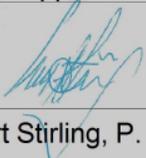


BC Hydro Smart Meter Radio Signal Analysis Findings Report

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December 19, 2011

| | Approval | |
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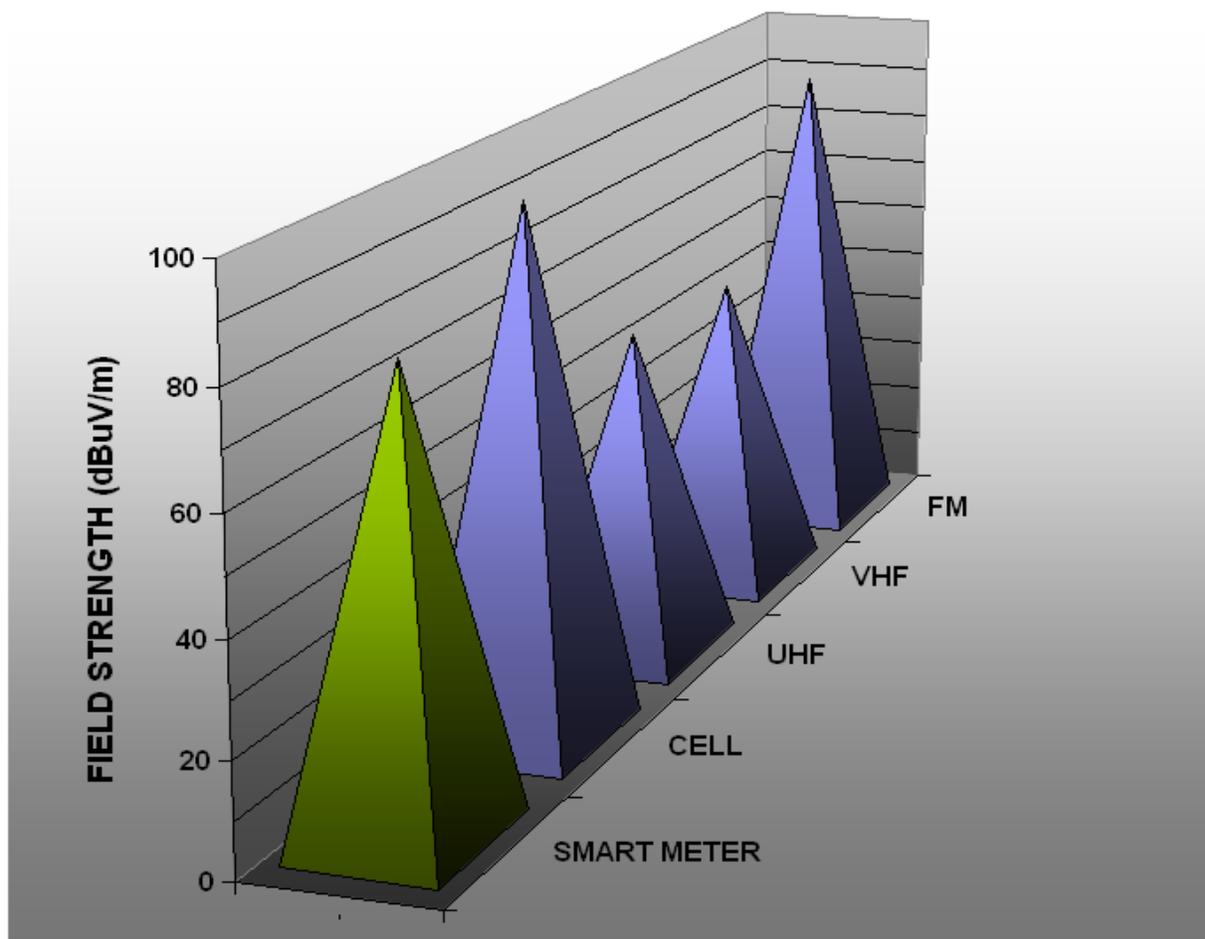
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Executive summary

