Commission for
Communications Regulation

Report

2010 Programme of Measurement of Non-Ionising Radiation Emissions

Second 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 second set of site surveys (23 sites) undertaken during the 2010 programme.

The site surveys were conducted during April - June 2010 by engineers of Vilicom Engineering 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 23 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 23 sites chosen as part of the 2010 Programme of Measurement of Non-Ionising Radiation emissions. The site surveys were conducted during April - June 2010 by engineers of Vilicom Engineering 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.

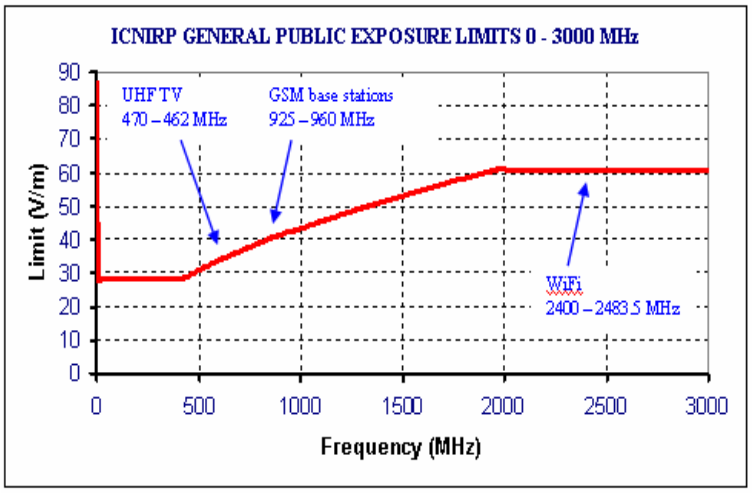
- to extrapolate to an estimate of the level under maximum traffic from the transmitter. For example, the base stations of mobile telephone networks produce emissions which vary according to the changing volume of calls or data traffic over the course of the day. The levels measured for the always-on 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 Cavan Town: Farnham St – Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004482	0.004482	28	6247
PMR	Not disclosed	0.005230	0.005230	28	5354
PMR	Not disclosed	0.004069	0.004069	28	6881
TETRA	Not disclosed	0.131220	0.227280	28	123
TETRA	Not disclosed	0.125314	0.217050	28	129
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	4260
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	41146
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	51586
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	62937
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	1733
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	21571
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	26359
TV PAL	623.533	0.005495	0.006964	34.3	4930
TV PAL	671.227	0.004726	0.005989	35.6	5948
TV DVB-T	684.293	0.001372	0.003610	36.0	9964
GSM	938.183	1.566751	3.133502	42.1	13
GSM	953.233	0.299571	0.599142	42.5	71
GSM	940.633	0.207253	0.414505	42.2	102
GSM	945.533	0.124451	0.248903	42.3	170
GSM	949.733	0.152230	0.304460	42.4	139
GSM	947.983	0.131069	0.262138	42.3	162
GSM	1835.000	0.103039	0.206077	58.9	286
GSM	1836.250	0.079250	0.158500	58.9	372
GSM	1857.250	0.091517	0.183033	59.3	324
GSM	1831.250	0.017199	0.034398	58.8	1711
GSM	1855.750	0.016312	0.032623	59.2	1816
GSM	1838.750	0.014060	0.028121	59.0	2097
UMTS FDD	2127.767	0.098401	0.636335	61	96
UMTS FDD	2166.733	0.091833	0.593862	61	103
UMTS FDD	2132.433	0.091306	0.590453	61	103
UMTS FDD	2119.133	0.080168	0.518425	61	118
UMTS FDD	2114.233	0.048865	0.315999	61	193
UMTS FDD	2148.067	0.039719	0.256854	61	237
FWALA	3715.700	0.002982	0.007522	61	8109
WiFi	5492.100	0.001064	0.004129	61	14774
FWA (Lic-exempt)	5736.500	0.001772	0.004470	61	13645

Continued overleaf….

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**	0.006527	1

3.2.2 Clare: Ennis - Carmody St

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
FM Radio	88.798	0.013198	0.013198	28	2122
FM Radio	93.240	0.011668	0.011668	28	2400
FM Radio	90.985	0.011041	0.011041	28	2536
FM Radio	98.433	0.010544	0.010544	28	2656
FM Radio	107.658	0.010268	0.010268	28	2727
FM Radio	100.620	0.007998	0.007998	28	3501
TETRA	Not disclosed	0.012823	0.022211	28	1261
TETRA	Not disclosed	0.011259	0.019501	28	1436
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	6194
GSM	946.000	0.628058	1.256117	42.3	34
GSM	940.517	0.433511	0.867022	42.2	49
GSM	954.983	0.337287	0.674575	42.5	63
GSM	938.183	0.119536	0.239073	42.1	176
GSM	939.350	0.298882	0.597764	42.1	70
GSM	953.000	0.096939	0.193879	42.4	219
GSM	1857.500	0.758578	1.517155	59.3	39
GSM	1831.500	0.717794	1.435589	58.8	41
GSM	1863.000	0.413048	0.826095	59.3	72
GSM	1834.750	0.404576	0.809152	58.9	73
GSM	1864.000	0.269464	0.538927	59.4	110
GSM	1833.750	0.396278	0.792556	58.9	74
UMTS	2133.600	0.168267	1.088142	61	56
UMTS	2128.700	0.133045	0.860371	61	71
UMTS	2167.667	0.092897	0.600739	61	102
UMTS	2119.133	0.079433	0.513672	61	119
UMTS	2148.767	0.075336	0.487176	61	125
UMTS	2111.900	0.057214	0.369986	61	165
FWALA	3506.333	0.100346	0.253135	61	241
FWALA	3581.667	0.049831	0.125705	61	485
WiFi	5623.000	0.004340	0.016840	61	3622
WiFi	5489.550	0.001609	0.006242	61	9772
WiFi	5521.000	0.001099	0.004264	61	14305
FWA (Lic-exempt)	5856.000	0.001393	0.003514	61	17357

