Commission for
Communications Regulation

Report

2008 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 and final set of site surveys (23 sites) undertaken during the 2008 programme.

The site surveys were conducted by engineers of Vilicom Engineering Ltd (20 sites) and ComReg (3 sites). Vilicom Engineering Ltd 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 fourth and final set of 23 sites chosen as part of the 2008 Programme of Measurement of Non-Ionising Radiation emissions. The site surveys were conducted by engineers of Vilicom Engineering Ltd (20 sites) and ComReg (3 sites). Vilicom Engineering Ltd 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.

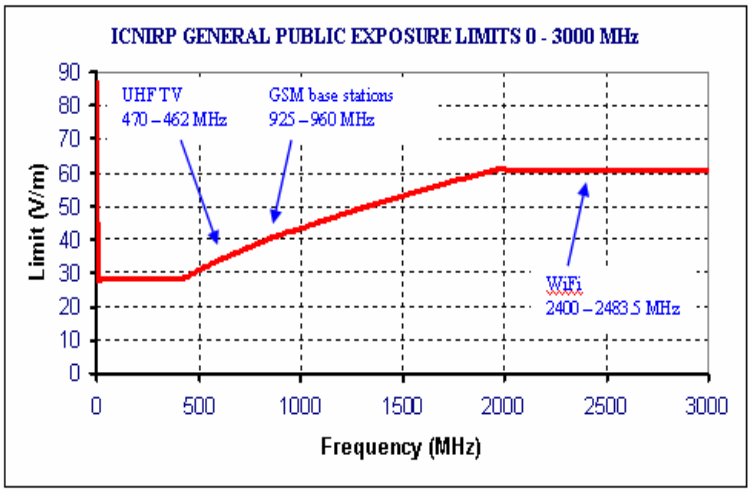
- to extrapolate to an estimate of the level under maximum traffic from the transmitter. For example, the base stations of mobile telephone networks produce emissions which vary according to the changing volume of calls or data traffic over the course of the day. The levels measured for the always-on 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 Carlow: Mount Leinster - Broadcasting Site

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004661	0.004661	28.0	6007
FM Radio	99.185	0.149279	0.149279	28.0	188
FM Radio	93.992	0.147062	0.147062	28.0	190
FM Radio	101.440	0.133968	0.133968	28.0	209
FM Radio	89.618	0.120226	0.120226	28.0	233
FM Radio	91.805	0.046935	0.046935	28.0	597
FM Radio	107.248	0.040318	0.040318	28.0	694
TV PAL	191.600	0.234153	0.296732	28.0	94
TV PAL	215.600	0.129271	0.163819	28.0	171
T-DAB	222.037	0.017398	0.020559	28.0	1362
TV PAL	486.987	0.169239	0.214469	30.3	141
TV PAL	511.160	0.107029	0.135633	31.1	229
TV DVB-T	668.120	0.011402	0.029991	35.5	1185
GSM 900	949.733	0.007736	0.015471	42.4	2739
GSM 900	940.167	0.005052	0.010105	42.2	4172
GSM 900	953.583	0.004920	0.009841	42.5	4315

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	0.000319	1

3.2.2 Clare: Bunratty Castle Hotel

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.005064	0.005064	28.0	5529
TV PAL	183.600	0.023227	0.029435	28.0	951
TV PAL	206.960	0.021355	0.027062	28.0	1035
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	4639
TV PAL	639.867	0.018535	0.023489	34.8	1481
TV PAL	664.040	0.017783	0.022535	35.4	1572
TV PAL	615.693	0.014355	0.018191	34.1	1876
TV PAL	695.400	0.013996	0.017736	36.3	2044
TV PAL	847.627	0.010580	0.013408	40.0	2986
TV PAL	831.947	0.010423	0.013209	39.7	3003
TV DVB-T	633.333	0.009311	0.024490	34.6	1413
TV DVB-T	659.467	0.007560	0.019884	35.3	1776
TV DVB-T	682.333	0.009047	0.023796	35.9	1509
TV DVB-T	712.387	0.006823	0.017947	36.7	2045
GSM 900	948.217	1.170847	2.341693	42.3	18
GSM 900	954.867	0.291743	0.583485	42.5	73
GSM 900	939.817	0.032434	0.064868	42.2	650
UMTS	2148.767	0.102565	0.663263	61.0	92
UMTS	2112.133	0.007816	0.050546	61.0	1207
FWALA	3514.500	0.000668	0.001684	61.0	36222

