



Commission for
Communications Regulation

Report

2008 Programme of Measurement of Non-Ionising Radiation Emissions

Third Interim Report

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1. Executive Summary

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

This report forms part of an ongoing series of interim reports which outline ComReg's programme of measurements and presents the results of the third set of 16 site surveys undertaken in 2008.

ComReg arranged for NIR measurements to be conducted at the 16 sites during September and early October 2008. The site surveys were conducted by engineers of Vilicom Engineering Ltd (15 sites) and Compliance Engineering Ireland Ltd (1 site - Ratoath). Both companies were 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 16 sites were below the relevant ICNIRP guideline limits for general public exposure¹. 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 licences² issued by ComReg that licensees must ensure that non-ionising radiation³ (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 third set of 16 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 (15 sites) and Compliance Engineering Ireland Ltd (1 site - Ratoath). Both companies were 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 3×10^{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 website⁵ as well as on Siteviewer⁶, 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 emissions⁷ 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 analyser⁹. 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).

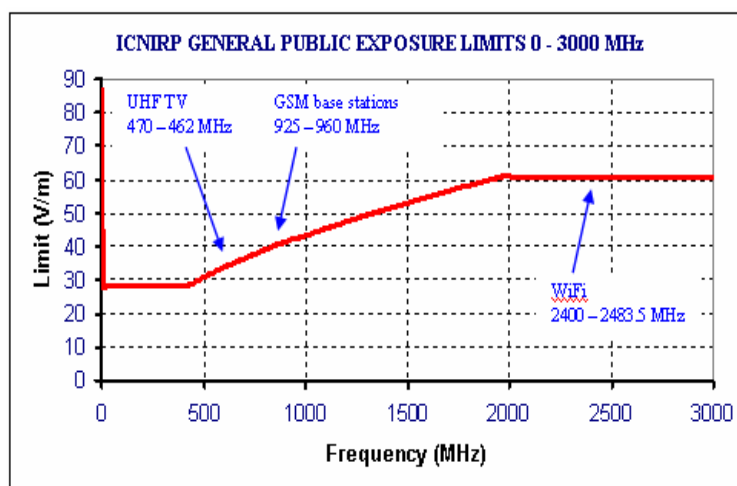
using a correction factor in order to account for the energy present within the full 7.6 MHz bandwidth of the signal.

- 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 to 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 Cork City: Dennehy's Cross – Magazine 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	0.0002296	0.0002296	28	121943
PMR	Not disclosed	0.0045090	0.0045090	28	6210
FM Radio	106.08	0.0439000	0.0439000	28	638
FM Radio	98.38	0.0400300	0.0400300	28	699
PMR	153.42	0.0122800	0.0122800	28	2280
PMR	Not disclosed	0.0076680	0.0076680	28	3652
T-DAB	227.15	0.0191300	0.0191300	28	1464
TV UHF	807.25	0.0484000	0.0371403	39.07	1052
GSM 900	954.24	1.1370000	2.2740000	42.47	19
GSM 900	945.78	0.0467700	0.0935400	42.29	452
GSM 1800	1832.17	0.2155000	0.4310000	58.86	137
GSM 1800	1854.41	0.0300000	0.0600000	59.21	987
UMTS	2129.55	0.4687000	1.4821595	61	41
UMTS	2167.22	0.2229000	0.7048717	61	87
UMTS	2112.47	0.1622000	0.5129214	61	119
UMTS	2147.49	0.0790900	0.2501045	61	244

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	0.00374	1

3.2.2 Cork City: North Monastery 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	75.93	0.0034300	0.0034300	28.00	8163
FM Radio	89.70	0.0161700	0.0161700	28.00	1732
FM Radio	91.97	0.0147500	0.0147500	29.00	1966
PMR	141.93	0.0023130	0.0023130	28.00	12105
PMR	164.74	0.0102800	0.0102800	28.00	2724
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	6040
TV PAL	647.25	0.0563100	0.0432101	34.98	810
TV PAL	615.27	0.0466900	0.0358281	34.11	952
TV PAL	671.20	0.0418500	0.0321141	35.62	1109
TV PAL	695.25	0.0317200	0.0243407	36.26	1489
GSM 900	952.59	3.9810000	7.9620000	42.44	5
GSM 900	940.20	0.0489800	0.0979600	42.16	430
GSM 1800	1857.03	0.0604300	0.1208600	59.25	490
GSM 1800	1839.84	0.0255000	0.0510000	58.98	1156
UMTS	2167.43	0.3679000	1.1634020	61.00	52
UMTS	2147.13	0.0779200	0.2464047	61.00	248
UMTS	2113.14	0.0367400	0.1161821	61.00	525
UMTS	2128.26	0.0137400	0.0434497	61.00	1404
FWALA	3545.5	0.0006607	0.0016667	61.00	36600
FWALA	3791.9	0.0008433	0.0021274	61.00	28673

