



Commission for
Communications Regulation

Report

2010 Programme of Measurement of Non-Ionising Radiation Emissions

Fourth Interim Report

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An Coimisiún um Rialáil Cumarsáide

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1. Executive Summary

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

This report forms part of an ongoing series of interim reports which outline ComReg's programme of measurements, and presents the results of the fourth set of site surveys (20 sites) undertaken during the 2010 programme.

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

On the basis of this work, ComReg has concluded that the NIR emissions measured from all of the 20 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 fourth set of 20 sites chosen as part of the 2010 Programme of Measurement of Non-Ionising Radiation emissions. The site surveys were conducted between October and December 2010 by engineers of Compliance Engineering Ireland Ltd which was contracted by ComReg to assist it with the programme.

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

³ Non-ionising radiation is that part of the electromagnetic spectrum below 3×10^{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).

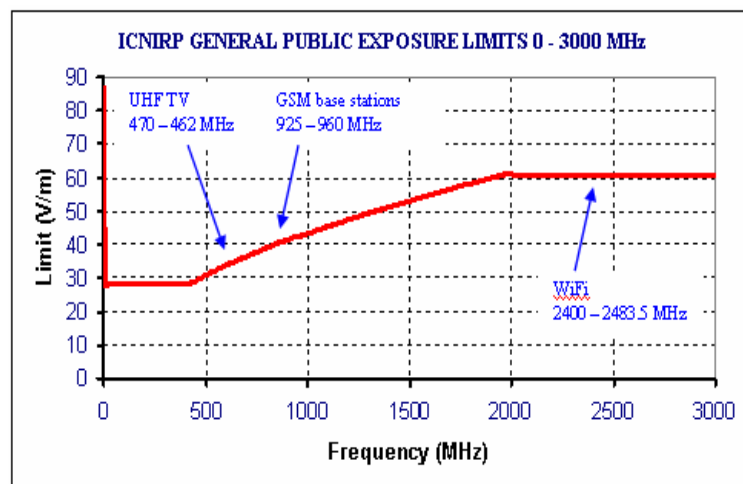
using a correction factor in order to account for the energy present within the full 7.6 MHz bandwidth of the signal.

- 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 Clare: Shannon Town - Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	88.10	0.0113	0.0113	28.0	2484.472
TV PAL	183.30	0.0085	0.0065	28.0	4293.798
TETRA	Not Disclosed	0.1562	0.2705	28.0	103.494
TETRA	Not Disclosed	0.1347	0.2333	28.0	120.013
GSM	947.36	0.6298	1.2596	42.3	33.599
GSM	938.61	0.6068	1.2136	42.1	34.711
GSM	953.79	0.2970	0.5940	42.5	71.490
GSM	1842.20	0.0050	0.0100	59.0	5925.319
GSM	1857.21	0.0025	0.0051	59.3	11641.674
UMTS FDD	2132.50	0.4195	1.3266	61.0	45.983
UMTS FDD	2127.50	0.3809	1.2045	61.0	50.643
UMTS FDD	2117.50	0.3600	1.1384	61.0	53.583
UMTS FDD	2112.50	0.3119	0.9863	61.0	61.846
UMTS FDD	2152.50	0.1418	0.4484	61.0	136.035
UMTS FDD	2147.50	0.1299	0.4108	61.0	148.497
UMTS FDD	2167.50	0.1074	0.3396	61.0	179.607

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	0.003677	1

3.2.2 Cork: Boherboy

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	101.79	0.0189	0.0189	28.0	1482.266
FM Radio	90.00	0.0178	0.0178	28.0	1569.507
FM Radio	92.18	0.0170	0.0170	28.0	1645.123
FM Radio	99.58	0.0170	0.0170	28.0	1651.917
FM Radio	94.38	0.0146	0.0146	28.0	1923.077
TV PAL	174.99	0.0379	0.0291	28.0	963.215
TV PAL	199.24	0.0304	0.0233	28.0	1201.641
TETRA	394.21	0.0015	0.0025	28.0	11125.814
TETRA	392.94	0.0012	0.0021	28.0	13164.338
TETRA	390.94	0.0011	0.0019	28.0	14749.824
TV PAL	472.97	0.0129	0.0099	29.5	2968.753
GSM	950.15	0.3218	0.6436	42.4	65.854
UMTS FDD	2114.50	0.0065	0.0206	61.0	2968.112