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**	0.004517	1

3.2.3 Cork: Buttevant – Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004193	0.004193	28	6678
PMR	Not disclosed	0.004281	0.004281	28	6541
PMR	Not disclosed	0.003917	0.003917	28	7148
TETRA	Not disclosed	0.240991	0.417408	28	67
GSM	953.000	1.480812	2.961625	42.4	14
GSM	950.667	0.808165	1.616330	42.4	26
GSM	955.800	0.505825	1.011649	42.5	42
GSM	948.450	0.237684	0.475368	42.3	89
GSM	945.183	0.108019	0.216038	42.3	196
GSM	939.350	0.024689	0.049378	42.1	853
UMTS TDD	1906.267	0.006266	0.022907	60.0	2621
UMTS TDD	1903.800	0.005895	0.021551	60.0	2784
UMTS TDD	1901.400	0.003330	0.012175	60.0	4925
UMTS FDD	2147.133	0.049147	0.317823	61	192
UMTS FDD	2168.600	0.047152	0.304920	61	200

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**	0.007316	1

3.2.4 Cork City: Collins Barracks - Old Youghal Rd

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004088	0.004088	28	6849
FM Radio	106.155	0.299226	0.299226	28	94
FM Radio	94.812	0.120365	0.120365	28	233
FM Radio	96.383	0.058546	0.058546	28	478
FM Radio	102.670	0.052180	0.052180	28	537
FM Radio	89.208	0.035278	0.035278	28	794
FM Radio	101.030	0.035035	0.035035	28	799
PMR	Not disclosed	0.017022	0.017022	28	1645
PMR	Not disclosed	0.013932	0.013932	28	2010
PMR	Not disclosed	0.003097	0.003097	28	9040
PMR	Not disclosed	0.003232	0.003232	28	8663
PMR	Not disclosed	0.002567	0.002567	28	10906
T-DAB	Not disclosed	0.023469	0.027733	28	1010
TETRA	Not disclosed	0.029614	0.051293	28	546
TETRA	Not disclosed	0.028510	0.049381	28	567
TETRA	Not disclosed	0.018239	0.031591	28	886
TETRA	Not disclosed	0.004748	0.008224	28	3405
TETRA	Not disclosed	0.004519	0.007826	28	3578
TETRA	Not disclosed	0.003195	0.005534	28	5059
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	3162
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	8392
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	18898
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	28884
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	35725
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	36173
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	17984
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	37724
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	55893
TV PAL	615.933	0.699842	0.886879	34.1	38
TV PAL	647.467	0.625893	0.793166	35.0	44
TV PAL	671.667	0.613762	0.777793	35.6	46
TV PAL	602.000	0.014774	0.018723	33.7	1802
TV PAL	522.800	0.012764	0.016176	31.4	1944
TV PAL	558.733	0.009110	0.011544	32.5	2815
TV PAL	719.240	0.805378	1.020620	36.9	36
TV PAL	783.453	0.059498	0.075399	38.5	510
TV PAL	807.533	0.048362	0.061286	39.1	638
TV PAL	759.373	0.037196	0.047137	37.9	804
TV PAL	733.573	0.010483	0.013285	37.2	2803

Continued overleaf….

Emission Type	Frequency	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
TV PAL	824.733	0.007473	0.009470	39.5	4170
TV DVB-T	668.733	0.063168	0.166148	35.6	214
GSM	955.567	0.812831	1.625661	42.5	26
GSM	953.233	0.090261	0.180522	42.5	235
GSM	945.417	0.043401	0.086802	42.3	487
GSM	938.067	0.024717	0.049434	42.1	852
GSM	947.283	0.017080	0.034161	42.3	1239
GSM	939.583	0.018093	0.036185	42.1	1165
GSM	1857.000	0.488090	0.976180	59.3	61
GSM	1856.000	0.250035	0.500069	59.2	118
GSM	1838.250	0.014109	0.028218	59.0	2089
GSM	1861.000	0.010740	0.021480	59.3	2762
GSM	1831.250	0.011028	0.022056	58.8	2668
GSM	1865.250	0.014142	0.028283	59.4	2100
UMTS FDD	2131.733	0.222075	1.436103	61	42
UMTS FDD	2128.000	0.213059	1.377798	61	44
UMTS FDD	2166.733	0.106782	0.690535	61	88
UMTS FDD	2147.600	0.098514	0.637068	61	96
UMTS FDD	2117.500	0.005266	0.034055	61	1791
UMTS FDD	2112.833	0.004781	0.030916	61	1973
WiFi	2440.358	0.004932	0.019135	61	3188
FWALA	3588.000	0.001320	0.003329	61	18322
FWALA	3560.000	0.001131	0.002853	61	21378
FWALA	3545.000	0.001046	0.002638	61	23119
FWALA	3505.000	0.000627	0.001583	61	38546
FWALA	3791.900	0.008433	0.025427	61	2399
FWALA	10241.113	0.002848	0.010159	61	6004