We live in radio-saturated environment; what’s more, even the electrical products we use generate some radio interference. In Canada, the airwaves are governed by various statutes and regulations: Unintentional radiators such as PCs, household appliances and electronics have to meet Industry Canada interference limits to legally be put on the market, simply to protect our communication infrastructure from accidental interference. Other Industry Canada interference regulations apply to all intentional radio sources, such as Cell phones, personal radios, mobile and wireless devices as well as Smart Meters. Additionally, overlying safety (human exposure) regulations apply to Intentional Radiators, mandated by Health Canada’s Health Code 6, to protect the general public and radio professionals from unsafe levels of radio energy.

Based on an ambient radio scan in Vancouver’s West End, in comparison to the Smart meter laboratory test bed, the continuous radio signals from ambient sources eclipsed the Smart Meter readings as described below. In terms of relative strength of key continuous ambient radio channels the following graph shows a summary of these findings.

SMART METER VS TYPICAL MAXIMUM AMBIENT RADIO BANDS*



* Comparison of maximum readings of the noted bands obtained on the street in Vancouver at Davie and Cardero to BC Hydro’s Smart Meter laboratory test panel, measured at 20 cm, with multiple meters transmitting at maximum nominal power (refer to the report and signal scan, below, for complete details)

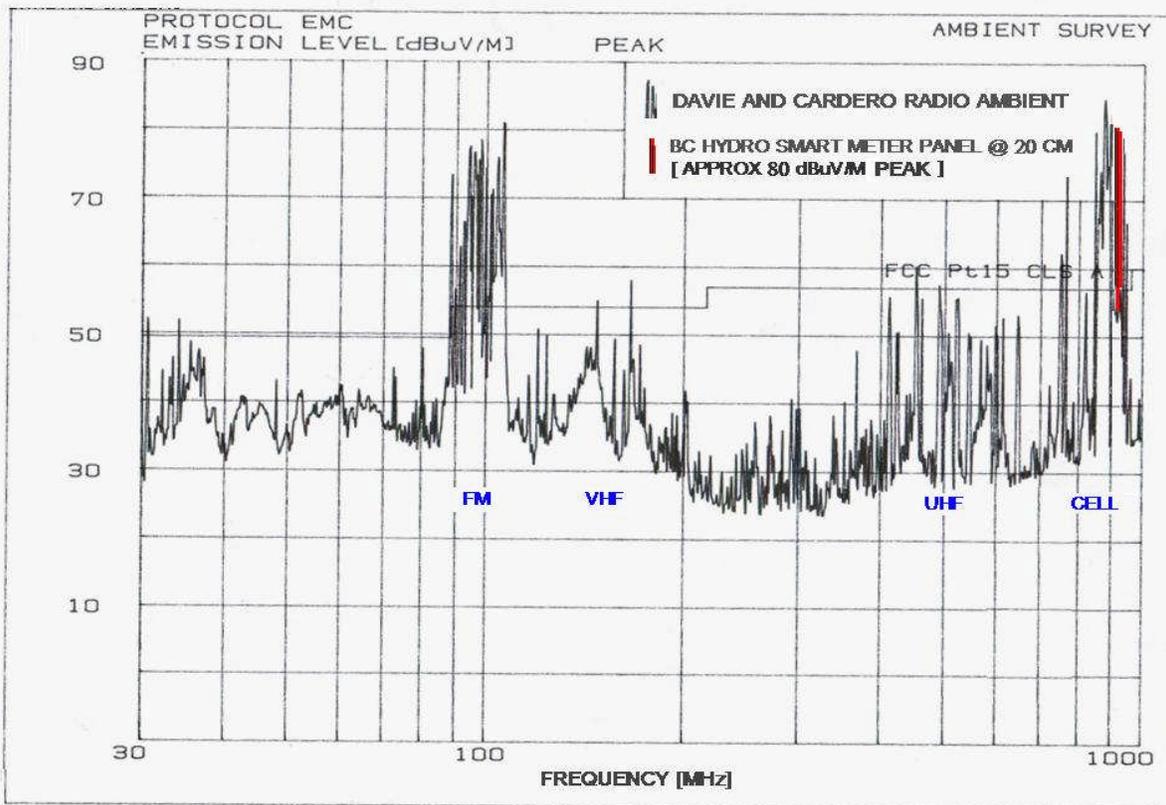
Various steady ambient radio band signals vs. the peak Smart Meter measurements at 20 cm

