Commission for Communications Regulation
An Coimisiún um Rialáil Cumarsáide

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1. Survey Summary

Address of Transmitter Site Surveyed:	Sragh Ave, Clara Rd., Tullamore, Co. Offaly.
Survey Date:	18/09/2023
Base Station ID's:	OY067, OF0007, OY_4288
Network Operators:	Vodafone/ Three / EIR
Technologies Measured:	GSM / LTE / UMTS
Frequency Bands:	700 / 800 / 900 / 1800 / 2100 MHz

Measurement Location: (at point of maximum non-ionising radiation near site, approximate distance from site.)	On footpath at side of Sragh Ave, in Burlington Business Park beside antenna location.

Measurement Location Coordinates (decimal):	**LAT**	**LONG**
	53.286683	-7.513439

Purpose and Conduct of Survey:

The purpose of this survey was to assess compliance with the limits for general public exposure to non-ionising radiation (**NIR**) set by the International Commission on Non-Ionising Radiation Protection (**ICNIRP) ("ICNIRP Public Exposure Limits")**.

Compliance with the ICNIRP Public Exposure Limits is a condition of a General Authorisation for an electronic communications network/service as well as of various Wireless Telegraphy licences issued by the Commission for Communications Regulation (**ComReg**).

The survey was conducted by:

- measuring the overall electromagnetic field (**EMF**) present at the point of highest exposure in a public area associated with the designated transmitter site;
- identifying the frequency of the principal emissions contributing to the EMF; and
- measuring the intensity (or level) of same.

Overall Conclusions of the Survey	
Frequency Selective Measurements: (Individual emissions measured at specific frequencies)	**Below ICNIRP Public Exposure Limits [Compliant]**
Total Exposure Quotient: (Assessment of cumulative emissions from multiple transmitters)	**Below ICNIRP Public Exposure Limits [Compliant]**

2. Surveyors

Survey conducted for ComReg by:	**Compliance Engineering Ireland Ltd.**	COMPLIANCE ENGINEERING IRELAND LTD

Survey Engineer(s):	**Report Writer:**	**Report Reviewer:**
Michael Reilly, BEng	Michael Reilly, BEng	John McAuley, MEng

3. Survey Location Details

Designated Transmitter Site Photo

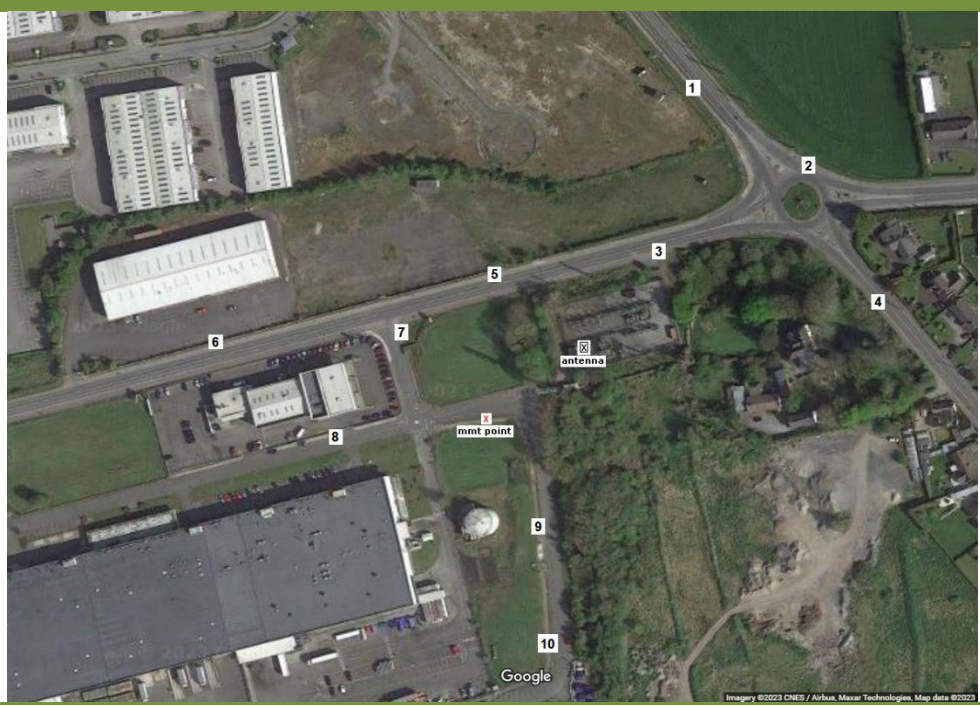
Survey Weather

Sky: Light Cloud

Temperature:
13° C

Relative Humidity:
47 %

Map(s) of Designated Transmitter Site and Measurement Location (Checks and Final)



