

FortisBC Inc.

Application for a Certificate of Public Convenience and Necessity (CPCN) for the  
Advanced Metering Infrastructure (AMI) Project - Project No. 3698682

UNDERTAKING No. 9

---

**HEARING DATE:** March 11, 2013

**TRANSCRIPT**

**REFERENCE:** Volume 7, pages 1430 to 1433

**REQUESTOR:** BCUC Chairperson, Len Kelsey

**WITNESS:** Dr. William Bailey and Dr. Yakov Shkolnikov

**QUESTION:** The Chairperson has requested that Exponent estimate total amount of RF energy exposure with added exposure from AMI meters including a bank of meters and making reasonable assumptions about rural to high density urban locations, cell tower proximity, pole mounted collectors, satellite television, peak duty cycle, and commonly used RF-emitting household devices.

---

**Response:**

**Difference from the previous exposure estimate**

This assessment is based on typical values rather than on maximum values provided in Exponent's "Status of Research on Radiofrequency Exposure and Health in Relation to Advanced Metering Infrastructure" report, dated October 13, 2011 (Exhibit B-1, Appendix C5). The maximum values in the Exponent report were computed based on Industry Canada's Radio Standards Specification 102 (RSS-102) and are very conservative (i.e. exposure is overestimated) because the goal of RSS-102 is to prevent a particular transmitter from exceeding Health Canada's Safety Code 6 limits (Exhibit B-1, Appendix B6) even under very rare operating conditions. These conditions include an assumption regarding maximum radiofrequency (RF) exposure from multiple transmitters, which is unlikely to occur simultaneously for multiple transmitters. For example, maximum exposure from cell phone use occurs when reception is poor, but that is also a situation in which exposure is low from the cellular base station. Therefore, typical values of RF fields from transmitters are utilized here to perform the exposure calculations instead of using assumptions about simultaneous maximum exposures from multiple sources.

**Definitions**

For purposes of our analysis, sources of RF exposure indoors where people spend the most time were divided into the following categories:

**Application for a Certificate of Public Convenience and Necessity (CPCN) for the  
Advanced Metering Infrastructure (AMI) Project - Project No. 3698682**

**UNDERTAKING No. 9**

---

**Group 1 devices**

The strongest typical-use sources of an RF signal in the environment are devices used inside the house by residents. Such devices include cell phones, cordless phones, Wi-Fi routers and other Wi-Fi enabled devices, and microwave ovens. We will refer to these as Group 1 devices.

**Group 2 devices**

RF transmitters installed or used in the vicinity of the residence (but not inside) will result in exposure that will typically be lower than that of Group 1 devices. Such transmitters include: cell phone base stations and FM towers in the vicinity of the residence, as well as AMI meters. We will refer to these as Group 2 devices. The presence of Group 2 devices in an urban environment results in greater exposure than in a rural environment where those sources may be less likely to be close to a residence.

**Group 3 devices (man-made background)**

RF transmitters installed at a greater distance from the house such as distant TV/FM/AM and cell phone towers and satellite TV will add to the exposure inside the residence, but the contribution from these Group 3 devices will be lower than from Group 1 and Group 2 devices. Therefore, they are treated collectively as a man-made background.

**Natural background**

The human body, the earth, and any object encountered in daily life are sources of RF fields. The exposure from these natural background sources will typically exceed exposure from Group 3 devices (and even some Group 2 devices).

**Exposure from individual sources**

**Exposure from Group 1 devices**

***Cell phones***

The exposure, or more precisely, the dosage from a cell phone is a function of the distance to the cell phone tower, conversation rate, and duration of the call (as a fraction of 6 minutes).

