Commission for Communications Regulation
An Coimisiún um Rialáil Cumarsáide

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Programme of Measurement of Non-Ionising Radiation Emissions

Site Survey Report 10/57_17

1. Survey Summary

Address of Transmitter Site Surveyed:	Monaghan Garda Station, Plantation Road, Monaghan
Site Type:	GSM, UMTS, PMR, TETRA
Survey Date:	27/04/10

Measurement Location: (at point of maximum non-ionising radiation near site)	Outside entrance to Bus Eireann bus station on North Road.

Measurement Location Coordinates:			deg	min	sec
	Latitude:	N	54	15	7
	Longitude:	W	6	58	8

Purpose and Conduct of Survey:

Non-ionising electromagnetic radiation levels were measured at the point of highest emissions which was determined near the site, in order to **assess compliance with** the international **ICNIRP Limits** for general public exposure to non-ionising radiation.

Compliance with the ICNIRP Limits is a **condition** of various wireless transmission **licences** issued by the **Commission for Communications Regulation (ComReg)**.

Overall Conclusions of the Survey	
Frequency Selective Measurements: (Individual emissions measured at specific frequencies)	**Below ICNIRP Public Limits (Compliant)**
Total Exposure Quotient: (Assessment of cumulative emissions from multiple transmitters)	**Below ICNIRP Public Limits (Compliant)**

2. Surveyors

Survey conducted on behalf of ComReg by:

Vilicom Engineering Ltd, 14 Joyce Way, Park West Business Park, D12

Survey Engineer(s):	**Report Writer:**	**Report Reviewer:**
Dermot Spillane, BE	Dermot Spillane, BE	John Ryan, BSc