Based on our investigation, with respect to Industry Canada’s ICES 001 radio interference regulations, BC Hydro’s Smart Meters, showed a margin of 14 dB below legal limits, yet at only 20 cm from the meter - well below the legal requirements. Regarding Health Code 6’s safe exposure limits, the un-averaged *peak* readings were only 0.002 percent of the safe legal limit.

The investigation showed that, as tested in the provided `worst case scenario`, BC Hydro’s Smart Meters pose no threat of illegal radio interference, or health hazards according to Canadian regulations.

Setups and Observations

A baseline ambient radio field strength scan was performed at the corner of Davie and Cardero Street in Vancouver, using an Industry Standard (CISPR 16 compliant) Radio Test Set, and vertically polarized broadband antennas (for reasonably omni-directional readings in the horizontal plane). The scan was from 30 to 1000 Megahertz (MHz), covering the majority of the strongest radio and telecom bands in the radio spectrum, including FM, UHF, VHF, and the 900 MHz Cellular band, to name a few: In the radio-intensive environment of a busy metropolitan center, there are literally thousands of active channels or `frequencies`, continually broadcasting to support society’s needs. The BC Hydro Smart Meters operate in a restrictive `unlicensed` Industrial Scientific and Medical (ISM) frequency range – or `band`, just above a Cellular Telephone band - at 902 to 928 MHz. The resulting plotted graph of Radio Field Strength vs. Frequency follows, with notations identifying the various key radio bands.



Radio Ambient scan in West End Vancouver compared to maximum Smart Meter signals

Note that the stepped horizontal `FCC Pt 15 Class A` line on the graph shows the maximum allowable interference permitted by Industry Canada (which is harmonized with the US’s FCC Part 15 Limits) from any `un-intentional` radiation from electronic devices sold in Canada. This is provided for reference purposes only, and the `Class A` designation is for products for non-residential use, with these

measurements typically performed in a rigorous, idealized setup at 3 meters from such devices. 'Intentional radiators' such as Smart Meters and other radio sources obviously have much higher allowable limits.

Using the same setup as the ambient scan above, measurements were repeated at BC Hydro's Smart Meter laboratory, with what was described by the Smart Meter system integration team, as the extreme conditions of; 1) multiple meters transmitting simultaneously, 2) each at maximum nominal output power, and 3) each in continuous transmission mode.

Accordingly, I observed at least 10 Smart Meters on the panel in the proximity of the measurement antenna, and a number of others, in the order of five or ten, just meters away, near by or in the same room. All of the noted Smart Meters appeared to be operational and actively transmitting. I also observed, when the test-bed meter panel was brought on-line, that the levels in the expected radio band jumped at least 30 dB (about 1000-fold) from the ambient readings in the area, caused by the dozens of other active Smart Meters scattered around the engineering complex. Finally, as part observing the overall signal band, I deliberately focused on a few of the given channels that the ISM frequency hopping algorithm randomly uses, and I could confirm that the signals were continuously transmitting. Accordingly, I have reason to believe that the set-up represented a worst case scenario for Smart Meter transmitted radio field strength.

Notwithstanding the continual operating mode in lieu of the true intermittent nature of a Smart Meter installed and transmitting in the field, and the multiple Smart Meter sources, the readings were additionally made at about 20 cm from the centre of meter panel, to demonstrate the measurement distance and setup prescribed by Canada Health Code 6.

