



Dennis Swanson  
Director, Regulatory Affairs

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December 14, 2012

**Via Email**  
**Original via Mail**

Ms. Erica Hamilton  
Commission Secretary  
BC Utilities Commission  
Sixth Floor, 900 Howe Street, Box 250  
Vancouver, BC V6Z 2N3

Dear Ms. Hamilton:

***Re: FortisBC Inc. (FortisBC) Application for a Certificate of Public Convenience and Necessity (CPCN) for the Advanced Metering Infrastructure Project – Responses to Intervener Information Request No. 2***

Please find attached FortisBC's responses to Information Request No. 2 from the British Columbia Pensioners' and Seniors Organization et al. (BCPSO), British Columbia Sustainable Energy Association (BCSEA), British Columbia Hydro and Power Authority (BCH), British Columbia Residential Utility Customers Association (BCRUCA), Citizens for Safe Technology Society (CSTS), Keith Miles, Andy Shadrack, Commercial Energy Consumers of British Columbia (CEC), Nelson Creston Green Party Constituency Association (NCGPCA), and West Kootenay Concerned Citizens (WKCC).

Sincerely,

A handwritten signature in blue ink, appearing to be "DS", with a horizontal line underneath.

Dennis Swanson  
Director, Regulatory Affairs

cc: Registered Interveners

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 1                                |

1 **1.0 Reference: BCPSO 1.3.2**

2 **Exhibit B1, page 7, line 11**

3 **Exhibit B1, page 69, Table 5**

4 1.1 Please under take a sensitivity analysis regarding the Project's costs/benefits  
5 and calculate the results per Table 5 based on a 15 year life for the AMI capital  
6 costs (as opposed to 20).

7

8 **Response:**

9 Please see the table below:

10 **Table BCPSO IR2 Q1.1 – AMI Financial Analysis (15 year life)**

| AMI Costs and Benefits |                             |                      |
|------------------------|-----------------------------|----------------------|
|                        |                             |                      |
| Benefits               |                             | 2012 NPV<br>(\$000s) |
|                        | Meter Reading               | (18,780)             |
|                        | Theft Reduction             | (30,312)             |
|                        | Remote Disconnect/Reconnect | (4,287)              |
|                        | Meter Exchanges             | (1,492)              |
|                        | Contact Centre              | (333)                |
|                        |                             |                      |
| <b>Costs</b>           |                             |                      |
|                        | Operating Costs             | 11,914               |
|                        | Depreciation Costs          | 13,900               |
|                        | Carrying Costs              | 15,469               |
|                        | Income Tax                  | 2,526                |
|                        |                             |                      |
| <b>Total</b>           |                             | (11,396)             |

11 This analysis is not consistent with the expected 20 year life of the meters.

12

13

14 **2.0 Reference: BCPSO 1.18.1**

15 2.1 Will future decisions regarding the types of reports required, when the reports will  
16 be generated and the triggers that will be used result in additional costs ((e.g.

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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 2                                |

1 programming, software, etc.) being incurred as these decisions are  
2 implemented?

3

4 **Response:**

5 The OpenWay Reporting System that is part of the AMI solution provides several out-of-the box  
6 reports as well as tools to customize new reports through a configuration tool which requires  
7 little or no programming. There are also existing reporting tools currently used by FortisBC to  
8 augment reporting requirements if required. The cost of the expected reporting system has  
9 taken into consideration these requirements and are included in the total resource and cost  
10 estimates in the application. There are no additional costs for reporting requirements expected.

11

12

13 2.2 If yes, please describe the scope of the activities that could generate additional  
14 costs.

15

16 **Response:**

17 Please refer to the response to BCPSO IR No. 2 Q2.1.

18

19

20 **3.0 Reference: BCPSO 1.21.1 / 1.23.1 / 1.26.1 / 1.28.1 / 1.29.1**

21 3.1 Please complete the following Table and indicate (by way of an "x") into which  
22 Cost Category or Categories each of the AMI Components fall.

|   | AMI-COMPONENT |     |     |     |      |     |
|---|---------------|-----|-----|-----|------|-----|
| Cost Category                             | HAN           | LAN | WAN | HES | MDMS | CIP |
| 3 <sup>RD</sup> Party Software & Services |               |     |     |     |      |     |
| Meters                                    |               |     |     |     |      |     |

|  |                                       |
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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 3                                |

|                        |  |  |  |  |  |  |
|------------------------|--|--|--|--|--|--|
| Network Infrastructure |  |  |  |  |  |  |
| System Integration     |  |  |  |  |  |  |
| Theft Protection       |  |  |  |  |  |  |

**Response:**

Please see the table below:

**Table BCPSO IR2 Q3.1: Cost Categories of AMI Components**

|   | AMI-COMPONENT |     |     |     |      |     |
|---|---------------|-----|-----|-----|------|-----|
| Cost Category                             | HAN           | LAN | WAN | HES | MDMS | CIP |
| 3 <sup>RD</sup> Party Software & Services | x             | x   |     | x   | x    |     |
| Meters                                    | x             | x   |     | x   |      |     |
| Network Infrastructure                    |               | x   | x   | x   |      |     |
| System Integration                        | x             |     |     | x   | x    | x   |
| Theft Protection                          |               | x   | x   | x   | x    |     |

**4.0 Reference: BCPSO 1.24.1 and 1.24.2**

4.1 The responses to BCPSO 1.24.1 and 1.24.2 appear to suggest that FortisBC does not anticipate any issue with getting data from the individual AMI-enabled meters to the local collectors and that the issues of economic communication options are all related to bringing the data from the local collectors to the HES (i.e., the utility), that is the WAN part of the system. Please confirm that this is the case.



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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 4                                |

1 **Response:**

2 FortisBC confirms that the existence and cost of WAN backhaul is the main factor for deciding  
3 whether it is economical to automatically backhaul AMI meter data.

4 However, this should not imply that FortisBC anticipates no issues getting data from the  
5 individual AMI-enabled meters to the local collectors. FortisBC has planned and allocated  
6 additional LAN infrastructure (repeaters) to mitigate these issues.

7  
8

9 4.2 If yes, will the manual meter reading for those customers with whom there is no  
10 economic WAN option be done by manually reading each individual AMI meter or  
11 by downloading the required data from the local collectors? If from each  
12 individual meter, please explain why the data could not be obtained from the  
13 local collectors.

14

15 **Response:**

16 FortisBC does not intend to install collectors in locations where there is no economic WAN  
17 option. This would require additional expenditures for hardware and LAN network design which  
18 are not likely to be offset by reduced manual meter reading time (due to the remote nature of  
19 the locations, which require considerable driving time even to access the collector). FortisBC  
20 intends to manually collect data directly from the meters.

21  
22

23 **5.0 Reference: BCPSO 1.37.1**

24 5.1 Please explain more fully the increase in costs (\$6.3 M) attributed to IT  
25 Infrastructure and Upgrades. If the increase is not attributable to inflation or  
26 scope changes, what is the basis for it?

27

28 **Response:**

29 The response to BCPSO IR No.1 Q37.1 was amended as of November 21, 2012 (Exhibit B-11-  
30 1). The amended response compares the 2012 AMI Application with Table 6.3 of the March  
31 2008 Amended Application. In the amended response the increase in costs attributed to IT  
32 Infrastructure and Upgrades, after inflation, scope changes and allowance for customer growth

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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 5                                |

1 is \$2.4 million. The increase can be attributed to Vendor Professional Services and internal  
2 FortisBC IT Infrastructure and Design.

3  
4

5 **6.0 Reference: BCPSO 1.40.2**

6 6.1 Do the LAN-related communications between the AMI-enabled meters and the  
7 collectors not have any associated operating costs?

8

9 **Response:**

10 Yes, the LAN-related communications between the AMI-enabled meters and the collectors have  
11 associated operating costs. These costs result from equipment failures of collectors or range  
12 extenders and have been accounted for in the financial analysis.

13  
14

15 **7.0 Reference: BCPSO 1.42.1**

16 7.1 What service life does FortisAlberta use for its MDMS (or equivalent computer  
17 equipment and software)?

18

19 **Response:**

20 FortisAlberta does not have the equivalent of a Meter Data Management System. The software  
21 that is related to AMI (Command Center) was capitalized with the meter costs which have an  
22 assumed depreciable life of 25 years.

23  
24

25 **8.0 Reference: BCPSO 1.44.1**

26 8.1 Assuming some or all of these employees don't transition to other (unfilled)  
27 positions or choose to leave the company/retire voluntarily, what how would  
28 FortisBC handle the circumstance and what would be the incremental cost?

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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 6                                |

1

2 **Response:**

3 The IBEW Local 213 Collective agreement does not have a provision that would require  
4 employees to be provided with an option for a "buy out". Therefore any employees who might  
5 be laid off are not expected to cause any incremental cost for the Company.

6

7

8 **9.0 Reference: Exhibit B1, page 83 (lines 1-11) and page 84 (lines 6-7)**

9 **BCPSO 1.45.1**

10 9.1 The response to BCPSO 1.45.1 states that the 8% is based on the number of  
11 identified thefts divided by the number of sites investigated for the period 2007-  
12 2011. Please explain why this calculation represents proportion of total theft  
13 sites that will be discovered annually.

14

15 **Response:**

16 The 8% is based on the average of historical information from 2007-2011 which is 92 total  
17 diversions found divided by 1,126 total sites investigated. This calculation forms the basis of the  
18 Status Quo 8% theft detection success. If AMI is not deployed there is no anticipated change in  
19 this level of theft detection as resources and methods are unchanged.

20 If AMI is deployed then the detection rate begins at historical levels and is expected to increase  
21 to 25% due to improvements in productivity and data quality as well as energy balancing.

22

23

24 9.2 Please provide a schedule that for the period 2007-2011 identifies:

25 a. The average annual number of grow sites in FortisBC's service area over  
26 2007-2011 based on the assumptions set out on page 82.

27 b. The average annual number of sites investigated

28 c. The average annual number of these sites (per (b)) identified as "grow  
29 sites"

30 d. The average annual number of these sites (per (b)) identified as "grow  
31 sites" involving diversion/theft of power.

32 e. The average percentage of grow sites that involve theft (i.e., d/c)



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 7                                |

1                                    f.            The percentage of theft sites identified each year (i.e.  $d / (a * e)$ )

2

3    **Response:**

4    Please see Table BCPSO IR2 Q9.2 below. Note that Column A has been calculated as the  
5    total number of theft sites versus number of production sites since 25% of producers are  
6    estimated to steal electricity for the purposes of the Application. Column G has been added for  
7    clarity to illustrate the calculation of the 8% theft detection rate cited in the Application.

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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 8                                |

1

**Table BCPSO IR2 Q9.2 – 2007 – 2011 Revenue Protection**

|  | A                 | B                  | C                  | D                        | E=D/C                 | F=D/(A*E)                         | G=D/B                        |                               |
|--|-------------------|--------------------|--------------------|--------------------------|-----------------------|-----------------------------------|------------------------------|-------------------------------|
| Year   | Total Grow Sites* | Total Theft Sites* | Sites Investigated | Known or Suspected Sites | Diversions Identified | Theft % of Known/ Suspected Sites | Annual % of Theft Identified | Theft % of Sites Investigated |
| 2007   | 761               | 381                | 254                | 42                       | 21                    | 50%                               | 3%                           | 8%                            |
| 2008   | 776               | 395                | 206                | 55                       | 28                    | 51%                               | 4%                           | 14%                           |
| 2009   | 792               | 229                | 189                | 45                       | 13                    | 29%                               | 2%                           | 7%                            |
| 2010   | 808               | 208                | 215                | 70                       | 18                    | 26%                               | 2%                           | 8%                            |
| 2011   | 824               | 162                | 262                | 61                       | 12                    | 20%                               | 1%                           | 5%                            |
| Average  | 792               | 275                | 225                | 55                       | 18                    | 35%                               | 2%                           | 8%                            |
| *estimated annual total grow sites and total theft sites reduced by 2% annually from 2012 figures. |                   |                    |                    |                          |                       |                                   |                              |                               |

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 9                                |

1           9.3   Exhibit B1, page 83 suggests that 25% of suspicious sites over the period 2009-  
2                   2011 involved theft whereas the response to BCPSO 1.45.1 indicates that only  
3                   8% of those investigated over the period 2007-2011 involved theft of power.  
4                   Please reconcile and clarify whether the difference in percentages is due strictly  
5                   to the difference in time periods or whether the percentages are based on  
6                   different definitions.

7

8    **Response:**

9    The difference in percentages is based on definitions.   Table BCPSO IR2 Q93 below clarifies  
10   the explanation which follows.

|  |                                       |
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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 10                               |

**Table BCPSO IR2 Q9.3 – 2007 – 2011 Revenue Protection**

|                | A            | B                        | C                     | D=(B-C)                | E=C/B                             | F=C/A                         | G=B/A                               | H                 | I=H*E              |
|----------------|--------------|--------------------------|-----------------------|------------------------|-----------------------------------|-------------------------------|-------------------------------------|-------------------|--------------------|
|                | Sites        | Known or Suspected Sites | Diversions Identified | High Load Paying Sites | Theft % of Known/ Suspected Sites | Theft % of Sites Investigated | Production Sites% of Investigations | Total Grow Sites* | Total Theft Sites* |
| Year           | Investigated |                          |                       |                        |                                   |                               |                                     |                   |                    |
| 2007           | 254          | 42                       | 21                    | 21                     | 50%                               | 8%                            | 17%                                 | 761               | 190                |
| 2008           | 206          | 55                       | 28                    | 27                     | 51%                               | 14%                           | 27%                                 | 776               | 194                |
| 2009           | 189          | 45                       | 13                    | 32                     | 29%                               | 7%                            | 24%                                 | 792               | 198                |
| 2010           | 215          | 70                       | 18                    | 52                     | 26%                               | 8%                            | 33%                                 | 808               | 202                |
| 2011           | 262          | 61                       | 12                    | 49                     | 20%                               | 5%                            | 23%                                 | 824               | 206                |
| <b>Average</b> | <b>225</b>   | <b>55</b>                | <b>18</b>             | <b>36</b>              | <b>**25%</b>                      | <b>8%</b>                     | <b>25%</b>                          | <b>792</b>        | <b>198</b>         |

\*estimated annual total grow sites and total theft sites reduced by 2% annually from 2012 figures.

\*\* 5 yr average of E is 35% conservative estimate of 25% used in Application based on decreasing trend 2009-2011.

The distinction must be made between the number of sites investigated and the number of production sites calculated to divert energy.

The number of sites investigated is the total number of premises investigated by FortisBC in Column A. An average 8% of these sites have been identified as diverting energy for the period 2007-2011 calculated in Column F. An average of 25% of these investigations are identified as production sites calculated in column G, while 75% of investigations are of no consequence. This calculation highlights the inefficiency of the Status Quo due to the poor quality of data received.

The number of theft sites is calculated as 25% of the 824 total production sites estimated to exist in the FortisBC service area. The 824 is derived from Dr. Plecas's report while the 25% theft ratio is derived from historical experience at FortisBC for the period 2009-2011 calculated in Column E. As noted in the table the actual 5 year average is 35% however the decreasing trend for 2009-2011 dictated a more conservative estimate.

The increase in theft detection from 8% to 25% with AMI is a reflection in part of the productivity gains possible with deployment since improved data quality and energy balancing will narrow the selection of sites investigated to those with a high likelihood of theft.

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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 11                               |

9.4 Please provide a schedule that for the period 2009-2011 identifies:

- a. The average annual number of grow sites in FortisBC's service area over 2009-2011 based on the assumptions set out on page 82.
- b. The average annual number of sites investigated
- c. The average annual number of these sites (per (b)) identified as "grow sites"
- d. The average annual number of these sites (per (b)) identified as "grow sites" involving diversion/theft of power.
- e. The average percentage of grow sites that involve theft (i.e., d/c)
- f. The percentage of theft sites identified each year (i.e. d / (a \* e))

**Response:**

Please see Table BCPSO IR2 Q9.4 which follows. Please note that Column A has been calculated as the total number of theft sites versus number of production sites since 25% of producers are estimated to steal electricity for the purposes of the Application. Column G has been added for clarity to illustrate the calculation of the 8% theft detection rate cited in the Application.

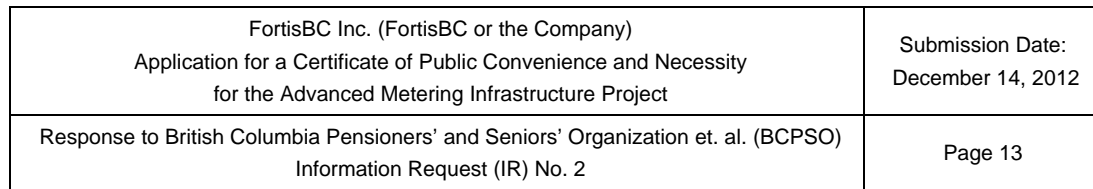


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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 12                               |

1 **Table BCPSO IR2 Q9.4 – 2009 – 2011 Revenue Protection**

|  | A                 | B                  | C                  | D                        | E=D/C                 | F=D/(A*E)                        | G=D/B                        |                               |
|--|-------------------|--------------------|--------------------|--------------------------|-----------------------|----------------------------------|------------------------------|-------------------------------|
|  | Total Grow Sites* | Total Theft Sites* | Sites Investigated | Known or Suspected Sites | Diversions Identified | Theft % of Known/Suspected Sites | Annual % of Theft Identified | Theft % of Sites Investigated |
| Year   |                   |                    |                    |                          |                       |                                  |                              |                               |
| 2009   | 792               | 229                | 189                | 45                       | 13                    | 29%                              | 2%                           | 7%                            |
| 2010   | 808               | 208                | 215                | 70                       | 18                    | 26%                              | 2%                           | 8%                            |
| 2011   | 824               | 162                | 262                | 61                       | 12                    | 20%                              | 1%                           | 5%                            |
| Average  | 808               | 200                | 222                | 59                       | 14                    | 25%                              | 2%                           | 7%                            |
| *estimated annual total grow sites and total theft sites reduced by 2% annually from 2012 figures. |                   |                    |                    |                          |                       |                                  |                              |                               |

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3

4 **Response:**

14

15 **Response:**

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|    |             |                   |                     |
|----|-------------|-------------------|---------------------|
| 27 | <b>10.0</b> | <b>Reference:</b> | <b>BCPSO 1.47.2</b> |
| 28 |             |                   | <b>BCPSO 1.54.2</b> |

29           10.1   The referenced process flowchart does not identify the required interaction with  
30                   the customer similar to that provided on page 90 in the event of a customer  
31                   move. Please fully describe this part of the disconnect process for non-payment  
32                   after the implementation of AMI.

|  |                                       |
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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 14                               |

1

2 **Response:**

- 3 1. The customer account becomes overdue;
- 4 2. If full payment is not received by the next bill, an overdue message is printed on that bill;
- 5 3. If the account continues to be overdue, an automated Notice of Disconnection is mailed
- 6 to the customer;
- 7 4. After 14 days, a request for a 48-hour door tag is made:
- 8 ○ If a door tag is placed at the premise, the location will move to Step 5 after the 48
- 9 hour period expires;
- 10 ○ If no door tag can be placed at the premise the Collections Representative will
- 11 attempt to reach the customer by phone and the premise moves into Step 5.
- 12 5. Collections Representative #1 determines if the premise is eligible for disconnection.
- 13 This ensures that:
- 14 ○ No issues preventing disconnection were identified when the 48 hour door tag
- 15 was placed or other secondary point of contact was established;
- 16 ○ Overdue amounts still exist;
- 17 ○ Appropriate points of contact (Notice of Disconnection, the customer contacting
- 18 the company regarding their overdue balance, defaulted payment arrangements,
- 19 a 48 hour door tag, a phone call from FortisBC) have been made that include at
- 20 least two points of contact;
- 21 ○ There are no special account warnings (i.e. life support, etc);
- 22 6. If still eligible, Collections Representative #1 refers the address for disconnection;
- 23 7. Collections Representative #2 reviews the list of services eligible for disconnection and
- 24 completes a final quality check (this is essentially ensuring that nothing was missed in
- 25 the prior check by Collections Representative #1);
- 26 8. Service is disconnected remotely.

|  |                                       |
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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 15                               |

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3 **11.0 Reference: BCPSO 1.47.3 and 1.47.4**

4 11.1 With respect to BCPSO 1.47.3, why is the lost revenue margin treated as the  
5 benefit? If the premise is vacant and the disconnection occurs sooner due to  
6 AMI, isn't the savings the reduced power requirements provided by FortisBC (for  
7 which it is not compensated) and isn't the value the cost of purchasing such  
8 requirements?