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	0.000234	1

3.2.3 Cork: Cobh - St Colman's Park

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	97.77	0.0061	0.0061	28.0	4620.462
FM Radio	88.20	0.0056	0.0056	28.0	4973.357
FM Radio	99.98	0.0050	0.0050	28.0	5547.850
FM Radio	92.58	0.0045	0.0045	28.0	6166.043
TV PAL	179.78	0.0126	0.0097	28.0	2894.993
TETRA	393.66	0.7340	1.2713	28.0	22.024
TETRA	394.24	0.1211	0.2098	28.0	133.491
TETRA	390.96	0.0034	0.0058	28.0	4801.250
TV PAL	514.09	0.0075	0.0058	29.5	5101.004
GSM	955.01	0.5333	1.0666	42.5	39.839
GSM	947.04	0.0454	0.0908	42.3	466.221
GSM	937.79	0.0340	0.0679	42.1	619.771
GSM	1842.23	0.0032	0.0064	59.0	9172.623
UMTS FDD	2167.50	0.1742	0.5509	61.0	110.733
UMTS FDD	2147.50	0.0203	0.0640	61.0	952.581
UMTS FDD	2152.50	0.0180	0.0568	61.0	1073.442
UMTS FDD	2127.50	0.0112	0.0353	61.0	1730.023
UMTS FDD	2132.50	0.0107	0.0338	61.0	1806.157

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	0.002839	1

3.2.4 Cork City: Ballintemple Blackrock Road

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	106.09	0.0171	0.0171	28.0	1641.266
FM Radio	96.37	0.0088	0.0088	28.0	3167.063
FM Radio	94.77	0.0082	0.0082	28.0	3414.218
FM Radio	106.68	0.0081	0.0081	28.0	3452.528
FM Radio	102.58	0.0080	0.0080	28.0	3515.380
FM Radio	93.08	0.0071	0.0071	28.0	3966.568
TV PAL	174.00	0.0149	0.0114	28.0	2453.351
TV PAL	181.23	0.0139	0.0107	28.0	2628.212
T-DAB	226.78	0.0044	0.0073	28.0	3820.982
TETRA	390.84	0.0197	0.0341	28.0	821.016
TETRA	392.29	0.0162	0.0280	28.0	999.741
TETRA	392.56	0.0157	0.0272	28.0	1029.014
TETRA	392.41	0.0032	0.0056	28.0	4995.614
TETRA	393.53	0.0032	0.0055	28.0	5061.305
TETRA	393.96	0.0030	0.0052	28.0	5403.011
TETRA	394.41	0.0030	0.0051	28.0	5444.866
TETRA	394.71	0.0025	0.0044	28.0	6435.433
PMR	456.28	0.0046	0.0046	29.4	6369.763
TV PAL	667.72	0.0092	0.0070	29.4	4182.320
GSM	948.04	0.0216	0.0433	42.3	978.656
GSM	940.00	0.0144	0.0287	42.2	1466.830
GSM	957.15	0.0122	0.0245	42.5	1739.149
GSM	1844.94	0.0244	0.0487	59.1	1212.234
GSM	1861.01	0.0176	0.0352	59.3	1683.221
GSM	1856.37	0.0071	0.0143	59.2	4156.800
UMTS FDD	2127.50	1.9030	6.0179	61.0	10.136
UMTS FDD	2132.50	1.8860	5.9641	61.0	10.228
UMTS FDD	2152.50	0.0373	0.1180	61.0	517.013
UMTS FDD	2147.50	0.0261	0.0824	61.0	739.922
UMTS FDD	2167.50	0.0142	0.0450	61.0	1356.523
UMTS FDD	2117.50	0.0110	0.0347	61.0	1758.410
UMTS FDD	2112.50	0.0096	0.0304	61.0	2004.756

