SAFE LIVING
Technologies Inc.

Assessment of Radio Frequency / Microwave Radiation Emissions from Smart Meters in Toronto

Smart Meter Model Numbers:

Elster R1S - 1st Generation REX1
Elster R2S - 2nd Generation REX2

Rob Metzinger
Electronics Engineering Technologies, BBEC
President

Safe Living Technologies Inc.
Canada

Date of Assessment: August 20, 2012

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Introduction:

Safe Living Technologies was invited by Toronto Hydro to accompany a third party organization to measure and document the Radio Frequency “RF” / Microwave Radiation output of a typical Smart Meter. The measurements were to be conducted at two locations in the city of Toronto, Canada. The Smart Meters of interest are typical single, residential units installed on detached homes. The homes will be referred to as Location #1 and Location #2 in this assessment. Toronto Hydro is interested in understanding Radio Frequency / Microwave Radiation transmission patterns of their Smart Meters as well as their transmission power.

The Radio Frequency assessment will include graphical illustrations of transmission patterns, power density output values and Safety Code 6 calculations of the Smart Meter RF emissions.

In the past two years, dozens of Toronto and surrounding residents have contacted Safe Living Technologies regarding adverse health effects immediately after the installation of a Smart Meter at their residence. Hence the reason for our interest in the RF / Microwave Radiation output of Smart Meters and our willingness to assist Toronto Hydro in this endeavour. See appendix C for possible health effects.

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Understanding Radio Frequency / Microwave Radiation

AC Electromagnetic waves are composed of electric and magnetic components. As AC electric and AC magnetic fields approach higher frequencies, the fields become airborne and in this condition are Radio Waves or high frequency electromagnetic waves. Radio frequency waves are used to convey information from one place to another through the air. Sources of RF Radiation contain transmission antennas and can be internal and external to the structure. External sources include mobile phone communication towers, radio and television antennas, radar installations, smart meters, satellite navigation systems and homeland security to name a few. These high energy, airborne waves, travel at speed of light, are capable of traveling miles and designed to penetrate concrete. Internal sources have less powerful transmitters and travel a shorter distance but still pose a significant risk because of their close proximity. Sources would include wireless routers which help network our computers and allow us to share internet connections. Other internal source includes cordless phones baby monitors and wireless security systems etc... These are all artificial frequencies generated by man-made technologies.

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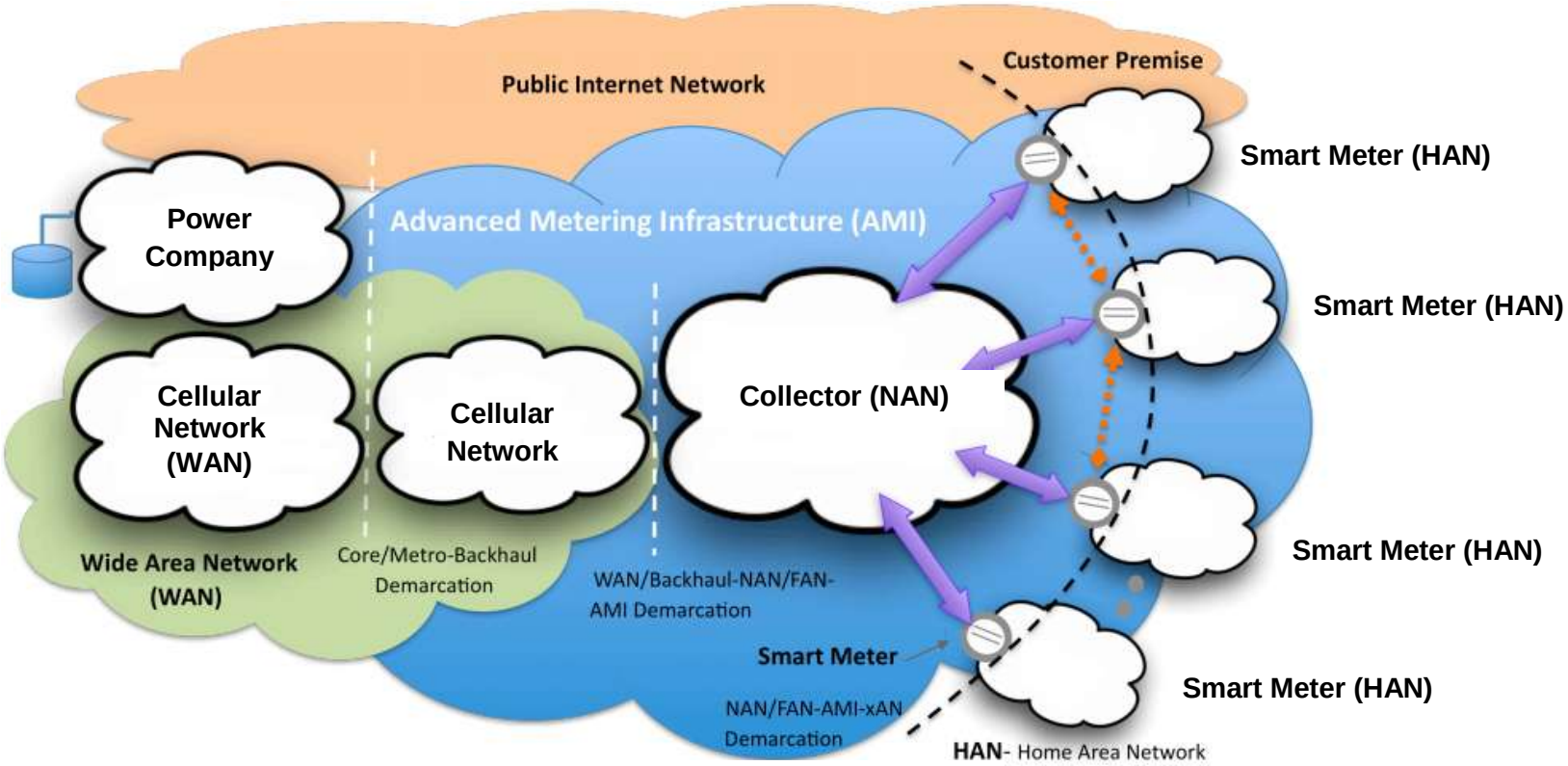
How Smart Meters Operate

Smart Meters are replacements for the older 'spinning dial' or analog electric meters. Smart Meters are a new type of electrical power meter that will measure the energy you consume. They will automatically send the information back to the utility by a wireless signal via a specialized collector meter, instead of having a physical person visit your property and read your meter. Smart meters are a part of an overall system that includes a mesh network or series of wireless antennas at the neighborhood level. The collector unit gathers and stores all of the neighbourhoods power usage information and retransmits it back to the utility company at set intervals. The typical power output of a Smart Meter is typically ¼ to 1 watt at 902-928 MHz. The typical power output of a collector meter is 1 watt in the cellular band of 850MHz and 1900MHz.