9

10 **Response:**

11 In its analysis, FortisBC has assumed that the "vacant" premise is not actually vacant, and that  
12 there is a new customer that has not yet applied for service. Without continuously monitoring  
13 the premise, FortisBC cannot know with certainty whether this is always the case, or whether  
14 the premise is actually vacant for a certain period. Typically however, based on FortisBC's  
15 experience, premises generally remain unoccupied for less than one month between customers,  
16 hence the assumption is reasonable.

17 The benefit would be reduced from approximately \$69 per MWh (the revenue margin in 2013) to  
18 \$57 per MWh (the marginal power purchase cost in 2013) if FortisBC instead assumed that  
19 100% of "vacant" premises were unoccupied.

20  
21

22 11.2 Exhibit B1 (page 91) states that CSP visits will still be required for 50% of vacant  
23 premise situations and 100% of non-payment situations. Why then are the  
24 savings based on the full number of assumed annual disconnects and  
25 reconnections, per BCPSO 1.47.4?

26

27 **Response:**

28 As discussed in the response to BCPSO IR No. 1 Q47.4, the benefit reflects the full avoided  
29 cost of all reconnects and disconnects since Customer Service Persons (who previously  
30 performed other work) will be performing the required site visits after AMI implementation.

31 Therefore, the overall operating and maintenance budget will be reduced by the full cost of all  
32 site visits required by the current non-AMI process.

|  |                                       |
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| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 16                               |

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**12.0 Reference: Joe Tatangelo #30 and #38**  
**BCPSO #1.27.2**

12.1 The first reference states that the existing meter reading operations are being eliminated. However, the second reference suggests that a portion of the meter reading operations is being retained to read those AMI meters that do not have an economic WAN option. How many metering reading positions are reflected in the forecast savings set out on page 80?

**Response:**

As noted in the responses to Tatangelo IR No. 1 Q30 and Q38, AMI will eliminate existing manual meter reading operations. Existing meter reading operations consist of a workforce (and vehicles, etc) dedicated exclusively to obtaining manual meter reads.

Post-AMI implementation, the Company has forecast the need for approximately 1 full-time equivalent manual meter reading personnel to service those customer premises for which an alternate, economical WAN solution is not available. However, given the expected geographic dispersion of the impacted customer premises, it is expected that this work will become a portion of the work attributed to other roles within the Company – and not remain a dedicated “manual meter reading” workforce – and therefore cannot be characterized as a continuation of existing manual meter reading operations.

**13.0 Reference: Joe Tatangelo #51 and #52**

13.1 Is it FortisBC’s contention that all utilities that have or have had prepaid meters used AMI-enabled meters?

**Response:**

No, please refer to the response to BCUC IR No. 1 Q110.5.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 17                               |

1           13.2   The response to #51 appears to suggest that prepaid meter users must be able  
2                   to see their account balance, which suggests some form of in-house display.  
3                   However the response to #52 states that no determination has been made as to  
4                   whether a pre-paid program requires an in-home display. Please reconcile.

5

6    **Response:**

7    The FortisBC response to Tatangelo IR No. 1 Q51 states (in part):

8                   *The program is not possible without AMI meters since continuous consumption data is*  
9                   *required in order for customers to see their account balance.*

10                  *FortisBC believes that AMI will provide many important tools that will help low or fixed-*  
11                  *income customers to manage their consumption by providing the capability to:*

- 12                   • *find current account balance at any time, either over the phone, online or with an*  
13                    *optional in-home display;*

14   The FortisBC response to Tatangelo IR No. 1 Q52 states (in part):

15                  *FortisBC has not determined whether a pre-pay program requires an in-home display*  
16                  *unit to be successful.*

17   FortisBC believes the responses consistently indicate that customers require “real-time” account  
18   balance information, but that in-home displays are not necessarily required for that purpose  
19   (and that phone and online account balance inquiries may be sufficient).

20

21

22   **14.0   Reference:   CEC #18.1, #20.1, #22.1 and #74.2**

23           14.1   Given a) the large number of feeders and customers on each feeder; b ) the  
24                   limited number transformer meters and portable meters and c) the need to  
25                   restrict the analysis to feeder sections with 50 residences – how much of  
26                   FortisBC’s total residential customer base can be analyzed each year for  
27                   purposes of testing for theft?

28

29   **Response:**

30   The capital budget for strategic energy balancing includes sufficient meters to perform a  
31   detailed analysis of 20 percent of feeders annually and to perform a high level assessment of

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 18                               |

1 an additional 30 percent of feeders in order to identify the next area of focus for detailed  
2 analysis.

3  
4

5 14.2 If the practical annual coverage of FortisBC's customer base for purposes of theft  
6 analysis is less than 100% - how has this been factored into the calculation theft  
7 reduction savings?

8

9 **Response:**

10 In recognition that a full scale energy balancing model is not proposed in the Application the  
11 Company has limited the increase in theft detection from 8 percent to 25 percent. Please see  
12 the response to BCUC IR No. 2 Q62.5.

13  
14

15 **15.0 Reference: CEC #27.2**

16 15.1 The response suggests that there are less than 110,508 residential and  
17 commercial customers with meters (since some commercial customers are not  
18 metered). Please reconcile this with the statement that FortisBC plans to install  
19 approximately 115,000 AMI residential and commercial AMI meters (per Exhibit  
20 B1, page 40).

21

22 **Response:**

23 In FortisBC's initial analysis of the number of customer meters, it was anticipated that there  
24 would be yearly customer growth by the time meters were starting to be deployed. FortisBC had  
25 to extrapolate in order to account for this growth in the customer base. During the Define and  
26 Design phase of the AMI project accurate numbers will be obtained so that the proper amount of  
27 meters are ordered and installed.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 19                               |

1    **16.0    Reference:    CEC #50.3 and 50.5**

2                                    **Exhibit B1, page 49**

3                    16.1    Does the fact that a small number of customers will not have an economic WAN  
4                                    option and their metering data will continue to be manually downloaded impact at  
5                                    all the benefits that have been attributed to AMI (.e.g. theft reduction and reduced  
6                                    disconnect/reconnect costs)?

7

8    **Response:**

9    Yes, the small number of customers that cannot be connected to the AMI communication  
10   network will have a negative impact on some of the benefits listed in the response to CEC IR  
11   No. 1 Q50.5. However, the impact will be minimized by installing AMI meters at these locations  
12   and manually downloading the data at regular intervals. By contrast, the response to CEC IR  
13   No. 1 Q50.5 assumed that “opt-out” customers did not have AMI “radio-off” meters installed  
14   (which is an “opt-out” alternative that the Company does not recommend) and were therefore  
15   unable to retain the benefits noted.

16   The AMI benefits that are substantially or entirely preserved by installing non-communicating  
17   “radio-off” AMI meters and manually downloading the data are:

- 18                    • Lower Measurement Canada compliance costs;  
19                    • Lower meter exchange costs; and  
20                    • Theft detection benefits.

21   Measurement Canada and meter exchange benefits as described in the Application are entirely  
22   preserved. The theft detection benefits are substantially preserved since the downloaded AMI  
23   data will still allow the energy balancing method of detecting power theft to be employed.

24   The cost/benefit analysis has taken into account the potential impact to ongoing meter reading  
25   costs by forecasting a requirement for approximately one meter reader, however, impacts to  
26   other benefits not listed above are considered immaterial to the overall project.

27

28

29                    16.2    If yes, how has this been factored into the cost/benefit analysis?

30

31    **Response:**

32    Please see the response to BCPSO IR No. 2 Q16.1.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 20                               |

1

2

3 16.3 If no, please explain why given the response to CEC 50.5.

4

5 **Response:**

6 Please see the response to BCPSO IR No. 2 Q16.1.

7

8

9 **17.0 Reference: CEC #52.3**

10 17.1 The response suggests that the meter would be exchanged/replaced every 17  
11 years. Please reconcile this with assumed service life of 20 years.

12

13 **Response:**

14 The referenced figure of 17 years is lower than the assumed meter life of 20 years due to meter  
15 exchanges completed as part of compliance sampling activities and from the replacement of  
16 damaged or broken meters. These exchanges are expected to account for close to 1,000 meter  
17 exchanges per year. This brings down the average time between exchanges when using the 20  
18 year meter lifespan assumed in the financial analysis.

19

20

21 **18.0 Reference: CEC #54.2**

22 18.1 If the current metering installation is too old to accept a modern meter, why  
23 should the customer be responsible for the upgrade cost?

24

25 **Response:**

26 FortisBC will be able to use meter adapters that will allow current meter forms to be used on  
27 most of the older metering installations. In unusual situations where a modern meter cannot be  
28 installed, an upgrade of the customer's electrical service may be required. In those situations  
29 the customer may be required to pay for all or a portion of the wiring upgrade, as the customer  
30 owns the meter base. This is consistent with current FortisBC practice when an outdated meter  
31 must be exchanged for a modern style.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Pensioners' and Seniors' Organization et. al. (BCPSO)<br>Information Request (IR) No. 2   | Page 21                               |

1 FortisBC has budgeted, as part of the AMI CPCN, funds to upgrade approximately 1,000 meter  
2 bases which would be reviewed on a case by case basis.

3 Please also refer to the responses to CEC IR No. 1 Q 54.0, Q54.1, Q54.2, Q56.1 and Q56.2.

4

5

6 18.2 Technically who owns the meter base, FortisBC or the customer?

7

8 **Response:**

9 The customer owns the meter base.



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 1                                |

**75.0 Topic: Greenhouse Gas Emissions**

**Reference: Exhibit B-1, pp. 83-84, lines 30 – 2.**

FortisBC says: “It is expected that with an AMI-enabled theft detection program, marijuana grow operators may choose to switch to alternate energy sources rather than pay for electricity. This reduction in gross load is accounted for by assuming a 1 percent growth in grow sites in the probable AMI forecast as opposed to the 2 percent assumed in the status quo model.”

75.1 Please confirm that “a 1 percent growth in grow sites ... as opposed to the 2 percent assumed in the status quo model” is intended to represent the reduction in energy demand from grow ops that FortisBC forecasts for the AMI case relative to the “status quo” case.

**Response:**

Confirmed.

75.2 Please provide a calculation using GHGenius v.4.0 of the annual greenhouse gas emissions of one grow-op of typical energy consumption (as defined by FortisBC in its analysis of theft detection) using fossil fuel powered generation, specifying fuel type (diesel or gasoline) if possible.

**Response:**

Assuming diesel fuel consumption of approximately 2 gallons (7.57 litres) per hour for a 30 kW<sup>1</sup> generator<sup>2</sup> and annual electrical consumption of 151,200 kWhs for one grow-op as detailed in Section 5.3.2 of the Application, annual associated GHG emissions calculated using GHGenius v.4.0 are estimated at approximately 300 tonnes annually.

<sup>1</sup> Based on an average of 30 lights (1000W per light) per grow-op

<sup>2</sup> <http://www.hardydiesel.com/diesel-generators/mitsubishi-powered-30-kw-diesel-generator.html>

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 2                                |

1    **76.0    Topic:            Meaning of “IHD”**

2                                    **Reference: Exhibit B-1, Glossary of Terms, page vii**

3                    “IHD: means In-Home Display or In-Home Device.”

4            76.1    Please confirm that most of the time when FortisBC uses “IHD” in the filed  
5                    materials it means In-Home Display, not In-Home Device. Please identify any  
6                    instances in the filed materials where FortisBC intends “IHD” to mean In-Home  
7                    Device.

8  
9    **Response:**

10    FortisBC confirms that “IHD” was intended in the majority of times to refer to an “In-Home  
11    Display”. The only known instances where IHD referred to the more generic “In-Home Device”  
12    was in Exhibit B-1, Section 4.1.1, page 43, lines 11 and 13.

13  
14

15            76.2    Please confirm or comment on the following:

16                    76.2.1    An In-Home Display is one type of In-Home Device.

17

18    **Response:**

19    Confirmed.

20  
21

22                    76.2.2    Other examples of In-Home Devices would include smart appliances.

23

24    **Response:**

25    Confirmed.

26  
27

28                    76.2.3    In the present context, the central function of an In-Home Display is to  
29                    display electricity consumption and cost information.

30



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 3                                |

1 **Response:**

2 Confirmed.

3

4

5 76.2.4 An In-Home Display might or might not be connected to other In-Home  
6 Devices.

7

8 **Response:**

9 Confirmed.

10

11

12 **77.0 Topic: Function of ZigBee board in meter**

13 **Reference: Exhibit B-11, BCSEA IR#1 15.6.6, page 50**

14 "FortisBC expects AMI meters to be the ZigBee network coordinator controlling the  
15 formation and security of the ZigBee HAN network. FortisBC believes this to be the case  
16 in Texas as well.

17 The Zigbee addressing scheme is capable of supporting more than 64,000 nodes per  
18 network and multiple network coordinators can be linked together to support extremely  
19 large networks.

20 The Itron meter supports up to 10 registered HAN devices."

21 77.1 Please provide more information about the function of the ZigBee board in the  
22 meter as the "coordinator" of a home area network (HAN) consisting of one or  
23 more In-Home Devices.

24

25 **Response:**

26 Every ZigBee mesh network must have one device that is the network coordinator. The  
27 coordinator sets the channel on which the network operates, and manages the device  
28 provisioning process. In a ZigBee Smart Energy network, the coordinator may also be a Trust  
29 Center, providing Smart Energy secure authentication of devices on the network, or the  
30 coordinator may delegate Trust Center responsibilities to another device on the network.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 4                                |

Itron's CENTRON meter is always both a coordinator and a Trust Center. Other devices on the network must be either a router, or an end-device on the network.

77.1.1 Is the coordinator limited exclusively to registering devices on the HAN?

**Response:**

Yes.

77.1.2 Does the coordinator authorize communication between one In-Home Device and another In-Home Device on the HAN?

**Response:**

Authorizing key establishment and communications between devices on the HAN is the role of the Trust Center in a ZigBee Smart Energy network. Itron's CENTRON meter is both a ZigBee coordinator and a Trust Center. As a Trust Center, the CENTRON has configurable authorization policy which can be set to either allow or disallow direct communications between devices on the HAN. By default, the CENTRON allows devices to establish communications with each other.

77.1.3 Does the coordinator store any information other than authentication data? Please list the types of information that would be stored in the ZigBee board in the meter.

**Response:**

As the coordinator, the meter's ZigBee stack will store information about devices which have joined the network, their MAC addresses, and their ID on the ZigBee network (called a "PAN ID"). At the application level, the CENTRON meter also maintains communications logs and event logs which store, for example, communications between devices, communications

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 5                                |

statistics, and relevant events, such as demand response event start notifications, text message acknowledgements, and demand response opt-out notifications.

77.1.4 For clarity, please confirm that the ZigBee system requires at least one device on the home area network to serve the “coordinator” function.

**Response:**

Please refer to the response to BCSEA IR No. 2 Q77.1.

77.1.5 Please confirm that there is one and only one ZigBee Coordinator for a HAN. Please confirm that if the Smart Meter is the ZigBee Coordinator, then no other HAN device can be a Coordinator for that HAN.

**Response:**

Confirmed. Please also refer to the response to BCSEA IR No. 2 Q77.1.

77.1.6 Please describe all the functions that the Coordinator in the Itron meters will perform for the system proposed by FortisBC.

**Response:**

The Itron CENTRON meter’s ZigBee stack will perform all the functions of a ZigBee network coordinator, including:

- Set a channel to operate on (ZigBee operates on channels 11 – 25);
- Respond to “beacon requests” from ZigBee devices searching for networks;
- Manage device provisioning, at the network layer, onto the ZigBee network; and
- Maintain information about the devices which have successfully joined the ZigBee network.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 6                                |

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77.1.7 Please explain the purpose of a Trust Center.

**Response:**

On Smart Energy networks, all devices which join the network must be authenticated by a Trust Center. This means that the Trust Center must explicitly allow the device to join, based on information in the device’s cryptographic certificate. The Trust Center may also provide authorization policies, indicating what operations individual devices are allowed to perform. For example, a Trust Center may allow a particular device to establish communications with other devices on the network, or may disallow a device to communicate with other devices.

77.1.8 Please compare the functions and complexity of a ZigBee Coordinator to those of a ZigBee Router and ZigBee End Device.

**Response:**

A ZigBee coordinator is the one device which forms the ZigBee network.

A router on the ZigBee network is any device which maintains routing tables, and can route messages to other devices on the network. Router devices are necessary to form a “mesh” network, extending the range of ZigBee communications.

An end device is a device that joins a ZigBee network, but does not route messages to other nodes; instead, it just receives messages addressed to it explicitly.

77.1.9 Please classify the ZigBee types (Coordinator, Router, End Device) for In-Home Displays and Gateways for the system proposed by FortisBC.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 7                                |

1 **Response:**

2 In the system proposed by FortisBC, the electric meter is the Coordinator, and any IHDs or  
3 Gateways which join the meter's network may be either routers or end devices. Whether a  
4 device acts as a ZigBee router or end device is up to that individual device's implementation.

5 In order to offer the range-extending benefits of mesh networks, the Company will recommend  
6 the use of IHDs and gateways which are ZigBee routers.

7  
8

9 77.2 What customer information is stored in the ZigBee board in the meter, particularly  
10 when the customer has a Home Area Network of which the ZigBee board in the  
11 meter is the coordinator?

12

13 **Response:**

14 The only network level device information that the meter, acting as a ZigBee coordinator, stores  
15 is device identification information, particularly the IEEE MAC address of the device, the PAN ID  
16 which is an address on the ZigBee network assigned to each device by the coordinator. The  
17 only application-level information stored in the meter are messages received by the meter in  
18 response to ZigBee Smart Energy transactions (demand response events, message delivery  
19 acknowledgements, etc). There is no customer-specific information contained in any ZigBee  
20 Smart Energy messages.

21  
22

23 77.3 Would it be feasible for FortisBC or Itron to configure the ZigBee board in the  
24 AMI meters so that the home area network "coordinator" function was not in the  
25 meter but in an In-Home Device, such as the In-Home Display or Gateway?

26

27 **Response:**

28 No. To maximize the security and integrity of FortisBC's AMI network, the meter will always be  
29 the ZigBee coordinator and ZigBee Smart Energy Trust Center. The system proposed by  
30 FortisBC does not include configurable capabilities to change the meter's role in the HAN.

31  
32

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 8                                |

1                    77.3.1 If this was feasible, would doing so reduce the basis for any customer  
2                    concerns regarding privacy and security associated with having the  
3                    customer's HAN information flowing through the utility's meter?

4

5    **Response:**

6    No. First, the proposed system configuration maximizes system security. Further, regardless of  
7    whether the meter is the coordinator or Trust Center, the meter will always be the server for  
8    providing Metering information, Test Messages and Demand Response/Load Control  
9    messages, and would still receive the same responses from devices on the HAN. Secondly,  
10   these response messages, which are documented in the ZigBee Smart Energy standard,  
11   contain no customer-specific information such as name, address, etc.

12

13

14                   77.3.2 Does FortisBC have any objection to configuring the ZigBee board in the  
15                   AMI meters so that the HAN coordinator function is within an In-Home  
16                   Device? If so, please explain.