Initial measurement point check readings: (approximate)	1. 1.19 V/m 2. 1.32 V/m 3. 0.92 V/m 4. 0.19 V/m 5. 0. 09 V/m	6. 1.48 V/m 7. 1.07 V/m 8. 0.87 V/m 9. 1.01 V/m 10. 1.22 V/m

4. Introductory Note

Purpose of Survey

The survey of the designated transmitter site (**"Designated Site"**) was commissioned by ComReg as part of its Programme of Measurement of Non-Ionising Radiation. The purpose of the survey was to assess whether NIR (occurring within the radio frequency part of the electromagnetic spectrum) from the Designated Site complied with the limits for general public exposure specified in the guidelines published by ICNIRP ("**ICNIRP Public Exposure Limits"**).[1] Compliance with the ICNIRP Public Exposure Limits is a condition of a General Authorisation for the provision of an electronic communications network/service (e.g. mobile phone and broadcasting networks) as well as of various Wireless Telegraphy licences (in respect of transmitting stations) issued by ComReg.

Survey Methodology

Measurements of the NIR from the Designated Site were conducted in accordance with the methodology outlined in ComReg Document 08/51R4[2]. Once standardised, these methodologies are to be incorporated. Methodologies used in conducting this site reports are listed below;

- European Electronic Communications Committee (**ECC**) Recommendation (02)04[3];
- European Committee for Electrotechnical Standardisation (**CENELEC**) measurement standard EN 50492:2008[4], and
- Measurement techniques developed by the Institut für Mobil- und Satellitenfunktechnik (**IMST**) and the EM-Institut on behalf of the German Federal Office for Radiation Protection.[5]

Additional methodologies to be used in conducting this site report are listed below:

- Measurement techniques as published by Dr. Helmut Keller on behalf of Narda Safety Test Solutions.[6]

Note re this Report Version

If you have downloaded this report from ComReg's Siteviewer[7] or from www.comreg.ie, you are reading an abbreviated version. The full technical version of this report also contains a comprehensive technical record of the measurements and any calculations performed, a list of equipment used, and a technical appendix. A copy of the full report is available upon request from ComReg.

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[1] Current ICNIRP guidelines:

- *"Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)",* ICNIRP, published in 'Health Physics', March 2020, Volume 118, No. 5: https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf
- *"Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz to 100 kHz)",* ICNIRP, published in 'Health Physics', December 2010, Volume 99, No. 6: https://www.icnirp.org/cms/upload/publications/ICNIRPLFgdl.pdf

[2] https://www.comreg.ie/publication/programme-of-measurement-of-non-ionising-radiation-methodology-for-the-conduct-of-surveys-to-measure-non-ionising-radiation-from-transmission-sites

[3] ECC RECOMMENDATION (02)04, *"Measuring Non-Ionising Electromagnetic Radiation (9 kHz – 300 GHz)"*, ECC, (revised Bratislava 2003, Helsinki 2007): http://www.erodocdb.dk/Docs/doc98/official/pdf/REC0204.PDF

[4] EN 50492:2008, *"Basic standard for the in-situ measurement of electromagnetic field strength related to human exposure in the vicinity of base stations"*, CENELEC, November 2008: http://www.cenelec.eu

[5] See: http://www.bfs.de .

[6] *"On the Assessment of Human Exposure to Electromagnetic Fields Transmitted by 5G NR Base Stations", published in 'Health Physics', November 2019 Volume 117, No.5: https://journals.lww.com/health-physics/fulltext/2019/11000/on_the_assessment_of_human_exposure_to.7.aspx*

7 https://siteviewer.comreg.ie/

5. Survey Overview

Survey Stages

In accordance with the methodology outlined in ComReg Document 08/51R4, this survey was conducted in three stages:

1. **Initial Site Survey**
2. **Full Survey – Broadband Measurements**
3. **Full Survey – Frequency Selective Measurements**

An outline of each stage, along with the results and conclusions of the measurements, are presented in the following three sections.

