

**An Analysis of Radiofrequency Fields Associated
with Operation of the Hydro One Smart Meter
System**

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Prepared for

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Summary

Implementation of a new Smart Meter technology by Hydro One will make use of low power radiofrequency (RF) transmitters for automatic electric power meter reading. The technology will also provide customers the possibility of automatically controlling their own use of electricity based on energy rates during the day. A study of RF fields produced by the transmitting components of the system shows that the potential exposure of individuals will comply with applicable guidelines by Health Canada in their Safety Code 6 for human exposure by a very wide margin ranging from hundreds to hundreds of thousands of times less than those limits. For example, immediately adjacent to a power meter, the RF field power density will be about 0.1 watt per square meter (W/m^2) compared to the exposure limit of $10 W/m^2$ appropriate to the 2.4 GHz band. Typical exposure to access points that are mounted 8 meters above ground will be even lower, more than 57,000 times less than the exposure limit. When put in the context of established adverse health effects of RF fields, with Safety Code 6 limits incorporating a safety factor of 50, typical exposures to the Smart Meter system will, at worst, range from a factor of 5,000 to more than 5,000,000 times less than the threshold for hazardous effects. When compared with RF fields produced by many devices found in our everyday environment, such as radio and television broadcast stations, cellular telephones, and microwave ovens, typical RF exposures resulting from the Hydro One Smart Meter technology will be very much weaker.

RF transmitting components of the system include 1 watt, or less, transmitters contained within the power meter, in repeater units, and within access points (referred to as MeshGates). The system constitutes a sophisticated mesh network wherein each meter can act as a repeater for assisting in delivering outgoing data to access points or other nearby meters from whence the data is further relayed.

Based on this analysis for the system as being implemented by Hydro One, Smart Meter system related RF exposure of individuals who live and/or work in or around structures that are equipped with the Smart Meter system will be compliant with the relevant Safety Code 6 limits for safe exposure by a wide margin.

A glossary of terms found in this report is included at the end of this report.

Introduction and Background

Automatic Meter Reading (AMR) technology is being adopted by Hydro One to facilitate remote reading of electricity usage by customers without the traditional deployment of field personnel for obtaining monthly readings from individual meters.

Beyond the capability that AMR technology brings to the company, Hydro One is implementing advanced features which are a part of the AMR equipment that will allow individual customers to monitor their own usage of electric energy and even control devices within their homes based on dynamic electric energy charges during the day by programming such appliances as hot water heaters, furnaces and air conditioning systems to operate only when electric energy rates are less costly. This program is referred to as the Smart Meter program by Hydro One and will, eventually, become widespread throughout Canada with similar system implementations within the United States. The equipment that will be used relies upon radiofrequency (RF) signals for communicating the data associated with meter readings and making electricity rates at various times of the day available to customers. This report addresses the RF fields that may be produced by the system's operation in relation to the potential for exposure of individuals in the vicinity of the various transmitting portions of the system. Comparisons between the expected RF field strengths produced by the Smart Meter system components and maximum exposure limits specified in Canadian Safety Code 6 are made for forming a perspective on possible exposure of the general public.

The system being implemented by Hydro One is provided by Trilliant Networks Inc.¹ and consists of a number of different components, each of which make use of RF signals from low power transmitters. Figure 1 provides a simplified illustration of how the Smart Meter system will be configured with the Trilliant Networks equipment. In this system, so-called endpoint devices consist of the electric power meters which contain a low power transmitter. These different devices employ low power transmitters to provide communications among the different power meters installed on homes and, ultimately, communicating back to the electric utility company. As Figure 1 illustrates, electric power meters provide energy consumption data to Hydro One via miniature radio transmitters contained within the power meters. To ultimately reach Hydro One's facilities, the signal that originates at each power meter must communicate with a so-called access point (also referred to as a MeshGate by Trilliant). In some cases, an intermediate relay unit will be used to facilitate this connection. At each access point, data being received from many different power meters in the general area are retransmitted over a wireless area network (WAN) to Hydro One. The WAN is provided by a company that offers wireless Internet connectivity and the WAN transmitter inside each access point is similar to the AirCard found in laptop computers used for accessing the Internet. This means that each access point contains two transmitters, one for communicating with the rest of the AMR network and one for connection via the WAN to Hydro One.

The Trilliant Networks equipment is configured as a mesh network. This means that the AMR transmitter inside each power meter is designed to communicate with each other meter transmitter within its range if necessary to get the data signal back to an access point. In essence, each meter transmitter also acts as a repeater. In the event that a given power meter can't directly reach the nearest access point, the data can be handled by a closer meter and relayed to the access point or to yet another meter or a specific relay transmitter for ultimate communication with the access point. Thus, the grouping

¹ Trilliant Networks, Inc., 1100 Island Drive, Redwood City, CA 94065.

of a large number of meters with their internal transmitters forms the mesh network, the various meters simulating the interconnection points (or nodes) similar to a screen mesh. Through the mesh approach, more distant meters can still communicate with an access point through the help of its neighbors and an access point can communicate with the more distant meters that may be out of direct range of the access point. Actual dedicated relay transmitters are used in some locations to facilitate the communications.

The small transmitters that are used in this system transmit with very low power and transmit very infrequently. These transmitters that compose the mesh network equipment operate with a maximum power of only one watt within the license free band of 2.4000-2.4835 GHz (hereafter referred to as the 2.4 GHz band) and use an antenna contained within the power meter². Furthermore, they only transmit ever so often, typically less than two minutes in each hour (a maximum, worst case duty cycle of the transmitters has been estimated by Trilliant Networks at approximately 3.3%). At the various access points, in addition to the 2.4 GHz band transmitter that communicates with power meters, the AirCard transmitter operates with a nominal power of 0.5 watt and transmits in the frequency band used by the particular company that provides the WAN access (typically this is in the 900 MHz or 1.9 GHz frequency range³). The WAN transmitter is estimated to operate with a duty cycle of approximately 0.25% (this corresponds to an average of approximately 9 seconds each hour).

While the meter transmitters are constrained to where the power meters are located, repeaters will typically be mounted outdoors and elevated approximately 8 meters above ground. The duty cycle of repeaters is also small since they will only operate when necessary to relay signals on to an access point. The duty cycle of a dedicated repeater may be greater than that of a given individual meter, however, since it may be required to relay data from more meters during any particular time period than a power meter installed on a house.

Access points are also typically installed at elevated points, but sometimes at the power meter, and are designed to accommodate data transmissions from many power meters installed on the premises of homeowners and businesses. In practice, these access points are configured to interact with as many as 500 individual power meters.

Within each home equipped with a Smart Meter, different electrical devices, such as furnaces, water heaters, and air conditioning systems will be able to communicate with the electric utility system via a very low power transmitter at each of those devices. If so equipped, the transmitters operate with approximately 180 milliwatts (0.18 W).⁴ The maximum duty cycle of these premise device transmitters is very small and, if used, approximately 0.125% (equivalent to approximately 4.5 seconds each hour).

² The gain of the antenna contained in the power meter is +2 dBi.

³ The gain of the antenna used in access points for the WAN connection is +2 dBi.

⁴ The gain of the antenna inside these premise devices is approximately -2 dBi.

Radiofrequency Exposure Limits

In Canada, human exposure to RF fields is guided by the recommendations of Health Canada's Safety Code 6⁵ as revised in 2009. Exposure limits are based on limiting the rate at which RF energy is absorbed within the body to safe levels. The exposure limits in Safety Code 6 are similar to those contained in several other guidelines or standards including limits developed by the Institute of Electrical and Electronics Engineers⁶, guidelines published by the International Commission on Non-ionizing Radiation Protection⁷ and those promulgated by the Federal Communications Commission⁸ in the United States. The Safety Code 6 exposure limits are expressed in terms of the plane wave equivalent power density of the RF field or the strength of the electric and/or magnetic field components of the RF field. Power density is expressed as power per unit area and is most commonly given in units of milliwatts per square centimeter (mW/cm^2) or watts per square meter (W/m^2).

Safety Code 6 distinguishes between exposure limits for RF and microwave exposed workers and persons not classed as RF and microwave exposed workers (including the general public) with the limits for the general public being more stringent by a factor of five times. For the 2.4 GHz band, the Safety Code 6 exposure limit for the public is a continuous power density of $10 \text{ W}/\text{m}^2$ (equivalent to 1 milliwatt per square centimeter (mW/cm^2)). Human exposure, relative to Safety Code 6, is measured in terms of the time-averaged value of power density as averaged over any six-minute period. This means that intermittent RF fields, similar to those produced by the Smart Meter system operated by Hydro One must be averaged over any six-minute period for comparison to the exposure limits of Safety Code 6.

