



Office of Utility Regulation

Audit of Emissions from Radio Masts

Information Notice

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1. Introduction

In February 2005, the OUR published its first full audit of all mast sites operated by licensed operators and the details of that audit were made public in a document entitled “Audit of Emissions from Radio Masts in Guernsey: Report and Information Notice; OUR 05/05R”). This full audit was followed later in 2005 by a smaller sample audit of 14 sites undertaken for the OUR by Ofcom, the UK regulator. In both audits all sites complied fully with the guidelines applied, the International Commission for Non-Ionising Radiation Protection’s (“ICNIRP”) guidelines.

Since then there has been a number of developments in the wireless market but most particularly in the mobile market. The arrival of Airtel-Vodafone (“Airtel”) along with the continued development of the mobile networks of C&W Guernsey (“C&WG”) and Wave Telecom (“Wave”) has resulted in both more mast locations compared to 2005 but also a higher concentration of equipment in almost half the sites as mast sharing has increased.

All operators in the telecoms markets, whether providing fixed or mobile services, are required to comply with certain obligations laid out in the form of their duties under the various applicable laws, such as the Regulation of Utilities (Bailiwick of Guernsey) Law 2001 (“Regulation Law”) and the Telecommunications (Bailiwick of Guernsey) Law 2001 (“Telecoms Law”). Further, the licence conditions that operators are required to comply with also include conditions designed to protect consumers and the environment. Of particular relevance in the context of this audit is the condition which covers the requirement of all operators to ensure that emissions from any radio sites operated or controlled by a licensee complies with the highest internationally accepted standard with respect to the levels of emissions. This condition states that:

“The Licensee shall ensure that non-ionising radiation emissions from its Licensed Telecommunications Network are within the limits specified by the guidelines published by the International Commission for Non-Ionising Radiation Protection (ICNIRP) and that it complies with any radiation emission standards adopted and published from time to time by ETSI, the European Committee for Electrotechnical Standardisation and any other standards specified by the DG.”

The OUR believes it is important that the operators’ compliance with their obligations be assessed and the results of that assessment made public. In the DG’s opinion it is the publication of the results of the individual site audits which will help provide as much reassurance as possible to the public on the degree to which radio equipment operated by the telecoms operators comply with standards designed to ensure the safety and wellbeing of those living close to such sites.

Therefore this audit has involved a number of separate tasks. These included:

- An audit of emission levels for each operator at each site utilised by that operator;
- An assessment of the cumulative emission levels at sites that are shared by more than one operator;
- A review of the operator’s processes and procedures for ensuring on-going compliance;

- An assessment of the appropriate safety guidelines against which compliance should be assessed; and
- The publication of the results of the individual site audits so that the fullest information possible can be made available to the general public.

The main conclusions from this audit are that:

- The ICNIRP guidelines remain the most appropriate standard against which to assess emission levels in Guernsey;
- Emission levels from all sites comply with the ICNIRP guidelines;
- The effect of site sharing has led to higher emission levels at individual sites but the cumulative emission levels are still below the ICNIRP reference levels;
- Operators have appropriate processes and procedures in place to ensure on-going compliance, although some sites at the time of the audit did not have appropriate signage in place to alert the general public to the fact that RF equipment was in operation (although this has since been addressed by the operators concerned);
- Two sites are at heights that allow for easier access by the general public to the antennae equipment than considered appropriate. The OUR will be asking the operators concerned to consider, in consultation with the relevant planning authorities, how this might be addressed.

The OUR is aware there is likely to be further developments in the use of wireless technology in the Bailiwick, both in the fixed and mobile markets. The DG will therefore undertake further sample audits of approximately 15 sites in Summer of 2009 and 2010 to monitor on-going compliance. Given the very low level readings from the non-mobile operators' sites, the DG intends that the audits in 2009 and 2010 will focus solely on the mobile operators.

The individual site reports are available on the OUR's website – www.regutil.gg – and an overview of the location and summary information on each site can be found on Digimap – <http://maps.digimap.gg/masts/>. The Digimap information contains site location information, a picture of the mast structure and summary emission level information.

2. Structure of this Report

The rest of this paper is structured as follows:

- Section 3:** Describes the background to the audit and details how members of the public may access further information on the detailed results of the audit;
- Section 4:** Sets out the DG's assessment of the appropriate standard against which emissions should be assessed;
- Section 5:** Sets out the summary result of the audit of each mast site including the cumulative result;
- Section 6:** Details the results of the audit of the individual operators' processes and procedures for ensuring compliance with their licence obligations;
- Section 7:** Summarises the issues identified by the audit and the recommendations arising from the review; and
- Section 8:** Sets out the conclusions and further work in relation to future on-going compliance

The DG would like to thank all operators for their co-operation and assistance to both the OUR and to Red-M, the consultants engaged by the OUR to undertake this audit.

2.1 The Auditors

The audit has been undertaken on behalf of the OUR by Red-M. Red-M is independent of operators and equipment vendors and provides a range of services connected with the provision of telecommunications services, with particular emphasis on mobile cellular systems. It has provided services to a range of clients including cellular operators, cellular equipment manufacturers, local councils and private individuals.

3. Background

The OUR was established in October 2001 to regulate the telecommunications, post and electricity sectors in Guernsey independently from the companies and from the States of Guernsey.

Among the objectives of the OUR is the requirement set out in the Regulation Law to

“ensure that utility activities are carried out in such a way as to best serve and contribute to the economic and social development and well-being of the Bailiwick” and to “lessen where practicable, any adverse impact of utility activities on the environment”.

These general duties are further reflected in the licence conditions under which all telecoms operators provide services. In particular, a specific licence condition has been included to cover the management of radio based networks, of which the most common are mobile networks and point-to-point links. These are the most prevalent radio based networks in the Bailiwick. This licence condition states that:

“The Licensee shall ensure that non-ionising radiation emissions from its Licensed Telecommunications Network are within the limits specified by the guidelines published by the International Commission for Non-Ionising Radiation Protection (ICNIRP) and that it complies with any radiation emission standards adopted and published from time to time by ETSI, the European Committee for Electrotechnical Standardisation and any other standards specified by the DG.”

To ensure that operators are in compliance with their licence obligations, the DG has undertaken an audit of operators using radio spectrum in the Bailiwick and assess emission levels from infrastructure in place and operational during April 2008.

Sections 4, 5 and 6 set out the DG’s conclusions on the appropriate guidelines to be following in assessing emission levels, the findings of the audit of mast sites and reports on the processes and procedures in place by the telecoms operators.

3.1 Radio Emissions from Radio Masts

All radio waves are electromagnetic (“EM”) waves which are composed of electric and magnetic fields. These waves are described as ‘non-ionising radiation’ as distinct from the ionising radiation produced by radioactive sources.

Exposure to EM waves is measured in terms of the electric and magnetic field strengths which are produced by a transmitter at locations which could be accessed by the public. The electric field strength, E, is measured in volts per meter [V.m-1]. The power which could be absorbed by an object at a given location is proportional to the area of the object multiplied by the square of the electric field strength.

We are all regularly exposed to EM radiation from a variety of sources. Besides mobile phone systems, common sources of radio waves include television broadcasts which in the Bailiwick

(and the UK) operate at frequencies between 400 MHz and 860 MHz and microwave communication links (dishes) which usually operate at frequencies above 1000 MHz.

The potential health impact of EM fields has been studied for many years. The increase in the usage of mobile phones has caused an increased public concern in this area, with the result that a number of bodies have been set up and tasked with overseeing research into such effects. The conclusions from these investigations are used to set regulatory limits on field exposure which reflect a precautionary principle based on the current state of knowledge. This is discussed further in section 4.

3.2 Publication of the Results

It is important to the DG that the public has confidence in the ability of the licensed telecoms operators within the Bailiwick, and in particular those using radio spectrum as part of their networks, to manage those networks for the good of all and that their networks are in compliance with the highest possible standards.

In order to help promote confidence and to reassure the general public, the DG is publishing full details of this audit. The summary details of the individual site audits are set out in section 5. The actual individual site reports are available from the OUR free of charge either by following the link on the OUR website – www.regutil.gg – or by contacting our Office. In addition summary details on each site, which shows the location, description and summary results of the emission levels can be found on the Digimap website – <http://maps.digimap.gg/masts/>. You may contact the OUR either by:

- phone – 711120
- email – info@regutil.gg

specifying the site report you are interested in and the name and address to which you would like the report sent. Alternatively we will be happy to email you a copy should you prefer.

4. Guidelines for Emission Levels

Part of this audit also consisted of reviewing latest progress on guidelines with respect to maximum exposure levels to electromagnetic radiation and to recommend benchmarking levels against which the site audit will be compared. The DG is aware that, in the context of public concern on the erection of new base stations over the past year, concern has been raised about what are the appropriate guidelines for exposure levels against which to require the telecoms operators to comply.

Currently, the OUR requires operators, under the terms of their licences, to comply with the ICNIRP guidelines. The OUR has asked its advisors to assess the various standards that are utilised in a number of countries and assess the rationale for those standards and comment on whether Guernsey should consider amending the guidelines to operators on exposure levels from base stations.

This report contains the results of that review together with Red-M's recommendation for benchmark levels.

4.1 Relevant Bodies

All radio waves are electromagnetic waves, which are composed of electric and magnetic fields. These waves are referred to as 'non-ionising radiation' as distinct from the ionising radiation produced by radioactive sources.

The potential health impact of EM fields has been studied for many years by both civil and military bodies. The increase in the usage of mobile phones has caused an increased public concern in this area, with the result that a number of bodies have been set up and tasked with overseeing research into such effects.

The conclusions from these investigations are used to set regulatory limits on field exposure which reflect a precautionary principle based on the current state of knowledge.

The following are a list of the relevant bodies involved in the set-up of guidelines with respect to EM exposure which we believe are most relevant to any consideration by the OUR of this matter.

4.1.1 The International Commission on Non-ionizing Radiation Protection (ICNIRP)

ICNIRP is an independent non-governmental scientific organization, for the World Health Organization and the International Labour Office, responsible for providing guidance and advice on the health hazards of non-ionizing radiation exposure¹.

After examining available research, ICNIRP issued guidelines for limiting potential hazard from EM exposure in 1998². These guidelines are reviewed on an ongoing basis as part of the assessment of the state-of-the-art research into exposure to EM radiation, but no update of the guidelines has been proposed since that date.

¹<http://www.icnirp.de/>

² International Commission on Non-Ionizing Radiation Protection, "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300GHz), Health Physics, vol. 75, no. 4, pp. 494-522, April, 1998.

Figure 1 shows the reference levels for public and occupational exposures in the range 100kHz to 10GHz.

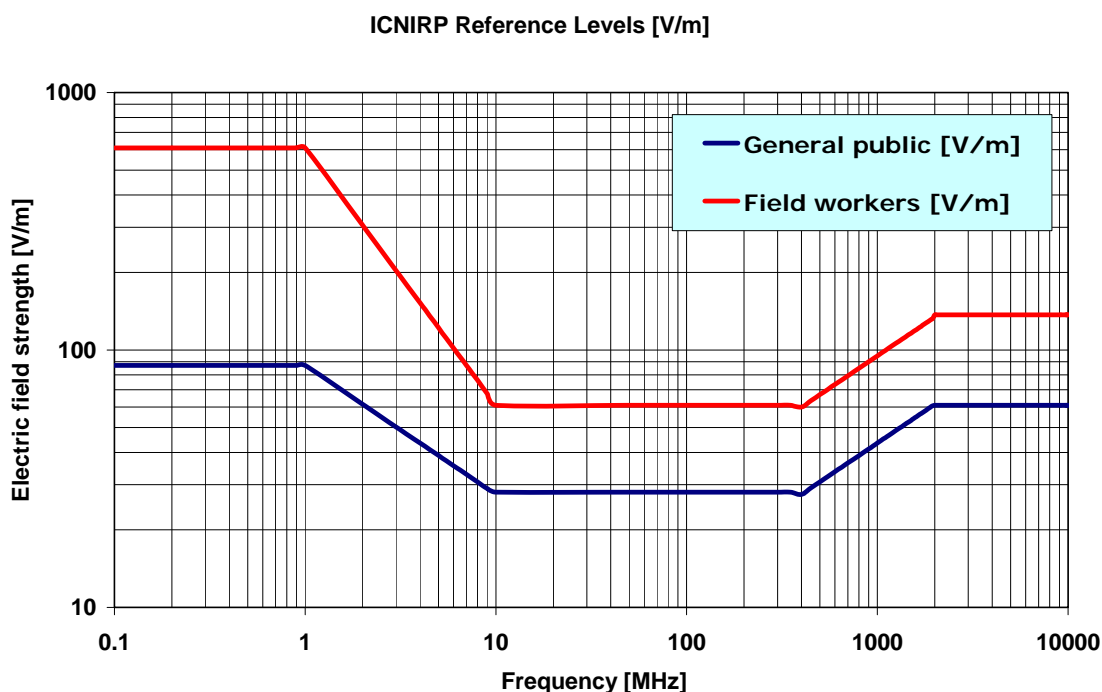


Figure 1 ICNIRP Reference Field Strength Levels versus frequency for public (blue line) and occupational (red line) exposures

4.1.2 The UK's Health Protection Agency

The HPA³ is an independent UK statutory body, with areas of interest in the health protection of UK citizens.

