Commission for Communications Regulation
An Coimisiún um Rialáil Cumarsáide

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Programme of Measurement of Non-Ionising Radiation Emissions

Site Survey Report 17/66_9

1. Survey Summary

Address of Transmitter Site Surveyed:	Cross Guns Bridge, Dublin 9
Site Type:	UMTS, LTE
Survey Date:	26/03/2017

Measurement Location: (at point of maximum non-ionising radiation near site)	On the southside of the canal at the west canal lock gate

Measurement Location Coordinates:	**LAT**	*deg*	*min*	*sec*	**LONG**	*deg*	*min*	*sec*
	N	53	21	52.5	**W**	06	16	22.1

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:**
Lewis Brien, BElec	Lewis Brien, BElec	John McAuley, MEng

3. Survey Location Details

Transmitter Site Photo

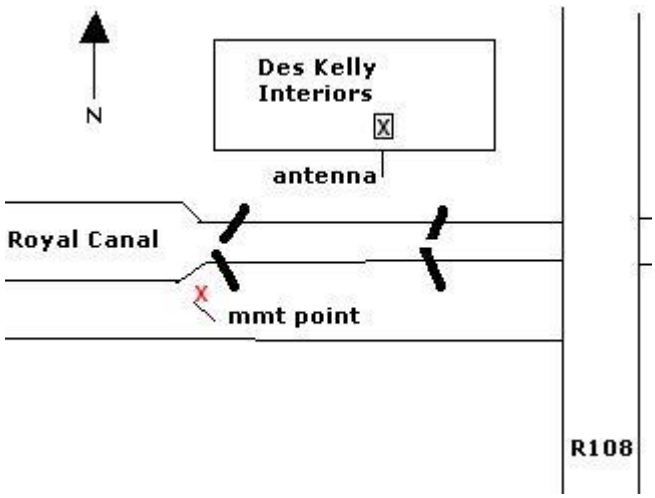
Survey Weather

Sky: light overcast

Temperature:
11 ° C

Relative Humidity:
65 %

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 08/51R2[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] http://www.comreg.ie/_fileupload/publications/ComReg0851R2.pdf

[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 08/51R2, 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 **far-field** which is the region[7] where the distance from the radiating antenna exceeds 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 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 this region.

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** region. This is the region located less than one wavelength from the radiating antenna. Here, 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] $E = H \times Z_0$ where Z_0 (characteristic impedance of free space) $\approx 377\ \Omega$

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

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.

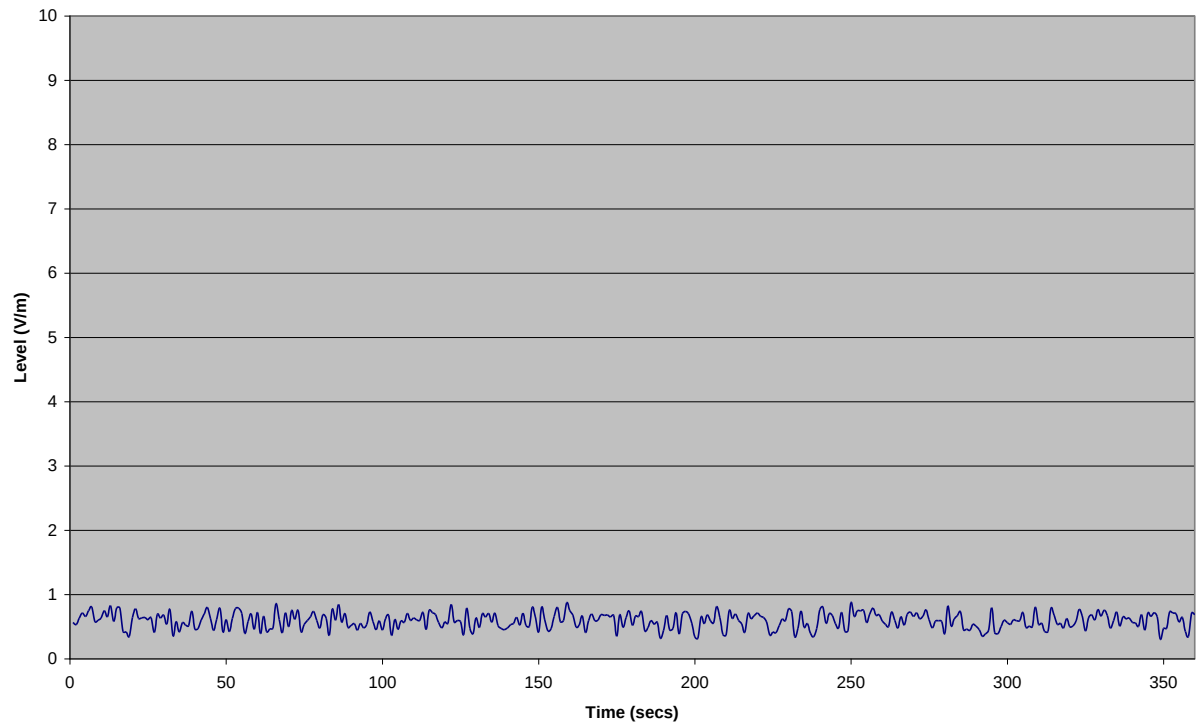
7. Full Survey – Broadband Measurements

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).