A feature of all RF exposure limits, including those recommended by Safety Code 6, is the inclusion of safety factors. The exposure limits are developed by determining the lowest RF energy absorption rate that has been determined to result in a potentially hazardous biological effect if the body is continuously exposed. The incident power density that could result in this rate of energy absorption is then reduced by a safety factor such that the exposure limits for the public are fifty-fold less than the hazard level. Hence, RF fields that just reach the exposure limit are still fifty times less than the threshold for potentially hazardous exposure.

⁵ Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz - Safety Code 6 (2009), (HC Pub. 091029). Health Canada, 2009.

⁶ IEEE (2005). Standard C95.1-2005. *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*. Published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017. www.standards.ieee.org

⁷ ICNIRP (1998). Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Prepared by the International Commission on Non-Ionizing Radiation Protection. *Health Physics*, Vol.74, Number 4, pp. 494-522. April. www.icnirp.de

⁸ FCC (1997a). Federal Communications Commission. "Radiofrequency radiation exposure limits," 47 CFR 1.1310 *et seq.* (Federal Communications Commission, Washington, DC).

Although RF exposure limits have been in existence since the 1960's, there has been, from time to time, arguments brought by some that the limits are not sufficiently protective. Despite these criticisms, the inherently conservative nature of the various guidelines for safe human exposure, world-wide, continues to be evident from the widespread support from various government scientific agencies, health protection organizations, and expert panels. In case after case, published commentaries or statements rendered by these entities have formed the notably uniform position that RF exposures that comply with presently used guidelines, those of Safety Code 6 included, should be considered safe. Effectively, these comments embrace the view that the biological bases for current exposure guidelines are sufficiently robust to overcome arguments against the scientific soundness of established adverse health effects found in the literature. Numerous examples of statements recognizing the adequacy of present-day RF exposure limits and the present status of our knowledge about biological effects of RF fields are listed in Appendix A with World Wide Web links to the sources.⁹

Maximum Likely RF Fields Resulting from the Smart Meter System

RF fields that might be associated with emissions from the various transmitting components of the Hydro One Smart Meter system were calculated following the methodology described here. This method includes the conservative approach of accounting for the possibility of ground reflections that can enhance the local RF field strength at any given location. The intensities of RF fields (expressed as power density) were calculated using conventional field calculation methods but with the inclusion of a ground reflection factor as recommended by the FCC¹⁰. Power densities were calculated according to the following relationship:

$$S(W / m^2) = \frac{P_t \times G_{\max} \times \delta \times 2.56}{4\pi R^2} \quad \text{Equation 1}$$

Where,

S is plane-wave equivalent power density (W/m²)

P_t is maximum transmitter output power (W)

G_{max} is the maximum possible antenna power gain (a dimensionless factor)

δ is the duty cycle of the transmitter (percentage of time that the transmitter actually transmits over time)

R is the radial distance between the transmitter and the point of interest (meters)

2.56 is a factor accounts for possible ground reflections that could enhance the resultant power density. Ground reflection could cause a maximum 1.6-fold increase of the field

⁹ It is notable that in some of the examples in Appendix A, the issue of so-called electro-sensitivity (a reported extreme sensitivity of some persons to detect the presence of weak RF fields) is mentioned. This phenomenon, at present, has not been found to be substantiated via blinded, scientific studies.

¹⁰ FCC (1997). *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*. Federal Communications Commission, Office of Engineering & Technology, OET Bulletin 65, Edition 97-01, August.

strength leading to an increase of $(1.6)^2$ or 2.56 in the power density since it is proportional to the square of field strength.

Calculations were performed for distances from 0.3 meters up to 300 meters from each transmitting device.

Figure 2 illustrates the results of this analysis showing the maximum expected power density from the 2.4 GHz transmissions that might exist in the vicinity of one of the power meters and in the vicinity of an access point (a MeshGate which contains both a 2.4 GHz transmitter for communication with the meter network as well as an AirCard transmitter for wireless connection to a WAN) and the very low power transmitters that might be attached to various kinds of appliances or other devices that consume electrical energy for communication with the customer's power meter over a home area network. Immediately adjacent to a power meter, for example, the power density is calculated to be 0.1 W/m^2 . In Figure 2, the curves for the power meter by itself and an access point that consists of a transmitter similar to that in a power meter and an additional WAN transmitter fall virtually on top of each other. This is because of the lower power for the AirCard transmitter and its very low duty cycle. The lowest curve in Figure 2 represents the RF field power density that might exist in the vicinity of a so-called premise device, the small transmitter that could be installed on various electrical appliances. Relay units operate with the same power as the power meter transmitters and, hence, would be expected to produce similar power densities in their vicinity.

The distance scale of Figure 2 represents the straight line distance from the electric power meter or the access point (MeshGate) or dedicated relay unit locations. Generally, relay transmitters and access points will be located on poles at a height of approximately 8 meters above ground. Hence, the indicated values of power density are, generally, highly conservative since most exposure situations will result in a minimum distance of closest approach of 8 meters and the power densities shown for closer distances will not be relevant to most conditions for access points or relay units.

Figure 2 shows that the RF field to which individuals could be exposed from the Smart Meter system will be very weak when compared to the relevant human exposure limits defined in Safety Code 6, being typically at least a hundred times less than the limits.

Perspective on RF Fields

The RF field power densities that will be produced by the Smart Meter system operated by Hydro One will be very weak, even very close to the various RF transmitting components of the system. When compared to the Safety Code 6 limits established for safe human exposure, Figure 2 indicates that the resulting RF fields will be substantially less than the limits set for the general public. For example, in the area immediately adjacent to a power meter, the power density will be approximately 100 times less than

the public exposure limit. At greater distances, the power density becomes even less with an increasing margin between the RF field and the exposure limit.

While the RF fields near an access point will be greater due to the AirCard (WAN) transmitter on-time, even in this case, the fields are small in comparison to the limits. Because of the very low duty cycle of the WAN transmitter, it adds an almost unperceivable contribution to the power density of the 2.4 GHz transmitter for communication with the power meter network. For typical exposure distances associated with access points mounted on poles at 8 meters above ground, the power density will be approximately 57,000 times less than the Safety Code 6 public exposure limit. For the more rare case of an access point being installed on a building rooftop or other location where individuals may have close access, the field will still be substantially less than the public limit, being approximately 100 times less than the limit for the case of a person being immediately proximate to the access point.

These power densities can be put in some perspective by comparing them to those fields that are produced by operation of conventional microwave ovens used in residential kitchens. All microwave ovens leak small amounts of RF energy during their normal operation (a tiny fraction of the allowable leakage set by the Food and Drug Administration in the United States of 50 W/m^2). Most microwave ovens produce RF fields within several meters of the oven in the range of 0.1 W/m^2 at the microwave oven frequency of 2.45 GHz, similar to the frequency band used by the transmitters used in the Smart Meter system.

WI-FI systems, commonly found today at so-called hotspots, for wireless access to the Internet, produce RF fields in the range of $0.1\text{-}0.2 \text{ W/m}^2$ ^{11,12}. Similar values of power density are found near wireless routers that are commonly used in homes for distributing Internet connectivity to personal computers. All of these values are orders of magnitude less than the limits set for safe human exposure in Safety Code 6 or any of the other national or international standards.

Should a customer elect to install a home area network for communication with the Smart Meter equipment in their home, RF exposure of the customer or other individuals within the home would likely be dominated by the wireless router being used by the customer, not the RF transmission components inside the power meter or the very low power transmitters that could be attached to various electrical appliances or equipment. Such exposure would be principally driven by distance between the customer and their in-home home area network equipment rather than proximity to the power meter. Typical building materials can introduce significant attenuation of the Smart Meter signals originating from the various transmitting components of the system.

¹¹ Foster, K.R. (2007). Radiofrequency exposure from wireless LANS utilizing WI-FFI technology. *Health Physics*, Vol. 92, No. 3, March, pp. 280-282.

¹² Schmidt, G. et al. (2007). Exposure of the general public due to wireless LAN applications in public places. *Radiation Protection Dosimetry*, Vol. 123, No. 1, Epub June 11, pp. 48-52.