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	0.019306	1

3.2.5 Cork City: Lower Glanmire Road - Silversprings Hotel

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	106.69	0.0054	0.0054	28.0	5206.396
PMR	156.60	0.0037	0.0037	28.0	7547.170
PMR	153.00	0.0021	0.0021	28.0	13409.962
TV PAL	185.80	0.0179	0.0137	28.0	2041.715
TV PAL	178.39	0.0177	0.0136	28.0	2060.151
TV PAL	212.93	0.0157	0.0120	28.0	2331.154
TV PAL	189.53	0.0157	0.0120	28.0	2332.643
T-DAB	227.19	0.0043	0.0072	28.0	3866.805
TETRA	393.96	0.0670	0.1161	28.0	241.245
TETRA	393.54	0.0426	0.0738	28.0	379.301
TETRA	392.01	0.0183	0.0318	28.0	881.451
TETRA	393.21	0.0022	0.0038	28.0	7301.629
TV PAL	535.98	0.0109	0.0083	29.4	3526.089
TV PAL	783.34	0.0107	0.0082	38.5	4689.199
TV UHF (DVB-T)	666.31	0.0107	0.0126	35.5	2813.722
GSM	951.39	0.6330	1.2660	42.4	33.500
GSM	955.21	0.0184	0.0367	42.5	1157.308
GSM	939.99	0.0093	0.0186	42.2	2261.854
GSM	1863.40	0.2032	0.4064	59.4	146.050
GSM	1841.00	0.0855	0.1710	59.0	345.092
GSM	1855.18	0.0110	0.0220	59.2	2691.984
UMTS FDD	2127.50	0.1340	0.4237	61.0	143.953
UMTS FDD	2152.50	0.1227	0.3880	61.0	157.211
UMTS FDD	2147.50	0.1194	0.3776	61.0	161.556
UMTS FDD	2132.50	0.1040	0.3289	61.0	185.478
UMTS FDD	2117.50	0.0860	0.2719	61.0	224.378
UMTS FDD	2112.50	0.0597	0.1889	61.0	322.949
UMTS FDD	2167.50	0.0272	0.0861	61.0	708.141

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	0.001162	1

3.2.6 Donegal: Letterkenny - Gortlee Road,

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	103.28	0.0035	0.0035	28.0	7916.313
PMR	Not Disclosed	0.0023	0.0023	28.0	12340.238
PMR	Not Disclosed	0.0641	0.0641	28.0	437.022
TETRA	Not Disclosed	0.0114	0.0198	28.0	1416.810
TETRA	Not Disclosed	0.0051	0.0088	28.0	3173.500
TETRA	Not Disclosed	0.0018	0.0032	28.0	8828.950
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	20570.175
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	7547.678
TV PAL	751.13	0.0332	0.0255	29.4	1155.616
TV PAL	719.14	0.0329	0.0252	36.9	1462.562
TV PAL	847.27	0.0270	0.0207	40.0	1935.523
TV PAL	511.78	0.0111	0.0085	31.1	3666.856
TV PAL	535.05	0.0108	0.0083	31.8	3828.918
TV PAL	567.46	0.0104	0.0080	32.8	4102.270
TV PAL	487.43	0.0098	0.0075	30.4	4051.477
TV UHF (DVB-T)	545.00	0.0102	0.0120	32.1	2669.591
GSM	954.03	0.0408	0.0816	42.5	520.596
GSM	939.95	0.0145	0.0290	42.2	1451.640
GSM	947.83	0.0113	0.0227	42.3	1868.132
GSM	1841.16	1.0500	0.7036	59.0	28.095
GSM	1854.81	0.3518	0.7036	59.2	84.164
UMTS FDD	2167.50	0.4218	1.3339	61.0	45.732
UMTS FDD	2147.50	0.2418	0.7646	61.0	79.776
UMTS FDD	2162.50	0.1056	0.3339	61.0	182.668
UMTS FDD	2117.50	0.0518	0.1639	61.0	372.102
UMTS FDD	2112.75	0.0313	0.0989	61.0	616.877
UMTS FDD	2132.50	0.0305	0.0963	61.0	633.282
UMTS FDD	2127.50	0.0263	0.0830	61.0	734.848

