Commission for Communications Regulation
An Coimisiún um Rialáil Cumarsáide

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1. Survey Summary

Address of Transmitter Site Surveyed:	Clayton Hotel, Cardiff Lane, Sir John Rogersons Quay, Grand Canal Dock, Dublin 2
Site Type:	GSM, UMTS, LTE
Survey Date:	24/06/2019

Measurement Location: (at point of maximum non-ionising radiation near site)	On public footpath opposite entrance to Clayton hotel.

Measurement Location Coordinates:	**LAT**	***deg***	***min***	***sec***	**LONG**	***deg***	***min***	***sec***
	N	53	20	42.8	**W**	6	14	25.7

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 Limits (Compliant)**
Total Exposure Quotient: (Assessment of cumulative emissions from multiple transmitters)	**Below ICNIRP Public 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

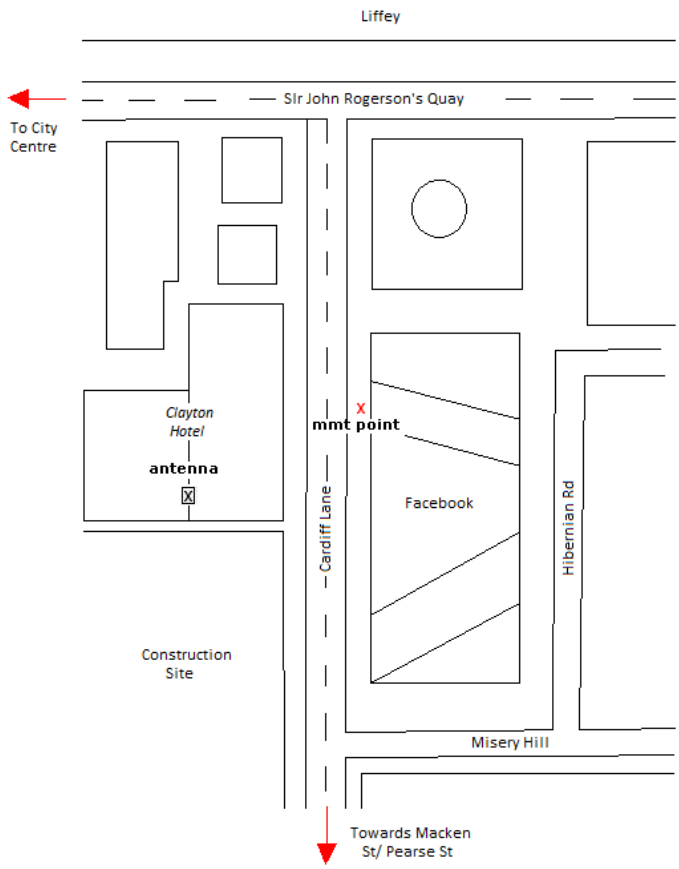
Survey Weather

Sky: Overcast

Temperature:
13° C

Relative Humidity:
47 %

Map of Designated Transmitter Site and Measurement Location



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 08/51R3[2]. This methodology incorporates many of the measurement methods and procedures outlined in:

- 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]

Note re this Report Version

If you have downloaded this report from www.siteviewer.ie or from www.comreg.ie, you are reading an abbreviated version. In addition to sections 1 to 8, the full extended technical version of this report contains a comprehensive technical record of the measurements and any calculations performed, a list of equipment used, as well as a technical appendix. A copy of the extended report is available on request from ComReg.

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[1] Current ICNIRP guidelines:

- *"Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)"*, ICNIRP, published in 'Health Physics', April 1998, Volume 74, No. 4: http://www.icnirp.org/documents/emfgdl.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: http://www.icnirp.org/documents/LFgdl.pdf

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

[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 .

5. Survey Overview

Survey Stages

In accordance with the methodology outlined in ComReg Document 08/51R3, 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[6] in the **radiating near-field**[7] and the **far-field**[8]**,** which is located beyond a distance of at least the wavelength of the radiated EMF. 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 identifies wavelengths for 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 (mobile phone base)	925 MHz	0.32 m
GSM 1800 (mobile phone base)	1805 MHz	0.17 m
UMTS (mobile phone base)	2110 MHz	0.14 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**[9] region. In this region, located within a distance of at least the wavelength of the

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

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

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

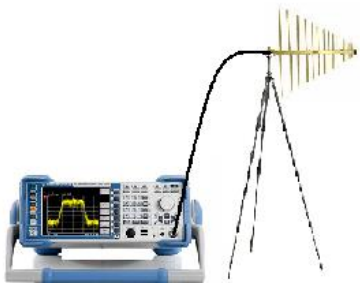
[9] Within a distance of max(λ, D, $D^2/4\lambda$)

radiated EMF, the relationship between E and H becomes very complex and there is no direct correlation between both components of the EMF.