In an Environmental Protection Agency study, environmental field measurements across the United States showed that most people, most of the time, are exposed to very weak RF fields from broadcast stations¹³. In that study, the median RF field exposure of the public was determined to be approximately 0.05 W/m². The same study estimated that 1% of the public in metropolitan areas was exposed to RF fields exceeding 0.01 W/m². These data on common public exposure to ambient broadcast signals fall within or even above the calculated values for RF fields associated with operation of the various AMR systems studied.

This study is focused on the Smart Meter system being implemented by Hydro One. The study does not take into account the potential for RF fields that may be produced by other devices or systems that are not a part of the Smart Meter system. Such devices or systems could include the use of cellular or cordless telephones, cellular telephone base stations, the presence of broadcast radio and television stations, or operation of any other appliance or equipment that may be a source of RF energy.

Conclusions

An analysis of RF fields that may be produced during operation of different components of the Hydro One Smart Meter system shows that the intensities of these fields are small fractions of the present RF exposure limits established for the general public in Health Canada's Safety Code 6. Weak RF fields in the frequency range of 2.4 GHz will be produced on an intermittent basis during the systems normal operation. These fields may have power densities that, for the most part, range from as great as 0.1 W/m² to levels hundreds of thousands of times less. The present exposure limits for members of the public to the 2.45 GHz band is 10 W/m². In a worst case scenario of a person able to get immediately next to an access point, despite the difficulty, the maximum power density expected would be approximately 0.1 W/m². When put in the context of established adverse health effects of RF fields, typical exposures to the Smart Meter system will, at worst, range from a factor of 5,000 to more than 5,000,000 times less than the threshold for hazardous effects.

Based on this analysis for the system as being implemented by Hydro One, Smart Meter system related RF exposure of individuals who live and/or work in or around structures that are equipped with the Smart Meter system will be compliant with existing standards and regulations for safe exposure by a very wide margin. Because of the very weak fields produced by the various components of the system, it is likely that the RF exposure of most individuals will be predominated by other RF sources in their vicinity.

¹³ Tell R. A., Mantiply E. D. (1980): Population exposure to VHF and UHF radiation in the United States. *Proc IEEE* 68:6-12.

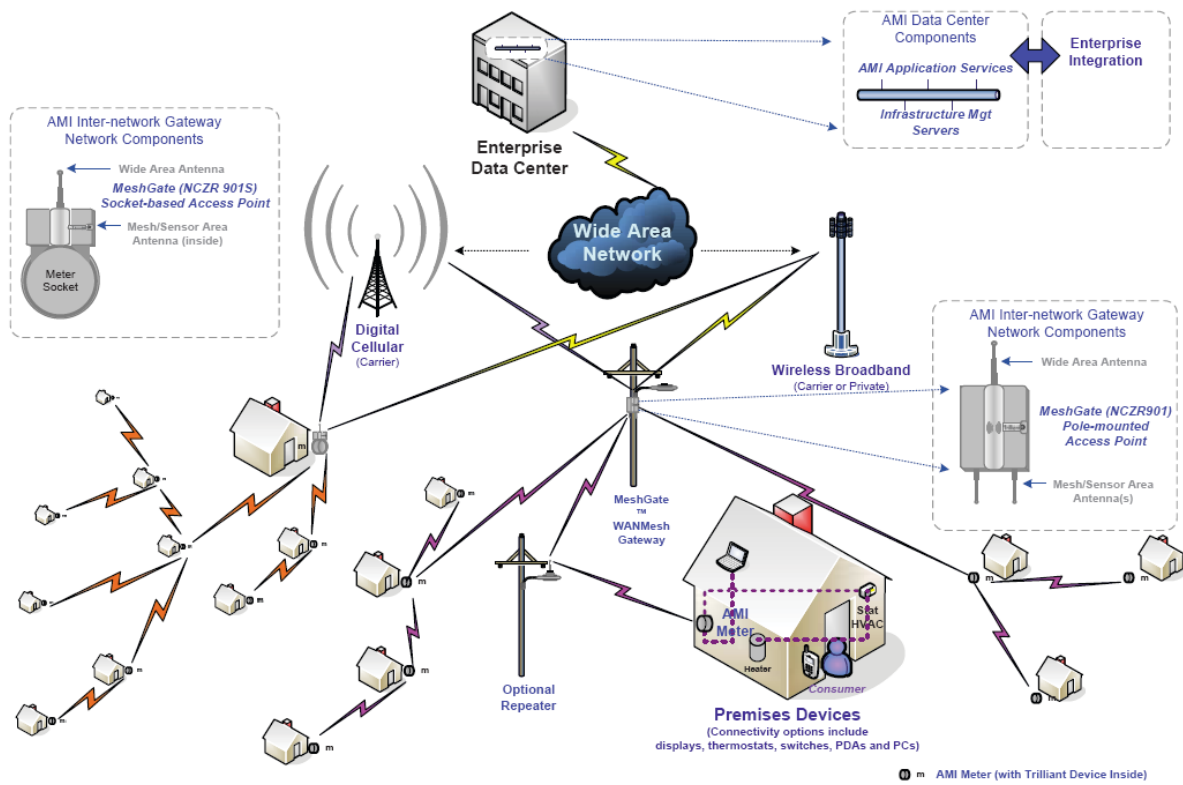


Figure 1. Illustration of components of the Hydro One Smart Meter system showing the use of radiofrequency (RF) signals for communications among electric power meters, relays, access points and, ultimately, Hydro One’s enterprise management systems. (From Trilliant Networks’ sales literature).

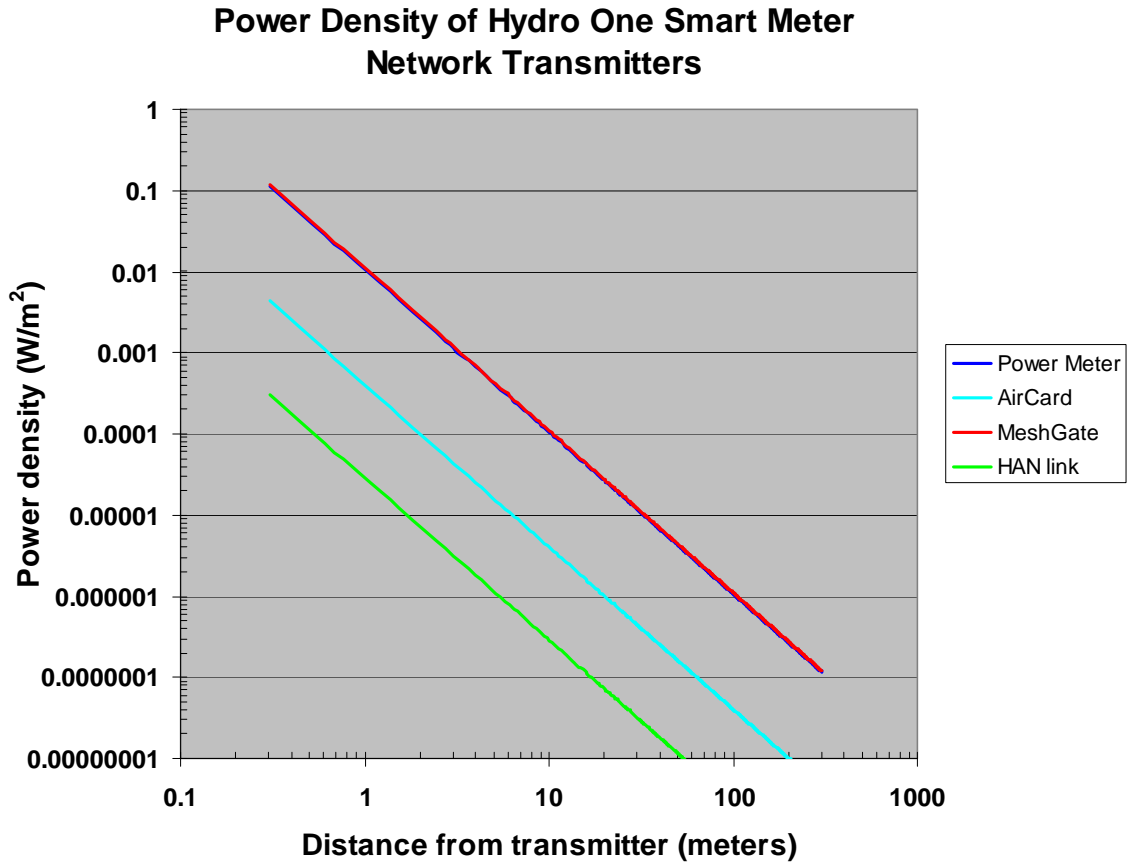


Figure 2. Calculated RF power density vs. distance for the various transmitters employed as part of the Hydro One Smart Meter program including electric power meters, access points (MeshGates), and internal meter home area network transmitters. Repeater units would produce RF fields approximately the same as the indicated MeshGate. The red curve for the MeshGate falls virtually on top of the blue curve for a power meter transmitter because the added power density associated with the AirCard WAN connection represents such a small value of time-averaged power density. HAN refers to a home area network.