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	0.000975	1

3.2.7 Donegal: Letterkenny Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	100.98	0.0051	0.0051	28.0	5539.070
FM Radio	106.89	0.0050	0.0050	28.0	5586.592
FM Radio	103.28	0.0041	0.0041	28.0	6819.289
FM Radio	89.20	0.0039	0.0039	28.0	7148.328
PMR	164.19	0.1278	0.1278	28.0	219.092
PMR	159.69	0.0061	0.0061	28.0	4591.669
PMR	162.20	0.0055	0.0055	28.0	5117.894
PMR	165.27	0.0048	0.0048	28.0	5839.416
PMR	157.70	0.0019	0.0019	28.0	14388.489
PMR	166.75	0.0018	0.0018	28.0	15828.151
TETRA	392.41	0.0558	0.0966	28.0	289.814
TETRA	392.06	0.0333	0.0577	28.0	485.168
TETRA	392.29	0.0059	0.0102	28.0	2733.481
PMR	459.20	0.0055	0.0055	29.5	5374.828
PMR	461.25	0.0611	0.0611	29.5	483.077
TV PAL	535.20	0.0145	0.0111	29.5	2658.523
TV PAL	567.24	0.0128	0.0098	32.7	3327.853
TV PAL	487.27	0.0124	0.0095	30.4	3191.321
TV PAL	511.72	0.0120	0.0092	31.1	3368.194
TV PAL	750.89	0.0080	0.0061	37.7	6131.328
TV UHF (DVB-T)	546.50	0.0110	0.0129	32.1	2485.451
GSM	957.05	0.2489	0.4978	42.5	85.451
GSM	939.40	0.0431	0.0861	42.1	489.354
GSM	949.60	0.0283	0.0566	42.4	748.878
GSM	1841.61	0.2621	0.5242	59.0	112.565
GSM	1856.97	0.1328	0.2656	59.3	223.088
UMTS FDD	2147.50	0.1459	0.4614	61.0	132.212
UMTS FDD	2152.50	0.1387	0.4386	61.0	139.075
UMTS FDD	2167.50	0.0759	0.2400	61.0	254.147
UMTS FDD	2132.50	0.0235	0.0744	61.0	819.794
UMTS FDD	2162.50	0.0233	0.0736	61.0	828.954

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UMTS FDD	2127.50	0.0177	0.0561	61.0	1087.359
UMTS FDD	2117.50	0.0080	0.0252	61.0	2423.641
UMTS FDD	2112.50	0.0070	0.0220	61.0	2772.712

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	0.000413	1

3.2.8 Galway City: Dangan, Newcastle - Westwood House Hotel

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	88.80	0.0041	0.0041	28.0	6869.480
FM Radio	100.60	0.0037	0.0037	28.0	7551.241
FM Radio	93.19	0.0036	0.0036	28.0	7797.271
TV PAL	184.15	0.0118	0.0091	28.0	3085.872
TETRA	Not Disclosed	0.0083	0.0143	28.0	1957.831
TETRA	Not Disclosed	0.0081	0.0140	28.0	1993.810
TETRA	Not Disclosed	0.0058	0.0101	28.0	2782.890
TETRA	Not Disclosed	0.0053	0.0091	28.0	3075.101
TETRA	Not Disclosed	0.0033	0.0057	28.0	4931.607
TV PAL	514.62	0.0060	0.0046	29.6	6430.814
TV PAL	831.33	0.0058	0.0044	39.6	8953.493
GSM	952.99	1.4920	2.9840	42.4	14.225
GSM	957.16	0.9546	1.9092	42.5	22.281
GSM	940.24	0.6537	1.3074	42.2	32.249
GSM	1855.99	0.8843	1.7686	59.2	33.494
GSM	1840.57	0.4847	0.9694	59.0	60.852
GSM	1865.58	0.0092	0.0184	59.4	3228.743
UMTS FDD	2152.50	0.8118	2.5672	61.0	23.762
UMTS FDD	2147.50	0.7825	2.4745	61.0	24.651
UMTS FDD	2132.72	0.2887	0.9130	61.0	66.816
UMTS FDD	2127.50	0.2777	0.8782	61.0	69.463
UMTS FDD	2167.50	0.2164	0.6843	61.0	89.139
UMTS FDD	2117.50	0.2060	0.6514	61.0	93.640
UMTS FDD	2112.50	0.1979	0.6258	61.0	97.472