Measurement of Electromagnetic Fields

Electromagnetic fields (**EMFs**) can be sub-divided into two components:

- Electric field (**E-field**) (measured in volts per metre or "V/m"]; and
- Magnetic field (**H-field)** (measured in amperes per metre or "A/m"].

The E-field and the H-field are mathematically interdependent[8] in the **radiating near-field**[9] and the **far-field[10],** which are located before and beyond a distance of at least the wavelength of the radiated EMF respectively. The measurement locations for most transmitter installations lie well within the far-field, as the wavelengths of the transmitted signals are relatively short, and the antennas are typically located many metres from any public area.

The following table gives examples of wavelengths for some commonly transmitted signals:

Transmitter Type	Frequency	Wavelength
PMR Low Band VHF	68 MHz	4.41 m
UHF TV	470 MHz	0.64 m
GSM 900 (2G mobile base station)	925 MHz	0.32 m
LTE 1800 (4G mobile base station)	1805 MHz	0.17 m
UMTS (3G mobile base station)	2110 MHz	0.14 m
5G NR (5G Mobile base station)	3500 MHz	0.09 m

In the radiating near-field and far-field, only one component needs to be measured, as the other component can be readily derived from it. Normally, it is the E-field which is measured.

In the case of transmitters of very long wavelength signals, such as long wave radio (1.19 km wavelength), the H-field and E-field must be measured separately as the point of measurement will most likely lie within the **reactive near-field**[11] region. In this region, located within a distance of at least the wavelength of the radiated EMF, the relationship between E and H becomes very complex and there is no direct correlation between both components of the EMF.

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[8] $E \approx H \times Z_0$ (Radiating Near Field) and $E = H \times Z_0$ (Far Field), where Z_0 (characteristic impedance of free space) $\approx 377\ \Omega$

[9] Beyond a distance of max(λ, D, $D^2/4\lambda$), where λ is the wavelength and D is the antenna's largest dimension

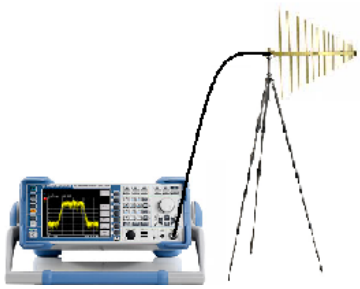
[10] Beyond a distance of max(5λ, 5D, $0.6D^2/\lambda$)

[11] Within a distance of max (λ, D, $D^2/4\lambda$)

Measurement Equipment

The measurement of EMFs is a complex process which involves the use of various meters, spectrum analysers, probes and antennas, appropriate to the frequencies of the emissions being measured.

The table below shows examples of equipment typically used to measure EMFs in NIR surveys.

<table>
<tr><th>Initial Site Survey and Broadband Measurements</th><th colspan="2">Frequency Selective Measurements</th></tr>
<tr><td> 
</td><td colspan="2">SPECTRUM ANALYSER WITH TRIPOD MOUNTED ANTENNA CONNECTED
 
PORTABLE SPECTRUM ANALYSER WITH ANTENNA DIRECTLY CONNECTED
  </td></tr>
<tr><td>Used to measure the overall electric or magnetic field present over a range of frequencies (e.g. 100kHz to 3GHz).</td><td colspan="2">Spectrum analysers are used to measure individual emissions at specific frequencies. Individual emissions contribute to the overall EMF. Examples of individual emissions are a TV signal, and a mobile phone signal for a particular mobile operator. There may be a number of emissions from different transmitters contributing to the overall EMF at a particular location.</td></tr>
</table>

6. Initial Site Survey

An initial survey was carried out in the area around the Designated Site in order to determine the point of maximum NIR. This is the location at which the overall E-field strength level measured was somewhat higher than that measured in other areas around the site and represents the highest level of exposure to which a member of the general public might be subjected in the vicinity of the transmitter.

For this initial survey a calibrated field strength meter fitted with a **3 GHz isotropic probe** was used. The meter and probe were used to measure the sum of all electrical fields present at **all frequencies from 100 kHz up to 3 GHz**.

Once the point of maximum NIR was determined, broadband and frequency-selective measurements were conducted at that location (see following two sections). For the duration of those measurements, the various instruments, antennas and probes used were mounted on non-metallic supports.