Appendix A

Statements from Governments and Expert Panels Concerning Health Effects and Safe Exposure Levels of Radiofrequency Energy (2000-2010)

U.K. Independent Expert Group on Mobile Phones (IEGMP) (2000)

IEGMP, “Mobile Phones and Health,” Independent Expert Group on Mobile Phones,” c/o National Radiological Protection Board, Chilton, Didcot,” Oxon, UK. www.iegmp.org.uk
“The balance of evidence to date suggests that exposures to RF radiation below NRPB and ICNIRP guidelines do not cause adverse health effects to the general population...” (p. 3).

World Health Organization (2000)

Fact Sheet N193 Electromagnetic Fields and Public Health

http://www.who.int/docstore/peh-emf/publications/facts_press/efact/efs193.html

“Cancer: Current scientific evidence indicates that exposure to RF fields, such as those emitted by mobile phones and their base stations, is unlikely to induce or promote cancers.”

“Other health risks: Scientists have reported other effects of using mobile phones including changes in brain activity, reaction times, and sleep patterns. These effects are small and have no apparent health significance.” “None of the recent reviews have concluded that exposure to the RF fields from mobile phones or their base stations causes any adverse health consequence.”

Japanese Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT) (2001)

Interim Report by Committee to Promote Research on the Possible Biological Effects of Electromagnetic Fields (30 January 2001), MPHPT Communications News, Vol. 11, No. 23.

http://www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol11/Vol11_23.pdf

“Research into the effects of radio waves on the human body has been conducted for more than 50 years in countries around the world, including Japan. Based on voluminous findings from those studies, exposure guidelines including the Japanese guideline of the ‘Radio Radiation Protection Guidelines for Human Exposure to Electromagnetic Fields’ has been developed with a safety margin enough to protect human health from adverse effects of radio waves.” (summary point 1, p. 3)

Singapore Health Sciences Authority (2001)

Pulse@HSA (Health Sciences Authority), Frequently Asked Questions about EME & Mobile Phones

“Up to the present time, all international and national committees that have evaluated this whole body of evidence have reached the same conclusions: that there are no established health effects from EMF exposures below the international guidelines limits.” (p. 12)

Australian Government, Australian Radiation Protection and Nuclear Safety Agency, Committee on Electromagnetic Energy Public Health Issues (2003)

Fact Sheet EME Series No 1 “Electromagnetic Energy and Its Effects” <http://www.arpansa.gov.au/pubs/eme/fact1.pdf> “The weight of national and international scientific opinion is that there is no substantiated evidence that exposure to low level RF EME causes adverse health effects.”

French Environmental Health and Safety Agency (AFSSE) (2003)

AFSSE Statement on Mobile Phones and Health

http://afsse.fr/upload/bibliotheque/994597576240248663335826568793/statement_mobile_phones_2003.pdf

”With regard to the risk of cancer, we can accept that with the levels of power used in mobile telephony, radiation does not have an effect on our cells’ genes (it is not ‘genotoxic’). Work carried out on animals using long-term exposure does not indicate a risk of cancer; it shows neither an actual ‘initiator’ effect nor a promoter’ effect for cancers caused by carcinogenic agents.” (p.4)

“At present, the scientific data available does not indicate that children are particularly susceptible to radiation caused by telephones nor do they have a higher exposure in comparison to adults.” (p. 5)

U.K. National Radiological Protection Board (NRPB), Advisory Group on Non-Ionizing Radiation (AGNIR) (2004)

“Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0 – 300 GHz),” Documents of the NRPB, Vol. 15, No. 3, NRPB, Chilton, Didcot, Oxfordshire, U.K.

<http://www.hpa.org.uk/Publications/Radiation/NRPBArchive/DocumentsOfTheNRPB/Abd1503/> “Overall, AGNIR concluded that, in aggregate, the research published since the IEGMP² report does not give cause for concern and that the weight of evidence now available does not suggest that there are adverse health effects from exposures to RF fields below guideline levels” (p. 8).

²IEGMP: U.K. Independent Expert Group on Mobile Phones (see first item on page 1)

World Health Organization (2004)

Electromagnetic Fields (EMF). Summary of health effects

<http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html>

“Conclusions from scientific research In the area of biological effects and medical applications of non-ionizing radiation approximately 25,000 articles have been published over the past 30 years. Despite the feeling of some people that more research needs to be

done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research.”

Health Council of the Netherlands (2004)

Electromagnetic Fields Committee. Mobile Phones and Children: Is Precaution Warranted? *Bioelectromagnetics* 25:142-144.

“The Health Council therefore sees no reason to recommend limiting the use of mobile phones by children.” (p. 142)

U.S. Department of Health and Human Services, Centers for Disease Prevention and Control (2005)

CDC Fact Sheet: Frequently Asked Questions about Cell Phones and Your Health http://www.cdc.gov/nceh/radiation/factsheets/cellphone_facts.pdf

“In the last 10 years, hundreds of new research studies have been done to more directly study possible effects of cell phone use. Although some studies have raised concerns, the scientific research, when taken together, does not indicate a significant association between cell phone use and health effects.” (p. 1)

European Cancer Prevention Organization (2005)

During annual symposium on Cell Phones and Cancer in Blankenberge, Belgium on November 4-5, 2005, a consensus statement was developed about the health effects of electromagnetic fields from cell phones. <http://www.ecpo.org/>

The consensus statement includes the conclusion that “The European Cancer Prevention Organization states that, in 2005 there is insufficient contemporary proof with regard to increased cancer risk to change mobile phoning habits.”

German Research Centre Jülich, Programme Group Humans, Environment, Technology (MUT) (2005)

This program brought together 25 leading experts from Germany and Switzerland in a risk dialogue to assess the results of recent scientific studies on mobile phones and base stations

<http://www.fz-juelich.de/portal/index.php?index=721&jahr=2005&cmd=show&mid=288>

Dr. Peter Wiedemann, head of the Jülich MUT Programme Group, concluded that "The scientific studies examined in the risk dialogue do not support suspicions that mobile telephony has harmful effects on health."

Swedish State Radiation Protection Authority (SSI) (2006)

Recent Research on EMF and Health Risk, Fourth annual report from SSI's Independent Expert Group on Electromagnetic Fields

http://www.ssi.se/ssi_rapporter/pdf/ssi_rapp_2007_4.pdf

Mobile phone: “Recently published studies on mobile phone use and cancer risk do not change the earlier overall assessment of the available evidence from epidemiological studies. In particular an extended follow up of a cohort study from Denmark does not

alter the conclusions. Currently available evidence suggests that for adult brain tumours there is no association with mobile phone use for at least up to, say, ten years of use. For longer latency the majority of the evidence also speaks against an association, but the data are still sparse. The same conclusion holds for short-term use and acoustic neuroma. However, for long-term use and acoustic neuroma there is a concern, and more information is required.” (p. 5)

Base station: “The overall conclusion is that exposure from transmitters is unlikely to be a health risk.” (p. 36)

Australian Communications and Media Authority (2006)

Mobile Phones, Your Health and Regulation of Radiofrequency Electromagnetic Energy

http://emr.acma.gov.au/mobile_phone_health.pdf

Mobile phone: “The weight of national and international scientific opinion is that there is no substantiated evidence that using a mobile phone causes harmful health effects. Although there have been studies reporting biological effects at low levels, there has been no indication that such effects might constitute a human health hazard, even with long-term exposure...The general consensus of scientific opinion is that, provided mobile phones do not exceed the limits of recognised standards, there will be no harmful effects.” (p. 8)

Base station: “The weight of national and international expert opinion is that there is no substantiated evidence that there are adverse health effects resulting from the emissions of mobile phone towers or base stations.” (p. 9)

Health Canada (2006)

It’s Your Health, Safety and Safe Use of Mobile Phones

http://www.hc-sc.gc.ca/iyh-vsv/prod/cell_e.html

“There is no firm evidence to date that RF emissions from cell phones cause ill health.”

