Commission for
Communications Regulation

Report

2009 Programme of Measurement of Non-Ionising Radiation Emissions

Fourth 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 fourth set of site surveys (20 sites) undertaken during the 2009 programme.

The site surveys were conducted during October - December 2009 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 20 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 fourth set of 20 sites chosen as part of the 2009 Programme of Measurement of Non-Ionising Radiation emissions. The site surveys were conducted during October – December 2009 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.

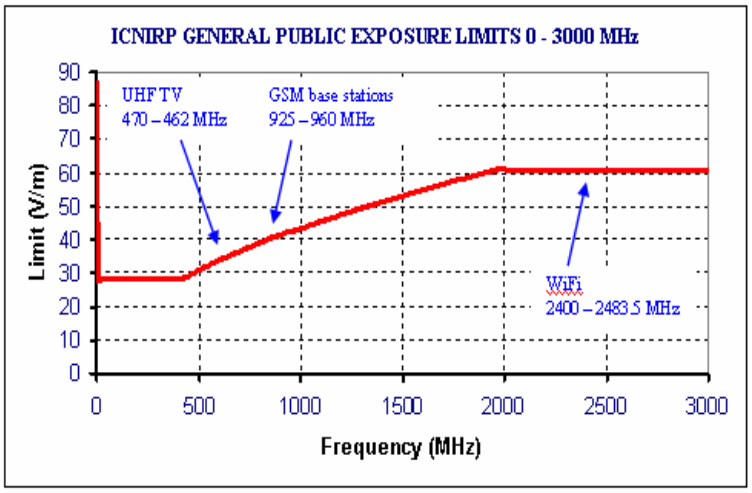
- to extrapolate to an estimate of the level under maximum traffic from the transmitter. For example, the base stations of mobile telephone networks produce emissions which vary according to the changing volume of calls or data traffic over the course of the day. The levels measured for the always-on 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 Clare: Ballyvaughan - 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	0.004608	0.004608	28.0	6077
GSM	955.100	0.364754	0.729508	42.5	58
GSM	953.817	0.063606	0.127213	42.5	334

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**	0.000304	1

3.2.2 Cork City: Beaumont - Church 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	0.004624	0.004624	28	6056
FM Radio	106.155	0.013243	0.013243	28	2114
FM Radio	96.383	0.012474	0.012474	28	2245
FM Radio	106.770	0.011803	0.011803	28	2372
FM Radio	94.812	0.009716	0.009716	28	2882
TETRA	Not disclosed	0.011324	0.019614	28	1428
TETRA	Not disclosed	0.011220	0.019434	28	1441
TETRA	Not disclosed	0.003954	0.006848	28	4089
TETRA	Not disclosed	0.003467	0.006006	28	4662
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	30931
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	32803
TV PAL	759.653	0.007656	0.009702	37.9	3906
TV PAL	727.333	0.006599	0.008363	37.1	4434
TV PAL	783.893	0.005224	0.006620	38.5	5815
TV PAL	807.460	0.004983	0.006315	39.1	6187
TV DVB-T	668.080	0.004603	0.012106	35.5	2936
GSM	954.400	0.017398	0.034796	42.5	1221
GSM	949.733	0.015153	0.030306	42.4	1398
GSM	947.983	0.012912	0.025824	42.3	1639
GSM	939.583	0.011350	0.022700	42.1	1857
GSM	953.000	0.008482	0.016964	42.4	2502
GSM	940.750	0.008175	0.016350	42.2	2579
GSM	1834.250	0.020535	0.041071	58.9	1434
GSM	1845.250	0.019476	0.038952	59.1	1516
GSM	1857.750	0.014689	0.029379	59.3	2017
GSM	1862.250	0.014488	0.028975	59.3	2048
GSM	1854.750	0.013092	0.026184	59.2	2262
UMTS FDD	2133.600	0.663743	4.292256	61	14
UMTS FDD	2126.600	0.594977	3.847562	61	16
UMTS FDD	2166.500	0.310456	2.007639	61	30
UMTS FDD	2148.767	0.226464	1.464487	61	42
UMTS FDD	2117.967	0.145211	0.939043	61	65
UMTS FDD	2111.433	0.121899	0.788289	61	77