For localized exposure, Health Canada Safety Code 6 requires use of SAR (W/kg) rather than power density ( $W/m^2$ ). The typical cell phone's maximum specific absorption rate (SAR) is 60% of the Safety Code 6 limit. The range of maximum SAR varies between 12% and 99%. Both the conversation rate and the actual cell phone transmitter power in use (rather than maximum rated power) will tend to reduce the actual SAR. In rural environments, GSM phones will

**Application for a Certificate of Public Convenience and Necessity (CPCN) for the  
Advanced Metering Infrastructure (AMI) Project - Project No. 3698682**

**UNDERTAKING No. 9**

---

typically operate at a maximum power; in cities and suburban areas, one-quarter of maximum power can be assumed to cover a wide range of operations.<sup>1</sup> This difference is more a function of the distance to the tower than a comparison of rural to urban or suburban locations. Close to a tower, the cell phone transmits less power and therefore generates less exposure. A recent study has suggested that after taking into account normal conversation rate and actual cell phone transmitter power, typical SAR values are 6% to 9% of the Safety Code 6 limit for both GSM and CDMA phones.<sup>2</sup>

Based on these considerations and variability between models, a value of 10% of the Safety Code 6 limit is used for cell phone exposure, with awareness that there can be a dramatic variability depending on the usage conditions and on handset type.

***Cordless phones***

Cordless phone exposure expressed as specific absorption rate (SAR) is expected to vary from 0.008 – 0.06 watts per kilogram (W/kg).<sup>3</sup> The geometric mean of these exposures is 0.02 W/kg. Therefore, exposure is expected to be 1.25% of the Safety Code 6 limit, with large variability depending on the usage conditions and on handset type.

Cordless phone base stations also increase exposure to RF fields. They are expected to result in exposure that is between 0.00076% (when not in use)<sup>4</sup> and 0.0038% (when in use)<sup>5</sup> of the Safety Code 6 limit.

***Wi-Fi***

Studies of Wi-Fi in Europe found that it contributes an additional in-home exposure of 0.045 milliwatts per meter squared (mW/m<sup>2</sup>).<sup>6</sup> Since Wi-Fi in Canada operates at a power levels that are a factor of 10 greater than in Europe, the expected exposure from an in-home Wi-Fi in Canada is greater, 0.45 mW/m<sup>2</sup> (0.0045% of the Safety Code 6 limit).

---

<sup>1</sup> Lönn S, Forssén U, Vecchia P, Ahlbom A, Feychting M. Output power levels from mobile phones in different geographical areas; implications for exposure assessment. *Occup Environ Med* 61: 769–772, 2004.

<sup>2</sup> Abdulla H and Badra RE. Head exposure to cellular telephones: A system-level study. In *IEEE Latin-American Conference on Communications (LATINCOM)*, pp. 1–6, 2010.

<sup>3</sup> Health Protection Agency of the UK. Cordless Telephones. [Online]. Available:

[http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb\\_C/1195733767519](http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733767519).

<sup>4</sup> Frei P, Mohler E, Bürgi A, Fröhlich J, Neubauer G, Braun-Fahrländer C, Rösli M. A prediction model for personal radio frequency electromagnetic field exposure. *Sci Total Environ* 408: 102–108, 2009.

<sup>5</sup> Health Protection Agency of the UK. Cordless Telephones. [Online]. Available:

[http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb\\_C/1195733767519](http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733767519).

This is based on the assumption that the exposure in Frei et al. (2009) is based primarily on a no use scenario and a factor of 5 more frequent transmissions.

<sup>6</sup> Frei P, Mohler E, Bürgi A, Fröhlich J, Neubauer G, Braun-Fahrländer C, Rösli M. A prediction model for personal radio frequency electromagnetic field exposure. *Sci Total Environ* 408: 102–108, 2009.

Application for a Certificate of Public Convenience and Necessity (CPCN) for the  
Advanced Metering Infrastructure (AMI) Project - Project No. 3698682

UNDERTAKING No. 9

---

***Microwave ovens***

A microwave oven will contribute approximately 2.3% of the Safety Code 6 limit at a distance of 30 cm and 1 minute usage time.<sup>7</sup>

**Exposures from Group 2 devices**

***Cellular base station antenna***

Outdoor exposure from a cellular base station can approach 0.005 mW/cm<sup>2</sup> of the Safety Code 6 limit.<sup>8</sup> Correcting for building material absorption, this translates to an indoor exposure of 0.16% of the Safety Code 6 limit.<sup>9</sup>

***TV and radio antenna***

Signals from nearby TV and FM radio transmitters near a residence can result exposure of 2 volts per meter (V/m),<sup>10</sup> or 0.0011 mW/cm<sup>2</sup>. This is equivalent to 0.53% of the Safety Code 6 limit.