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.

Initial Site Survey and Broadband Measurements	**Frequency Selective Measurements**
	**SPECTRUM ANALYSER WITH TRIPOD MOUNTED ANTENNA CONNECTED**  **PORTABLE SPECTRUM ANALYSER WITH ANTENNA DIRECTLY CONNECTED** 
Used to measure the overall electric or magnetic field present over a range of frequencies (e.g. 100kHz to 3GHz).	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.

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 all measurements, the various instruments, antennas and probes used were mounted on non-metallic supports.

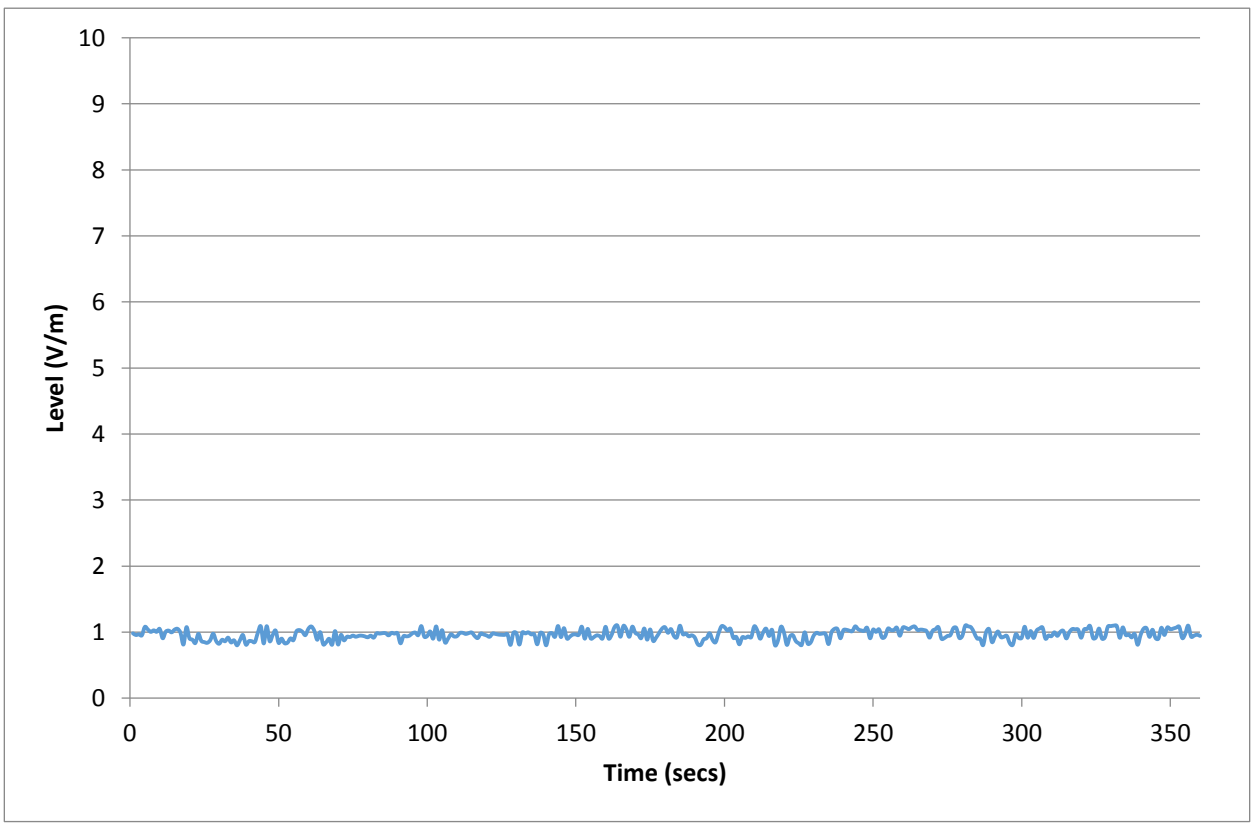
7. Full Survey – Broadband Measurements

The purpose of these measurements was to get an overview of the intensity of the electromagnetic field present at the point of maximum NIR near the site. There, the field strength meter was mounted on a tripod and, fitted with a **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 **60 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 28 V/m.