7. Full Survey – Broadband Measurements

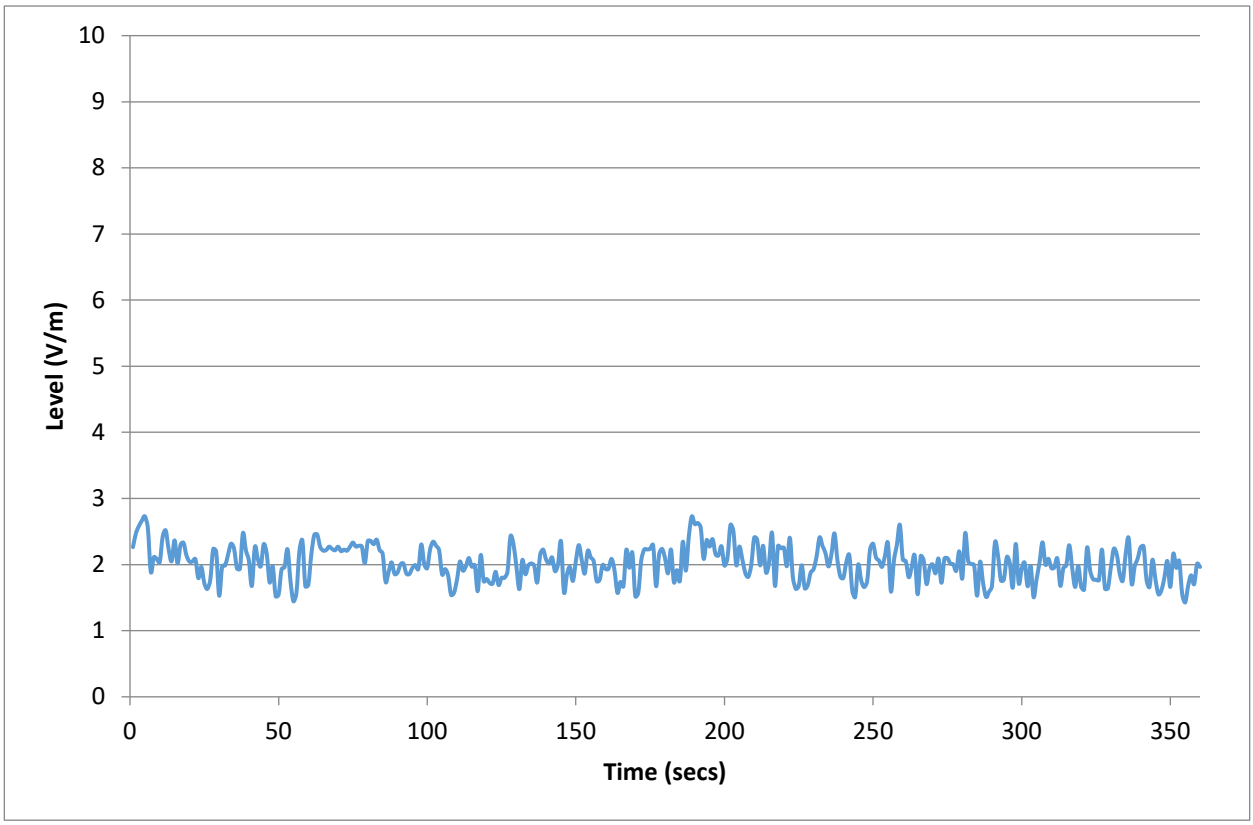
The purpose of these measurements was to get an overview of the intensity of the EMF present at the point of maximum NIR near the Designated Site.

There, the field strength meter (which was mounted on a tripod and fitted with **3GHz isotropic probe)**, was set to record, over a six-minute period, simultaneous measurements of the sum of all received signals within the frequency range of the probe. This measurement was then repeated using a **40 GHz isotropic probe**.

The broadband measurement results presented below show the levels in volts per metre (V/m) recorded during the six-minute period. The average and maximum levels can be compared to the lowest maximum ICNIRP Public Exposure Limits which is 27.7 V/m.

If a broadband measurement is higher than 27.7 V/m, it does not necessarily follow that the ICNIRP Public Exposure Limits have been exceeded because the limits are frequency dependent. A more detailed investigation involving frequency selective measurement is necessary to assess compliance with the ICNIRP Public Exposure Limits (see following section).