The setup used vertical polarization for the log periodic dipole array antenna to capture the field in the immediate horizontal circumference of the measurement area. The Radio Measurement Test Set used a 1 MHz Video and 1 MHz Resolution Bandwidth, in peak capture mode to find the full range of frequencies and highest output of the 50 channels active in the band. The resulting maximum readings were over-laid on the graph of ambient Radio Field Strength vs. Frequency in the West End of Vancouver. **The Smart Meter readings from 902 to 928 MHz, at maximum amplitude of nearly 80 dB μ V/m, are depicted in red.**

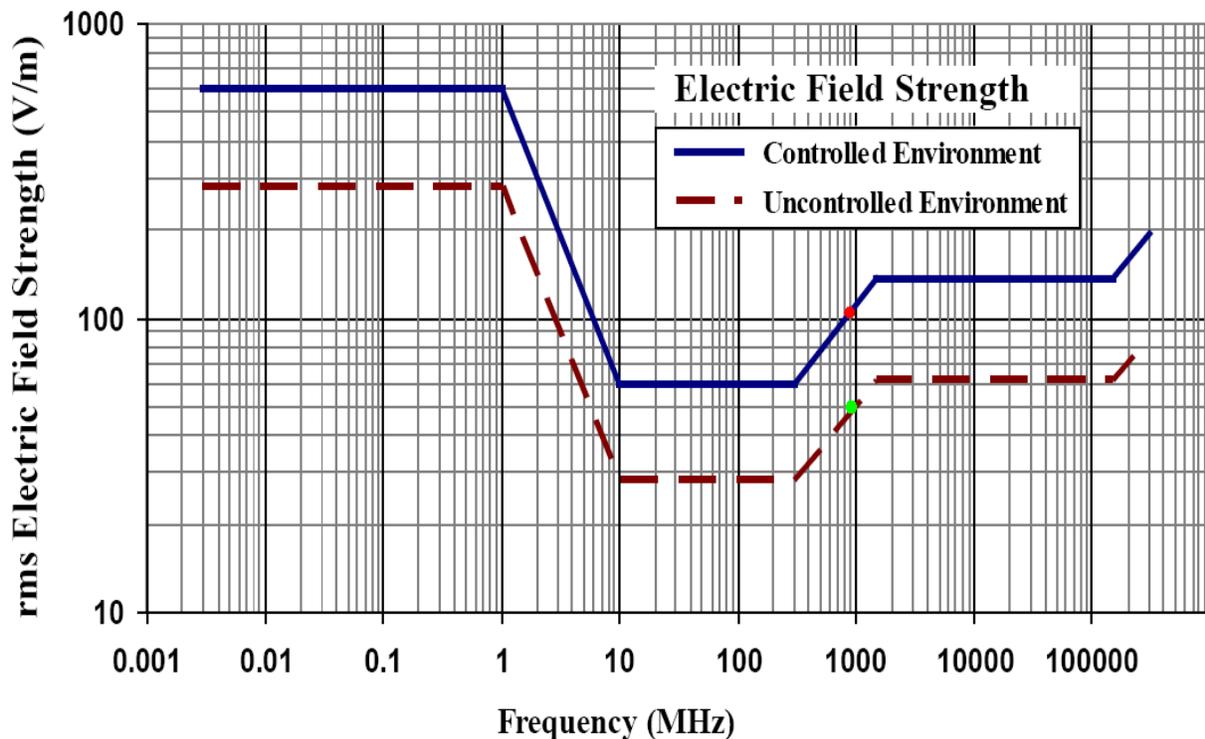
As professional engineer experienced in radio certification, I must note that these readings were somewhat conservative for what was expected for a system of this kind, but in the idealized standard tests for certification purposes, we would need to be even more rigorous than in a real-world scenario: That is to say, certification testing measurements also involve identifying any spurious, often directional, radio lobes resulting from a standardized and repeatable set-up. Therefore it was not unreasonable to find that there was considerable margin below the legal radio interference limits specified by Industry Canada's standardized, but idealized setup. Conversely, the test method that was used precisely followed Health Code 6's mandated setup.

Regulations and Limits

Industry Canada regulates radio sources in Canadian territory to mitigate interference with all telecommunications plus vital radio-based infrastructure, including everything from avionics systems to military applications.

