Commission for
Communications Regulation

Report

2010 Programme of Measurement of Non-Ionising Radiation Emissions

Third Interim Report

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1. Executive Summary

The Commission for Communications Regulation (ComReg) currently arranges for Non-Ionising Radiation (NIR) surveys to be conducted near a sample number of licensed transmitter sites nationwide. Each survey involves measurement of NIR emission levels at the point of highest emissions (in a public area) associated with the transmitter. Sites are surveyed in order to assess compliance on the part of transmitter operators with their licence conditions relating to NIR emissions.

This report forms part of an ongoing series of interim reports which outline ComReg's programme of measurements, and presents the results of the third set of site surveys (15 sites) undertaken during the 2010 programme.

The site surveys were conducted during September and early October 2010 by engineers of Compliance Engineering Ireland Ltd which was contracted by ComReg to assist it with the programme.

On the basis of this work, ComReg has concluded that the NIR emissions measured from all of the 15 sites were below the relevant ICNIRP guideline limits for general public exposure[1]. The results of the measurements taken at all the sites are presented in this report.

[1] See Annex 2

2. Introduction

The Commission for Communications Regulation (ComReg) is the licensing authority for the use of the radio frequency spectrum in Ireland. The frequency spectrum is a valuable national resource which has been used for communications purposes for over 100 years. Applications which make use of the radio spectrum include a wide range of services such as radio and television broadcasting, mobile telephony and other telecommunications services such as internet connection.

It is a condition of various licences[2] issued by ComReg that licensees must ensure that non-ionising radiation[3] (NIR) emissions from each transmitter operated under the licence must be within the limits set down in the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP)[4]. Levels of NIR emissions from a licensed transmitter must not exceed the ICNIRP limits in any part of the site or surrounding area to which the general public has access.

In order to assess compliance on the part of transmitter operators with their licence conditions relating to NIR, ComReg currently arranges for NIR surveys to be conducted near a sample number of licensed transmitter sites nationwide. Each survey involves measurement of NIR emission levels at the point of highest emissions (in a public area) associated with the transmitter.

This report presents the results of measurements taken at the second set of 15 sites chosen as part of the 2010 Programme of Measurement of Non-Ionising Radiation emissions. The site surveys were conducted during September and early October 2010 by engineers of Compliance Engineering Ireland Ltd which was contracted by ComReg to assist it with the programme.

[2] Issued pursuant to the Wireless Telegraphy Act, 1926 (No. 45 of 1926) e.g. for services such as GSM & UMTS Mobile Telephony, Radio & TV Broadcasting, MMDS, Wireless Broadband etc.

[3] Non-ionising radiation is that part of the electromagnetic spectrum below 3 x 10^{15} Hz (3000 million MHz). Radio waves, infrared radiation and visible light are examples of NIR. (see Annex 1)

[4] See Annexes 1& 2 for further details.

Abbreviated versions of the individual site survey reports are available on the ComReg website[5] as well as on Siteviewer[6], an on-line facility provided by ComReg, which allows the public to view details of GSM and 3G mobile telephony base stations throughout Ireland. Copies of the full site reports are available on request.

[5] www.comreg.ie
[6] www.siteviewer.ie

3. Measurement Results

3.1 Explanatory Note

At the point of highest emissions[7] associated with each site, the engineers measured the electric field strength (or electric field voltage)[8] of emissions in the relevant radio frequency bands.

The tables which follow in the next sub-section present the levels measured at each site. The sites are listed in order by county.

The tables show the measured levels alongside the relevant ICNIRP limits for general public exposure. They include levels measured in respect of emissions from the transmitter site, along with the levels for emissions from nearby sites, if particularly high at the location.

The tables present the measurements for each site under the following headings:

1. Signal Type
2. Frequency
3. Measured Level V/m
4. Adjusted Level V/m
5. ICNIRP guideline limit
6. Total Exposure Quotient

A brief explanation of each of the headings follows:-

[7] See Annex 3 for an outline of the site survey methodology.

[8] See Annex 4 for an outline of how electromagnetic fields are measured.

Signal Type

The type of signal to which an emission on a particular frequency relates e.g. **GSM** (2nd generation mobile phone system), **UMTS** (3rd generation mobile phone system), **FM Radio**, **TV PAL** (analogue television), **FWALA** (wireless broadband) etc.

Frequency (MHz)

Various radio services are transmitted in predefined frequency ranges. For example 3G (or UMTS) mobile telephony base stations transmit signals on a frequency somewhere in the range 2110 – 2170 MHz. At each site transmitting a 3G signal, measurements were taken in that frequency range and the results of those measurements are presented in the tables. Other services such as GSM 900, GSM 1800, TETRA, Television etc. are presented in similar manner in the tables, if applicable. The frequencies of emissions associated with some services (e.g. emergency services) are not shown in the interests of confidentiality and security.

Measured Level V/m

The tables show the electric field strength levels measured for each emission (signal) type from the designated site, along with the levels for emissions from nearby sites, if particularly high. In many instances more than one measured level is shown for each emission type. This is due to the fact that different mobile operators often transmit signals from the same site on different frequency channels.

Adjusted Level V/m

For some emission types an adjusted level has been calculated from the measured level for any or all of the following reasons:

- to compensate for the limited measurement resolution of the spectrum analyser[9]. For example, a measurement of a digital television signal performed with at a resolution of 5 MHz needs to be adjusted upwards

[9] Spectrum analysers are used to measure individual emissions at specific frequencies (see Annex 4).

using a correction factor in order to account for the energy present within the full 7.6 MHz bandwidth of the signal.

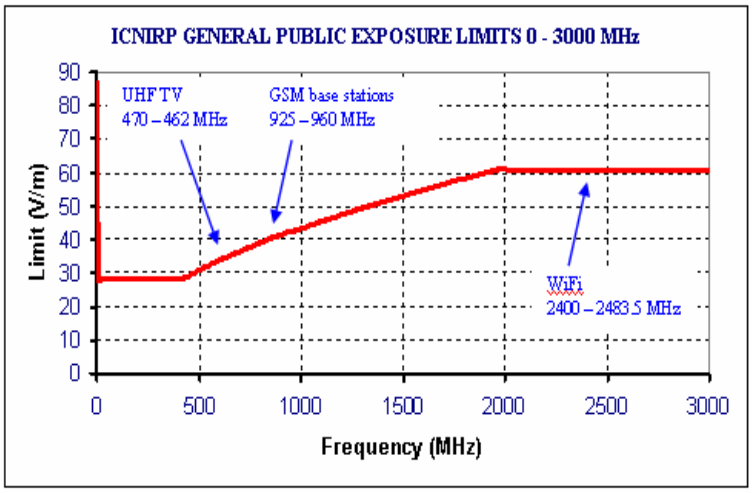
- to extrapolate to an estimate of the level under maximum traffic from the transmitter. For example, the base stations of mobile telephone networks produce emissions which vary according to the changing volume of calls or data traffic over the course of the day. The levels measured for the always-on pilot channels of the base stations can be used to extrapolate to a level which would be expected if all voice and data channels were in operation.

- to account for the characteristics of certain complex signal types (e.g. analogue PAL TV).

For further details concerning the calculation of Adjusted Levels, please refer to Annex 5.

ICNIRP guideline limit

For each site the table shows the measured and adjusted electric field strength levels in Volts per metre (V/m) alongside the relevant ICNIRP general public guideline limits. It should be noted that the ICNIRP guideline limits vary according to frequency as illustrated:



For example, for a GSM mobile signal on a frequency of 940.050 MHz, the relevant limit is 42.158 V/m, while for a 3G mobile signal on a frequency of 2147.2 MHz the relevant limit is 61 V/m. Thus the limits for the different measurements presented in the tables will vary as the measurements have been performed at different frequencies.

For further details concerning the ICNIRP Limits, please refer to Annex 2.