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	0.003374	1

3.2.3 Donegal: Letterkenny - Curragh Leas

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004640	0.004640	28.0	6035
PMR	Not disclosed	0.028249	0.028249	28.0	991
PMR	Not disclosed	0.103157	0.103157	28.0	271
TV PAL	486.987	0.011655	0.014769	30.3	2054
TV PAL	567.347	0.010728	0.013595	32.8	2409
TV PAL	767.267	0.007762	0.009837	38.1	3872
TV PAL	791.440	0.007439	0.009427	38.7	4103
GSM 900	946.700	1.243083	2.486165	42.3	17
GSM 900	938.533	0.716968	1.433937	42.1	29
GSM 900	953.000	0.422182	0.844365	42.4	50
UMTS	2148.767	0.131371	0.849544	61.0	72
UMTS	2113.300	0.077446	0.500825	61.0	122
WiFi	2470.140	0.032509	0.126134	61.0	484
WiFi	2438.410	0.001122	0.007379	61.0	8267
FWALA	3553.800	0.043202	0.108981	61.0	560
FWALA	3548.100	0.034395	0.086767	61.0	703
FWALA	3543.000	0.008740	0.022047	61.0	2767
FWA (Lic-exempt)	5801.000	0.000979	0.002471	61.0	24688
FWA (Lic-exempt)	5808.500	0.001000	0.002523	61.0	24181

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**	0.005294	1

3.2.4 Donegal: Lifford – Greyhound Stadium

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004710	0.004710	28.0	5945
FM Radio	90.917	0.012589	0.012589	28.0	2224
FM Radio	93.103	0.010423	0.010423	28.0	2686
PMR	Not disclosed	0.002894	0.002894	28.0	9675
PMR	Not disclosed	0.002780	0.002780	28.0	10073
T-DAB	225.680	0.006615	0.007816	28.0	3582
T-DAB	229.227	0.006295	0.007439	28.0	3764
TETRA	393.883	0.004222	0.007312	28.0	3829
TETRA	394.150	0.003408	0.005903	28.0	4743
TV PAL	486.987	0.048250	0.061145	30.3	496
TV PAL	535.333	0.045082	0.057130	31.8	557
TV PAL	511.160	0.043803	0.055509	31.1	560
TV PAL	567.347	0.023041	0.029199	32.8	1122
TV PAL	551.667	0.020821	0.026385	32.3	1224
TV PAL	632.027	0.020773	0.026325	34.6	1313
TV PAL	679.067	0.022310	0.028273	35.8	1267
TV PAL	711.080	0.017239	0.021846	36.7	1678
GSM 1800	1808.000	0.067143	0.134286	58.5	435
GSM 1800	1809.500	0.059498	0.118995	58.5	492
GSM 1800	1850.250	0.051464	0.102927	59.1	575
GSM 1800	1866.000	0.038815	0.077630	59.4	765
GSM 1800	1834.750	0.031915	0.063831	58.9	923
UMTS	2111.433	0.114025	0.737370	61.0	83
UMTS	2145.967	0.011628	0.075194	61.0	811
UMTS	2162.300	0.009089	0.058774	61.0	1038
UMTS	2166.967	0.009047	0.058504	61.0	1043

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	0.000179	1

3.2.5 Dublin 15: Huntstown

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004726	0.004726	28.0	5925
TETRA	Not disclosed	0.003112	0.005390	28.0	5195
TV PAL	743.747	0.004571	0.005792	37.5	6474
TV DVB-T	739.173	0.001849	0.004864	37.4	7686
TV DVB-T	792.747	0.001822	0.004792	38.7	8079
GSM 900	955.800	0.718621	1.437242	42.5	30
GSM 1800	1831.500	0.913061	1.826123	58.8	32
UMTS	2168.133	1.573983	10.178544	61.0	6
UMTS	2145.967	0.659933	4.267619	61.0	14
FWALA	3514.500	0.000663	0.001672	61.0	36473
FWALA	3743.000	0.001832	0.004622	61.0	13197
WiFi	5489.550	0.002861	0.011100	61.0	5495