Note: A smart meter can also be a collector meter and contain multiple transmitters



NAN - Neighbourhood Area Network

***SOURCE**: Smart Grid Communications architectural Framework, Sonoma Innovation*

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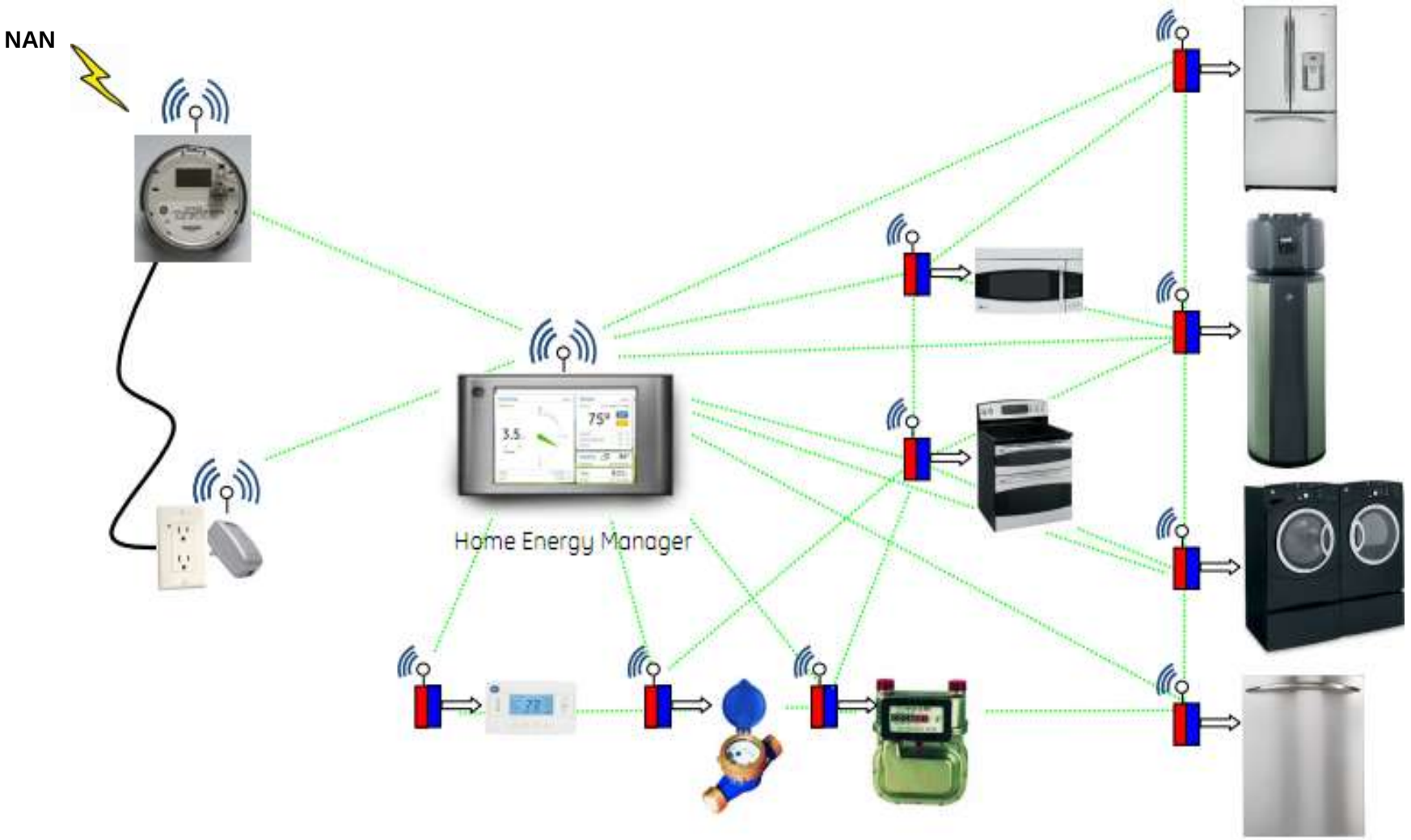
The typical smart home of the future may contain dozens internal transmitters, one on each appliance. The purpose is to provide real time insight into energy consumption patterns. For this to function properly, each household appliance will require a wireless transmitter that emits radio frequency/microwave radiation. The power output is estimated at 60mW at 2405-2483 MHz.



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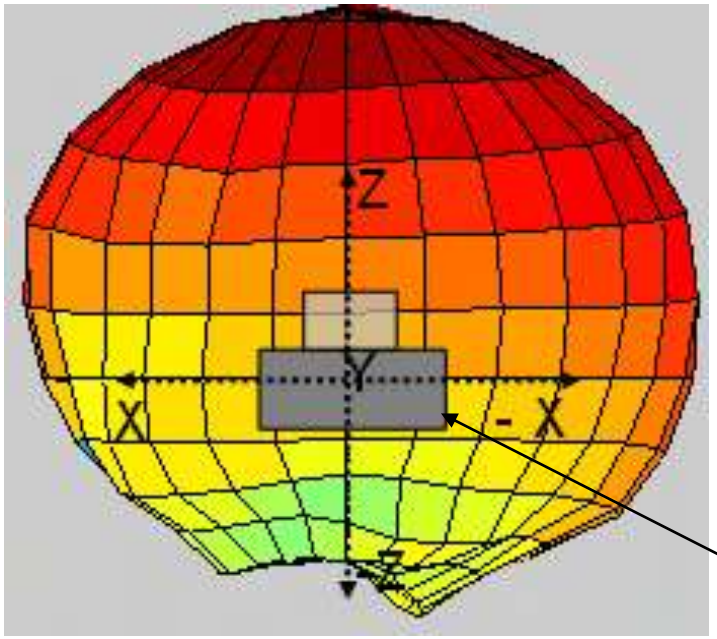
Smart Meter Signal Emission Pattern

Top view



Smart Meter RF Wave Forms are Spherical / Omni-Directional Emission Pattern

Radio Frequencies will emit in all directions and penetrate the living space behind the Smart Meter as well as radiate outwards.