If a broadband measurement is higher than 28 V/m, it does not necessarily follow that the ICNIRP Public Exposure Limits have been exceeded because the limits are frequency dependent. For example, if the emissions are in the 2100 MHz (mobile phone) frequency band, then the limit which applies is higher at 61 V/m. A more detailed investigation involving frequency selective measurement is necessary to assess compliance with the ICNIRP Public Exposure Limits (see following section).

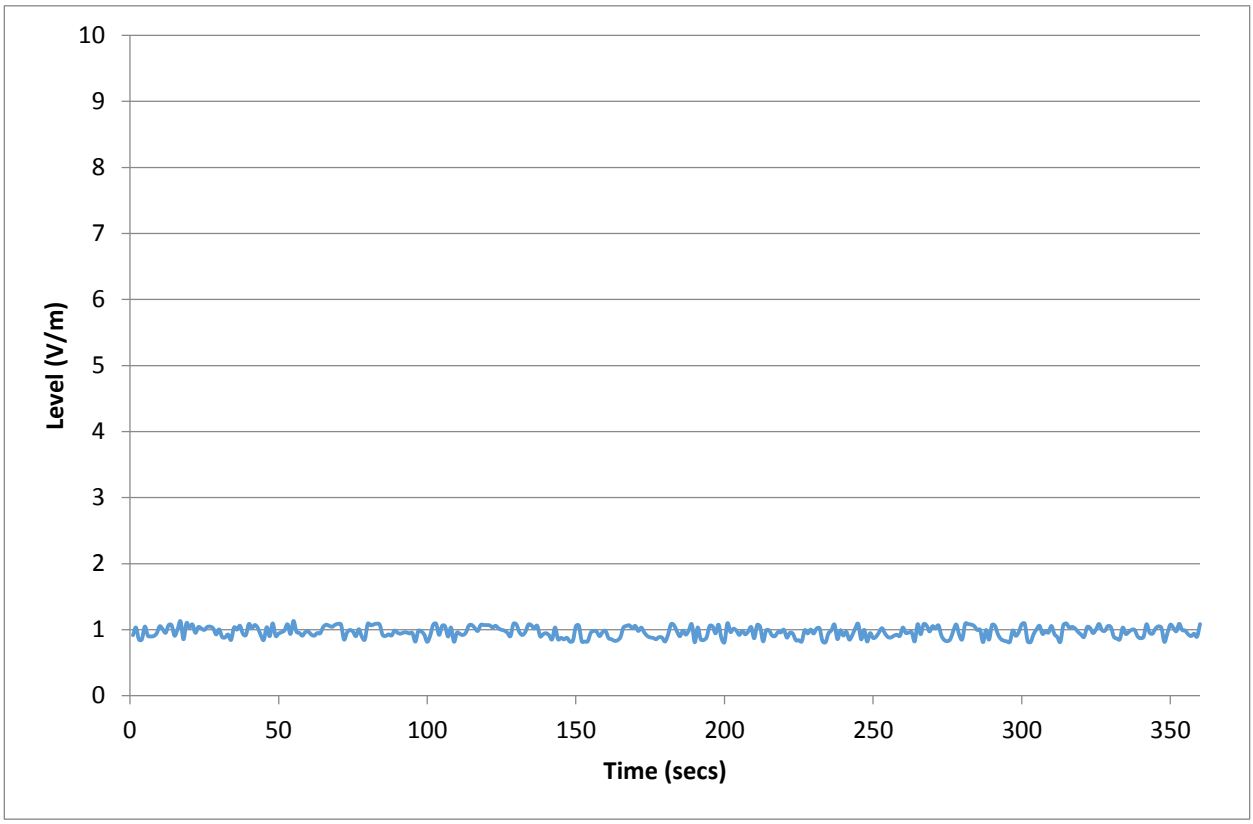
Electric field strengths recorded over 6 minute period using 3 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	0.96 V/m	**Peak Measurement V/m:**	1.10 V/m
Date:	24/06/2019	**Start Time:**	13:57
Meter:	NBM-550	**Probe:**	EF3091
Frequency Range:	100 kHz – 3 GHz		