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	0.013273	1

3.2.9 Galway City: Junction Seamus Quirke Rd / Ragoon Rd

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	95.77	0.0056	0.0056	28.0	4999.107
FM Radio	103.28	0.0051	0.0051	28.0	5532.503
FM Radio	101.28	0.0048	0.0048	28.0	5846.732
PMR	Not Disclosed	0.0031	0.0031	28.0	9093.862
PMR	Not Disclosed	0.0020	0.0020	28.0	14170.040
TETRA	Not Disclosed	0.0090	0.0155	28.0	1801.204
TETRA	Not Disclosed	0.0079	0.0136	28.0	2053.844
TETRA	Not Disclosed	0.0059	0.0103	28.0	2722.892
TETRA	Not Disclosed	0.0049	0.0084	28.0	3322.196
TETRA	Not Disclosed	0.0037	0.0064	28.0	4360.887
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	31034.264
TV PAL	514.23	0.0064	0.0049	29.6	6039.880
GSM	940.61	1.3880	2.7760	42.2	15.191
GSM	951.96	0.3652	0.7304	42.4	58.083
GSM	953.63	0.1620	0.3240	42.5	131.053
GSM	1866.40	0.4648	0.9296	59.4	63.901
GSM	1841.98	0.3303	0.6606	59.0	89.332
GSM	1857.00	0.1213	0.2426	59.3	244.241
UMTS FDD	2127.50	0.5775	1.8262	61.0	33.402
UMTS FDD	2132.50	0.6199	1.9603	61.0	31.118
UMTS FDD	2147.50	0.4461	1.4107	61.0	43.241
UMTS FDD	2152.50	0.3874	1.2251	61.0	49.793
UMTS FDD	2167.50	0.1175	0.3716	61.0	164.168
UMTS FDD	2112.50	0.0494	0.1562	61.0	390.560
UMTS FDD	2117.50	0.0050	0.0158	61.0	3860.268

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	0.007987	1

3.2.10 Kerry: Ballybunion - Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	97.58	0.0089	0.0089	28.0	3145.714
PMR	Not Disclosed	0.0016	0.0016	28.0	17857.143
PMR	Not Disclosed	0.0012	0.0012	28.0	24242.424
TETRA	Not Disclosed	0.0017	0.0029	28.0	9576.900
TETRA	Not Disclosed	0.0015	0.0026	28.0	10893.401
GSM	948.76	1.0560	2.1120	42.4	20.053
GSM	952.54	0.4144	0.8288	42.4	51.203
GSM	938.41	0.0029	0.0057	42.1	7387.069
UMTS FDD	2147.19	0.3565	1.1274	61.0	54.109
UMTS FDD	2167.50	0.0650	0.2055	61.0	296.857
UMTS FDD	2117.50	0.0269	0.0849	61.0	718.427
UMTS FDD	2112.50	0.0149	0.0471	61.0	1293.746

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	0.003224	1

3.2.11 Kerry: Rathmore – Garda Station

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
PMR	152.20	0.0014	0.0014	28.0	20527.859
TV PAL	175.30	0.0128	0.0098	28.0	2845.352
TV PAL	200.74	0.0117	0.0090	28.0	3125.502
TETRA	393.51	0.0014	0.0025	28.0	11320.594
PMR	456.17	0.0100	0.0100	29.4	2946.763
GSM	950.98	1.8740	3.7480	42.4	11.313
GSM	939.23	0.9085	1.8170	42.1	23.192
GSM	953.42	0.7231	1.4462	42.5	29.357
UMTS FDD	2117.50	0.4538	1.4351	61.0	42.507
UMTS FDD	2112.50	0.4311	1.3633	61.0	44.745
UMTS FDD	2147.62	0.4263	1.3481	61.0	45.249

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	0.012374	1

3.2.12 Kilkenny: Ballyragget - Watertower

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
TETRA	Not Disclosed	0.0116	0.0200	28.0	1398.426
GSM	953.84	0.3321	0.6642	42.5	63.935
GSM	939.40	0.0144	0.0287	42.1	1468.405
GSM	946.78	0.0129	0.0258	42.3	1637.325
UMTS FDD	2147.67	0.2802	0.8861	61.0	68.843
UMTS FDD	2167.18	0.2189	0.6922	61.0	88.121