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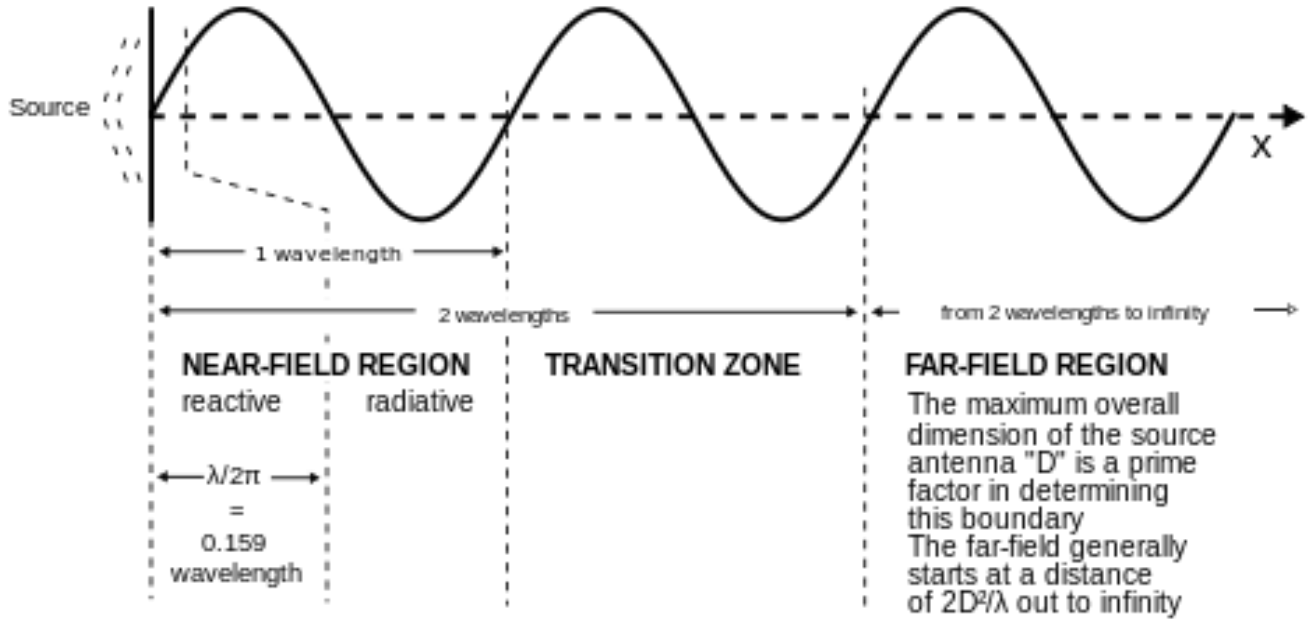
Determining the Appropriate Far-Field Measurement Distance

Antenna Used - UBB27 Gigahertz Solutions 27MHZ – 3.3 GHz Far-Field Antenna

902 MHz Radio Wave has a wavelength of 33 cm
928 MHz Radio Frequency Wave has a wavelength of 32cm

Minimum Measuring Distance is $2D^2/\lambda$ "Safety Code 6 for short antennas"

D = antenna length which is unknown – Let us assume a max length of 16 cm which is the approximate diameter of the smart meter enclosure
$(2 \times 16cm^2)/33cm$ =15.5 cm or 6.1 inches
We prefer to keep a distance of 3 feet or more than 2 wave lengths



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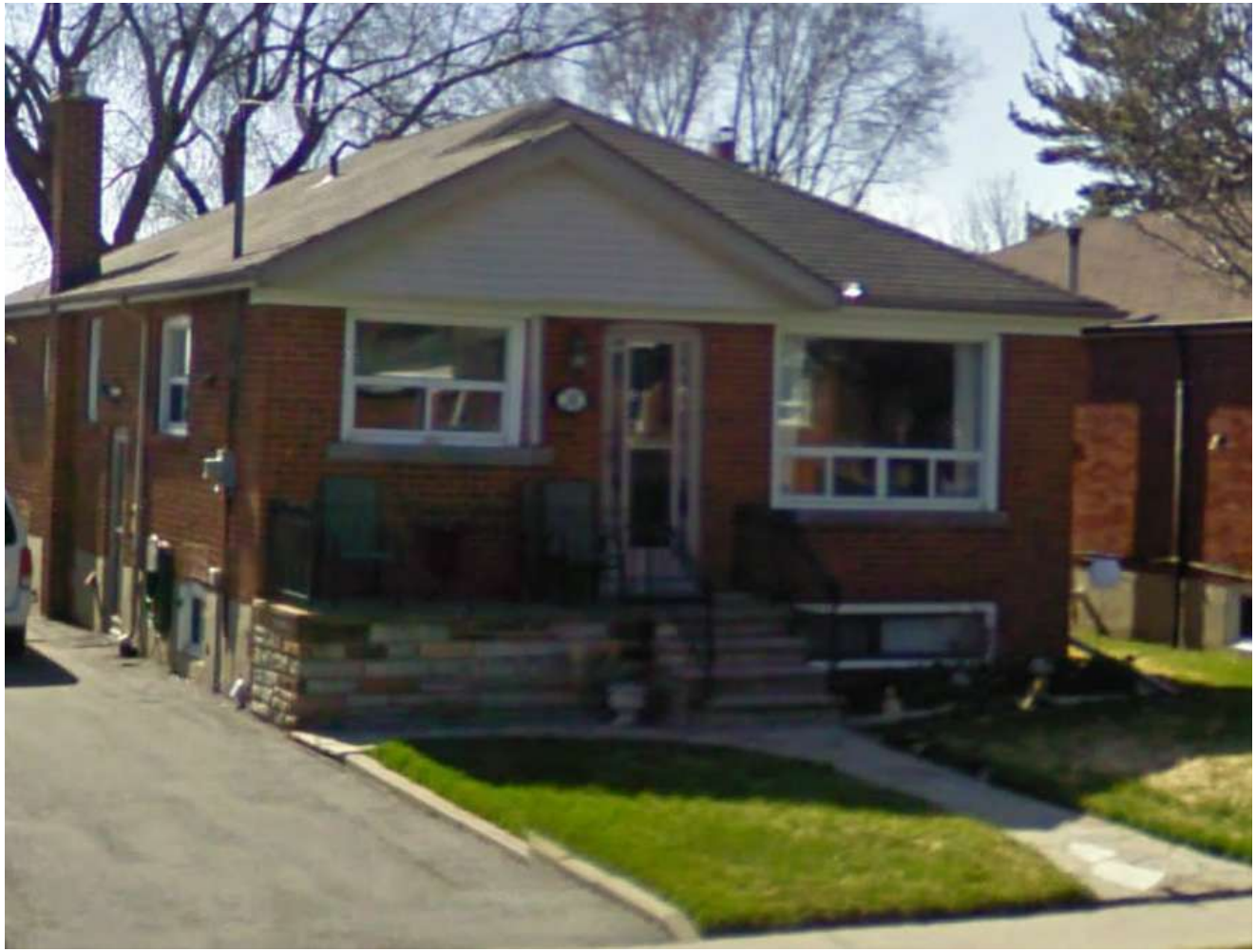
Location #1 Toronto, ON Canada