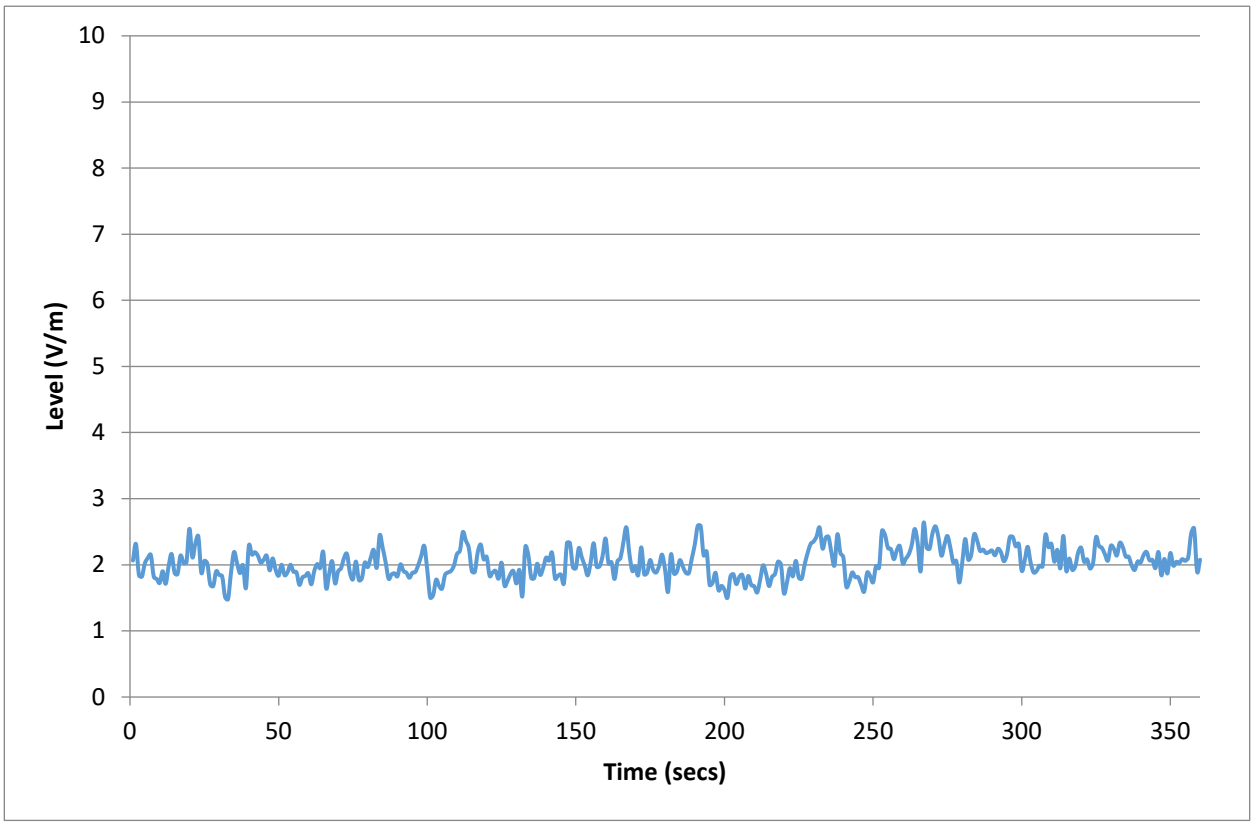
Electric field strengths recorded over 6-minute period using 3 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	2.02 V/m	**Peak Measurement V/m:**	2.73 V/m
Date:	18/09/2023	**Start Time:**	09:31
Meter:	NBM-550	**Probe:**	EF3091
Frequency Range:	100 kHz – 3 GHz		

Electric field strengths recorded over 6 min period using 40 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	2.03 V/m	**Peak Measurement V/m:**	2.63 V/m
Date:	18/09/2023	**Start Time:**	09:38
Meter:	NBM-550	**Probe:**	EF 4091
Frequency Range:	27 MHz – 40 GHz		

Conclusion of the Broadband Measurements

The mean and peak measurements were below the lowest ICNIRP guideline limit of 27.7 V/m.

8. Full Survey – Frequency Selective Measurements

Basic Measurement Procedure

A more detailed survey was performed at the point of maximum NIR near the Designated Site to identify the individual transmit frequencies and field strengths of each type of emission - e.g. mobile (GSM, UMTS, LTE and 5G NR), wireless broadband (BWA), television (DVB-T), FM radio - and their contribution to the total EMF.