Total Exposure Quotient

For each site, Total Exposure Quotients 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.

In order to satisfy the criteria of the ICNIRP Guidelines, the Quotients must be less than or equal to 1.

The two quotients are as follows:

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).

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.

Please refer to Annex 2 for further information concerning the calculation of the Quotients.

3.2 Measurement Results by Site

3.2.1 Dublin: Dun Laoghaire - Mounttown Lower

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	90.69	0.0394	0.0394	28.0	710.299
FM Radio	88.49	0.0390	0.0390	28.0	717.581
FM Radio	92.87	0.0320	0.0320	28.0	876.095
FM Radio	104.35	0.0271	0.0271	28.0	1034.355
FM Radio	100.32	0.0262	0.0262	28.0	1069.927
FM Radio	96.67	0.0218	0.0218	28.0	1283.815
T-DAB	227.35	0.0096	0.0161	28.0	1742.514
TETRA	Not Disclosed	0.0051	0.0088	28.0	3199.249
TETRA	Not Disclosed	0.0039	0.0068	28.0	4093.646
TETRA	Not Disclosed	0.0029	0.0050	28.0	5638.580
TV PAL	740.98	0.0116	0.0089	37.4	4199.566
TV UHF (DVB-T)	737.82	0.0133	0.0157	37.3	2385.201
GSM	952.98	0.9656	1.9312	42.4	21.979
GSM	948.79	0.5457	1.0914	42.4	38.807
GSM	938.83	0.0140	0.0279	42.1	1507.887
GSM	1857.61	0.9691	1.9382	59.3	30.576
UMTS FDD	2127.40	4.0040	12.6618	61.0	4.818
UMTS FDD	2132.40	3.5480	11.2198	61.0	5.437
UMTS FDD	2147.40	0.6188	1.9568	61.0	31.173
UMTS FDD	2152.40	0.4972	1.5723	61.0	38.797
FWALA	3548.00	0.0024	0.0039	61.0	17199.381

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**	0.082423	1

3.2.2 Dublin: Swords - Rathbeale Rd

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]
T-DAB	227.26	0.0047	0.0079	28.0	3541.713
TETRA	Not Disclosed	0.0028	0.0049	28.0	5690.182
TETRA	Not Disclosed	0.0026	0.0046	28.0	6139.691
TETRA	Not Disclosed	0.0022	0.0037	28.0	7518.980
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	640.953
TV PAL	737.48	0.0089	0.0069	37.3	5451.078
TV PAL	799.34	0.0084	0.0065	38.9	6023.085
GSM	938.81	1.1490	2.2980	42.1	18.333
GSM	954.63	0.9547	1.9094	42.5	22.250
GSM	947.58	0.8905	1.7810	42.3	23.766
GSM	1860.58	1.2780	2.5560	59.3	23.204
GSM	1854.88	0.4973	0.9946	59.2	59.540
GSM	1840.25	0.4920	0.9840	59.0	59.944
UMTS FDD	2147.40	1.9790	6.2582	61.0	9.747
UMTS FDD	2132.40	1.7520	5.5403	61.0	11.010
UMTS FDD	2152.40	1.7190	5.4360	61.0	11.221
UMTS FDD	2127.40	1.4640	4.6296	61.0	13.176
UMTS FDD	2167.40	0.6392	2.0213	61.0	30.178
UMTS FDD	2117.80	0.5784	1.8291	61.0	33.350
UMTS FDD	2112.80	0.5128	1.6216	61.0	37.617
FWALA	3564.50	0.1514	0.2497	61.0	414.835
FWALA	3547.25	0.0244	0.0403	61.0	2179.030

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**	0.044383	1

3.2.3 Dublin 3: Clontarf Castle

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	102.148	0.0161	0.0161	28.0	1735
FM Radio	104.370	0.0144	0.0144	28.0	1942
FM Radio	98.044	0.0143	0.0143	28.0	1965
FM Radio	100.287	0.0137	0.0137	28.0	2044
PMR	Not Disclosed	0.0048	0.0048	28.0	5788
TV PAL	207.340	0.0438	0.0336	28.0	834
TV PAL	183.200	0.0291	0.0223	28.0	1255
T-DAB	227.680	0.0150	0.0251	28.0	1116
TETRA	Not Disclosed	0.0039	0.0067	28.0	4199
TETRA	Not Disclosed	0.0037	0.0064	28.0	4405
TETRA	Not Disclosed	0.0035	0.0060	28.0	4663
TETRA	Not Disclosed	0.0033	0.0058	28.0	4842
TETRA	Not Disclosed	0.0033	0.0056	28.0	4965
TETRA	Not Disclosed	0.0030	0.0053	28.0	5325
TV PAL	739.440	0.0490	0.0376	37.4	996
TV PAL	799.290	0.0458	0.0351	38.9	1107
TV PAL	567.280	0.0339	0.0260	32.7	1260
TV PAL	583.190	0.0336	0.0257	33.2	1290
TV PAL	775.090	0.0284	0.0218	38.3	1755
TV PAL	535.320	0.0258	0.0198	31.8	1608
TV UHF (DVB-T)	737.730	0.0633	0.0747	37.3	500
GSM	954.802	0.9599	1.9198	42.5	22
GSM	939.591	0.4949	0.9898	42.1	43
GSM	946.433	0.4500	0.9000	42.3	47
GSM	1841.790	0.2152	0.4304	59.0	137
GSM	1834.173	0.1404	0.2808	58.9	210
GSM	1864.599	0.0112	0.0224	59.4	2651
UMTS FDD	2117.800	0.8488	2.6842	61.0	23
UMTS FDD	2112.800	0.6847	2.1652	61.0	28
UMTS FDD	2147.400	0.5484	1.7342	61.0	35
UMTS FDD	2152.400	0.4702	1.4869	61.0	41

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UMTS FDD	2127.400	0.4222	1.3351	61.0	46
UMTS FDD	2132.400	0.3153	0.9971	61.0	61
UMTS FDD	2167.400	0.2840	0.8981	61.0	68
FWALA	3568.250	0.1585	0.3027	61.0	202

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**	0.00872	1

3.2.4 Dublin 4: Ballsbridge - Four Seasons Hotel

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	100.29	0.0180	0.0180	28.0	1555.556
FM Radio	101.80	0.0159	0.0159	28.0	1762.115
FM Radio	104.38	0.0150	0.0150	28.0	1871.658
FM Radio	98.08	0.0148	0.0148	28.0	1893.171
FM Radio	103.79	0.0141	0.0141	28.0	1983.003
FM Radio	102.19	0.0121	0.0121	28.0	2315.964
TV PAL	183.51	0.0223	0.0171	28.0	1634.103
TV PAL	207.19	0.0173	0.0132	28.0	2116.282
T-DAB	227.12	0.0101	0.0169	28.0	1658.404
TETRA	Not Disclosed	0.0073	0.0126	28.0	2224.244
TETRA	Not Disclosed	0.0071	0.0123	28.0	2275.272
TETRA	Not Disclosed	0.0064	0.0111	28.0	2514.905
TETRA	Not Disclosed	0.0064	0.0111	28.0	2520.001
TETRA	Not Disclosed	0.0063	0.0109	28.0	2561.529
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	8540.514
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	24255.548
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	26096.067
TV PAL	583.31	0.0190	0.0145	33.2	2284.798
TV PAL	535.37	0.0185	0.0142	31.8	2248.216
TV PAL	775.27	0.0182	0.0140	38.3	2738.086
TV PAL	567.32	0.0172	0.0132	32.8	2482.521
TV PAL	799.02	0.0119	0.0091	38.9	4261.910
TV-UHF (DVB-T)	737.66	0.0278	0.0327	37.3	1140.475
GSM	940.02	0.8965	1.7930	42.2	23.512
GSM	953.59	0.1213	0.2426	42.5	175.022
GSM	950.00	0.0169	0.0338	42.4	1254.600
GSM	1864.21	0.6101	1.2202	59.4	48.654
GSM	1843.82	0.0312	0.0623	59.0	947.402
GSM	1857.22	0.0046	0.0093	59.3	6404.699
UMTS FDD	2117.80	2.2580	7.1405	61.0	8.543
UMTS FDD	2112.80	1.8720	5.9198	61.0	10.304