***FortisBC AMI meters***

At a distance of 1 meter indoors,<sup>11</sup> a typical FortisBC AMI meter (operating at a duty cycle of 0.06%) will produce exposure of 0.00025% of the Safety Code 6 limit, taking into account a factor of 10 reduction due to the reflection from the meter panel, but without taking into account reduction in exposure due to wall materials. Since wall materials would be expected to reduce exposure from AMI meters by approximately a factor of 6,<sup>12</sup> the expected exposure drops to 0.000041% of the Safety Code 6 limit.

Moreover, the reflection factor of 2.56 included in our original calculation (which serves to estimate spatial peak exposure outdoors), while appropriate for the RSS-102 evaluation, actually results in an overestimate of the indoor exposure. A more appropriate reflection factor for indoor exposures is 1.15% because there are no distant reflections sources to be considered

---

<sup>7</sup> 21 CFR 1030.10

<sup>8</sup> Valberg PA, van Deventer TE, Repacholi MH. Workgroup report: Base stations and wireless networks-radiofrequency (RF) exposures and health consequences. *Environ Health Perspect* 115: 416–424, 2007.

<sup>9</sup> Frei P, Mohler E, Bürgi A, Fröhlich J, Neubauer G, Braun-Fahrländer C, Rösli M. A prediction model for personal radio frequency electromagnetic field exposure. *Sci Total Environ* 408: 102–108, 2009. Table 4.

<sup>10</sup> Anglesio L, Benedetto A, Bonino A, Colla D, Martire F, Saudino Fusette S, d' Amore G. Population exposure to electromagnetic fields generated by radio base stations: evaluation of the urban background by using provisional model and instrumental measurements. *Radiat Prot Dosimetry* 97: 355–358, 2001.

<sup>11</sup> The distance of 0.5 meters from the AMI meter (including the wall thickness) assumed in the 2011 Exponent report is unlikely to be maintained for a long duration.

<sup>12</sup> Frei P, Mohler E, Bürgi A, Fröhlich J, Neubauer G, Braun-Fahrländer C, Rösli M. A prediction model for personal radio frequency electromagnetic field exposure. *Sci Total Environ* 408: 102–108, 2009. Table 4.

**Application for a Certificate of Public Convenience and Necessity (CPCN) for the  
Advanced Metering Infrastructure (AMI) Project - Project No. 3698682**

**UNDERTAKING No. 9**

---

in indoor environment.<sup>13</sup> Applying this indoor reflection factor, the exposure from the AMI meter is 0.000019% of the Safety Code 6 limit.

A simple calculation of exposure at a distance of 1 meter in the back of the AMI meter bank (here, a very large 45 AMI meter bank assembled from very closely mounted meters was assumed), the exposure is expected to be 0.0019% of the Safety Code 6 limit (taking into account a factor of 10 reduction due to the reflection from the meter panel). Correction for a reduction in exposure due to wall material reduces this value to 0.00032%.

Approximate exposure from the ZigBee radio inside the AMI meter would be 0.000024%, of the Safety Code 6 limit compared to a ZigBee in-home display exposure of 0.0024% (when operating at 1% duty cycle at a distance of 1 meter).

**Exposure from Group 3 devices (man-made background)**

The reported cumulative man-made background indoor exposure is 0.1 mW/m<sup>2</sup>. This is equivalent to approximately 0.005% of the Safety Code 6 limit.<sup>14</sup>

**Exposure from natural background**

The natural background exposure from earth (including walls, floors, and any other surface at room temperature) is approximately 0.013% of the Safety Code 6 limit. Natural background exposure from a human body is 0.018% of the Safety Code 6 limit.<sup>15</sup>

**Combined exposure from multiple devices**

The exposure from multiple devices was combined by the addition of the contribution from each device expressed as a percentage of the Safety Code 6 limit for the general public.