The HPA's limits on human exposure to EM fields were first published⁴ by the ex-National Radiological Protection Board (NRPB) in 2004, and following a thorough review of the scientific evidence⁵ available to that date and an extensive consultation exercise⁶, the HPA revised its guidelines on the exposure limits to coincide with those of ICNIRP. This was made clear in their latest report, published in the same year, in which they concluded that:

“The review of current scientific knowledge, the adoption of a cautious approach to the interpretation of these data, and a recognition of the benefits of international

³ <http://www.hpa.org.uk/radiation>

⁴ National Radiological Protection Board, “Restrictions on Human Exposure to Static and Time Varying Electromagnetic Fields and Radiation: Scientific basis and recommendations for the implementation of the Board’s Statement”, Documents of the NRPB, Volume 4 no. 5, 1993. 0-859-513661

⁵ Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0-300GHz), Documents of the NRPB, vol. 15 No. 3 (2004).

⁶ Proposals for Limiting Exposure to EM Fields (0-300GHz): Summary of comments received on the May 2003 consultation document and responses from NRPB, *NRPB-W59*, July 2004 (ISBN: 0 85951 540 0).

harmonisation, combine in a recommendation to adopt the ICNIRP exposure guidelines for occupational and general public exposure to electromagnetic fields between 0 and 300GHz.” [NRPB 2004]

4.1.3 The European Committee for Electrotechnical Standardisation (CENELEC)

In 1999, the European Council in its recommendation (1999/519/EC) has endorsed the guidelines set by ICNIRP on reference exposure levels, and recommended that these should form the basis of the European standard⁷. These recommendations still apply.

In its recommendation, the Council of Europe states that:

“It is imperative to protect members of the general public within the Community against established adverse health effects that may result as a consequence of exposure electromagnetic fields” [European Council]

It is important to note here the emphasis on “established adverse health effects”. Established effects are effects that can be measured and repeated and have a recognised medical definition as opposed to other more subjective effects associated with human perception. These will be discussed in further detail in section 4.1.4 hereafter.

The Council’s recommendation then goes on to say:

“.....; recalling that only established effects have been used as the basis for the recommended limitations of exposure; advice on this matter has been International Commission on Non-Ionising Radiation Protection (ICNIRP) and has been endorsed by the Commissions’ Scientific Steering Committee;” [European Council 1999]

In 2002 and as a result of these recommendations, CENELEC, the European Committee for Electrotechnical Standardisation, has set the European Standard EN50385:2002 relating to “*Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz) - General public*”.

Standard EN50385:2002, and its associated standards, is in line with ICNIRP’s and provides a basis for measuring and calculating field strength levels around base stations.

This standard also sets the maximum transmit power below which a radiating element (antenna) can be considered as safe.

4.1.4 The World Health Organisation (WHO)

The WHO is an organisation within the United Nations whose main role is to direct, advise and coordinate all actions relating to health matters at the UN. According to its website, the WHO is “responsible for providing leadership on global health matters, shaping the health

⁷ European Council recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz-300 GHz), in *Official Journal of European Communities* L 199/59 of 30 July 1999

research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends.” The six key tasks of the WHO are to promote development, foster health security, strengthen health systems, harness research, information and evidence, enhance partnerships and improve the performance of health agencies. The WHO is also pursuing an active role in attempting to bring together the research and guidelines set around the world.

Ongoing international research into the health hazards of EM fields is coordinated by the WHO’s EMF Project⁸. The Project has established priorities and guidelines for conducting such research.

In recent publications and conferences (see footnote 10), the WHO’s EMF Project acknowledges the existence of differences between the guideline levels set by different countries and has set its goal on achieving a harmonisation of these levels. Harmonisation, in the views of the WHO, is essential as it addresses the organisation’s need to provide a consistent message with regard to protection levels around the world, and would minimise the problems linked with the implementation of a policy for health protection from RF fields.

To understand the arguments put forward by the WHO, we discuss in this section the findings of a report published on behalf of the organisation⁹ on the issue of guideline level discrepancies across the globe. The author of the report is a specialist on the issues of health-related exposure to EM fields¹⁰.

The report identifies two “competing” principles for the establishment of these guidelines: a science-based approach and a precautionary approach.

The science-based limits are based on expert evaluation of the scientific literature which is itself based on research into studies of the adverse effect of exposure to EM radiation. The limits are then set with a view to prevent hazards by radiation with an appropriate margin. The precautionary-based limits are on the other hand “specifically intended to minimise the yet unknown risks” of EM fields by the country of adoption.

4.2 Approach to Setting Limits

4.2.1 The concept of precautionary limits

A few countries, such as Switzerland and Italy, have recently instituted exposure limits that are based on the precautionary measure. The Swiss exposure guidelines (contained in an ordinance, or letter of law) for instance were set at the lowest levels that were felt to be technically and economically feasible.

It should also be noted that the Swiss ordinance has a list of exceptions where the guidelines do not apply, such as old installations for instance, and applies differently according to what type of technology/system it refers to (cellular, broadcasting, power lines...). The guidelines were more specifically intended to apply to “sensitive areas”. These areas include places where people can stay for a prolonged time, and would therefore suggest that streets/rooftops/radio site would be excluded, but places such as schools, hospitals, workplaces would be included.

⁸ <http://www.who.int/emf>

⁹ http://www.who.int/peh-emf/meetings/day2Varna_Foster.pdf

¹⁰Foster KR. Radiofrequency exposure from wireless LANs. *HiTh Phys* 92:280-289; 2007

The Swiss introduced the notion of installation limit values (ILV) as an equivalent to the limits set by ICNIRP and have set these to levels that are about 10 times lower than the ICNIRP levels (see Table 1). The Swiss Guidelines states that:

“contrary to the exposure limit values, [ILVs] are not based on health effects but on the technical and economic practicability. The experience shows that long term exposure from a single source at places of sensitive use can in the great majority of cases be kept far below the exposure limit values without unduly impeding the construction and operation of installations. The ILV are therefore not new, lower safety limit values. They simply reflect today’s state of technology to reduce long term exposure.”

4.2.2 Science-based limits

In the science-based approach, we find for example the ICNIRP guidelines which are adopted in Western Europe and numerous countries worldwide. We also find the guidelines adopted by the US Federal Communications Commission (FCC), as well as those adopted by Russia and China. It will become clearer however in the following sections that the science used to establish those guidelines are different between the West European (ICNIRP) and US approach on one hand and the Russian/Chinese approaches on the other hand.

Red-M has noted that translations of the Russian or Chinese documents are very difficult to get hold of and most of the analysis below is based on the publications cited in this section.

Despite these 2 groups’ science-based approach, there are differences between the maximum exposure levels in the standards set by these countries as illustrated in Table 1. The limits presented in the table are the maximum limits [in V/m] at the typical frequency of 2GHz used for cellular communications worldwide.

4.2.3 Differences in the science-based approaches

The WHO report goes on by reviewing the guidelines and the possible reasons for the discrepancies in the science-based maximum levels.

Setting aside the limits adopted by countries on a precautionary basis, the differences between the ICNIRP field strength reference levels for example and the Chinese or Russian maximum levels vary by a factor of 10.

Guideline/ref	Countries of adoption	Max limits at 2GHz [V/m]	Applied basis
ICNIRP	Western Europe and numerous countries worldwide	61	Science-based
IEEE C95 ¹¹	FCC in the US	61	Science-based

¹¹ IEEE Standards Coordinating Committee 28 on Non-Ionizing Radiation Hazards: Standard for Safe Levels

Sanitary norms and regulations 2.2.4/2.1.8.055-96	Russia and most countries from the former Warsaw Pact	6.1	Science-based
UDC 614.898.5 GB 9175-88	China	6.1	Science-based
Swiss ordinance ¹²	Italy, Switzerland	6	Precautionary limits

Table 1- Difference between EM exposure standards around the world

In the view of the WHO, the difference between the scientific approaches adopted by the Russian/Chinese scientists and the Western European science community (including the US), rests on the following 3 key points:

1. A lack of clarity in the descriptions of the studies, methodology followed and standard of reporting in many of the Russian/Chinese studies.
2. Absence of controlled experiments in many of the Russian/Chinese reports.
3. And finally, use of little known or subjective “symptoms” in the reporting of the effects of the Russian/Chinese EM exposure experiments that are difficult to analyse or replicate in other studies.

Point 1 regarding the lack of clarity ranks the highest in the WHO’s review of the Russian and the Chinese standard. The organisation notes that the reports often lacked crucial information such as the frequency of the tests and the intensity of the exposure. In Western Europe, the WHO highlights the fact that such studies would need to be thoroughly reviewed by peers before it can be taken into account in the setting of the standard.

On the second point, the WHO notes that many of the Russian/Chinese papers are merely case studies as opposed to clinically controlled experiments with an emphasis on the repeatability of the methodology, the control of the experiment’s parameters and the measurability of the results. As a result, these reports would bear little weight in the Western health agencies’ view as to the validity of their outcome.

The final key difference between the Western guidelines (ICNIRP and the US’s IEEE C95) and those of the Russian or Chinese guidelines is in the way exposure is assessed: in the West, observations are principally measured as thermal effects (heating of the biological tissues) with exposure limited to a few minutes to a few hours and can thus be quantified by conventional measuring techniques. In Russia and China, the effects that have been observed are behavioural and cognitive rather than thermal and rely on infinitesimal levels of radiation levels administered over longer periods of time to detect effects that are often very subjective in nature and difficult to replicate or measure with sufficient accuracy. A number of symptoms and conditions reported in the Russian and the Chinese studies would be difficult to analyse or quantify by any Western health organisation, and the criteria used to diagnose those conditions are non-specific with no clear medical significance. This stems mainly from differences about health and medicine in general between the Russian and Eastern European literature and that of the West.

with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300KHz (ANSI/IEEE, 1999), The Institute of Electrical and Electronic Engineers, New York, 1992

¹² Regulation for the protection of the general population in Switzerland, J. Baumann and G Goldberg, 1999

4.2.4 Short-term versus long-term effects

From the review of the literature available on the subject, Red-M believes that the two science-based approaches are not contradictory but rather complementary: in the case of the ICNIRP guidelines, the emphasis is on the short-term exposure (few minutes to few hours) and is concerned with established effects such as the heating of the tissues. It would therefore apply mainly to instances where the public would only be exposed momentarily to EM radiation such as for example passing near a transmitter, or stopping close to a source for a short period of time.

In the case of the Russian/Chinese guidelines, the emphasis is on low level, continuous radiation and the fact that the impact might only materialise over periods of decades. As a result, the studies tend to focus on low doses of radiation and on the reaction of participants exposed to those doses. These standards would therefore apply to everyday situations and would concern places where people live, work or spend prolonged periods of time.

4.2.5 Enforcement of limits

Clearly these two approaches have led to the differences we have today in the maximum exposure limits, and the WHO's aim to reach harmonisation of the levels will certainly lead to a convergence of the methods and a realisation that the levels should be consistent across the world.

One final point that Red-M wishes to highlight is with respect to implementation and enforcement of those guidelines. Whereas in western Europe, the Directive 2004/40/EC¹³ sets out an agenda for enforcing the ICNIRP limits to protect the health and safety of people in the workplace, no evidence was found in the open literature about enforcement, auditing or monitoring of the levels in countries such as Russia or China which have tighter levels. This potentially reduces the scope of the guidelines.

If, in addition, the tighter guidelines only apply to sensitive areas such as the Swiss implementation, then most areas in the immediate vicinity of radio masts would be excluded from having to satisfy these tighter levels.