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	0.034844	1

3.2.6 Galway: Dunmore – Telephone Exchange Barrack Sq

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004498	0.004498	28.0	6225
GSM 900	946.930	0.381505	0.763010	42.3	55
GSM 900	937.950	0.009539	0.019078	42.1	2207
GSM 900	957.317	0.005333	0.010667	42.5	3988
UMTS	2147.833	0.465586	3.010826	61.0	20

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	0.002762	1

3.2.7 Galway: Glenamaddy – Kikerrin Road

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004519	0.004519	28.0	6197
TV PAL	807.773	0.006630	0.008402	39.1	4651
TV PAL	783.600	0.006584	0.008344	38.5	4613
TV PAL	847.627	0.004797	0.006079	40.0	6585
TV PAL	831.947	0.004457	0.005648	39.7	7022
GSM 900	953.817	0.486407	0.972814	42.5	44

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	0.000525	1

3.2.8 Kerry: Farranfore – Telephone Exchange

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004721	0.004721	28.0	5931
FM Radio	107.248	0.007889	0.007889	28.0	3549
FM Radio	102.533	0.007674	0.007674	28.0	3649
GSM 900	946.000	1.515305	3.030610	42.3	14

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	0.005135	1

3.2.9 Kerry: Killarney – Quality Hotel Park Road

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004792	0.004792	28.0	5843
FM Radio	96.588	0.013335	0.013335	28.0	2100
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	6403
GSM 900	953.583	0.855067	1.710133	42.5	25
GSM 900	948.450	0.762079	1.524158	42.3	28
GSM 900	938.650	0.008913	0.017825	42.1	2363
GSM 1800	1839.750	0.009550	0.019100	59.0	3088
UMTS	1904.270	0.003593	0.023237	60.0	2582
UMTS	2166.500	0.549541	3.553740	61.0	17
UMTS	2147.600	0.156315	1.010847	61.0	60
UMTS	2114.000	0.042024	0.271760	61.0	224
FWALA	3598.800	0.000632	0.001595	61.0	38236

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	0.006607	1

3.2.10 Kildare: Naas Industrial Estate

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.0046480	0.0046480	28.00	6024
FM Radio	89.072	0.0118900	0.0118900	28.00	2355
FM Radio	91.327	0.0092420	0.0092420	28.00	3030
FM Radio	93.445	0.0101600	0.0101600	28.00	2756
FM Radio	98.707	0.0084920	0.0084920	28.00	3297
FM Radio	100.893	0.0103800	0.0103800	28.00	2697
TV PAL	183.147	0.0428000	0.0544250	28.00	514
TV PAL	207.787	0.0431400	0.0548574	28.00	510
PMR	458.893	0.0006764	0.0006764	29.45	43547
TV PAL	775.600	0.0693800	0.0882245	38.29	434
TV PAL	799.920	0.0773400	0.0983466	38.89	395
GSM 900	939.233	0.2356000	0.4712000	42.14	89
GSM 900	946.000	0.2938000	0.5876000	42.29	72
GSM 900	954.050	0.2962000	0.5924000	42.47	72
GSM 1800	1839.500	0.1360000	0.2720000	58.97	217
GSM 1800	1841.750	0.2540000	0.5080000	59.01	116
GSM 1800	1857.250	0.1229000	0.2458000	59.26	241
GSM 1800	1861.250	0.0640600	0.1281200	59.32	463
GSM 1800	1866.500	0.1717000	0.3434000	59.40	173
UMTS	2114.200	0.1081000	0.6990500	61.00	87
UMTS	2132.200	0.0459500	0.2971448	61.00	205
UMTS	2148.400	0.0904000	0.5845895	61.00	104
UMTS	2169.100	0.1075000	0.6951700	61.00	88