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**	0.010999	1

3.2.3 Cork: Ballincollig Commercial Park

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	0.004390	0.004390	28	6378
FM Radio	107.863	0.008810	0.008810	28	3178
PMR	Not disclosed	0.044823	0.044823	28	625
PMR	Not disclosed	0.013756	0.013756	28	2035
TETRA	Not disclosed	0.408790	0.708045	28	40
TETRA	Not disclosed	0.387704	0.671523	28	42
TV PAL	519.400	0.007682	0.009736	31.3	3219
TV PAL	839.780	0.005052	0.006403	39.8	6223
TV DVB-T	668.080	0.005058	0.013304	35.5	2671
GSM	939.350	1.011579	2.023159	42.1	21
GSM	953.350	0.829851	1.659702	42.5	26
GSM	949.033	0.542001	1.084002	42.4	39
GSM	946.583	0.432016	0.864032	42.3	49
GSM	940.750	0.085704	0.171408	42.2	246
GSM	954.867	0.078614	0.157228	42.5	270
GSM	1862.000	0.864968	1.729936	59.3	34
GSM	1856.500	0.628782	1.257564	59.2	47
GSM	1833.500	0.156495	0.312990	58.9	188
GSM	1844.250	0.144046	0.288091	59.0	205
GSM	1838.000	0.053027	0.106055	58.9	556
UMTS FDD	2113.767	0.136301	0.881426	61	69
UMTS FDD	2132.667	0.110917	0.717275	61	85
UMTS FDD	2166.733	0.080353	0.519620	61	117
UMTS FDD	2128.700	0.073367	0.474445	61	129
UMTS FDD	2146.200	0.051761	0.334723	61	182
FWALA	3580.667	0.092897	0.331412	61	184

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**	0.008049	1

3.2.4 Cork: Bantry - Market St Eircom Exchange

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	98.297	0.025852	0.025852	28	1083
FM Radio	93.103	0.022131	0.022131	28	1265
FM Radio	88.662	0.020583	0.020583	28	1360
FM Radio	90.917	0.017080	0.017080	28	1639
FM Radio	105.403	0.014808	0.014808	28	1891
FM Radio	94.812	0.009716	0.009716	28	2882
PMR	Not disclosed	0.006855	0.006855	28	4085
TETRA	Not disclosed	0.014322	0.024806	28	1129
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	34464
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	47908
GSM	947.283	0.360164	0.720328	42.3	59
GSM	954.050	0.097949	0.195898	42.5	217
GSM	953.233	0.064789	0.129578	42.5	328
GSM	1854.500	0.006166	0.012332	59.2	4802
UMTS FDD	2168.133	0.012359	0.079926	61	763

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**	0.000326	1

3.2.5 Cork: Skibbereen - 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	0.004613	0.004613	28	6070
GSM	947.517	1.470618	2.941237	42.3	14
GSM	954.283	0.934329	1.868659	42.5	23
GSM	945.183	0.158307	0.316614	42.3	134
GSM	952.883	0.072946	0.145892	42.4	291
GSM	940.283	0.017022	0.034043	42.2	1239
GSM	939.467	0.008072	0.016145	42.1	2610
UMTS TDD	1902.067	0.006676	0.024404	60.0	2457
UMTS FDD	2147.367	0.215278	1.392149	61	44
UMTS FDD	2168.833	0.098514	0.637068	61	96
UMTS FDD	2117.033	0.028940	0.187148	61	326
UMTS FDD	2112.133	0.018030	0.116597	61	523