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	0.000586	1

3.2.13 Limerick: Glin - Eircom Site

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
TV PAL	176.94	0.0144	0.0111	28.0	2528.107
TV PAL	183.09	0.0141	0.0108	28.0	2596.434
TETRA	Not Disclosed	0.0019	0.0034	28.0	8328.597
TETRA	Not Disclosed	0.0017	0.0030	28.0	9453.689
TETRA	Not Disclosed	0.0015	0.0026	28.0	10670.500
TETRA	Not Disclosed	0.0014	0.0024	28.0	11886.623
GSM	947.19	0.2308	0.4616	42.3	91.676
GSM	955.23	0.0070	0.0141	42.5	3022.534
GSM	938.62	0.0069	0.0137	42.1	3070.396
UMTS FDD	2166.92	0.0081	0.0257	61.0	2372.956

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	0.00012	1

3.2.14 Mayo: Claremorris – Eircom Castlebar Road

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	94.58	0.0080	0.0080	28.0	3513.615
FM Radio	93.64	0.0036	0.0036	28.0	7705.008
FM Radio	89.40	0.0034	0.0034	28.0	8228.034
TETRA	391.19	0.4238	0.7340	28.0	38.145
PMR	456.30	0.0323	0.0323	29.4	910.748
GSM	945.97	0.2896	0.5792	42.3	73.015
GSM	955.22	0.0177	0.0353	42.5	1203.189
GSM	939.63	0.0138	0.0276	42.1	1527.118
UMTS FDD	2147.50	0.1432	0.4528	61.0	134.705
UMTS FDD	2152.50	0.0998	0.3155	61.0	193.342

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	0.000959	1

3.2.15 Tipperary: Nenagh - The Hawthorns

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	107.77	0.0049	0.0049	28.0	5760.132
FM Radio	100.57	0.0048	0.0048	28.0	5891.016
FM Radio	98.38	0.0047	0.0047	28.0	5922.166
FM Radio	93.19	0.0044	0.0044	28.0	6356.413
FM Radio	88.80	0.0043	0.0043	28.0	6487.488
PMR	170.15	0.0021	0.0021	28.0	13127.051
TV PAL	183.62	0.0146	0.0112	28.0	2495.275
TV PAL	207.16	0.0130	0.0100	28.0	2799.530
TETRA	393.76	0.0461	0.0798	28.0	350.744
TETRA	394.44	0.0456	0.0790	28.0	354.591
GSM	950.57	0.6317	1.2634	42.4	33.555
GSM	938.80	0.0282	0.0564	42.1	747.247
GSM	954.20	0.0057	0.0114	42.5	3721.215
GSM	1841.43	0.0764	0.1528	59.0	386.050
UMTS FDD	2152.50	0.0892	0.2820	61.0	216.301
UMTS FDD	2147.50	0.0811	0.2566	61.0	237.734
UMTS FDD	2132.52	0.0262	0.0828	61.0	736.813
UMTS FDD	2127.50	0.0248	0.0783	61.0	778.755
UMTS FDD	2167.21	0.0151	0.0476	61.0	1280.860
UMTS FDD	2117.50	0.0118	0.0372	61.0	1638.892
UMTS FDD	2112.50	0.0090	0.0284	61.0	2148.319

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	0.000957	1

3.2.16 Tipperary: New Inn

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
TETRA	393.14	0.0069	0.0120	28.0	2338.465
TETRA	391.49	0.0021	0.0036	28.0	7839.868
TETRA	392.64	0.0013	0.0023	28.0	12010.258
TETRA	393.59	0.0012	0.0021	28.0	13218.158
GSM	952.18	0.2137	0.4274	42.4	99.272
GSM	957.63	0.0069	0.0138	42.6	3084.234
GSM	937.97	0.0071	0.0142	42.1	2967.672
UMTS FDD	2117.50	0.0071	0.0226	61.0	2700.512
UMTS FDD	2112.50	0.0059	0.0187	61.0	3262.814