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	0.001060	1

3.2.11 Kilkenny: Glencoum - MMDS Site

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004803	0.004803	28.0	5830
FM Radio	99.185	0.040832	0.040832	28.0	686
FM Radio	99.992	0.039264	0.039264	28.0	713
FM Radio	101.440	0.036517	0.036517	28.0	767
FM Radio	89.550	0.024946	0.024946	28.0	1122
FM Radio	91.805	0.023605	0.023605	28.0	1186
TV PAL	191.440	0.110281	0.139754	28.0	200
TV PAL	215.600	0.090469	0.114647	28.0	244
TV PAL	487.640	0.192088	0.243424	30.4	125
TV PAL	511.160	0.169044	0.214222	31.1	145
TV DVB-T	666.253	0.009451	0.024860	35.5	1428
GSM 900	957.783	0.051168	0.102336	42.6	416
GSM 900	951.250	0.049091	0.098182	42.4	432
GSM 900	941.217	0.045394	0.090788	42.2	465
UMTS	2113.533	0.025882	0.167373	61.0	364
UMTS	2148.300	0.005254	0.033977	61.0	1795
MMDS PAL	2645.700	0.017498	0.022175	61.0	2751
FWALA	3521.700	0.001914	0.004829	61.0	12632

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	0.000185	1

3.2.12 Leitrim: Dromod

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.0055120	0.0055120	28.00	5080
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	2483
TV PAL	606.667	0.0088110	0.0112042	33.87	3023
TV PAL	623.333	0.0111100	0.0141276	34.33	2430
TV PAL	647.333	0.0106300	0.0135172	34.98	2588
TV PAL	670.640	0.0160200	0.0203712	35.61	1748
TV PAL	703.280	0.0129700	0.0164928	36.46	2211
TV PAL	847.920	0.0130300	0.0165691	40.04	2416
GSM 900	945.300	1.6350000	3.2700000	42.28	13
GSM 900	949.267	0.7153000	1.4306000	42.36	30
GSM 900	955.800	0.7496000	1.4992000	42.51	28

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	0.0083674	1

3.2.13 Limerick: Newcastle West – Shopping Centre Market Place

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004721	0.004721	28.0	5931
PMR	153.824	0.002874	0.002874	28.0	9742
PMR	152.997	0.002541	0.002541	28.0	11019
GSM 900	953.000	1.065369	2.130738	42.4	20
GSM 900	949.033	0.495450	0.990900	42.4	43
GSM 900	943.783	0.060884	0.121767	42.2	347
GSM 1800	1835.500	0.696627	1.393253	58.9	42
UMTS	2149.000	0.432514	2.796956	61.0	22
UMTS	2167.200	0.318053	2.056770	61.0	30
UMTS	2112.833	0.064195	0.415131	61.0	147
WiFi	2413.360	0.005991	0.023245	61.0	2624
FWALA	3511.800	0.000594	0.001497	61.0	40736
FWALA	3739.700	0.002979	0.014200	61.0	4296
WiFi	5483.600	0.001581	0.006135	61.0	9943

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	0.006921	1

3.2.14 Limerick City: Plassey Park Road

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004983	0.004983	28.0	5619
FM Radio	103.012	0.009194	0.009194	28.0	3045
T-DAB	227.733	0.008770	0.010363	28.0	2702
TV PAL	639.867	0.007228	0.009159	34.8	3797
TV PAL	694.747	0.006194	0.007850	36.2	4617
TV DVB-T	632.027	0.006599	0.017358	34.6	1991
TV DVB-T	660.773	0.005761	0.015153	35.3	2333
TV DVB-T	684.293	0.006081	0.015995	36.0	2249
TV DVB-T	714.347	0.005591	0.014706	36.7	2499
GSM 900	953.817	2.368645	4.737290	42.5	9
GSM 900	944.717	0.180302	0.360604	42.3	117
GSM 900	949.267	0.016692	0.033383	42.4	1269
GSM 1800	1855.750	0.797995	1.595989	59.2	37
GSM 1800	1839.500	0.143549	0.287098	59.0	205
GSM 1800	1862.500	0.060256	0.120512	59.3	492
UMTS	1907.800	0.011967	0.077390	60.1	776
UMTS	2111.200	0.067764	0.438213	61.0	139
UMTS	2148.300	0.053272	0.344497	61.0	177
UMTS	2167.200	0.045604	0.294907	61.0	207
FWALA	3522.400	0.000505	0.001275	61.0	47860
FWALA	3763.400	0.003540	0.008930	61.0	6831