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**	0.007476	1

3.2.6 Donegal: Ballyshannon - 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	0.004290	0.004290	28.0	6526
FM Radio	94.675	0.009386	0.009386	28.0	2983
TV PAL	783.600	0.004375	0.005545	38.5	6942
TV PAL	807.120	0.003758	0.004763	39.1	8202
GSM	948.683	1.545254	3.090509	42.4	14
GSM	937.833	1.051962	2.103924	42.1	20
GSM	939.467	0.309742	0.619484	42.1	68
GSM	953.350	0.292752	0.585504	42.5	73
GSM	946.000	0.266993	0.533986	42.3	79
GSM	954.283	0.149279	0.298559	42.5	142
UMTS FDD	2147.367	0.054138	0.350095	61.0	174
UMTS FDD	2166.267	0.027071	0.175059	61.0	348
UMTS FDD	2118.200	0.012445	0.080480	61.0	758
UMTS FDD	2114.233	0.008308	0.053726	61.0	1135

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**	0.008481	1

3.2.7 Dublin: Galloping Green

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	0.004672	0.004672	28.0	5993
PMR	Not disclosed	0.004677	0.004677	28.0	5986
FM Radio	104.447	0.047098	0.047098	28.0	595
FM Radio	90.712	0.044361	0.044361	28.0	631
FM Radio	92.898	0.037368	0.037368	28.0	749
FM Radio	88.457	0.036392	0.036392	28.0	769
FM Radio	96.725	0.028054	0.028054	28.0	998
FM Radio	103.832	0.024462	0.024462	28.0	1145
PMR	Not disclosed	0.002025	0.002025	28.0	13825
PMR	Not disclosed	0.001943	0.001943	28.0	14410
PMR	Not disclosed	0.002597	0.002597	28.0	10781
T-DAB	227.200	0.018072	0.021355	28.0	1311
TETRA	Not disclosed	0.006361	0.011017	28.0	2542
TETRA	Not disclosed	0.004107	0.007113	28.0	3936
TETRA	Not disclosed	0.003652	0.006325	28.0	4427
TETRA	Not disclosed	0.003528	0.006110	28.0	4582
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	23765
TV PAL	535.333	0.019679	0.024938	31.8	1276
TV PAL	583.680	0.013552	0.017174	33.2	1934
TV PAL	567.347	0.012148	0.015394	32.8	2127
TV PAL	743.093	0.011117	0.014088	37.5	2660
TV DVB-T	741.133	0.015542	0.040879	37.4	916
TV DVB-T	797.320	0.008610	0.022646	38.8	1714
GSM 900	939.933	2.529298	5.058596	42.2	8
GSM 900	953.467	0.635331	1.270662	42.5	33
GSM 900	938.650	0.293089	0.586179	42.1	72
GSM 900	955.100	0.058412	0.116823	42.5	364
GSM 900	946.233	0.029992	0.059983	42.3	705
GSM 1800	1844.500	0.018923	0.037847	59.1	1560
GSM 1800	1856.000	0.010035	0.020069	59.2	2952
GSM 1800	1843.500	0.009462	0.018925	59.0	3120
UMTS FDD	2133.367	0.345939	2.237101	61.0	27
UMTS FDD	2127.300	0.331894	2.146276	61.0	28
UMTS FDD	2153.433	0.325087	2.102256	61.0	29
UMTS FDD	2146.200	0.282813	1.828882	61.0	33
FWALA	3529.667	0.001095	0.002763	61.0	22079

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**	0.020183	1

3.2.8 Dublin: Garristown 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	0.004613	0.004613	28.0	6070
TETRA	Not disclosed	0.004534	0.007853	28.0	3565
TV PAL	831.947	0.017080	0.021645	39.7	1832
TV PAL	751.587	0.015704	0.019901	37.7	1894
TV PAL	847.627	0.014876	0.018852	40.0	2123
TV PAL	719.573	0.010328	0.013088	36.9	2818
GSM	954.867	1.673016	3.346031	42.5	13
GSM	947.283	0.006026	0.012051	42.3	3512
UMTS TDD	1909.867	0.006464	0.023630	60.1	2543
WiFi	2409.185	0.005834	0.022638	61.0	2695
FWALA	3526.000	0.000619	0.001563	61.0	39037