3. Survey Location Details

Transmitter Site Photo

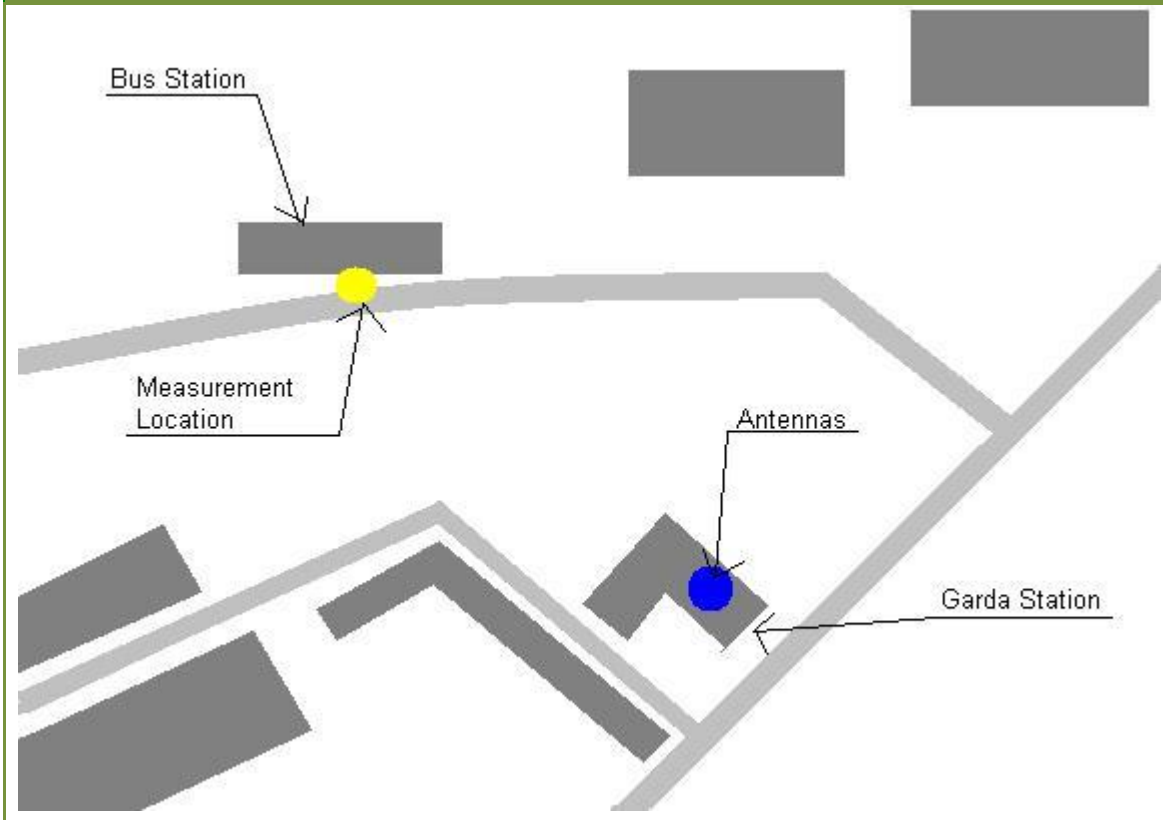
Survey Weather Conditions

Sky:
Cloudy

Temperature:
13° C

Relative Humidity:
61%

Map of Transmitter Site and Measurement Location



4. Introductory Note

Purpose of Survey

The survey of the designated transmitter site was commissioned by the Commission for Communications Regulation (ComReg) as part of its Programme of Measurement of Non-Ionising Radiation Emissions. The purpose of the survey was to assess whether non-ionising electromagnetic radiation emissions from the site were compliant with the limits specified in the guidelines[1] published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Compliance with the ICNIRP limits is a condition of various Wireless Telegraphy licences (e.g. GSM and UMTS Mobile telephony, wireless broadband, broadcasting etc.) issued by ComReg.

Survey Methodology

Measurements of the non-ionising radiation emissions from the site were conducted in accordance with the methodology outlined in document ComReg 08/51R[2], which incorporates many of the measurement methods and procedures outlined in ECC Recommendation (02)04[3].

Note re this Report Version

If you have downloaded this report from www.siteviewer.ie or from www.comreg.ie, you are reading an abbreviated version. In addition to sections 1 to 8, the full extended technical version of this report contains a comprehensive technical record of the measurements and any calculations performed, a list of equipment used, as well as a technical appendix. A copy of the extended report is available on request from ComReg.

[1] "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)", International Commission on Non-Ionizing Radiation Protection, Published in 'Health Physics', April 1998, Volume 74, Number 4. www.icnirp.de

[2] http://www.comreg.ie/_fileupload/publications/ComReg0851R.pdf

[3] 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.

5. Survey Overview

Survey Stages

In accordance with the methodology outlined in document ComReg 08/51R, the survey was conducted in three stages as follows:

1. **Initial Site Survey**
2. **Full Survey – Broadband Measurements**
3. **Full Survey – Frequency Selective Measurements**

Brief outlines of each stage, along with results and conclusions of the measurements are presented in the three sections which follow.

Measurement of Electromagnetic Fields

Electromagnetic fields can be sub-divided into two components:

(1) Electric field **E** [measured in Volts per metre or V/m]

(2) Magnetic field **H** [measured in Amperes per metre or A/m]

The E-field and the H-field are mathematically interdependent[4] in the **far-field** which is the region[5] 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 relationship between E and H becomes very complex and there is no direct correlation between both components of the electromagnetic field.

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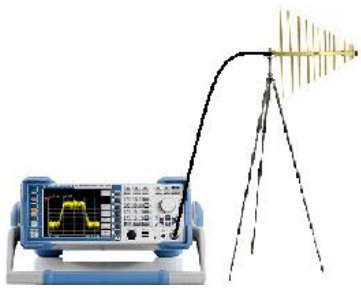
[4] $E = H \times Z_0$ where Z_0 (characteristic impedance of free space) $\approx 377\ \Omega$

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

Measurement Equipment

The measurement of electromagnetic fields is a complex process which involves the use of various meters, spectrum analysers, probes and antennas, which are appropriate to the frequencies of the emissions being measured.

The table below shows examples of equipment typically used to measure electromagnetic fields in non-ionising radiation surveys.

<table>
<tr><th>Initial Site Survey and Broadband Measurements</th><th colspan="2">Frequency Selective Measurements</th></tr>
<tr><td> 
</td><td colspan="2">SPECTRUM ANALYSER WITH TRIPOD MOUNTED ANTENNA CONNECTED
 
PORTABLE SPECTRUM ANALYSER WITH ANTENNA DIRECTLY CONNECTED
  </td></tr>
<tr><td>Used to measure the overall electric or magnetic field present over a range of frequencies.
(e.g. 100kHz to 3GHz)</td><td colspan="2">Spectrum analysers are used to measure individual emissions at specific frequencies. The individual emissions contribute to the overall electromagnetic field. Examples of individual emissions are a TV signal and a mobile phone signal for a particular mobile operator. There may be a number of emissions from different transmitters contributing to the overall electromagnetic field at a particular location.</td></tr>
</table>

6. Initial Site Survey

An initial survey was carried out in the area around the designated transmitter site in order to determine the point of maximum non-ionising radiation (NIR). This is the location at which the overall electrical field strength level measured was somewhat higher than that measured in all other areas around the site and represents the highest level of exposure to which a member of the general public might be subjected in the vicinity of the transmitter.