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	0.000102	1

3.2.17 Waterford: Dungarvan - Grafton Square

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	95.07	0.0080	0.0080	28.0	3502.627
FM Radio	102.18	0.0064	0.0064	28.0	4367.493
FM Radio	98.49	0.0045	0.0045	28.0	6229.143
FM Radio	88.48	0.0044	0.0044	28.0	6354.970
PMR	153.00	0.0028	0.0028	28.0	10148.605
TETRA	392.66	0.0030	0.0051	28.0	5439.370
TETRA	394.94	0.0026	0.0046	28.0	6146.695
TETRA	393.81	0.0020	0.0034	28.0	8285.909
PMR	454.45	0.0034	0.0034	29.3	8530.856
GSM	948.58	0.2680	0.5360	42.3	79.009
GSM	954.61	0.2397	0.4794	42.5	88.617
GSM	942.17	0.1652	0.3304	42.2	127.740
GSM	1850.01	0.2470	0.4940	59.1	119.719
GSM	1835.19	0.1146	0.2292	58.9	256.997
UMTS FDD	2147.50	0.1459	0.4614	61.0	132.212
UMTS FDD	2152.50	0.1666	0.5268	61.0	115.785
UMTS FDD	2147.50	0.1324	0.4187	61.0	145.693
UMTS FDD	2127.50	0.0904	0.2859	61.0	213.382
UMTS FDD	2167.50	0.0710	0.2244	61.0	271.878
UMTS FDD	2132.50	0.0615	0.1944	61.0	313.808
UMTS FDD	2112.50	0.0077	0.0245	61.0	2493.828
UMTS FDD	2117.50	0.0077	0.0242	61.0	2515.618
WiFi	2462.71	0.0242	0.0516	61.0	1182.432
WiFi	2430.14	0.0136	0.0289	61.0	2111.984
WiFi	2412.22	0.0116	0.0248	61.0	2462.468

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	0.00066	1

3.2.18 Westmeath: Mullingar - Lakepoint Business Park

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	100.83	0.0040	0.0040	28.0	7040.483
FM Radio	93.48	0.0039	0.0039	28.0	7161.125
FM Radio	98.69	0.0039	0.0039	28.0	7237.012
PMR	153.18	0.0024	0.0024	28.0	11480.115
TV PAL	175.57	0.0140	0.0107	28.0	2611.292
TETRA	392.59	0.0017	0.0030	28.0	9442.645
TETRA	393.36	0.0016	0.0028	28.0	10015.990
GSM	947.84	0.0082	0.0165	42.3	2573.377
GSM	958.54	0.0054	0.0109	42.6	3915.606
GSM	942.55	0.0035	0.0069	42.2	6103.783
GSM	1841.24	0.0027	0.0054	59.0	10897.820
UMTS FDD	2152.50	0.8611	2.7231	61.0	22.401
UMTS FDD	2147.50	0.7613	2.4075	61.0	25.338
UMTS FDD	2167.50	0.5714	1.8069	61.0	33.759
UMTS FDD	2112.50	0.0090	0.0283	61.0	2154.317
UMTS FDD	2117.50	0.0089	0.0280	61.0	2177.174
UMTS FDD	2127.50	0.0081	0.0256	61.0	2378.808
UMTS FDD	2132.50	0.0075	0.0239	61.0	2556.289

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	0.004429	1

3.2.19 Wexford: Ferns

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	89.60	0.0089	0.0089	28.0	3153.863
FM Radio	101.38	0.0077	0.0077	28.0	3650.111
FM Radio	91.79	0.0076	0.0076	28.0	3688.093
FM Radio	99.19	0.0071	0.0071	28.0	3958.157
FM Radio	93.98	0.0063	0.0063	28.0	4472.843
TETRA	Not Disclosed	0.0014	0.0025	28.0	11376.360
TETRA	Not Disclosed	0.0012	0.0020	28.0	14008.499
TETRA	Not Disclosed	0.0011	0.0019	28.0	14629.690
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	27713.024
TV PAL	510.68	0.0119	0.0091	29.4	3232.035
TV PAL	487.09	0.0082	0.0063	30.3	4826.774
GSM	940.21	0.5219	1.0438	42.2	40.392
GSM	955.24	0.3586	0.7172	42.5	59.254
GSM	951.63	0.1832	0.3664	42.4	115.766
UMTS FDD	2120.00	0.4122	1.3035	61.0	46.797
UMTS FDD	2112.50	0.3040	0.9613	61.0	63.453