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**	0.006203	1

3.2.9 Dublin: Portmarnock - Country Club 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	0.008463	0.008463	28	3309
T-DAB	227.680	0.007120	0.008414	28	3328
TETRA	Not disclosed	0.005502	0.009529	28	2938
TETRA	Not disclosed	0.005389	0.009334	28	3000
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	40726
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	32282
TV PAL	799.933	0.009829	0.012456	38.9	3122
TV PAL	775.107	0.005023	0.006366	38.3	6013
TV DVB-T	740.480	0.002972	0.007816	37.4	4787
TV DVB-T	795.360	0.001631	0.004290	38.8	9038
GSM	940.167	2.894010	5.788020	42.2	7
GSM	954.983	1.704119	3.408239	42.5	12
GSM	945.767	0.751623	1.503246	42.3	28
GSM	950.900	0.735360	1.470720	42.4	29
GSM	953.700	0.374973	0.749946	42.5	57
GSM	937.833	0.250611	0.501222	42.1	84
GSM	1856.000	1.288250	2.576499	59.2	23
UMTS TDD	1913.267	0.006524	0.023849	60.1	2522
UMTS TDD	1910.267	0.005636	0.020605	60.1	2917
UMTS FDD	2118.667	0.210620	1.362027	61	45
UMTS FDD	2166.267	0.172982	1.118628	61	55
UMTS FDD	2126.133	0.154525	0.999276	61	61
UMTS FDD	2111.433	0.136301	0.881426	61	69
UMTS FDD	2133.833	0.104112	0.673264	61	91
UMTS FDD	2146.667	0.062087	0.401500	61	152
FWALA	3557.667	0.146218	0.368852	61	165
FWALA	3570.333	0.036183	0.091275	61	668
FWALA	3543.000	0.002032	0.005127	61	11898
FWALA	3751.400	0.019588	0.049414	61	1234
FWALA	3736.400	0.015831	0.039935	61	1527
FWALA	3742.100	0.012927	0.032610	61	1871
FWALA	3766.100	0.007371	0.018593	61	3281
FWALA	3756.800	0.006823	0.017213	61	3544
FWALA	3790.700	0.003652	0.009212	61	6622

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**	0.031612	1

3.2.10 Dublin 16: Ballyboden - Scholarstown 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	0.004819	0.004819	28	5810
FM Radio	98.160	0.021802	0.021802	28	1284
FM Radio	104.447	0.021014	0.021014	28	1332
FM Radio	106.018	0.020941	0.020941	28	1337
FM Radio	102.192	0.020797	0.020797	28	1346
FM Radio	105.267	0.018030	0.018030	28	1553
FM Radio	90.643	0.016444	0.016444	28	1703
T-DAB	227.333	0.009343	0.011041	28	2536
TETRA	Not disclosed	0.003003	0.005201	28	5384
TETRA	Not disclosed	0.002887	0.005001	28	5599
TETRA	Not disclosed	0.002701	0.004678	28	5985
TETRA	Not disclosed	0.002585	0.004478	28	6253
TETRA	Not disclosed	0.002924	0.004135	28	6771
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	27491
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	29534
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	22612
TV PAL	535.333	0.020654	0.026174	31.8	1215
TV PAL	567.347	0.012560	0.015917	32.8	2058
TV PAL	583.680	0.011156	0.014137	33.2	2350
TV PAL	743.093	0.007006	0.008879	37.5	4221
TV DVB-T	738.520	0.003532	0.009290	37.4	4022
TV DVB-T	797.320	0.002275	0.005984	38.8	6488
GSM	945.533	0.733669	1.467337	42.3	29
GSM	938.533	0.101859	0.203718	42.1	207
GSM	949.617	0.048084	0.096168	42.4	441
GSM	948.333	0.017298	0.034596	42.3	1224
GSM	1833.250	1.704119	3.408239	58.9	17
GSM	1831.500	0.153638	0.307277	58.8	192
GSM	1845.250	0.042560	0.085120	59.1	694
UMTS FDD	2147.367	0.194984	1.260915	61	48
UMTS FDD	2133.833	0.021038	0.136046	61	448
UMTS FDD	2127.767	0.015136	0.097878	61	623
UMTS FDD	2113.300	0.004498	0.029086	61	2097
UMTS FDD	2117.267	0.004441	0.028720	61	2124
FWALA	3571.333	0.000956	0.002412	61	25292
FWALA	3724.400	0.000726	0.001832	61	33303
WiFi	5487.000	0.001744	0.006766	61	9016