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	0.013382	1

3.2.15 Longford: Newtown Forbes

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.0049310	0.0049310	28	5678
FM Radio	89.755	0.0099520	0.0099520	28	2814
FM Radio	103.148	0.0189100	0.0189100	28	1481
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	35593
TV PAL	623.333	0.0131400	0.0167090	34.33	2055
TV PAL	648.000	0.0329000	0.0418361	35.00	837
TV PAL	671.280	0.0343800	0.0437181	35.62	815
TV PAL	703.280	0.0265100	0.0337105	36.46	1082
GSM 900	946.583	1.7420000	3.4840000	42.30	12
GSM 900	955.916	0.0167200	0.0334400	42.51	1271
UMTS	2168.200	0.0095280	0.0616147	61.00	990
WiFi	2443.698	0.0076570	0.0297093	61.00	2053
FWALA	3787.433	0.0035727	0.0090127	61.00	6768

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	0.006790	1

3.2.16 Mayo: Ballyhaunis

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004539	0.004539	28.0	6168
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	4032
TV PAL	783.600	0.004350	0.005513	38.5	6982
GSM 900	953.700	0.557828	1.115655	42.5	38
GSM 900	947.050	0.302691	0.605383	42.3	70
GSM 900	943.550	0.052360	0.104720	42.2	403
UMTS	2166.267	0.234963	1.519447	61.0	40
UMTS	2147.367	0.096716	0.625440	61.0	98
UMTS	2113.533	0.061447	0.397361	61.0	154
WiFi	2443.977	0.005604	0.021744	61.0	2805

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	0.001669	1

3.2.17 Monaghan: Ballybay – Church Avenue

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004618	0.004618	28.0	6063
TV PAL	719.573	0.021953	0.027820	36.9	1326
TV PAL	831.947	0.014757	0.018701	39.7	2121
TV PAL	751.687	0.010328	0.013088	37.7	2880
GSM 900	945.183	2.529298	5.058596	42.3	8
UMTS	2148.533	0.007362	0.047609	61.0	1281
UMTS	2166.500	0.005814	0.037600	61.0	1622

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	0.014322	1

3.2.18 Offaly: Moneygall – Garda Station

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004770	0.004770	28.0	5870
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	7843
TV PAL	831.947	0.007595	0.009624	39.7	4121
TV PAL	847.627	0.007499	0.009503	40.0	4213
GSM 900	953.467	0.223100	0.446200	42.5	95
GSM 900	950.433	0.095280	0.190559	42.4	222
GSM 900	938.067	0.039857	0.079713	42.1	528
UMTS	2111.433	0.019634	0.126965	61.0	480
UMTS	2146.667	0.013788	0.089163	61.0	684
UMTS	2168.600	0.004721	0.030527	61.0	1998
MMDS PAL	2629.580	0.027353	0.034663	61.0	1760
MMDS PAL	2645.700	0.001122	0.032201	61.0	1894

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	0.000142	1

3.2.19 Sligo: Ballymote – Telephone Exchange

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004915	0.004915	28.0	5697
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	506
GSM 900	947.750	0.188799	0.377598	42.3	112
GSM 900	956.850	0.023686	0.047373	42.5	898
GSM 900	940.283	0.005278	0.010557	42.2	3994
UMTS	2148.767	0.284774	1.841559	61.0	33