EMR Technician: Rob Metzinger
Testing Date: Aug 20th, 2012
Time on-site: 9:30 – 11:45



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Location #1 Toronto, ON Canada

Smart Meter Details: The 2nd Generation REX2 (R2S) meter is both a smart metering endpoint and gateway into the home, supporting both 900 MHz and 2.4 GHz ZigBee communications. REX2 meters include an integral Elster-designed frequency hopping spread spectrum (FHSS) transceiver operating in the 900 MHz unlicensed band. This 900 MHz module provides excellent communications range and penetration, allowing the REX2 meter to act as an intelligent two-way endpoint in the Elster EnergyAxis® local area network (EA_LAN). **- Information extracted from the REX2™ meter Technical manual TM42-2225C provided by Toronto Hydro**

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Location #1 Toronto, ON Canada

Measurement Setup: Gigahertz Solutions HF59B Radio Frequency Analyzer and Gigahertz Solutions NFA1000 Data Logger

HF59B for Audio Analysis

Narda SRM 3000 – Provided by a 3rd party

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Equipment Used:
Gigahertz Solutions **HF59B** RF Analyzer
Gigahertz Solutions **NFA1000** Data Logger
NFASoft Data Analysis Software

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Location #1 Toronto, ON Canada

Data Collected Outside, distance of 3 feet, directly in front of smart meter:

Smart Meter Data Log: Outdoor Smart Meter Log @ 3 feet in front of Smart Meter
Logging Time: Approx (9:30am – 10:45am)

Maximum Reading: 5322 µW/m² Microwatts / Square Meter
Average: 323 µW/m² Microwatts / Square Meter
Average of Peaks: 3649 µW/m² Microwatts / Square Meter
Transmissions Per Hour (Edges): 13
Safety Code 6 Safety Limit for 900 MHz, General Public: (Appendix B) f/150 = 900/150 = 6 W/m^2 or 6,000,000 µW/m²
% Safety Code 6: (5322.00 x 100)/6,000,000 = 0.089 %

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Location #2
Toronto, ON Canada

EMR Technician: Rob Metzinger
Testing Date: Aug 20th, 2012
Time on-site: 12:15 – 13:30

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Location #2

Smart Meter Details: The 1st Generation REX1 (R1S) meter uses a frequency hopping spread spectrum (FHSS) transceiver operating in the unlicensed band ISM Band of 902 MHz – 928 MHz

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Location #2

Measurement Setup: Gigahertz Solutions HF59B Radio Frequency Analyzer and Gigahertz Solutions NFA1000 Data Logger

Equipment Used:
Gigahertz Solutions **HF59B** RF Analyzer
Gigahertz Solutions **NFA1000** Data Logger
NFASoft Data Analysis Software

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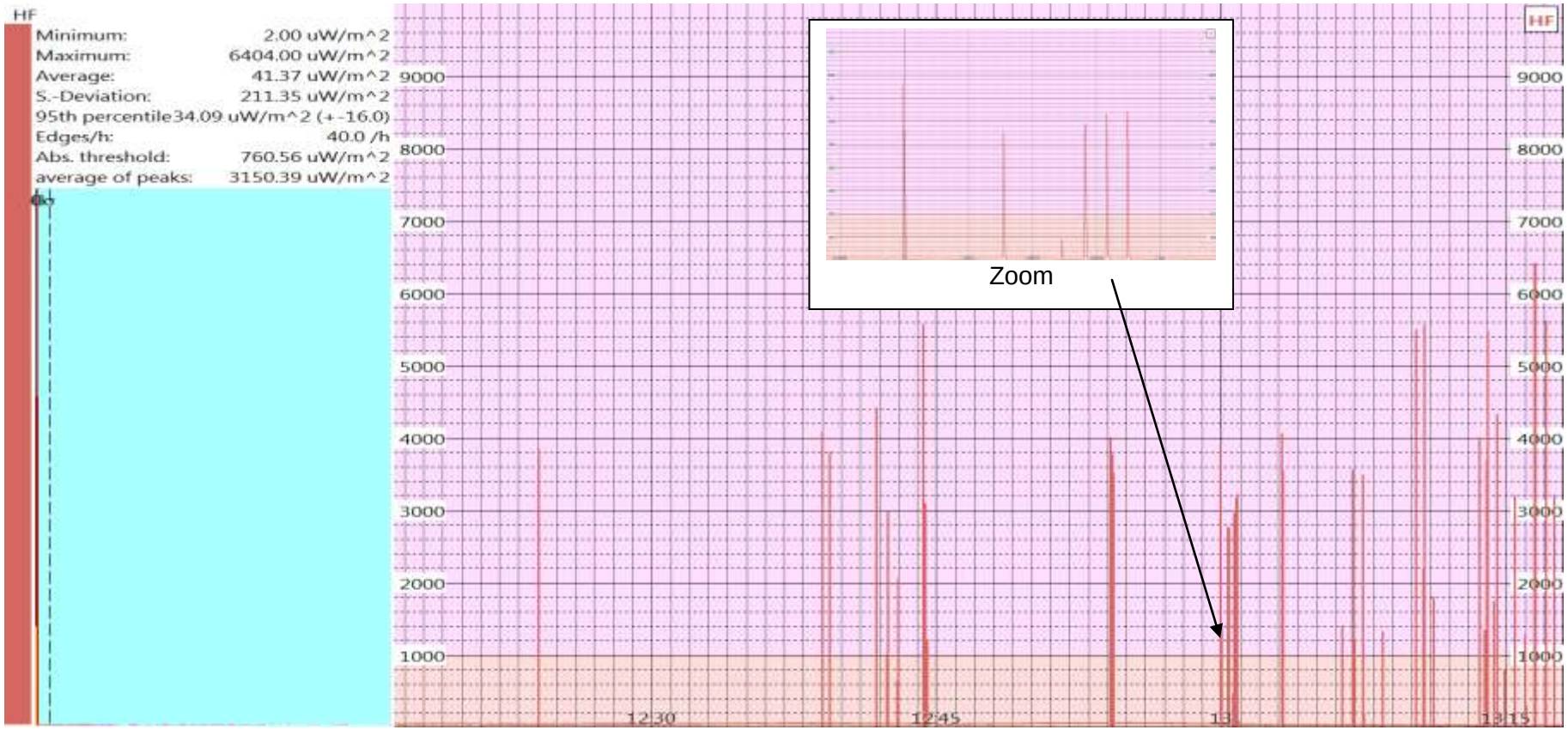
Location #2

Data Collected Outside, distance of 3 feet, directly in front of smart meter:

Smart Meter Data Log: Outdoor Smart Meter Log @ 3 feet in front of Smart Meter
Logging Time: Approx (12:15pm – 1:15pm)