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	0.035598	1

3.2.3 Cork City: Summer Hill North

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIR Limit (V/m)	Times below limit (of Adjusted Level)
PMR	75.93	0.0036610	0.0036610	28.00	7648
FM Radio	93.57	0.0086790	0.0086790	28.00	3226
FM Radio	89.20	0.0081440	0.0081440	28.00	3438
PMR	153.00	0.0045230	0.0045230	28.00	6191
PMR	Not disclosed	0.0103500	0.0103500	28.00	2705
T-DAB	226.67	0.0204700	0.0204700	28.00	1368
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	126
TV PAL	646.84	0.0163000	0.0125080	34.97	2796
TV PAL	806.71	0.0152400	0.0116946	39.05	3339
GSM 900	954.86	0.4064000	0.8128000	42.49	52
GSM 900	955.84	0.3559000	0.7118000	42.51	60
GSM 900	938.88	0.0076220	0.0152440	42.13	2764
GSM 1800	1855.39	0.4102000	0.8204000	59.23	72
GSM 1800	1865.37	0.1708000	0.3416000	59.39	174
GSM 1800	1844.18	0.0670300	0.1340600	59.05	440
UMTS	2167.41	0.1527000	0.4828798	61.00	126
UMTS	2127.89	0.1366000	0.4319671	61.00	141
UMTS	2112.55	0.1292000	0.4085663	61.00	149
FWALA	3579.9	0.0022909	0.005779	61.00	10555

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	0.001098	1

3.2.4 Cork City: Toghher Road

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIR Limit (V/m)	Times below limit (of Adjusted Level)
PMR	Not disclosed	0.0002704	0.0002704	28.00	103552
PMR	79.13	0.0035170	0.0035170	28.00	7961
FM Radio	96.36	0.0406500	0.0406500	28.00	689
FM Radio	89.20	0.0345600	0.0345600	29.00	839
PMR	153.42	0.0040960	0.0040960	28.00	6836
PMR	Not disclosed	0.0057040	0.0057040	28.00	4909
TETRA	Not disclosed	0.0017240	0.0029861	28.00	9377
PMR	458.81	0.0018080	0.0018080	29.45	16290
TV PAL	727.26	0.0169100	0.0129761	37.08	2858
GSM 900	952.77	2.6430000	5.2860000	42.44	8
GSM 900	940.95	2.2300000	4.4600000	42.18	9
GSM 900	950.57	0.2338000	0.4676000	42.39	91
GSM 1800	1866.43	0.5808000	1.1616000	59.40	51
GSM 1800	1844.16	0.2076000	0.4152000	59.05	142
GSM 1800	1854.80	0.0208600	0.0417200	59.22	1419
UMTS	2167.34	0.4115000	1.3012773	61.00	47
UMTS	2129.40	0.3507000	1.1090108	61.00	55
UMTS	2112.42	0.2539000	0.8029023	61.00	76
UMTS	2147.21	0.1360000	0.4300698	61.00	142
FWALA	3580.5	0.0007439	0.0018765	61.00	32507
FWALA	3775.1	0.0149624	0.0377444	61.00	1616
FWALA	3764.3	0.0117085	0.0295361	61.00	2065
FWALA	3782.3	0.0079891	0.0201536	61.00	3027
FWALA	3791.9	0.0081846	0.0206468	61.00	2954