During the course of the surveys in Guernsey, Red-M found that only on rare occasions did the levels measured approach even the tighter guidelines set by Russia and China and these measurements were only evident in close proximity to the sites. As expected, the electrical field strength was found to decrease very rapidly as distance from the site increases suggesting that, on the basis of the results of the audit, all but one site would meet the tighter guidelines.

4.2.6 The Guernsey audits

The audit conducted by Red-M is concerned primarily with radiation at or very near the sites. These cannot be regarded as "sensitive areas" as defined by the Swiss standards for example which adopted the precautionary guidelines, or areas where people gather as the masts would

¹³ Directive 2004/04/EC of the European Parliament and the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields), 29th April 2004

be usually secluded, protected within a compound and generally isolated from residential places.

4.3 Recommended Benchmark Levels

In view of the arguments put forward in the previous section, Red-M believes that, from the arguments put forward by the WHO, it appears that the standard of the work gone into the assessment of the safety limits for RF exposure by the Russian community for example, is not as high and thorough as the one ICNIRP employed before publishing their guidelines. The WHO holds regular forums and conferences into the harmonisation of guidelines and no definitive outcome has yet been published with respect to adopting new standards or a unified standard. Red-M believes that adopting the Russian limits would be more of a precautionary measure than based on a peer-reviewed, controlled scientific approach.

Furthermore, the Guernsey audit is concerned with EM levels at or very near sites and would not constitute in the majority of cases what is regarded, in the tighter guidelines, as “sensitive areas”.

As a result, and until the WHO achieves its goal of harmonising the standards across the world by use of further research and consultations, Red-M has recommended using the public reference field strengths set by ICNIRP for comparing the results of the audit from the Guernsey sites and benchmarking the surveyed emissions against these levels.

4.3.1 Reference Electric Field Strength Levels

Reference field strength limits derived from the plot in Figure 1 for typical cellular frequencies are shown in Table 2 below:

ICNIRP Reference Field Strengths, [V.m ⁻¹]	900 MHz	1.8 GHz	2.2GHz
Field Workers	90	127.3	137
General Public	41.25	58.3	61

Table 2 ICNIRP Reference field strengths for typical cellular bands

4.3.2 Basic Restriction Levels

For antennas that are within touching distance of people, ICNIRP have defined *Basic Restriction* levels of transmit power above which SAR (Specific Absorption Rate), or E-field measurements are required before an antenna can be considered as compliant with the guidelines. The SAR is a measure of the amount of radio frequency energy absorbed by the body when using a RF device such as a mobile phone or an antenna and is generally used only when the device comes into contact with the human body. The Basic Restriction levels are provided in the table below:

Average SAR, [W/kg]	Whole body	Localised (head and trunk)	Localised (limbs)
Field Workers	0.40	10	20
General Public	0.08	2	4

Table 3-ICNIRP Basic Restriction levels between 10MHz and 10GHz

The unit body area (or weight) over which the Basic Restriction levels should be applied is 10 grams and corresponds approximately to the weight of the end of a finger.

In particular, and in its clause on Evaluation of Results and Determination of Compliance, the Standard states that:

“If the average power emitted by the base station is less than or equal to 20mW then the base station is deemed to comply without testing.

If the average power emitted by the base station is more than 20mW, then E, H, or SAR calculations and/or measurements shall be performed according to clause 4. The results of calculations and/or measurements shall be compared directly to the limits.

The product is deemed to fulfill the requirements of this standard if the calculated and/or measured values are less than or equal to the limits.” [CENELEC 2002]

The 20mW (or 13dBm) threshold level applies to the general public and is derived from the *Basic Restriction* levels of 2 W.kg⁻¹ for the head, neck and trunk as defined by ICNIRP, considering an element of 10g of human flesh. The levels for occupational exposure should be multiplied by 5.

It should be noted that these threshold levels determine the antenna “touch-safe” criteria below which an antenna needs not be tested for compliance. These levels would therefore not apply to antennas which are not accessible by the general public.

4.3.3 Minimum clearance distance from antennas

The predicted peak-to-peak levels of electric field strength E_{PP} for the antennas are estimated using the following expression

$$E_{PP} = \sqrt{\frac{377P_T}{2\pi r^2}} \text{ [V.m}^{-1}\text{]} \quad [1]$$

where P_T is the maximum transmit EIRP [in Watts] and r is the distance from the centre of radiation of the antenna [in meters]. This formula assumes free-space propagation between the transmitter and the probe. While this might be a reasonable assumption in the case of the rooftop level and the street level calculations, this might be over-optimistic and would therefore represent a worst-case scenario in most situations where there is no direct line of sight to the antenna. The minimum clearance distance from an antenna for ICNIRP compliance can be estimated from this expression and is given by

$$r = \sqrt{\frac{377 P_T}{2\pi E_{ICNIRP}^2}} \text{ [m]} \quad [2]$$

where E_{ICNIRP} are the maximum peak-to-peak levels as recommended by ICNIRP for public exposure. The clearance distance defines the extent of the exclusion zone around a site: all areas outside this exclusion zone will have levels that are safely below the ICNIRP guidelines.

Exclusion zone for outdoor antennas

In order to estimate typical exclusion zone distances, we have used the scenario depicted in Figure 2 whereby the site would be at about 10m height, and the public would be allowed to get to within touching distance of the mast supporting the antenna. In the region immediately below the antenna, the transmit power is much lower than along the boresight because the radiation pattern of the antenna would generally focus the RF power towards the horizon as illustrated in the figure. Assuming the most common antenna types used by Guernsey’s cellular operators, Red-M found that the gain at or near the supporting mast, would be 20 to 30dB lower than in the antenna’s main direction. The antennas used in the fixed-links operated by Newtel would have even more loss immediately below the antenna.

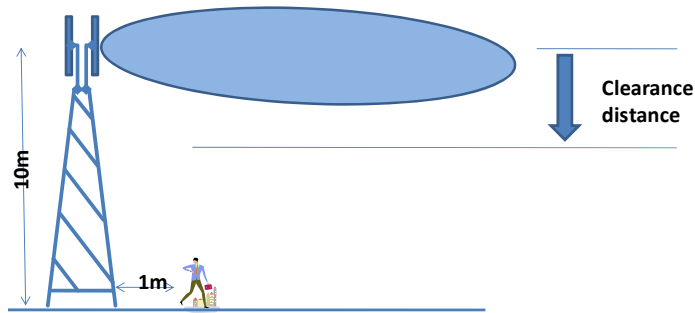


Figure 2- A typical antenna height is about 10m from the ground

Red-M estimated the minimum clearance distance from the centre of radiation of the antenna using ICNIRP’s public exposure. Table 4 shows the typical transmitter characteristics used by the operators in Guernsey, as derived from their site database information provided as part of this audit.

	C&W/Wave Telecom	Airtel/Wave Telecom	Airtel/Wave Telecom	NewTel
Frequency band	900 MHz	1800 MHz	2100 MHz	2400-5800 MHz
Max EIRP power per carrier	30 dBW	30 dBW	30 dBW	14 dBW
Typical number of carriers per sector	2	2	1	1

E_{ICNIRP}	41.3 V/m	58.3 V/m	61 V/m	61 V/m
Field strength below the antenna – at street level	2.4 V/m	2.4 V/m	1.7 V/m	0.3 V/m
Clearance distance (peak ICNIRP)	84 cm	59 cm	57 cm	6 cm

Table 4 Typical minimum clearance distance for general public exposure around sites for Guernsey operators

Red-M also assumed a nominal 2 degrees downtilt for the antenna beam to reflect general practice.

The results suggest that, provided the base of antennas mounted on masts or structures are at least 4 metres above the ground (average height of a person fully stretched up + the clearance distances given in Table 4), and that these masts or structures are not accessible to the public or that the public is prevented from standing in front of the antennas, it would be unlikely that the public would be exposed to field strength above the ICNIRP recommended Reference levels. So a simple message would be that as long as members of the general public or workers are kept away from the front of the antenna, then the field strength levels should be below ICNIRP's Reference levels.

For sites that are lower than the clearance distance, these figures would need to be estimated or measured on a case by case basis, hence the surveys being carried out by Red-M as part of this audit.

Indoor sites

For indoor sites that are within touching distance, the Basic Restriction levels in section 4.3.2 of this report apply, whereby an antenna would only be considered safe if its transmit power is less than 20mW (or 13dBm).

The exclusion zone distances estimated above apply to general public protection. For occupational purposes, workers accessing a site might get closer as the levels of exposure are higher than those for the general public (see Table 2).

For occupational purposes, the auditors have concentrated their investigations on the policies set by the operators for dealing with instances where antennas require access for maintenance, installation, adjustment or other purposes involving the actual handling of radiating elements.

4.3.4 Cumulative exposure quotient

In situations where exposure to EM field can occur at different frequencies, it is important that the aggregate effect of the fields is taken into account. As a result, Red-M uses the Exposure Quotient (EQ) to calculate the cumulative effects from the different frequencies present on a site and compare it to the ICNIRP Reference level.

The EQ is calculated as the sum of the ratios of the measured field strength to the ICNIRP Reference level at each frequency band as defined in the expression below:

$$EQ = \left(\frac{E_{MEAS}^{GSM}}{E_{ICNIRP}^{GSM}} \right)^2 + \left(\frac{E_{MEAS}^{DCS}}{E_{ICNIRP}^{DCS}} \right)^2 + \left(\frac{E_{MEAS}^{UMTS}}{E_{ICNIRP}^{UMTS}} \right)^2 \leq 1$$

where E_{ICNIRP}^{GSM} for example is the ICNIRP Reference level for the GSM900 band reported in Table 2, and E_{MEAS}^{GSM} is the field strength measured on the day of the survey in that band. Note that we take into account all the measured field strengths across any given band in this calculation and not just the highest measured peak.

A band EQ of 1 (unity) means that the cumulative radiation levels at the surveyed frequency bands has reached or exceeded the ICNIRP Reference level.

4.4 Conclusions

The DG is aware that concerns do exist with regard to the possible health effects of exposure to emissions from RF equipment utilised by the telecoms operators in the Bailiwick. The DG has considered whether the current guidelines, requiring compliance with the ICNIRP limits, remains appropriate and provides adequate safeguards on public health. On the basis of the assessment carried out by Red-M, the DG remains of the view that the ICNIRP Guidelines remain the appropriate guidelines against which to assess compliance.

The DG notes that, while there are lower standards in place in other countries, he is not convinced that these afford any greater level of protection to Islanders than that currently offered by the ICNIRP guidelines. Emission levels measured at all sites in Guernsey during this audit were found to be at levels that, even if assessed against the lower guidelines applied in countries such as Russia or Switzerland, all but one site would still meet this lower standard.

Given that the WHO is seeking to standardise the guidelines that all countries assess emission levels against, the DG does not believe that it is logical for Guernsey to adopt standards that goes against this aim at this time. However he will keep this matter under review as further research is carried out at an international level into the further development of the appropriate guidelines in this area.

5. Sites in the Bailiwick of Guernsey

5.1 Cellular Operators' sites

At the time of the audit, there were 66 sites used by Guernsey's cellular operators for supporting their services. This number has seen an increase since the last audit carried out by CDS in 2004 where 48 sites were deployed. This increase in the number of sites is primarily a result of an additional operator launching since that audit (Airtel-Vodafone) and an increase in the portfolio of sites of the existing operators to sustain the demand partly for 3rd generation services and also as extra demand for voice and data services on the GSM networks.

The table overleaf lists the sites identified during the audit, with additional information such as the address, type of site and date/time of the survey. A more comprehensive set of information relating to these sites is provided in a separate spreadsheet in Appendix A. There is an individual detailed report available for each site providing significantly more detailed information on the audit at each site.

These sites were all surveyed by Red-M between April 8th and May 1st 2008. The surveys were conducted by a qualified RF engineer and consisted of:

- A visual inspection of the site to determine its type, the type of antennas deployed and their height.
- An inspection of the signs put by the operators around the site to warn of the existence of RF emissions
- A GPS reading of the site location
- A measure of the RF field strength levels in all the frequency bands transmitted at the site using a frequency-selective probe
- A photograph of the site, and of the measurement location.

A list of the sites audited and the results of the highest reading recorded at each site is listed in Table 5 below.