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UMTS FDD	2132.40	0.6359	2.0109	61.0	30.335
UMTS FDD	2127.40	0.5521	1.7459	61.0	34.939
UMTS FDD	2167.40	0.1628	0.5148	61.0	118.487
UMTS FDD	2152.40	0.0482	0.1523	61.0	400.618
UMTS FDD	2147.40	0.0397	0.1254	61.0	486.501
FWALA	3570.50	0.0040	0.0065	61.0	11027.739
FWALA	3556.25	0.0005	0.0008	61.0	66444.609

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**	0.027379	1

3.2.5 Dublin 6: Ranelagh Rd

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	90.70	0.0155	0.0155	28.0	1809.955
FM Radio	104.38	0.0132	0.0132	28.0	2127.660
FM Radio	100.28	0.0121	0.0121	28.0	2323.651
FM Radio	102.18	0.0120	0.0120	28.0	2335.279
FM Radio	106.78	0.0120	0.0120	28.0	2341.137
FM Radio	88.50	0.0101	0.0101	28.0	2777.778
TV PAL	207.46	0.0182	0.0140	28.0	2006.920
T-DAB	227.72	0.0238	0.0398	28.0	703.291
TETRA	Not Disclosed	0.0039	0.0067	28.0	4158.942
TETRA	Not Disclosed	0.0032	0.0055	28.0	5086.787
TETRA	Not Disclosed	0.0030	0.0052	28.0	5430.234
TETRA	Not Disclosed	0.0028	0.0048	28.0	5857.177
TV PAL	567.31	0.0612	0.0470	32.8	697.354
TV PAL	583.30	0.0410	0.0314	33.2	1056.013
TV PAL	742.95	0.0315	0.0242	37.5	1551.231
TV PAL	535.10	0.0238	0.0183	31.8	1740.937
TV UHF (DVB-T)	737.37	0.0222	0.0262	37.3	1424.031
GSM	938.18	2.0440	4.0880	42.1	10.302
GSM	952.79	0.0715	0.1430	42.4	296.843
GSM	946.59	0.0086	0.0172	42.3	2458.688
GSM	1834.44	0.3942	0.7884	58.9	74.698
GSM	1847.88	0.0249	0.0498	59.1	1186.888
UMTS FDD	2127.40	0.3505	1.1084	61.0	55.035
UMTS FDD	2132.40	0.3277	1.0363	61.0	58.864
UMTS FDD	2112.80	0.3126	0.9885	61.0	61.707
UMTS FDD	2117.80	0.2571	0.8130	61.0	75.028
UMTS FDD	2152.40	0.2465	0.7795	61.0	78.255
UMTS FDD	2147.40	0.2373	0.7504	61.0	81.288
UMTS FDD	2167.40	0.0161	0.0509	61.0	1198.122

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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**	0.010995	1

3.2.6 Dublin 7: Cabra - Quarry Road

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	104.37	0.0090	0.0090	28.0	3115.958
FM Radio	100.30	0.0079	0.0079	28.0	3563.248
FM Radio	102.16	0.0075	0.0075	28.0	3739.816
PMR	Not Disclosed	0.0019	0.0019	28.0	14814.815
TV PAL	183.24	0.0183	0.0140	28.0	1997.039
TV PAL	207.07	0.0153	0.0117	28.0	2392.259
T-DAB	227.74	0.0085	0.0142	28.0	1973.454
TETRA	Not Disclosed	0.0069	0.0120	28.0	2338.465
TETRA	Not Disclosed	0.0047	0.0082	28.0	3421.335
TETRA	Not Disclosed	0.0033	0.0058	28.0	4867.753
TETRA	Not Disclosed	0.0033	0.0057	28.0	4934.618
TETRA	Not Disclosed	0.0032	0.0055	28.0	5077.201
TETRA	Not Disclosed	0.0025	0.0044	28.0	6430.313
TV PAL	535.38	0.0103	0.0079	31.8	4015.486
TV UHF (DVB-T)	737.42	0.0134	0.0158	37.3	2361.421
GSM	950.42	0.6123	1.2246	42.4	34.615
GSM	946.99	0.2415	0.4830	42.3	87.605
GSM	954.43	0.0167	0.0333	42.5	1274.883
GSM	939.00	0.0124	0.0247	42.1	1704.464
GSM	1866.00	1.2180	2.4360	59.4	24.383
GSM	1855.44	0.8969	1.7938	59.2	33.018
GSM	1840.56	0.2607	0.5214	59.0	113.138
UMTS FDD	2147.40	1.8360	5.8060	61.0	10.506
UMTS FDD	2132.40	1.8330	5.7965	61.0	10.524
UMTS FDD	2127.40	1.6170	5.1134	61.0	11.929
UMTS FDD	2152.40	1.3860	4.3829	61.0	13.918
UMTS FDD	2167.40	1.1130	3.5196	61.0	17.331
UMTS FDD	2112.80	0.6532	2.0656	61.0	29.531
UMTS FDD	2117.80	0.6505	2.0571	61.0	29.654

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FWALA	3542.75	0.0095	0.0157	61.0	5077.574
FWALA	3559.25	0.0054	0.0089	61.0	8376.177
FWALA	3582.50	0.0062	0.0102	61.0	7427.747
FWALA	3657.50	0.0033	0.0045	61.0	15653.407
WiFi	5594.50	0.0060	0.0114	61.0	6602.389

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**	0.039537	1

3.2.7 Dublin 8: Rialto - Herberton Rd / South Circular Rd

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	90.70	0.0075	0.0075	28.0	3755.869
FM Radio	98.08	0.0074	0.0074	28.0	3763.441
FM Radio	92.88	0.0070	0.0070	28.0	3978.968
FM Radio	93.48	0.0068	0.0068	28.0	4091.175
FM Radio	94.88	0.0068	0.0068	28.0	4093.567
FM Radio	100.28	0.0065	0.0065	28.0	4279.383
TV PAL	183.70	0.0196	0.0150	28.0	1865.399
TV PAL	207.33	0.0186	0.0143	28.0	1960.573
T-DAB	227.78	0.0060	0.0100	28.0	2793.480
TETRA	Not Disclosed	0.0047	0.0081	28.0	3438.802
TETRA	Not Disclosed	0.0046	0.0079	28.0	3532.738
TETRA	Not Disclosed	0.0044	0.0077	28.0	3654.116
TETRA	Not Disclosed	0.0036	0.0062	28.0	4510.549
TETRA	Not Disclosed	0.0031	0.0053	28.0	5277.769
TETRA	Not Disclosed	0.0027	0.0046	28.0	6063.694
TETRA	Not Disclosed	0.0021	0.0037	28.0	7596.714
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	7060.814
TV PAL	567.04	0.0157	0.0121	32.7	2713.848
TV PAL	535.33	0.0126	0.0096	31.8	3297.141
TV PAL	582.87	0.0092	0.0070	33.2	4715.689
TV UHF (DVB-T)	738.33	0.0178	0.0210	37.4	1780.796
GSM	940.47	0.0900	0.1800	42.2	234.210
GSM	951.38	0.0226	0.0451	42.4	939.964
GSM	954.60	0.0135	0.0271	42.5	1569.950
GSM	1843.02	3.1190	6.2380	59.0	9.463
GSM	1867.39	1.5660	3.1320	59.4	18.971
GSM	1851.38	0.0069	0.0138	59.2	4286.556
UMTS FDD	2147.40	1.7260	5.4581	61.0	11.176
UMTS FDD	2152.40	1.4260	4.5094	61.0	13.527
UMTS FDD	2132.40	1.1820	3.7378	61.0	16.320
UMTS FDD	2127.40	1.0790	3.4121	61.0	17.877
UMTS FDD	2117.80	0.0834	0.2639	61.0	231.181