17

18    **Response:**

19    Yes, FortisBC and Itron would object to configuring the ZigBee board in the meter to not be the  
20    coordinator. If the meter were not the coordinator, it would be forced to search for other HAN  
21    environments, and join other ZigBee networks. This would allow the meter to join less secure  
22    networks, for example ZigBee Home Automation networks. The Company believes that this  
23    mode of operations would be a security and potential data privacy vulnerability, whereas if the  
24    meter coordinates and authenticates devices on its own secure network, those issues are  
25    eliminated.

26    Itron's ZigBee implementation design has been influenced by Itron's AMI customers, including  
27    Southern California Edison, CenterPoint Energy, and San Diego Gas & Electric, which have all  
28    maintained that the meter must be the coordinator and Trust Center to maximize the security of  
29    their AMI infrastructure.

30

31

32                   77.4    Would it be feasible for FortisBC or Itron to configure the ZigBee board in the  
33                   AMI meters so that that it connects only with an In-Home Display and, at the  
34                   customer's option, an in-home gateway device?

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 9                                |

1

2 **Response:**

3 Yes. Since the meter is the Trust Center, FortisBC can manage which devices are able to join

4 the ZigBee network successfully.

5

6

7 77.4.1 Would this architecture provide separation between the customer's home

8 area network and the utility?

9

10 **Response:**

11 Yes. The meter does not preclude other devices forming separate HAN networks within the

12 same home.

13

14

15 77.4.2 Would this reduce the basis for any customer concerns regarding privacy

16 and security associated with having the customer's HAN information

17 flowing through the utility's meter?

18

19 **Response:**

20 Yes, this architecture would allow customers to purchase their own devices for the home which

21 do not communicate directly with the utility's meter.

22

23

24 77.5 What happens if the customer wishes to have more than 10 In-Home Devices on

25 the HAN?

26

27 **Response:**

28 The Itron meter's HAN only allows 10 devices. However, one of those devices might be a

29 gateway, which also communicates with a separate HAN in the home, thus providing metering

30 data to an unlimited number of devices in the home.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 10                               |

1  
2  
3        77.6    Please confirm that each product added, deleted or changed from the customer's  
4               ZigBee network would need to be registered to the AMI meter and registered  
5               through FortisBC or its system process.

6  
7    **Response:**  
8    The Itron meter includes a configurable Trust Center policy for authenticating devices joining the  
9    Home Area Network formed by the meter. Since that policy is configurable, it can be configured  
10   to require devices to be registered with FortisBC or to allow any device to join that has a valid  
11   Smart Energy certificate.

12   FortisBC, in order to preserve maximum security on the system, intends to require registration  
13   of any HAN device seeking to join the meter's HAN.

14  
15  
16        77.7    Please confirm that information regarding each of these HAN devices would be  
17               stored in the Smart Meter and the online registering service. If not please  
18               explain.

19  
20   **Response:**  
21   Yes. Device-specific information for each HAN device registered through FortisBC would be  
22   stored in the meter. This information includes the device's IEEE MAC address, as well as an  
23   installation code assigned by the device manufacturer.

24  
25  
26               77.7.1 If so, please discuss the privacy and security issues regarding the storage  
27               of this level of information in a device (the Smart Meter) not owned by the  
28               customer.

29

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 11                               |

1 **Response:**

2 No customer privacy is violated with the storage of this information. The customer only needs to  
3 provide this information to FortisBC if they wish to connect their home devices to the electric  
4 meter.

5  
6

7 77.8 If the types of products that are allowed on the ZigBee network was to be limited  
8 in some way (such as being limited to In-Home Displays and Gateways), could  
9 this limiting function be done at the time of registering? If not, please explain.

10

11 **Response:**

12 Yes. Since registration of devices is initiated by the customer, and completed by the FortisBC  
13 head-end system (HES), the Company has the ability to limit device access to the meter's HAN  
14 at the time of registration.

15  
16

17 77.9 Is it true that the Smart Energy Profile requires the installation of special  
18 Certification codes?

19

20 **Response:**

21 A HAN device's IEEE MAC address and a manufacturer-supplied "Installation Code" must be  
22 supplied to the meter to allow a device to join the meter's HAN.

23  
24

25 77.9.1 Please explain the process involved in generating Certification codes. For  
26 example, does each ZigBee coordinator or AMI meter need its own code?  
27 How are the certificates obtained? What organization generates them?  
28 How are they disposed of?

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 12                               |

1

2 **Response:**

3 The installation code is determined by each device manufacturer independently. In addition,  
4 Smart Energy devices include a certificate issued by Certicom. The certificate is never  
5 exchanged with another device, and cannot be stored in the meter or by FortisBC. The  
6 certificate information is used by each device to generate a symmetric key with the Trust  
7 Center, or with another device on the HAN it is attempting to communicate with. ZigBee Smart  
8 Energy defines a process for establishing keys based on device certificate information, which  
9 does not require the devices to access each other's certificates.

10

11

12 **78.0 Topic: ZigBee Coordinator**

13 **Reference: Exhibit B-11, BCUC IR#1 15.6.7, page 51**

14 Regarding the concept of the customer's HAN device being the coordinator and the  
15 Smart Meter being an end device, FortisBC states:

16 "It is technically possible in both jurisdictions. The customer's HAN device would need to  
17 both be a Zigbee end device (to connect to the meter) and a Zigbee server (to connect  
18 to the customer HAN network)."

19 78.1 Please clarify why the customer's HAN device would need to be a Zigbee end  
20 device if it is the coordinator and the meter is an end device.

21

22 **Response:**

23 The meter will be the coordinator for all links to the meter.

24 To clarify, the customer's HAN device does not need to be a "ZigBee Server". A customer HAN  
25 device that joins the meter's HAN must be either a ZigBee end device or a ZigBee router.

26

27

28 78.2 Please discuss the pros and cons of such a setup (meter as an end device).

29

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 13                               |

1    **Response:**

2    When the meter is an end device, it cannot control the channel on which the HAN is formed,  
3    and cannot enforce policy regarding which devices to allow on and off the network. Please also  
4    see the response to BCSEA IR No. 1 Q16.5.

5    If customers wish to create separate HAN environments which do not communicate with the  
6    meter, or wish to partition their HAN such that only a gateway communicates with the meter,  
7    that is possible even with the meter being a coordinator and Trust Center.

8  
9

10           78.3    Please discuss the hardware requirements and complexity for an end device  
11                    versus a coordinator.

12

13    **Response:**

14    From a hardware perspective, most coordinators, routers, and end devices use the same  
15    ZigBee chip, regardless of the role on the HAN the device plays. There is additional stack code  
16    needed for coordinator and router functionality, but the added complexity or computational  
17    requirements are minimal.

18  
19

20           78.4    Please discuss the hardware ramifications if the Itron meter was an End Device  
21                    instead of a Network Coordinator.

22

23    **Response:**

24    The Itron meter is “hardware capable” of being a ZigBee end device, however, for system  
25    security reasons, FortisBC intends to require the meter to be the coordinator.

26  
27

28           78.5    Please discuss the need for over-the-air updates if the Itron meter was an End  
29                    Device instead of a Network Coordinator.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 14                               |

1

2 **Response:**

3 The Itron meter's ZigBee stack is always capable of being updated over-the-air via the proposed  
4 AMI network. This functionality is the same regardless of whether the meter is the coordinator  
5 or end device.

6

7

8 **79.0 Topic: ZigBee Coordinator**

9 Reference: Exhibit B-11, BCSEA IR#1 16.5, page 53; Exhibit B-11, BCSEA IR#1  
10 Appendix 3.1, Section 5.2, Page 27, Figure 5; Exhibit B-11, BCSEA IR#1 Appendix 3.1,  
11 Section 5.3, Recommendation M1, page 29

12 FortisBC explains in regards to the ZigBee acting as the center control manager:

13 "The AMI meter will be ZigBee Network Coordinator. This ensures that FortisBC can  
14 ensure that only devices that will not harm the meter and that will adequately secure  
15 customer data can be registered."

16 79.1 Please discuss the relationship between the Network Coordinator and the Trust  
17 Center.

18

19 **Response:**

20 Network Coordinator is a ZigBee network layer function; one device must form a network on a  
21 specific channel, advertise that network to other devices, and allow devices to join.

22 Trust Center is an application layer function specific to ZigBee Smart Energy networks (as  
23 opposed to ZigBee Home Automation or ZigBee Light link networks).

24 The ZigBee coordinator and ZigBee Smart Energy Trust Center could potentially be two  
25 different devices, with the coordinator directing joining devices to authenticate and establish  
26 keys with a separate Trust Center. However, the Itron meter is both a coordinator and Trust  
27 Center.

28

29

30 79.2 Please confirm that a customer with their own private ZigBee network of devices  
31 would have their own ZigBee Network Coordinator. Please discuss how this is  
32 managed.



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 15                               |

1

2 **Response:**

3 Confirmed. A customer could have their own private ZigBee network with a separate  
4 coordinator. In that case, the two networks (the meter's and the private coordinator's) would not  
5 communicate with each other without a linking gateway device. A gateway device could join  
6 both networks, and deliver metering information obtained from the meter's HAN to the private  
7 coordinator's HAN.

8

9

10 79.3 Please discuss in detail the ways in which harm could be done to the meter and  
11 the types of devices that could hard the meter.

12

13 **Response:**

14 With the meter being a coordinator and Trust Center, the potential for harm to the meter is  
15 minimized. Harmful scenarios that this configuration protects against include:

16 1. A separate Trust Center could allow any number of devices on the network, and  
17 allow all of them to communicate with the meter simultaneously, effectively creating a  
18 "denial of service" attack, which would reduce the performance of ZigBee  
19 communications, and delay the meter's response to individual requests. Even if this  
20 occurred, however, the AMI (or utility-facing) functions of the meter would be  
21 unaffected.

22 2. A variation on the first scenario that would impact the AMI network would be if  
23 unlimited devices sent responses to the meter, basically flooding it with events to be  
24 backhauled over the AMI network to the back-office. This situation is averted with  
25 the meter as the coordinator and Trust Center, since FortisBC could kick such "bad  
26 actor" devices off the meter's network and prevent them from re-joining the meter's  
27 HAN.

28 3. There remains a danger that a particular device, even with it joining the meter's HAN  
29 and successfully authenticating, could be a "bad actor" and request updates to  
30 multiple information attributes, say, every Meter Cluster attribute, every 100  
31 milliseconds (for example). If this were to occur, ZigBee performance would be  
32 harmed; however, with the meter as the coordinator and Trust Center, FortisBC  
33 could detect this problem, and remove the "bad actor" device from the meter's HAN.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 16                               |

1  
2  
3           79.4   Please discuss in detail how the AMI meter being the ZigBee Network  
4                   Coordinator ensures that customer data is adequately secure.

5  
6    **Response:**

7    The AMI meter being the ZigBee coordinator does not, in and of itself, ensure the security of  
8    customer data, since the AMI meter is a network coordinator with a network layer function. The  
9    AMI meter arbitrates which end devices are allowed to connect to the utility network. In this  
10   way, FortisBC can ensure that customer devices have access to and retain the correct customer  
11   consumption information.

12  
13  
14           79.5   If the Smart Meter was an End Device and the Network Coordinator was in the  
15                   customer's premises, please discuss in detail how this could be done to ensure  
16                   no harm is done to the meter, and so that customer data could be adequately  
17                   secured.

18  
19   **Response:**

20   The meter must be the Network Coordinator in order for it to exercise policy over the devices  
21   that join the HAN, otherwise there cannot be assurance that customer data is secured. Please  
22   also refer to the response to BCSEA IR No. 2 Q79.4.

23   Also, as per the response to BCSEA IR No. 2 Q79.3, there are additional threats to the meter  
24   and AMI system if the meter is not the coordinator and Trust Center.

25  
26  
27           79.6   Please compare the privacy and security concerns for the two scenarios (Smart  
28                   Meter as the Network Coordinator or as an End Device).

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 17                               |

1

2 **Response:**

3 As noted in the response to BCSEA IR No. 2 Q79.4, application layer messages defined by the  
4 ZigBee Smart Energy standard do not contain customer-specific data. If the meter is the Trust  
5 Center, FortisBC can ensure that only the right customer data is exchanged with devices on the  
6 HAN, which it cannot do if the meter is not the Trust Center.

7

8

9 **80.0 Topic: In-Home Displays and three utilities**

10 **Reference: Exhibit B-1, Section 8.2.3**

11 In the referenced section 8.2.3, FortisBC states:

12 “BC Hydro, FEI and FortisBC will continue to work together to ensure that in-home  
13 display devices purchased will work for any of the three utilities.”<sup>3</sup>

14 80.1 Please discuss how the three utilities plan to work together.

15

16 **Response:**

17 The three utilities will continue to discuss ways to ensure that commercially available ZigBee  
18 products are compatible with the advanced metering systems of each utility (if they have one),  
19 and that any demand-side management rebates are available for similar products.

20

21

22 80.2 Please discuss how it was decided that the in-home display devices should work  
23 for any of the three utilities. Please include the advantages and disadvantages of  
24 doing so, and other approaches that were explored.

25

26 **Response:**

27 Inter-utility IHD compatibility is a goal that would allow customers who have purchased an IHD  
28 in one part of the province to use it in another part of the province, or to purchase a similar  
29 device for use in another part of the province without worrying about compatibility. Given that

---

<sup>3</sup> Exhibit B-1, Section 8.2.3

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 18                               |

ZigBee products must already meet ZigBee compatibility standards (as described in the response to BCSEA IR1 Q6.1), this goal seemed reasonable, achievable and advantageous to customers throughout the province. FortisBC does not believe there are any material disadvantages to this approach.

80.3 Were the potential issues with SEP versions (SEP 1.x or SEP 2.0) taken into account when this decision was made? Please discuss.

**Response:**

Potential issues with SEP 1.x and SEP 2.0 were not specifically considered when this decision was made. However, these issues will have to be considered if the goals articulated in the referenced section and the response provided to BCSEA IR2 Q80.2 above are to be met.

**81.0 Topic: Home Automation and HAN in FortisBC AMI RFP**

**Reference: RFP, Exhibit B-11, Appendix BCSEA IR#1 8.1, page 29 of 124**

In the RFP, FortisBC states:

“The following are FortisBC’s key objectives with respect to the implementation of AMI:....

e) Support customer in-home automation by providing usage information and price signals into the customer’s home.” [underline added]

81.1 Please explain what FortisBC meant by “in-home automation” as the phrase was used in the RFP.

**Response:**

As used in the RFP, the phrase referred to the ability to support in-home displays and other devices that could display or respond to pricing signals from the utility.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 19                               |

1           81.2   Is there a distinction to be made between the smart meter supporting in-home  
2                   automation by providing usage information and price signals into the customer's  
3                   home, and the smart meter providing the "coordinator" function for a home area  
4                   network that includes home automation devices?

5

6   **Response:**

7   The ability of the smart meter to provide coordination functions and the ability to support "in-  
8   home automation" are linked. The ability of the AMI systems to support "in-home automation"  
9   relies on a safe, secure link between the meter and at least one ZigBee device in the home (as  
10   described in the response to BCSEA IR1 Q15.6.7 and Q16.5).

11

12

13           81.3   Could the smart meter support in-home automation by providing usage  
14                   information and price signals into the customer's home without providing the  
15                   "coordinator" function for a home area network? If so, how.

16

17   **Response:**

18   FortisBC believes it is technically possible, but this approach would not be as safe (in terms of  
19   the devices permitted to attach to the FortisBC network) and secure as having the AMI perform  
20   the "coordinator" function. Please also see the response to BCSEA IR1 Q16.5.

21

22

23           81.4   At the risk of repeating IR 77.4, would configuring the ZigBee board in the AMI  
24                   meters so that that it connects only with an In-Home Display and, at the  
25                   customer's option, an in-home gateway device support in-home automation while  
26                   reducing the basis for any customer concerns regarding privacy and security  
27                   associated with having the customer's HAN information flowing through the  
28                   utility's meter?

29

30   **Response:**

31   Please refer to the responses to BCSEA IR2 Q77.4.1 and Q77.4.2.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 20                               |

**82.0 Topic: SEP Versions**

**Reference: Exhibit B-11, BCSEA IR#1 1.1, 1.2, 1.3, 1.5.1; CSTS IR#1 54.1**

FortisBC states:

“ZigBee SEP 1.1 may be the only available standard that can be implemented initially.”  
[underline added] [BCSEA IR#1 1.1]

“Only one version or the other can be implemented in the meter at any point in time. The HAN firmware can be upgraded “over the air” (remotely).” [BCSEA IR#1 1.2]

“It is expected that gateway devices will be available that can allow a meter running v2.0 to interoperate with devices running v1.1 (or vice-versa). The Zigbee Alliance intends to start working on such a solution by the end of 2012.” [BCSEA IR#1 1.3]

“The Zigbee Alliance expects to have a ratified specification [for SEP 2.0] by the end of 2012 (although the date has slipped previously). FortisBC does not have information regarding the hurdles that need to be overcome to achieve a ratified specification, nor what the risks may be.” [BCSEA IR#1 1.5.1]

“Zigbee Smart Energy v2.0 includes additional functionality related to:

- Deployments in multi-dwelling units;
- Supporting multiple energy service interfaces in a single premise;
- Supporting any transport layer based on IETF IP compliant standards, including but not limited to ZigBee IP, other RF-based and Power Line Carrier (PLC)-based transports; and
- Supporting internationally recognized standards to ensure long-term interoperability with multiple technologies.” [CSTS IR#1 54.1]

82.1 Does FortisBC agree that the customer privacy and security implications may be different for SEP 2.0 than for SEP 1.1? Why?

**Response:**

Customer and utility data will be private and secure regardless of whether SEP 2.0 or SEP 1.1 is implemented, so the practical implications of using either technology are the same with respect to those considerations.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 21                               |

1  
2  
3           82.2   Does FortisBC plan to obtain Commission approval for implementation of SEP  
4                   2.0? Please explain.

5  
6    **Response:**

7    No. FortisBC will consider all customer benefits and issues, then decide whether to implement  
8    SEP 2.0 prior to allowing HAN devices to be connected to AMI meters. This will ensure that  
9    customers have no stranded assets. For this reason, FortisBC does not believe Commission  
10   approval is required.

11  
12  
13                   82.2.1   Would FortisBC be averse to a Commission direction that FortisBC seek  
14                           public input and obtain Commission approval before implementing SEP  
15                           2.0? If so, please explain.

16  
17   **Response:**

18   FortisBC takes no position in this regard, but believes such a direction is unnecessary as  
19   described in the response to BCSEA IR No. 2 Q82.2.

20  
21  
22   **83.0   Topic:           Pilot testing**  
23                           **Reference: Exhibit B-11, BCSEA IR#1 1.5.3, page 2; Exhibit B-6,**  
24                           **BCUC IR#1 28.1.2, pages 69-73**

25    BCSEA-SCBC asked: “What testing has been done for v2.0 or is expected before it is  
26    considered complete? Does FortisBC plan any pilot testing?” [underline added]

27    FortisBC responded: “No testing has been done or is planned before the standard is  
28    considered complete. FortisBC expects to do pilot testing as described in the response  
29    to BCUC IR No. 1 Q28.1.2.”

30    In BCUC IR No. 1 Q28.1.2, the Commission asked when In-Home Display devices  
31    would be available to the ratepayer. FortisBC states “The IHD devices will be piloted in  
32    2014, with availability to customers expected in 2015.” [underline added]

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 22                               |

1           83.1    There may be confusion between pilot testing of In-Home Displays and pilot  
2                   testing of SEP 2.0. Please clarify.

3

4    **Response:**

5    FortisBC would prefer to pilot both SEP 1.x and SEP 2.0 IHD devices in 2014 (assuming SEP  
6    2.0 IHD devices are available).

7

8

9           83.2    Please confirm that FortisBC will be the party conducting the pilot testing, or  
10                   otherwise explain.

11

12   **Response:**

13   Confirmed.

14

15

16           83.3    Will FortisBC prepare a report on the pilot testing of the In-Home Displays and/or  
17                   SEP 2.0? If so, when? If not, why not?

18

19   **Response:**

20   FortisBC does not intend to prepare a report on the pilot testing of In-Home Displays, but would  
21   not be averse to doing so if required as a condition of approval.