U.S. Federal Communications Commission (2006)

Mobile Phones and Health Concerns

<http://ftp.fcc.gov/cgb/consumerfacts/mobilephone.html>

“There is no scientific evidence that proves that wireless phone usage can lead to cancer or a variety of other problems, including headaches, dizziness or memory loss.”

UK Institution of Engineering and Technology, Biological Effects Policy Advisory Group on Low-level Electromagnetic Fields (2006)

The Possible Harmful Biological Effects of Low-Level Electromagnetic Fields of Frequencies up to 300 GHz <http://www.theiet.org/publicaffairs/bepag/postat02final.pdf>

“...the balance of scientific evidence to date does not indicate that harmful effects occur in humans due to low-level exposure to electromagnetic fields (“EMF”).” (p. 1)

New Zealand Ministry of Health, National Radiation Laboratory (2007)

Safety of Cell Phones <http://www.nrl.moh.govt.nz/faq/cellphonesandcellsites.asp>

“The balance of current research evidence suggests that exposures to the radiofrequency energy produced by cellphones do not cause health problems provided they comply with

international guidelines. Reviews of all the research have not found clear, consistent evidence of any adverse effects.”

Hong Kong, Office of the Telecommunications Authority (2007)

“Know More about Radiofrequency Electromagnetic Radiation”

<http://www.ofta.gov.hk/en/freq-spec/radiation.pdf>

“Is it safe to use held-held mobile phones?”

“Many studies have concluded that there is no evidence that mobile phones bring hazards to health when used under normal operating conditions.”

“Is it safe to live close to radiofrequency transmitters?”

“Operators of radio stations are required to ensure that the levels of electromagnetic radiation of their radio transmitters including those on rooftops in residential areas are within the limits stipulated in the Code of Practice. Despite densely-packed transmitters on some rooftops in residential areas, therefore, the buildings are absolutely safe to live in.”

Health Council of the Netherlands (2007)

“UMTS³ and DECT⁴ are systems for mobile communication. Some people wonder whether exposure to the radio waves of UMTS antennae or DECT base stations and handsets used at home may cause health problems. Recent research does not give any indications for this, however. This is the message of the Health Council of the Netherlands in its fourth Annual Update on Electromagnetic Fields...”

<http://www.gezondheidsraad.nl/sites/default/files/Press%20release%20200706%20site.pdf>

³UMTS: Universal Mobile Telecommunications System (UMTS) is one of the third-generation (3G) mobile phone technologies

⁴CT: Digital Enhanced Cordless Telecommunication is a European Telecommunications Standard Institute standard for digital cordless phones

Ireland Expert Group on Health Effects of Electromagnetic Fields (2007)

[http://www.dcmnr.gov.ie/NR/rdonlyres/9E29937F-1A27-4A16-A8C3-](http://www.dcmnr.gov.ie/NR/rdonlyres/9E29937F-1A27-4A16-A8C3-F403A623300C/0/ElectromagneticReport.pdf)

[F403A623300C/0/ElectromagneticReport.pdf](http://www.dcmnr.gov.ie/NR/rdonlyres/9E29937F-1A27-4A16-A8C3-F403A623300C/0/ElectromagneticReport.pdf)

“So far no adverse short or long-term health effects have been found from exposure to the RF signals produced by mobile phones and base station transmitters.” (p. 3)

“There are no data available to suggest that the use of mobile phones by children is a health hazard.” (p. 3)

“The ICNIRP guidelines provides adequate protection for the public from any EMF sources.” (p. 4)

International Commission on Non-ionizing Radiation Protection (ICNIRP) (2007)

”It is however the opinion of ICNIRP that present guidelines provide adequate protection against any adverse effect established so far.” Paolo Vecchia, Chairman, ICNIRP, Scientific Rationale of ICNIRP Guidelines, Abstract, WHO/ICNIRP/EMF-NET Joint Workshop on Current Trends in Health and Safety Risk Assessment of Work-Related Exposure to EMFs, Milan, Italy, February 14-16, 2007

<http://www.icnirp.de/Joint/VecchiaAbstract.pdf>

European Commission Scientific Committee on Emerging and Newly Identified Health Risks - Possible Effects of Electromagnetic Fields (EMF) on Human Health (2007)

http://ec.europa.eu/health/ph_risk/committees/04_scenihp/docs/scenihp_o_007.pdf

“RF field exposure has not convincingly been shown to have an effect on self-reported symptoms or well-being.” (p.6)

“In conclusion, no health effect has been consistently demonstrated at exposure levels below the limits of ICNIRP (International Commission on Non Ionising Radiation Protection) established in 1998.” (p. 6)

States of Jersey (2007)

Regarding emissions from mobile masts, “...it is equally clear that there is no scientific evidence to show that an actual risk exists.” States of Jersey, Review into the perceived health effects of mobile phone masts (s.r.8/2007) – Response of the Minister for Economic Development, May 30, 2007.

http://www.scrutiny.gov.je/view_doc.asp?panelid=0&reviewid=0&target=Reports&doc=documents/reports/S-260-48911-3052007.htm

Japan Ministry of Internal Affairs and Communications (2007)

“Consequently, this committee cannot recognize that there is any firm evidence of effects on health, including nonthermal effects, from radio waves at strengths that do not exceed the policy for protection from radio waves.” Committee to Promote Research on the Possible Effects of Electromagnetic Fields, Biweekly Newsletter of the Ministry of Internal Affairs and Communications (MIC), Communications News, Vol. 18(6), July 6, 2007.

http://www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol18/Vol18_06/Vol18_06.html

Finland (2007)

“No evidence of detrimental health effects were obtained in the studies on cell cultures, laboratory animals, voluntary persons, or theoretical modelling.” HERMO - Health Risk Assessment of Mobile Communications, A Finnish Research Programme 2004-2007. Final report. November 30, 2007. http://www.uku.fi/hermo/english/Final_report.shtml

United Kingdom (2007)

“The MTHR Programme was set up to resolve uncertainties identified by previous evaluations of the possible health risks associated with the widespread use of mobile phone technology. None of the research supported by the Programme and published so far demonstrates that biological or adverse health effects are produced by radiofrequency exposure from mobile phones...The Committee has recognized that, while many of the concerns raised by the Stewart Committee have been reduced by the Programme and work done elsewhere, some still remain. It has therefore proposed a further programme of work to address these.” Mobile Telecommunications Health Research (MTHR) Programme, Report 2007. See Report 2007 at <http://www.mthr.org.uk/>

European Commission, EMF-NET, Sixth Framework Programme (2007)

“Overall, there is no convincing scientific evidence that acute or long-term exposure to low level RF fields can affect reproduction and development in mammals: where consistent effects have been reported they can be attributable to thermal insults induced by exposure and not to any field-specific effect unrelated to heating.” EMF-NET: Effects of the exposure to electromagnetic fields: From science to public health and safer workplace. WP2.2 Deliverable report D4bis: Effects on reproduction and development, November 2007. <http://web.jrc.ec.europa.eu/emf%2Dnet/reports.cfm>

World Health Organization (2007)

“Despite extensive research, to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health.” (Key Point #6) <http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html>

“To date, all expert reviews on the health effects of exposure to RF fields have reached the same conclusion: There have been no adverse health consequences established from exposure to RF fields at levels below the international guidelines on exposure limits published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998).” Children and Mobile Phones: Clarification statement (second paragraph) http://www.who.int/peh-emf/meetings/ottawa_june05/en/index4.html

Fact Sheet #304: Electromagnetic fields and public health: Base stations and wireless technologies <http://www.who.int/mediacentre/factsheets/fs304/en/index.html>

“Conclusions: Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects.”

European Commission (2008)

Health and Consumer Protection Directorate-General, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) (2008). Possible effects of electromagnetic fields (EMF) on human health -- opinion of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Toxicology. 2008 (Apr 18) 246:248-250.

http://ec.europa.eu/health/ph_risk/committees/04_scenihhr/docs/scenihhr_o_007.pdf

“Since the adoption of the 2001 opinion extensive research has been conducted regarding possible health effects of exposure to low intensity RF fields, including epidemiologic, in vivo, and in vitro research. In conclusion, no health effect has been consistently demonstrated at exposure levels below the limits of ICNIRP (International Committee on Non Ionising Radiation Protection) established in 1998.”

United Kingdom (2008).