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UMTS FDD	2112.80	0.0605	0.1913	61.0	318.839
UMTS FDD	2167.40	0.0404	0.1278	61.0	477.457

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**	0.034356	1

3.2.8 Dublin 10: Ballyfermot Garda Station

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	95.98	0.0287	0.0287	28.0	977.312
FM Radio	98.68	0.0079	0.0079	28.0	3555.104
FM Radio	100.89	0.0078	0.0078	28.0	3597.584
FM Radio	98.09	0.0077	0.0077	28.0	3628.823
FM Radio	100.29	0.0076	0.0076	28.0	3701.745
FM Radio	104.39	0.0075	0.0075	28.0	3710.083
TV PAL	183.19	0.0323	0.0248	28.0	1129.863
TV PAL	207.13	0.0290	0.0222	28.0	1259.692
T-DAB	227.86	0.0048	0.0080	28.0	3512.773
TETRA	Not Disclosed	0.1903	0.3296	28.0	84.949
TETRA	Not Disclosed	0.1880	0.3256	28.0	85.988
TETRA	Not Disclosed	0.1775	0.3074	28.0	91.075
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	2220.460
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	5812.901
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	15588.325
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	21624.911
TV PAL	799.09	0.0155	0.0119	38.9	3263.125
TV PAL	774.99	0.0155	0.0119	38.3	3221.840
TV PAL	567.45	0.0109	0.0084	32.8	3917.821
TV PAL	535.45	0.0099	0.0076	31.8	4210.585
TV UHF (DVB-T)	737.70	0.0048	0.0056	37.3	6630.849
GSM	954.80	0.8839	1.7678	42.5	24.034
GSM	948.34	0.0236	0.0471	42.3	898.629
GSM	939.16	0.0160	0.0320	42.1	1318.454
GSM	1840.97	0.1567	0.3134	59.0	188.247
GSM	1857.59	0.1276	0.2552	59.3	232.219
GSM	1863.78	0.0072	0.0143	59.4	4148.788
UMTS FDD	2147.40	0.5495	1.7377	61.0	35.104
UMTS FDD	2152.40	0.5411	1.7111	61.0	35.649
UMTS FDD	2167.40	0.0858	0.2712	61.0	224.927
UMTS FDD	2117.80	0.0190	0.0601	61.0	1015.250

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UMTS FDD	2112.80	0.1633	0.5164	61.0	118.125
UMTS FDD	2127.40	0.0126	0.0397	61.0	1537.032
UMTS FDD	2132.40	0.0115	0.0364	61.0	1675.913
FWALA	3569.75	0.0686	0.1132	61.0	854.235
FWALA	3593.75	0.0272	0.0448	61.0	1978.526

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**	0.003873	1

3.2.9 Dublin 11: Finglas - Ballygall Rd West

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	104.38	0.0110	0.0110	28.0	2536.232
FM Radio	98.06	0.0110	0.0110	28.0	2536.232
FM Radio	88.52	0.0091	0.0091	28.0	3073.208
FM Radio	92.90	0.0082	0.0082	28.0	3433.897
FM Radio	94.91	0.0077	0.0077	28.0	3613.836
PMR	Not Disclosed	0.0018	0.0018	28.0	15283.843
TV PAL	207.36	0.0189	0.0145	28.0	1933.573
TV PAL	183.20	0.0173	0.0133	28.0	2108.947
T-DAB	226.80	0.0141	0.0235	28.0	1191.647
TETRA	Not Disclosed	0.0106	0.0183	28.0	1530.853
TETRA	Not Disclosed	0.0085	0.0147	28.0	1903.203
TETRA	Not Disclosed	0.0066	0.0114	28.0	2447.881
TETRA	Not Disclosed	0.0063	0.0109	28.0	2565.187
TV PAL	567.31	0.0117	0.0090	32.8	3658.868
TV UHF (DVB-T)	737.79	0.0174	0.0206	37.3	1814.849
GSM	955.00	0.0406	0.0813	42.5	522.783
GSM	949.61	0.0087	0.0175	42.4	2421.511
GSM	939.35	0.0065	0.0130	42.1	3245.696
GSM	1841.61	0.7652	1.5304	59.0	38.556
GSM	1854.60	0.0415	0.0830	59.2	713.599
GSM	1867.40	0.0065	0.0129	59.4	4596.817
UMTS FDD	2152.40	2.9760	9.4110	61.0	6.482
UMTS FDD	2127.40	2.3590	7.4599	61.0	8.177
UMTS FDD	2132.40	2.1100	6.6725	61.0	9.142
UMTS FDD	2147.40	2.0850	6.5934	61.0	9.252
UMTS FDD	2167.40	0.0675	0.2133	61.0	285.944

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**	0.0631	1

3.2.10 Dublin 17: Northern Cross - Belcamp Lane

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	90.31	0.0098	0.0098	28.0	2871.206
FM Radio	98.67	0.0084	0.0084	28.0	3323.048
FM Radio	93.49	0.0070	0.0070	28.0	4014.913
FM Radio	100.88	0.0068	0.0068	28.0	4094.765
TV PAL	183.16	0.0263	0.0202	28.0	1385.948
TV PAL	207.21	0.0254	0.0195	28.0	1437.239
T-DAB	226.79	0.0153	0.0256	28.0	1094.417
TETRA	Not Disclosed	0.0110	0.0190	28.0	1474.982
TETRA	Not Disclosed	0.0095	0.0165	28.0	1700.590
TETRA	Not Disclosed	0.0035	0.0060	28.0	4636.022
TETRA	Not Disclosed	0.0030	0.0053	28.0	5308.968
TETRA	Not Disclosed	0.0024	0.0041	28.0	6876.141
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	19884.617
TV PAL	534.87	0.0108	0.0083	31.8	3853.179
TV PAL	774.94	0.0098	0.0075	38.3	5070.069
TV PAL	799.46	0.0090	0.0069	38.9	5639.526
TV UHF (DVB-T)	737.50	0.0107	0.0126	37.3	2951.936
GSM	953.41	0.8408	1.6816	42.5	25.248
GSM	938.41	0.1365	0.2730	42.1	154.289
GSM	949.38	0.0548	0.1095	42.4	386.908
GSM	1855.34	0.5953	1.1906	59.2	49.745
GSM	1832.47	0.2387	0.4774	58.9	123.293
GSM	1865.56	0.0078	0.0155	59.4	3822.189
UMTS FDD	2132.40	1.6380	5.1798	61.0	11.776
UMTS FDD	2152.40	1.3730	4.3418	61.0	14.049
UMTS FDD	2147.40	1.3340	4.2185	61.0	14.460
UMTS FDD	2127.40	1.2640	3.9971	61.0	15.261
UMTS FDD	2167.40	0.8400	2.6563	61.0	22.964
WiFi	2414.18	1.7440	3.7147	61.0	16.421
WiFi	2447.63	0.3194	0.6803	61.0	89.663
WiFi	2467.56	0.1721	0.3666	61.0	166.406
WiFi	2431.50	0.1461	0.3112	61.0	196.020

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FWALA	3595.25	0.0068	0.0112	61.0	5455.977
FWALA	3547.25	0.0038	0.0063	61.0	9625.019
FWALA	3583.25	0.0025	0.0042	61.0	14583.707

