Commission for Communications Regulation
An Coimisiún um Rialáil Cumarsáide

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Programme of Measurement of Non-Ionising Radiation Emissions

Site Survey Report 19/11_7

1. Survey Summary

Address of Transmitter Site Surveyed:	Grand Canal Dock, Ringsend Rd, Dublin 4
Site Type:	GSM, UMTS, LTE
Survey Date:	16/11/2018

Measurement Location: (at point of maximum non-ionising radiation near site)	At footbridge between Hanover Quay and Grand Canal Street Upper, on opposite side of canal to transmitter location.

Measurement Location Coordinates:	**LAT**	*deg*	*min*	*sec*	**LONG**	*deg*	*min*	*sec*
	N	53	20	36.7	**W**	6	13	49.2

Purpose and Conduct of Survey:

Non-ionising electromagnetic radiation levels were measured at the point of highest emissions which was determined near the site, in order to **assess compliance with** the international **ICNIRP Limits** for general public exposure to non-ionising radiation.

Compliance with the ICNIRP 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).

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

Transmitter Site Photo

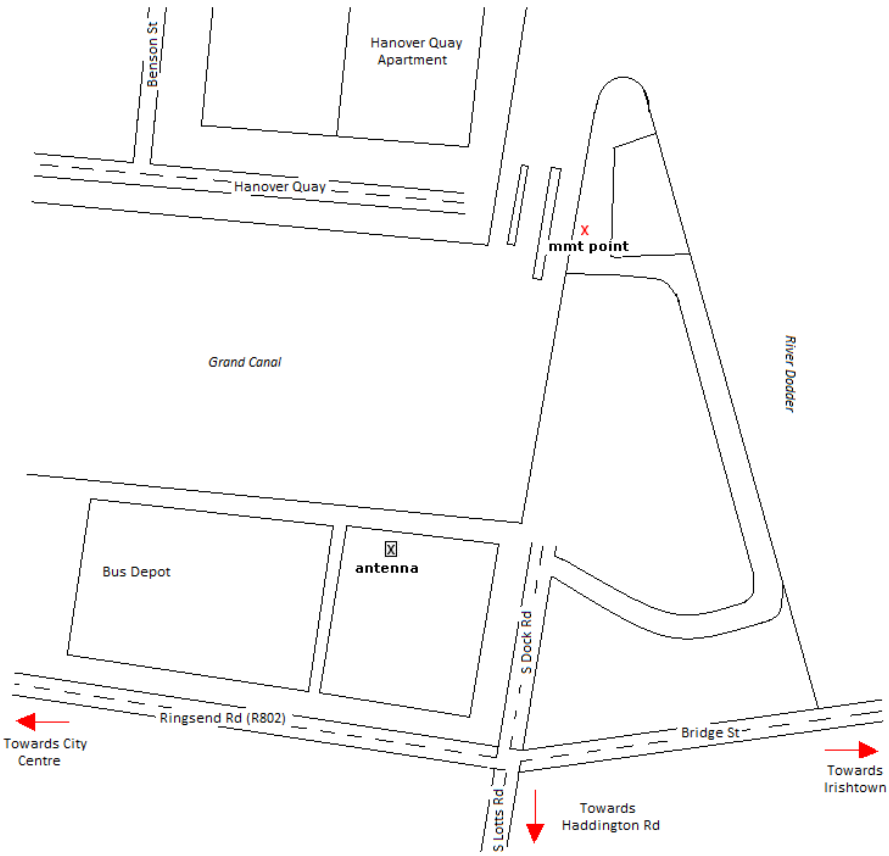
Survey Weather

Sky: Light Cloud

Temperature:
14° C

Relative Humidity:
45 %

Map of Transmitter Site and Measurement Location



4. Introductory Note

Purpose of Survey

The survey of the designated transmitter site was commissioned by the Commission for Communications Regulation (ComReg) as part of its Programme of Measurement of Non-Ionising Radiation Emissions. The purpose of the survey was to assess whether non-ionising radiation emissions (occurring within the radio frequency part of the electromagnetic spectrum) from the site were compliant with the limits for general public exposure specified in the guidelines[1] published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Compliance with the ICNIRP limits is a condition of a General Authorisation for the provision of an electronic communications network and/or 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 non-ionising radiation emissions from the site were conducted in accordance with the methodology outlined in document ComReg 08/51R3[2]. This methodology incorporates many of the measurement methods and procedures outlined in ECC Recommendation (02)04[3] and CENELEC measurement standard EN 50492:2008[4], as well as 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:**

