The fifth generation of mobile telecommunications technology
Base station	Radio transmitter infrastructure that controls and communicates to mobile phones
Downlink	In mobile communication, a downlink refers to the transmission link from the base stations to the mobile devices such as mobile phones or tablets.
E-field strength	Electric field strength
EMF	Electromagnetic fields
Far field	Regions where the distance from the measurement point to the source is greater than D^2/λ where D is the diameter of the source antenna and λ is the wavelength of the frequency.
GHz	Gigahertz (1 GHz is equivalent to 1000 MHz)
ICNRIP	The International Commission on Non-Ionizing Radiation Protection
IEC	The International Electrotechnical Commission
IEGMP	The Independent Expert Group on Mobile Phones
kHz	Kilohertz (1 kHz is equivalent to 1000 Hz)
MHz	Megahertz (1 MHz is equivalent to 1000 KHz)
NRPB	The National Radiological Protection Board, now part of Public Health England
Ofcom	The Office of Communications
RA	The Radiocommunications Agency
rms	The root mean square (rms) is defined as the square root of the arithmetic mean of the squares of a set of numbers
$W m^{-2}$	Watts per square metre, a measure of radiated power density.