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**	0.029235	1

3.2.11 Dublin 20: Palmerstown - Old Lucan Rd

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	98.68	0.0105	0.0105	28.0	2669.209
FM Radio	89.10	0.0098	0.0098	28.0	2859.769
FM Radio	91.30	0.0084	0.0084	28.0	3342.485
FM Radio	93.48	0.0078	0.0078	28.0	3590.664
FM Radio	100.89	0.0076	0.0076	28.0	3674.059
TV PAL	183.19	0.0343	0.0263	28.0	1064.311
TV PAL	207.32	0.0211	0.0162	28.0	1730.136
T-DAB	227.21	0.0040	0.0067	28.0	4196.863
TETRA	Not Disclosed	0.0055	0.0095	28.0	2959.145
TETRA	Not Disclosed	0.0048	0.0084	28.0	3342.806
TETRA	Not Disclosed	0.0046	0.0079	28.0	3549.025
TETRA	Not Disclosed	0.0022	0.0039	28.0	7249.241
TETRA	Not Disclosed	0.0019	0.0033	28.0	8441.675
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	21805.930
TV PAL	535.12	0.0228	0.0175	31.8	1821.251
TV PAL	799.59	0.0126	0.0097	38.9	4010.458
TV PAL	566.58	0.0126	0.0096	32.7	3392.011
TV PAL	583.21	0.0124	0.0095	33.2	3494.206
TV UHF (DVB-T)	738.25	0.0152	0.0179	37.4	2081.580
GSM	940.24	1.1340	2.2680	42.2	18.590
GSM	950.97	0.0058	0.0115	42.4	3682.643
GSM	954.44	0.0106	0.0211	42.5	2013.233
GSM	1843.96	1.3800	2.7600	59.0	21.393
GSM	1833.79	0.9855	1.9710	58.9	29.874
GSM	1861.63	0.0086	0.0173	59.3	3433.645
UMTS FDD	2132.40	0.9642	3.0491	61.0	20.006
UMTS FDD	2127.40	0.9235	2.9204	61.0	20.888
UMTS FDD	2152.40	0.7675	2.4271	61.0	25.133
UMTS FDD	2147.40	0.7612	2.4071	61.0	25.341
UMTS FDD	2117.80	0.3268	1.0334	61.0	59.026
UMTS FDD	2112.80	0.3064	0.9689	61.0	62.956

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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**	0.014673	1

3.2.12 Dublin 22: Clondalkin - Nangor Rd / Cherrywood Villas

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	91.29	0.0158	0.0158	28.0	1767.677
FM Radio	104.39	0.0143	0.0143	28.0	1960.784
FM Radio	100.89	0.0114	0.0114	28.0	2458.297
FM Radio	100.27	0.0108	0.0108	28.0	2585.411
FM Radio	89.10	0.0105	0.0105	28.0	2666.667
FM Radio	92.87	0.0103	0.0103	28.0	2721.088
PMR	Not Disclosed	0.0046	0.0046	28.0	6039.689
PMR	Not Disclosed	0.0021	0.0021	28.0	13139.371
TV PAL	183.00	0.0795	0.0609	28.0	459.424
TV PAL	207.28	0.0714	0.0548	28.0	511.072
T-DAB	227.73	0.0034	0.0057	28.0	4922.627
TETRA	Not Disclosed	0.0169	0.0293	28.0	954.298
TETRA	Not Disclosed	0.0144	0.0250	28.0	1121.068
TETRA	Not Disclosed	0.0140	0.0243	28.0	1152.231
TETRA	Not Disclosed	0.0084	0.0145	28.0	1935.793
TETRA	Not Disclosed	0.0073	0.0126	28.0	2219.359
TETRA	Not Disclosed	0.0065	0.0113	28.0	2475.242
TETRA	Not Disclosed	0.0062	0.0107	28.0	2606.127
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	26303.590
TV PAL	799.52	0.0194	0.0149	38.9	2612.885
TV PAL	567.35	0.0118	0.0090	32.8	3621.755
TV PAL	535.45	0.0116	0.0089	31.8	3563.804
TV UHF (DVB-T)	737.22	0.0118	0.0140	37.3	2672.191
GSM	947.98	0.1071	0.2142	42.3	197.644
GSM	954.81	0.0627	0.1255	42.5	338.600
GSM	938.41	0.0175	0.0350	42.1	1204.833
GSM	1841.77	0.1310	0.2620	59.0	225.226
GSM	1854.69	0.0587	0.1175	59.2	504.051
GSM	1863.88	0.0205	0.0411	59.4	1445.045
UMTS FDD	2132.40	0.9816	3.1041	61.0	19.651

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UMTS FDD	2127.40	0.7010	2.2168	61.0	27.517
UMTS FDD	2117.80	0.2899	0.9168	61.0	66.539
UMTS FDD	2112.80	0.2458	0.7773	61.0	78.477
UMTS FDD	2152.40	0.1955	0.6182	61.0	98.669
UMTS FDD	2147.40	0.1391	0.4399	61.0	138.675
UMTS FDD	2167.40	0.0438	0.1386	61.0	440.204

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**	0.004531	1

3.2.13 Kildare: Celbridge - Willowbrook Rd / Whitehorn Grove

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	89.10	0.0086	0.0086	28.0	3274.854
FM Radio	95.49	0.0084	0.0084	28.0	3328.578
FM Radio	98.69	0.0066	0.0066	28.0	4250.797
FM Radio	104.39	0.0064	0.0064	28.0	4394.225
FM Radio	100.87	0.0062	0.0062	28.0	4497.270
FM Radio	93.49	0.0062	0.0062	28.0	4529.279
TV PAL	188.73	0.0140	0.0107	28.0	2609.426
TETRA	Not Disclosed	0.6901	1.1953	28.0	23.425
TETRA	Not Disclosed	0.6693	1.1593	28.0	24.153
GSM	938.37	1.2820	2.5640	42.1	16.428
GSM	951.02	0.7819	1.5638	42.4	27.115
GSM	947.35	0.6286	1.2572	42.3	33.663
GSM	1844.57	0.5061	1.0122	59.1	58.342
GSM	1856.02	0.0069	0.0137	59.2	4311.286
UMTS FDD	2127.40	0.7006	2.2155	61.0	27.533
UMTS FDD	2132.40	0.6116	1.9341	61.0	31.540
UMTS FDD	3147.40	0.3139	0.9926	61.0	61.452
UMTS FDD	2152.40	0.2542	0.8039	61.0	75.884
UMTS FDD	2167.40	0.0087	0.0276	61.0	2208.077

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**	0.012542	1

3.2.14 Louth: Dunleer

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	105.48	0.0088	0.0088	28.0	3184.713
FM Radio	96.96	0.0084	0.0084	28.0	3351.287
FM Radio	95.81	0.0082	0.0082	28.0	3407.570
FM Radio	95.20	0.0076	0.0076	28.0	3704.194
PMR	Not Disclosed	0.0020	0.0020	28.0	13725.490
TV PAL	198.13	0.0138	0.0106	28.0	2645.353
T-DAB	227.24	0.0050	0.0084	28.0	3346.600
TETRA	Not Disclosed	0.0086	0.0148	28.0	1888.088
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	207.562
GSM	952.61	0.2255	0.4510	42.4	94.099
GSM	945.97	0.1918	0.3836	42.3	110.246
UMTS FDD	2167.61	0.2018	0.6382	61.0	95.588
UMTS FDD	2147.85	0.1941	0.6138	61.0	99.381
UMTS FDD	2117.22	0.0155	0.0491	61.0	1242.897

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**	0.000431	1

3.2.15 Meath: Carlanstown

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	96.37	0.0072	0.0072	28.0	3892.132
FM Radio	95.81	0.0064	0.0064	28.0	4355.265
FM Radio	107.38	0.0063	0.0063	28.0	4439.512
FM Radio	101.46	0.0062	0.0062	28.0	4516.129
TETRA	Not Disclosed	0.0012	0.0021	28.0	13250.662
TETRA	Not Disclosed	0.0012	0.0020	28.0	13793.351
GSM	945.53	0.4586	0.9172	42.3	46.097
GSM	955.39	0.0058	0.0116	42.5	3664.451

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**	0.000471	1

4. Conclusion

The conclusion of this report is that at all 15 licensed transmitter sites surveyed on behalf of ComReg during September and early October 2010 as part of the 2010 Programme of Measurement of Non-Ionising Radiation Emissions:

(1) Measurements undertaken of non-ionising radiation emission levels on individual frequencies were found to fall below the international ICNIRP reference levels for general public exposure.