Position Statement by The Institution of Engineering and Technology: The Possible Harmful Biological Effects of Low-level Electromagnetic Fields of Frequencies up to 300 GHz. (May 2008) www.theiet.org/factfiles “In summary, the absence of robust new evidence of harmful effects of EMFs in the past two years is reassuring and is consistent with findings over the past decade.”

United Kingdom (2008).

Sense About Science. Making Sense of Radiation. A Guide to Radiation and Its Health Effects. <http://www.senseaboutscience.org.uk/pdf/makingsenseofradiation.pdf>

“A concern often raised by campaign groups is that mobile phones can have biological effects (affect our cells) despite being too weak to cause significant heating. Because non-thermal effects cover everything except heating it is a very broad term – it can refer both to cancer and insomnia – but there is no evidence that RF radiation causes harmful non-thermal effects.”

UK Government (2008)

“The published evidence for health effects of radiofrequency (RF) electromagnetic fields in general is reviewed in Health Effects from Radiofrequency Electromagnetic Fields: Report of an Independent Advisory Group on Non-ionising Radiation. The report found that, as a whole, the research published since the report of the Independent Expert Group on Mobile Phones does not give cause for concern. The weight of evidence now available does not suggest that there are adverse health effects from exposures to RF fields below guideline levels.” <http://www.number10.gov.uk/output/Page14249.asp>

Australian Radiation Protection and Nuclear Safety Agency, Committee on Electromagnetic Energy (2008). <http://www.arpansa.gov.au/pubs/eme/fact1.pdf>

“The weight of national and international scientific opinion is that there is no substantiated evidence that exposure to low level RF EME causes adverse health effects.”

U.S. National Cancer Institute (2008).

Fact Sheet on Cellular Telephone Use and Cancer Risk. <http://www.cancer.gov/cancertopics/factsheet/Risk/cellphones>

“Studies have not shown any consistent link between cellular telephone use and cancer...”

“Incidence data from the Surveillance, Epidemiology and End Results (SEER) program of the National Cancer Institute have shown no increase between 1987 and 2005 in the age-adjusted incidence of brain or other nervous system cancers despite the dramatic increase in use of cellular telephones...”

Food and Drug Administration (2008). Cell Phones.

<http://www.fda.gov/cdrh/wireless/health.html>

“The weight of scientific evidence has not linked cell phones with any health problems.”

“The scientific evidence does not show a danger to any users of cell phones from RF exposure, including children and teenagers.”

WHO/IARC (International Agency for Research on Cancer) World Cancer Report 2008 <http://www.iarc.fr/en/publications/pdfs-online/wcr/index.php>

“Radiofrequency radiation emitted by mobile telephones has been investigated in a number of studies. There is some evidence that long-term and heavy use of mobile/cellular phones may be associated with moderate increased risks of gliomas, parotid gland tumours, and acoustic neuromas; however, evidence is conflicting and a role of bias in these studies cannot be ruled out.” (p. 170)

“With reference to radio frequency, available data do not show any excess risk of brain cancer and other neoplasms associated with the use of mobile phones.” (p. 170)

Concerning brain tumors: “After 1983 and more recently during the period of increasing prevalence of mobile phone users, the incidence has remained relatively stable for both men and women.” (p. 461)

Sweden SSI (2008) Recent Research on EMF and Health Risks- Fifth Annual Report from SSI: Independent Expert Group on Electromagnetic fields, 2007(Revised edition 15 April, 2008)

<http://www.stralsakerhetsmyndigheten.se/Global/Publikationer/Rapport/Stralskydd/2008/ssi-rapp-2008-12.pdf>

Most of these studies have not demonstrated effects of RF exposure on the studied outcomes, including also attempts to replicate the genotoxic effects observed in the REFLEX European programme. Six recent studies on carcinogenicity, some with higher exposure levels than previously used, consistently report lack of carcinogenic effects, and two studies on genotoxicity report no increase in micronuclei or DNA strand breaks after RF exposure. Most recent volunteer studies have investigated the effects of GSM mobile phone RF radiation on cognitive function, sleep, heart rate variability, blood pressure, and hypersensitivity. In general, the recent, methodologically more rigorous studies do not replicate the positive findings from smaller, less rigorous studies published a few years ago, but a few positive effects are reported. Two national Interphone publications are based on very small numbers and do not change the overall assessment, and two published meta-analyses provide little additional information.

European Commission (2009). Health Effects of Exposure to EMF. Opinion of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) (p. 4).

http://ec.europa.eu/health/ph_risk/committees/04_scenihr/scenihr_opinions_en.htm

“It is concluded from three independent lines of evidence (epidemiological, animal and in vitro studies) that exposure to RF fields is unlikely to lead to an increase in cancer in humans.“

“...the conclusion that scientific studies have failed to provide support for an effect of RF fields on self-reported symptoms still holds.”

“There is some evidence that RF fields can influence EEG patterns and sleep in humans. However, the health relevance is uncertain... Other studies on functions/aspects of the nervous system, such as cognitive functions, sensory functions, structural stability, and cellular responses show no or no consistent effects.”

“Recent studies have not shown effects from RF fields on human or animal reproduction and development. No new data have appeared that indicate any other effects on human health.”

The Netherlands, Health Council (2009)

<http://www.gezondheidsraad.nl/sites/default/files/200902.pdf>

Annual Update 2008: “The Committee further discusses the relationship between electromagnetic fields and brain activity and that between electromagnetic fields and health symptoms. In both cases the Committee concludes that there is no scientific

evidence that exposure to environmental levels of radiofrequency electromagnetic fields causes health problems.”

Isle of Man (2009)

<http://www.gov.im/lib/docs/cso/mobilephonemastscominreport.pdf>

The Council of Ministers considered and accepted the Working Group’s Report as the appropriate approach to the health impacts of mobile phone masts in the Island. The final recommendations of the Working Party for the government included endorsement of the ICNIRP guidelines.

Spain’s Comité Científico Asesor en Radiofrecuencias y Salud (CCARS) (2009)

http://www.ccars.es/sites/default/files/Report_on_Radiofrequency_and_Health_2007-2008.pdf

Report on radiofrequency and health (2007-2008). The committee concluded from a review of the literature that the use and exposure of adults to mobile phones over a period of less than 10 years is not associated with an increased risk of brain tumor, and that the results of recent scientific research do not justify changes in Spain’s exposure limits [currently based on ICNIRP guidelines].

ICNIRP (2009): "Exposure to high frequency electromagnetic fields, biological effects and health consequences (100 kHz-300 GHz)"

<http://www.icnirp.de/documents/RFReview.pdf>

“The mechanisms by which RF exposure heats biological tissue are well understood and the most marked and consistent effect of RF exposure is that of heating, resulting in a number of heat-related physiological and pathological responses in human subjects and laboratory animals. Heating also remains a potential confounder in *in vitro* studies and may account for some of the positive effects reported.”

German Telecommunications Research Programme Final Report (2009):

<http://www.emf-forschungsprogramm.de/abschlussphase/abschlusskonferenz.html>

“The DMF’s findings give no reason to question the protective effect of current limit values.”

Finland’s Radiation and Nuclear Safety Authority (Stuk) (2009)

http://www.stuk.fi/julkaisut_maaraykset/fi_FI/katsaukset/files/81811016537538837/default/taustakentat_engl_22_7_2009_lopullinen.pdf

“There is no evidence so far on the health effects due to long-term exposure to radio frequency radiation but anyone can reduce one’s own exposure easily.”

ICNIRP (2009): ICNIRP statement on the “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)”

<http://icnirp.org/documents/StatementEMF.pdf>

“..it is the opinion of ICNIRP that the scientific literature published since the 1998 guidelines has provided no evidence of any adverse effects below the basic restrictions and does not necessitate an immediate revision of its guidance on limiting exposure to high frequency electromagnetic fields.”

US National Institute of Environmental Health Sciences, National Toxicology Program (2009)

“Cell Phone Radiofrequency Radiation Studies”

<http://www.niehs.nih.gov/health/docs/cell-phone-fact-sheet.pdf>

“The weight of scientific evidence has not conclusively linked cell phones with any health problems. Additional research is needed. The NTP is conducting studies on radiofrequency radiation emitted by cell phones.”

US Health Physics Society (2009)

http://hps.org/documents/Mobile_Telephone_Fact_Sheet_update_May_2010.pdf

“These analyses, together with other previous reviews by expert groups and health agencies, show there is no clear evidence for health hazards from exposures to RF fields below international (IEEE or ICNIRP) exposure guidelines.”