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	0.00575	1

3.2.5 Cork City: MacCurtain St – Junction York St

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004350	0.004350	28	6437
FM Radio	89.687	0.032847	0.032847	28	852
FM Radio	101.508	0.029376	0.029376	28	953
FM Radio	94.128	0.027797	0.027797	28	1007
FM Radio	92.010	0.027669	0.027669	28	1012
FM Radio	94.812	0.025235	0.025235	28	1110
FM Radio	106.155	0.019566	0.019566	28	1431
PMR	Not disclosed	0.006187	0.006187	28	4525
PMR	Not disclosed	0.005848	0.005848	28	4788
PMR	Not disclosed	0.002241	0.002241	28	12493
PMR	Not disclosed	0.002101	0.002101	28	13325
PMR	Not disclosed	0.002097	0.002097	28	13355
T-DAB	227.600	0.008492	0.010035	28	2790
TETRA	Not disclosed	0.009047	0.015670	28	1787
TETRA	Not disclosed	0.008700	0.015068	28	1858
TETRA	Not disclosed	0.003289	0.005696	28	4916
TETRA	Not disclosed	0.003073	0.005322	28	5261
TETRA	Not disclosed	0.002649	0.004587	28	6104
TETRA	Not disclosed	0.002512	0.004351	28	6436
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	7348
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	8164
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	8137
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	8201
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	10210
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	51101
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	17818
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	35065
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	48639
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	60703
TV PAL	671.667	0.072194	0.091488	35.6	390
TV PAL	647.467	0.044720	0.056671	35.0	617
TV PAL	615.933	0.030903	0.039162	34.1	871
TV PAL	719.240	0.041976	0.053194	36.9	693
TV PAL	783.453	0.009817	0.012441	38.5	3093
TV PAL	727.267	0.009005	0.011412	37.1	3249
TV PAL	807.533	0.010864	0.013768	39.1	2838
TV PAL	759.373	0.011803	0.014958	37.9	2533
TV PAL	851.107	0.005794	0.007343	40.1	5463
TV DVB-T	664.333	0.018514	0.048696	35.4	728

Continued overleaf….

Emission Type	Frequency	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
GSM	947.633	0.065088	0.130176	42.3	325
GSM	946.117	0.051168	0.102336	42.3	413
GSM	937.950	0.037584	0.075167	42.1	560
GSM	940.517	0.013351	0.026701	42.2	1579
GSM	953.117	0.023659	0.047318	42.4	897
GSM	938.767	0.026242	0.052484	42.1	803
GSM	1833.000	0.090469	0.180938	58.9	325
GSM	1843.750	0.089640	0.179279	59.0	329
GSM	1835.500	0.034316	0.068633	58.9	858
GSM	1854.500	0.024946	0.049892	59.2	1187
GSM	1847.000	0.023878	0.047756	59.1	1237
GSM	1865.000	0.021306	0.042612	59.4	1394
UMTS FDD	2126.133	0.392193	2.536213	61	24
UMTS FDD	2132.433	0.365595	2.364208	61	26
UMTS FDD	2168.367	0.240713	1.556631	61	39
UMTS FDD	2146.900	0.019253	0.124505	61	490
UMTS FDD	2119.133	0.007745	0.050082	61	1218
UMTS FDD	2113.767	0.007337	0.047444	61	1286
WiFi	2415.308	0.008443	0.032759	61	1862
WiFi	2465.130	0.005297	0.020551	61	2968
MMDS PAL	2525.420	0.034277	0.043437	61	1404
MMDS PAL	2653.760	0.030200	0.038271	61	1594
MMDS PAL	2557.040	0.028907	0.036632	61	1665
MMDS PAL	2669.260	0.028151	0.035675	61	1710
MMDS PAL	2509.300	0.025942	0.032875	61	1856
MMDS PAL	2677.940	0.025852	0.032762	61	1862
MMDS DVB-T	2515.500	0.009343	0.024575	61	2482
MMDS DVB-T	2550.220	0.007568	0.019907	61	3064
MMDS DVB-T	2609.120	0.008375	0.022029	61	2769
MMDS DVB-T	2566.340	0.007178	0.018880	61	3231
MMDS DVB-T	2575.020	0.006784	0.017844	61	3418
MMDS DVB-T	2646.320	0.006958	0.018302	61	3333
FWALA	3582.000	0.009026	0.022769	61	2679
FWALA	3514.000	0.000909	0.002293	61	26606
FWALA	3589.667	0.000761	0.001920	61	31767
FWALA	10246.953	0.002982	0.010638	61	5734

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**	0.003956	1

3.2.6 Cork City: Model Farm Road

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004164	0.004164	28	6724
PMR	Not disclosed	0.004715	0.004715	28	5938
FM Radio	101.030	0.041831	0.041831	28	669
FM Radio	89.208	0.035278	0.035278	28	794
FM Radio	93.582	0.033458	0.033458	28	837
FM Radio	98.843	0.032211	0.032211	28	869
FM Radio	91.395	0.030444	0.030444	28	920
FM Radio	96.452	0.017599	0.017599	28	1591
PMR	Not disclosed	0.003495	0.003495	28	8010
PMR	Not disclosed	0.003346	0.003346	28	8369
TETRA	Not disclosed	0.004732	0.008195	28	3417
TETRA	Not disclosed	0.003715	0.006435	28	4351
TETRA	Not disclosed	0.002366	0.004098	28	6833
TETRA	Not disclosed	0.002323	0.004023	28	6960
TETRA	Not disclosed	0.002211	0.003829	28	7313
TETRA	Not disclosed	0.002418	0.004189	28	6685
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	28030
TV PAL	783.133	0.004853	0.006150	38.5	6257
TV PAL	727.320	0.004803	0.006086	37.1	6093
TV PAL	808.007	0.004571	0.005792	39.1	6748
TV PAL	758.867	0.004276	0.005418	37.9	6991
TV DVB-T	668.800	0.009705	0.025527	35.6	1393
GSM	938.650	1.663413	3.326825	42.1	13
GSM	953.583	0.490343	0.980686	42.5	43
GSM	954.633	0.039174	0.078348	42.5	542
GSM	947.167	0.028022	0.056044	42.3	755
GSM	951.950	0.012036	0.024073	42.4	1762
GSM	950.550	0.008985	0.017969	42.4	2359
GSM	1864.250	1.037528	2.075057	59.4	29
GSM	1856.250	0.423643	0.847286	59.2	70
GSM	1861.500	0.054513	0.109026	59.3	544
GSM	1831.500	0.026455	0.052909	58.8	1112
GSM	1834.750	0.023550	0.047101	58.9	1250
GSM	1835.750	0.019275	0.038550	58.9	1528
UMTS FDD	2131.500	0.121619	0.786476	61	78
UMTS FDD	2126.833	0.072946	0.471721	61	129
UMTS FDD	2113.300	0.071203	0.460453	61	132
UMTS FDD	2116.567	0.067143	0.434196	61	140