Maximum Reading: 6404 µW/m² Microwatts / Square Meter
Average: 41 µW/m² Microwatts / Square Meter
Average of Peaks: 3150 µW/m² Microwatts / Square Meter
Transmissions Per Hour (Edges): 40
Safety Code 6 Safety Limit for 900 MHz, General Public: (Appendix B) f/150 = 900/150 = 6 W/m^2 or 6,000,000 µW/m²
% Safety Code 6: (6404.00 x 100)/6,000,000 = 0.107 %

Equipment Used:
Gigahertz Solutions **HF59B** RF Analyzer
Gigahertz Solutions **NFA1000** Data Logger
NFASoft Data Analysis Software

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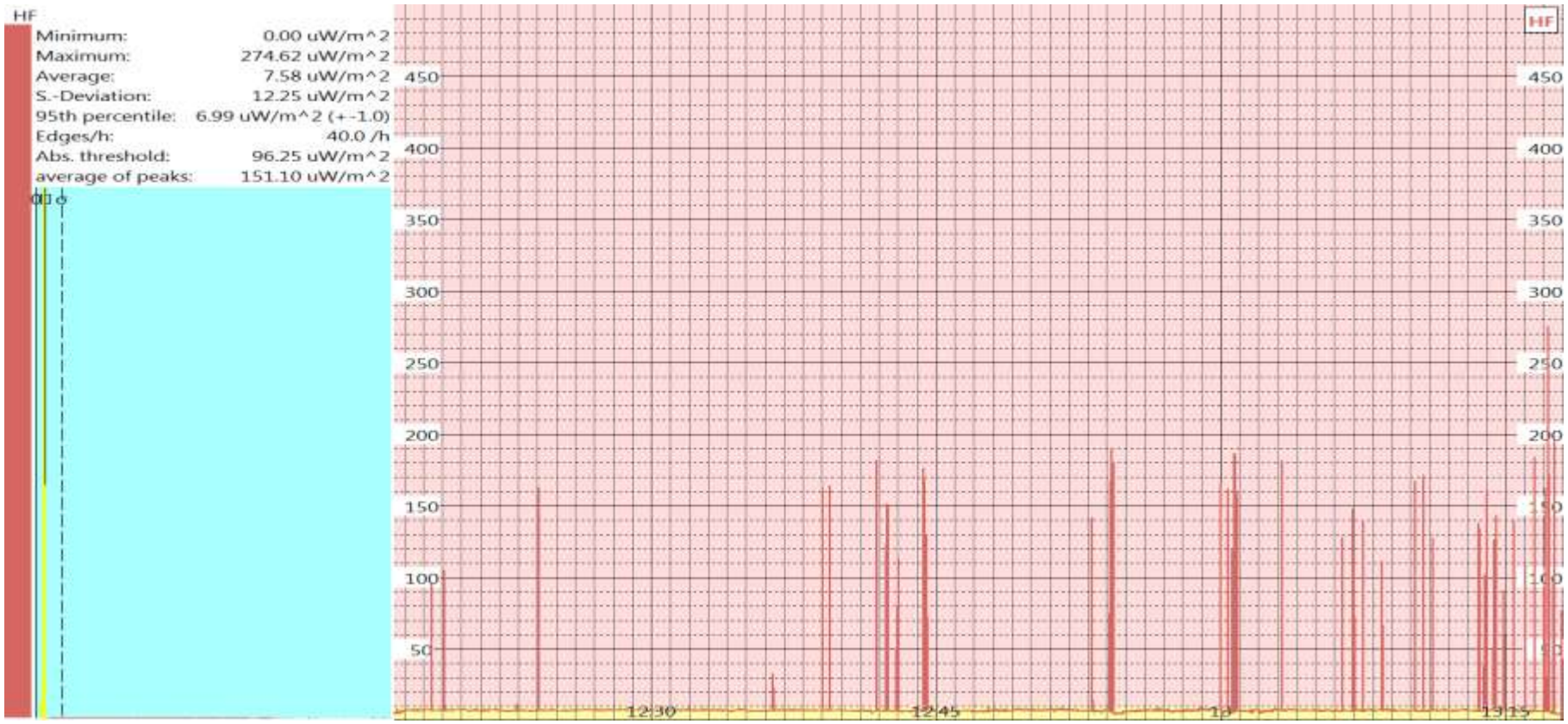
Location #2

Data Collected Inside, distance of 3 feet, directly behind smart meter:

Smart Meter Data Log: Indoor Smart Meter Log @ 3 feet behind Meter / Brick wall.
Logging Time: Approx (12:15pm – 1:15pm)



Maximum Reading: 275 µW/m² Microwatts / Square Meter
Average: 7.6 µW/m² Microwatts / Square Meter
Average of Peaks: 151 µW/m² Microwatts / Square Meter
Transmissions Per Hour: 40
Safety Code 6 Safety Limit for 900 MHz, General Public: (Appendix B) f/150 = 900/150 = 6 W/m^2 or 6,000,000 µW/m²
% Safety Code 6: (274.62 x 100)/6,000,000 = 0.005 %

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Stipulations: Please consider the above documented results as a single snapshot in time. Further long term analysis and testing would be required in order to thoroughly evaluate the smart meters at these two locations. Safe Living Technologies would be happy to continue this evaluation process with Toronto Hydro to gain a complete understanding of the details involved with Smart Meters RF transmissions patterns in the city of Toronto. When testing is continued, other real world conditions should be considered such as multiple unit installation or meter banks, isolated meter placements such as in between buildings, meters with physical obstructions impeding their transmissions, meters installed inside of buildings, effects of RF reflections, collector meters etc…

Background Radiation levels did not influence the readings in this assessment. Cordless phone and cellular activity was noted through audio and spectrum analysis but was not strong enough to influence our assessment of the smart meter output. At Location#1, it should be noted that a neighbouring smart meter was within 30 feet of the test area facing the smart meter under test.

As the smart meter output its data, an additional HF59B was set in audio monitoring mode. This device was used to verify when the Smart Meter was transmitting. The HF59B output a distinct audible tone each time the smart meter transmitted, identifying the Smart Meter as the source. Times were noted and verified in the data recordings above and also by the Narda SRM 3000 provided by the third party. This occurrence was observed by all in attendance thus confirming each measuring device is reporting the same events.