French Agency for Environmental and Occupational Health Safety (2009)

http://www.afsset.fr/upload/bibliotheque/964737982279214719846901993881/Rapport_RF_20_151009_1.pdf

“..the currently available experimental data do not indicate short-term or long-term effects from RF EMF exposure, nor do current epidemiological data point to effects from short-term exposure. Questions remain for long-term effects, the group states; however, no biological mechanism has been established to support the presence of long-term harm.”

French Parliament (2009)

http://www.assemblee-nationale.fr/13/rap-off/i2005-tl.asp#P1889_148540

“The majority of researchers have confirmed, albeit with some caution, the absence of any health risk. There is a near consensus on the harmlessness of mobile phone relays,”

“With regard to the possible effects of mobile phone, a majority of researchers affirm, though cautiously, the absence of a proven health hazard,”

Germany Federal Office for Radiation Protection BfS (2009)

http://www.bfs.de/en/elektro/papiere/EMF_Wirkungen

http://www.bfs.de/en/elektro/hff/papiere.html/Fruchtbarkeit_Mann.html

“..research to date has not demonstrated a lasting threat to animals or plants from EMF below the limits, nor significant effects of mobile phone EMF on testes and sperm -- only minor fluctuations in individual physiological parameters. “

Nordic countries (2009)

EXPOSURE OF THE GENERAL PUBLIC TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS - A joint statement from the Nordic Radiation Safety Authorities

http://www.stuk.fi/stuk/tiedotteet/fi_FI/news_578/_files/82468261251448918/default/Nordic_Statement-EMF161109.pdf

“The Nordic authorities agree that there is no scientific evidence for adverse health effects caused by radiofrequency field strengths in the normal living environment at present.The Nordic authorities therefore at present see no need for a common recommendation for further actions to reduce these radiofrequency fields.”

Sweden SSI (2009)

Recent Research on EMF and Health Risks Sixth annual report from SSM's independent Expert Group on Electromagnetic Fields

Report number: 2009:36 ISSN: 2000-0456, Available at

<http://www.stralsakerhetsmyndigheten.se/Global/Publikationer/Rapport/Stralskydd/2009/SSM-Rapport-2009-36.pdf>

“Overall the studies published to date do not demonstrate an increased risk of cancer related to mobile phone use within approximately ten years of use for any tumour of the brain or any other head tumour.” “For slow-growing tumours such as meningioma and acoustic neuroma, as well as for glioma among longterm users, the absence of association reported thus far is less conclusive because the observation period has been too short.”, and “Long-term animal data on balance do not indicate any carcinogenic effect.”

“..these results in combination with the negative animal data and very low exposure from transmitters make it highly unlikely that living in the vicinity of a transmitter implicates an increased risk of cancer.”

“While the symptoms experienced by patients with perceived electromagnetic hypersensitivity are very real and some subjects suffer severely, there is no evidence that RF exposure is a causal factor.”

UK Health Protection Agency (HPA) (2010)

Health Advice on Mobile Phones

http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1195733769169

Although HPA mentions in this statement that scientific evidence is limited, in particular regarding long term use and children, they clearly state at the beginning of the paper:

“The scientific consensus is that, apart from the increased risk of a road accident due to mobile phone use when driving, there is no clear evidence of adverse health effects from the use of mobile phones or from phone masts.”

WHO (2010)

<http://www.who.int/mediacentre/factsheets/fs193/en/index.html>

Electromagnetic fields and public health: mobile phones. To date, no adverse health effects have been established for mobile phone use.

ICNIRP (2010)

Note on the Interphone publication

<http://icnirp.org/documents/ICNIRPnote.pdf>

ICNIRP therefore considers that the results of Interphone study give no reason for alteration of the current guidelines.

UK HPA (2010)

<http://www.hpa.org.uk/NewsCentre/NationalPressReleases/2010PressReleases/100518INTERPHONE/>

Dr John Cooper, director of the Health Protection Agency's Centre for Radiation, Chemicals and Environmental Hazards, said: "The INTERPHONE study has not established an increase in brain cancer but some uncertainties remain, particularly regarding high users. The HPA welcomes both the study and the call from the International Agency for Research on Cancer for further research into mobile phone use and brain cancer."

FDA (2010)

<http://www.fda.gov/downloads/ForConsumers/ConsumerUpdates/UCM212306.pdf>

"No evidence linking cell phone use to risk of brain tumors"

National Cancer Institute (2010)

<http://www.cancer.gov/newscenter/pressreleases/Interphone2010Results>

"NCI Statement: International Study Shows No Increased Risk of Brain Tumors from Cell Phone Use"

Australia Cancer Council (2010)

<http://www.cancer.org.au/Newsmedia/mediareleases/mediareleases2010/17May2010.htm>

"World's largest mobile phone study fails to find brain cancer link
Mobile phones and cancer risk – Interphone study"

Austria (2010): Scientific Expert Panel on EMF and health confirms ICNIRP limits

<http://www.wbf.or.at/wbf-expertenforum/expertenforum-2010/>

The Austrian Scientific Advisory Board Funk (WBF) has unanimously concluded that the current state of scientific evidence on mobile phone use shows no conclusive health hazard could be proven. WBF says it may therefore continue to be assumed that mobile phones - in compliance with the limits – represents no health risk to humans.

The Institution of Engineering and Technology (2010)

<http://www.theiet.org/factfiles/bioeffects/emf-position.cfm>

The Possible Harmful Biological Effects of Low-Level Electromagnetic Fields of Frequencies up to 300 GHz

BEPAG has concluded that the balance of scientific evidence to date still does not indicate that harmful effects occur in humans due to low-level exposure to EMFs. This conclusion remains the same as that reached in its previous position statements, the last being in May 2008, and has not been substantially altered by the peer-reviewed literature published in the past two years.

European health risk assessment network on EMF exposure (2010)

http://efhran.polimi.it/docs/IMS-EFHRAN_09072010.pdf

Report on the analysis of risks associated to exposure to EMF: *in vitro* and *in vivo* (animals) studies

For the three frequency ranges examined, the conclusions of the 2009 SCENIHR report are still valid in spite of the publication of several positive findings. Many of the new

publications originate from laboratories and countries that are new to bioelectromagnetics research. This translates sometimes into unsatisfactory dosimetry or statistical analysis. Health risk assessment to be performed in the coming years (e.g., WHO EMF project) will need to be carried out with strict quality criteria.

Glossary of Terms

access point- a term typically used to describe an electronic device that provides for wireless connectivity via a WAN to the Internet or a particular computer facility. Access points can allow users who may using an appropriately configured laptop computer to gain access to the Internet. Often, access points (**see hotspots**) are found in libraries, hotels, and so-called wireless cafes.

AirCard- a term commonly applied to devices that can be inserted in a laptop computer to provide wireless connectivity to a WAN from whence connection to the Internet may be achieved. AirCards are composed of miniature receivers and low power transmitters.

antenna- a device designed to efficiently convert conducted electrical energy into radiating electromagnetic waves in free space (or vice versa).

attenuation- the phenomenon by which the amplitude of an RF signal is reduced as it moves from one point in a system to another. It is often given in decibels.

averaging Time (T_{avg})- the appropriate time period over which exposure is averaged for purposes of determining compliance with an exposure limit. For exposure durations less than the averaging time, the exposure limit (EL'), in any time interval, is found from:

$$EL' = EL \left(\frac{T_{avg}}{T_{exp}} \right)$$

where T_{exp} is the exposure duration in that interval expressed in the same units as T_{avg} .

continuous exposure- exposure for durations exceeding the corresponding averaging time (usually 6 minutes). Exposure for less than the averaging time is called short-term exposure.

dBi- decibel referenced to an isotropic antenna- a theoretical antenna which transmits (or receives) electromagnetic energy uniformly in all directions (i.e., there is no preferential direction).

decibel (dB)- a dimensionless quantity used to logarithmically compare some value to a reference level. For power levels (watts or watts/m^2), it would be ten times the logarithm (to the base ten) of the given power level divided by a reference power level. For quantities like volts or volts per meter, a decibel is twenty times the logarithm (to the base ten) of the ratio of a level to a reference level.

duty cycle- a measured of the percentage or fraction of time that an RF device is in operation. A duty cycle of 1.0, or 100%, corresponds to continuous operation. Also called duty factor. A duty cycle of 0.01 or 1% corresponds to a transmitter operating on average only 1% of the time.

electric field strength- a field vector (E) describing the force that electrical charges have on other electrical charges, often related to voltage differences, measured in volts per meter (V/m).

electromagnetic field- a composition of both an electric field and a magnetic field that are related in a fixed way that can convey electromagnetic energy. Antennas produce electromagnetic fields when they are used to transmit signals.

endpoint device- a term used to designate the ultimate device connected to a mesh network. In the context of a Smart Meter mesh network, an electric power meter is the endpoint device since it represents the furthest point within the network to which data may be sent and from which data may be received.

energy absorption rate- see specific absorption rate

EPA- Environmental Protection Agency.

established adverse health effects- biological effects observed from research studies that have been verified in studies at independent laboratories and that have been deemed by experts to be considered as adverse to health.

exposure- exposure occurs whenever a person is subjected to electric, magnetic or electromagnetic fields or to contact currents other than those originating from physiological processes in the body and other natural phenomena.