Continued overleaf….

Emission Type	Frequency	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
UMTS FDD	2167.667	0.053518	0.346087	61	176
UMTS FDD	2147.600	0.004875	0.031527	61	1935
FWALA	3580.000	0.001046	0.002638	61	23119

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**	0.008582	1

3.2.7 Cork: Inishannon

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004116	0.004116	28	6802
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	58804
GSM	947.283	0.481948	0.963896	42.3	44
GSM	950.550	0.339234	0.678469	42.4	62
GSM	946.117	0.128677	0.257353	42.3	164
GSM	954.867	0.011858	0.023715	42.5	1792

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**	0.000812	1

3.2.8 Donegal: Glenties - Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR VHF Low	Not disclosed	0.004164	0.004164	28	6724
TETRA	Not disclosed	0.010174	0.017622	28	1589
TETRA	Not disclosed	0.002432	0.004213	28	6647
TV PAL	623.533	0.013259	0.016802	34.3	2043
TV PAL	647.707	0.009099	0.011531	35.0	3035
TV PAL	703.240	0.009204	0.011664	36.5	3126
GSM	947.633	1.142878	2.285757	42.3	19
GSM	951.483	0.962720	1.925440	42.4	22
GSM	946.583	0.187068	0.374136	42.3	113
GSM	938.183	0.037844	0.075689	42.1	556
GSM	954.633	0.010046	0.020092	42.5	2114
GSM	939.467	0.004281	0.008561	42.1	4923
UMTS FDD	2166.500	0.091201	0.589774	61	103
UMTS FDD	2147.133	0.088206	0.570408	61	107
UMTS FDD	2117.500	0.084333	0.545363	61	112
UMTS FDD	2113.533	0.084140	0.544109	61	112
WiFi	2474.037	0.008119	0.031502	61	1936

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**	0.0054	1

3.2.9 Galway: Ballinasloe St Michael's Square

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004513	0.004513	28	6204
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	22855
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	59143
GSM	953.817	0.739605	1.479211	42.5	29
GSM	950.433	0.170805	0.341610	42.4	124
GSM	946.583	0.151182	0.302364	42.3	140
GSM	941.567	0.015578	0.031155	42.2	1354
GSM	938.533	0.015329	0.030657	42.1	1374
GSM	939.467	0.012402	0.024804	42.1	1699
GSM	1831.750	0.011054	0.022107	58.8	2662
UMTS FDD	2112.600	0.119812	0.774793	61	79
UMTS FDD	2117.033	0.093864	0.606996	61	100
UMTS FDD	2168.367	0.029888	0.193279	61	316
UMTS FDD	2146.900	0.004667	0.030178	61	2021
WiFi	2437.853	0.014454	0.056083	61	1088
WiFi	2424.772	0.009761	0.037873	61	1611
WiFi	2447.317	0.006259	0.024285	61	2512

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**	0.001603	1

3.2.10 Galway: Loughrea - Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004493	0.004493	28	6232
PMR	Not disclosed	0.004116	0.004116	28	6802
PMR	Not disclosed	0.005610	0.005610	28	4991
TETRA	Not disclosed	0.246320	0.426639	28	66
TETRA	Not disclosed	0.003228	0.005592	28	5007
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	58804
GSM	940.050	1.832314	3.664629	42.2	12
GSM	942.967	1.608792	3.217585	42.2	13
GSM	952.767	0.256153	0.512307	42.4	83
GSM	944.717	0.091622	0.183244	42.3	231
GSM	938.650	0.104833	0.209667	42.1	201
UMTS FDD	2167.200	0.053518	0.346087	61	176
UMTS FDD	2146.900	0.030304	0.195968	61	311
WiFi	2440.637	0.006464	0.025080	61	2432

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**	0.013828	1

3.2.11 Kerry: Killarney - College St - Scots Gardens Hotel

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004036	0.004036	28	6937
TETRA	Not disclosed	0.018880	0.032701	28	856
TETRA	Not disclosed	0.018471	0.031993	28	875
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	19050
GSM	954.633	0.428055	0.856111	42.5	50
GSM	948.217	0.029410	0.058821	42.3	720
GSM	946.350	0.016199	0.032399	42.3	1306
GSM	941.450	0.022725	0.045450	42.2	928
GSM	953.117	0.017239	0.034477	42.4	1231
GSM	938.300	0.015293	0.030587	42.1	1377
GSM	1838.500	0.021953	0.043907	59.0	1343
GSM	1832.500	0.020464	0.040929	58.9	1438
GSM	1856.000	0.011940	0.023880	59.2	2481
GSM	1841.250	0.015631	0.031263	59.0	1887
UMTS FDD	2119.133	0.106660	0.689740	61	88
UMTS FDD	2166.267	0.095280	0.616149	61	99
UMTS FDD	2114.000	0.040691	0.263139	61	232
UMTS FDD	2145.967	0.006486	0.041946	61	1454
WiFi	5504.000	0.001377	0.005344	61	11416