Site Name	Base Station Site Address	Parish	Post Code	Site type	Suvey date	Survey time
Airport Generator Shed	La Villiaze	Forest	GY8 0DS	Rooftop	15-Apr-08	14:39
Airport Radar Tower	La Villiaze	St Andrews	GY6 8YE	Mast	24-Apr-08	08:41
Airport terminal	La Villiaze	Forest	GY8 0DS	Indoor	15-Apr-08	15:33
Alderney Exchange	Longis Road	Alderney	-	Mast	22-Apr-08	09:00
Alderney Water Tower	Les Mouriaux, St Anne	Alderney	-	Rooftop	22-Apr-08	09:52
Arcade - Balloonees	9, Commercial Arcade	St Peter Port	-	Indoor	18-Apr-08	12:44
Argiva TV Transmitter	Les Rochers, St Anne	Alderney	-	Tower	21-Apr-08	13:18
BBC Tower, Pleinmont	La Rue de Chemin Le Roi	Toreteval	GY8 0LB	Tower	23-Apr-08	14:18
Beau Sejour	Leisure Centre, Amherst Road	St Peter Port	GY1 2DL	Rooftop	16-Apr-08	12:05
Best's Quarry	Mauxmarquis Road	St Andrews	-	Mast	15-Apr-08	10:30
Castel Hospital	La Neuve Rue	Castel	GY5 7NJ	Rooftop	27-Apr-08	11:51
Centenary house	La Vranque, St Peter Port	St Peters	GY1 2EY	Pole	18-Apr-08	11:25
Court House (car park)	St James Street	St Peter Port	-	Indoor	17-Apr-08	08:51
Dairy	Baliffs Cross, St Andrews	St Andrews	GY6 8RJ	Rooftop	15-Apr-08	11:30
DoR	Cambridge Park	St Peter Port	GY1 1UY	Rooftop	28-Apr-08	09:22
Falcon	Vinery, Rue du Pre Bourdon	St Saviour	GY7 9JS	Monopole	01-May-08	10:57
Fermain Valley Hotel.	Fermain Road	St Peter Port	-	Rooftop	25-Apr-08	16:23
Fish Co-op	Castel Emplacement	St Peter Port	-	Rooftop	24-Apr-08	11:36
Fort Doyle	Platte saline	Alderney	-	Pole	21-Apr-08	11:48
Fort George	Rue De La Douzaine	St Peter Port	GY1 1ZW	Mast	09-Apr-08	12:48
Fort Richmond	Perrelle Bay		-	Rooftop	23-Apr-08	12:28
Fort Sausmarez	La Rue Canteraine	St Peters	-	Rooftop	10-Apr-08	11:05
Gervaise Farm	Route des Houquets	St Saviour	GY7 9UJ	Monopole	27-Apr-08	10:32
Gouffre	Oriana, La Rue Du Gouffre	Forest	-	Indoor	25-Apr-08	12:58
Guernsey College	Pitronnerie Road	St Peter Port	GY1 2RL	Monopole		
Herm	Herm	Herm	-	Rooftop	13-Apr-08	11:51
High St	Waterloo House, High Street	St Peter Port	-	Indoor	18-Apr-08	14:22
Homefield	La Collette, La rue de L'Epinielle	Forest	GY8 0HL	Monopole	10-Apr-08	16:13
Hubits	Les Hubits Farm, Les Traudes	St Martins	GY4 6NE	Monopole	08-Apr-08	09:38
Jamblin	Jamblin Quarry, Jamblin Road	Vale	GY3 5EU	Monopole	29-Apr-08	10:23
Jerbourg (Bunker)	La Route De Jerbourg	St Martins	-	Pole	08-Apr-08	11:26
Kingsmill Water	Guernsey Water, Kings Mills	Castel	-	Rooftop	23-Apr-08	11:13
La Fregate Hotel	La Fregate Hotel, Beauregard Lane	St Peter Port	GY1 1UT	Rooftop	24-Apr-08	12:44
La Moinerie		Sark	-	Rooftop	26-Apr-08	08:19
Les Adams	Rue de Felconte	St Pierre Du B	GY7 9LJ	Pole	25-Apr-08	12:03
Les Caches	Business Park,Les Caches Road	St Martins	GY4 6PH	Mast	09-Apr-08	11:10
Les Touillets	Argiva transmitter, Rue D'Eglise	Castel	GY5 7NB	Tower	10-Apr-08	13:30
Little Sark	Clos de La Pointe, Little Sark	Sark	-	Pole	14-Apr-08	11:16
Marais vinery	Rue de Marais	Vale	GY6 8AZ	Monopole	27-Apr-08	12:56
Maraive	Vinery, La rue de la Maraive	Vale	GY3 5BE	Monopole	29-Apr-08	11:58
Maseline Harbour - Sark	Maseline Harbour	Sark	-	Pole	15-Apr-08	13:49
Mignot plateau - St Barnabas church	Rosemary Lane, Cornet Street	St Peter Port	N/A	Indoor - wall m	17-Apr-08	11:44
Nelson House	Pitronnerie Road, St Peter Port	St Peters	GY1 2RL	Monopole		
Oakfield	Vinery, Les Osmonds Lane, La Route Des C	St Sampsons	GY2 4GF	Monopole	28-Apr-08	10:21
Odeon Bunker	Alderney	Alderney	-	Rooftop	21-Apr-08	12:37
Petit Bot	Las Tapitas restaurant	Forest	GY4 6UJ	Rooftop	22-Apr-08	16:03
Police HQ	Hospital Lane	St Peter Port	GY1 2QN	Rooftop	24-Apr-08	13:42
PoP	St Georges Complex	St Peter Port	GY1 2BH	Rooftop	24-Apr-08	10:42
Princess Elizabeth Hospital (Outdoo	Rue Mignot, La Rue De La Corbinerie	St Andrews	GY4 6UU	Rooftop	17-Apr-08	10:18
Regency	Marette Road, L'Islet	St Sampsons	GY2 4FR	Monopole	29-Apr-08	09:21
Reservoir	Rue a l'Or	St Saviour	-	Rooftop	24-Apr-08	10:45
Rohais	BBC, Les Rohais	St Peter Port	-	Pole	23-Apr-08	10:23
Ronez Quarry	Les Vardes Quarry	St Sampsons	GY2 4TF	Mast/rooftop	27-Apr-08	15:46
Sark Harbour - crane sheds	Sark Harbour Office,	Sark	GY9 0SB	Rooftop	15-Apr-08	13:49
Sark Harbour - old harbour	Sark Harbour Office,	Sark	GY9 0SB	Wall mount	15-Apr-08	13:49
Sark Telephone Exchange	Rue Lucas	Sark	GY9 0SG	Mast	14-Apr-08	12:03
SEB	SEB Chimney, North Side	Vale	GY1 3AD	Rooftop	28-Apr-08	12:06
Sir Charles Frossard House	Le Charroterie	St Peter Port	GY1 1FH	Rooftop	16-Apr-08	10:24
St Peter Port Harbour	Cambridge Berth	St Peter Port	-	Pole	11-Apr-08	12:11
St Peters Exchange	La Route du Longfrie	St Peters	GY7 9RX	Mast	11-Apr-08	10:00
St Pierre Park	Rohais	St Peter Port	GY1 1FD	Rooftop	20-Apr-08	11:35
TRS	Huberts Lane	St Peter Port	GY1 1RG	Mast	19-Apr-08	14:04
Vale Garage	Vale Garage complex Braye Road	Vale	GY3 5PA	Wall mount		
Victoria Tower	Victoria Tower, The Arsenal	St Peter Port	GY1 1UW	Rooftop	19-Apr-08	14:44
Watchtower	Rue De La Masse	Castel	GY5 7PT	Rooftop	10-Apr-08	14:46
Water tower	Forest Road	St Martins	GY4 6UB	Rooftop	09-Apr-08	15:17
Wave Shop	24 High Street	St Peter Port	GY1 2JU	Indoor	18-Apr-08	14:54
Westwood	Vinery, Rue des Grons	St Martins	GY4 6JR	Monopole	08-Apr-08	16:44

Table 5 List of existing Guernsey sites including PMR and WiFi sites in the grey shaded cells

The detailed results of these surveys were delivered to the OUR in 66 separate audit reports.

5.2 Fixed links sites

Newtel operates dedicated fixed-links and has 18 sites. The full list of these sites is provided in the table below.

Site name	Site Address	Postcode	Frequency [GHz]
Beau Sejour Leisure Centre	Amherst, St Peter Port	GY1 2DL	2.4
			2.4
			5.8
			5.8
			2.4
			2.4
Digimap	Guernsey Tobacco Factory, La Ramee, St Peter Port	GY1 2ET	2.4
Cour de Parc	La Rue des Pres		5.8
			5.8
Sir Charles Frossard House	La Charroterie, St Peter Port	GY1 1FH	5.8
Royal Court	St James Chambers, St Peter Port	GY1 2PA	5.8
Cadastre Building	Nelson Place, Smith Street, St Peter Port	GY1 2JG	5.8
Airport Tower	La Villiaze, Forest	GY8 0DS	5.8
Sigma-Aztec	Braye Road, Vale	GY1 3SD	5.8
Bulwer Avenue	St Sampson	GY2 4ET	5.8
Quay side	PO Box 109, St Sampson Harbour	GY1 3ET	5.8
			2.4
Project & Hire	Bulwer Avenue, St Sampson	GY2 4LQ	2.4
XKO Communications	Pitronnerie Road, St Peter Port	GY1 2RF	5.8
JEC telecom hut	100Kv substation compound, Barkers Quarry		5.8
			5.8
La Tonnelle House	Safferys		5.8
Mont Cuet Landfill Site	Choute, Vale		2.4
Arkavist	Braye Road, Vale		5.8
Intergrated Skills	Fort Complex, Tracheries, St Sampsons	GY2 4SN	2.4
BBC Radio Guernsey	Bulwer avenue, St Sampsons	GY2 4LA	5.8

Table 6 - List of Newtel sites

Surveying the fixed link sites was outside the scope of this work as it was considered that the field strength measured at street level would be extremely small given the highly directional nature of the antennas. A theoretical calculation of the expected radiation levels was estimated based on the information provided by the operator, backed by the ETSI specification and the corresponding Ofcom Interface Requirement documents^{14,15} for the type of equipment used by Newtel. The levels were found to be extremely small as expected and the results presented in the relevant section of this report (section 7.2).

¹⁴ UK Radio Interface Requirement 2007, Fixed Broadband Services Operating in the Frequency Range 5725-5850MHz (version 1.0), Dec. 2003

¹⁵ UK Interface Requirement for Wideband Transmission Systems Operating in the 2.4GHz ISM band and Using Wide Band Modulation Techniques, Nov. 2006

5.3 Other sites

Guernsey also has a small number of operators of other types of wireless systems: a Wireless LAN operator in the WiFi band (MicroTech), a Personal Mobile Radio operator (Links two-way radio) and a satellite link operator (Hughes Networks). The processes and procedures put in place by these operators with respect to EM exposure were also reviewed as part of this audit. The low emissions levels, or high directivity of their antennas meant that these operators' emission levels were not measured during the surveys, but were assessed from the information supplied by the operators.

MicroTech

The list of sites operated by MicroTech, the WLAN operator, is given below:

Site name	Nelson House	Guernsey College of Further Education
Site Location	Pitronnerie Road, St. Peter Port, GY1 2RL	Pitronnerie Road, St. Peter Port, GY1 2RL
Services	Data	Data
Frequency band	2.4GHz	2.4GHz
Height	12 meters above ground at local site	40 meters above ground at local site
Radiated power	30mW - 100mW max from antenna port	30mW - 100mW max from antenna port
Carriers	11	11
Antenna beamwidth	11°	11°
Tilt	+5 degrees approx	-1 degrees approx

Table 7 - MicroTech sites

The sites are very low power (30 -100mW) and operate in the unlicensed band (2.4GHz), similar to the band used for WiFi home systems. The sites are also very high above ground. For these reasons, Red-M does not believe MicroTech sites should cause any concern with respect to EM radiation.

Links 2-way radio

The list of sites operated by Links 2-way radio, the PMR operator, is given below:

Site name	Address	Site type	Frequency band	Height	EIRP	Nb of carriers	Azimuth
DoR	Cambridge Park, St	Rooftop	164-167MHz	21	41W	1	220
				22	41W	1	360

	Peter Port			22	41W	1	360
				20	41W	1	360
Beau Sejour	Amherst, St Peter Port	Rooftop	165MHz	20	41W	1	220

Table 8 - Sites operated by Links 2-way radio

Links operates two sites: one in Beau Sejour and the other in the Duke of Richmond Hotel (DoR). The sites are omni-directional and only operate in an intermittent fashion. Furthermore, these sites are single-carrier and have lower power than cellular sites (40dBm compared to ~60dBm for maximum output power at GSM or UMTS). These sites are also at a height that ensures the immediate vicinity of the transmitters at street level would be outside the exclusion zone. A good illustration of the expected low levels is shown in Table 9 where Red-M reported the cumulative EQ measured at one of the sites (Duke of Richmond). The EQ for that site was found to be 1/6119175 of ICNIRP.