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**	0.005054	1

3.2.11 Galway: Headford - Church 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]
TETRA	Not disclosed	0.005702	0.009876	28.0	2835
TV PAL	831.393	0.004775	0.006052	39.6	6552
GSM	953.000	0.923634	1.847268	42.4	23
GSM	948.567	0.032810	0.065619	42.3	645
GSM	938.650	0.006464	0.012928	42.1	3259

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**	0.001897	1

3.2.12 Galway: Kilcolgan

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	0.004406	0.004406	28	6356
TV PAL	831.947	0.007405	0.009383	39.7	4227
TV PAL	847.627	0.005070	0.006425	40.0	6231
TV DVB-T	692.787	0.001624	0.004271	36.2	8474
GSM	946.583	0.418794	0.837587	42.3	51
GSM	939.817	0.034514	0.069029	42.2	611
GSM	954.050	0.007798	0.015597	42.5	2723
WiFi	2473.202	0.011092	0.043036	61	1417

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**	0.000395	1

3.2.13 Galway: Tuam - Temple Jarlath Ct - Eircom

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	0.004524	0.004524	28	6190
FM Radio	96.793	0.008841	0.008841	28	3167
TETRA	Not disclosed	0.101042	0.175009	28	160
TETRA	Not disclosed	0.096828	0.167711	28	167
TV PAL	831.947	0.010186	0.012908	39.7	3072
TV PAL	847.627	0.009152	0.011597	40.0	3452
TV DVB-T	690.827	0.001517	0.003990	36.1	9057
GSM	940.400	0.381505	0.763010	42.2	55
GSM	952.883	0.210620	0.421240	42.4	101
GSM	946.467	0.051404	0.102809	42.3	411
GSM	938.067	0.041928	0.083855	42.1	502
GSM	954.983	0.038150	0.076301	42.5	557
GSM	1834.750	0.171791	0.343582	58.9	171
UMTS FDD	2112.600	0.114156	0.738220	61	83
UMTS FDD	2118.900	0.102920	0.665558	61	92
UMTS FDD	2152.967	0.079891	0.516637	61	118
UMTS FDD	2147.367	0.021577	0.139536	61	437
UMTS FDD	2166.267	0.020965	0.135577	61	450
FWALA	3515.000	0.007295	0.018401	61	3315
FWALA	3522.667	0.005489	0.013847	61	4405
FWALA	3519.000	0.001622	0.004091	61	14910
FWALA	3512.000	0.001545	0.003898	61	15649

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**	0.000896	1

3.2.14 Kerry: Caherciveen 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	0.004539	0.004539	28	6168
TETRA	Not disclosed	0.029992	0.051947	28	539
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	43
GSM	949.033	0.605341	1.210682	42.4	35
GSM	945.533	0.118577	0.237154	42.3	178
GSM	947.867	0.113240	0.226480	42.3	187
GSM	939.583	0.107399	0.214798	42.1	196
GSM	952.533	0.107399	0.214798	42.4	198
GSM	953.817	0.021355	0.042710	42.5	994
UMTS FDD	2147.367	0.081846	0.529280	61	115
UMTS FDD	2116.567	0.043803	0.283260	61	215
UMTS FDD	2114.233	0.042024	0.271760	61	224
UMTS FDD	2166.967	0.033729	0.218115	61	280

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**	0.001614	1

3.2.15 Kerry: Sneem - 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	0.004875	0.004875	28	5743
TETRA	Not disclosed	0.001912	0.002704	28	10355
GSM	945.767	0.768245	1.536491	42.3	28
GSM	955.683	0.692628	1.385256	42.5	31
GSM	946.817	0.344747	0.689493	42.3	61
GSM	954.050	0.208930	0.417859	42.5	102
GSM	939.817	0.014639	0.029277	42.2	1440
UMTS FDD	2148.767	0.076384	0.493953	61	123
UMTS FDD	2166.967	0.004903	0.031709	61	1924