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**	0.000664	1

3.2.12 Leitrim: Carrick-on-Shannon - Summer Hill

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004694	0.004694	28	5966
PMR	Not disclosed	0.004330	0.004330	28	6466
TETRA	Not disclosed	0.269464	0.466725	28	60
TETRA	Not disclosed	0.244343	0.423215	28	66
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	5081
TV PAL	518.347	0.009376	0.011881	31.3	2635
TV PAL	648.360	0.007269	0.009212	35.0	3801
TV PAL	657.507	0.006216	0.007877	35.3	4476
TV PAL	623.533	0.005598	0.007094	34.3	4840
TV PAL	671.227	0.007071	0.008961	35.6	3975
TV PAL	703.240	0.004320	0.005475	36.5	6660
TV DVB-T	683.640	0.001474	0.003877	36.0	9273
GSM	938.300	1.297179	2.594359	42.1	16
GSM	941.683	0.923634	1.847268	42.2	23
GSM	953.233	0.309742	0.619484	42.5	69
GSM	954.283	0.124165	0.248330	42.5	171
GSM	940.167	0.111815	0.223630	42.2	189
GSM	946.350	0.028741	0.057482	42.3	736
GSM	1857.000	0.590881	1.181762	59.3	50
GSM	1854.750	0.197697	0.395394	59.2	150
GSM	1831.500	0.030269	0.060538	58.8	972
UMTS FDD	2118.900	0.047098	0.304569	61	200
UMTS FDD	2113.067	0.041068	0.265574	61	230
UMTS FDD	2116.967	0.040133	0.259529	61	235
UMTS FDD	2148.067	0.007178	0.046418	61	1314
FWALA	3733.400	0.000871	0.002197	61	27764

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**	0.007001	1

3.2.13 Limerick City - Upper Henry St

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.007228	0.007228	28	3874
FM Radio	107.043	0.010532	0.010532	28	2659
FM Radio	89.345	0.009727	0.009727	28	2878
FM Radio	91.600	0.008923	0.008923	28	3138
FM Radio	103.080	0.008156	0.008156	28	3433
FM Radio	104.242	0.007682	0.007682	28	3645
FM Radio	101.235	0.006918	0.006918	28	4047
PMR	Not disclosed	0.016199	0.016199	28	1728
PMR	Not disclosed	0.014555	0.014555	28	1924
PMR	Not disclosed	0.002871	0.002871	28	9753
PMR	Not disclosed	0.002393	0.002393	28	11699
T-DAB	227.253	0.008551	0.010104	28	2771
TETRA	Not disclosed	0.020701	0.035856	28	781
TETRA	Not disclosed	0.019187	0.033232	28	843
TETRA	Not disclosed	0.017865	0.030943	28	905
TETRA	Not disclosed	0.002185	0.003785	28	7398
TETRA	Not disclosed	0.002014	0.003488	28	8028
TETRA	Not disclosed	0.002068	0.003581	28	7818
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	47796
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	49999
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	28488
TV UHF (DVB-T)	678.413	0.003859	0.010151	35.8	3528
GSM	938.183	2.488857	4.977715	42.1	8
GSM	953.817	0.108143	0.216287	42.5	196
GSM	955.683	0.133506	0.267012	42.5	159
GSM	950.317	0.011416	0.022831	42.4	1857
GSM	948.917	0.015153	0.030306	42.4	1398
GSM	1864.500	0.695024	1.390049	59.4	43
GSM	1866.750	0.254097	0.508195	59.4	117
GSM	1857.500	0.105317	0.210635	59.3	281
GSM	1855.250	0.052966	0.105933	59.2	559
GSM	1838.250	0.019231	0.038462	59.0	1533
GSM	1839.500	0.011844	0.023688	59.0	2490
UMTS FDD	2133.367	0.232274	1.502054	61	41
UMTS FDD	2126.833	0.222844	1.441072	61	42

Continued overleaf….

Emission Type	Frequency	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
UMTS FDD	2167.667	0.118987	0.769459	61	79
UMTS FDD	2117.500	0.031046	0.200764	61	304
UMTS FDD	2112.600	0.024462	0.158192	61	386
UMTS FDD	2148.767	0.005230	0.033821	61	1804
WiFi	2446.760	0.006645	0.025783	61	2366
WiFi	2408.907	0.005333	0.020693	61	2948
FWALA	3555.333	0.045920	0.115838	61	527
FWALA	3531.667	0.001483	0.003740	61	16311
FWALA	3572.333	0.000816	0.002058	61	29647
FWALA	3594.333	0.017783	0.044859	61	1360
FWALA	3740.900	0.002924	0.007377	61	8269
FWALA	3728.900	0.000770	0.001942	61	31403
WiFi	5624.700	0.001263	0.004902	61	12445
WiFi	5598.350	0.001002	0.003889	61	15685