(1) "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)", International Commission on Non-Ionizing Radiation Protection, Published in 'Health Physics', April 1998, Volume 74, No. 4. http://www.icnirp.org/documents/emfgdl.pdf

(2) "Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz to 100 kHz)", International Commission on Non-Ionizing Radiation Protection, 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 (revised Bratislava 2003, Helsinki 2007), "Measuring Non-Ionising Electromagnetic Radiation (9 kHz – 300 GHz), European Communications Committee, 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', Brussels, CENELEC, November 2008, http://www.cenelec.eu

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

5. Survey Overview

Survey Stages

In accordance with the methodology outlined in document ComReg 08/51R3, the survey was conducted in three stages as follows:

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

Brief outlines of each stage, along with results and conclusions of the measurements are presented in the three sections which follow.

Measurement of Electromagnetic Fields

Electromagnetic fields can be sub-divided into two components:

(1) Electric field **E** [measured in Volts per metre or V/m]

(2) Magnetic field **H** [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 are located beyond a distance of at least the wavelength of the radiated electromagnetic field. 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 shows 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 the far field, only one component needs to be measured, as the other component can be easily derived from it. Normally it is only the electric field which is measured in these regions.

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

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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 $\max(\lambda, D, D^2/4\lambda)$, where λ is the wavelength and D is the antenna's largest dimension

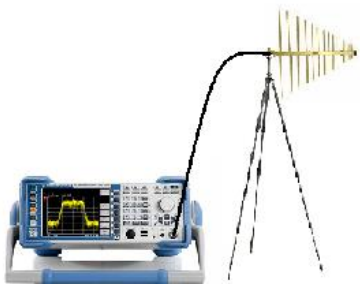
[8] Beyond a distance of $\max(5\lambda, 5D, 0.6D^2/\lambda)$

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

Measurement Equipment

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

The table below shows examples of equipment typically used to measure electromagnetic fields in non-ionising radiation 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. The individual emissions contribute to the overall electromagnetic field. 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 electromagnetic field at a particular location.

6. Initial Site Survey

An initial survey was carried out in the area around the designated transmitter site in order to determine the point of maximum non-ionising radiation (NIR). This is the location at which the overall electric field strength level measured was somewhat higher than that measured in all 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.