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**	0.002811	1

3.2.16 Limerick: Hospital - Emly 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	0.004539	0.004539	28.0	6168
PMR	Not disclosed	0.004300	0.004300	28.0	6511
GSM	939.350	1.538155	3.076309	42.1	14
GSM	953.583	0.938642	1.877284	42.5	23
GSM	946.700	0.717794	1.435589	42.3	29
GSM	938.533	0.454465	0.908929	42.1	46
GSM	955.100	0.130317	0.260633	42.5	163
GSM	951.250	0.048641	0.097281	42.4	436
UMTS FDD	2148.300	0.075422	0.487737	61.0	125

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**	0.009007	1

3.2.17 Limerick: Knocklong

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	Not disclosed	Not disclosed	Not disclosed	369
GSM	949.150	0.195884	0.391769	42.4	108
GSM	954.400	0.183654	0.367308	42.5	116
GSM	955.333	0.089433	0.178867	42.5	238
UMTS FDD	2167.200	0.018260	0.118083	61	517

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**	0.000189	1

3.2.18 Mayo: Ballina - Teeling Street ESB

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	0.004426	0.004426	28.0	6326
PMR	Not disclosed	0.031550	0.031550	28.0	887
PMR	Not disclosed	0.029785	0.029785	28.0	940
PMR	Not disclosed	0.154170	0.154170	28.0	182
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	4758
GSM	937.833	0.417830	0.835661	42.1	50
GSM	953.817	0.394457	0.788915	42.5	54
GSM	940.750	0.110281	0.220562	42.2	191
GSM	938.767	0.075683	0.151367	42.1	278
GSM	1861.500	0.178649	0.357298	59.3	166
GSM	1856.750	0.136773	0.273546	59.2	217
GSM	1863.750	0.135207	0.270415	59.4	220
GSM	1855.500	0.130918	0.261836	59.2	226
GSM	1865.750	0.075858	0.151716	59.4	391
GSM	1836.500	0.023041	0.046082	58.9	1279
UMTS FDD	2146.200	0.088614	0.573041	61.0	106
UMTS FDD	2113.533	0.043954	0.284240	61.0	215
UMTS FDD	2166.500	0.033304	0.215370	61.0	283
WiFi	2438.132	0.014928	0.057921	61.0	1053
WiFi	2440.358	0.009183	0.035631	61.0	1712
WiFi	2415.308	0.008995	0.034901	61.0	1748
WiFi	2448.708	0.008433	0.032722	61.0	1864
FWALA	3518.667	0.001578	0.003980	61.0	15328
FWALA	3511.333	0.001308	0.003299	61.0	18492

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**	0.001041	1

3.2.19 Tipperary: Clonmel - Long Hill Broadcasting Site

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	0.004385	0.004385	28.0	6385
FM Radio	100.142	0.613056	0.613056	28.0	46
FM Radio	92.693	0.496592	0.496592	28.0	56
FM Radio	90.507	0.472607	0.472607	28.0	59
FM Radio	88.252	0.454465	0.454465	28.0	62
FM Radio	97.887	0.356862	0.356862	28.0	78
FM Radio	97.135	0.194760	0.194760	28.0	144
TV PAL	191.440	0.054200	0.068685	28.0	408
TV PAL	215.760	0.039446	0.049988	28.0	560
TETRA	Not disclosed	0.143219	0.248062	28.0	113
TETRA	Not disclosed	0.115345	0.199784	28.0	140
TV PAL	487.640	0.025119	0.031832	30.4	954
TV PAL	511.160	0.022182	0.028110	31.1	1106
TV PAL	647.707	0.016634	0.021080	35.0	1660
TV PAL	623.533	0.011337	0.014367	34.3	2390
TV PAL	703.240	0.016634	0.021080	36.5	1730
GSM	945.067	0.221055	0.442110	42.3	96
GSM	938.183	0.048641	0.097281	42.1	433
GSM	939.700	0.041352	0.082705	42.1	510
GSM	955.450	0.035975	0.071950	42.5	591
GSM	952.650	0.033612	0.067225	42.4	631
GSM	939.000	0.028379	0.056758	42.1	742
GSM	1856.250	0.135207	0.270415	59.2	219
GSM	1854.500	0.056494	0.112987	59.2	524
GSM	1832.250	0.017559	0.035118	58.9	1676
UMTS FDD	2145.967	0.137562	0.889581	61.0	69
UMTS FDD	2112.833	0.103992	0.672490	61.0	91
UMTS FDD	2116.567	0.098062	0.634141	61.0	96
WiFi	2453.997	0.008630	0.033484	61.0	1822
FWALA	3552.000	0.006792	0.017134	61.0	3560
FWALA	3544.667	0.003162	0.007977	61.0	7647
FWALA	3547.667	0.003151	0.007950	61.0	7673