For this initial survey a calibrated **field strength meter** fitted with an **18 GHz isotropic probe** was used. The meter and probe were used to measure the sum of all electrical fields present at **all frequencies from 3 MHz up to 18 GHz**.

Once the point of maximum NIR was determined, broadband and frequency selective measurements were conducted at that location (see following two sections).

For the duration of those measurements, the various instruments, antennas and probes used were mounted on non-metallic supports.

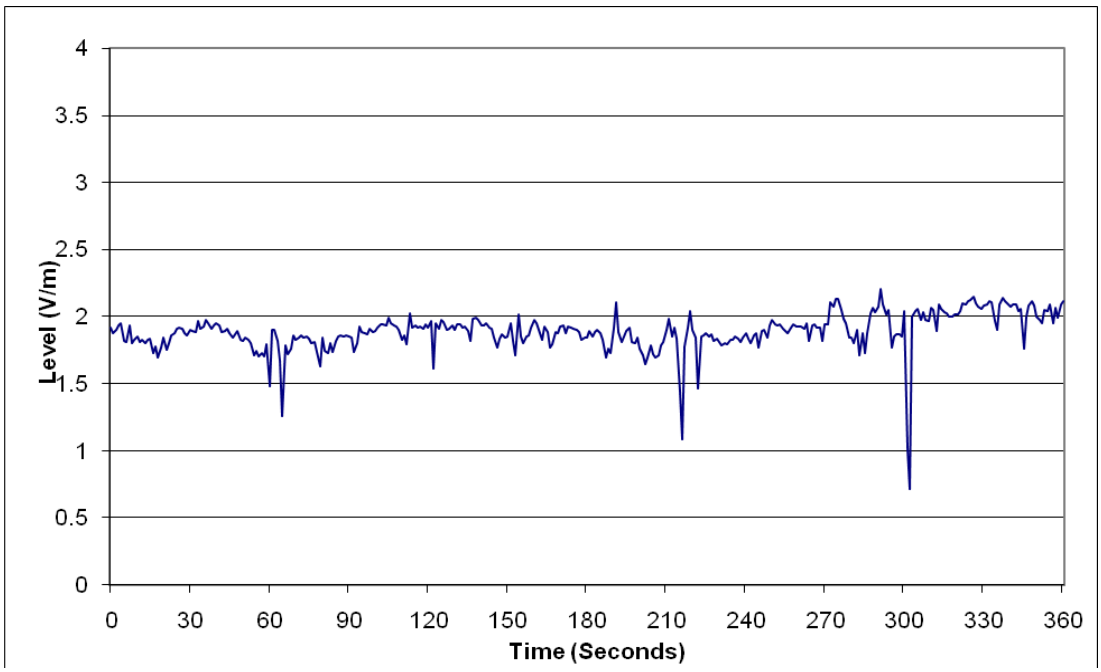
7. Full Survey – Broadband Measurements

The purpose of these measurements was to get an overview of the intensity of the electromagnetic field present at the point of maximum NIR near the site. There, the field strength meter and probe combination were mounted on a tripod and were set to record, over a six minute period, simultaneous measurements of the sum of all received signals within the frequency range of the probe.

The broadband measurement results presented in the graph and table below show the levels in Volts per metre (V/m) recorded in the course of the six minute measurement. The average and maximum levels can be compared to the lowest maximum ICNIRP general public guideline limit which is 28 V/m.

If a broadband measurement is higher than 28 V/m, it does not necessarily follow that the ICNIRP Limits have been exceeded, as the limits are frequency dependent. For example, if the emissions are in the 2100 MHz UMTS mobile phone frequency band, then the limit which applies is higher at 61 V/m. A more detailed investigation involving frequency selective measurement is necessary to assess compliance with the ICNIRP Limits (see next section).

Electric field strengths recorded over 6 min period using 18 GHz probe at point of max NIR:



Acquisition Mode: 1 Sec. Sampling

Mean Measurement:	1.89	**Peak Measurement:**	2.21
Date:	27/04/2010	**Start Time:**	10:03
Meter:	Narda NBM 550	**Probe:**	EF 1891 (3 MHz - 18 GHz)

Conclusion of the Broadband Measurements

The mean and peak measurements were below the lowest ICNIRP guideline limit of 28 V/m.

8. Full Survey – Frequency Selective Measurements

Basic Measurement Procedure

A more detailed survey was performed at the point of maximum NIR near the site in order to identify the individual transmit frequencies and field strengths of each type of emission (e.g. mobile telephone GSM and UMTS, wireless broadband, TV, radio signals etc) and their contribution to the total electromagnetic field. The measurements were performed using spectrum analyser equipment and a range of antennas to match the frequency bands in which emissions were measured.