Hughes Networks

Hughes Networks is a broadband satellite network operator that provides professional managed services to Camelot, the Lottery operator, for a secure backhaul of their new payment terminals. The network also supports broadband media services that allow the new terminals to advertise Camelot's products and local information.

The sites are typically located in customer premises (usually shops) and consist of a satellite dish either on a roof or wall-mounted. At the time of the audit, Hughes Networks had one rooftop site in Vale.

6. Operators Processes and Procedures

During the course of this audit, Red-M had the opportunity to meet a number of Guernsey wireless operators (Cable & Wireless, Wave Telecom, Airtel-Vodafone, Links and Newtel) in order to discuss the processes and procedures put in place in order to comply with their licence requirements. The documents requested by Red-M included:

- Health & Safety procedures
- Statement of work (new installs or maintenance work)
- Site share procedure (notification of site maintenance/new install to co-hosts)
- Guidelines to contractors on site install
- Guidelines on how to set-up exclusion zones and site signage policy
- Code of practice
- Procedures and guidelines on RF surveys prior to commissioning sites

Most of these documents are concerned with occupational exposure and the safeguards put in place the operators to deal with aspects of workers handling radiating elements during site visits. Guidelines on setting-up exclusion zones and signage on the other hand are generally intended for the protection of the general public from RF hazards.

Part of the surveys was also focusing on the accessibility of the sites. The engineer was tasked with evaluating how easy a site could be accessed by the general public and how any exclusion was implemented and physically delimited by the operators to ensure that radiating elements of the antennas are kept out of reach of the public.

Overall, Red-M believes that all the operators have sufficient processes or mechanisms for limiting exposure to RF radiation, to the general public and to workers (employees, sub-contractors...), and that the limits used to define acceptable levels of radiation are those recommended by ICNIRP.

Red-M has come across some instances where practices on the ground did not reflect the procedures in place, and where applicable, these have been highlighted in this report.

7. Results of the Site Audits

7.1 Survey Methodology

EM field levels have been measured in these surveys using a carefully designed and controlled methodology. Elements of this methodology include:

- A peak search around the site performed in order to determine with accuracy the location where the maximum radiation levels were received. To achieve this, the survey engineer walked in the area surrounding the site along a pre-defined template path, using the hand-held probe and notes the location of maximum reading.
- Subject to accessibility, walks were limited to a nominal 100m from the site. Generally, stretching up to the point (and slightly beyond) where the peak values were measured.
- A note of the position of the peak reading was made by the engineer.
- The probe was then positioned on a tripod at the exact location of the maximum radiation level readings and the measurement taken. The height of the probe was approximately 1.5m above the ground.
- The exact measurement position was recorded using a GPS receiver and photos of the site were taken.

The measurements were performed using:

- An isotropic field probe, which reacts to all polarisations (directions) of the electric field, in a similar way to biological tissue.
- A carefully calibrated exposure level meter for all cellular frequencies to ensure that that the measurements are meaningful and accurate.

The probe and meter's serial number are reported in the individual reports.

7.2 Field strength Levels

7.2.1 Cellular Operators' sites

The surveys were conducted during working days (Monday-Friday) between the 8th of April and the 1st of May 2008, generally within working hours (8:00 and 17:00). This would generally be regarded as peak-times in operators' pricing structure as traffic would generally be higher during this period than in the evening or at night.

Summary results of the EM emissions from all the Guernsey cellular sites (GSM, DCS and UMTS) are shown in Table 9 in order of decreasing cumulative EQ measured at the site (full results showing per operator contribution to the cumulative EQ are shown in *Appendix A*).

Site Name	Cumulative EQ	Cumulative EQ ratio
Centenary house	4.46E-02	1/ 22
Little Sark	4.32E-02	1/ 23
La Moinerie	3.23E-02	1/ 31
High St	2.60E-02	1/ 39
Airport Generator Shed	2.17E-02	1/ 46
Airport Radar Tower	2.13E-02	1/ 47
Court House (car park)	1.53E-02	1/ 65
Maseline Harbour - Sark	1.35E-02	1/ 74
Les Adams	8.64E-03	1/ 116
Jerbourg (Bunker)	7.31E-03	1/ 137
Airport terminal	5.99E-03	1/ 167
BBC Tower, Pleinmont	5.49E-03	1/ 182
St Peters Exchange	5.43E-03	1/ 184
Water tower	5.06E-03	1/ 198
Hubits	5.06E-03	1/ 198
Fish Co-op	4.98E-03	1/ 201
Dairy	4.58E-03	1/ 218
Oakfield	4.58E-03	1/ 218
Fermain Valley Hotel.	3.88E-03	1/ 258
Maraive	3.41E-03	1/ 293
Ronez Quarry	2.90E-03	1/ 345
Regency	2.82E-03	1/ 354
Homefield	2.81E-03	1/ 356
Sark Harbour - old harbour	2.64E-03	1/ 379
Sir Charles Frossard House	2.59E-03	1/ 387
St Peter Port Harbour	2.56E-03	1/ 390
Alderney Water Tower	2.52E-03	1/ 396
Westwood	2.42E-03	1/ 413
Sark Harbour - crane sheds	2.36E-03	1/ 424
Falcon	2.31E-03	1/ 432
Rohais	2.28E-03	1/ 439
Fort Doyle	2.23E-03	1/ 448
Odeon Bunker	2.20E-03	1/ 454
Best's Quarry	2.20E-03	1/ 455
Petit Bot	2.17E-03	1/ 461
La Fregate Hotel	1.97E-03	1/ 507
Mignot plateau - St Barnabas church	1.64E-03	1/ 610
Beau Sejour	1.62E-03	1/ 617
Jamblin	1.35E-03	1/ 739
Arqiva TV Transmitter	1.26E-03	1/ 795
Sark Telephone Exchange	1.19E-03	1/ 842
Les Touillets	1.17E-03	1/ 852
Watchtower	1.17E-03	1/ 853
Alderney Exchange	1.06E-03	1/ 945
Gervaise Farm	1.03E-03	1/ 967
SEB	9.80E-04	1/ 1021
Marais vinery	9.61E-04	1/ 1041
Reservoir	8.73E-04	1/ 1146
PoP	8.54E-04	1/ 1171
Les Caches	7.76E-04	1/ 1288
St Pierre Park	5.48E-04	1/ 1824
Arcade - Balloonees	4.55E-04	1/ 2199
Police HQ	4.50E-04	1/ 2223
TRS	4.48E-04	1/ 2230
Princess Elizabeth Hospital (Indoors)	3.55E-04	1/ 2814
Wave Shop	2.90E-04	1/ 3449
Gouffre	2.04E-04	1/ 4909
Kingsmill Water	1.65E-04	1/ 6045
Victoria Tower	8.95E-05	1/ 11176
Princess Elizabeth Hospital (Outdoo	8.56E-05	1/ 11686
Fort Sausmarez	5.01E-05	1/ 19965
Fort Richmond	3.77E-05	1/ 26522
Herm	3.06E-05	1/ 32676
Fort George	2.07E-05	1/ 48397
Castel Hospital	2.81E-07	1/ 3558719
DoR	1.63E-07	1/ 6119175

Table 9 - Cumulative EQ from the cellular sites

These results show that the cumulative exposure quotient, which expresses the aggregate exposure as a ratio of the ICNIRP Reference level, of all the cellular transmissions (GSM,

DCS and UMTS) measured at any given site were below the ICNIRP *Reference* levels for public exposure, and varied between 1/22 and 1/3558719. For comparison, we also added in the table the results of the survey for the PMR-only site (two-way radio) at the Duke of Richmond Hotel, which showed very small levels (EQ of 1/6119175). A band Exposure Quotient of unity (one) would mean that the ICNIRP *Reference* level was reached across the frequency band of the operator, either as a single peak within that band, or as a cumulative effect.

Compared to the levels recorded during the 2004-05 site audit, a number of factors may contribute to the increase in levels observed in the band EQ. The most likely factors are:

1. Increase in the transmit power. The cellular operators networks are getting more mature and their share of the total traffic would be closely dependent on the quality of service they offer. As a result, operators would tend to increase their levels (but would be within the maximum levels permitted by their licence conditions and the GSM specifications).
2. At the time the 2004 audit was carried out, mobile phone penetration rates were in the region of 70% whereas now it is over 100% and the volume of calls has increased significantly since.
3. With the arrival of a new operator, the competition for new or existing customers becomes more acute. The net result is that operators will use higher power to increase their coverage footprint. The background “noise” generated by the increase in transmit powers will also contribute to the observed increase in EM exposure.
4. Operators will tend to have additional sites to target specific areas with high traffic requirements (such as around town centres, venues, tourist attractions, ports of entry...). New sites will also be built, resulting in an adjustment of the transmit parameters of neighbouring sites in order to reduce interference. One parameter that operators will generally adjust in the downtilt of the antennas, resulting in higher power being received near the site, even if the total power from the site has not been increased.
5. The number of channels transmitted at the site. The greater the number of channels, the larger the band Exposure Quotient as this is calculated as the sum of contributions from all channels within the band. As a result, sites with multiple channels such as at Beau Sejour or Harbour will generate higher band EQ than sites with single channels.

It is worth noting that, as described in the more comprehensive set of results presented in *Appendix A* that 7 out of 8 of the sites with a cumulative EQ greater than 1/100 belong to the same operator (C&W).

Further investigation of the sites recorded with the 8 highest cumulative EQ during the audit was carried out in order to determine how close these sites were to equal or exceed the ICNIRP Reference levels. In this investigation, we used the site parameters provided by the operators at the start of the audit.

Site Name	Measured Field strength [V/m]	Band EQ	Band EQ Rel to ICNIRP	Max antenna EIRP [dBm]	Nb of Channels in sector	Minimum distance for rms FS to be below ICNIRP [m]	Minimum distance for rms FS to be below ICNIRP with double the Nb of carriers [m]
Centenary house	5.90	4.46E-02	1/ 22	52	2	2.3	3.4
Little Sark	3.91	4.25E-02	1/ 24	52	2	2.3	3.4
La Moinerie	3.96	3.23E-02	1/ 31	0	2	0.006	0.008
High St	4.15	2.55E-02	1/ 39	35	2	0.3	0.5
Airport Generator Shed	3.83	2.17E-02	1/ 46	57.3	2	4.4	6.2
Airport Radar Tower	3.10	1.74E-02	1/ 58	52	2	2.3	3.4
Court House (car park)	3.58	1.53E-02	1/ 65	35	2	0.3	0.5
Maseline Harbour - Sark	3.33	1.35E-02	1/ 74	35	2	0.3	0.5

Table 10 - Sites measured with a cumulative EQ of more than 1/100th of ICNIRP – All data refers to GSM900 transmission.

In the above table, columns 2-4 show the results of the measurements for the operator with the strongest field strength at the site, columns 5-6 show the maximum transmit power from the listed sites (for a single sector/antenna) and the number of carriers on that sector. Column 7 shows the distance from the site, along the antenna's pointing direction, beyond which the field strength drops below the ICNIRP Reference level. Column 8 shows the results of Red-M's sensitivity analysis which consists of doubling the number of carriers at that site, also equivalent to doubling the maximum transmit power for the same number of carriers.

The results show that a doubling of the number of carriers (or transmit power) would only result in a 50% increase in the exclusion zone radius. Since the distances are typically of the order of 5m or less, the absolute impact of doubling the power at a site on the exclusion zone distance remains small.

In Table 11, we used the same approach as above but reported in columns 2-4 the approximate distance at which Red-M made the measurements from the site, the field strength [V/m] evaluated at that position using the theoretical approach, and the field strength expected at that position using a hypothetical doubling of the number of carriers (or of the transmit power). Columns 5-6 show the estimated EQ at that distance, and columns 7-8 show the EQ ratio for the current situation and the hypothetical situation.

With the exception of La Moinerie and Maseline Harbour which show measured levels exceeding the theoretical levels estimated from the operator's data, the levels measured at the other sites appear to be of the same order of magnitude as those predicted. Exceptions for La Moinerie and Maseline might be due to erroneous information provided by the operators as the theoretical estimations are based on a worst-case scenario and should therefore exceed measured levels.