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	0.028260	1

3.2.5 Cork: Middleton - 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	79.13	0.0036760	0.0036760	28.00	7617
FM Radio	88.73	0.0053500	0.0053500	28.00	5234
PMR	138.73	0.0023770	0.0023770	28.00	11780
PMR	157.53	0.0021510	0.0021510	28.00	13017
TETRA	397.13	0.0018920	0.0032770	28.00	8544
PMR	459.93	0.0018960	0.0018960	29.49	15553
GSM 900	957.42	0.3403000	0.6806000	42.55	63
GSM 900	947.61	0.0162200	0.0324400	42.33	1305
GSM 1800	1855.00	1.0830000	2.1660000	59.22	27
GSM 1800	1839.41	0.0173400	0.0346800	58.97	1700
UMTS	2167.25	0.3062000	0.9682894	61.00	63
UMTS	2147.29	0.2347000	0.7421866	61.00	82
UMTS	2112.54	0.0100300	0.0317176	61.00	1923

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	0.001995	1

3.2.6 Cork: Youghal – Windmill 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	0.0053518	0.0053518	28.00	5232
PMR	69.29	0.0007508	0.0007508	28.00	37296
PMR	75.93	0.0037170	0.0037170	28.00	7533
FM Radio	96.76	0.0064600	0.0064600	28.00	4334
FM Radio	103.98	0.0064220	0.0064220	28.00	4360
PMR	144.33	0.0022810	0.0022810	28.00	12275
PMR	157.53	0.0023350	0.0023350	28.00	11991
TV PAL	631.39	0.0176000	0.0135056	34.55	2558
GSM 900	949.99	0.6220000	1.2440000	42.38	34
GSM 900	940.60	0.5505000	1.1010000	42.17	38
GSM 900	955.86	0.0509900	0.1019800	42.51	417
GSM 1800	1833.39	0.0529300	0.1058600	58.87	556
GSM 1800	1854.36	0.0326200	0.0652400	59.21	908
UMTS	2112.67	0.8772000	2.7739500	61.00	22
UMTS	2146.98	0.0563600	0.1782260	61.00	342
UMTS	2167.07	0.0113100	0.0357654	61.00	1706

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	0.003631	1

3.2.7 Dublin 7: North Circular Road – Park House

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	75.53	0.0035400	0.0035400	28.00	7910
FM Radio	104.38	0.0075980	0.0075980	28.00	3685
FM Radio	98.08	0.0068690	0.0068690	28.00	4076
PMR	137.73	0.0021870	0.0021870	28.00	12803
PMR	171.51	0.0398600	0.0398600	28.00	702
TV PAL	188.95	0.0247000	0.0189538	28.00	1477
TETRA	Not disclosed	0.0089270	0.0154620	28.00	1811
TETRA	Not disclosed	0.0079050	0.0136919	28.00	2045
TETRA	Not disclosed	0.0078390	0.0135775	28.00	2062
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	7533
GSM 900	954.40	0.7070000	1.4140000	42.48	30
GSM 900	938.61	0.3269000	0.6538000	42.13	64
GSM 900	947.33	0.0306300	0.0612600	42.32	691
GSM 1800	1854.79	0.7883000	1.5766000	59.22	38
GSM 1800	1834.58	0.2608000	0.5216000	58.89	113
GSM 1800	1864.95	0.2523000	0.5046000	59.38	118
UMTS	2126.96	0.0691900	0.2187980	61.00	279
UMTS	2147.31	0.0117100	0.0370303	61.00	1647
UMTS	2112.65	0.0094850	0.0299942	61.00	2034
FWALA	3594.6	0.2828134	1.0089454	61.00	60
FWALA	3549.6	0.0335351	0.0845966	61.00	721
FWALA	3749	0.0019165	0.0048345	61.00	12618
WiFi	5543.1	0.0023308	0.0090434	61.00	6745