The measurements were performed using spectrum analyser equipment and a range of antennas to match the frequency bands in which emissions were measured.

Table of Measurement Results

A list of the measurements made is presented in the table on the following page. For each emission measured, the table shows:

- **Emission Type** (e.g. GSM, UMTS, LTE, 5G NR, DVB-T etc);
- Transmission **frequency** of the signal;
- **Measured Level** (in volts per metre (V/m));
- **Adjusted Level** (if applicable to account for the characteristics of certain signal types or to compensate for limitations of measurement equipment or to estimate emissions for maximum call or data traffic); and
- **ICNIRP Public Limit**.

Further details of Adjusted Level/s and ICNIRP Public Exposure Limits are in the explanatory notes which follow the table of measurement results.

Assessment of ICNIRP Compliance of Individual Emissions

The levels for each measured emission (as adjusted where necessary) are compared to the relevant ICNIRP Public Exposure Limit which applies for the particular frequency of the emission. It should be again noted that the ICNIRP Public Exposure Limit varies according to frequency - the limits for the different measurements presented in the tables will vary as the measurements have been performed at different frequencies.

Assessment of ICNIRP Compliance of Cumulative Emissions

The levels measured for individual emissions are used to calculate **Total Exposure Quotients** to assess the cumulative effect of individual emissions from multiple transmitters. Further details of these quotients are in the explanatory notes which follow the table of measurement results.

The calculated values of the Total Exposure Quotients must be ≤ 1 in order for the aggregate of multiple measurements to satisfy the criteria of the ICNIRP Public Exposure Limit.

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency (MHz)**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Exposure Limit (V/m)**	**Times below Limit** [adjusted Values]
FM Radio	95.690	0.01716	0.01716	27.7	1614.219
FM Radio	106.190	0.00506	0.00506	27.7	5471.065
FM Radio	103.450	0.00502	0.00502	27.7	5515.731
FM Radio	91.620	0.00501	0.00501	27.7	5524.531
FM Radio	96.430	0.00469	0.00469	27.7	5911.225
FM Radio	92.590	0.00467	0.00467	27.7	5932.748
FM Radio	90.650	0.00451	0.00451	27.7	6143.269
TETRA	redacted	redacted	redacted	27.7	redacted
TETRA	redacted	redacted	redacted	27.7	redacted
TETRA	redacted	redacted	redacted	27.7	redacted
TETRA	redacted	redacted	redacted	27.7	redacted
TETRA	redacted	redacted	redacted	27.7	redacted
PMR	redacted	0.06535	0.06535	29.6	452.587
PMR	redacted	0.00152	0.00152	29.4	19300.581
PMR	redacted	0.00072	0.00072	29.6	41183.892
LTE	763.000	0.07920	0.22651	38.0	167.677
LTE	773.000	0.04400	0.12584	38.2	303.790
LTE	783.000	0.00210	0.00601	38.5	6406.167
LTE	796.000	0.16510	0.47219	38.8	82.157
LTE	806.000	0.05100	0.14586	39.0	267.630
LTE	816.000	0.01740	0.04976	39.3	789.283
GSM	927.212	0.36250	0.72500	41.9	57.750
GSM	958.770	0.31760	0.63520	42.6	67.027
GSM	947.875	0.14540	0.29080	42.3	145.574
UMTS FDD	937.000	0.23110	0.86300	42.1	48.771
UMTS FDD	943.000	0.22690	0.84732	42.2	49.832
UMTS FDD	932.500	0.21650	0.80848	42.0	51.935
UMTS FDD	953.500	0.10890	0.40667	42.5	104.406
GSM	1842.410	0.00517	0.01033	59.0	5713.412
LTE	1815.000	0.21230	0.74374	58.6	78.763
LTE	1830.000	0.11230	0.45428	58.8	129.482
LTE	1855.000	0.40820	1.65125	59.2	35.864
LTE	1875.000	0.14130	0.49501	59.5	120.279
LTE	2120.000	0.40810	1.73851	61.0	35.088
LTE	2140.000	0.00490	0.02087	61.0	2922.296
LTE	2160.000	0.37080	1.57961	61.0	38.617

Total Exposure Quotients [calculated from Adjusted Levels]			
Quotient	**Frequency Range**	**Calculated Quotient Value**	**Limit**
Electrical Stimulation Effects (as per ICNIRP 2010)	**1 Hz to 10 MHz**	n/a	1
Thermal Effects etc. (as per ICNIRP 2020)	**100 kHz and above**	0.004705	1