Table of Measurement Results

A list of the measurements made is presented in the table on the next page. For each emission measured, the table shows:

- **Emission Type** (e.g. GSM or UMTS mobile phone, TV etc)
- Transmission **frequency** of the signal
- **Measured Level** (in Volts per metre, V/m)
- **Adjusted Level** if applicable (to account for the characteristics of certain signal types or to compensate for limitations of measurement equipment or to estimate emissions for max call or data traffic)
- **ICNIRP Limit** for Public Exposure

For further details of Adjusted Levels and ICNIRP Limits, please see the explanatory notes which follow the table of measurement results.

Assessment of ICNIRP Compliance of Individual Emissions

The levels for each emission measured, which have been adjusted where necessary, are compared to the relevant ICNIRP general public guideline limit which applies at the particular frequency of the emission. It should be noted that the ICNIRP guideline limits vary according to frequency. The limits for the different measurements presented in the tables will vary as the measurements have been performed at different frequencies.

Assessment of ICNIRP Compliance of Cumulative Emissions

The levels measured for individual emissions are used to calculate two **Total Exposure Quotients** in order assess the cumulative effect of emissions from multiple transmitters. For further details of the quotients, please see the explanatory notes which follow the tables of measurement results.

The calculated values of the quotients must be ≤ 1 in order for the aggregate of NIR emissions to satisfy the criteria of the ICNIRP Guidelines.

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

Total Exposure Quotients [calculated from Adjusted Levels]			
Quotient	**Frequency Range**	**Calculated Quotient Value**	**Limit**
Electrical Stimulation Effects	**1 Hz to 10 MHz**	n/a	1
Thermal Effects	**100 kHz and above**	0.014612	1

Conclusions of Frequency Selective Measurements	
Frequency Selective Measurements: (Individual emissions measured at specific frequencies)	**Below ICNIRP Public Limits (Compliant)**
Total Exposure Quotient: (Assessment of cumulative emissions from multiple transmitters)	**Below ICNIRP Public Limits (Compliant)**

Explanatory Notes

Adjusted Levels[6]

For some emissions an adjusted level has been calculated from the measured level for any or all of the following reasons:

- to compensate for the limited measurement resolution of the spectrum analyser. For example, a measurement of a digital television signal performed with at a resolution of 5 MHz needs to be adjusted upwards using a correction factor in order to account for the energy present within the full 7.6 MHz bandwidth of the signal.

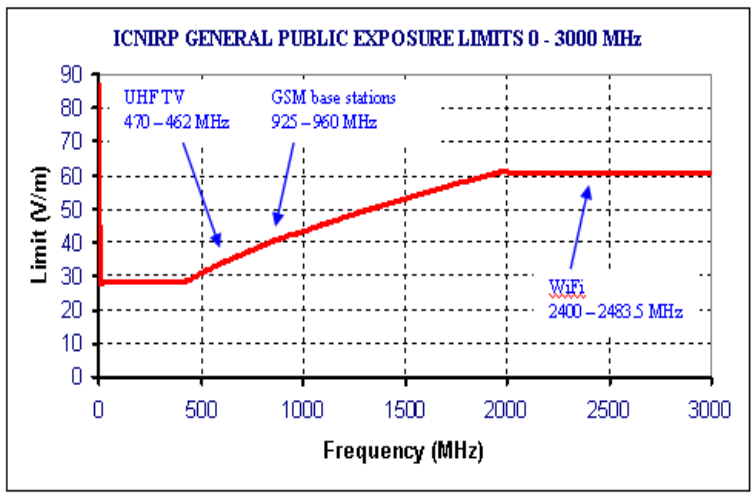
- to extrapolate to an estimate of the level under maximum traffic from the transmitter. For example, the base stations of mobile telephone networks produce emissions which vary according to the changing volume of calls or data traffic over the course of the day.

- to account for the characteristics of certain complex signal types (e.g. analogue PAL TV).

The ICNIRP Public Exposure Limit

The ICNIRP Limits vary according to the frequency of the emissions, as illustrated here.

It can be seen that the limits applicable to GSM 900 mobile phone transmissions are higher than those applicable to UHF TV transmissions.



Total Exposure Quotients

The Total Exposure Quotients (which must be ≤ 1) are calculated, in accordance with mathematical formulas specified in the ICNIRP Guidelines, in order assess the cumulative effect of emissions from multiple transmitters. The quotients in this report are calculated from the Adjusted Levels rather than from the Measured Levels, in order to account for total potential public exposure under maximum traffic conditions. 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.

[6] See appendices to the extended technical version of this report for further details re calculation of adjusted levels.