22

23

24           83.4    A preliminary project plan is provided in Exhibit B-6, BCUC IR#1 40.1, and it is  
25                   not clear where pilot testing of In-Home Displays and/or SEP 2.0 is  
26                   accomplished. Please specify where in the preliminary project plan these tasks  
27                   occur, or explain when they occur in relation to other project tasks.

28



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 23                               |

1 **Response:**

2 FortisBC plans to begin field testing of HAN functionality and IHDs after Region 1 has been  
3 completed (network device and meter installation complete) and accepted as operational.

4  
5  
6 83.5 Please confirm that pilot testing for In-Home Displays and/or SEP 2.0 is included  
7 in the AMI budget, and provide a reference.

8  
9 **Response:**

10 Pilot testing of the IHDs will be performed by FortisBC PowerSense and AMI project staff. The  
11 costs are included in the respective budgets. The AMI Project portion of the testing is included  
12 in the 2015 project capital costs, shown on line 27 of the Net AMI schedule under "Project  
13 Capital".

14  
15

16 **84.0 Topic: Home Area Network and Home Automation**

17 Reference: Exhibit B-11, CEC IR#1 51.1, page 75; Exhibit B-1, Glossary of Terms, page  
18 viii; Exhibit B-1, Section 4.1.1, page 41; Exhibit B-11, BCSEA IR#1 15.6.3

19 In response to CEC IR#1 51.1, FortisBC states that "The ZigBee™ Alliance website  
20 states: ZigBee Home Automation offers a global standard for interoperable products  
21 enabling smart homes that can control the following product categories:

- 22 - Appliances;
- 23 - Audio;
- 24 - Cards & Readers;
- 25 - Closures, e.g. window shades;
- 26 - Energy Efficiency;
- 27 - Health & Fitness;
- 28 - Information Systems;
- 29 - Lighting;
- 30 - Networking Devices;

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 24                               |

- 1 - Payment Equipment; and  
2 - Security”  
3

4 In the AMI Application glossary, FortisBC defines HAN as the “Home Area Network” and:  
5 “Home Area Network – This optional network connects the AMI meters with customer-  
6 purchased IHDs. This will allow will allow a customer to view power usage within their  
7 home and enable them to make informed decisions affecting the level or timing of their  
8 electric consumption”.

9 “IHD: means In-Home Display or In-Home Device.”

10 FortisBC states:

11 “Customers will be required to provide a unique identifier for their HAN devices to  
12 FortisBC (such as the MAC address of the device) so that FortisBC can associate that  
13 device with the electricity account and ensure data is exchanged with only that device.

14 Only information that is required to securely connect HAN devices to the AMI network  
15 will be collected from the customer, and only if the customer requests a HAN device to  
16 be connected.” [BCSEA IR#1 15.6.3]

17 84.1 For clarity, please confirm that in FortisBC’s definition of Home Area Network  
18 “IHD” refers to In-Home Displays, rather than In-Home Devices.  
19

20 **Response:**

21 Confirmed.  
22  
23

24 84.2 Does FortisBC see the Home Area Network (with the ZigBee Coordination  
25 function in the ZigBee board in the meter) and ZigBee Home Automation as one  
26 and the same? If so, why? If not, why not?  
27

28 **Response:**

29 In the ZigBee Alliance standards there are profiles for different purposes. Those include:

- 30 • Home automation;  
31 • Commercial building automation;  
32 • Health care;

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 25                               |

- 1       • Remote control; and
- 2       • Smart energy

3 Most operate with the same 802.15.4 radio technology using ZigBee Pro. At the application  
4 layer they will share some common clusters but have unique security models and features.

5 The Itron meter supports the Smart Energy profile (not the Home Automation profile).

6  
7

8           84.3   Does FortisBC agree that some of the smart home products that are capable of  
9                   being controlled by ZigBee Home Automation may have little or nothing to do  
10                  with electricity consumption?

11

12   **Response:**

13   Agreed.

14  
15

16           84.4   Is the concept that all of the smart home product categories capable of being  
17                   controlled by ZigBee Home Automation will be registered through FortisBC and  
18                  the ZigBee board on the utility meter?

19

20   **Response:**

21   No. ZigBee Home Automation or ZigBee Light Link networks can be installed in the home  
22   independent of the meter's HAN, with no communications interface with the meter's HAN.  
23   Thus, devices on those networks do not need to be registered with FortisBC or the meter.

24  
25

26           84.4.1 If so, is that an optimal design? Is it necessary and/or desirable for  
27                   FortisBC to be the operator of a website at which a customer registers  
28                  various home automation devices?

29

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 26                               |

1 **Response:**

2 Please refer to the responses to BCSEA IR No. 2 Q84.4 and Q84.4.2.

3

4

5 84.4.2 Would FortisBC agree that in terms of privacy and security of customer

6 information there is distinction to be made between requiring the

7 customer to provide to FortisBC a unique identifier for an In-Home

8 Display (showing electricity consumption and cost) and requiring the

9 customer to provide to FortisBC a unique identifier for other types of In-

10 Home Device that have no direct involvement with electricity

11 consumption?

12

13 **Response:**

14 No, FortisBC does not agree. A customer will only register a ZigBee device with FortisBC if

15 they choose to do so. If customers do choose to connect ZigBee devices of any type, they

16 should be able to choose whether to connect to the utility network through the meter (if the

17 device is permitted by the utility), or whether to create their own network (which does not require

18 permission of the utility, nor registration with the utility).

19

20

21 84.5 How does FortisBC's concept of how the ZigBee board in the meter will be

22 configured to connect to In-Home Displays and other In-Home Devices compare

23 with FortisBC's understanding of BC Hydro's concept of how the ZigBee board in

24 the meter will be configured to connect to In-Home Displays and other In-Home

25 Devices?

26

27 **Response:**

28 FortisBC does not have detail on how BC Hydro intends to configure and operate their system

29 to support ZigBee devices, nor how that configuration may change in the future. Conceptually

30 however, configuration and operation will be similar since both companies are using similar

31 products and software.

32

33

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 27                               |

1                   84.5.1 Will they operate in the same way? If not, please indicate how they  
2                   operate differently and why.

3

4   **Response:**

5   Please refer to the response to BCSEA IR No. 2 Q84.5.

6

7

8           84.6   Please confirm that a customer who wanted to have a home automation system  
9           that did not 'pass through' the electricity meter would be able to receives  
10          electricity consumption and price information from the meter through a Gateway.

11

12   **Response:**

13   Confirmed, assuming the gateway device is simultaneously connected to the meter's HAN and  
14   the customer's Home Automation network.

15

16

17                   84.6.1 Please confirm that this would limit the exposure of the customer's home  
18                   automation system to only the Gateway.

19

20   **Response:**

21   Confirmed, in this case only the customer's Gateway device would be connected to the utility  
22   AMI network.

23

24

25                   84.6.2 Please confirm that the Gateway would be the only HAN device  
26                   coordinated by the ZigBee board in the meter.

27

28   **Response:**

29   Confirmed. In the scenario described, the customer's Gateway device would be the only device  
30   coordinated by the meter.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 28                               |

1

2

3 **85.0 Topic: Control messages**

4 **Reference: Exhibit B-11, BCSEA IR#1 15.6.8**

5 "FortisBC expects the AMI system to be able to send control messages (on/off,  
6 thermostat setpoints) to customer devices that are equipped to receive these  
7 commands.

8 These controllable devices incorporate settings that allow the customer to decide  
9 whether to accept signals from the utility or not.

10 FortisBC has no intention of sending control signals to customer devices for any reason.  
11 If customer demand warranted such a service, FortisBC would only send such control  
12 signals at the explicit request of a customer or as part of an approved rate structure."

13 85.1 To clarify, please confirm that "FortisBC has no intention of sending control  
14 signals to customer devices for any reason" means except with customer  
15 permission and as part of future rate structures that have not yet been planned or  
16 approved by the Commission. Alternatively, please explain.

17

18 **Response:**

19 Confirmed.

20

21

22 **86.0 Topic: Home Automation in FortisBC AMI RFP**

23 **Reference: Exhibit B-6, BCUC IR#1 30.2.1, page 48-49**

24 FortisBC states:

25 "If another HAN technology/protocol becomes dominant in home automation, FortisBC  
26 expects the market to respond with protocol-bridging gateway devices capable of  
27 interfacing Zigbee to other protocols. These gateway devices already exist, for example  
28 devices that can interface ZigBee PRO, WiFi, 6LoWPAN and JenNet, plus an interface  
29 to an INSTEON and/or X10 networks".

30 86.1 Does this mean that if the AMI system is implemented as proposed a customer  
31 will be able to choose to install a gateway device that connects the ZigBee board  
32 in the Itron meter to the customer's own home automation system of the types  
33 described?

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 29                               |

1

2 **Response:**

3 Yes, if the AMI system is implemented as proposed a customer will be able to choose to install  
4 a gateway device that connects the ZigBee board in the Itron meter to the customer's own home  
5 automation system of the types described.

6

7

8 86.1.1 Would this be a practical way to separate the customer's home area  
9 network from the utility's electronic network?

10

11 **Response:**

12 Yes, this would this be a practical way for the customers to choose a different HAN technology  
13 or to separate the customer's home area network from the utility's electronic network.

14

15

16 86.1.2 Would this promote innovation and customer choice by allowing  
17 manufacturers to offer non-ZigBee In-Home Displays and In-Home  
18 Devices?

19

20 **Response:**

21 Yes, the ability for customers to select protocol-bridging gateway devices promotes customer  
22 choice and may therefore promote innovation.

23

24

25 **87.0 Topic: Alternative In-Home Displays**

26 **Reference: Exhibit B-11, BCSEA IR#1 19.1, page 56**

27 Asked about Blue Line Innovations In-Home Displays, FortisBC states:

28 "FortisBC is not an expert in the operation of Blue Line Innovations In-Home Displays  
29 that work without advanced meters. However, the Company understands that they work  
30 by placing a sensor on the customer's meter that reads the spinning disc (on electro-

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 30                               |

mechanical meter) or the optical port (on digital meters) and wirelessly transmits those pulses to a display device in the home in which the pulses are converted to energy consumption.”

87.1 Can the Blue Line product and other sensor based In-Home Display products read the optical port of the particular Itron meter that FortisBC has proposed?

**Response:**

From information available on the Blue Line Innovations website, it appears the Blue Line PowerCost Monitor product is compatible with the AMI meters that FortisBC has proposed.

87.2 Does FortisBC have any objection to customers attaching such sensors to existing or AMI meters? If so, please explain why and indicate what criteria would make attaching these sensors acceptable.

**Response:**

Provided that the sensors do not cause safety issues or interfere with FortisBC operations, FortisBC would not object to customers attaching these devices to existing or AMI meters. FortisBC is aware that some customers already have these devices attached to their existing meters, and they do not interfere with FortisBC operations.

87.3 Does FortisBC agree that sensor type In-Home Display systems can be a viable alternative to a ZigBee In-Home Display system? If not, why not?

**Response:**

Yes, FortisBC agrees that sensor type displays like those sold by Blue Line Innovations can be a viable alternative to a ZigBee In-Home Display system, however it should be noted such sensors typically require a battery power source whereas a ZigBee In-Home Display could simply be wall powered within the premises. FortisBC has no issue with customers using these devices with AMI meters provided they do not cause safety issues or interfere with operations.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 31                               |

1  
2  
3 87.4 Is FortisBC willing to pilot test In-Home Display systems other than ZigBee  
4 systems?

5  
6 **Response:**

7 FortisBC currently intends to pilot test only ZigBee In-Home Display systems. FortisBC has no  
8 issue with customers using non-ZigBee devices with AMI meters (such as BlueLine monitors)  
9 provided they do not cause safety issues or interfere with operations.

10  
11

12 **88.0 Topic: Meter-to-IHD performance**

13 **Reference: Exhibit B-11, BCSEA IR#1 24.3, page 62; Exhibit B-11,**  
14 **BCSEA IR#1 24.3.2, page 62-63; Exhibit B-11, CSTS IR#1 54.1**

15 FortisBC states:

16 “ZigBee currently has challenges in an apartment environment or at long distances.  
17 There are vendors working on solutions and within future Zigbee specifications there is a  
18 design for a federated trust centre solution that would allow for meshing of meters with  
19 per suite security to address the apartment range challenges. [BCSEA IR#1 24.3]

20 The need for repeaters is implementation specific. If they are required, they need to be  
21 powered. [BCSEA IR#1 24.3.1]

22 FortisBC does not guarantee that the HAN signal will communicate with customer  
23 devices or that communication will be error-free. The customer is responsible to get the  
24 signal to the location of their ZigBee devices. [BCSEA IR#1 24.3.2]

25 88.1 What efforts will FortisBC make to implement measures to provide  
26 communications from the meter to the In-Home Display in apartment buildings  
27 and other challenging communications situations?

28  
29 **Response:**

30 FortisBC intends to monitor the ZigBee market for products and protocol enhancements that will  
31 help facilitate improved communications in apartment buildings and other challenging  
32 communications solutions. This will enable FortisBC to provide basic advice to customers that

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 32                               |

1 wish to have ZigBee HAN services but are experiencing communications issues. FortisBC  
2 intends to provide this information via its website.

3  
4

5 88.2 It is noted that SEP 2.0 includes additional functionality related to "deployments  
6 in multi-dwelling units" [Exhibit B-11, CSTS IR#1 54.1]. Will this help meter to  
7 IHD performance in apartments? If so, how?

8

9 **Response:**

10 Smart Energy v2.0 includes the ability to implement Smart Energy on various technologies,  
11 including ZigBee, Wi-Fi, and HomePlug, and bridge those technologies together using IP  
12 networking. Thus, communications can be extended well beyond the normal range of ZigBee  
13 networks by leveraging other infrastructure which exists in large building, such as power lines  
14 and sometimes Wi-Fi networks.

15  
16

17 88.2.1 Will SEP 2.0 improve meter to IHD performance if a single customer  
18 requires service, with no intermediate customers?

19

20 **Response:**

21 Unlike mesh networking, which relies on device density, Smart Energy v2.0 uses IP addressing  
22 and routing to connect various networks running over various technologies. Thus, even if a  
23 single customer requires service in a building, Smart Energy v2.0 can improve IHD performance  
24 in terms of providing service.

25  
26

27 88.2.2 Please discuss security and privacy issues regarding how SEP 2.0 will  
28 improve meter to IHD performance in multiple unit dwellings.

29

30 **Response:**

31 Smart Energy v2.0, like ZigBee Smart Energy v1.x, requires key establishment based on  
32 certificate data before devices are allowed onto a network, and also requires encryption of

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 33                               |

transmitted data using those keys. Smart Energy v2.0 can support the same policy that Itron will implement in FortisBC AMI meters, which does not allow arbitrary messages to be sent over the network.

88.3 Please confirm that within future Zigbee specifications there is a design for a 'federated trust centre' solution that would allow for meshing of meters with per suite security to address the apartment range challenges.

**Response:**

Confirmed. ZigBee Smart Energy v1.2 includes a feature called "Federated Trust Center" which essentially leverages the mesh capabilities of ZigBee to create a single mesh throughout an entire building. This requires a single, dedicated Trust Center in the building to manage device joining and authentication for all HAN devices in the building.

**89.0 Topic: IPv6**

**Reference: Exhibit B-11, BCUC IR#1 26.1, page 65**

FortisBC states:

"FortisBC has not completed a final design of the entire AMI system, but the preliminary design indicates that IPv6 will be used in the Home Area Network, RF Local Area Network and between the HES and MDMS."

89.1 Please explain in detail why IPv6 would be used in the Home Area Network.

**Response:**

In anticipation of the continued expansion of IP-connected devices which can participate in IP networks and be addressable, IPv6 was chosen for Smart Energy v2.0 to ensure that the limitations of the IPv4 address space would not limit the number of connected devices.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 34                               |

1           89.2   What factors were considered in making the preliminary decision to use IPv6 for  
2                   the Home Area Network? Examples of factors include complexity (protocol and  
3                   product), cost, need for increased or global address space on a Home Area  
4                   Network, battery life, compatibility, etc.) What alternatives were examined?

5  
6    **Response:**

7    The decision to use IPv6 was made because:

- 8           • The impact to device complexity and cost is minimal;
- 9           • An expanded address space was needed to allow for the connection of many types  
10           of devices to IP-based networking infrastructure; and
- 11           • The Smart Energy v2.0 Application Specification can be implemented on various IP-  
12           based networking technologies, including IPv4 implementations.

13   The ZigBee IP networking layer uses a technology called 6LoWPAN to perform header  
14   compression on over the air packets, minimizing the size of IPv6 addresses.

15  
16

17           89.3   When will FortisBC complete the final design of the entire AMI system?

18

19   **Response:**

20   The final design will be completed during the Define/Design stage of the project (please also  
21   refer to BCUC IR No. 1 Q40.1).

22  
23

24   **90.0   Topic:           Update speeds of In-Home Displays**

25                   **Reference: Exhibit B-11, BCSEA IR#1 19.2, page 56; Exhibit B-11,**  
26                   **CSTS IR #1 54.12; BC Hydro RFEI, Exhibit B-11, BCSEA IR#1**  
27                   **Appendix 9.0, Section 1.6.2, page 13 of 16**

28   FortisBC states in response to a BCSEA IR: "There should be no significant difference in  
29   update speeds between non-ZigBee In-Home Display and ZigBee HAN enabled  
30   devices. In either case, FortisBC understands the units should update information no  
31   less than approximately every 30 seconds."

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 35                               |

FortisBC states in response to CSTS IR #1 54.12: "On the HAN side the Zigbee SEP 1.x says that a device may not query a meter more frequently than every 2 seconds for longer than 15 minutes."

The BC Hydro Request for Expressions of Interest regarding In-Home Feedback Devices states:

"REQ 24. Near Real-Time Display of Information

When viewing cumulative consumption information, the device shall update every 30 seconds."

REQ 25. Fast-Polling Display of Information

The device shall utilize a 'fast polling' mode that persists for 15 minutes when the device is put into consumption display mode. While in this mode, the device shall display updated power (energy per hour in kW and \$) information every 2 seconds." [BCSEA IR#1 Appendix 9.0, Section 1.6.2]

90.1 Does FortisBC expect the In-Home Display units to meet the BC Hydro RFEI REQ 24 and REQ 25 requirements? If not, please explain.

**Response:**

FortisBC will require that In-Home Display devices that will be connected to the AMI meter via ZigBee, to be compatible with the ZigBee Smart Energy profile certification. It is up to the individual ZigBee vendors to decide whether they will meet any other requirements, including BC Hydro's requirements. For clarity, this does not preclude customers from using non-ZigBee In-Home Display devices as discussed in the response to BCSEA IR No. 2 Q87.2

90.2 Please explain the difference between the display of "cumulative consumption information" (to be updated no less than every 30 seconds) and display of "updated power (energy per hour in kW and \$) information" every 2 seconds.

**Response:**

Cumulative consumption is the integral of instantaneous demand values over a period of time, representing the total amount of energy used, and is expressed in kilowatt-hours (kWh). Cumulative consumption (typically expressed in kilowatt-hours) does not change as rapidly as the instantaneous demand for energy (typically expressed in kilowatts), and therefore need not be provided as often.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 36                               |

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90.3 If the device must display updated power every 2 seconds in fast polling mode, why would the display not be updated every 2 seconds?

**Response:**

How often a ZigBee display updates during “fast polling” mode is a function of each device’s implementation – an output of the device itself.

Generally speaking, displays are expected to update as soon as they retrieve updated metering information from the meter. Itron’s CENTRON meter updates its instantaneous demand value every second to 1 watt of resolution, allowing displays to perform rapid updates of new values during fast polling mode.

FortisBC agrees that the value of fast polling is enhanced when a display has the capability of updating values every 2 seconds.