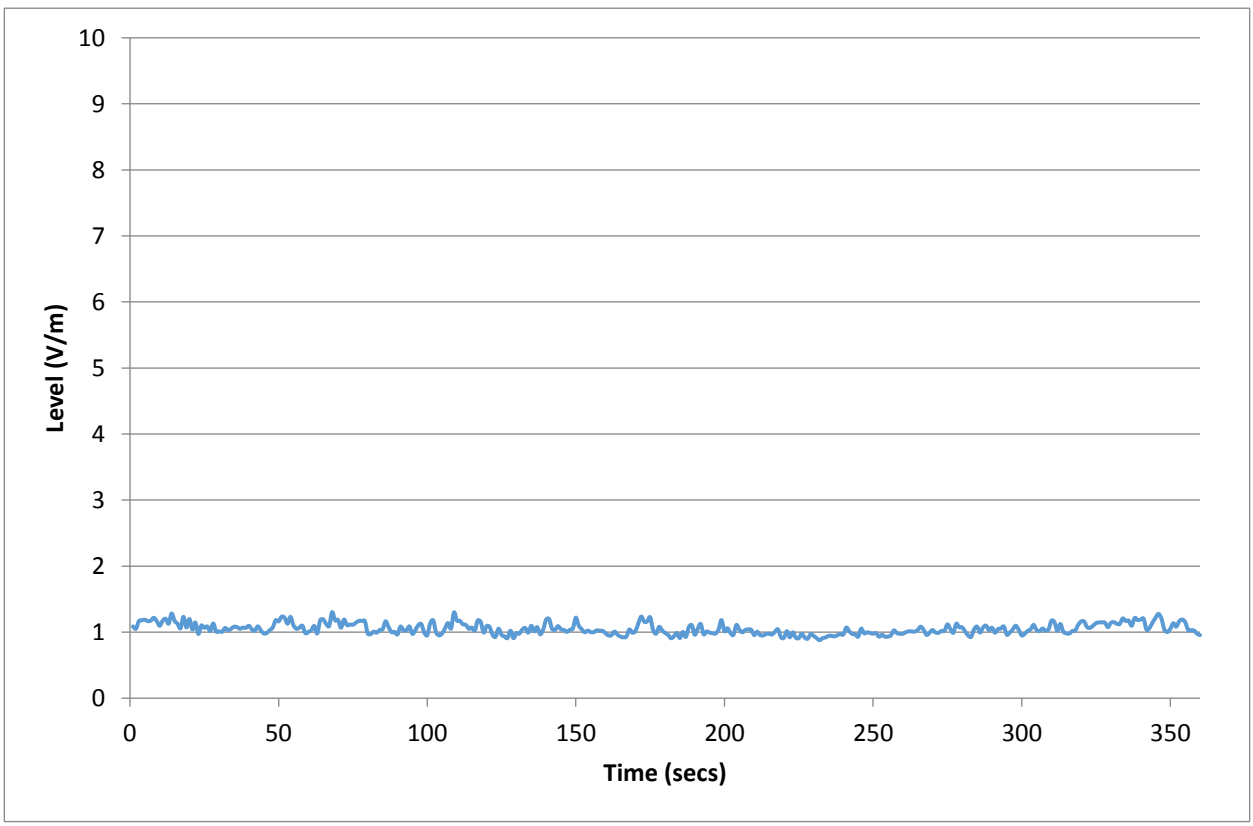
7. Full Survey – Broadband Measurements

The purpose of these measurements was to get an overview of the intensity of the 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 in the course of the six minute measurement. The average and maximum levels can be compared to the lowest maximum ICNIRP general public guideline limit which is 28 V/m.

If a broadband measurement is higher than 28 V/m, it does not necessarily follow that the ICNIRP Limits have been exceeded, as the limits are frequency dependent. For example, if the emissions are in the 2100 MHz UMTS 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 Limits (see next section).

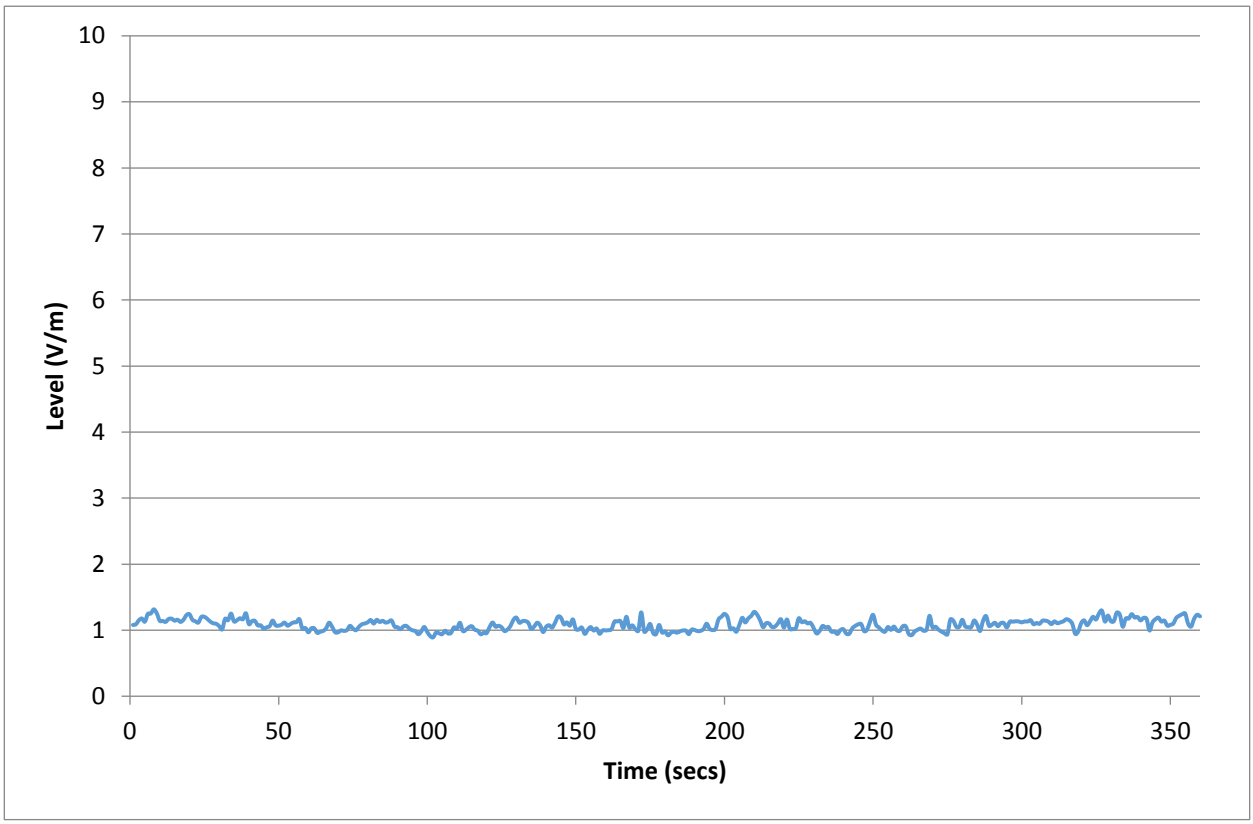
Electric field strengths recorded over 6 min period using 3 GHz probe at point of max NIR:



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	1.05 V/m	**Peak Measurement V/m:**	1.30 V/m
Date:	16/11/2018	**Start Time:**	15:38
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 max NIR:



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	1.08 V/m	**Peak Measurement V/m:**	1.32 V/m
Date:	16/11/2018	**Start Time:**	15:45
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 site in order to identify the individual transmit frequencies and field strengths of each type of emission (e.g. mobile telephone GSM, UMTS and LTE, wireless broadband, TV, radio signals etc) and their contribution to the total electromagnetic field. 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 next 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 max call or data traffic)
- **ICNIRP Limit** for Public Exposure

For further details of Adjusted Levels and ICNIRP Limits, please see the explanatory notes which follow the table of measurement results.

Assessment of ICNIRP Compliance of Individual Emissions

The levels for each emission measured, which have been adjusted where necessary, are compared to the relevant ICNIRP general public guideline limit which applies at the particular frequency of the emission. It should be noted that the ICNIRP guideline limits vary 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** in order assess the cumulative effect of emissions from multiple transmitters. For further details of the quotients, please see the explanatory notes which follow the tables of measurement results.

The calculated values of the quotients must be ≤ 1 in order for the aggregate of NIR emissions to satisfy the criteria of the ICNIRP Guidelines.

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency (MHz)**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
FM Radio	103.790	0.02304	0.02304	28.0	1215.278
FM Radio	94.870	0.02206	0.02206	28.0	1269.266
FM Radio	106.000	0.02053	0.02053	28.0	1363.858
FM Radio	100.320	0.01836	0.01836	28.0	1525.054
FM Radio	106.780	0.01766	0.01766	28.0	1585.504
FM Radio	96.680	0.01718	0.01718	28.0	1629.802
FM Radio	104.360	0.01535	0.01535	28.0	1824.104
FM Radio	98.090	0.01512	0.01512	28.0	1851.852
FM Radio	92.880	0.01501	0.01501	28.0	1865.423
FM Radio	105.210	0.01412	0.01412	28.0	1983.003
FM Radio	101.800	0.01358	0.01358	28.0	2061.856
FM Radio	88.480	0.01116	0.01116	28.0	2508.961
FM Radio	90.680	0.00961	0.00961	28.0	2913.025
FM Radio	103.190	0.00608	0.00608	28.0	4606.021
FM Radio	89.110	0.00587	0.00587	28.0	4771.643
FM Radio	93.520	0.00571	0.00571	28.0	4907.975
FM Radio	95.440	0.00531	0.00531	28.0	5270.092
FM Radio	89.990	0.00516	0.00516	28.0	5426.357
FM Radio	100.810	0.00511	0.00511	28.0	5483.745
FM Radio	91.250	0.00509	0.00509	28.0	5499.902
PMR	REDACTED	0.00173	0.00173	28.0	16147.636
PMR	REDACTED	0.00148	0.00148	28.0	18906.144
T-DAB	227.150	0.02050	0.02050	28.0	1365.854
TETRA	REDACTED	0.00845	0.01464	28.0	1913.113
TETRA	REDACTED	0.00594	0.01029	28.0	2721.975
TETRA	REDACTED	0.00553	0.00957	28.0	2924.350
TETRA	REDACTED	0.00511	0.00885	28.0	3165.421
TETRA	REDACTED	0.00464	0.00804	28.0	3484.010
TETRA	REDACTED	0.00350	0.00606	28.0	4617.483
TETRA	REDACTED	0.00266	0.00460	28.0	6084.233
TETRA	REDACTED	0.00261	0.00452	28.0	6198.546
TETRA	REDACTED	0.00243	0.00421	28.0	6644.393
TETRA	REDACTED	0.00222	0.00385	28.0	7272.068
TETRA	REDACTED	0.00217	0.00307	28.0	9119.756
TETRA	REDACTED	0.00212	0.00367	28.0	7639.796
TETRA	REDACTED	0.00200	0.00346	28.0	8095.046
TETRA	REDACTED	0.00198	0.00343	28.0	8156.311
TETRA	REDACTED	0.00196	0.00339	28.0	8260.505
TETRA	REDACTED	0.00185	0.00320	28.0	8743.000
TETRA	REDACTED	0.00169	0.00293	28.0	9542.980
TETRA	REDACTED	0.00169	0.00293	28.0	9559.910
TETRA	REDACTED	0.00168	0.00291	28.0	9616.780