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**	0.016025	1

3.2.14 Limerick: Mungret – ESB Compound

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.003904	0.003904	28	7172
PMR	Not disclosed	0.004989	0.004989	28	5613
PMR	Not disclosed	0.003443	0.003443	28	8131
PMR	Not disclosed	0.002948	0.002948	28	9499
PMR	Not disclosed	0.002723	0.002723	28	10284
TETRA	Not disclosed	0.009110	0.015778	28	1775
TETRA	Not disclosed	0.008453	0.014641	28	1912
TETRA	Not disclosed	0.007482	0.012959	28	2161
TETRA	Not disclosed	0.007170	0.012418	28	2255
TETRA	Not disclosed	0.006281	0.010878	28	2574
TETRA	Not disclosed	0.003006	0.005207	28	5378
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	49542
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	61642
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	24696
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	39143
TV PAL	658.160	0.011588	0.014685	35.3	2402
TV PAL	640.520	0.007456	0.009449	34.8	3683
TV PAL	694.747	0.005364	0.006798	36.2	5332
TV PAL	754.853	0.004742	0.006010	37.8	6286
TV DVB-T	680.373	0.003664	0.009638	35.9	3721
GSM	939.583	1.333521	2.667043	42.1	16
GSM	940.750	0.606038	1.212076	42.2	35
GSM	954.867	0.314413	0.628825	42.5	68
GSM	946.817	0.005540	0.011080	42.3	3819
GSM	950.550	0.011143	0.022286	42.4	1902
GSM	1839.500	0.715319	1.430639	59.0	41
GSM	1857.750	0.345144	0.690287	59.3	86
GSM	1838.250	0.293089	0.586179	59.0	101
GSM	1840.500	0.433511	0.867022	59.0	68
GSM	1856.500	0.086996	0.173992	59.2	341
UMTS FDD	2117.267	0.097163	0.628327	61	97
UMTS FDD	2112.833	0.094515	0.611203	61	100
UMTS FDD	2166.733	0.093756	0.606297	61	101
UMTS FDD	2132.667	0.080353	0.519620	61	117
UMTS FDD	2127.067	0.063096	0.408024	61	150
UMTS FDD	2148.767	0.047753	0.308806	61	198
FWALA	3541.333	0.001117	0.002817	61	21651

Continued overleaf….

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**	0.006547	1

3.2.15 Longford: Edgeworthstown – Main St

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004400	0.004400	28	6363
PMR	Not disclosed	0.007603	0.007603	28	3683
PMR	Not disclosed	0.002460	0.002460	28	11380
TETRA	Not disclosed	0.046452	0.080456	28	348
TETRA	Not disclosed	0.002521	0.004366	28	6414
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	13565
TV PAL	647.707	0.076736	0.097244	35.0	360
TV PAL	623.533	0.042121	0.053378	34.3	643
TV PAL	585.640	0.007303	0.009255	33.3	3595
TV PAL	603.933	0.010715	0.013579	33.8	2488
TV PAL	671.227	0.066988	0.084892	35.6	420
TV PAL	703.240	0.052300	0.066277	36.5	550
TV PAL	733.293	0.008923	0.011307	37.2	3293
TV PAL	812.347	0.006216	0.007877	39.2	4975
TV DVB-T	660.773	0.005176	0.013614	35.3	2596
TV DVB	637.253	0.005023	0.013213	34.7	2627
TV DVB	681.027	0.005708	0.015014	35.9	2390
TV DVB	716.960	0.006116	0.016088	36.8	2289
GSM	939.350	4.055085	8.110171	42.1	5
GSM	947.167	0.466659	0.933319	42.3	45
GSM	951.483	0.221309	0.442619	42.4	96
GSM	954.167	0.017844	0.035689	42.5	1190
GSM	1879.000	0.041831	0.083662	59.6	712
UMTS FDD	2148.067	0.074302	0.480491	61	127
UMTS FDD	2113.767	0.006816	0.044074	61	1384
WiFi	2468.470	0.005370	0.020837	61	2927

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**	0.037726	1

3.2.16 Mayo: Crossmolina – Ballina St

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004360	0.004360	28	6422
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	56873
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	48942
GSM	948.683	1.047129	2.094257	42.4	20
GSM	954.983	0.507575	1.015149	42.5	42
GSM	951.600	0.240713	0.481427	42.4	88
GSM	950.433	0.038637	0.077273	42.4	549
GSM	939.583	0.002526	0.005053	42.1	8341
UMTS TDD	1903.800	0.003412	0.012473	60.0	4810
UMTS FDD	2146.900	0.046452	0.300390	61	203
WiFi	2471.253	0.018155	0.070442	61	866
FWALA	3552.667	0.001157	0.002920	61	20892

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**	0.003174	1

3.2.17 Monaghan Town: Plantation Rd - Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.003926	0.003926	28	7131
PMR	Not disclosed	0.004406	0.004406	28	6356
TETRA	Not disclosed	0.246320	0.426639	28	66
TETRA	Not disclosed	0.245471	0.425168	28	66
GSM	938.417	1.706082	3.412165	42.1	12
GSM	954.633	1.427250	2.854500	42.5	15
GSM	940.050	0.291072	0.582143	42.2	72
GSM	956.733	1.053174	2.106347	42.5	20
GSM	953.700	0.334580	0.669160	42.5	63
GSM	952.650	0.052060	0.104119	42.4	408
GSM	1855.750	0.168655	0.337311	59.2	176
GSM	1833.750	0.036644	0.073288	58.9	803
GSM	1833.750	0.011954	0.023907	58.9	2463
GSM	1839.000	0.012750	0.025499	59.0	2312
GSM	1877.000	0.008690	0.017379	59.6	3428
GSM	1843.750	0.007261	0.014522	59.0	4066
UMTS TDD	1909.400	0.005070	0.018534	60.1	3242
UMTS FDD	2111.433	0.083176	0.537880	61	113
UMTS FDD	2118.900	0.072444	0.468474	61	130
UMTS FDD	2167.433	0.014471	0.093581	61	652
UMTS FDD	2145.967	0.007971	0.051545	61	1183
UMTS FDD	2133.367	0.005152	0.033319	61	1831
UMTS FDD	2128.933	0.004792	0.030987	61	1969
FWALA	3731.000	0.001327	0.003349	61	18217
FWALA	3725.900	0.001147	0.002893	61	21085