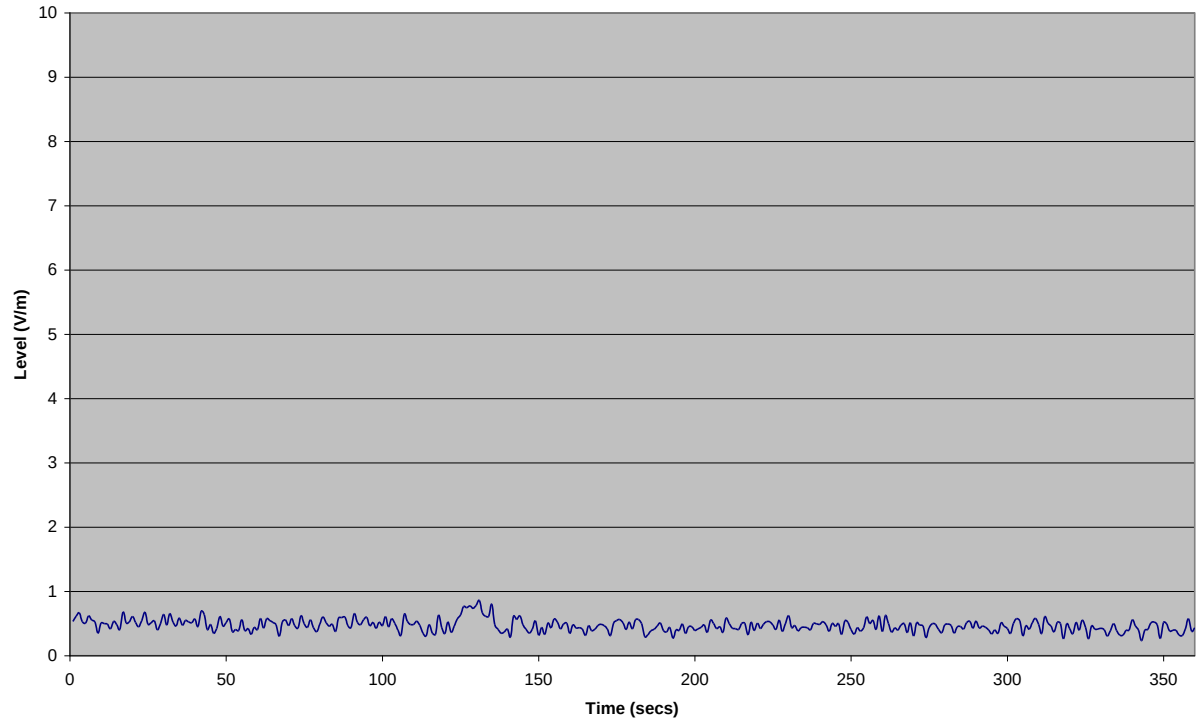
Electric field strengths recorded over 6 min period using 3 GHz probe at point of max NIR:



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	0.61 V/m	**Peak Measurement V/m:**	0.85 V/m
Date:	26/03/2017	**Start Time:**	07:33
Meter:	NBM-550	**Probe:**	EF3091
Frequency Range:	100kHz-3Ghz		