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	0.002503	1

3.2.8 Dublin 8: Heuston 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	72.22	0.0006615	0.0006615	28.00	42328
PMR	85.58	0.0062080	0.0062080	28.00	4510
FM Radio	91.30	0.0107600	0.0107600	28.00	2602
FM Radio	89.10	0.0105000	0.0105000	28.00	2667
PMR	137.73	0.0022630	0.0022630	28.00	12373
PMR	157.53	0.0020650	0.0020650	28.00	13559
TV PAL	183.16	0.0285400	0.0219005	28.00	1279
T-DAB	223.84	0.0095040	0.0095040	28.00	2946
TETRA	Not disclosed	0.0132800	0.0230016	28.00	1217
TETRA	Not disclosed	0.0103000	0.0178401	28.00	1569
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	557
PMR	451.68	0.0237900	0.0237900	29.22	1228
TV UHF	736.87	0.0191900	0.0147257	37.32	2534
GSM 900	940.98	1.9190000	3.8380000	42.18	11
GSM 900	952.60	0.0887500	0.1775000	42.44	239
GSM 900	949.93	0.0149400	0.0298800	42.38	1418
GSM 1800	1862.58	0.1601000	0.3202000	59.34	185
GSM 1800	1855.57	0.0714900	0.1429800	59.23	414
GSM 1800	1839.18	0.0234000	0.0468000	58.97	1260
UMTS	2167.30	0.1158000	0.3661918	61.00	167
UMTS	2147.56	0.0228000	0.0720999	61.00	846
UMTS	2112.85	0.0155700	0.0492367	61.00	1239
FWALA	3589.8	0.0220546	0.0786806	61.00	775
FWALA	3543.9	0.0021038	0.005307	61.00	11494
FWALA	3568.8	0.0014962	0.0037744	61.00	16162
FWALA	3743	0.0007023	0.0017715	61.00	34434

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	0.008379	1

3.2.9 Dublin 12: Crumlin Cross - Ashleaf Shopping Centre

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	75.53	0.0035000	0.0035000	28.00	8000
FM Radio	104.37	0.0104400	0.0104400	28.00	2682
FM Radio	98.68	0.0102000	0.0102000	28.00	2745
PMR	138.73	0.0022770	0.0022770	28.00	12297
PMR	172.92	0.0062990	0.0062990	28.00	4445
TV PAL	182.95	0.0552900	0.0424274	28.00	660
TV PAL	207.19	0.0473600	0.0363422	28.00	770
T-DAB	223.92	0.0094700	0.0094700	28.00	2957
T-DAB	227.17	0.0094390	0.0094390	28.00	2966
TETRA	Not disclosed	0.0022820	0.0039525	28.00	7084
PMR	462.78	0.0024720	0.0024720	29.58	11966
TV PAL	535.10	0.0131800	0.0101138	31.81	3145
TV PAL	742.49	0.0131600	0.0100985	37.47	3710
GSM 900	940.42	1.8740000	3.7480000	42.17	11
GSM 900	953.19	0.5154000	1.0308000	42.45	41
GSM 900	949.17	0.3094000	0.6188000	42.36	68
GSM 1800	1864.97	0.4755000	0.9510000	59.38	62
GSM 1800	1831.39	0.2278000	0.4556000	58.84	129
UMTS	2112.29	0.1299000	0.4107799	61.00	148
UMTS	2147.12	0.1106000	0.3497479	61.00	174
FWALA	3577.5	0.6095369	1.537633	61.00	40
FWALA	3755.3	0.0088818	0.0224054	61.00	2723
FWALA	3746	0.0084528	0.0084528	61.00	7217
WiFi	5498.9	0.0015996	0.0071534	61.00	8527

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	0.009739	1

3.2.10 Dublin 13: Sutton Cross

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	75.93	0.0036940	0.0036940	28.00	7580
PMR	138.73	0.0022970	0.0022970	28.00	12190
PMR	157.53	0.0022070	0.0022070	28.00	12687
TETRA	Not disclosed	0.0047410	0.0082117	28.00	3410
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	8499
GSM 900	954.42	1.7410000	3.4820000	42.48	12
GSM 900	946.19	0.0506300	0.1012600	42.30	418
GSM 900	939.84	0.0128900	0.0257800	42.15	1635
GSM 1800	1843.78	0.5594000	1.1188000	59.04	53
GSM 1800	1863.57	0.0501000	0.1002000	59.36	592
UMTS	2147.25	0.2630000	0.8316790	61.00	73
FWALA	3561	0.0006273	0.0015825	61.00	38547
FWALA	3755	0.0060744	0.0216704	61.00	2815
FWALA	3777.2	0.0012431	0.0031358	61.00	19453