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

3.2.20 Waterford: Tramore - Market St - Garda Station & Doneraile 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]
FM Radio	105.403	0.009829	0.009829	28	2849
TETRA	Not disclosed	0.158489	0.274512	28	102
TETRA	Not disclosed	0.143714	0.248920	28	112
GSM	946.233	0.524807	1.049615	42.3	40
GSM	952.650	0.189671	0.379341	42.4	112
GSM	953.817	0.065539	0.131078	42.5	324
GSM	951.367	0.028807	0.057614	42.4	736
GSM	1833.750	1.931968	3.863937	58.9	15
GSM	1854.500	0.439036	0.878072	59.2	67
GSM	1831.750	0.180717	0.361435	58.8	163
GSM	1841.000	0.078343	0.156686	59.0	377
UMTS FDD	2147.367	0.115744	0.748489	61	81
UMTS FDD	2166.733	0.051523	0.333185	61	183
UMTS FDD	2113.767	0.049488	0.320026	61	191
FWALA	3727.700	0.000724	0.001827	61	33379
WiFi	5486.150	0.001752	0.006797	61	8974

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**	0.005661	1

4. Conclusion

The conclusion of this report is that at all 20 licensed transmitter sites surveyed on behalf of ComReg during the period October – December 2009 as part of the 2009 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) $\approx 377\ \Omega$

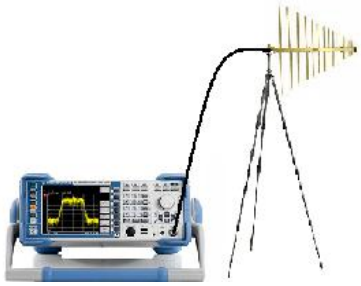
[17] Beyond a distance of $\lambda + 2D^2/\lambda$ where λ is the wavelength and D is the antenna's largest dimension

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.

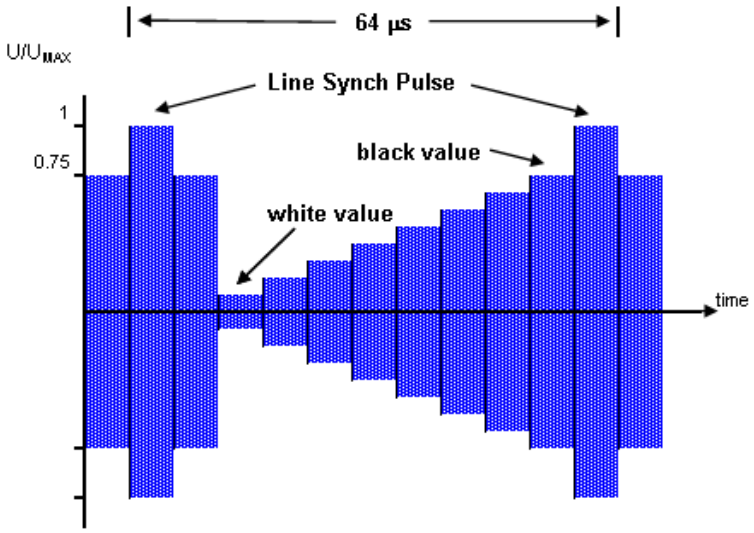


Figure 1: Luminance Signal in the Time Domain

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.