This is the case for example of the Airport Generator Sheds, which is predicted at 11.5 V/m and measured at only 3.8V/m. The activity at this site will almost certainly be linked with the airport activity (airplanes landing and taking off and plane capacity) and a difference is therefore to be expected depending on the day/time of the survey.

Site Name	Distance from site [m]	Predicted field strength [V/m]	Predicted FS after doubling the nb of carriers [V/m]	EQ	EQ after doubling the site power	EQ ratio from predicted FS	EQ ratio after doubling the TX power
Centenary house	20	6.3	8.9	1.40E-02	2.80E-02	1/ 71	1/ 36
Little Sark	20	6.3	8.9	1.40E-02	2.80E-02	1/ 71	1/ 36
La Moinerie	5	0.05	0.07	1.40E-06	2.80E-06	1/ 714286	1/ 357143
High St	5	3.5	5	4.40E-03	8.90E-03	1/ 227	1/ 112
Airport Generator Shed	20	11.5	16.3	4.70E-02	9.40E-02	1/ 21	1/ 11
Airport Radar Tower	20	6.3	8.9	1.40E-02	2.80E-02	1/ 71	1/ 36
Court House (car park)	5	3.5	5	4.40E-03	8.90E-03	1/ 227	1/ 112
Maseline Harbour - Sark	8	2.2	3.13	1.10E-03	2.10E-03	1/ 909	1/ 476

Table 11 - Impact of doubling the number of carrier on the EQ

For the rest of the sites, the theoretical calculation indicates that the sites were operating close to their maximum levels at the time of the surveys.

The results of this sensitivity analysis show that a doubling of the power (either through a doubling of the number of channels or as the transmit power on the same channels) would result in a doubling of the EQ.

One important thing to bear in mind in that, for the measured EQ to double, the entire transmission power will need to double. So if two carriers are used on that site, then both carriers' power would need to double in order to translate into the above results. Most operators would have either a limited number of channels at their disposal, and would need careful planning not to cause interference to their existing services by using adjacent channels for example. Doubling of existing power would also be constrained by the equipment used on the site, by the specification of the technology used and by their licence conditions. So it is not always a simple task to double the power at a given site.

As an illustration to the above sensitivity analysis, for the site with the highest measured EQ (Centenary House, EQ ratio of 1/22), for the ratio to get to levels above 1/10th of ICNIRP for example, the power would need to be multiplied by a factor of 2.2. For the ratio to come close to one (i.e. the site would be at the ICNIRP Reference level), the total power at the site would need to be multiplied by 22.

7.2.2 Fixed link operator (Newtel)

In the table below, Red-M estimated the levels that would be emitted from Newtel's sites using worst-case scenario for the radio propagation loss in the bands and the information provided by the operator for these sites. The calculations assumed propagation in free space, which would translate in minimal loss between the antenna and the position at which we predicted the field strength.

The field strengths were estimated at street level assuming a 30° incidence angle (from the vertical).

Site name	Cumulative EQ	Cumulative EQ ratio	Estimated field strength [V/m]	ICNIRP Ref. Level Relative to estimated field strength	Exposure Quotient	Exposure Quotient Relative to ICNIRP
Beau Sejour	5.98E-07	1/ 1673637	0.0156	3898	6.58E-08	1/ 15192909
			0.0221	2805	1.27E-07	1/ 7866194
			0.0278	2264	1.95E-07	1/ 5124628
			0.0248	2580	1.50E-07	1/ 6657960
			0.0078	8287	1.46E-08	1/ 68676472
			0.0139	4732	4.47E-08	1/ 22390775
Digimap	1.70E-07	1/ 5882418	0.0276	2425	1.70E-07	1/ 5882418
Cour de Parc	3.45E-08	1/ 29015691	0.0095	7169	1.95E-08	1/ 51400457
			0.0085	8163	1.50E-08	1/ 66626551
Sir Charles Frossard House	4.12E-08	1/ 24276912	0.0142	4927	4.12E-08	1/ 24276912
Royal Court	1.20E-07	1/ 8316163	0.0246	2884	1.20E-07	1/ 8316163
Cadastre Building	1.18E-07	1/ 8506800	0.0247	2917	1.18E-07	1/ 8506800
Airport Tower	9.08E-08	1/ 11008977	0.0220	3318	9.08E-08	1/ 11008977
Sigma-Aztec	1.25E-07	1/ 8011009	0.0261	2830	1.25E-07	1/ 8011009
Bulwer Avenue	1.71E-08	1/ 58550259	0.0098	7652	1.71E-08	1/ 58550259
Quay side	2.11E-08	1/ 47471045	0.0098	7733	1.67E-08	1/ 59803752
			0.0051	15172	4.34E-09	1/ 230196546
Project & Hire	7.86E-10	1/ 1272055789	0.0022	35666	7.86E-10	1/ 1272055789
XKO Communications	1.22E-09	1/ 817825173	0.0028	28598	1.22E-09	1/ 817825173
JEC telecom hut	7.60E-09	1/ 131618173	0.0055	14514	4.75E-09	1/ 210662030
			0.0044	18729	2.85E-09	1/ 350779332
La Tonnelle House	2.31E-07	1/ 4337840	0.0399	2083	2.31E-07	1/ 4337840
Mont Cuet Landfill Site	1.36E-09	1/ 734005193	0.0031	27093	1.36E-09	1/ 734005193
Arkavist	1.46E-07	1/ 6826855	0.0329	2613	1.46E-07	1/ 6826855
Intergrated Skills	6.78E-10	1/ 1474637103	0.0023	38401	6.78E-10	1/ 1474637103
BBC Radio Guernsey	1.19E-09	1/ 838906057	0.0030	28964	1.19E-09	1/ 838906057

Table 12 - Estimated Field strength and cumulative EQ for the Newtel sites based on the operator site information

The above results show that the field strength expected at street level would be well below the ICNIRP Reference levels and would therefore not expose the public to potentially harmful RF radiation levels.

7.3 Antenna Accessibility and Site Signage

The sites in Guernsey, Sark and Alderney consist of a mixture of rooftops, poles, wall-mounts and masts as indicated in the list in Table 5. Most sites were found to be either difficult or impossible to access without specialist climbing equipment. Most sites were found to be fenced off with a locked gate for security reasons. A minority of sites were however found to be neither protected nor sign-posted. In this section, we report on the few sites that will require further attention to bring them to a level where the operators would further reduce public exposure to the radiation emanating from them.

7.3.1 Antennas that are disguised

Red-M commented on the extent to which operators have attempted to minimise the visual impact of some transmit antennas by disguising them to blend in with the local clutter. Red-M is aware that, in order to preserve the aesthetics of the environment and reduce the visual

impact of antennas, radiating elements can be disguised and blended with their supporting structure.

However, the reverse side of “trying too hard to disguise them” is that these antennas become less noticeable by the non-expert eye and would therefore become less likely to have dissuasive effect on the general public. Service staff (cleaners, painters...) would be particularly at risk of coming in close contact with the devices.

Red-M has identified during the survey a small number of sites that fall into this category.



Figure 3 - Antennas at C&WG’s High Street store

In the example above, the antennas are disguised as the sides of the flower pot by blending them into a real flower pot and painting them in the same colour. The size and shape of the antenna can hardly be distinguished from the pot’s side panels.



Figure 4 – Antenna at Petit Bot site is disguised as a PVC pipe



Figure 5 - Antenna at PoP is disguised as a gutter downpipe

In the other two examples shown above, the antennas are disguised inside white tubes resembling gutter downpipe. The size, shape and colour of the antenna tube are identical to the real gutter pipes one can notice at the end of the roof.

Although Red-M noted the rationale for this approach is to minimise visual impact, it believes that the antennas should be well sign-posted if there is a risk that the general public, and that includes non-RF contractors, can come into contact with the elements. Furthermore, these antennas are outdoor antennas and can therefore transmit at the maximum allowed power for macrocells. The antenna in Figure 4 for example transmits at 38.9dBm and has 2 radio channels, taking the possible total radiated power to 41.9dBm.

Red-M notes however that for the cases of the antennas on Figure 4 and Figure 5, signs were posted either on the downpipe (as illustrated in Figure 5) or on the rooftop. There was no evidence however of any sign warning of the RF radiation hazard in the case of the antennas on Figure 3 (the C&WG shop on the High Street). The DG notes that C&WG has confirmed that it has already taken steps to address this issue.

7.3.2 Antennas with easy access

Red-M has also come across antennas with relatively “easy” access, where “easy” is used to refer to the fact that no specialist access equipment would be required to get within touching distance of the antenna, either because the building roof is accessible through a door or a pre-installed ladder, or that the antenna is at ground level.

A complete description of the sites described in this section, including photographs taken on the day of the survey, can be found in the individual site reports.

Mignot Plateau

The antennas at Mignot Plateau are wall-mounted but are within touching distance (see Figure 6 below), with the base of the antennas at about 2.5m from the ground.



Figure 6 - Antenna at Mignot Plateau

Access to the antenna is through a gate as shown in the picture, and the gate has a sign showing the extent of the exclusion zone. Red-M however believes that the antenna is too close to the ground to offer sufficient protection to the public.

7.3.3 High power antennas that have low height

As part of the site audit, Red-M found that some antennas were transmitting high power whilst not having sufficient height to provide an adequate exclusion zone.

Little Sark



Figure 7- Antennas at Little Sark are high power and are only ~4m high

The cumulative EQ measured on the Little Sark site was found to be 1/23 of ICNIRP. Although below the ICNIRP Reference level, it is felt that, should the transmitters be on high activity level, and given the low height of the antenna, the cumulative level could potentially get closer to the ICNIRP Reference level. Technical solutions, such as raising the antenna, or

up-tilting the panel, should be considered by the operators in order to minimise the risks of high level exposure from the site.

Court House



Figure 8 - Antennas at the Court House's main hall

One of the antennas in the Court House is located inside the main hall, at touching distance from the ground. The antenna, although indoors, is not deemed touch-safe by CENELEC¹⁶ as it receives 28dBm into its port (or 35dBm overall EIRP power including the antenna gain).

Although having its immediate surroundings protected by what appears to be a body walk-through scanner, Red-M believes further measures should be taken to offer greater protection. Furthermore, the antenna is not signed.

The DG will request the operators concerned to consider the options for addressing the concerns identified by Red-M with regard to Little Sark and Mignot Plateau. The DG accepts that operators will need to discuss possible solutions with the relevant planning authorities on Guernsey and Sark in relation to both these sites. With regard to the Court House, the DG has been informed by C&WG that it has already taken steps to address the issues identified by Red-M.

7.3.4 Site signage

The vast majority of sites were found to have appropriate signs (such as those shown in Figure 9 and Figure 10) generally posted at the foot of the mast, in the vicinity of the antenna or by the access gate. One example from each cellular operator is shown in the figures below.

¹⁶ CENELEC, the European body for electro-technical standardisation, puts the “touch-safe” limit at 13dBm (20mW).



Figure 9 – Typical sign by Newtel (top) and Wave (bottom)

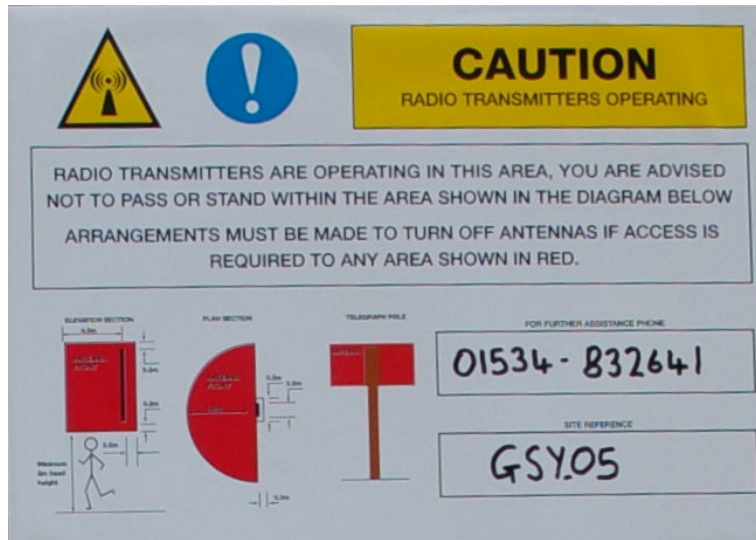


Figure 10 – Typical sign by Airtel-Vodafone



Figure 11 - Typical C&W RF hazard sign

A small number of sites were however found not to display any RF hazard sign (e.g. High Street, Court House). The antennas failing to display signs were generally those fixed to walls, disguised or indoors. Even though some were found to be difficult to get access to by passers-by and could as a result be assumed to be at the required safety distance, Red-M believes that these antennas should be clearly signed. Signs could be posted very close to the antenna or on the antenna itself so that general maintenance workers are warned of the existence of such devices and their potential hazard.