(2) The levels measured were not found to cause the aggregate of non-ionising radiation emissions to exceed the criteria for simultaneous exposure to multiple frequency fields specified in the guidelines published by ICNIRP.

Annex 1 - NIR and Emissions Standards

Definition

Non-ionising radiation (NIR) is that part of the electromagnetic spectrum below 3000 million MHz (3 x 10^{15} Hz). Non-ionising radiation includes all radiations and fields of the electromagnetic spectrum that do not normally have sufficient energy to produce ionisation in matter and is characterised by energy per photon of less than about 12 eV and wavelengths greater than 100 nm. Radio waves, infrared radiation and visible light are examples of NIR. Electromagnetic waves at frequencies above 3000 million MHz are known as ionising radiation and this includes X-rays and Gamma rays as well as some Ultraviolet radiation.

Standards for limiting exposure to non-ionising radiation

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an independent, scientific organisation established in 1992. The ICNIRP was established for the purpose of advancing Non-Ionising Radiation Protection and in particular to provide guidance and recommendations on protection from NIR exposure. ICNIRP operates in co-operation with the Environmental Health Division of the World Health Organisation and the United Nations Environment Programme.

In 1998 ICNIRP published guidelines[10] for limiting exposure to NIR (up to 300 GHz). Many countries have adopted the 1998 ICNIRP document as the reference for setting emissions limits. It should be noted that in 1999 the Council of the European Union issued a recommendation[11] to limit exposure of the general public to electromagnetic fields 0Hz - 300GHz

[10] "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)", Health Physics, vol 74, no. 4, April 1998

Available on the Web at www.icnirp.de.

[11] Recommendation of the European Council 1999/519/EC of July 12, 1999

based on a set of basic restrictions and reference levels developed internationally under the advice of the International Commission on Non-Ionizing Radiation Protection. In relation to emissions within the radio spectrum, these limits are equivalent to the ICNIRP guideline limits. An outline of the ICNIRP Guidelines is presented in Annex 2.

Non-ionising radiation licence conditions

It is a condition of various licences[12] issued by ComReg pursuant to the Wireless Telegraphy Act, 1926 (No. 45 of 1926) that licensees must ensure that NIR emissions from each radio installation operated thereunder must be within the limits specified in the guidelines published by ICNIRP.

[12] e.g. GSM, 3G Mobile, Radio and TV Broadcasting, MMDS, FWA (Wireless Broadband), among others.

Annex 2 – The ICNIRP Guidelines

SUMMARY OF THE ICNIRP GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC, MAGNETIC, AND ELECTROMAGNETIC FIELDS (UP TO 300 GHz)

In 1974, the International Radiation Protection Association (IRPA) formed a working group on non-ionising radiation (NIR), which examined the problems arising in the field of protection against the various types of NIR. In 1977, this working group became the International Non-Ionizing Radiation Committee (INIRC).

In cooperation with the Environmental Health Division of the World Health Organization (WHO), the IRPA/INIRC developed a number of health criteria documents on NIR as part of WHO's Environmental Health Criteria Program, sponsored by the United Nations Environment Program (UNEP). Each document includes an overview of the physical characteristics, measurement and instrumentation, sources, and applications of NIR, a thorough review of the literature on biological effects, and an evaluation of the health risks of exposure to NIR. These health criteria have provided the scientific database for the subsequent development of exposure limits and codes of practice relating to NIR.

At the Eighth International Congress of the IRPA, a new, independent scientific organization—the International Commission on Non-Ionizing Radiation Protection (ICNIRP)—was established as a successor to the IRPA/INIRC. The functions of the Commission are to investigate the hazards that may be associated with the different forms of NIR, develop international guidelines on NIR exposure limits, and deal with all aspects of NIR protection.

ICNIRP has defined two guideline exposure limits, one for members of the general public and one for people classified as occupational (e.g. telecommunication engineers). The occupationally exposed population consists of adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precautions. By contrast, the general public comprises individuals of all ages and of varying health status, and may include particularly susceptible groups or individuals. In many cases, members of the public are unaware of their exposure to EMF. Moreover, individual members of the public cannot reasonably be expected to take precautions to minimize or avoid exposure. It is these considerations that underlie the adoption of more stringent exposure restrictions for the public than for the occupationally exposed population.

ICNIRP has defined basic restrictions and reference levels. Depending on frequency, the physical quantities used to specify the basic restrictions on exposure to electromagnetic fields (EMF) are current density, specific absorption rate (SAR), and power density. SAR is not easily measurable in living people therefore reference levels have been obtained from the basic restrictions by mathematical modelling and by extrapolation from the results of laboratory investigations at specific frequencies.

The reference levels are provided for comparison with measured values of physical quantities; compliance with all reference levels given in these guidelines will ensure

compliance with basic restrictions. If measured values are higher than reference levels, it does not necessarily follow that the basic restrictions have been exceeded, but a more detailed analysis is necessary to assess compliance with the basic restrictions.

Frequency Range	E – Field Strength (Vm^{-1})	H – Field (Am^{-1})	B – Field (μT)	Equivalent plane wave power S (Wm^{-2})
up to 1 Hz	-	1.63×10^5	2×10^5	-
1 – 8 Hz	20,000	$1.63 \times 10^5/f^2$	$2.5 \times 10^5/f^2$	-
8 – 25 Hz	20,000	$1.63 \times 10^5/f$	$2.5 \times 10^4/f$	-
0.025 – 0.82 kHz	$500/f$	$20/f$	$25/f$	-
0.82 – 65 kHz	610	24.4	30.7	-
0.065 – 1 MHz	610	$1.6/f$	$2.0/f$	-
1 – 10 MHz	$610/f$	$1.6/f$	$2.0/f$	-
10 – 400 MHz	61	0.16	0.2	10
400 – 2000 MHz	$3f^{1/2}$	$0.008f^{1/2}$	$0.01f^{1/2}$	$f/40$
2 – 300 GHz	137	0.36	0.45	50

Table 1: Reference levels for <u>occupational exposure</u> to time-varying electric and magnetic fields (unperturbed rms values). f in units as indicated in the Frequency Range column.

Frequency Range	E – Field Strength (Vm^{-1})	H – Field (Am^{-1})	B – Field (μT)	Equivalent plane wave power S (Wm^{-2})
up to 1 Hz	-	3.2×10^4	4×10^4	-
1 – 8 Hz	10,000	$3.2 \times 10^4/f^2$	$4 \times 104/f^2$	-
8 – 25 Hz	10,000	$4{,}000/f$	$5000/f$	-
0.025 – 0.8 kHz	$250/f$	$4/f$	$5/f$	-
0.8 – 3 kHz	$250/f$	5	6.25	-
3 – 150 kHz	87	5	6.25	-
0.15 - 1 MHz	87	$0.73/f$	$0.092/f$	
1 – 10 MHz	$87/f^2$	$0.73/f$	$0.092/f$	-
10 – 400 MHz	28	0.16	0.092	2
400 – 2000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	$f/200$
2 – 300 GHz	61	0.16	0.20	10

Table 2: Reference levels for <u>general public exposure</u> to time-varying electric and magnetic fields (unperturbed rms values). f in units as indicated in the Frequency Range column.

Simultaneous Exposure to Multiple Frequency Fields (Total Exposure Quotients)

ICNIRP has specified a means of assessing additivity of exposures in situations of simultaneous exposure to fields of different frequencies. Additivity is examined separately for the effects of electrical and thermal stimulation, and ICNIRP has set out basic restrictions which should be met for both considerations.