Overall Conclusions of the Survey	
Frequency Selective Measurements: (Individual emissions measured at specific frequencies)	**Below ICNIRP Public Exposure Limits (Compliant)**
Total Exposure Quotient: (Assessment of cumulative emissions from multiple transmitters)	**Below ICNIRP Public Exposure Limits (Compliant)**

Explanatory Notes

Adjusted Levels

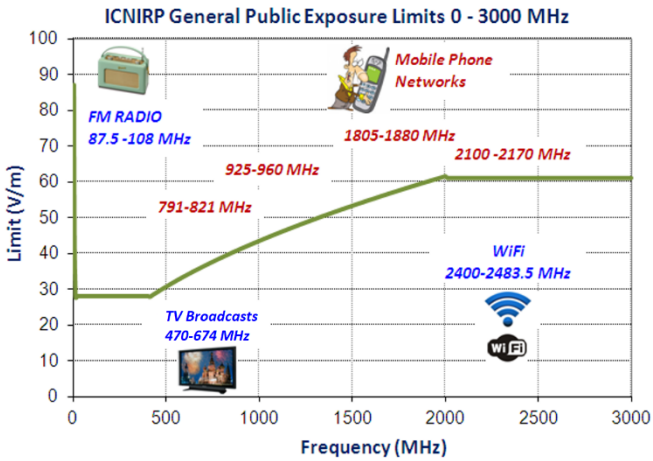
For some emissions, an adjusted level may be required to be derived from the measured level:

(1) to compensate for the limited measurement resolution of the spectrum analyser. For example, a measurement of a DVB-T (digital TV) signal performed with a resolution of 5 MHz needs to be adjusted upwards using a correction factor to account for the energy present within the full 7.61 MHz bandwidth of the signal; and/or

(2) to extrapolate to an estimate of the level under maximum traffic or duty cycle from the transmitter. For example, the base stations of mobile phone networks produce emissions which vary according to the changing volume of calls or data traffic over the course of the day.

ICNIRP Public Exposure Limits

These are set out in the ICNIRP Guidelines as reference levels for the practical assessment of exposure to electric and magnetic fields, as experienced by the general public (excluding occupational exposure and exposure during medical procedures). The limits vary according to the frequency of the emissions as illustrated in the adjacent diagram. For example, the limits for Wi-Fi in the 2400-2483.5 MHz frequency band are higher than those for FM Radio transmissions in the much lower 87.5-108 MHz frequency band.



Total Exposure Quotients

The Total Exposure Quotients (which must be ≤ 1) are calculated in accordance with mathematical formulas specified in the ICNIRP Guidelines to assess the cumulative effect of emissions from multiple transmitters. The quotients in this report are calculated from the Adjusted Levels rather than from the Measured Levels to account for total potential public exposure under maximum traffic conditions.

The two quotients are as follows:

(1) Quotient for Electrical Stimulation Effects (1 Hz to 10 MHz)
This quotient is calculated only in a small number of cases where strong emissions in the frequency range between 1 Hz and 10 MHz are present at the survey location (e.g. near a long wave radio transmitter site). This essentially involves summing the ratios (measured field strength/applicable limit) for each emission.

(2) Quotient for Thermal Effects etc. (100 kHz and above)
The measurements of any emissions above 100 kHz are used to calculate a quotient to assess any thermal (heat) and other effects as per ICNIRP 2020. This essentially involves summing the squares of the ratios (measured field strength/applicable limit) for each emission.

1. Measurement Equipment List

Field Strength Meter

Manufacturer:	Narda
Model:	NBM-550
Serial Number:	A-0068
Calibration Date:	23/05/2023

3 GHz Probe

Manufacturer:	Narda
Model:	EF 0391
Serial Number:	A-0119
Calibration Date:	24/05/2023
Frequency Range:	100 kHz – 3 GHz

40 GHz Probe

Manufacturer:	Narda
Model:	EF 4091
Serial Number:	A-0110
Calibration Date:	24/05/2023
Frequency Range:	27 MHz – 40 GHz

Frequency Selective Measurements

See individual band scans in previous section for details of antennas and spectrum analysers used.

2. Site Photographs

Photo 1. Broadband Measurement location looking towards antennas

Photo 2. Frequency selective measurement location looking towards antennas