Conclusions:

Transmission Patterns: Both meters transmitted at times of 9, 24, 39, 54 minutes within each hour. In addition to these standard 15 minute intervals, many other transmissions were detected throughout the hour. Location #1 averaged 13 transmissions per hour and Location #2 averaged 40 transmissions per hour. Many transmissions had multiple bursts within seconds of each other.
- Location #1 - The Elster R2S Smart Meter is sending data transmissions 13 + times per hour
- Location #2 - The Elster R1S Smart Meter is sending data transmissions 40 + times per hour

Outdoor Power Density: Measurement values at a distance of 3 feet are in compliance with Safety Code 6 Guidelines (See Appendix B section 4) but are not compliant with the Austrian Medical Association / Building Biology Guidelines for Biological thresholds. (See Appendix B section 2 for guidelines)

Indoor Power Density / RF Building Penetration: Smart Meter RF signals radiate 360 degrees, in all directions from its internal, omni-directional antenna (See page 7 for illustration). Consequently, a portion of the Smart Meter RF Signal is directed into the home behind the smart meter. At Location #2 4.2% of the maximum signal strength penetrated through the brick wall of the home. As per the Austrian Medical Associations / Building Biology Guidelines, these values are still not within desired biological thresholds. This signal strength will vary depending on the building material used for the wall.

Power Failure: When power was removed from the Smart Meter, one final transmission occurred before it completely shut down.

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Acknowledgements

At this point, the staff at Safe Living technologies would like to thank Toronto Hydro for inviting us to observe and participate in this smart meter assessment.

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Electronics Engineering Technologist, BBEC

President,
Safe Living Technologies Inc.

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Appendix A: Calibrated Measuring Equipment Used

Analyzer: Gigahertz Solutions HF59B Radio Frequency Analyzer
Antenna: Gigahertz Solutions UBB27, broadband, omni-directional 27MHz – 3.3 GHz
Data logger: Gigahertz Solutions NFA1000 Data Logger / 3D analyzer

The HF59B RF Analyzer, shown below possesses these main features:

- Isotropic tri-axial power density antenna “3D”
- Meter displays instantaneous and "maximum hold" values
- Measures power density in µW/m² (microwatts per Square meter)
- UBB27 Isotropic antenna covers 27MHz to 3.3 GHz
- Uncertainty +/- 3 dB
- Audio output for signal identification

Meter Used for Assessment

Meter Calibration:

3rd Party Calibration: Performed by Serco GmbH Germany, according to the standards of DIN EN ISO/EC 17025 and ISO9001

Factory Calibration:
Calibrated in factory by Gigahertz Solutions. Professional Laboratory measurement equipment was used from Anritsu, Rohde & Schwarz and IFR (former Merconi) using the internationally accepted “Absolute –Method” for the antenna. The final test prior to dispatch proved that it conforms to its specifications in every respect.

Meter Serial Number: 053000015287
Antenna Serial Number: 053030015032
Meter and Antenna Calibration Date: June 2, 2010
Serco Calibration Certificate Number: K0-0280-2010-06

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HF59B Calibration Certificate:

serco

Serco GmbH • Lise-Meitner Straße 6 • D-85521 Ottobrunn

Kalibrierschein
Calibration Certificate

Kalibrierzeichen
Calibration mark
K0-0280-2010-06

Gegenstand *Object*	HF-Analyser mit Ultrabreitbandantenne
Hersteller *Manufacturer*	Gigahertz Solutions GmbH
Typ *Type*	HF-Analyser: HF59B Antenne: UBB27_G3
Fabrikate/Serien-Nr. *Serial number*	HF-Analyser: 053000015287 Antenne: 053030015032
Auftraggeber *Customer*	Gigahertz Solutions GmbH Am Galgenberg 12 D-90579 Langenzenn
Auftragsnummer *Order No.*	K0-10004
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	5
Datum der Kalibrierung *Date of calibration*	02.06.2010

Die Kalibrierung erfolgt durch Vergleich mit Bezugsnormalen bzw. Bezugsnormalmesseinrichtungen, die in einer Kalibrierstelle des Deutschen Kalibrierdienstes (DKD) kalibriert und damit rückgeführt sind auf die nationalen Normale; mit denen die Physikalisch-Technische Bundesanstalt (PTB) die physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI) darstellt.

Die Kalibrierung erfolgte in Übereinstimmung mit den Normen DIN EN ISO/IEC 17025 und ISO 9001.

Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

The calibration is performed by comparison with reference standards or standard measuring equipment which are calibrated by a Calibration laboratory of the Deutscher Kalibrierdienst (DKD) and thus traceable to the national measurement standards maintained by the Physikalisch-Technische Bundesanstalt (PTB) for the realization of the physical units according to the international system of Units (SI).

The calibration is performed according to the standards DIN EN ISO/IEC 17025 and ISO 9001.

The user is obliged to have the object recalibrated at appropriate intervals.

Die angegebenen Messwerte gelten zum Zeitpunkt der Kalibrierung. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit.

The measured values are valid for the moment of calibration. Calibration certificates without signature are not valid.

Stempel *Seal*	Datum *Date*	Stellv. Leiter des Kalibrierlaboratoriums *Deputy Head of the calibration laboratory*	Bearbeiter *Person in charge*
Kalibrierlabor serco Ottobrunn	07.06.2010	R. Breitsameter	M. Rummer

Tel. +49 (0) 89 4449-1700, Fax: +49 (0) 89 4449-24165, e-mail: Rudolf.Breitsameter@serco.de

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The NFA1000 EMF Analyzer / Data Logger, shown below possesses these main features:

- Records simultaneously on 4 recording channels (CH1-3) for desired 3D measurement and optional channel 4 for Radio Frequency Data logging
- Frequency Range 5Hz – 1,000,000 Hz
- 3D potential-free electric field measurement
- 3D measurement of the magnetic field
- Ability for extensive long-term data recordings
- Accuracy better than +/- 2 dB

Meter Used for Assessment

Meter Calibration:

3rd Party Calibration: Performed by Serco GmbH Germany, according to the standards of DIN EN ISO/EC 17025 and ISO9001

Factory Calibration:
Calibrated in factory by Gigahertz Solutions. Professional Laboratory measurement equipment was used from Anritsu, Rohde & Schwarz and IFR (former Merconi) using the internationally accepted “Absolute –Method” for the antenna. The final test prior to dispatch proved that it conforms to its specifications in every respect.

Meter Serial Number: 035000000321
Meter Calibration Date: May 17, 2011
Serco Calibration Certificate Number: K0-0289-2011-05

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Website : www.slt.co
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NFA1000 Calibration Certificate:

serco

Serco GmbH • Lise-Meitner-Straße 6 • D-85521 Ottobrunn

Kalibrierschein
Calibration Certificate

Kalibrierzeichen
Calibration mark
K0-0289-2011-05

Gegenstand *Object*	3D-NF - Analyser
Hersteller *Manufacturer*	Gigahertz Solutions GmbH
Typ *Type*	NFA 1000
Fabrikate/Serien-Nr. *Serial number*	035000000321
Auftraggeber *Customer*	Gigahertz-Solutions GmbH Am Galgenberg 12 D-90579 Langenzenn
Auftragsnummer *Order No.*	K0-11001
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	5
Datum der Kalibrierung *Date of calibration*	16.05.2011

Die Kalibrierung erfolgt durch Vergleich mit Bezugsnormalen bzw. Bezugsnormalmess-einrichtungen, die in einer Kalibrierstelle des Deutschen Kalibrierdienstes (DKD) kalibriert und damit rückgeführt sind auf die nationalen Normale, mit denen die Physikalisch-Technische Bundesanstalt (PTB) die physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI) darstellt.