Federal Communications Commission (FCC)- the Federal Communications Commission (FCC) is an independent agency of the US Federal Government and is directly responsible to Congress. The FCC was established by the Communications Act of 1934 and is charged with regulating interstate and international communications by radio, television, wire, satellite, and cable. The FCC also allocates bands of frequencies for non-government communications services (the NTIA allocates government frequencies). The guidelines for human exposure to radio frequency electromagnetic fields as set by the FCC are contained in the Office of Engineering and Technology (OET) Bulletin 65, Edition 97-01 (August 1997). Additional information is contained in OET Bulletin 65 Supplement A (radio and television broadcast stations), Supplement B (amateur radio stations), and Supplement C (mobile and portable devices).

gain, antenna- a measure of the ability of an antenna to concentrate the power delivered to it from a transmitter into a directional beam of energy. A search light exhibits a large gain since it can concentrate light energy into a very narrow beam while not radiating very much light in other directions. It is common for cellular antennas to exhibit gains of 10 dB or more in the elevation plane, i.e., concentrate the power delivered to the antenna from the transmitter by a factor of 10 times in the direction of the main beam giving rise to an effective radiated power greater than the actual transmitter output power. In other directions, for example, behind the antenna, the antenna will greatly decrease the emitted signals. Gain is often referenced to an isotropic antenna (given as dBi).

gigahertz (GHz)- one billion hertz.

ground reflections- the phenomenon of radio signals reflected from the ground. Ground reflection of an incident RF signal (or field) creates a resultant RF field that is the summation of both the incident and reflected RF field. This resultant field may be either greater or less in strength than the incident field due to the phase relationship between the incident and reflected RF fields.

hertz- the unit for expressing frequency, one Hertz (Hz) equals one cycle per second.

hotspots (see access point)- a term commonly applied to access points that are made available for public use in connecting to a WAN for wireless Internet access.

IEEE- Institute of Electrical and Electronics Engineers.

isotropic antenna- a theoretical antenna which transmits (or receives) electromagnetic energy uniformly in all directions (i.e. there is no preferential direction). The radiated wave front is assumed to be an expanding sphere.

“license free”- a phrase meaning that an RF transmitter is operated at such low power and within an authorized frequency band that no formal license to operate is required by the applicable federal regulatory agency. There are restrictions placed on these devices, however, such as they shall not produce interference and/or may not create RF fields exceeding particular field strengths.

magnetic field strength- a field vector (H) that is equal to the magnetic flux density divided by the permeability of the medium. Magnetic field strength is expressed in units of amperes per meter (A/m).

median RF field- a field value, for example power density, representing the level below which half of measured power densities are below and half are above, sometimes used to describe RF exposure levels.

megahertz (MHz)- one million hertz.

mesh network- a network providing a means for routing data, voice and instructions between nodes. A mesh network allows for continuous connections and reconfiguration around broken or blocked data paths by “hopping” from node to node until the destination is reached.

microwave- an electromagnetic wave at super high frequencies, typically above 300 MHz, the wavelength of which is very short (micro).

microwave leakage- the property of microwave ovens to produce low level microwave fields outside the oven due to the leakage of microwave energy through cracks in the oven door seals.

milliwatt per square centimeter (mW/cm²)- a measure of the power density flowing through an area of space, one thousandth of a watt passing through a square centimeter. One milliwatt per square centimeter is equal to 10 watts per square meter.

omnidirectional antenna- an antenna that emits a signal of essentially constant strength in all directions, in contrast to a directional antenna.

plane wave- wave with parallel planar (flat) surfaces of constant phase (See also Spherical wave).

plane wave equivalent power density- the power density associated with an electromagnetic wave propagated in free space in which the front of the wave is flat (plane). Meters used for measuring power density are often calibrated in terms of the plane wave equivalent power density.

potentially hazardous exposure- a term typically used to denote a level (power density) of RF exposure that has been determined to be associated with a biological effect that, if continuously present, has been deemed to be potentially hazardous. The exposure limits in Safety Code 6 are based on biological effects research that has identified levels of exposure of laboratory animals that, if maintained for prolonged periods of time, could result in an adverse effect. The exposure limit contained in Safety Code 6 is obtained by dividing the potentially hazardous exposure level found through research by a factor of 50 for application to the general public.

power density- power density (S, sometimes called the Poynting vector) is the power per unit area normal to the direction of propagation, usually expressed in units of watts per square meter (W/m²) or, for convenience, milliwatts per square centimeter (mw/cm²) or microwatts per square centimeter (μw/cm²). For plane waves, power density, electric field strength, E, and magnetic field strength, H, are related by the impedance of free space, i.e. 120π (377) ohms. In particular, $S = E^2/120\pi = 120\pi H^2$ (Where E and H are expressed in units of V/m and A/m, respectively, S is in units of W/m²). Although many RF survey instruments indicate power density units, the actual quantities measured are E or E² or H or H².

Poynting vector- a field vector quantity equal to the vector product (cross product) of the electric field and magnetic field of an electromagnetic wave. The Poynting vector (S, also called power density) is equal to $E \times H$, with units of W/m².

premise device- a term used to denote devices equipped with very low power transmitters that can be connected to various types of electrical appliances, such as a thermostat that controls the operation of a home heating furnace and that communicate with the rest of the Smart Meter system at the home.

radiating field- the components of the total electromagnetic field produced by an antenna that contains all of the energy propagated away from the antenna. In the radiation

field, both the electric and magnetic fields are codependent with an intensity that varies inversely with distance from the source.

radio frequency (RF)- although the RF spectrum is formally defined in terms of frequency as extending from 0 to 3000 GHz, the frequency range of interest is 3 kHz to 300 GHz.

reflection- an electromagnetic wave (the “reflected” wave) caused by a change in the electrical properties of the environment in which an “incident” wave is propagating. This wave usually travels in a different direction than the incident wave. Generally, the larger and more abrupt the change in the electrical properties of the environment, the larger the reflected wave

relay unit- see repeater unit

repeater unit- a device that can simultaneously receive a radio signal and retransmit the signal. Repeater units are used to extend the range of low power transmitters in a geographical area.

RF - radiofrequency.

router- an electronic computer device that is used to route and forward information, typically between various computers within a local area network or between different local area networks.

Safety factor- additional safety is incorporated into exposure limits by the use of a safety factor (SF). A safe level exposure is divided by the safety factor to yield the allowable exposure limits. Health Canada uses a SF of 5 for occupational and 50 for public exposure limits. This means the exposure limit for the general public is 50 times less than a level determined to be safe.

specific absorption rate (SAR)- the time derivative of the incremental energy absorbed by (dissipated in) an incremental mass contained in a volume) of a given density. SAR is expressed in units of watts per kilogram (or milliwatts per gram, mW/g). Guidelines for human exposure to radio frequency fields are based on SAR thresholds where adverse biological effects may occur. When the human body is exposed to a radio frequency field, the SAR experienced is proportional to the squared value of the electric field strength induced in the body.

time average- for RF safety matters, the average of the power density of an RF field over a specified time period (six minutes for Safety Code 6). See averaging time.

transmitter- an electronic device that produces RF energy that can be transmitted by an antenna. The transmitted energy is typically referred to a radio signal or RF field.

WAN (wide area network)- a computer network that covers a broad area such as a whole community, town, or city. Commonly, WANs are implemented via a wireless connection using radio signals. High speed Internet connections can be provided to customers by wireless WANs.

WI-FI- an arbitrary name given to the wireless technology used in home networks, mobile phones, and other wireless electronic devices that employ the so-called IEEE 802.11 technologies (a standard that defines specific characteristics of wireless local area networks).