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	0.000996	1

3.2.20 Tipperary: Roscrea – ESB Ayr Hill

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.005146	0.005146	28.0	5441
PMR	Not disclosed	0.037844	0.037844	28.0	740
TV PAL	831.947	0.008414	0.010663	39.7	3720
TV PAL	847.627	0.006516	0.008258	40.0	4848
GSM 900	948.800	0.519398	1.038795	42.4	41
GSM 900	954.983	0.377138	0.754275	42.5	56
GSM 900	937.833	0.233884	0.467767	42.1	90
GSM 1800	1844.000	0.255270	0.510540	59.0	116
UMTS FDD	2148.767	0.576766	3.729801	61.0	16
UMTS FDD	2167.900	0.167494	1.083143	61.0	56
UMTS FDD	2113.533	0.153638	0.993541	61.0	61

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	0.005436	1

3.2.21 Waterford City: Waterford Garda Station

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.005715	0.005715	28.0	4900
FM Radio	107.453	0.190985	0.190985	28.0	147
FM Radio	102.807	0.018344	0.018344	28.0	1526
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	800
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	808
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	10190
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	65
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	429
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	3762
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	1843
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	18191
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	16365
TV PAL	727.413	0.009204	0.011664	37.1	3179
TV PAL	807.773	0.006902	0.008747	39.1	4468
GSM 900	939.583	1.627421	3.254843	42.1	13
GSM 900	953.000	0.781628	1.563256	42.4	27
GSM 900	947.050	0.136144	0.272289	42.3	155
GSM 1800	1856.500	0.746449	1.492898	59.2	40
GSM 1800	1832.250	0.173780	0.347560	58.9	169
UMTS	2111.433	0.844306	5.459912	61.0	11
UMTS	2148.767	0.217520	1.406649	61.0	43
UMTS	2166.033	0.091201	0.589774	61.0	103
MMDS DVB-T	2559.520	0.009931	0.026121	61.0	2335
MMDS DVB-T	2626.480	0.001122	0.025852	61.0	2360
FWALA	3566.700	0.016827	0.042448	61.0	1437
FWALA	3531.600	0.001122	0.041196	61.0	1481
FWALA	3559.200	0.001122	0.032535	61.0	1875
FWALA	3522.300	0.001122	0.007428	61.0	8213
FWALA	3749.000	0.000685	0.001727	61.0	35316
FWALA	3739.700	0.001122	0.001557	61.0	39172
FWA (Lic-exempt)	5840.500	0.057610	0.145329	61.0	420
FWA (Lic-exempt)	5828.000	0.001122	0.025993	61.0	2347

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	0.016966	1

3.2.22 Wexford: Duncannon Garda Station

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004808	0.004808	28.0	5823
TV PAL	856.120	0.024016	0.030434	40.2	1322
TV PAL	824.107	0.019476	0.024681	39.5	1599
TV PAL	743.093	0.013505	0.017115	37.5	2190
TV PAL	687.560	0.008337	0.010565	36.1	3413
GSM 900	940.983	0.898463	1.796925	42.2	23
GSM 900	953.817	0.650130	1.300259	42.5	33
GSM 900	948.217	0.048641	0.097281	42.3	435
UMTS	2146.900	0.149108	0.964241	61.0	63
UMTS	2111.900	0.015776	0.102020	61.0	598
FWALA	3525.600	0.000587	0.001480	61.0	41208