90.4 More generally, please explain the purpose of fast polling.

**Response:**

ZigBee Smart Energy sets a general guideline for display devices to only request updated values from a meter every 7.5 seconds to ensure that over the air traffic on the HAN is not unduly monopolized by a single device. There is an underlying assumption that as HAN environments grow to accommodate more and more devices, each individual device needs to be a “good citizen” of the HAN by keeping requests to the meter to an acceptable level.

However, it is also acknowledged that a customer may wish to receive, for a certain period of time, near real time feedback to understand the energy consumption impact of certain behaviours, for example turning on an electric dryer, or cycling on an air conditioning unit. During those times, fast polling provides a mechanism for providing near real time updates to displays that have the capability to receive them.

90.4.1 Why is there a 15 minute limit on fast polling?

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 37                               |

1

2 **Response:**

3 The 15 minute window is an arbitrary time limit; it does not reflect a limitation on the part of  
4 ZigBee or IEEE 802.15.4 mesh networks. Since the purpose of fast polling is to support direct  
5 interaction between devices and customers, the 15 minute window is intended to reflect the time  
6 needed by customers to observe the energy consumption impact of behaviour changes.

7

8

9 90.4.2 Is the 15 minute limit on fast polling imposed by the ZigBee board in the  
10 meter or by SEP (or something else)?

11

12 **Response:**

13 The 15 minute fast polling window is suggested by the ZigBee Smart Energy standard. Please  
14 see the response for BCSEA IR No. 2 Q90.4.1.

15

16

17 90.4.3 After the 15 minute restriction has passed, how soon can a new 15  
18 minute period be activated?

19

20 **Response:**

21 The frequency of 15 minute fast polling windows is defined by the limitations within a customer-  
22 owned IHD.

23 ZigBee Smart Energy imposes no restriction on how often, or how many, 15 minute fast polling  
24 windows can be initiated by a device.

25

26

27 90.4.4 Would FortisBC agree that non-ZigBee In-Home Displays do not have the  
28 same 15 minute restriction and could be queried indefinitely?

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 38                               |

1

2 **Response:**

3 The 15 minute window for fast polling is not a restriction. Please see the responses to BCSEA  
4 IR No. 2 Q90.4 and Q90.4.3.

5 ZigBee technology consciously focuses on minimizing interference and interruption of service,  
6 considered a strength for wireless systems expected to operate for 20 years without  
7 replacement or interruption. FortisBC selected ZigBee as the HAN technology because no  
8 other standards-based technology supports these operational characteristics.

9

10

11 **91.0 Topic: In-Home Feedback Devices requirements**

12 **Reference: Exhibit B-11, BCUC IR#1 9.2, page 27; Exhibit B-11,**  
13 **BCSEA IR #1 Appendix 9.0, Section 2, page 5 of 16**

14 Regarding the BC Hydro Request for Expressions of Interest regarding In-Home  
15 Feedback Devices, FortisBC states: "FortisBC has not decided whether it is necessary  
16 to issue a document such as the referenced BC Hydro document."

17 91.1 Please indicate when FortisBC believes it will be a position to decide whether or  
18 not to issue a document specifying In-Home Device requirements.

19

20 **Response:**

21 Once FortisBC has completed pilot testing, it will be in a better position to decide whether or not  
22 to issue a document specifying In-Home Device requirements. The preference of the Company  
23 is to rely on the ZigBee Smart Energy profile certification.

24

25

26 91.2 Please discuss the factors or considerations that will determine whether or not  
27 FortisBC will issue such a Requirements document.

28

29 **Response:**

30 FortisBC would only consider issuing such a Requirements document if the market did not  
31 provide ZigBee Smart Energy profile products that met customer needs. Please also refer to  
32 the response to BCSEA IR No. 2 Q91.1.



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 39                               |

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3           91.3    If FortisBC does not issue such a Requirements document, how will FortisBC  
4                    ensure compatibility, interoperability and qualification of the In-Home Devices  
5                    which will be attached to the smart meter's Home Area Network?

6  
7    **Response:**  
8    FortisBC intends to rely on ZigBee Smart Energy profile certification to ensure compatibility,  
9    interoperability and qualification of the In-Home Devices which will be attached to the smart  
10   meter's Home Area Network.

11  
12  
13                   91.3.1 How will manufacturers of In-Home Devices determine if their products  
14                    are acceptable for use in the FortisBC service area?

15  
16   **Response:**  
17   Please refer to the response to BCSEA IR No. 2 Q91.3.

18  
19  
20                   91.3.2 How will FortisBC determine what In-Home Devices are eligible for  
21                    incentives under energy efficiency and conservation programs?

22  
23   **Response:**  
24   Most likely, FortisBC will provide incentives for In-Home Display devices that achieve the  
25   ZigBee Smart Energy profile certification.

26  
27

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 40                               |

**92.0 Topic: BC Hydro In-Home Feedback Devices RFEI document**

**Reference: Exhibit B-11, BCUC IR#1 9.2, page 27; Exhibit B-11, BCSEA IR #1 Appendix 9.0, Section 2, page 5 of 16**

In the RFEI document, BC Hydro states:

“BC Hydro is mandated by the provincial government to provide customers with the ability to provision a home area network off of their smart meters by December 31, 2012, and ultimately launch an In-Home Device program under the Power Smart banner to encourage residential customers to conserve energy by providing them with detailed and timely information about how and when they use electricity in their home.

Potential solutions may include:

- Stand alone display devices (IHDs), or
- Gateway solutions, which are bundled software and hardware devices designed to connect a customer’s smart meter to home networks and PCs. Gateway devices themselves may be Wi-Fi devices, wired (Ethernet) devices, or USB dongles.

The product requirements document (please see section 6 of this document) outlines a minimum set of requirements identified as necessary to be compatible with BC Hydro’s current systems and future marketing efforts.”

92.1 Does FortisBC understand BC Hydro to have limited the acceptable In-Home Devices for its smart meter program to In-Home Displays and gateways?

**Response:**

FortisBC does not know whether BC Hydro has limited the acceptable In-Home Devices for its smart meter program to In-Home Displays and gateways.

92.2 Does FortisBC intend to take the same approach?

**Response:**

Please refer to the response to BCSEA IR No. 1 Q9.1.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 41                               |

1    **93.0    Topic: Price or cost information**

2                                    **Reference: Exhibit B-11, Table BCSEA IR1 Q2.4 – Digital Information**  
3                                    **Transmission, BCSEA IR#1 2.4, page 6**

4                    It is noted that cost or rate information is not listed in the table of data transmitted  
5                    between the Meter and the LAN.

6                    93.1    Is cost or rate information part of the information to be transmitted between the  
7                    LAN and the meter?

8  
9    **Response:**

10            Yes, cost or rate information is part of the information to be transmitted between the LAN and  
11            the meter.

12  
13

14                    93.2    Please describe how and where the cost or pricing information is provided from  
15                    FortisBC to the In-Home Display.

16

17    **Response:**

18            Price is presented by the ZigBee Pricing Cluster. This pricing cluster can accommodate TOU  
19            rates, inclining block rates, and flat rates.

20  
21

22                    93.2.1 Please confirm that cost or pricing information will not have to be input  
23                    manually to the In-Home Display.

24

25    **Response:**

26            Confirmed.

27  
28

29                    93.3    If a customer chooses to have an In-Home Display connected (wirelessly) to the  
30                    smart meter, the In-Home Display will show the cost of electricity consumed by  
31                    the customer. How exactly will the cost be displayed? Will it be on a 'running

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 42                               |

1 invoice' basis, i.e., the total to date of all charges since the last invoice? Will be  
2 the cost of energy being delivered at the time of the display (Tier 1 or Tier 2 rate  
3 as applicable times kWh consumption per minute or hour)?

4

5 **Response:**

6 The presentation of data on an in-home display, including cost data, is not a function of the  
7 ZigBee protocol. The presentation of data depends on how a particular IHD is designed to  
8 display that data, giving customers a choice. FortisBC expects that devices capable of  
9 displaying consumption and cost information in all the ways described in the question are or will  
10 be available on the market.

11

12

13 93.3.1 Will the customer be able to toggle between different presentations of  
14 "cost"?

15

16 **Response:**

17 This will depend on the specific IHD chosen. Please refer to the response to BCSEA IR No. 2  
18 Q93.3.

19

20

21 93.3.2 To what extent will the method of presentation of "cost of electricity" in the  
22 In-Home Display be determined by FortisBC versus by the manufacturer  
23 of the In-Home Display?

24

25 **Response:**

26 Although FortisBC will provide the electricity pricing data, the IHD will determine how the data is  
27 presented. Please also refer to the response to BCSEA IR No. 2 Q93.3.

28

29

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 43                               |

#### 94.0 Topic: Task Force Roadmap diagram

**Reference: Exhibit B-11, BCUC IR#1 2.4, page 4-6; Exhibit B-11, BCUC IR#1 3.5, page 14**

FortisBC listed all digital information transmitted and received between the meter and the LAN in Table BCSEA IR1 Q2.4<sup>4</sup> and FortisBC agreed that the red arrow in the diagram depicts that information<sup>5</sup> and that “the Itron meter with integrated Zigbee technology will contain both the Meter and Customer Facility Gateway depicted in Figure 1 and delineated by the purple oval”<sup>6</sup>.

Find below (Figure 1) the same diagram from Exhibit B-11, with further enhancements:

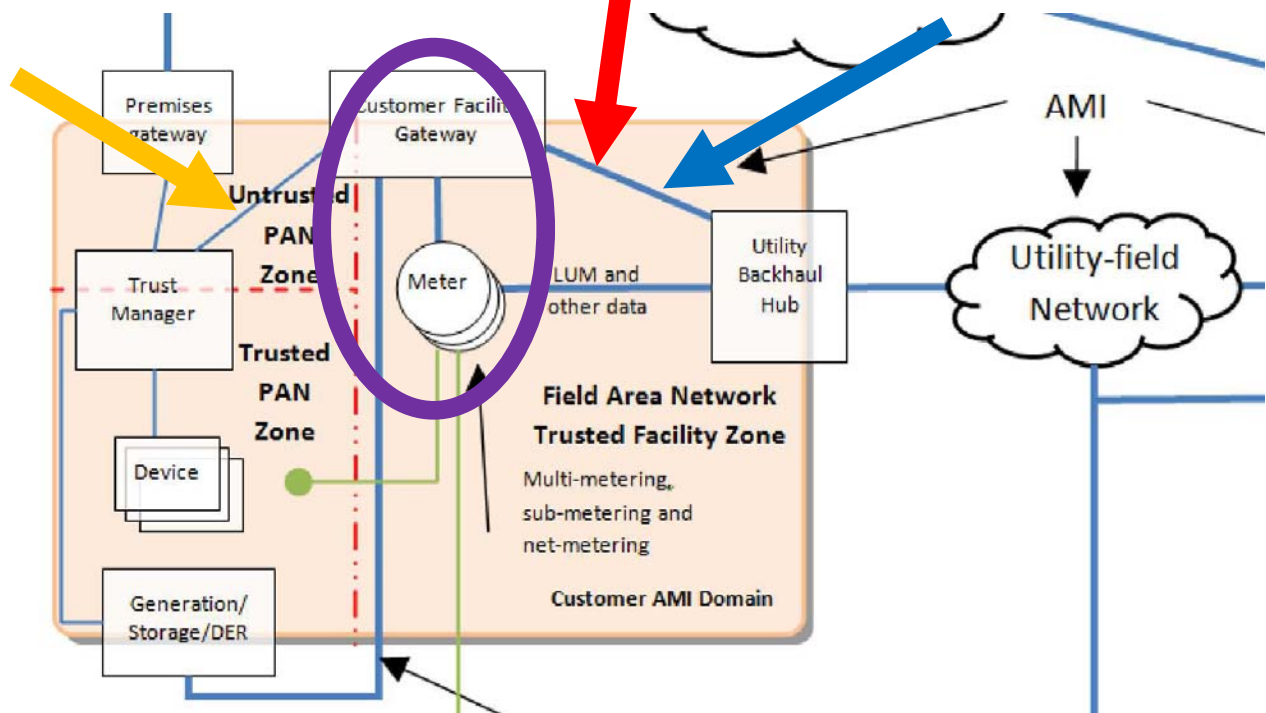


Figure 1 – Source: The Canadian Smart Grid Standards Roadmap: A strategic planning document, Standards Council of Canada, October 2012, Section 5.2, Page 27, Figure 5 (Exhibit B-11, BCSEA #IR1 3.1); [with red, orange, blue arrows and purple ovals added for emphasis]

<sup>4</sup> Exhibit B-11, BCSEA IR#1 2.4, page 6

<sup>5</sup> Exhibit B-11, BCSEA IR#1 3.5, page 14

<sup>6</sup> Exhibit B-11, BCSEA IR#1 3.6, page 16

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 44                               |

1            94.1    Would FortisBC agree that the information listed in Exhibit B-11, BCSEA IR #1  
2                            2.5 (page 7) is depicted by the Orange Arrow in Figure 1, above? If not, please  
3                            explain.

4

5    **Response:**

6    Agreed.

7

8

9            94.2    Considering that the “Logical AMI Diagram” shows a logical architecture, would  
10                            FortisBC agree that the integrated Zigbee Technology is generally described by  
11                            the “Customer Facility Gateway” in the diagram? If not, please explain.

12

13    **Response:**

14    Agreed.

15

16

17            94.3    Does FortisBC agree that the storing of ANSI C12.19 energy information<sup>7</sup> is  
18                            contained within the “Meter” as shown in Figure 1 above and is used for both  
19                            sending information to the head end (Red Arrow) and to the IHD (Orange  
20                            Arrow)? If not, please explain.

21

22    **Response:**

23    Agreed.

24

25

26            94.4    Please compare the translation process, computation requirements and storage  
27                            requirements needed to transmit the ANSI C12.19 energy information back to the  
28                            head end (Red Arrow) versus to the IHD (Orange Arrow).

---

<sup>7</sup> Exhibit B-11, BCSEA IR#1 3.7.2, page 20

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 45                               |

1

2 **Response:**

3 The computational requirements of transmitting ANSI C12.19 information either to the AMI HES  
4 or an IHD are minimal. In either case, data encryption is performed prior to transmission.  
5 Storage requirements are also minimal for either the HES or IHD.

6 FortisBC will determine the configuration of meters, including storage requirements for length of  
7 intervals and number of interval channels to store in the meter. These decisions will be finalized  
8 during the Define/Design phase of the proposed AMI Project.

9

10

11 94.5 Please confirm that “electricity pricing” information will be transmitted from the  
12 LAN to the Smart Meter (including the Zigbee card) as depicted by the Blue  
13 Arrow.

14

15 **Response:**

16 Correct, energy pricing information will be transmitted over the AMI network (LAN) to the meter,  
17 which will in turn publish energy price information to IHDs (or any device on the meter’s HAN),  
18 as depicted by the blue arrow above.

19

20

21 **95.0 Topic: Trust manager**

22 **Reference: Exhibit B-11, BCSEA IR#1 Appendix 3.1, Section 5.3,**  
23 **Recommendation M1, page 29**

24 Please refer to Figure 5 on page 27 of the “Canadian Smart Grid Roadmap” which  
25 shows a diagram for a “Smart Grid Advanced Metering Infrastructure Logical  
26 Architecture” (Logical AMI Diagram) <sup>8</sup>. Figure 2 below shows the same Logical AMI  
27 Diagram with a red/blue broad arrow added for the purpose of the questions that follow.

---

<sup>8</sup> Exhibit B-11, BCSEA IR#1 Appendix 3.1, Section 5.2, Figure 5, page 27

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 46                               |

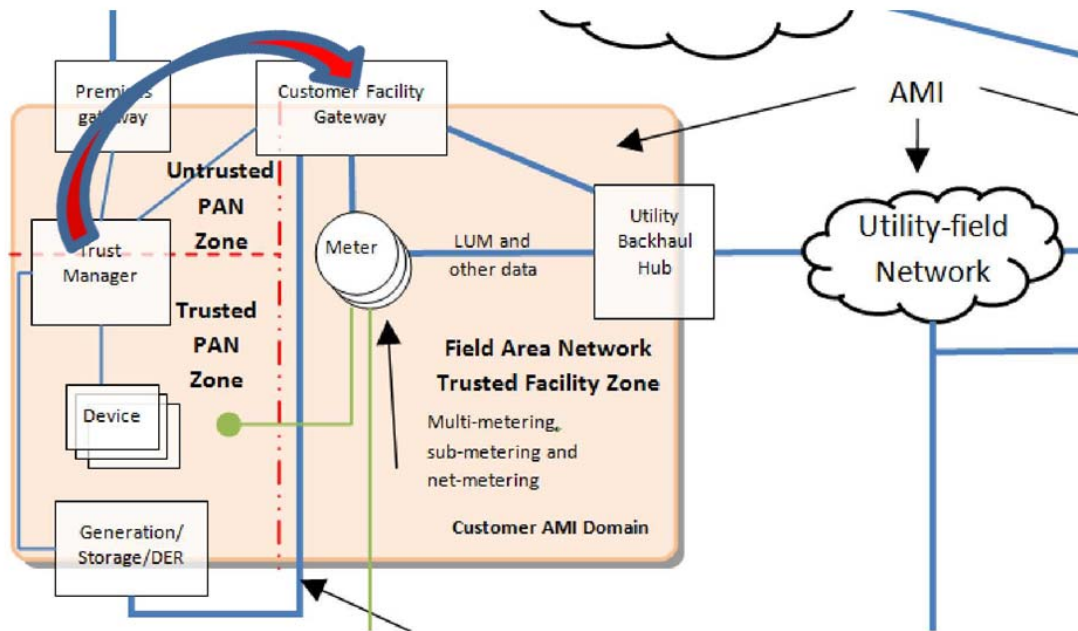


Figure 2 – Source: *The Canadian Smart Grid Standards Roadmap: A strategic planning document*, Standards Council of Canada, October 2012, Section 5.2, Page 27, Figure 5 (Exhibit B-11, BCSEA #IR1 3.1); [with red/blue broad arrow added for emphasis]

95.1 Looking at Figure 2 above, would FortisBC agree that the proposed Itron AMI solution shifts the “Trust Manager” function to the “Customer Facility Gateway” position as noted by the broad red/blue arrow. If not, please explain. If agreed, please answer the following questions:

**Response:**

The proposed AMI solution shifts the utility-customer Trust Manager function to the Customer Facility Gateway. This shift does not preclude the customer from implementing a second Trust Manager function in the location shown in the diagram.

95.1.1 Please discuss the ramifications of doing so from a privacy and security point of view.



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 47                               |

1 **Response:**

2 FortisBC does not believe there are any practical privacy or security ramifications to this shift.  
3 All data transferred between the utility and the meter is private and secure. As discussed in the  
4 response to BCSEA IR No. 1 Q15.6.5, customers have the ability to introduce a gateway device  
5 to limit the information transmitted between the utility and the meter if they wish.

6  
7  
8 95.1.2 Please discuss how FortisBC would meet the M1 Recommendation of the  
9 Task Force.

10  
11 **Response:**  
12 FortisBC believes that the proposed AMI solution meets the M1 Recommendations of the Task  
13 Force. The Trust Manager necessarily exists partially within the Untrusted PAN Zone  
14 regardless of whether it is implemented as shown in the diagram or within the Customer Facility  
15 Gateway. Furthermore, the customer is not precluded from creating a Trusted PAN Zone with a  
16 gateway device if they wish.

17  
18  
19 95.1.3 Please explain how “a clear and unambiguous separation (demarcation)  
20 between utility-owned and customer-owned equipment and services” is  
21 accomplished.

22  
23 **Response:**

24 Please refer to the responses to BCSEA IR No. 1 Q15.6.5 and BCSEA IR No. 2 Q95.1-Q95.1.2.

25  
26  
27 95.2 If the customer had the Network Coordinator within their own premises and their  
28 own control, would FortisBC agree that the “Trust Manager” could remain as  
29 shown in Figure 2. If not, please explain. If agreed, please answer the following  
30 questions:

31

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 48                               |

1 **Response:**

2 Agreed. Please also refer to the responses to BCSEA IR No. 2 Q94.1-94.1.2.

3  
4

5 95.2.1 Please discuss the ramifications of this solution on the privacy and  
6 security considerations.