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**	0.014612	1

3.2.18 Offaly: Banagher – Liffey Mills

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004416	0.004416	28	6341
TETRA	Not disclosed	0.015649	0.027106	28	1033
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	58466
TV PAL	847.627	0.005636	0.007143	40.0	5605
TV PAL	831.947	0.005578	0.007069	39.7	5610
TV DVB-T	688.867	0.001477	0.003886	36.1	9287
GSM	946.933	0.013677	0.027355	42.3	1547
GSM	954.750	0.013077	0.026154	42.5	1624
GSM	938.067	0.012176	0.024352	42.1	1729
GSM	951.133	0.012078	0.024156	42.4	1755
GSM	948.450	0.011708	0.023417	42.3	1808
GSM	949.617	0.010399	0.020798	42.4	2037
UMTS FDD	2118.667	0.140929	0.911351	61	67
UMTS FDD	2113.300	0.127791	0.826391	61	74
UMTS FDD	2168.833	0.065013	0.420422	61	145
UMTS FDD	2147.833	0.004482	0.028986	61	2104
FWALA	3756.800	0.000977	0.002465	61	24744

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**	0.000458	1

3.2.19 Roscommon: Strokestown – Elphin St

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004753	0.004753	28	5891
PMR	Not disclosed	0.003690	0.003690	28	7589
PMR	Not disclosed	0.003811	0.003811	28	7348
FM Radio	103.080	0.009462	0.009462	28	2959
FM Radio	104.105	0.007577	0.007577	28	3695
PMR	Not disclosed	0.002188	0.002188	28	12798
TETRA	Not disclosed	0.005117	0.008863	28	3159
TV PAL	647.707	0.014174	0.017962	35.0	1948
TV PAL	623.533	0.012359	0.015663	34.3	2192
TV PAL	671.227	0.013788	0.017473	35.6	2039
TV PAL	703.240	0.010423	0.013209	36.5	2761
TV DVB-T	633.987	0.002183	0.005741	34.6	6030
TV DVB-T	658.813	0.002150	0.005656	35.3	6240
TV DVB-T	682.333	0.002051	0.005395	35.9	6657
TV DVB-T	716.760	0.001554	0.004088	36.8	9005
GSM	946.000	2.262039	4.524077	42.3	9
GSM	952.533	0.209411	0.418822	42.4	101
GSM	951.133	0.154348	0.308695	42.4	137
UMTS FDD	2146.200	0.239332	1.547696	61	39

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**	0.012239	1

3.2.20 Sligo: Inishcrone – Church Lane

Table of Frequency Selective Measurement Resultsg					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004487	0.004487	28	6240
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	58466
GSM	948.567	0.157398	0.314797	42.3	135
GSM	949.850	0.149968	0.299937	42.4	141
GSM	948.100	0.122321	0.244641	42.3	173
GSM	954.750	0.029074	0.058147	42.5	731
UMTS FDD	2148.767	0.105560	0.682630	61	89

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**	0.000266	1

3.2.21 Tipperary: Carrick-on-Suir - Carrick Hotel

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004508	0.004508	28	6211
PMR	Not disclosed	0.009920	0.009920	28	2823
PMR	Not disclosed	0.006855	0.006855	28	4085
PMR	Not disclosed	0.006776	0.006776	28	4132
TETRA	Not disclosed	0.004093	0.007089	28	3950
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	59897
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	48249
TV PAL	727.413	0.005489	0.006956	37.1	5331
TV PAL	807.773	0.004340	0.005500	39.1	7105
GSM	949.383	0.097387	0.194774	42.4	218
GSM	947.400	0.090887	0.181773	42.3	233
GSM	945.300	0.094081	0.188161	42.3	225
GSM	938.650	0.029648	0.059297	42.1	710
GSM	955.100	0.026182	0.052364	42.5	812
GSM	951.483	0.003581	0.007162	42.4	5922
GSM	1837.750	1.055602	2.111203	58.9	28
GSM	1841.250	0.784332	1.568664	59.0	38
GSM	1855.250	0.012517	0.025034	59.2	2366
UMTS FDD	2147.600	0.138835	0.897812	61	68
UMTS FDD	2116.333	0.011003	0.071152	61	857
UMTS FDD	2114.233	0.009258	0.059867	61	1019
UMTS FDD	2132.900	0.005514	0.035660	61	1711
UMTS FDD	2128.000	0.005476	0.035415	61	1722
UMTS FDD	2167.667	0.004786	0.030952	61	1971
WiFi	2459.007	0.013274	0.051503	61	1184
WiFi	2415.030	0.006863	0.026628	61	2291
WiFi	2437.297	0.004613	0.017899	61	3408
WiFi	5480.200	0.001012	0.003925	61	15542
FWA (Lic-exempt)	5728.000	0.085114	0.214710	61	284
FWA (Lic-exempt)	5864.500	0.024860	0.062712	61	973