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:	0.48 V/m	**Peak Measurement V/m:**	0.86 V/m
Date:	26/03/2017	**Start Time:**	07:43
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	100.280	0.00984	0.00984	28.0	2844.372
FM Radio	98.080	0.00760	0.00760	28.0	3684.695
FM Radio	94.910	0.00695	0.00695	28.0	4027.618
FM Radio	88.500	0.00661	0.00661	28.0	4238.571
FM Radio	105.980	0.00599	0.00599	28.0	4671.338
FM Radio	90.700	0.00560	0.00560	28.0	5000.000
FM Radio	102.190	0.00560	0.00560	28.0	5002.680
FM Radio	96.670	0.00532	0.00532	28.0	5268.109
FM Radio	92.880	0.00523	0.00523	28.0	5356.801
FM Radio	106.770	0.00515	0.00515	28.0	5437.949
FM Radio	104.350	0.00486	0.00486	28.0	5761.317
FM Radio	98.720	0.00455	0.00455	28.0	6157.906
FM Radio	103.790	0.00454	0.00454	28.0	6170.119
FM Radio	101.780	0.00393	0.00393	28.0	7128.310
FM Radio	100.920	0.00363	0.00363	28.0	7715.624
T-DAB	227.610	0.00939	0.00939	28.0	2980.943
TETRA	Not Disclosed	0.01612	0.02792	28.0	1002.842
TETRA	Not Disclosed	0.01485	0.02572	28.0	1088.607
TETRA	Not Disclosed	0.01460	0.02529	28.0	1107.247
TETRA	Not Disclosed	0.01309	0.02267	28.0	1234.974
TETRA	Not Disclosed	0.01208	0.02092	28.0	1338.229
TETRA	Not Disclosed	0.01055	0.01827	28.0	1532.304
TETRA	Not Disclosed	0.00962	0.01666	28.0	1680.612
TETRA	Not Disclosed	0.00589	0.01020	28.0	2744.619
TETRA	Not Disclosed	0.00454	0.00787	28.0	3557.616
TETRA	Not Disclosed	0.00261	0.00453	28.0	6184.318
TETRA	Not Disclosed	0.00256	0.00443	28.0	6317.236
TETRA	Not Disclosed	0.00254	0.00440	28.0	6359.484
TETRA	Not Disclosed	0.00222	0.00384	28.0	7295.040
TETRA	Not Disclosed	0.00133	0.00229	28.0	12200.609
TETRA	Not Disclosed	0.00152	0.00215	28.0	12999.993
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	9247.067
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	16471.703
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	23303.421
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	35060.223
DVB-T	547.570	0.01839	0.02170	32.2	1482.719
DVB-T	567.910	0.01441	0.01700	32.8	1927.065
LTE	816.000	0.01055	0.03017	39.3	1301.755
LTE	806.000	0.01088	0.03112	39.0	1254.513
LTE	796.000	0.00464	0.01328	38.8	2920.794
GSM	947.831	0.03601	0.07202	42.3	587.780
GSM	928.375	0.02341	0.04682	41.9	894.814

GSM	937.469	0.01426	0.02852	42.1	1476.154
UMTS FDD	932.500	0.02020	0.07543	42.0	556.627
UMTS FDD	953.500	0.01703	0.06360	42.5	667.631
UMTS FDD	958.000	0.01520	0.05676	42.6	749.774
UMTS FDD	940.000	0.01036	0.03869	42.2	1089.670
GSM	1842.780	0.03148	0.06296	59.0	937.507
GSM	1805.190	0.02050	0.04100	58.4	1424.887
LTE	1830.000	0.01505	0.06088	58.8	966.166
LTE	1855.000	0.00951	0.03847	59.2	1539.572
LTE	1872.500	0.25570	0.89578	59.5	66.422
UMTS FDD	2127.500	0.31380	0.99233	61.0	61.472
UMTS FDD	2132.500	0.28110	0.88892	61.0	68.622
UMTS FDD	2122.500	0.08115	0.25662	61.0	237.705
UMTS FDD	2117.500	0.03362	0.10632	61.0	573.758
UMTS FDD	2147.500	0.03019	0.09547	61.0	638.945
UMTS FDD	2152.500	0.02292	0.07248	61.0	841.612
UMTS FDD	2112.500	0.02280	0.07210	61.0	846.042
UMTS FDD	2167.500	0.02200	0.06957	61.0	876.807
UMTS FDD	2162.500	0.02095	0.06625	61.0	920.752
UMTS FDD	2142.500	0.01081	0.03418	61.0	1784.436
UMTS FDD	2157.500	0.01012	0.03200	61.0	1906.103
WiFi	2414.690	0.67750	1.10222	61.0	55.343
WiFi	2409.570	0.53720	0.87397	61.0	69.796
WiFi	2463.510	0.03900	0.06345	61.0	961.401
WiFi	2436.800	0.02262	0.03680	61.0	1657.587

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**	0.00129	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

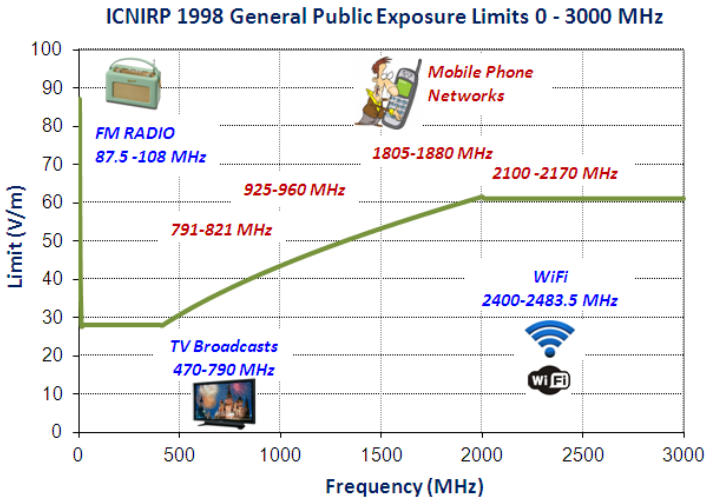
For some emissions an adjusted level has been calculated from the measured level for any or both of the following reasons:

(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.