7

8 **Response:**

9 If there were only a customer Network Coordinator, the devices on the utility network would not  
10 be trusted devices and could not be removed from the utility network if required. However, if  
11 there were both a utility and a customer Trust Manager, the information passed between the  
12 utility and the customer would be limited and would be in their control once in their PAN. The  
13 utility would also be protected if a customer exposed their own data in unsecure ways.

14  
15

16 95.2.2 Please discuss how this solution would meet the M1 Recommendation of  
17 the Task Force .

18

19 **Response:**

20 Although this solution (using only a customer-owned Trust Manager) would appear to meet the  
21 M1 Recommendation of the Task Force, it would not be safe and secure from a utility  
22 perspective as described in the response to BCSEA IR No. 2 Q95.2.1.

23  
24

25 95.2.3 Please explain how this solution provides “a clear and unambiguous  
26 separation (demarcation) between utility-owned and customer-owned  
27 equipment and services” .

28

29 **Response:**

30 This solution provides “a clear and unambiguous separation (demarcation) between utility-  
31 owned and customer-owned equipment and services” (as does the dual customer and utility

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 49                               |

1 Trust Manager approach), but introduces the issues discussed in the response to BCSEA IR  
2 No. 2 Q95.2.2.

3  
4

5 **96.0 Topic: LCD screen on Itron meter**

6 **Reference: none**

7 96.1 Does the proposed Itron meter have an LCD screen showing (a) electricity  
8 consumption in kWh and (b) cost on the meter itself (as distinct from on an In-  
9 Home Display)? If not, why not?

10

11 **Response:**

12 The AMI meters proposed by FortisBC can display electricity consumption in kWh on the meter  
13 display. However, the meter is a measurement device and was not designed to show actual  
14 pricing and cost information on the meter display. Displaying cost information on the meter  
15 would require the application and calculation of billing determinants from other systems, and  
16 there are more effective (and private) ways to provide cost information and price signals to  
17 customers, such as the Internet and in-home displays.

18  
19

20 **97.0 Topic: SEP 1.x and RIB rates**

21 **Reference:**

22 BCSEA-SCBC understands that BC Hydro has developed, or has had developed for it, a  
23 specific version of SEP 1.x called SEP 1.1.2 to deal with the BC Hydro Residential  
24 Inclining Block (RIB) rate structure.

25 97.1 Will FortisBC have to adjust SEP 1.x to accommodate FortisBC's RIB rate? If so,  
26 how will this be done (in general terms), and is it covered in the budget? If not,  
27 please explain why not.

28

29 **Response:**

30 SEP 1.1b (new version name) supports five consumption tiers. FortisBC understands that  
31 future extensions are being designed for inclusion in the SEP 1.2 specification. This will include  
32 more tiers and blended TOU-over-tiered rates. It is also important to note that FortisBC

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 50                               |

1 understands that BC Hydro did not “develop” a solution, but worked within the Zigbee Alliance to  
2 help create a standards-based solution that can be used by any other entity that requires it,  
3 helping ensure device interoperation.

4 If FortisBC needed to further extend the specification (which it does not currently anticipate),  
5 there is no cost other than the time required to work through the Zigbee Alliance.

6  
7

8 **98.0 Topic: Health**

9 **Reference: Exhibit B-11, BCSEA IR1 56.1**

10 “56.1 Please show the calculation of the Exposure Limit for the RF-LAN, with references  
11 from Health Canada Safety Code 6 (2009).

12 Response: Exposure limit at the 902 to 928 MHz frequency band utilized by RF-LAN is  
13 specified in Table 6 21 of the Health Canada Safety Code 6 (2009). Using the row  
14 corresponding to 300 – 1,500 MHz, 22 the limit for power density in units of W/m<sup>2</sup> is  
15 frequency f (in MHz) divided by 150. Dividing 902 23 by 150 results in power density limit  
16 value of 6 W/m<sup>2</sup>; likewise, dividing 928 by 150 results in 24 power density limit value of  
17 6.2 W/m<sup>2</sup>. Using a conversion factor of 1 W/m<sup>2</sup> = 10 mW/cm<sup>2</sup>, the 25 result is 6  
18 mW/cm<sup>2</sup> to 6.2 mW/cm<sup>2</sup>.” [underline added]

19 98.1 The conversion factor appears to be stated backwards. If so, please provide a  
20 revised response.

21

22 **Response:**

23 The response should read:

24 The exposure limit at the 902 to 928 MHz frequency band utilized by RF-LAN is  
25 specified in Table 6 of the Health Canada Safety Code 6 (2009). Using the row  
26 corresponding to 300 – 1,500 MHz, the limit for power density in units of W/m<sup>2</sup> is  
27 frequency f (in MHz) divided by 150. Dividing 902 by 150 results in power density limit  
28 value of 6.0 W/m<sup>2</sup>; likewise, dividing 928 by 150 results in power density limit value of  
29 6.2 W/m<sup>2</sup>. Using conversion factor of 10 W/m<sup>2</sup> = 1 mW/cm<sup>2</sup>, the result is 0.60 mW/cm<sup>2</sup>  
30 at 902 MHz and 0.62 mW/cm<sup>2</sup> at 928 MHz.

31  
32

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 51                               |

1 **99.0 Topic: Health**

2 **Reference: Exhibit B-1**

3 “58.1 Please show the calculation of the Exposure Limit for the ZigBee radio, with  
4 references from Health Canada Safety Code 6 (2009).

5 Response: The exposure limit at the 2,400 to 2,484 MHz frequency band used by RF-  
6 LAN is specified in Table 6 of the Health Canada Safety Code 6 (2009). Using row  
7 corresponding to 1,500 – 15,000 MHz, the limit for power density is 10 W/m<sup>2</sup>. Using a  
8 conversion factor of 1 W/m<sup>2</sup> = 10 mW/cm<sup>2</sup>, the result is 1 mW/cm<sup>2</sup>.” [underline added]

9 99.1 The conversion factor appears to be stated backwards. If so, please provide a  
10 revised response.

11

12 **Response:**

13 The response should read:

14 The exposure limit at the 2,400 to 2,484 MHz frequency band used by RF-LAN is  
15 specified in Table 6 of the Health Canada Safety Code 6 (2009). Using the row  
16 corresponding to 1,500 – 15,000 MHz, the limit for power density is 10 W/m<sup>2</sup>. Using  
17 conversion factor of 10 W/m<sup>2</sup> = 1 mW/cm<sup>2</sup>, the result is 1 mW/cm<sup>2</sup>.

18

19

20 **100.0 Topic: Health**

21 **Reference: Exhibit B-6, Fortis response to BCSEA-SCBC IR 64.1**

22 IR 64.1 says, “Can it be said that Health Canada Safety Code 6 is intended to protect  
23 only against thermal consequences of RF exposure? Or is Health Canada Safety Code  
24 6 intended to protect against any levels of RF exposure?” Fortis responds, “No. ...”

25 100.1 For clarity, which question is Fortis saying “no” to?

26

27 **Response:**

28 FortisBC is responding “no” to the first question.

29

30

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 52                               |

1 **101.0 Topic: Health**

2 **Reference: Exhibit B-6, Fortis response to BCSEA-SCBC IR 64.1**

3 101.1 Is Fortis aware of research studies on RF energy and health that distinguish  
4 between possible health effects of the quantum of RF exposure and possible  
5 health effects of sudden pulsations of RF exposure?

6  
7 **Response:**

8 No, FortisBC is not aware of peer reviewed research studies on RF energy and health that  
9 distinguish between possible health effects of the quantum of RF exposure and possible health  
10 effects of sudden pulsations of RF exposure.

11 All effects of RF signals on biological tissue are based on the physics of interactions between  
12 electromagnetic fields and the tissue. The formal method for performing calculations of these  
13 interactions is quantum electrodynamics, though classical physics approaches are a good  
14 approximation for all confirmed biological and health effects. Therefore, whether the RF  
15 exposure is a result of a pulse of electromagnetic wave, a burst of RF signal, or a continuous  
16 wave exposure, all are appropriately described as a quantum RF exposure. It should be noted  
17 that the assessment of biological or health responses to radiofrequency fields does not depend  
18 upon knowledge of the mechanism of interaction. When responses to radiofrequency fields are  
19 found, then scientists develop and test hypotheses to describe and understand the mechanism  
20 of interaction. If there is a measurable physical effect of radiofrequency exposure, then  
21 scientists anywhere in the world should be able to reproduce and confirm the effect independent  
22 of any hypothesis proposed to explain the observed effect.

23  
24

25 **102.0 Topic: Opt-out Provisions**

26 **Reference: Exhibit B-6, IR response to BCSEA-SCBC 68.0 and CEC**  
27 **50.0.**

28 In response to CEC IR 50.3, FortisBC says, "The benefits associated with the Project  
29 are dependent on the robust and cost-effective communications functionality of the AIM  
30 system."

31 BCSEA-SCBC would like to explore in more detail the possibilities and costs of opt-out  
32 options for customers who may for any reason desire not to have a wireless meter  
33 attached to their homes.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 53                               |

1           102.1 Please list and describe in more detail than in the response to CEC IR 50.1 the  
2           technically feasible alternatives for customers to opt out of having an electricity  
3           meter that communicates its information in a “wireless” manner using RF.

4

5    **Response:**

6    If “opt-out” is interpreted to mean “opt-out of a wirelessly communicating electric meter”, then a  
7    list would include (not all of which are necessarily available in the North American market):

- 8           • Manually read meters (ranging from meters of the customer’s choice to a radio-off AMI
- 9           meter);
- 10          • PLC-connected meters;
- 11          • RJ-45 (Ethernet) connected meters;
- 12          • Fibre-optic connected meters; and
- 13          • Telephone or cable-connected meters

14   FortisBC is not aware of any AMI meters available for the North American market that can be  
15   directly connected to fibre-optic, telephone or cable lines. The PLC and RJ-45 options are  
16   presumed to be uneconomic based on the FortisBC analysis of PLC and the fact that neither  
17   option was proposed in the AMI RFP process. Please refer to the response to CSTS IR No. 2  
18   Q29.1 for further discussion on the feasibility of an RJ-45 meter.

19

20

21                   102.1.1       Does FortisBC assume that opting out would necessarily require  
22                   manual meter reading?

23

24   **Response:**

25   Please refer to the response to BCUC IR No. 2 Q50.2 for an opt-out option that FortisBC  
26   considers feasible. It is unlikely that an opt-out option involving multiple LAN technologies  
27   would be economically feasible as described in the responses to BCSEA IR No. 2 Q103.1.1-  
28   103.1.4.

29

30

31                   102.1.2       Would it be technically and economically feasible to use PLC  
32                   technology on a home-by-home basis to enable customers to opt out?

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 54                               |

1 Would this be possible on a residential block or neighbourhood basis?  
2 Please discuss the technical issues and costs.

3  
4 **Response:**  
5 Using commercially available PLC technology on a home-by-home basis to enable customers to  
6 opt out would be technically, but not economically feasible. Please refer to the response to  
7 BCSEA IR No. 2 Q103.1.1.

8  
9  
10 102.1.3 Would it be technically and economically feasible to use fibre optic  
11 technology, internet cable technology or telephone line technology on a  
12 home-by-home basis to enable customers to opt out? Would this be  
13 possible on a residential block or neighbourhood basis? Please discuss  
14 the technical issues and costs.

15  
16 **Response:**  
17 Using fibre optic technology, internet cable technology or telephone line technology (which may  
18 not be commercially available in North America) on a home-by-home basis to enable customers  
19 to opt out would be technically, but not economically feasible. Please refer to the response to  
20 BCSEA IR No. 2 Q103.1.1.

21  
22  
23 102.2 Please describe any loss of “robust and cost-effective communications  
24 functionality of the AMI system” (per Fortis’s response to CEC IR 50.3) that  
25 would be caused by:

26 102.2.1 Implementing opting out with PLC technology at a home-by-home  
27 level,

28  
29 **Response:**  
30 PLC technology does not provide the data bandwidth that RF technology does (please see the  
31 response to CSTS IR No. 2 Q40.1), so the communication would not be as robust. FortisBC is  
32 also aware of only one PLC system available in North America that claims to support HAN  
33 devices.



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 55                               |

Estimates for PLC meters are \$7-\$20 million higher than the proposed AMI system (Appendix B-1, Section 7.3 and BCUC IR2 Q32.2.1). Therefore, implementing PLC technology (which generally requires significant hardware investments at the substation level as described in the response BCSEA IR No. 2 Q103.1.1) for fewer customers would make the hybrid PLC-RF option even less cost-effective than a complete PLC implementation.

102.2.2 Implementing opting out with PLC technology at a block or neighbourhood level,

**Response:**

The same communication and cost-effectiveness issues described in the response to BCSEA IR No. 2 Q102.2.1 arise with a block or neighbourhood implementation of PLC.

102.2.3 Implementing opting out with fibre optic, cable or telephone line technology,

**Response:**

FortisBC is not aware of any broadly-deployed AMI solution that uses cable or third-party telephone lines for the LAN, so has not evaluated the cost. If these solutions were available, then theoretically all could provide robust communications.

The cost of connecting customers via fibre optics is expensive (please refer to the response to CSTS IR No. 1 Q12.5) so this option would not be cost-effective. Cable and telephony installations would also be prohibitively expensive, both requiring dedicated wiring to every meter at minimum.

102.2.4 “Allowing customers to retain their existing meters or to have “radio inactive” meters,” as per Fortis’s response to CEC IR 50.7.1.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 56                               |

1  
2 **Response:**  
3 "Robust communications" are lost with these options since neither provide remote  
4 communication with customer meters and erode some or all of the benefits of the proposed AMI  
5 installation. There are minimal incremental costs to these options, although benefits are eroded  
6 as described in the response to BCUC IR No. 2 Q84.4.

7  
8

9 **103.0 Topic: Opt-out provisions**

10 **Reference: Exhibit B-6. IR response to CEC 50.3**

11 FortisBC says, "FortisBC does not agree in principle with providing choices to individual  
12 customers that have a clearly demonstrable negative financial impact to other  
13 customers. Offering individual customers the extreme case "opt-out" option of having a  
14 manually-read meter of their preference without paying for the related incremental costs  
15 and lost benefits to other customers violates this principle."

16 103.1 Assuming a one-time window for opting out that takes place with the  
17 implementation of the AMI program and is not changed thereafter, please list the  
18 direct costs and the factors causing "demonstrable negative financial impact to  
19 other customers" and provide an approximate costing for opt-out options that  
20 use:

21 103.1.1 PLC technology at a home-by-home level.

22

23 **Response:**

24 FortisBC cannot estimate the cost of "opting out" on a home-by-home basis. However, the  
25 majority of PLC systems require significant hardware investments at the substation level  
26 (approximately \$200,000 per substation for one system that FortisBC is aware of). In addition,  
27 new head-end software and hardware would be required to support the PLC solution.

28 These additional investments are intended to support all of the customers served by a  
29 substation, not just a few that opt-out, so the cost per opt-out customer would be prohibitive with  
30 this hybrid scenario.

31  
32

33 103.1.2 PLC technology at a block or neighbourhood level.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 57                               |

1  
2 **Response:**  
3 The economics of this scenario improve as compared to home-by-home implementation, but the  
4 costs per opt-out customer would still be prohibitive for the reasons discussed in the response  
5 to BCSEA IR No. 2 Q103.1.1.

6  
7  
8 103.1.3 Fibre optic, cable or telephone line technology at a home-by-  
9 home, block or neighbourhood level.

10  
11 **Response:**  
12 FortisBC is not aware of any broadly-deployed AMI solution that uses cable or third-party  
13 telephone lines for the LAN, so has not evaluated the cost.  
14 The cost of connecting customers via fibre optics is expensive (please refer to the response to  
15 CSTS IR No. 1 Q12.5) so the cost per opt-out customer would be prohibitive.

16  
17  
18 103.1.4 "Allowing customers to retain their existing meters or to have  
19 "radio inactive" meters," as per Fortis's response to CEC IR 50.7.1.

20  
21 **Response:**  
22 A potential "opt-out" solution using "radio-off" AMI meters (including costs) is described in the  
23 response to BCUC IR No. 2 Q50.2. If implemented in the manner described, this option would  
24 have immaterial impacts on other customers.

25 The cost of an opt-out program that allows customers to retain their existing meters is discussed  
26 in the response to BCUC IR No. 2 Q84.4. Due to the more significant benefit erosion for this  
27 option, the cost would be higher than the radio-off option.

28  
29  
30 103.2 For opting out that might take place subsequent to the implementation of the AMI  
31 program, please list the direct costs and the factors causing "demonstrable

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 58                               |

1 negative financial impact to other customers” and provide an approximate costing  
2 for opt-out options that use:

3 103.2.1 PLC technology at a home-by-home level.

4

5 **Response:**

6 A post-implementation opt-out option would not change the prohibitive costs per-customer opt-  
7 out costs identified in the responses to BCSEA IR No. 2 Q103.1.1-103.1.4.

8

9

10 103.2.2 PLC technology at a block or neighbourhood level.

11

12 **Response:**

13 Please refer to the response to BCSEA IR No. 2 Q103.2.1.

14

15

16 103.2.3 Fibre optic, cable or telephone line technology at a home-by-  
17 home, block or neighbourhood level.

18

19 **Response:**

20 Please refer to the response to BCSEA IR No. 2 Q103.2.1.

21

22

23 103.2.4 “Allowing customers to retain their existing meters or to have  
24 “radio inactive” meters,” as per Fortis’s response to CEC IR 50.7.1.

25

26 **Response:**

27 Please refer to the response to BCSEA IR No. 2 Q103.2.1.

28

29

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 59                               |

1 **104.0 Topic: Opt-out provisions**

2 **Reference: Exhibit B-6. IR response to CEC 50.3**

3 FortisBC says, "Offering individual customers the extreme case "opt-out" option of  
4 having a manually-read meter of their preference without paying for the related  
5 incremental costs and lost benefits to other customers violates this principle."

6 104.1 Would FortisBC be willing to consider allowing opt-out provisions for customers  
7 who would pay for that option, individually, or on a block or neighbourhood  
8 basis?

9

10 **Response:**

11 FortisBC does not consider allowing customers to have a manually-read meter of their  
12 preference to be a viable option. This is because all the benefits listed in the response to CEC  
13 IR No. 1 Q50.5 are eroded with this option (in particular, theft reduction), making the opt-out  
14 cost both high and difficult to accurately measure.

15

16

17 104.2 Please discuss how an opt-out program could be implemented and what terms  
18 would need to be addressed.

19

20 **Response:**

21 Please see the responses to BCSEA IR No. 2 Q104.1 and BCUC IR No. 2 Q50.2.

22

23

24 **105.0 Topic: Opt-out provisions**

25 **Reference: Exhibit B-6, IR response to CEC 50.5**

26 105.1 Please discuss the erosion of AMI benefits regarding "reduced theft reduction" in  
27 more detail. Is it possible that a modest amount of opting out would have little or  
28 no practical effect on theft reduction?

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Sustainable Energy Association (BCSEA)<br>Information Request (IR) No. 2  | Page 60                               |

1

2 **Response:**

3 Even a modest amount of opting out would have an effect on theft reduction if the manually-  
4 read opt-out meter did not store interval data, making energy balancing less accurate and  
5 decreasing the detection thresholds (since more consumption would be effectively unmetered).

6 By contrast, as discussed in the response to BCPSO IR No. 2 Q16.1, if an AMI meter with “radio  
7 off” was the opt-out meter choice, the theft detection benefits are substantially preserved since  
8 the manually downloadable meter data will still allow energy balancing to be used to detect  
9 power theft. As well, the implementation of AMI itself will still provide a deterrence effect as  
10 forecast in the analysis, further preserving the theft reduction benefit.