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	0.003012	1

3.2.23 Wexford: Forth Mountain

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.004688	0.004688	28.0	5973
PMR	Not disclosed	0.164627	0.164627	28.0	170
PMR	Not disclosed	0.161065	0.161065	28.0	174
FM Radio	96.383	1.704119	1.704119	28.0	16
FM Radio	103.148	1.665329	1.665329	28.0	17
PMR	162.017	0.003354	0.003354	28.0	8349
TV PAL	191.600	0.034874	0.044194	28.0	634
TV PAL	515.500	0.029546	0.037442	31.2	834
TV PAL	486.987	0.064938	0.082293	30.3	369
TV PAL	511.160	0.057280	0.072588	31.1	428
TV PAL	727.027	0.010471	0.013270	37.1	2794
TV PAL	759.533	0.009484	0.012019	37.9	3153
TV DVB-T	668.373	0.006910	0.018176	35.5	1956
TV DVB-T	827.373	0.002535	0.006668	39.6	5931
GSM 900	958.133	0.363078	0.726156	42.6	59
GSM 900	946.350	0.310099	0.620197	42.3	68
GSM 900	941.100	0.211592	0.423185	42.2	100
GSM 1800	1839.500	0.120226	0.240453	59.0	245
UMTS	2112.133	0.144046	0.931506	61.0	65
UMTS	2146.200	0.072527	0.469014	61.0	130
UMTS	2166.733	0.005957	0.038520	61.0	1584
MMDS PAL	2629.580	0.067999	0.086172	61.0	708
MMDS PAL	2677.940	0.001122	0.084989	61.0	718
MMDS DVB-T	2615.320	0.018323	0.048194	61.0	1266
MMDS DVB-T	2655.000	0.001122	0.046881	61.0	1301
MMDS DVB-T	2598.580	0.001122	0.038725	61.0	1575
FWALA	3525.900	0.042073	0.106134	61.0	575
FWALA	3514.200	0.001122	0.037485	61.0	1627
FWALA	3518.700	0.001122	0.033216	61.0	1836
FWALA	3736.100	0.042658	0.107610	61.0	567
FWALA	3742.100	0.001122	0.080048	61.0	762
FWALA	3748.100	0.001122	0.006673	61.0	9141
FWA (Lic-exempt)	5732.500	0.003304	0.011786	61.0	5176

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	0.008257	1

4. Conclusion

The conclusion of this report is that at all of the 23 licensed transmitter sites, comprising the fourth and final set of sites surveyed under ComReg's 2008 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) $\approx 377\ \Omega$

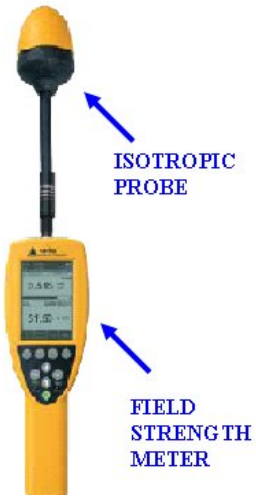
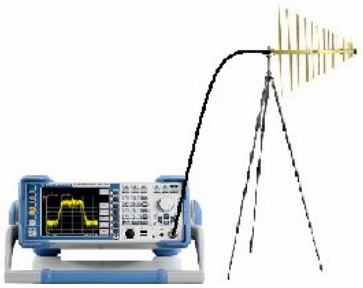
[17] Beyond a distance of $\lambda + 2D^2/\lambda$ where λ is the wavelength and D is the antenna's largest dimension

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.

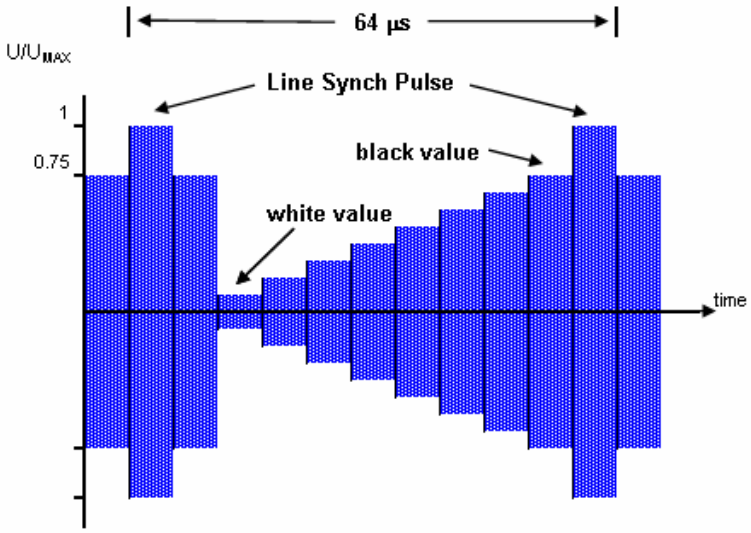


Figure 1: Luminance Signal in the Time Domain

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.