---

<sup>13</sup> Simba AY, Hikage T, Watanabe S, and Nojima T. Specific absorption rates of anatomically realistic human models exposed to RF electromagnetic fields from mobile phones used in elevators. *IEEE Transactions on Microwave Theory and Techniques* 57: 1250–1259, 2009.

<sup>14</sup> Joseph W, Frei P, Roösli M, Thuróczy G, Gajsek GP, Trcek T, Bolte J, Vermeeren G, Mohler E, Juhász P. Comparison of personal radio frequency electromagnetic field exposure in different urban areas across Europe. *Environmental Research* 110: 658–663, 2010.

<sup>15</sup> International Commission on Non-Ionizing Radiation Protection (ICNIRP). *Exposure to High Frequency Electromagnetic Fields, Biological Effects, and Health Consequences (100 kHz-300 GHz)*. Oberschleißheim, Germany: ICNIRP, 2009.

Application for a Certificate of Public Convenience and Necessity (CPCN) for the  
Advanced Metering Infrastructure (AMI) Project - Project No. 3698682

UNDERTAKING No. 9

---

**Exposure scenarios**

***Exposure scenario 1 (equivalent to a dense urban environment)***

Combined exposure from Group 1 sources including a cell phone in use, WiFi installed in the residence, a cordless base station in the residence (phone not in use), in-home display and a microwave oven in use; Group 2 devices including nearby TV/FM antenna and cell phone tower, and a AMI meter bank (consisting of 45 meters) on the outer wall of the residence, ZigBee radio in the meter turned on (for modeling purposes ZigBee was turned on in 30% of the meters on the bank); Group 3 devices; and natural background exposure from the earth and a single human body.

The combined or aggregate exposure is estimated to be 13% of the Safety Code 6 limit. AMI meter contribution is only 1/30,000 of the overall exposure.

***Exposure scenario 2 (equivalent to a rural environment)***

Combined exposure from Group 3 devices and natural background exposure from the earth.

The combined exposure is estimated to be 0.018% of the Safety Code 6 limit.

***Exposure scenario 3 (equivalent to a rural environment)***

Exposure scenario 3 includes the same sources as exposure scenario 2, with an additional Group 2 device consisting of a single AMI meter on the residence (exposure from AMI meters on nearby residences would be far below the man-made background level).

The combined exposure is estimated to be 0.01802% of the Safety Code 6 limit.<sup>16</sup> The contribution of the AMI meter is only 1/950 of the overall exposure.

***Exposure scenario 4***

Typical manmade background sources, natural exposure from the earth, and a large bank of AMI meters (consisting of 45 meters) on the residence.

The combined exposure is estimated to be 0.0183% of the Safety Code 6 limit. The AMI meter contribution is only 1/57 of the overall exposure.

---

<sup>16</sup> At the maximum observed AMI meter duty cycle (0.58%), the combined exposure in exposure scenario 3 would be 0.0181% of the Safety Code 6 limit. The contribution from the AMI meter is overestimated, however, for both the typical and maximum observed duty cycle because the attenuation from walls and other building materials is not included.

Application for a Certificate of Public Convenience and Necessity (CPCN) for the  
Advanced Metering Infrastructure (AMI) Project - Project No. 3698682

UNDERTAKING No. 9

---

***Exposure scenario 5***

Typical man-made background sources, natural exposure from the earth, an AMI meter bank on the residence as described in exposure scenario 3, and a cordless phone in use.

The combined exposure is estimated to be 1.27% of the Safety Code 6 limit. The contribution of the AMI meter is only 1/4,000 of the overall exposure.

***Exposure scenario 6***

Typical manmade background sources, natural exposure from the earth, an AMI meter bank on the residence as described in exposure scenario 3, and a single human body.

The combined exposure is estimated to be 0.036% of the Safety Code 6 limit. The contribution from the AMI meter is only 1/110 of the overall exposure.