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**	0.002288	1

3.2.22 Waterford: Kilmacthomas – Traceys Hill

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.003520	0.003520	28	7955
PMR	Not disclosed	0.002477	0.002477	28	11302
TETRA	Not disclosed	0.059979	0.103887	28	270
TETRA	Not disclosed	0.002065	0.003577	28	7827
TETRA	Not disclosed	0.002014	0.003488	28	8028
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	59691
TV PAL	735.253	0.307610	0.389820	37.3	96
TV PAL	767.267	0.241546	0.306101	38.1	124
TV PAL	815.613	0.211836	0.268451	39.3	146
TV PAL	729.373	0.012303	0.015591	37.1	2382
TV PAL	809.080	0.008680	0.010999	39.1	3556
TV PAL	747.667	0.007194	0.009117	37.6	4124
GSM	955.217	1.319775	2.639551	42.5	16
GSM	953.700	0.199297	0.398593	42.5	107
GSM	946.233	0.012957	0.025914	42.3	1632
GSM	940.283	0.012064	0.024128	42.2	1747
GSM	949.967	0.010127	0.020255	42.4	2092
GSM	950.667	0.008251	0.016502	42.4	2569
UMTS TDD	1910.467	0.005761	0.021060	60.1	2854
UMTS FDD	2111.433	0.190327	1.230795	61	50
UMTS FDD	2117.500	0.188365	1.218108	61	50
UMTS FDD	2167.667	0.004726	0.030562	61	1996
UMTS FDD	2146.900	0.004715	0.030492	61	2001

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**	0.004988	1

3.2.23 Wexford: New Ross - The Quay

Table of Frequency Selective Measurement Results					
Emission Type	**Frequency**	**Measured Level (V/m)**	**Adjusted Level (V/m)**	**ICNIRP Limit (V/m)**	**Times below Limit** [adjusted Values]
PMR	Not disclosed	0.004759	0.004759	28	5884
FM Radio	105.403	0.007499	0.007499	28	3734
FM Radio	96.383	0.007278	0.007278	28	3847
PMR	Not disclosed	0.003090	0.003090	28	9061
TETRA	Not disclosed	0.034159	0.059164	28	473
TETRA	Not disclosed	0.029478	0.051058	28	548
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	57333
TV PAL	511.067	0.010423	0.013209	31.1	2353
TV PAL	487.067	0.009386	0.011895	30.3	2551
TV PAL	745.227	0.031952	0.040492	37.5	927
TV PAL	669.440	0.027447	0.034783	35.6	1023
TV PAL	711.973	0.021627	0.027407	36.7	1339
TV PAL	736.720	0.020488	0.025964	37.3	1437
TV PAL	634.640	0.008851	0.011217	34.6	3088
TV PAL	801.680	0.014421	0.018275	38.9	2130
TV DVB-T	616.667	0.002489	0.006546	34.1	5216
TV DVB	664.027	0.002438	0.006412	35.4	5526
TV DVB	699.600	0.002231	0.005868	36.4	6198
TV DVB	642.373	0.002283	0.006005	34.8	5804
GSM	954.050	0.819408	1.638815	42.5	26
GSM	939.000	0.099426	0.198852	42.1	212
GSM	940.633	0.080631	0.161261	42.2	262
GSM	946.117	0.029648	0.059297	42.3	713
GSM	947.750	0.023014	0.046029	42.3	920
GSM	950.083	0.022568	0.045137	42.4	939
GSM	1844.750	0.006645	0.013290	59.1	4444
UMTS FDD	2167.900	0.056820	0.367439	61	166
UMTS FDD	2119.133	0.017906	0.115794	61	527
UMTS FDD	2131.267	0.016199	0.104758	61	582
UMTS FDD	2128.233	0.015740	0.101785	61	599
UMTS FDD	2111.900	0.012662	0.081881	61	745
UMTS FDD	2145.967	0.007219	0.046686	61	1307

Continued overleaf….

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**	0.00159	1

4. Conclusion

The conclusion of this report is that at all 23 licensed transmitter sites surveyed on behalf of ComReg during the period April - June 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) $\approx 377\ \Omega$

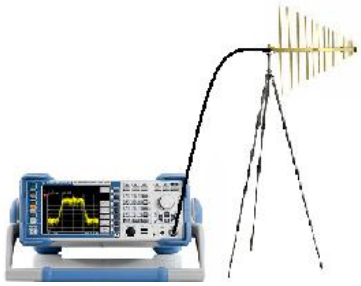
[17] Beyond a distance of $\lambda + 2D^2/\lambda$ where λ is the wavelength and D is the antenna's largest dimension

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.

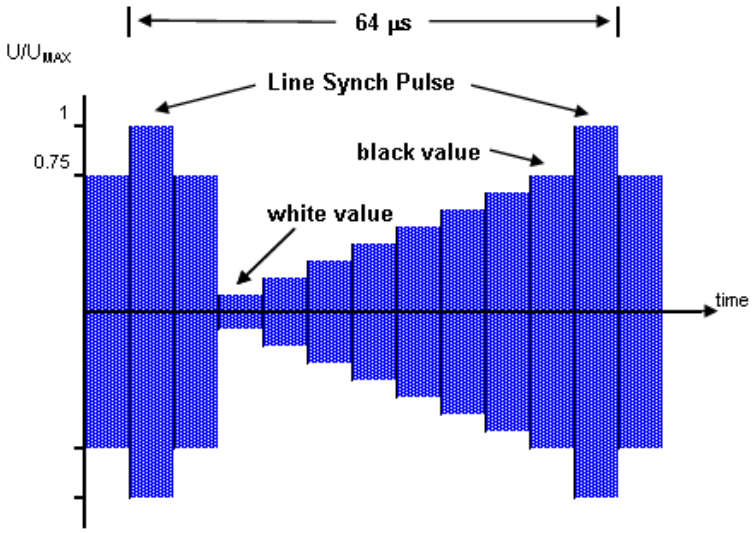


Figure 1: Luminance Signal in the Time Domain

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.