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	0.007273	1

3.2.11 Dublin 18: Cabinteely 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	81.86	0.0040350	0.0040350	28.00	6939
FM Radio	104.37	0.0183500	0.0183500	28.00	1526
FM Radio	105.97	0.0170400	0.0170400	28.00	1643
PMR	138.73	0.0024780	0.0024780	28.00	11299
PMR	Not disclosed	0.0594800	0.0594800	28.00	471
TETRA	Not disclosed	0.0017480	0.0030276	28.00	9248
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	17916
TV PAL	567.17	0.0183200	0.0140581	32.75	2329
TV PAL	743.02	0.0162000	0.0124313	37.48	3015
GSM 900	952.98	1.9820000	3.9640000	42.45	11
GSM 900	941.02	1.0480000	2.0960000	42.18	20
GSM 900	949.16	0.5231000	1.0462000	42.36	40
GSM 1800	1857.80	0.6308000	1.2616000	59.27	47
GSM 1800	1833.22	0.0150700	0.0301400	58.87	1953
UMTS	2129.57	0.4845000	1.5321235	61.00	40
UMTS	2167.25	0.2251000	0.7118287	61.00	86
UMTS	2147.03	0.0414600	0.1311080	61.00	465
FWALA	3546.60	0.0007112	0.0017941	61.00	34000
FWALA	3764.00	0.0040133	0.0101240	61.00	6025

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	0.013032	1

3.2.12 Dublin 22: Naas Road - Red Cow 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	72.87	0.0001244	0.0001244	28.00	224987
PMR	75.93	0.0037010	0.0037010	28.00	7566
FM Radio	104.37	0.0199500	0.0199500	28.00	1404
FM Radio	89.10	0.0188400	0.0188400	28.00	1486
PMR	138.73	0.0022580	0.0022580	28.00	12400
PMR	166.74	0.0019290	0.0019290	28.00	14515
TV VHF	206.97	0.0429300	0.0329428	28.00	850
TV VHF	183.10	0.0419600	0.0321985	28.00	870
T-DAB	227.19	0.0094910	0.0094910	28.00	2950
TETRA	399.75	0.0449400	0.0635548	28.00	441
TETRA	Not disclosed	0.0099330	0.0172045	28.00	1627
PMR	456.74	0.0151000	0.0151000	29.39	1946
TV UHF	736.88	0.0632400	0.0485279	37.33	769
TV UHF	567.31	0.0367700	0.0282159	32.75	1161
TV UHF	534.89	0.0231300	0.0177491	31.80	1792
TV UHF	582.82	0.0229800	0.0176340	33.19	1882
GSM 900	940.21	2.3160000	4.6320000	42.16	9
GSM 900	954.21	1.5300000	3.0600000	42.47	14
GSM 900	951.76	0.0973500	0.1947000	42.42	218
GSM 1800	1863.60	0.6140000	1.2280000	59.36	48
GSM 1800	1855.19	0.6056000	1.2112000	59.22	49
GSM 1800	1836.78	0.0890300	0.1780600	58.93	331
UMTS	2112.21	0.2098000	0.6634459	61.00	92
UMTS	2167.52	0.1987000	0.6283446	61.00	97
UMTS	2147.23	0.0417700	0.1320883	61.00	462
FWALA	3563.7	0.0067608	0.0241195	61.00	2529
FWALA	3596.7	0.0040041	0.0101007	61.00	6039
FWALA	3542.7	0.0028807	0.007267	61.00	8394
FWALA	3767.9	0.0044926	0.0160276	61.00	3806
FWALA	3760.1	0.0043152	0.0108856	61.00	5604
FWALA	3751.7	0.0032285	0.0081443	61.00	7490
FWALA	3743.9	0.002894	0.0073005	61.00	8356
FWALA	3735.5	0.0020091	0.0050682	61.00	12036
FWALA	10178.38	0.0022751	0.0081165	61.00	7516

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	0.018381	1

3.2.13 Dublin: Lusk – Main Street

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	75.93	0.0037160	0.0037160	28.00	7535
FM Radio	88.73	0.0053840	0.0053840	28.00	5201
PMR	138.73	0.0023590	0.0023590	28.00	11869
PMR	157.53	0.0021000	0.0021000	28.00	13333
TETRA	397.13	0.0018790	0.0032545	28.00	8603
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	16027
GSM 900	940.22	1.0890000	2.1780000	42.16	19
GSM 900	950.78	0.0328400	0.0656800	42.40	646
GSM 900	953.41	0.0107400	0.0214800	42.46	1977
GSM 1800	1858.23	0.0046350	0.0092700	59.27	6394
UMTS	2112.76	0.1726000	0.5458091	61.00	112
UMTS	2147.10	0.0101200	0.0320022	61.00	1906