The BC Hydro Smart Meters, fall under the un-licensed ISM requirements in the 902 to 928 MHz band. Industry Canada's ICES 001 ([http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/ICES-001e.pdf/\\$FILE/ICES-001e.pdf](http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/ICES-001e.pdf/$FILE/ICES-001e.pdf)) regulations in this band restrict maximum possible field strength to under 50 microvolts per meter, or about 94 dB μ V/m, based on a measurement at 3 meters from the source. What's more, a time-averaging scenario allows a de-rating of up to 20 dB, for pulsed transmissions (i.e., for as low as a 1 percent duty cycle in a typical 100 ms transmission).

The maximum radiant energy stipulated in Health Code 6, published by Health Canada, (http://www.thermoguy.com/pdfs/Safety_Code_6.pdf) is intended to safely limit the permissible radio energy exposure levels for the general public and trained radio professionals at 20 cm from any radio source. Clearly these levels would be many times higher than the radio interference standards set by Industry Canada. Additionally, Health Code 6 specifies a time averaging algorithm over a 6 minute exposure, thus, for example, for a 1 second transmission, the averaging allows for a 1/360th mean of the peak transmitted burst.. The following graph from Health Code 6 shows these limits, with the Smart meter frequencies highlighted. As noted, for the general public at 900 MHz, the safe exposure limit after time averaging is 154.00 dBuV/m: In other words, correcting for the different measurement proximity (mathematically, Health Code 6 safety readings at 20 cm will be over 100 times higher than the very same Industry Canada interference readings at 3 meters). the allowable increase between the Industry Canada *radio interference limits*, and Health Code 6 *safety limits* is a factor of about 10,000!



- Uncontrolled (General Public) maximum exposure approx 49 V/m at 900 MHz 154.00 dBuV/m
- Controlled (Trained Professionals) maximum exposure approx 105 V/m at 900 MHz 160.00 dBuV/m

Health Code 6 Safe Radio Field Intensity Limits

Summary of findings:

BC Hydro’s Smart Meters are regulated under Industry Canada’s ICES 001 radio interference standard, which permits up to 94 dBuV/m of average radio field strength, measured in an idealized, repeatable setup at 3 meters from the source. That’s 50 microvolts per meter in a non-logarithmic scale. In comparison, Health Canada’s Health Code 6 stipulates legal safe average radio field exposure limits for the public and for radio professionals. In the Smart Meter frequency range it permits up to 154 dBuV/m for general public, at a 20 cm proximity from the meters, and much higher levels for trained professionals. The former limits would allow the public to be exposed to up to 49 Volts per meter right next to a Smart

Meter, and therefore somewhat less than 500,000 microvolts per meter at 3 meters: a factor of around 10,000 higher than the legal interference limits!

The readings taken at BC Hydro's Smart Meter lab were regarded to be a worst case scenario based on the pretext that 1) multiple meters were transmitting simultaneously, 2) each of these were at maximum nominal output power, and 3) each was in continuous transmission mode. The peak radio field – without discounting for the short and intermittent nature of daily transmissions from Smart Meters installed in the field - with measurements at a proximity of 20 cm from the center of the network of 10 or more transmitting Smart Meters was 80 dBuV/m; 10 microvolts per meter in the non-log scale. This translates to 1/50,000 or 0.002 percent of Health Code 6 limits -- if Smart Meters transmitted continuously. In reality, however factoring in time averaging over 6 minutes, per Health Code 6 guidelines, the levels would be reduced considerably.

In summary, with respect to Industry Canada ICES 001 regulations for BC Hydro's Smart Meters, there was a margin of 14 dB below legal radio interference limits but at only 20 cm from the meter; well below the requirements. With respect to Health Code 6's safe exposure limits, the un-averaged *peak* readings were only 0.002 percent of the safe legal limit.

The investigation demonstrated that as tested in the purported worst case scenario, BC Hydro's Smart Meters pose no threat of illegal radio interference, or health hazards according to Canadian regulations.