11 Please also refer to the response to BCUC IR No. 2 Q84.4.

12

13

14 **106.0 Topic: AMI Support for Electric Vehicle Charging**

15 **Reference: Exhibit B-6, Fortis response to BCSEA-SCBC IR 4.1**

16 106.1 Please confirm whether the proposed advanced meters with SEP 2.0 would  
17 enable the drivers of electric vehicles to be billed for electricity usage through  
18 meters not their own.

19

20 **Response:**

21 This capability is one of the marketing requirements for SEP 2.0.

22

23

24 106.2 Please confirm whether the proposed advanced meters with SEP 2.0 would  
25 enable the drivers of electric vehicles to pay securely for electricity usage through  
26 meters not their own, using credit cards or debit cards or other electronic  
27 payment system.

28

29 **Response:**

30 FortisBC could not find specific reference to this capability, but believes it is technically feasible.

31



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Residential Utility Customers Association (BCRUCA)<br>Information Request (IR) No. 2  | Page 1                                |

**1.0 Reference: Fortis BC Response to BCRUCA IR No. 1.7.1**

Fortis BC states:” In matters related to health, FortisBC relies on the expertise of the Provincial Health Officer, Health Canada, and World Health Organization, who have all confirmed that wireless meters pose no known health risk or reason for concern. In situations requiring accommodation, FortisBC will assess extenuating circumstances for individual customers on a case-by-case basis.”

1.1 Please provide the Statements of the Chief Medical Health Officer of British Columbia regarding health concerns about cellular phone transmission antennae and base stations.

**Response:**

Please refer to Attachment BCH 2.1 provided in response to BCH IR2 2.1.

1.2 Please provide Health Canada's Smart Meters Update dated December 2011.

**Response:**

Please refer to Attachment BCH 2.4 provided in response to BCH IR2 Q2.4.

1.3 Please confirm the precautionary measures that Health Canada and the WHO recommend with regards to reducing RF energy exposure from smart meters.

**Response:**

FortisBC confirms both Health Canada and the WHO do not consider that any precautionary measures are needed to reduce RF energy exposure from advanced meters given that the RF energy exposure levels are far below both Canadian and international safety limits.



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Residential Utility Customers Association (BCRUCA)<br>Information Request (IR) No. 2  | Page 2                                |

1           1.4     Please confirm the BC Ministry of Health's position on smart meters and RF  
2                   energy exposure associated with their use.

3

4     **Response:**

5     Please refer to the responses to BCH IR2 Q2.5, Q2.5.1, and Q2.5.2.

6

7

8     **2.0     Reference:     Fortis BC Response to BCSEA IR 1.68.1**

9                   **Application & Revenue Requirements**

10           Fortis BC states: "Fortis BC believes that the "opt-out" customers should pay for the  
11           incremental costs and lost benefits related to their choice."

12           2.1     Under what circumstances would Fortis BC consider an opt-out acceptable?

13

14     **Response:**

15     FortisBC assumes the question should refer to the response to BCSEA IR1 Q68.2.

16     Please refer to the response to BCUC IR No. 2 Q50.2.

17

18

19           2.2     If customers opted out and were paying for incremental costs and lost benefits  
20           related to their choice would a separate rate schedule and request be  
21           necessary? Is Fortis BC proposing such a rate schedule for approval?

22

23     **Response:**

24     FortisBC believes that a separate rate schedule would be required for an "opt-out" program.  
25     FortisBC has not proposed such a rate schedule.

26

27

28           2.3     Please confirm the precautionary measures that Health Canada and the WHO  
29           recommend with regards to reducing RF energy exposure from smart meters.





|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Residential Utility Customers Association (BCRUCA)<br>Information Request (IR) No. 2  | Page 3                                |

1

2 **Response:**

3 Please refer to the response to BCRUCA IR2 Q1.3 above.

4

5

6 2.4 If there were a significant number of customers decided to opt-out would that  
7 situation not seriously erode the benefits of the project as presented.

8

9 **Response:**

10 As shown in the response to BCUC IR No. 2 Q84.4, benefits erosion is significant if customers  
11 are allowed to choose a non-AMI meter. The erosion is reduced with a “radio-off” AMI meter.  
12 Please also refer to the responses to CEC IR No. 1 Q50.5 and Q50.6.

13

14

15 2.5 Please provide a range of benefits lost assuming that 25%; 50%; 75%; or 100%  
16 of the savings due to grow ops do not materialize as a result of the ability to opt-  
17 out.

18

19 **Response:**

20 Please see the responses to BCUC IR No. 2 Q50.2 and Q50.4.

21

22

23 **3.0 Reference: Fortis BC Response to BCUC IR 1.56.14**

24 **AMI Cost and Benefits & Revenue Requirements**

25 3.1 Please describe and quantify the risks associated with achieving the overall costs  
26 and benefits associated with the AMI CPCN.

27

28 **Response:**

29 FortisBC assumes the question should have referred to BCUC IR No. 1 Q53.14.



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to British Columbia Residential Utility Customers Association (BCRUCA)<br>Information Request (IR) No. 2  | Page 4                                |

1 Please refer to the responses to BCUC IR1 Q46.1 (cost risks), Q53.3 (Exhibit B-6-5) and  
2 Q53.11 (benefits range).

3  
4

5 3.2 Please discuss the merits of a cost collar that the BCUC could enforce.

6

7 **Response:**

8 Please refer to the responses to BCUC IR No. 2 Q89.3 and Q89.3.1.

9  
10

11 3.3 Would Fortis BC proceed with the project with a cost collar in place? If not, why  
12 not?

13

14 **Response:**

15 Please refer to the responses to BCUC IR No. 2 Q89.3 and Q89.3.1.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 1                                |

## 1.0 Follow up to response to CSTS IR#1 - 1.1

1.1 Would a device that does not emit RF fit within the definition of “advanced meter” as defined?

*Response:*

FortisBC confirms that the definition of “advanced meter” as provided in the Application encompasses both meters using PLC communications technology as well as meters using RF communications technology.

1.1 Would the definition of “advanced meter” as provided in the Application include technology that uses 3rd party telecommunication facilities or fibre optics communication technology?

### **Response:**

FortisBC confirms that any meter that is part of a metering system which permits remote, two-way communication between customer meters and the utility and provides the type of functionality outlined in the AMI Application could be considered an “advanced meter”. If a meter that used third-party telecommunication facilities or fibre optics communication technology fits this definition, then it could be considered an “advanced meter”.

## 2.0 Follow up to response to CSTS IR#1 - 2.3, 3.3, 12.3, 12.10, 13.3, 34.6

2.1 At the time of the application, what consideration had FortisBC given to:

- a. the ability to achieve these “immediate benefits” using non-RF communication technologies;
- b. whether RF communication technology is necessary to achieve consistency with the CEA and regulation;
- c. the use of third party telephone lines as an alternative to the RF mesh LAN solution;
- d. the expansion of its fibre optic network (and/or the use of a third party fibre optic network) as an alternative to the RF mesh LAN solution;
- e. fire risk associated with its prospective AMI Project, that is, the possibility that the proposed AMI meters may increase the risk of fire;



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 2                                |

- f. concerns about the potential impact of RF communication technology on pacemakers and other medical equipment;

**Response:**

At the time of the Application, FortisBC had given the following consideration to the above items:

- a. The consideration given to non-RF communication technologies is provided in Sections 4.1.3 and 7.0 of Exhibit B-1;
- b. FortisBC considered that the selected AMI RF communication technology was consistent with the CEA and regulation, but had not considered whether it was “necessary”;
- c. FortisBC did not receive any RFP responses that included the use of third party telephone lines, so did not give these technologies consideration;
- d. FortisBC did not receive any RFP responses that included the use of its fibre optic (and/or the use of a third party fibre optic network), so did not give these technologies consideration. FortisBC did include the location of its fibre optic network in the RFP;
- e. FortisBC has never considered there to be any increased fire risk associated with the advanced meters selected; and
- f. FortisBC has never considered there to be any potential impact to pacemakers or other medical equipment from the advanced meters selected.

**3.0 Follow up to responses to CEC IR No. 1 Q 50.6**

- 3.1 How often will the opt-out customer have to pay the per-manual download fee?

**Response:**

If an opt-out program was implemented as described in the response to BCUC IR No. 2 Q50.2, FortisBC would download information from residential customers and bill on that data on a bi-monthly basis. This is consistent with current meter reading and billing practices.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 3                                |

1

2

3 **4.0 Follow up to responses to CEC IR No. 1 Q 50.73 & 50.74**

4 FortisBC states:

5 *"Both natural (from earth and even human bodies) and man-made RF signals are*  
6 *constantly present all around us."*

7 *"...considering the multiple sources of natural and man-made RF signals, it is clear that*  
8 *that such a reduction from an AMI meter would not significantly reduce an individual's*  
9 *total exposure."*

10 4.1 What other source of natural or man-made RF signal incessantly strobes (on/off)  
11 an 18 - 125mSec blast of 900 MHz RF radiation 1,268 times per day (about one  
12 per minute) on a continuous basis?

13

14 **Response:**

15 FortisBC is not aware of natural sources of short, intermittent 900 MHz RF emissions. Several  
16 "man-made" sources of RF signals rapidly turn RF signals on and off. They include WiFi  
17 routers, cell phones, cordless phones, and baby monitors. Several of these sources operate at  
18 or near the 900 MHz frequency range of the proposed FortisBC AMI meters.

19 Please also refer to the response to BCSEA IR No. 2 Q101.1.

20

21

22 4.2 What other source of natural or man-made RF signal incessantly strobes of any  
23 emission of any duration or any strength on an on/off basis 1,268 times per day?

24

25 **Response:**

26 FortisBC has not conducted an assessment of all natural or man-made RF signals. Please also  
27 refer to the responses to CSTS IR No. 2 Q4.1 and BCSEA IR No. 2 Q101.1.

28

29

30 4.3 What studies have been done on the effect on human health of continuous, long-  
31 term exposure to strobe flashes (of any emission of any duration or any strength)  
32 on an on/off basis 1,268 times per day?

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 4                                |

1

2 **Response:**

3 Studies and reviews of health research on cell phones, and on signals similar to those of cell  
4 phones, which produce RF signals at frequencies and with other characteristics grossly similar  
5 to the RF signals from FortisBC advanced meters, are reviewed and cited in Exponent's report  
6 "Status of Research on Radiofrequency Exposure and Health in Relation to Advanced Metering  
7 Infrastructure.". The exposures from advanced meters would however, be far lower than those  
8 associated with the typical use of cell phones.

9 Health Canada is aware of the intermittent transmission characteristics of advanced meters, as  
10 indicated in the following quotation from the attached (Appendix CSTS IR2 4.3) It's Your Health  
11 update:

12 *Survey results have shown that smart meters transmit data in short bursts, and when not*  
13 *transmitting data, the smart meter does not emit RF energy. Furthermore, indoor and*  
14 *outdoor survey measurements of RF energy from smart meters during transmission*  
15 *bursts were found to be far below the human exposure limits specified in Health*  
16 *Canada's Safety Code 6.*

17 *Based on this information, Health Canada has concluded that exposure to RF energy*  
18 *from smart meters does not pose a public health risk.*

19  
20

21 4.4 What studies have been done on the effect on birds and/or bees of continuous,  
22 long term-exposure to strobe flashes (of any emission of any duration or any  
23 strength) on an on/off basis<sup>1</sup>, 268 times per day?

24

25 **Response:**

26 Several studies looked at geographic correlations between bird populations and mobile phone  
27 base stations (Everaert and Bauwens, 2007) or measured radiofrequency fields (Balmori, 2005;  
28 Balmori and Hallberg, 2007) but design limitations, e.g., the lack of investigation of confounding  
29 factors, precludes any clear interpretation of these studies. Two experimental studies in which  
30 migrating birds were directly exposed to far higher intensities of radiofrequency fields from X-  
31 band radar reported no effect on flight behaviour (Bruderer and Boldt, 1994; Bruderer et al,  
32 1999). In contrast a strong search light had a quite profound effect on flight behaviour (Bruderer  
33 et al, 1999). A claim that a cell phone affected bee behaviour has been reported without direct  
34 evidence that the radiofrequency field was involved (Shabib, 2011). In short, there is no clear,  
35 confirmed adverse effect of radiofrequency fields on bird or bee health.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 5                                |

## 5.0 Follow up to responses to CEC IR No. 1 Q 96.1

5.1 What are the customer fees associated with Nelson Hydro's opt-out program?

### **Response:**

As per Schedule M-1 of the City of Nelson's Electrical Utility Amendment Bylaw No. 3225, customer's choosing to opt-out of a radio read meter at their service entrance, must pay a setup charge of \$145.00 and manual read charge of \$20.00 each billing cycle.

The City of Nelson's Electrical Utility Amendment Bylaw No. 3225 can be found at the following link:

<https://nelson.civicweb.net/Documents/DocumentList.aspx?ID=16867>

5.2 Are the RF emissions from Nelson Hydro's meters similar to the RF emissions from FortisBC's proposed AMI meters?

### **Response:**

The Itron AMR meters used by the City of Nelson use the same 900 MHz ISM spectrum as the OpenWay smart meters. There are two output power levels supported by the AMR meters: mobile mode and network mode. The MPE values for these two options are shown below:

| Transmitter      | MPE Limit              | MPE                           | Margin                      |
|------------------|------------------------|-------------------------------|-----------------------------|
| Mobile mode AMR  | 0.6 mW/cm <sup>2</sup> | 0.00000795 mW/cm <sup>2</sup> | <b>0.0013%</b> of the limit |
| Network mode AMR | 0.6 mW/cm <sup>2</sup> | 0.0000516 mW/cm <sup>2</sup>  | <b>0.0085%</b> of the limit |

The output power level and duty cycle of the AMR meters are lower than the OpenWay meters. The other difference between these devices is that the AMR meters transmit at a set interval (30 seconds) as opposed to the OpenWay meters that have more random transmission patterns based on network settings and activity.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 6                                |

1     **6.0     Follow up to response to CSTS IR#1 - 4.11**

2             6.1     How is it that FortisBC's legal costs relating to negotiation of the Itron contract  
3                     amount to as much as \$360,000? Please provide particulars in that regard.

4

5     **Response:**

6     The costs of \$360,000 relate primarily to legal advice and drafting related to an extensive  
7     negotiation process related to the main AMI contracts associated with procurement, design,  
8     installation and ongoing maintenance of nearly all hardware and software elements of the AMI  
9     system (excluding the WAN).

10

11

12     **7.0     Hydro-Quebec advanced meters**

13             7.1     Are the characteristics of RF exposure from the proposed AMI meters the same  
14                     as the characteristics of RF exposure from the advanced meters proposed /  
15                     deployed by Hydro Quebec?

16

17     **Response:**

18     Given that Hydro Québec has selected a different vendor for their AMI system, the RF  
19     characteristics and exposure will not be the same. FortisBC has no details regarding the RF  
20     emissions of the proposed Hydro Québec AMI system.

21

22

23     **8.0     Follow up to response to CSTS IR#1 - 5.1**

24             5.1     *Has FortisBC considered implementing a mandatory time-based rate structure or*  
25                     *a mandatory critical peak pricing structure?*

26             *Response:*

27             *The Company intends to evaluate voluntary time-based rates as a complement to*  
28             *existing rate structures. There are no current plans to make time-based rates*  
29             *mandatory.*

30             8.1     The question has not been answered. FortisBC's response goes to its future  
31                     intentions; however, the question goes to whether FortisBC has considered



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 7                                |

implementing a mandatory time-based rate structure or a mandatory critical peak pricing structure. Please answer the question with particulars as to what considerations FortisBC has undertaken in that regard.

**Response:**

The Company respectfully submits that the question was answered – FortisBC could not know (and would not have expected) that the question referred to past considerations of the Company.

FortisBC recommended in its 2009 Cost of Service Application that the BC Utilities Commission delay implementation of conservation rates until after the implementation of AMI. FortisBC indicated in that application that it preferred to introduce time-based rates after AMI rather than an inclining block rate.

The Commission did not agree with FortisBC and ordered the Company to implement a residential inclining block rate, which has now occurred (prior to the implementation of AMI). Therefore, the position of FortisBC has evolved with respect to time-based rates (as described in the response cited above) in part due to the implementation of a default residential inclining block rate.

**9.0 Follow up to response to CSTS IR#1 - 6.1**

*6.1 What input has FortisBC received from local governments with respect to the prospective AMI program?*

*Response:*

*The comments FortisBC has received from local governments with respect to the prospective AMI program have been related to the health and privacy concerns of their constituents discussed in Section 8.0 of the Application, as well as the feasibility of an opt-out provision.*

9.1 Provide a copy of each of “the comments FortisBC has received from local governments with respect to the prospective AMI program”, including those from Osoyoos and Kaslo as referenced in your response to CSTS IR#1 - 6.2.

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 8                                |

1

2 **Response:**

3 Please refer to Appendix CSTS IR2 9.1.

4

5

6 **10.0 Follow up to response to CSTS IR#1 - 7.1**

7 *7.1 Would Fortis BC expect the referenced customer health concerns to exist with*  
8 *respect to non-RF communication technology?*

9 *Response:*

10 *FortisBC does not consider that there are health concerns founded on accepted science*  
11 *regardless of whether the AMI system uses RF or non-RF technology.*

12 10.1 The question has not been answered. The question is not about the validity of  
13 the concerns from the perspective of FortisBC. The question is about the  
14 existence of the referenced customer health concerns and whether FortisBC  
15 would expect those concerns to exist with respect to non-RF communication  
16 technology. Please answer the question.

17

18 **Response:**

19 The Company respectfully submits that the question was answered. FortisBC cannot know how  
20 “customer health concerns” (whether for a specific customer or in a general sense) might  
21 change if a different LAN technology was proposed and will not speculate in that regard. The  
22 validity of health concerns is however relevant to the question since any customer concern  
23 should be evaluated in terms of the validity of the concern.

24

25

26 **11.0 Follow up to response to CSTS IR#1 - 10.1**

27 *10.1 What considerations has FortisBC and/or its “experienced consultant” given to*  
28 *non-RF communication technologies in the context of the procurement process?*

29 *Response:*

30 *Please refer to the response to BCUC IR No. 1 Q38.3.*

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 9                                |

1           11.1   What considerations has Itron given to non-RF communication technologies in  
2                   the context of the procurement process?

3

4    **Response:**

5    Itron considered the possible inclusion of PLC meters as part of the procurement process.  
6    Please also refer to the response to BCUC IR No. 1 Q106.1.

7

8

9    **12.0   Follow up to response to CSTS IR#1 - 11.1**

10           11.1   *Has FortisBC monitored the progress and results from utilities that have*  
11                   *implemented or are in the process of implementing advanced metering projects without*  
12                   *the use of RF communication technology?*

13           *Response:*

14           *FortisBC believe [sic] that's very few PLC systems have been selected in North America*  
15                   *since 2008. FortisBC has monitored the progress of FortisAlberta, which has*  
16                   *implemented PLC AMI technology.*

17           12.1   FortisBC's answer to this question is limited to PLC. Please re-answer the  
18                   question in a manner that addresses the use by other utilities of PLC, third party  
19                   telecom and/or fibre optic communication technologies, regardless of the scale  
20                   on which these non-RF communication technologies have been deployed.

21

22    **Response:**

23    FortisBC answered the question with respect to PLC.

24    FortisBC is not aware of specific non-PLC, non-RF AMI implementations, so has not monitored  
25    the progress and results from any implementations.

26

27

28    **13.0   Follow up to response to CSTS IR#1 - 12.1**

29           12.1   *What consideration has FortisBC given to the use of third party telephone lines*  
30                   *as an alternative to the RF mesh LAN solution? What would the cost be in that regard*  
31                   *and how would that cost be reflected in rate increases over a long term period?*



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 10                               |

1        *Response:*

2        *FortisBC is not aware of any broadly-deployed AMI solution that uses third-party*  
3        *telephone lines for the LAN, so has not evaluated the cost.*

4        13.1    FortisBC has qualified its response to “broadly-deployed” examples. We request  
5                that    FortisBC list utilities deploying third party telephone lines as an alternative  
6                to the RF mesh LAN solution - regardless of the scale of the deployment.