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	0.002752	1

3.2.14 Louth: Drogheda - West Street

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
PMR	76.06	0.0145400	0.0145400	28.00	1926
PMR	76.81	0.0141900	0.0141900	28.00	1973
PMR	138.73	0.0022720	0.0022720	28.00	12324
PMR	157.53	0.0020280	0.0020280	28.00	13807
TV PAL	185.39	0.0194600	0.0149329	28.00	1875
TETRA	Not disclosed	0.0016870	0.0029220	28.00	9583
PMR	458.92	0.0021180	0.0021180	29.46	13907
GSM 900	951.56	3.5470000	7.0940000	42.42	6
GSM 900	938.01	0.4164000	0.8328000	42.11	51
GSM 900	959.60	0.3640000	0.7280000	42.59	59
GSM 1800	1839.36	0.4771000	0.9542000	58.97	62
GSM 1800	1856.19	0.3188000	0.6376000	59.24	93
UMTS	2147.41	0.1378000	0.4357619	61.00	140
UMTS	2167.13	0.0092100	0.0291246	61.00	2094
FWALA	3583.6	0.0014289	0.0036046	61	16923
FWALA	3799.4	0.0107895	0.0384918	61	1585
FWALA	3740.3	0.0070713	0.0252271	61	2418
FWALA	3757.1	0.0040504	0.0144500	61	4221
FWA	5733.5	0.1095217	0.2762821	61	221

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	0.029107	1

3.2.15 Meath: Ratoath - Fairyhouse Road

Measurements

Signal Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below limit (of Adjusted Level)
TV PAL	183.150	0.016	0.012	28.000	2270.265
GSM900	940.396	1.174	2.348	42.166	17.958
GSM900	941.755	1.058	2.116	42.196	19.941
GSM900	946.469	0.085	0.169	42.302	249.596
GSM900	952.188	0.057	0.113	42.429	374.154
GSM900	959.688	0.018	0.036	42.596	1191.827
GSM1800	1833.758	0.376	0.752	58.881	78.278
GSM1800	1844.378	0.337	0.675	59.051	87.535
GSM1800	1837.977	0.200	0.400	58.948	147.519
UMTS	2148.390	0.603	1.906	61.000	32.006

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	0.006956	1

3.2.16 Wicklow: Greystones Dart 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	79.13	0.0037080	0.0037080	28.00	7551
FM Radio	96.18	0.0140600	0.0140600	28.00	1991
FM Radio	101.28	0.0075150	0.0075150	29.00	3859
PMR	147.93	0.0024790	0.0024790	28.00	11295
PMR	166.73	0.0021940	0.0021940	28.00	12762
TETRA	Not disclosed	0.0336700	0.0583182	28.00	480
PMR	Not disclosed	Not disclosed	Not disclosed	Not disclosed	75
GSM 900	938.38	1.0380000	2.0760000	42.12	20
GSM 900	952.56	0.0340400	0.0680800	42.44	623
GSM 900	946.38	0.0142600	0.0285200	42.30	1483
GSM 1800	1834.60	0.2531000	0.5062000	58.89	116
UMTS	2131.40	0.8246000	2.6076142	61.00	23
UMTS	2147.10	0.0794600	0.2512746	61.00	243
UMTS	2167.43	0.0140900	0.0445565	61.00	1369
UMTS	2112.94	0.0139800	0.0442086	61.00	1380
FWALA	3576	0.0027102	0.0068368	61.00	8922

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	0.004535	1

4. Conclusion

The conclusion of this report is that at all 16 licensed transmitter sites surveyed on behalf of ComReg during September and early October 2008:

- (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 (3×10^{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 guidelines¹⁰ 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 recommendation¹¹ 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 licences¹² 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 occupational exposure 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	$3.2 \times 10^4/f^2$	$4 \times 10^4/f^2$	-
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 general public exposure 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 criteria¹³ 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:

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

and

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

where

E_i = the electric field strength at frequency i ;

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

H_j = 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:

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

and

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

where

E_i = the electric field strength at frequency i ;

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

H_j = the magnetic field strength at frequency j ;

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

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

d = $1.6/f \text{ A m}^{-1}$ (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 08/51¹⁴, which incorporates many of the measurement methods and procedures outlined in ECC Recommendation (02)04¹⁵.