Electric field strengths recorded over 6 min period using 60 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	0.97 V/m	**Peak Measurement V/m:**	1.13 V/m
Date:	24/06/2019	**Start Time:**	14:04
Meter:	NBM-550	**Probe:**	EF 6091
Frequency Range:	100 MHz – 60 GHz		

Conclusion of the Broadband Measurements

The mean and peak measurements were below the lowest ICNIRP guideline limit of 28 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 phone (GSM, UMTS and LTE), wireless broadband, TV, radio signals etc.) 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 or UMTS mobile phone, TV 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 measure (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	94.890	0.01195	0.01195	28.0	2343.096
FM Radio	98.100	0.00986	0.00986	28.0	2839.469
FM Radio	96.660	0.00914	0.00914	28.0	3064.799
FM Radio	92.890	0.00776	0.00776	28.0	3607.318
FM Radio	102.210	0.00776	0.00776	28.0	3607.318
FM Radio	90.690	0.00755	0.00755	28.0	3709.101
FM Radio	91.290	0.00742	0.00742	28.0	3772.568
FM Radio	106.760	0.00736	0.00736	28.0	3802.798
FM Radio	103.770	0.00677	0.00677	28.0	4138.339
FM Radio	100.910	0.00657	0.00657	28.0	4259.203
FM Radio	106.010	0.00657	0.00657	28.0	4261.147
FM Radio	100.280	0.00642	0.00642	28.0	4363.410
FM Radio	104.400	0.00635	0.00635	28.0	4412.228
FM Radio	101.790	0.00620	0.00620	28.0	4516.129
FM Radio	98.670	0.00594	0.00594	28.0	4713.011
FM Radio	95.490	0.00572	0.00572	28.0	4893.394
FM Radio	93.480	0.00568	0.00568	28.0	4932.182
FM Radio	96.040	0.00549	0.00549	28.0	5102.041
FM Radio	88.510	0.00504	0.00504	28.0	5552.251
FM Radio	89.880	0.00491	0.00491	28.0	5703.809
T-DAB	227.420	0.00839	0.00839	28.0	3337.704
TETRA	**REDACTED**	0.00364	0.00631	28.0	4436.281
TETRA	**REDACTED**	0.00359	0.00622	28.0	4497.999
TETRA	**REDACTED**	0.00321	0.00556	28.0	5037.646
TETRA	**REDACTED**	0.00303	0.00524	28.0	5342.303
TETRA	**REDACTED**	0.00300	0.00520	28.0	5381.427
TETRA	**REDACTED**	0.00292	0.00505	28.0	5545.732
TETRA	**REDACTED**	0.00285	0.00494	28.0	5672.213
TETRA	**REDACTED**	0.00271	0.00469	28.0	5976.269
TETRA	**REDACTED**	0.00258	0.00447	28.0	6270.678
TETRA	**REDACTED**	0.00237	0.00410	28.0	6832.548
TETRA	**REDACTED**	0.00229	0.00396	28.0	7062.389
TETRA	**REDACTED**	0.00228	0.00394	28.0	7102.727
TETRA	**REDACTED**	0.00208	0.00360	28.0	7783.249
TETRA	**REDACTED**	0.00194	0.00275	28.0	10195.154
TETRA	**REDACTED**	0.00188	0.00326	28.0	8589.696
TETRA	**REDACTED**	0.00182	0.00316	28.0	8862.833
TETRA	**REDACTED**	0.00171	0.00297	28.0	9437.132
TETRA	**REDACTED**	0.00168	0.00238	28.0	11778.102
TETRA	**REDACTED**	0.00168	0.00290	28.0	9651.228
TETRA	**REDACTED**	0.00162	0.00280	28.0	9991.228
TETRA	**REDACTED**	0.00157	0.00272	28.0	10283.593