For practical application of the basic restrictions, ICNIRP has advised that the following criteria[13] regarding reference levels of field strengths should be applied:

Induced Current Density and Electrical Stimulation

For induced current density and electrical stimulation effects, relevant up to 10 MHz, the following two requirements should be applied to the field levels:

$$\sum_{i=1\ \mathrm{Hz}}^{1\ \mathrm{MHz}} \frac{E_i}{E_{L,i}} + \sum_{i>1\ \mathrm{MHz}}^{10\ \mathrm{MHz}} \frac{E_i}{a} \leq 1,$$

and

$$\sum_{j=1\ \mathrm{Hz}}^{65\ \mathrm{kHz}} \frac{H_j}{H_{L,j}} + \sum_{j>65\ \mathrm{kHz}}^{10\ \mathrm{MHz}} \frac{H_j}{b} \leq 1,$$

where

E_i = the electric field strength at frequency i;

$E_{L,i}$ = the electric field reference level from Tables 1 and 2;

Hj = the magnetic field strength at frequency j;

$H_{L,j}$ = the magnetic field reference level from Tables 1 and 2;

a = 610 V m^{-1} for occupational exposure and 87 V m^{-1} for general public exposure; and

b = 24.4 A m^{-1} (30.7 μT) for occupational exposure and 5 A m^{-1} (6.25 μT) for general public exposure.

[13] The calculated values are referred to as '**Total Exposure Quotients'** elsewhere in this report.

Thermal Considerations

For thermal considerations, relevant above 100 kHz, the following two requirements should be applied to the field levels:

$$\sum_{i=100\ \mathrm{kHz}}^{1\ \mathrm{MHz}} \left(\frac{E_i}{c}\right)^2 + \sum_{i>1\ \mathrm{MHz}}^{300\ \mathrm{GHz}} \left(\frac{E_i}{E_{L,i}}\right)^2 \leq 1,$$

and

$$\sum_{j=100\ \mathrm{kHz}}^{1\ \mathrm{MHz}} \left(\frac{H_j}{d}\right)^2 + \sum_{j>1\ \mathrm{MHz}}^{300\ \mathrm{GHz}} \left(\frac{H_j}{H_{L,j}}\right)^2 \leq 1,$$

where

E_i = the electric field strength at frequency i;

$E_{L,\,i}$ = the electric field reference level from Tables 1 and 2;

Hj = the magnetic field strength at frequency j;

$H_{L,\,j}$ = the magnetic field reference level from Tables 1 and 2;

c = $610/f$ V m^{-1} (f in MHz) for occupational exposure and $87/f^{1/2}$ V m^{-1} for general public exposure; and

d = $1.6/f$ A m^{-1} (f in MHz) for occupational exposure and $0.73/f$ for general public exposure.

Annex 3 – Survey Methodology

The purpose of the surveys was to quantify the electromagnetic field (EMF) present at each area and to identify the frequency and intensity (or level) of the principal emissions contributing to the field. The locations of the survey were chosen by ComReg.

Some of the typical emission types encountered when measuring EMF are AM and FM broadcast radio, broadcast television signals, wireless CCTV, mobile radio, emergency services radios, pager base station radios, taxi base station radios, mobile phone base station signals and wireless broadband signals.

Measurements of the non-ionising radiation emissions from the site were conducted in accordance with the methodology outlined in document ComReg 08/51[14], which incorporates many of the measurement methods and procedures outlined in ECC Recommendation (02)04[15].

Surveys were, in most cases, conducted in three stages as follows:

1 Initial Site Survey

At all sites surveyed, initial investigations were carried out using a field strength meter and a broadband probe to find the position of the maximum field strength. The probe used for the initial investigation measured and summed all emissions present in a broad frequency range (typically 100 kHz to 3 GHz).

2 Broadband Measurements

Once the location was identified, the field strength meter and broadband probe were mounted on a non-conductive tripod and the aggregate field strength in Volts per meter was recorded over a period exceeding six minutes.

[14] http://www.comreg.ie/_fileupload/publications/ComReg0851.pdf

[15] ECC REC (02)04 (revised Bratislava 2003, Helsinki 2007), "Measuring Non-Ionising Electromagnetic Radiation (9 kHz – 300 GHz), published by the European Communications Committee on www.ero.dk.

3 Frequency Selective Measurements

Measurements of emissions at specific frequencies were then carried out at the same location using a spectrum analyser and a range of antennas matched to the frequencies being measured. The spectrum analyser was set to sweep a frequency range continuously for a period of up to six minutes and the results were stored in the spectrum analyser.

This procedure was repeated at different frequency ranges until the electromagnetic fields at all relevant frequencies were recorded. The results were later transferred to a computer for analysis and comparison with the ICNIRP general public guideline levels.

Annex 4 – 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[16] in the **far-field** which is the region[17] 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

[16] $E = H \times Z_0$ where Z_0 (characteristic impedance of free space) $\approx 377\ \Omega$

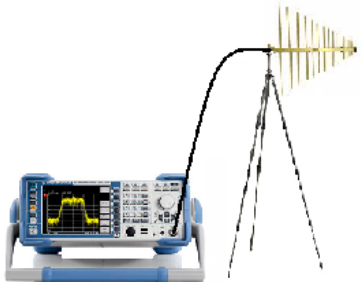
[17] Beyond a distance of $\lambda + 2D^2/\lambda$ where λ is the wavelength and D is the antenna's largest dimension

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

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.

<table>
<tr><th>Initial Site Survey and Broadband Measurements</th><th colspan="2">Frequency Selective Measurements</th></tr>
<tr><td> 
</td><td>SPECTRUM ANALYSER WITH TRIPOD MOUNTED ANTENNA CONNECTED
  </td><td>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. 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.</td></tr>
</table>

Annex 5 – Derivation of Adjusted Levels

In the case of some services an adjusted level is calculated from the measured electric field level and is presented in the relevant frequency selective measurement table for comparison with the applicable emission limit. For a particular measurement, the adjustment may be performed for any or all of the following reasons

(a) to compensate for when the bandwidth of the emission exceeds the maximum resolution bandwidth (RBW) of the spectrum analyser used.

(b) to extrapolate to an estimate of the level of emissions from a transmitter under maximum traffic conditions (e.g. when a mobile phone base station is serving its maximum number of calls and data clients).

(c) to account for the characteristics of emissions with complex signal structures (e.g. PAL TV)

Compensating for the limited measurement resolution of the spectrum analyser

In many cases it is necessary to compensate for the limited measurement resolution of the spectrum analyser, as the bandwidth of the signal measured may be greater than the resolution bandwidth (RBW) of the analyser. For example, a measurement of a digital television signal performed with at an RBW setting of 5 MHz needs to be adjusted upwards by multiplying it by a correction factor in order to account for the energy present within the full 7.61 MHz bandwidth of the signal.

The correction factor is derived as follows:

RBW CORRECTION FACTOR: $K_{RBW} = 10 \times \log_{10} (B_{Signal} / B_N)$ Where B_{Signal} is the signal/emission bandwidth B_N is the noise bandwidth of the analyser filter (for a Gaussian Filter: $B_N \approx 1.1 \times B_{3dB}$)	
Example:	Measuring a 7.61 MHz DVB-T signal with 5 MHz RBW: B_{Signal} = 7.61 MHz B_{3dB} = RBW = 5 MHz => $B_N = 1.1 \times 5 = 5.1$ $K_{RBW} = 10 \times \log_{10} (7.61 / 5.1) = 1.74$ dB

Extrapolation to Max Traffic Signal Level

In the case of some networks it is necessary to extrapolate to an estimate of the level under maximum traffic 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.