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The measured values are valid for the moment of calibration. Calibration certificates without signature are not valid.

Stempel *Seal*	Datum *Date*	Stellv. Leiter des Kalibrierlaboratoriums *Deputy head of the calibration laboratory*	Bearbeiter *Person in charge*
Kalibrierlabor serco Ottobrunn	17.05.2011	R. Breitsameter	M. Rummer

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Appendix B: Exposure Guidelines:

1] Thermal Guidelines: In Canada, guidelines for Radio Frequency Wave exposure lay under the jurisdiction of Health Canada. Safety code 6 was developed in 1999 and offers federal guidelines for safe RF exposure levels. These limits are in the range of **2,000,000 to 10,000,000 µW/m²** microwatts per square meter and are based solely on the short term thermal effects or the heating of body tissue. Adverse biological effects have been documented at levels far below Safety Code 6 guidelines. No Canadian biological exposure guidelines exist for long term exposure to low level Radio Frequency Radiation. This also holds true for the USA as well.

2] Our Recommendations:
Biological Guidelines: BUILDING BIOLOGY (2008) / AUSTRIAN MEDICAL ASSOCIATION EVALUATION GUIDELINES For Sleeping Areas

Building Biology Evaluation Guidelines for Sleeping Areas SBM-2008	**No Concern**	**Slight Concern**	**Severe Concern**	**Extreme Concern**
Power density in microwatt per square meter **µW/m²**	**< 0.1**	**0.1-10**	**10 - 1000**	**> 1000**

3] BIOINITIATIVE REPORT RECOMMENDED EXPOSURE GUIDELINES 2007
Biologically Based Precautionary Levels - 2007 Safe Level for Radio Frequency: **1,000 µW/m²**
Dr. Martin Blank - Columbia University http://www.bioinitiative.org/

Average measurements in homes in Toronto:
200 – 2000 µW/m²

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4]Exposure Guidelines: Canada's Safety Code 6 (SC6):

Safety Code 6 (SC6), published by Health Canada, specifies maximum radio frequency fields (RFF) exposure limits for the general public (GP) and for the radio frequency and microwave exposed workers (RF workers). The maximum exposure limit of SC6 is expressed in a linear scale in field strength (volts per metre or V/m, and amperes per metre or A/m) or in power density measurement units (watts per squared metre or W/m^2). The industry normally uses the simpler "percentage of maximum exposure limit" for the general public or RF workers. Note: Exposure levels for "RF" workers are 5 times the limit for the General Public.
General Public – 2,000,000 $\mu W/m^2$
RF Workers – 10,000,000 $\mu W/m^2$

*****Radio wave radiation will heat body tissue. Safety Code 6 was implemented in 1999 and is based on the negative effects of the short term heating effects of body tissue. This is referred to as the thermal effect of RF radiation. Federal regulators are continuing to study the effects of long term low level exposures to this form of radiation.

The following is taken from:
Health Canada. "Environmental and Workplace Health". Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3KHz to 300GHz – Safety Code 6. 1999.
www.hc-sc.gc.ca

Safety Code 6

2.2 Exposure of Persons Not Classed as RF and Microwave Exposed Workers (Including the General Public)

2.2.1 Field Strength Limits

a. A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time. The spatial averaging is carried out over an area equivalent to the vertical cross-section of the human body (projected area). A time-averaging period of 0.1 h (6 min) should be employed for frequencies up to 15 000 MHz. Above these frequencies, a different averaging time is used and is described in Section 2.3.2.

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b. Where the electromagnetic radiation consists of a number of frequencies in the same or different frequency bands, shown in Column 1 of Table 5, then the ratio of the measured value at each frequency to the limit at that given frequency shown in Column 2, 3, or 4 shall be determined, and the sum of all ratios thus obtained for all frequencies shall not exceed unity when averaged spatially and over time. For field strength measurements, the measured values and the limits shall be squared before determining the ratios. See Section 2.1.1 for more details on calculating the sum.

Table 5
Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)

1 **Frequency (MHz)**	2 **Electric Field Strength; rms (V/m)**	3 **Magnetic Field Strength; rms (A/m)**	4 **Power Density (W/m^2)**	5 **Averaging Time (min)**
0.003-1	280	2.19		6
1-10	280/*f*	2.19/*f*		6
10 - 30	28	2.19/*f*		6
30-300	**28**	**0.073**	**2***	**6**
300-1 500	**$1.585f^{0.5}$**	**$0.0042f^{0.5}$**	***f* /150**	**6**
1 500-15 000	**61.4**	**0.163**	**10**	**6**
15 000-150 000	61.4	0.163	10	$616\,000/f^{1.2}$
150 000-300 000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616\,000/f^{1.2}$

* Power density limit is applicable at frequencies greater than 100 MHz.
Notes:
1 Frequency, f, is in MHz.
2 A power density of 10 W/m2 is equivalent to 1 mW/cm2.
3 A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (µT) or 12.57 milligauss (mG).

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Appendix C: Possible Health Effects

May 2011, a group of experts at the International Agency for Research on Cancer, an agency of the World Health Organization, WHO, classified radiofrequency electromagnetic fields as possibly carcinogenic (Group 2B) for humans (IARC 2011).

May 2011, the Parliamentary Assembly of the Council of Europe adopted the report "The potential dangers of electromagnetic fields and their effect on the environment" (PACE 2011). The report calls for a number of measures to protect humans and the environment, especially from high-frequency electromagnetic fields. One of the recommendations is to "take all reasonable measures to reduce exposure to electromagnetic fields, especially to radio frequencies from mobile phones, and particularly the exposure to children and young people who seem to be most at risk from head tumours".

April 2009, a resolution of the European Parliament called for a review of the EMF limits in the EU Council Recommendation of 1999, which was based on the guidelines of the ICNIRP, with reference to the BioInitiative Report (EU Parliament 2009).

Sweden, EMF syndrome is designated as Electromagnetic Hypersensitivity (EHS), considered a physical impairment and recognized as a disability. With reference to UN Resolution 48/96, Annex, of 20 December 1993 (UN 1993), local governments grant support to individuals with EHS. Employees with EHS have a right to support from their employers so as to enable them to work despite this impairment. Some hospitals in Sweden provide rooms with low EMF exposure.