TETRA	**REDACTED**	0.00151	0.00261	28.0	10734.268
TETRA	**REDACTED**	0.00150	0.00261	28.0	10748.542
TETRA	**REDACTED**	0.00149	0.00258	28.0	10864.118
TETRA	**REDACTED**	0.00125	0.00217	28.0	12891.394
TETRA	**REDACTED**	0.00115	0.00199	28.0	14081.714
TETRA	**REDACTED**	0.00109	0.00188	28.0	14871.948
PMR	**REDACTED**	**REDACTED**	**REDACTED**	**REDACTED**	7511.265
PMR	**REDACTED**	**REDACTED**	**REDACTED**	**REDACTED**	33853.356
PMR	**REDACTED**	**REDACTED**	**REDACTED**	**REDACTED**	37835.340
DVB-T	576.650	0.04896	0.05777	33.0	571.525
DVB-T	735.750	0.04870	0.05747	37.3	649.018
DVB-T	769.860	0.04714	0.05563	38.2	685.862
DVB-T	582.540	0.04319	0.05096	33.2	651.179
DVB-T	545.660	0.01765	0.02083	32.1	1542.187
DVB-T	568.620	0.01660	0.01959	32.8	1673.877
LTE	816.000	0.14890	0.42585	39.3	92.233
LTE	806.000	0.03220	0.09209	39.0	423.885
LTE	796.000	0.05050	0.14443	38.8	268.597
GSM	948.438	0.09232	0.18464	42.3	229.341
GSM	928.469	0.04473	0.08946	41.9	468.336
GSM	955.750	0.04055	0.08110	42.5	524.148
UMTS FDD	953.500	0.18130	0.67703	42.5	62.712
UMTS FDD	943.000	0.06643	0.24807	42.2	170.209
UMTS FDD	932.500	0.03043	0.11364	42.0	369.499
UMTS FDD	937.000	0.02899	0.10826	42.1	388.788
GSM	1842.970	0.01701	0.03402	59.0	1735.112
LTE	1815.000	0.05350	0.18742	58.6	312.548
LTE	1830.000	0.29950	1.21154	58.8	48.550
LTE	1855.000	0.03550	0.14360	59.2	412.388
LTE	1875.000	0.02170	0.07602	59.5	783.201
UMTS FDD	2147.500	0.19930	0.63025	61.0	96.788
UMTS FDD	2152.500	0.10070	0.31844	61.0	191.557
UMTS FDD	2132.500	0.07139	0.22576	61.0	270.203
UMTS FDD	2157.500	0.04814	0.15223	61.0	400.701
UMTS FDD	2127.500	0.04788	0.15141	61.0	402.877
UMTS FDD	2122.500	0.04249	0.13437	61.0	453.983
UMTS FDD	2112.500	0.03775	0.11938	61.0	510.987
UMTS FDD	2117.500	0.03757	0.11881	61.0	513.435
UMTS FDD	2142.500	0.03096	0.09790	61.0	623.054
UMTS FDD	2137.500	0.01700	0.05376	61.0	1134.692
WiFi	2417.500	0.09207	0.14979	61.0	407.240
WiFi	2408.670	0.08035	0.13072	61.0	466.641
WiFi	2452.710	0.02048	0.03332	61.0	1830.792
LTE	3590.143	0.02306	0.09823	61.0	620.993

Total Exposure Quotients [calculated from Adjusted Levels]			
Quotient	**Frequency Range**	**Calculated Quotient Value**	**Limit**
Electrical Stimulation Effects	**1 Hz to 10 MHz**	n/a	1
Thermal Effects	**100 kHz and above**	0.001111	1

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

Explanatory Notes

Adjusted Levels

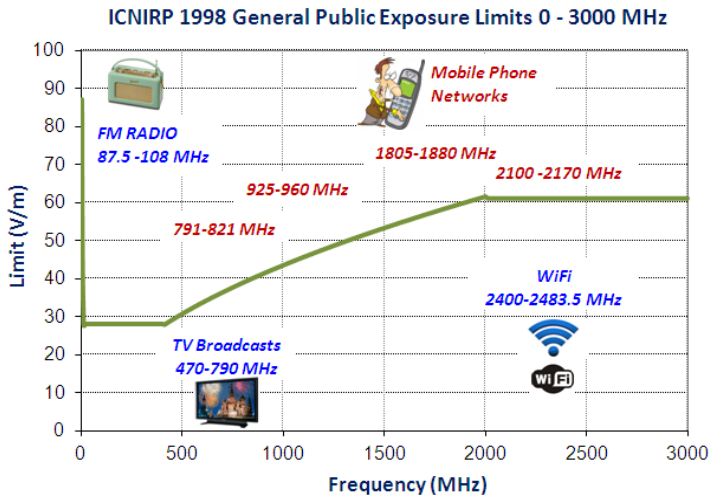
For some emissions, an adjusted level may be required to be derived from the measured level:

(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 (100 kHz and above)

The measurements of any emissions above 100 kHz are used to calculate a quotient to assess any thermal (heat) effects. This essentially involves summing the squares of the ratios (measured field strength/applicable limit) for each emission.