In the cases of GSM, TETRA and UMTS (3G), the estimated electric field levels for maximum traffic conditions are extrapolated from the constant pilot channels (BCCH for GSM and TETRA and P-CPICH for UMTS) as follows:

GSM and TETRA:

V/m Calculation	**dB Calculation**
$\mathbf{E_{MAX}} = E_{BCCH} \times \sqrt{n_{channels}}$	$\mathbf{E_{MAX}} = E_{BCCH} + 10\mathrm{Log}_{10}(n_{channels})$
$n_{channels}$ includes the BCCH plus the number of traffic channels. If the Number of traffic channels per BCCH is not known, $n_{channels}$ is taken as: **GSM:** 4 **TETRA (Emergency):** 3 **TETRA (Civil):** 2	

UMTS:

V/m Calculation	**dB Calculation**
$\mathbf{E_{MAX}} = E_{UMTS} \times \sqrt{R_{P\text{-}CPICH}}$	$\mathbf{E_{MAX}} = E_{UMTS} + R_{P\text{-}CPICH}$
$R_{P\text{-}CPICH} = P_{MAX} / P_{P\text{-}CPICH}$ The P-CPICH transmits with a constant power typically 10 dB below the maximum possible power (P_{MAX}) for a UMTS signal. Therefore $R_{P\text{-}CPICH}$ = 10 dB $\sqrt{R_{P\text{-}CPICH}} = \sqrt{10} = 3.1623$	

If necessary, as in the case of GSM and TETRA, the frequencies of the pilot channels present have been identified prior to recording the standard frequency selective scan of the band.

Accounting for characteristics of certain complex signals:

In the case of some signals with a complex structure, such as analogue PAL television, it is necessary to apply a correction factor for reasons such as the following:

- to take into account characteristics of the signal shape, which make it difficult to measure an RMS level directly, which is indicative of worst case exposure.

- to derive a level more indicative of the aggregate of emissions attributable to the individual signal components.

Analogue PAL TV

The peak field strength caused by the synch pulses of the picture (luminance) carrier is measured. The field strength from the picture signal is at its highest when a synch pulse is being transmitted.

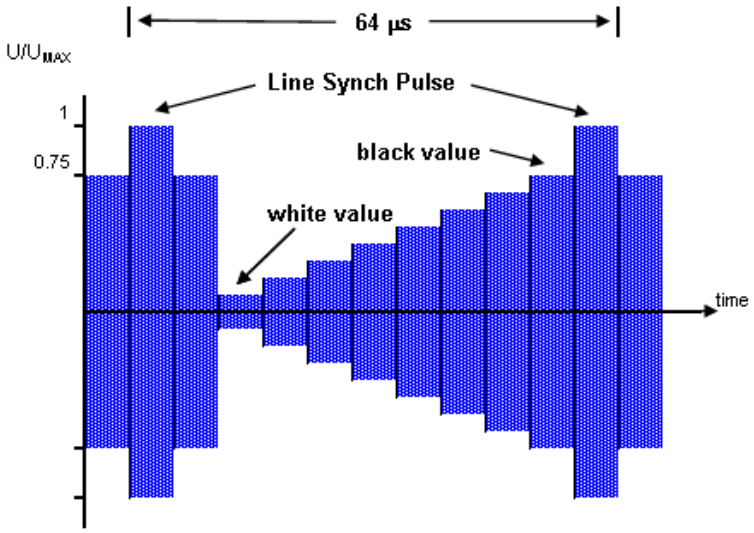


Figure 1: Luminance Signal in the Time Domain

For a black picture, the mean power is 2.5 dB below the peak power (i.e. for a synch pulse). It is assumed that 100% black picture is transmitted permanently for worst case exposure evaluation. The mean (RMS) level for a black picture is then calculated from the peak synch pulse level by applying a correction factor to the peak synch pulse level. The value of this **correction factor** is **-2.3 dB** rather than -2.5 dB, in

order to take into consideration the small contributions of the FM and NICAM sound signal components.

The level for the full PAL signal is thus derived by applying the correction factor to the measurement for the peak luminance signal:

$$\mathbf{E_{PAL}} = E_{LUM} \times k \qquad \text{corr factor } k = -2.3 \text{ dB} = 0.767$$

Annex 6 – Glossary

Antenna: - A conductive structure specifically designed to couple or to radiate electromagnetic energy.

BCCH: - Broadcast control channel. BCCH is a constant carrier on GSM base stations. Essentially it is the 'always on' pilot channel. The constant signal level of the BCCH allows for extrapolation to a maximum traffic signal level for a base station.

Broadband Measurement: - A measurement carried out using a meter and probe combination that simultaneously measures and sums all received signals within the frequency range of the probe. Generally this meter and probe combination is not as sensitive as the equipment used for narrowband measurements but is useful for getting an overall picture of the level of electromagnetic fields present at a site.

ComReg: - The Commission for Communications Regulation. ComReg is the statutory body responsible for the regulation of the electronic communications sector (telecommunications, radiocommunications and broadcasting transmission) and the postal sector in Ireland.

Electric Field Strength: - Electric field strength is a quantitative expression of the intensity of an electric field at a particular location. The standard unit is the Volt per meter (V/m). A field strength of 1 V/m represents a potential difference of one volt between points separated by one meter.

Electromagnetic Field (EMF): - Combined electric and magnetic fields, in this case radiating from an antenna.

Electromagnetic Spectrum: - The complete range of the wavelengths of electromagnetic radiation, beginning with the radio waves and extending through microwaves and visible light (a very small part of the spectrum) all the way to the extremely short gamma rays that are a product of radioactive atoms. The electromagnetic spectrum contains both non-ionizing and ionizing radiation

Frequency: - The number of cycles completed in one second by an electromagnetic wave. It is expressed in Hertz (Hz) or a multiple of Hertz, e.g. kHz (kilohertz, 1,000 Hertz), MHz (MegaHertz, 1,000,000 Hertz) and GHz (GigaHertz, 1,000,000,000 Hertz).

Frequency Range: - A group of frequencies between a selected start and stop frequency. E.g. the frequency range of the FM broadcast band includes all frequencies between 88 and 108 MHz.

Frequency Selective Measurement: - A measurement carried out using a receiver and an antenna which measures the received signal strength at specific frequencies. A spectrum analyser is usually used as the receiver, and a range of antennas is used which are suitable for reception of all the frequencies to be measured.

ICNIRP: - The International Commission on Non-Ionizing Radiation Protection.

Ionising radiation: - Ionising radiation, also called radioactivity, is electromagnetic (EM) radiation whose waves contain energy sufficient to overcome the binding energy of electrons in atoms or molecules, thus creating ions. It occurs at frequencies higher than ultraviolet light and includes x-rays and gamma rays. The sources of electromagnetic fields measured in this survey do not produce any ionising radiation.

Isotropic probe: Receives electromagnetic signals regardless of polarisation or direction of travel. An isotropic probe is designed to give the same reading, no matter which way it is pointed.

Non-ionising radiation (NIR): - Includes all radiations and fields of the electromagnetic spectrum that do not normally have sufficient energy to produce ionization in matter; characterized by energy per photon less than approximately 12 electron Volts, wavelengths greater than 100 nm, and frequencies lower than 3×10^{15} Hz.

Occupational Exposure: - All exposure to EMF experienced by individuals who are exposed under known conditions in the course of performing their work and who are trained to be aware of potential risk and to take appropriate precautions.

Public Exposure: - All exposure to EMF experienced by members of the general public, excluding occupational exposure and exposure during medical procedures.

P-CPICH: - Primary Common Pilot channel. P-CPICH is a downlink channel broadcast by UMTS Node-Bs (i.e. 3G base stations) with constant power. It allows extrapolation to a maximum traffic signal level for a UMTS channel.

Radiofrequency (RF): - For this survey any radio signals between the frequencies 100 kHz to 40 GHz.

Spectrum analyser: - An instrument that displays signal amplitude (strength) as it varies by signal frequency. The frequency appears on the horizontal axis, and the amplitude is displayed on the vertical axis. It can be set to sweep a frequency band where the amplitude of the received signals show up as spikes on the recorded trace.