The DG has already raised the issue of appropriate signage with the companies concerned and both C&WG and Newtel have confirmed that all sites now have appropriate signage in place. The DG will however review this issue further in the near future.

8. Summary of Recommendations and Conclusions

As can be seen from the foregoing information, a comprehensive audit of all operational mast sites has been completed and a full review of the processes and procedures of the operators has also been carried out.

The following points are a summary of the audit's outcome:

- The benchmark levels against which EM radiation should be assessed are those recommended by ICNIRP. These levels remain the industry standard across the world and have been adopted by the European Council and the HPA in their recommendations. Red-M investigated alternative guidelines and found no evidence to suggest that those alternative guidelines offer a scientifically more robust definition of the protection levels, or that the methods employed to arrive at those levels are scientifically proven or that the countries that adopted them have put in place the necessary tools or processes to enforce or implement those guidelines.
- On the operators' processes and procedures, Red-M believes that the large majority of operators in Guernsey have in place the necessary processes to protect the public and their workforce. This is done by setting up a centralised system for allowing employees and sub-contractors to work safely in the vicinity of their radiating equipment, having thorough risk assessment procedures for identifying sources of RF hazard, by limiting their transmissions to the levels permitted by their licence conditions and the relevant equipment standards, by setting-up exclusion zones around their sites to prevent the public from getting close to any potentially harmful area, and by displaying sign of the presence of radio equipment.
- Some sites were found not to display any sign that RF equipment is live. For these sites Red-M recommends that the operators pay special attention in ensuring this is complied with. The DG notes that the operators concerned (Newtel and C&WG) have confirmed that they have taken steps to address this issue.
- 8 out of the 65 sites surveyed were found to have cumulative Exposure Quotients higher than 1/100. For comparison, none of the sites surveyed in 2004 had a cumulative EQ higher than 1/100. Possible reasons for this increase are given in section 7.2.1 of this report.
- Even though these sites have seen increases in their EQ, they still comply with the ICNIRP guidelines and are therefore not causing unnecessary exposure.
- Red-M also carried out a sensitivity analysis on the highest 8 sites in order to investigate under what circumstances these sites would fail the ICNIRP levels. The analysis showed that, for the highest measured site (Centenary House), the power at the site would need to be multiplied by 22 in order to reach an EQ of 1. Red-M however believes that getting the extra power to achieve that would be a challenge and does not therefore see a high likelihood of this materialising.
- Red-M would however recommend that those sites with the highest EQ be monitored by the operators themselves to ensure that the levels remain below ICNIRP, and by OUR as part of their on-going audit process.
- One indoor site was found to transmit at higher power than the "touch-safety" limit even though it was found to be within touching distance (Court House). For this site (and others in the same category), Red-M recommends that the operators comply with

the touch-safe limit of 20mW (or 13dBm) into the antenna port, unless those antennas have been SAR¹⁷ tested. C&WG, the operator of this site, has already confirmed that it has taken steps to address this issue.

- Two sites (Maseline Harbour and La Moinerie) were measured at much higher levels than what the worst-case levels predicted using the data supplied by the operator of these 2 sites appear to indicate. We recommend that the operator of these 2 sites look at the measured levels and the calculations and provide an explanation as to why there is such a large discrepancy between the two.

The OUR will be writing to each operator audited to follow-up with them the findings of this audit and to ensure that the actions need to further protect the general public are taken. The OUR is aware that the majority of the issues identified by RED-M (such as lack of signage at some sites and power levels at the Courthouse site) have already been addressed by the operators concerned. There are also some issues with regard to access to a small number of sites which may need to be considered in discussions between the operators and the relevant planning authorities in the various Islands.

The reviews planned for 2009 and 2010 will concentrate on the mobile operators as the DG believes these sites give rise to most public concern and the level of emissions from the equipment operated by the smaller operators are extremely low. This exercise was conducted in the interests of the community and their safety is a key consideration in this exercise. The process going forward is intended to ensure that Islanders have good quality information in this sensitive area and are kept fully informed. In planning the future audits in 2009 and 2010, the DG will look to consult with the public representatives in Alderney and Sark and with parish constables in Guernsey to consider where resources are focussed for ongoing monitoring programmes.

¹⁷ SAR tests (Specification Absorption Ratio) are conducted in labs to accurately measure the power flux density (in mW/cm²) over the surface of the antenna and can determine whether the antenna satisfies the ICNIRP limit. The touch-safe limit is a precautionary limit that ensures the ICNIRP limit is always satisfied given the conductive properties of a typical antenna.

Appendix A Results of the EM exposure surveys

Site names A-D

Site Name	Freq band	Technology	Cumulative EQ	Cumulative EQ ratio	Airtel-Vodafone				Cable&Wireless				Wave Telecom						
					Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP			
Airport Generator Shed	900	GSM	2.17E-02	1/ 46															
Airport Radar Tower	900	GSM	2.13E-02	1/ 47					3.0997	14	1.74E-02	1/58	0.055884	752	6.23E-06	1/160613			
Airport Radar Tower	1800	DCS			2.3138	25	3.82E-03	1,262					0.015753	3724	1.60E-07	1/6246063			
Airport Radar Tower	2100	UMTS			0.28781	212	1.21E-04	1,8296											
Airport terminal	900	GSM	5.99E-03	1/ 167					2.192	19	5.91E-03	1/169	0.22041	191	7.09E-05	1/14096			
Airport terminal	1800	DCS			0.0512	1151	2.39E-06	1,418307											
Airport terminal	2100	UMTS			0.013818	4415	3.90E-07	1,2588750											
Alderney Exchange	900	GSM	1.06E-03	1/ 945					0.65442	65	1.05E-03	1/949	0.04409	954	3.23E-06	1/309602			
Alderney Exchange	1800	DCS			0.028913	2039	6.29E-07	1,1589769											
Alderney Water Tower	900	GSM	2.52E-03	1/ 396					0.025249	1687	1.92E-06	1/520144	1.3003	32	2.47E-03	1/404			
Alderney Water Tower	1800	DCS			0.22347	264	3.86E-05	1,25930					0.075917	773	1.96E-06	1/509139			
Alderney Water Tower	2100	UMTS			0.016562	3683	5.50E-07	1,1819635					0.065989	924	7.74E-06	1/129269			
Arcade - Balloonees	900	GSM	4.55E-04	1/ 2199					0.60093	71	4.51E-04	1/2220	0.03991	1053	2.32E-06	1/431843			
Arcade - Balloonees	1800	DCS			0.048252	1222	1.67E-06	1,599161					0.030036	1953	3.16E-07	1/3168820			
Arqiva TV Transmitter	900	GSM	1.26E-03	1/ 795					0.3289	130	7.13E-05	1/14020	0.74251	57	8.37E-04	1/1195			
Arqiva TV Transmitter	1800	DCS			0.68124	87	3.19E-04	1,3138					0.18762	313	1.14E-05	1/87489			
Arqiva TV Transmitter	2100	UMTS			0.083176	733	1.18E-05	1,84453					0.064509	946	7.72E-06	1/129617			
BBC Tower, Pleinmont	900	GSM	5.49E-03	1// 182					0.82774	51	8.83E-04	1/1133	0.47218	89	2.87E-04	1/3486			
BBC Tower, Pleinmont	1800	DCS			1.898	31	2.88E-03	1,347					1.8896	31	1.37E-03	731			
BBC Tower, Pleinmont	2100	UMTS			0.1714	356	5.26E-05	1,19003					0.98439	620	1.63E-05	61282			
Beau Sejour	900	GSM	1.62E-03	1/ 617					0.74982	57	4.64E-04	1/2155	0.91741	46	1.01E-03	1/990			
Beau Sejour	1800	DCS			0.28489	207	5.88E-05	1,16994					0.25425	231	5.62E-05	1/17786			
Beau Sejour	2100	UMTS			0.064843	941	8.09E-06	1,123549					0.11409	535	2.29E-05	1/43597			
Best's Quarry	900	GSM	2.20E-03	1/ 455					0.43897	97	3.64E-04	1/2745	0.34083	123	1.84E-04	1/5441			
Best's Quarry	1800	DCS			1.155	51	4.72E-04	1,2120					1.6016999	37	1.16E-03	1/860			
Best's Quarry	2100	UMTS			0.095746	637	1.67E-05	1,59840											
Castel Hospital	900	GSM	2.81E-07	1/ 3558719									0.0050579	8312	1.86E-07	1/5372126			
Castel Hospital	1800	DCS			0.0071193	8281	9.50E-08	1,10578783											
Centenary house	900	GSM	4.46E-02	1/ 22					5.9039	7	4.46E-02	1/22							
Centenary house	1800	DCS			0.014112	4178	3.24E-07	1,3089718											
Court House (car park)	900	GSM	1.53E-02	1/ 65					3.583	12	1.53E-02	1/65							
Dairy	900	GSM	4.58E-03	1/ 218					0.013856	3075	7.10E-07	1/1404705	1.2024	35	4.55E-03	1/220			
Dairy	2100	UMTS											0.12137	503	2.79E-05	1/35890			
DoR	165	PMR	1.63E-07	1/ 6119175					THE ONLY OPERATOR HERE IS LINKS TWO-WAY RADIO										

Columns with a red header are Airtel-Vodafone, those with a dark blue header are for Cable & Wireless and those with a light blue coloured header are for Wave Telecom. Grey shaded cells mean the operator does not have transmitters at that frequency or that the levels recorded were well below the metre sensitivity.