TETRA	REDACTED	0.00161	0.00278	28.0	10072.154
TETRA	REDACTED	0.00150	0.00260	28.0	10784.395
TETRA	REDACTED	0.00143	0.00248	28.0	11288.972
TETRA	REDACTED	0.00138	0.00238	28.0	11756.951
TETRA	REDACTED	0.00137	0.00237	28.0	11817.111
TETRA	REDACTED	0.00130	0.00226	28.0	12416.135
TETRA	REDACTED	0.00128	0.00222	28.0	12609.834
TETRA	REDACTED	0.00116	0.00201	28.0	13924.037
TETRA	REDACTED	0.00112	0.00194	28.0	14446.656
TETRA	REDACTED	0.00111	0.00157	28.0	17836.928
TETRA	REDACTED	0.00109	0.00188	28.0	14899.362
TETRA	REDACTED	0.00108	0.00186	28.0	15037.960
TETRA	REDACTED	0.00103	0.00179	28.0	15649.378
PMR	REDACTED	REDACTED	REDACTED	REDACTED	2961.193
PMR	REDACTED	REDACTED	REDACTED	REDACTED	3761.890
PMR	REDACTED	REDACTED	REDACTED	REDACTED	3798.618
PMR	REDACTED	REDACTED	REDACTED	REDACTED	6489.708
PMR	REDACTED	REDACTED	REDACTED	REDACTED	11276.313
PMR	REDACTED	REDACTED	REDACTED	REDACTED	15433.195
PMR	REDACTED	REDACTED	REDACTED	REDACTED	16471.891
PMR	REDACTED	REDACTED	REDACTED	REDACTED	16662.975
PMR	REDACTED	REDACTED	REDACTED	REDACTED	18933.473
PMR	REDACTED	REDACTED	REDACTED	REDACTED	20180.391
PMR	REDACTED	REDACTED	REDACTED	REDACTED	213553.272
PMR	REDACTED	REDACTED	REDACTED	REDACTED	226072.318
PMR	REDACTED	REDACTED	REDACTED	REDACTED	241514.832
PMR	REDACTED	REDACTED	REDACTED	REDACTED	252412.155
PMR	REDACTED	REDACTED	REDACTED	REDACTED	256927.924
PMR	REDACTED	REDACTED	REDACTED	REDACTED	257641.210
PMR	REDACTED	REDACTED	REDACTED	REDACTED	273598.633
PMR	REDACTED	REDACTED	REDACTED	REDACTED	279548.934
PMR	REDACTED	REDACTED	REDACTED	REDACTED	298565.271
PMR	REDACTED	REDACTED	REDACTED	REDACTED	300000.538
PMR	REDACTED	REDACTED	REDACTED	REDACTED	311309.268
PMR	REDACTED	REDACTED	REDACTED	REDACTED	318371.227
PMR	REDACTED	REDACTED	REDACTED	REDACTED	330301.329
PMR	REDACTED	REDACTED	REDACTED	REDACTED	346909.702
PMR	REDACTED	REDACTED	REDACTED	REDACTED	351206.823
PMR	REDACTED	REDACTED	REDACTED	REDACTED	362647.487
PMR	REDACTED	REDACTED	REDACTED	REDACTED	363102.186
PMR	REDACTED	REDACTED	REDACTED	REDACTED	370614.031
PMR	REDACTED	REDACTED	REDACTED	REDACTED	373685.971
PMR	REDACTED	REDACTED	REDACTED	REDACTED	377747.838
DVB-T	546.500	0.07631	0.09005	32.1	356.972
DVB-T	569.770	0.07021	0.08285	32.8	396.161
DVB-T	771.730	0.01722	0.02032	38.2	1879.837
DVB-T	737.040	0.01561	0.01842	37.3	2026.578
LTE	816.000	0.17670	0.50536	39.3	77.722