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 interdependent¹⁶ in the **far-field** which is the region¹⁷ 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) $\approx 377 \Omega$

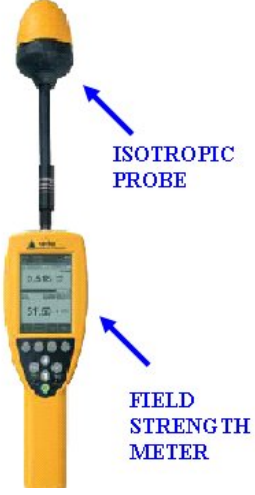
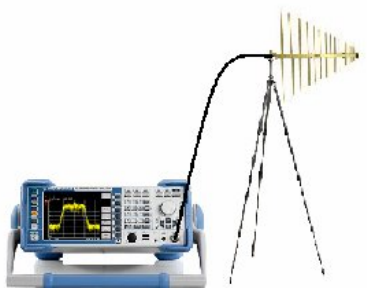

¹⁷ Beyond a distance of $\lambda + 2D^2/\lambda$ where λ is the wavelength and D is the antenna's largest dimension

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.

Initial Site Survey and Broadband Measurements	Frequency Selective Measurements	
 <p>Used to measure the overall electric or magnetic field present over a range of frequencies. (e.g. 100kHz to 3GHz)</p>	<p>SPECTRUM ANALYSER WITH TRIPOD MOUNTED ANTENNA CONNECTED</p> 	<p>PORTABLE SPECTRUM ANALYSER WITH ANTENNA DIRECTLY CONNECTED</p>  <p>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.</p>

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:

$$\text{RBW CORRECTION FACTOR: } K_{\text{RBW}} = 10 \times \log_{10} (B_{\text{Signal}} / B_{\text{N}})$$

Where B_{Signal} is the signal/emission bandwidth

B_{N} is the noise bandwidth of the analyser
filter
(for a Gaussian Filter: $B_{\text{N}} \approx 1.1 \times B_{3\text{dB}}$)

Example: Measuring a 7.61 MHz DVB-T signal with 5 MHz RBW:

$$B_{\text{Signal}} = 7.61 \text{ MHz}$$

$$B_{3\text{dB}} = \text{RBW} = 5 \text{ MHz} \quad \Rightarrow \quad B_{\text{N}} = 1.1 \times 5 = 5.1$$

$$K_{\text{RBW}} = 10 \times \log_{10} (7.61 / 5.1) = 1.74 \text{ dB}$$

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
$E_{\text{MAX}} = E_{\text{BCCH}} \times \sqrt{n_{\text{channels}}}$	$E_{\text{MAX}} = E_{\text{BCCH}} + 10\text{Log}_{10}(n_{\text{channels}})$
<p>n_{channels} includes the BCCH plus the number of traffic channels.</p> <p>If the Number of traffic channels per BCCH is not known, n_{channels} is taken as:</p> <p>GSM: 4 TETRA (Emergency): 3 TETRA (Civil): 2</p>	

UMTS:

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

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.

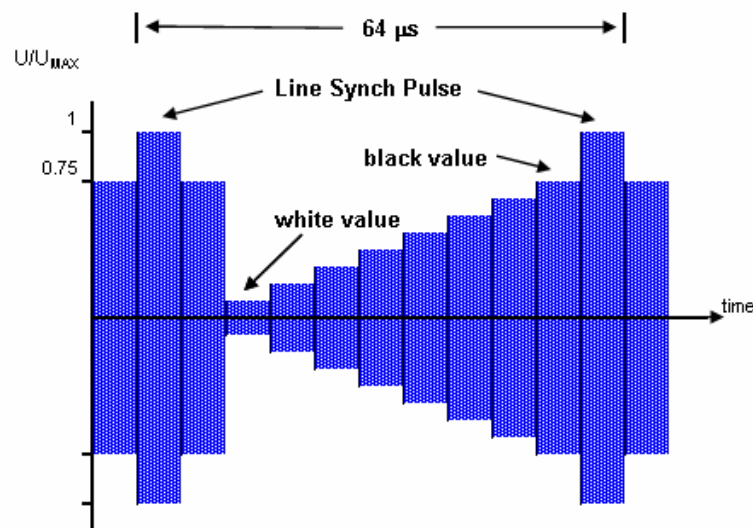


Figure 1: Luminance Signal in the Time Domain

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:

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

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.