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	0.001678	1

3.2.20 Wicklow: Arklow - off Main Street

Table of Frequency Selective Measurement Results					
Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	104.39	0.0091	0.0091	28.0	3060.444
TV PAL	Not Disclosed	0.0086	0.0066	28.0	4263.708
TETRA	Not Disclosed	0.0101	0.0175	28.0	1603.751
TETRA	Not Disclosed	0.0094	0.0163	28.0	1716.480
TETRA	Not Disclosed	0.0082	0.0142	28.0	1973.847
PMR	Not Disclosed	Not Disclosed	Not Disclosed	Not Disclosed	2745.102
TV PAL	473.73	0.0096	0.0073	29.4	3999.104
GSM	946.21	0.5017	1.0034	42.3	42.152
GSM	939.42	0.1398	0.2796	42.1	150.729
GSM	952.81	0.0462	0.0924	42.4	459.339
GSM	1837.40	0.0465	0.0805	58.9	633.347
GSM	1857.78	0.0403	0.0805	59.3	736.214
GSM	1860.77	0.0132	0.0265	59.3	2241.606
UMTS FDD	2117.50	0.2615	0.8269	61.0	73.766
UMTS FDD	2112.50	0.1903	0.6018	61.0	101.365
UMTS FDD	2312.50	0.1026	0.3245	61.0	188.009
UMTS FDD	2127.50	0.0948	0.2998	61.0	203.478
UMTS FDD	2152.50	0.0304	0.0961	61.0	634.531
UMTS FDD	2147.50	0.0273	0.0862	61.0	707.881
UMTS FDD	2167.50	0.0227	0.0718	61.0	849.769

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	0.000956	1

4. Conclusion

The conclusion of this report is that at all 20 licensed transmitter sites surveyed on behalf of ComReg between October and December 2010 as part of the 2010 Programme of Measurement of Non-Ionising Radiation Emissions:

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

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

Annex 1 - NIR and Emissions Standards

Definition

Non-ionising radiation (NIR) is that part of the electromagnetic spectrum below 3000 million MHz (3×10^{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
$E_{MAX} = E_{BCCH} \times \sqrt{n_{channels}}$	$E_{MAX} = E_{BCCH} + 10 \text{Log}_{10}(n_{channels})$
$n_{channels}$ 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
$E_{MAX} = E_{UMTS} \times \sqrt{R_{P-CPICH}}$	$E_{MAX} = E_{UMTS} + R_{P-CPICH}$
$R_{P-CPICH} = P_{MAX} / P_{P-CPICH}$	
The P-CPICH transmits with a constant power typically 10 dB below the maximum possible power (P_{MAX}) for a UMTS signal.	
Therefore $R_{P-CPICH} = 10$ dB	
$\sqrt{R_{P-CPICH}} = \sqrt{10} = 3.1623$	

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.

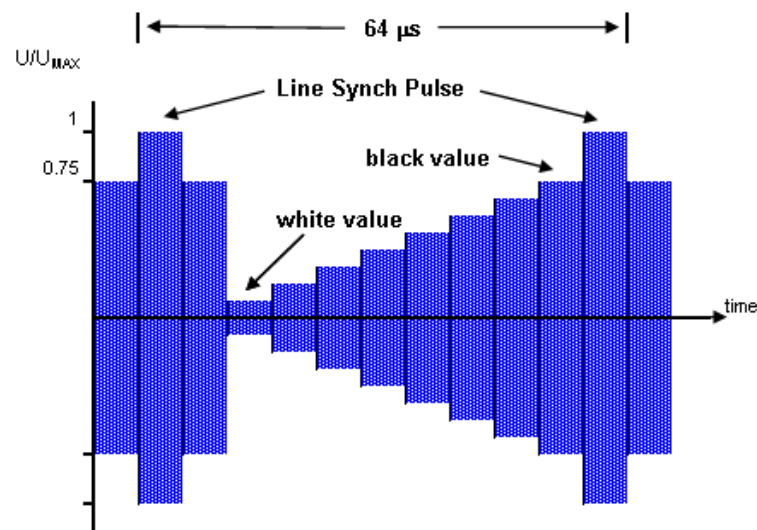


Figure 1: Luminance Signal in the Time Domain

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:

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

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.