Site names F-L

Site Name	Freq band	Tech-nology	Cumulative EQ	Cumulative EQ ratio	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	
Falcon	900	GSM	2.31E-03	1/ 432					0.011752	3625	4.70E-07	1/2111762	0.94325	45	1.79E-03	1/559	
Falcon	1800	DCS			0.65824	90	4.50E-04	1,2221					0.028436	2036	8.08E-07	1/1238212	
Falcon	2100	UMTS											0.14542	419	7.18E-05	1/13927	
Fermain Valley Hotel.	900	GSM	3.88E-03	1/ 258					1.3535	31	3.88E-03	1/258					
Fish Co-op	900	GSM	4.98E-03	1/ 201					0.19376	220	1.34E-04	1/7477	1.7967	23	4.69E-03	1/213	
Fish Co-op	1800	DCS			0.1086	543	1.54E-05	1,64760					0.064254	913	7.49E-06	1/133461	
Fish Co-op	2100	UMTS			0.032126	1899	1.76E-06	1,569558					0.28288	216	1.33E-04	1/7534	
Fort Doyle	900	GSM	2.23E-03	1/ 448					1.3332	32	2.23E-03	1/449	0.079564	528	3.97E-06	1/252038	
Fort George	900	GSM	2.07E-05	1/ 48397					0.053315	799	7.14E-06	1/139966					
Fort George	1800	DCS											0.010602	5533	6.94E-08	1/14399817	
Fort George	2100	UMTS											0.089471	682	1.34E-05	1/74358	
Fort Richmond	900	GSM	3.77E-05	1/ 26522					0.10884	391	2.57E-05	1/38846	0.073777	570	1.00E-05	1/99561	
Fort Richmond	1800	DCS			0.048399	1218	1.76E-06	1,569101					0.017967	3265	1.61E-07	1/6212128	
Fort Sausmarez	900	GSM	5.01E-05	1/ 19965					0.18976	225	4.94E-05	1/20232	0.02083	2018	6.61E-07	1/1512355	
Gervaise Farm	900	GSM	1.03E-03	1/ 967									0.50603	83	1.00E-03	1/995	
Gervaise Farm	2100	UMTS											0.091365	668	2.90E-05	1/34499	
Gouffre	900	GSM	2.04E-04	1/ 4909					0.31653	135	2.03E-04	1/4920	0.013083	3214	4.43E-07	1/2258695	
Guernsey College	2400	WiFi							SITE OPERATED BY MICROTTECH AT 2.4GHz ONLY								
Herm	900	GSM	3.06E-05	1/ 32676									0.14913	282	3.06E-05	1/32676	
High St	900	GSM	2.60E-02	1/ 39					4.152	10	2.55E-02	1/39	0.70593	60	4.08E-04	1/2454	
High St	1800	DCS			0.028959	2036	7.94E-07	1,1259805					0.018908	3102	2.78E-07	1/3591352	
High St	2100	UMTS			0.015083	4044	6.36E-07	1,1572717					0.028013	2178	1.42E-06	1/702813	
Homefield	900	GSM	2.81E-03	1/ 356									1.1587	36	2.75E-03	1/363	
Homefield	2100	UMTS											0.18193	335	5.74E-05	1/17432	
Hubits	900	GSM	5.06E-03	1/ 198									1.0144	41	2.08E-03	1/482	
Hubits	1800	DCS			1.3151	45	8.56E-04	1,1169					1.7466	34	1.91E-03	1/524	
Hubits	2100	UMTS			0.28979	210	1.65E-04	1,6047					161829993	377	5.24E-05	1/19082	
Jamblin	900	GSM	1.35E-03	1/ 739									0.6936	61	1.26E-03	1/794	
Jamblin	2100	UMTS											0.16583	368	9.25E-05	1/10809	
Jerbourg (Bunker)	900	GSM	7.31E-03	1/ 137					1.1037	39	3.28E-03	1/305	1.6232	26	4.03E-03	1/248	
Kingsmill Water	900	GSM	1.65E-04	1/ 6045					0.34698	123	1.65E-04	1/6045					
La Fregate Hotel	900	GSM	1.97E-03	1/ 507					0.072391	589	3.33E-05	1/30058	0.09333	450	2.25E-05	1/44460	
La Fregate Hotel	1800	DCS			1.2516	47	1.16E-03	1,861					1.0994	53	7.28E-04	1374	
La Fregate Hotel	2100	UMTS			0.0925	659	1.53E-05	1,65310					0.076421	798	9.93E-06	100717	
La Moinerie	900	GSM	3.23E-02	1/ 31					3.9626	11	3.23E-02	1/31					
Les Adams	900	GSM	8.64E-03	1/ 116					0.042588	1000	5.30E-06	1/188639	1.8727	22	7.59E-03	1/132	
Les Adams	1800	DCS			0.012821	4598	2.78E-07	1,3591699									
Les Adams	2100	UMTS											0.56093	109	1.05E-03	1/956	
Les Caches	1800	DCS	7.76E-04	1/ 1288	1.1014	54	7.76E-04	1,1288									
Les Touillets	900	GSM	1.17E-03	1/ 852					0.11795	361	5.50E-05	1/18186	0.732	57	8.15E-04	1/1226	
Les Touillets	1800	DCS			0.48412	122	1.86E-04	1,5389					0.39415	149	5.25E-05	1/19054	
Les Touillets	2100	UMTS											0.18532	329	6.48E-05	1/15431	
Little Sark	900	GSM	4.32E-02	1/ 23					3.907201	11	4.25E-02	1/24	0.74192	57	6.70E-04	1/1492	

Site names M-Sa

Site Name	Freq band	Technology	Cumulative EQ	Cumulative EQ ratio	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP
Marais vinery	900	GSM	9.61E-04	1/ 1041									0.59938	70	9.22E-04	1/1085
Marais vinery	2100	UMTS											0.10169	600	3.93E-05	1/25449
Maraive	900	GSM	3.41E-03	1/ 293									1.0403	40	3.37E-03	1/296
Maraive	2100	UMTS											0.10441	584	3.92E-05	1/25533
Maseline Harbour - Sark	900	GSM	1.35E-02	1/ 74					3.3307	13	1.35E-02	1/74				
Maseline Harbour - Sark	1800	DCS			0.04353	1354	1.27E-06	1,786829					0.0719	816	3.57E-06	1/280132
Mignot plateau - St Barnabas church	900	GSM	1.64E-03	1/ 610					0.21001	203	9.79E-05	1/10220	0.93601	45	1.41E-03	1/711
Mignot plateau - St Barnabas church	1800	DCS			0.19992	295	4.68E-05	1,21361					0.11845	495	9.58E-06	1/104379
Mignot plateau - St Barnabas church	2100	UMTS			0.08438	723	1.01E-05	1,98956					0.1908	320	6.88E-05	1/14536
Nelson House	2400	WiFi			SITE OPERATED BY MICROTECH ONLY AT 2.4GHz											
Oakfield	900	GSM	4.58E-03	1/ 218					0.020596	2079	1.60E-06	1/626390	0.72561	58	1.79E-03	1/560
Oakfield	1800	DCS			1.4773	40	2.60E-03	1,385					0.0639	918	4.80E-06	1/208436
Oakfield	2100	UMTS			0.17844	342	9.69E-05	1,10324					0.1866	327	9.64E-05	1/10374
Odeon Bunker	900	GSM	2.20E-03	1/ 454					1.0596	40	2.19E-03	1/456	0.027646	1521	2.22E-06	1/449844
Odeon Bunker	1800	DCS			0.0646	913	1.49E-06	1,670926					0.089628	654	3.74E-06	1/267366
Petit Bot	900	GSM	2.17E-03	1/ 461					0.96223	44	6.06E-04	1/1650	1.1377	37	1.55E-03	1/646
Petit Bot	2100	UMTS											0.095615	638	1.74E-05	1/57625
Police HQ	900	GSM	4.50E-04	1/ 2223					0.012083	3526	5.69E-07	1/1757788	0.57315	73	4.47E-04	1/2238
Police HQ	1800	DCS			0.040911	1441	1.20E-06	1,833784					0.010768	5448	3.01E-07	1/3320715
Police HQ	2100	UMTS			0.022366	2727	8.64E-07	1,1157263								
PoP	900	GSM	8.54E-04	1/ 1171					0.022862	1863	1.84E-06	1/544810	0.034711	1211	1.90E-06	1/526183
PoP	1800	DCS			0.028479	2070	6.48E-07	1,1542464					1.083	54	8.50E-04	1/1177
Princess Elizabeth Hospital (Indoors)	900	GSM	3.55E-04	1/ 2814									0.011804	3562	2.69E-07	1/3712707
Princess Elizabeth Hospital (Indoors)	1800	DCS			0.70323	84	3.25E-04	1,3073					0.012919	4541	8.20E-08	1/12132816
Princess Elizabeth Hospital (Indoors)	2100	UMTS			0.12835	475	2.96E-05	1,33832								
Princess Elizabeth Hospital (Outdoors)	900	GSM	8.56E-05	1/ 11686									0.058029	725	4.85E-06	1/206383
Princess Elizabeth Hospital (Outdoors)	1800	DCS			0.32596	181	6.64E-05	1,15059					0.20025	293	1.26E-05	1/79592
Princess Elizabeth Hospital (Outdoors)	2100	UMTS			0.029614	2060	1.75E-06	1,570200								
Regency	900	GSM	2.82E-03	1/ 354									0.96122	44	2.11E-03	1/474
Regency	1800	DCS			0.59271	99	4.02E-04	1,2487					0.056163	1044	1.10E-06	1/906652
Regency	2100	UMTS			0.18425	331	1.27E-04	1,7876					0.23709	257	1.84E-04	1/5446
Reservoir	900	GSM	8.73E-04	1/ 1146					0.64109	66	8.73E-04	1/1146				
Rohais	900	GSM	2.28E-03	1/ 439					1.043	41	2.27E-03	1/440	0.0481	873	7.02E-06	1/142434
Ronez Quarry	900	GSM	2.90E-03	1/ 345					0.83277	51	2.90E-03	1/345				
Sark Harbour - crane sheds	900	GSM	2.36E-03	1/ 424					0.85357	50	9.90E-04	1/1010				
Sark Harbour - crane sheds	1800	DCS			0.57345	103	2.05E-04	1,4879					1.319	44	1.16E-03	1/858
Sark Harbour - old harbour	900	GSM	2.64E-03	1/ 379					1.1534	37	1.69E-03	1/591				
Sark Harbour - old harbour	1800	DCS			1.2081	49	9.36E-04	1,1068					0.10319	568	7.49E-06	1/133513
Sark Telephone Exchange	900	GSM	1.19E-03	1/ 842					0.40115	106	4.64E-04	1/2154	0.5567399	76	6.34E-04	1/1576
Sark Telephone Exchange	2100	UMTS			0.19491	313	7.46E-05	1,13403					0.08497	718	1.38E-05	1/72492

Site names Se-W

Site Name	Freq band	Technology	Cumulative EQ	Cumulative EQ ratio	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP	Max Field strength [V/m]	ICNIRP Ref. level to Max FS	Band EQ	Band EQ Rel to ICNIRP
SEB	900	GSM	9.80E-04	1/ 1021					0.30163	141	4.90E-04	1/2042	0.1919	219	1.49E-04	1/6711
SEB	1800	DCS			0.49458	119	3.26E-04	1,3069								
SEB	2100	UMTS			0.055208	1105	6.67E-06	1,149961								
Sir Charles Frossard House	900	GSM	2.59E-03	1/ 387					1.4329	30	2.57E-03	1/389	0.084391	498	1.05E-05	1/95188
Sir Charles Frossard House	1800	DCS			0.062	951	3.15E-06	1,317472								
Sir Charles Frossard House	2100	UMTS			0.029502	2086	1.57E-06	1,635252								
St Peter Port Harbour	900	GSM	2.56E-03	1/ 390					0.72471	59	1.38E-03	1/725				
St Peter Port Harbour	1800	DCS			0.39636	149	1.56E-04	1,6430					0.89808	65	6.11E-04	1/1637
St Peter Port Harbour	2100	UMTS			0.1084	563	2.10E-04	1,4764					0.11319	539	2.06E-04	1/4859
St Peters Exchange	900	GSM	5.43E-03	1/ 184					1.0634	40	1.60E-03	1/627	0.70723	59	7.47E-04	1/1339
St Peters Exchange	1800	DCS			2.0576999	29	2.99E-03	1,335					0.03474	1689	3.94E-07	1/2535615
St Peters Exchange	2100	UMTS			0.19931	306	6.81E-05	1,14691					0.13095	466	3.33E-05	1/30052
St Pierre Park	900	GSM	5.48E-04	1/ 1824					0.025616	1663	9.78E-07	1/1022855	0.59589	71	5.42E-04	1/1845
St Pierre Park	2100	UMTS											0.053943	1131	5.28E-06	1/189449
TRS	900	GSM	4.48E-04	1/ 2230					0.37551	113	3.14E-04	1/3180	0.013627	3085	3.65E-07	1/2743093
TRS	1800	DCS			0.37019	159	9.70E-05	1,10306					0.15531	378	2.93E-05	1/34095
TRS	2100	UMTS			0.031202	1955	1.84E-06	1,543373					0.054953	1110	5.42E-06	1/184460
Vale Garage	14000	SAT-link			ONLY OPERATOR HERE IS HUGHES NETWORKS											
Victoria Tower	900	GSM	8.95E-05	1/ 11176					0.081993	520	1.44E-05	1/69207	0.0085152	4938	1.97E-07	1/5071976
Victoria Tower	1800	DCS			0.099491	593	7.68E-06	1,130283					0.18381	319	5.30E-05	1/18862
Victoria Tower	2100	UMTS			0.022671	2691	1.08E-06	1,922751					0.087776	695	1.31E-05	1/76628
Watchtower	900	GSM	1.17E-03	1/ 853					0.13028	327	5.79E-05	1/17258	0.50201	84	4.50E-04	1/2221
Watchtower	1800	DCS			0.93931	63	6.09E-04	1,1643								
Watchtower	2100	UMTS											0.19495	313	5.54E-05	1/18052
Water tower	900	GSM	5.06E-03	1/ 198					1.4715	29	2.66E-03	1/375	1.3525	31	2.39E-03	1/418
Water tower	2100	UMTS			0.045197	1350	3.66E-06	1,273423					0.0034202	17835	5.70E-08	1/17488879
Wave Shop	900	GSM	2.90E-04	1/ 3449									0.013779	3051	3.69E-07	1/2711897
Wave Shop	1800	DCS											0.66089	89	2.77E-04	1/3608
Wave Shop	2100	UMTS											0.084827	719	1.24E-05	1/80669
Westwood	900	GSM	2.42E-03	1/ 413									0.83559	50	1.24E-03	1/808
Westwood	1800	DCS			1.0254	57	9.11E-04	1,1097					0.45213	130	6.15E-05	1/16259
Westwood	2100	UMTS			0.31089	196	1.75E-04	1,5726					0.13715	445	3.28E-05	1/30514