Typical Symptoms of Electromagnetic Hypersensitivity "EHS"

Neurological: headaches, dizziness, nausea, difficulty concentrating, memory loss, irritability, depression, anxiety, insomnia, fatigue, weakness, tremors, muscle spasms, numbness, tingling, altered reflexes, muscle and joint paint, leg/foot pain, "Flu-like" symptoms, fever. More severe reactions can include seizures, paralysis, psychosis and stroke.
Cardiac: palpitations, arrhythmias, pain or pressure in the chest, low or high blood pressure, slow or fast heart rate, shortness of breath.
Respiratory: sinusitis, bronchitis, pneumonia, asthma.
Dermatological: skin rash, itching, burning, facial flushing.
Ophthalmologic: pain or burning in the eyes, pressure in/behind the eyes, deteriorating vision, floaters, cataracts.
Others: digestive problems, abdominal pain, enlarged thyroid, testicular/ovarian pain, dryness of lips, tongue, mouth, eyes, great thirst, dehydration, nosebleeds, internal bleeding, altered sugar metabolism, immune abnormalities, redistribution of metals within the body, hair loss, pain in the teeth, deteriorating fillings, impaired sense of smell, ringing in the ears, sensitivity to sounds and light, infertility

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Appendix D: Power Density Conversion Table

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Radio Frequency "RF" Power Density to Volts Per Meter Unit Conversion Chart

milliVolts Per Meter	Volts Per Meter	Watts/Sq Meter	milliWatts/sq Meter	microWatts/Sq Meter	Watts/Sq Centimeter	milliWatts/Sq Centimeter	microWatts/Sq Centimeter
0.001,94 mV/m	0.000,001,94 V/m	0.000,000,000,000,01 W/m²	0.000,000,000,01 mW/m²	0.000,000,01 µW/m²	0.000,000,000,000,000,001 W/cm²	0.000,000,000,000,001 mW/cm²	0.000,000,000,001 µW/cm²
0.006,14 mV/m	0.000,006,14 V/m	0.000,000,000,000,1 W/m²	0.000,000,000,1 mW/m²	0.000,001 µW/m²	0.000,000,000,000,000,01 W/cm²	0.000,000,000,000,01 mW/cm²	0.000,000,000,01 µW/cm²
0.019,4 mV/m	0.000,019,4 V/m	0.000,000,000,001 W/m²	0.000,000,001 mW/m²	0.000,01 µW/m²	0.000,000,000,000,000,1 W/cm²	0.000,000,000,000,1 mW/cm²	0.000,000,000,1 µW/cm²
0.0614 mV/m	0.000,061,4 V/m	0.000,000,000,01 W/m²	0.000,000,01 mW/m²	0.000,1 µW/m²	0.000,000,000,000,000,001 W/cm²	0.000,000,000,001 mW/cm²	0.000,000,001 µW/cm²
0.194 mV/m	0.000,194 V/m	0.000,000,000,1 W/m²	0.000,000,1 mW/m²	0.001 µW/m²	0.000,000,000,000,000,01 W/cm²	0.000,000,000,01 mW/cm²	0.000,000,01 µW/cm²
0.614 mV/m	0.000,614 V/m	0.000,000,001 W/m²	0.000,001 mW/m²	0.01 µW/m²	0.000,000,000,000,000,1 W/cm²	0.000,000,000,1 mW/cm²	0.000,000,1 µW/cm²
1.94 mV/m	0.001,94 V/m	0.000,000,01 W/m²	0.000,01 mW/m²	0.1 µW/m²	0.000,000,000,000,001 W/cm²	0.000,000,001 mW/cm²	0.000,001 µW/cm²
6.14 mV/m	0.006,14 V/m	0.000,000,1 W/m²	0.000,1 mW/m²	1 µW/m²	0.000,000,000,000,01 W/cm²	0.000,000,01 mW/cm²	0.000,01 µW/cm²
19.4 mV/m	0.019,4 V/m	0.000,001 W/m²	0.001 mW/m²	10 µW/m²	0.000,000,000,000,1 W/cm²	0.000.000,1 mW/cm²	0.000,1 µW/cm²
61.4 mV/m	0.061,4 V/m	0.000,01 W/m²	0.01 mW/m²	100 µW/m²	0.000,000,000,001 W/cm²	0.000,001 mW/cm²	0.001 µW/cm²
194 mV/m	0.194 V/m	0.000,1 W/m²	0.1 mW/m²	1,000 µW/m²	0.000,000,000,01 W/cm²	0.000,01 mW/cm²	0.01 µW/cm²
614 mV/m	0.614 V/m	0.001 W/m²	1 mW/m²	10,000 µW/m²	0.000,000,000,1 W/cm²	0.000,1 mW/cm²	0.1 µW/cm²
1,942 mV/m	1.94 V/m	0.01 W/m²	10 mW/m²	100,000 µW/m²	0.000,000,001 W/cm²	0.001 mW/cm²	1 µW/cm²
6,140 mV/m	6.14 V/m	0.1 W/m²	100 mW/m²	1,000,000 µW/m²	0.000,000,01 W/cm²	0.01 mW/cm²	10 µW/cm²
19,416 mV/m	19.4 V/m	1 W/m²	1,000 mW/m²	10,000,000 µW/m²	0.000,000,1 W/cm²	0.1 mW/cm²	100 µW/cm²
61,400 mV/m	61.4 V/m	10 W/m²	10,000 mW/m²	100,000,000 µW/m²	0.000,001 W/cm²	1 mW/cm²	1,000 µW/cm²
194,164 mV/m	194 V/m	100 W/m²	100,000 mW/m²	1,000,000,000 µW/m²	0.000,01 W/cm²	10 mW/cm²	10,000 µW/cm²
614,003 mV/m	614 V/m	1,000 W/m²	1,000,000mW/m²	10,000,000,000µW/m²	0.000,1 W/cm²	100 mW/cm²	100,000 µW/cm²
1,941,648 mV/m	1942 V/m	10,000 W/m²	10,000,000 mW/m²	100,000,000,000 µW/m²	0.001 W/cm²	1,000 mW/cm²	1,000,000 µW/cm²
6,140,032 mV/m	6140 V/m	100,000 W/m²	100,000,000 mW/m²	1,000,000,000,000 µW/m²	0.01 W/cm²	10,000 mW/cm²	10,000,000 µW/cm²
					0.1 W/cm²		
					1 W/cm²		
					10 W/cm²		

Formuals: V/m = √ (W/m2 x 377) Volts per meter = the square root of the product of Watts per square meter times 377
Note: V/m and mV/m are rounded