LTE	806.000	0.01260	0.03604	39.0	1083.262
LTE	796.000	0.10150	0.29029	38.8	133.637
GSM	949.404	0.51190	1.02380	42.4	41.382
GSM	926.031	0.24270	0.48540	41.8	86.202
GSM	957.438	0.08109	0.16218	42.5	262.338
GSM	944.406	0.05864	0.11728	42.3	360.295
UMTS FDD	953.500	0.25530	0.95337	42.5	44.535
UMTS FDD	932.500	0.19720	0.73641	42.0	57.018
UMTS FDD	937.000	0.07930	0.29613	42.1	142.131
GSM	1841.190	0.06597	0.13194	59.0	447.173
LTE	1815.000	0.02060	0.07217	58.6	811.714
LTE	1830.000	0.47570	1.92430	58.8	30.567
LTE	1855.000	0.01970	0.07969	59.2	743.136
LTE	1875.000	0.10990	0.38501	59.5	154.645
UMTS FDD	2147.500	0.30480	0.96387	61.0	63.287
UMTS FDD	2152.500	0.25750	0.81429	61.0	74.912
UMTS FDD	2142.500	0.22290	0.70488	61.0	86.540
UMTS FDD	2137.500	0.10550	0.33362	61.0	182.841
UMTS FDD	2117.500	0.05090	0.16096	61.0	378.974
UMTS FDD	2122.500	0.03780	0.11953	61.0	510.311
UMTS FDD	2112.500	0.03677	0.11628	61.0	524.606
UMTS FDD	2127.500	0.03574	0.11302	61.0	539.725
UMTS FDD	2132.500	0.02754	0.08709	61.0	700.427
WiFi	2435.000	0.21180	0.34458	61.0	177.028
WiFi	2415.520	0.10980	0.17863	61.0	341.481
BWA/WIMAX	3410.619	0.00255	0.01086	61.0	5617.599
BWA/WIMAX	3434.762	0.00420	0.01790	61.0	3408.655
LTE	3590.143	0.00249	0.01009	61.0	6048.228
BWA/WIMAX	3718.286	0.00175	0.00744	61.0	8197.001
WiFi	5209.683	0.00344	0.01465	61.0	4164.571
WiFi	5493.881	0.00397	0.01689	61.0	3611.180
BWA/WIMAX	5740.714	0.00099	0.00422	61.0	14450.521
BWA/WIMAX	5761.667	0.00164	0.00697	61.0	8749.027
BWA/WIMAX	5785.952	0.00111	0.00471	61.0	12937.503
BWA/WIMAX	5844.048	0.00231	0.00984	61.0	6197.030

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**	0.003618	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

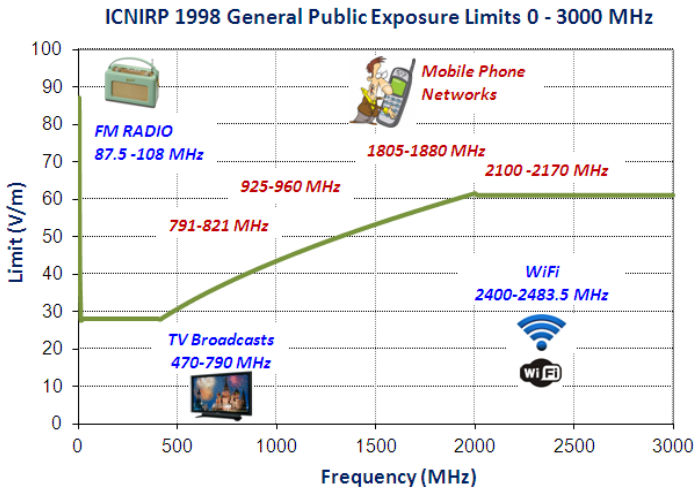
For some emissions an adjusted level has been calculated from the measured level for any or both of the following reasons:

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

(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 telephone 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 here. For example, the limits for WiFi in the 2400-2483.5 MHz band are higher than those for FM Radio transmissions in the much lower 87.5-108 MHz band.



Total Exposure Quotients

The Total Exposure Quotients (which must be ≤ 1) are calculated, in accordance with mathematical formulas specified in the ICNIRP Guidelines, in order 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, in order 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.