7  
8        **Response:**

9        FortisBC used the term “broadly-deployed” to differentiate the implementation of a telephone-  
10        based AMI system from downloading consumption data from a small number of large-power  
11        customer meters using telephone or cellular lines.

12        FortisBC is not aware of any utilities that have implemented AMI using third party telephone  
13        lines as an alternative to an RF mesh LAN solution, so has not evaluated the cost.

14  
15  
16        **14.0    Follow up to response to CSTS IR#1 - 12.2**

17        *12.2    What barriers or show-stoppers would exist to prevent the deployment of non-RF*  
18        *emitting meters along with a third party telephone line LAN communications*  
19        *infrastructure?*

20        *Response:*

21        *Please refer to the response to CSTS IR No. 1 Q12.1.*

22        14.1    FortisBC has not answered the question. Is the answer that FortisBC does not  
23                know    what barriers exist because it has not looked into it?

24  
25        **Response:**

26        The Company respectfully submits that it did answer the question. FortisBC is unaware of any  
27        third-party telephone line based AMI systems or implementations, so there is no point in  
28        evaluating any theoretical barriers.

29  
30



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 11                               |

**15.0 Follow up to response to CSTS IR#1 - 12.4**

15.1 Where is fibre present and absent within the FortisBC service area, whether such fibre be owned by FortisBC or another company/utility? A map would be of assistance in assimilating the answer to this question.

**Response:**

FortisBC has access to fibre optic transmission facilities, either owned or leased, in the following locations:

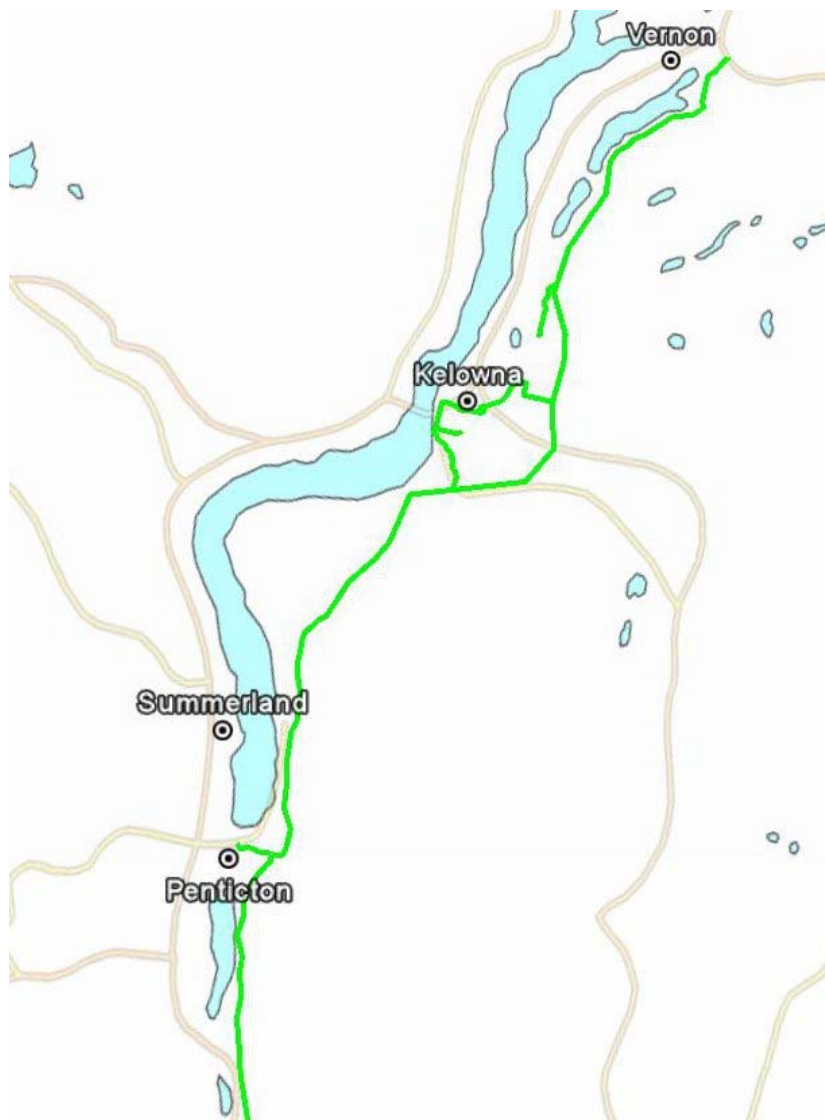
- Okanagan Valley from;
  - Vernon to Kelowna
  - Kelowna to Penticton
  - Penticton to Oliver
  - Oliver to Osoyoos
- Boundary Region from;
  - Oliver to Grand Forks
- West Kootenay Region from;
  - Warfield to Trail
  - Warfield to Brilliant (NE of Castlegar)
  - Brilliant to South Slocan
  - South Slocan to Corra Linn Generating Station

It should be noted that these fibre optic routes follow FortisBC transmission line Rights of Way and in many cases are not located in proximity to residences. The fibre optic routes are point to point and are not suitable for distribution to customer premises. Please refer to the following three diagrams for visual representations of the fibre optic routes.

The location of FortisBC fibre was included in the AMI RFP.

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 12                               |

1 **Figure CSTS IR2 Q15.1a - FortisBC Central Okanagan Fibre Optic Facilities Overview Map**



2

3

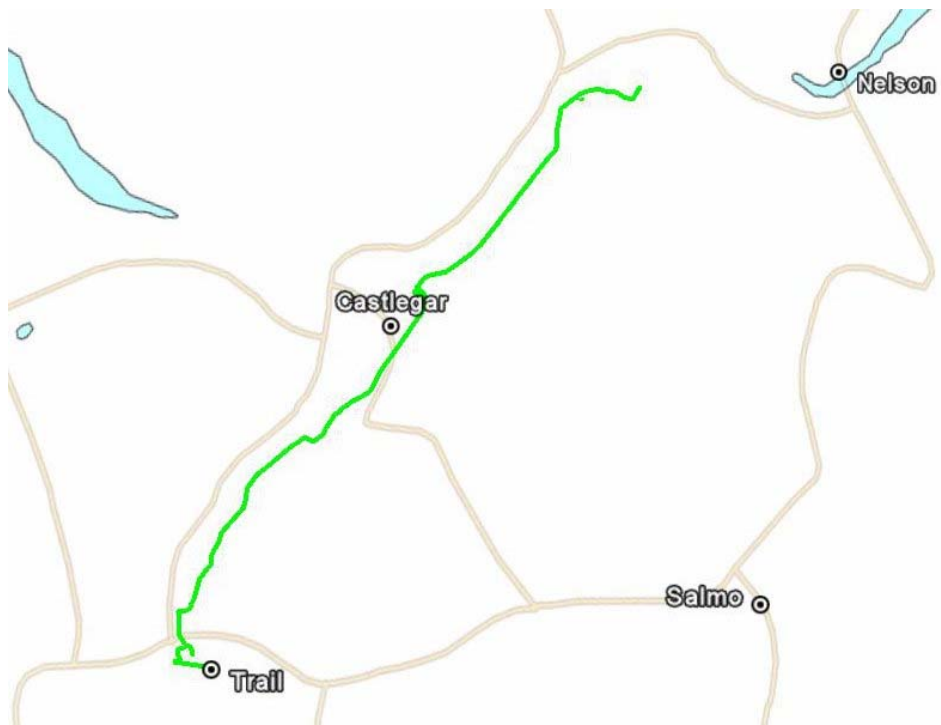
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 13                               |

1 **Figure CSTS IR2 Q15.1b - FortisBC South Okanagan/Boundary Fibre Optic Facilities**  
 2 **Overview Map**



3  
 4 **Figure CSTS IR2 Q15.1c – FortisBC West Kootenay Fibre Optic Facilities Overview Map**



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 14                               |

1

2

3 **16.0 Follow up to response to CSTS IR#1 - 12.5**

4 16.1 What is the per kilometer build rate used in calculating the answer to CSTS IR#1  
5 - 12.5?

6

7 **Response:**

8 FortisBC used a cost of approximately \$40,000 per kilometre to estimate the fibre build cost  
9 provided in response to CSTS IR No. 1 Q12.5.

10

11

12 **17.0 Follow up to response to CSTS IR#1 - 12.8**

13 12.8 *Would the use of a fibre optic network as an alternative to the RF mesh LAN*  
14 *solution eliminate health and environmental concerns with respect to the AMI Project?*

15 *Response:*

16 *FortisBC does not consider that there are health concerns founded on accepted science*  
17 *related to AMI systems, regardless of whether they use RF or non-RF technology.*

18 17.1 The question has not been answered. The question is not about the validity of  
19 the concerns from the perspective of FortisBC. The question is about the  
20 existence of the referenced customer health concerns and whether FortisBC  
21 would expect those concerns to exist with respect to fibre optic communication  
22 technology. Please answer the question.

23

24 **Response:**

25 The Company respectfully submits that the question was answered. FortisBC cannot know how  
26 “customer health concerns” (whether for a specific customer or in a general sense) might  
27 change if a different LAN technology was proposed and will not speculate in that regard. The  
28 validity of health concerns is however relevant to the question since any customer concern  
29 should be evaluated in terms of the validity of the concern.

30



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 15                               |

1  
2

3 **18.0 Follow up to response to CSTS IR#1 - 17.2 & 17.3**

4 *17.2 What is the frequency and extent of fluctuation of RF levels with respect to the*  
5 *proposed meters? Is the on/off manner in which emissions occur analogous to the*  
6 *fluctuating emission levels of a strobe light? At what speed are the emissions flashing*  
7 *on and off? How often? What is the frequency with which an RF emission occurs?*  
8 *What is the duration of each transmission?*

9 *Response:*

10 *Please refer to the response to BCSEA IR No. 1 Q55.5.*

11 18.1 We did not find the answer to all our questions in your response to BCSEA IR  
12 No. 1 Q55.5. Please directly answer each of the questions posed in CSTS  
13 IR#1 - 17.2 and 17.3; that is, answer the questions without referring us to  
14 other materials.

15

16 **Response:**

17 The frequency of the RF signals from the FortisBC advanced meters is between 902 MHz and  
18 928 MHz. The RF level will fluctuate depending on whether the advanced meter is transmitting  
19 or not. The RF exposure from the meters at a mean duty cycle of 0.06% will be 0.000056  
20 mW/cm<sup>2</sup> and decline with distance to far lower levels.

21 The signals from the advanced meters will be more like that of a flashlight that is turned on and  
22 off for short irregular periods. A strobe light analogy suggests an extremely powerful and  
23 regularly repeating signal, which is not like that of an advanced meter.

24 With respect to the frequency, speed and duration of signals, please refer to Appendix BCSEA  
25 IR No. 1 55.5 and 55.8, CSTS IR No. 2 Q35.1, CEC IR No. 2 Q34.1 and Q34.4.

26 BC Hydro has commissioned reports to further quantify the duty cycle and number of  
27 transmissions for the same Itron meters that FortisBC has selected for use in the proposed AMI  
28 project. The real-world measured data collected during these studies suggests that the total  
29 duty cycle and the number of transmissions for the max, min and average meter will be reduced  
30 from the numbers FortisBC has provided in the Application and in response to CEC IR No. 2  
31 Q34.1. Please refer to Appendix CEC IR2 34.1 for these studies and their conclusions.

32

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 16                               |

1  
2

3 **19.0 Follow up to response to CSTS IR#1 - 18.1**

4 *18.1 Disclose all the projects that Exponent has provided an opinion or report on, with*  
5 *respect to matters of health, safety and/or environment, and briefly summarize the*  
6 *conclusions on the opinion / report provided by Exponent in each instance.*

7 *Response:*

8 *FortisBC considers this request overly broad. Exponent's work for other clients may in*  
9 *any case also be subject to attorney-client privilege.*

10 19.1 At page 133, line 28, of FortisBC's application, FortisBC states:

11 FortisBC understands these concerns, and has commissioned an **independent**  
12 **study** that reviews the latest scientific research on the health effects of EMF  
13 (also known as radiofrequency fields or RF).

14 [emphasis added]

15 The information sought by way of CSTS IR#1 - 18.1 goes directly to the claimed  
16 independence of the Exponent Report and is therefore not overly broad.

17 Attorney-client privilege would not apply with respect to the identification of  
18 matters where Exponent prepared material that was made public in the context of  
19 judicial or quasi-judicial proceedings. We are not seeking documents. Rather,  
20 we are seeking particulars as to what matters Exponent has reported on and  
21 what their conclusion has been, on health and safety, in each such matter.

22 Please answer CSTS IR#1 - 18.1. If Exponent is in the business of product  
23 defence, making sizeable profits helping polluters and manufacturers of  
24 dangerous products (such as asbestos, beryllium and chromium) stymie public  
25 health and environmental regulators, we want to know about it.

26

27 **Response:**

28 Exponent is not in the business of product defence. As stated on its website, "Our  
29 multidisciplinary organization of scientists, physicians, engineers, and regulatory consultants  
30 performs in-depth investigations in more than 90 technical disciplines. We analyze failures and  
31 accidents to determine their causes and to understand how to prevent them. We evaluate  
32 complex human health and environmental issues to find cost-effective solutions."

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 17                               |

The scientific and engineering work performed by Exponent professionals is necessarily carried out by those involved in each project and the firm-wide approach is to perform the work to the highest scientific and engineering standards.

In the report submitted to FortisBC and the BCUC "Status of Research on Radiofrequency Exposure and Health in Relation to Advanced Metering Infrastructure" Exponent scientists and engineers summarized the research, as well as the assessments and conclusions of multiple health and scientific agencies of this research, including the International Agency for Research on Cancer, the Swedish Radiation Safety Authority, and the International Commission on Non-Ionizing Radiation Protection. The conclusions of these agencies are consistent with those of Health Canada and the health agencies of British Columbia. The scientists and engineers who prepared this report have also reviewed smart meter exposures with respect to regulatory limits and summarized the status of research on radiofrequency exposures and health in other reports. Such work includes reports and testimony submitted to regulatory commissions in Nevada and Maine. The research summarized by reviews of national and international health and scientific agencies in those reports is similar to that summarized for this proceeding.

FortisBC regards the final paragraph of CSTS IR2 Q19.1 to be unhelpful to the Commission and unclear in what it asks for, but FortisBC submits that the above provides the appropriate substantive response to CSTS.

## **20.0 Follow up to response to CSTS IR#1 - 19.1**

*19.1 In evaluating the nature of RF exposure, what consideration has FortisBC and/or Exponent given to the extent and amount of fluctuations in RF levels, the frequency with which instances of RF emissions occur and the speed at which the emissions are flashing on and off?*

*Response:*

*The exposure characteristics of the RF signals from the FortisBC AMI meters were considered from the perspective of Safety Code 6 compliance and more generally with respect to the relevant scientific literature.*

20.1 The question has not been answered. Please answer the question with reference to the specific consideration, in evaluating the nature of RF exposure, that FortisBC and/or Exponent have given to:

1.1.1.1. the extent and amount of fluctuations in RF levels,

1.1.1.2. the frequency with which instances of RF emissions occur; and

1.1.1.3. the speed at which the emissions are flashing on and off.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 18                               |

1 To be clear, we are not asking for FortisBC to demonstrate a fresh consideration  
2 / discussion of these RF characteristics. We are asking about what past  
3 considerations have occurred in that regard, prior to the submission of the  
4 application and the Exponent Report.

5

6 **Response:**

7 Apart from the information already provided in response to CSTS IR No. 1 Q17.2 and CSTS IR  
8 No. 2 Q18.1, FortisBC has made no specific study of the three exposure characteristics  
9 described above prior to submission of its Application.

10

11

12 20.2 What is meant by “the relevant scientific literature”? How has relevance been  
13 determined?

14

15 **Response:**

16 FortisBC was aware of scientific literature on the topic of radiofrequency fields and health  
17 summarized by Health Canada and provincial health and regulatory authorities. Relevance was  
18 determined by the frequency range of radiofrequency signals associated with the FortisBC  
19 advanced meters.

20

21

22 **21.0 Follow up to response to CSTS IR#1 - 19.2**

23 *19.2 Have there been studies or tests of exposure risk in relation to exposure to RF*  
24 *emissions that replicate the actual pattern of emissions that are expected to occur from*  
25 *the proposed meters, i.e. replicating the extent and amount of fluctuations in RF levels,*  
26 *the frequency with which instances of RF emissions occur and the speed at which the*  
27 *emissions are flashing on and off?*

28 *Response:*

29 *Exponent is aware of laboratory studies that have involved exposures to RF signals of*  
30 *similar frequencies, on/off ‘speeds’, and generally higher intensities and longer duration*  
31 *duty cycles.*

32 21.1 Please particularize your reference to “laboratory studies” by naming and  
33 describing the studies and providing documentation with respect to same.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 19                               |

1

2 **Response:**

3 Reviews of laboratory studies of RF signals at frequencies and with other characteristics grossly  
4 similar to the RF signals from FortisBC advanced meters are reviewed and cited in Exponent's  
5 report "Status of Research on Radiofrequency Exposure and Health in Relation to Advanced  
6 Metering Infrastructure," although the exposures in these studies would generally be higher  
7 than those associated with FortisBC advanced meters.

8

9

10 **22.0 Follow up to response to CSTS IR#1 - 20.2**

11 *20.2 What consideration has FortisBC given to the assessment of exposure risks*  
12 *according to alternative standards such as the non-thermal standard?*

13 *Response:*

14 *FortisBC is not aware of any science-based, generally accepted "non-thermal standard".*

15 22.1 The question has not been answered. The standard referred to is referenced by  
16 the allusion in the Exponent Report at page 17 to "some studies" that have  
17 reported effects occurring with RF exposures below the level that raises the body  
18 temperature. The standard referred to is further exemplified in the 2007  
19 Bioinitiative report. It considers adverse health affects as occurring at non-  
20 thermal levels of exposure. What consideration has FortisBC given to the  
21 assessment of exposure risks according to that standard, regardless of whether  
22 FortisBC regards that standard as being science-based or generally accepted?

23

24 **Response:**

25 Respectfully, FortisBC answered the question. Please also refer to the response to WKCC IR  
26 No. 2 Q32. FortisBC has not considered following an unofficial 'standard' that has not been  
27 accepted by Health Canada or provincial health agencies.

28

29

30 **23.0 Follow up to response to CSTS IR#1 - 21.3, 22.3 & 22.4**

31 *21.3 Set out the range of opinion amongst scientists and medical professionals who*  
32 *have expressed an opinion on the matter of whether raising the body temperature is the*  
33 *effect that would occur first.*

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 20                               |

**Response:**

*The range of opinions about the adverse effect of RF exposure with the lowest threshold is scattered across the scientific literature. As part of the work towards evaluating and updating the ICNIRP standard, this agency invited scientists from around the world to participate in an international seminar on the topic of non-thermal RF electromagnetic fields (ICNIRP, 1997).*

23.1 The question has not been answered. You have provided information as to where the opinions are found ("scattered across the scientific literature") but you have not set out the range of opinion. Please answer the questions:

1.1.1.1. What is the range of differing opinion amongst scientists and medical professionals who have expressed an opinion on the matter of whether raising the body temperature is the effect that would occur first?

1.1.1.2. Set out the range of opinion amongst scientists and medical professionals who have expressed an opinion on the matter of whether an adequate approach to protection is achieved by setting exposure limits according to the point of tissue warming.

1.1.1.3. Particularize the position of those scientists and medical professionals who have expressed an opinion (contrary to that of Exponent) on the matter of whether an adequate approach to protection is achieved by setting exposure limits according to the point of tissue warming?

Please answer these questions directly rather than referring us to other answers which in turn make further reference to other answers.

**Response:**

Respectfully, FortisBC did offer the response that the range of opinions was scattered across the scientific literature.

1.1.1.1 In general, the range of opinion spans those who believe that a variety of adverse biological effects occur at levels of exposure to radiofrequency fields too low to produce any tissue heating and those who believe that most, if not all, potentially adverse effects of radiofrequency exposure occur as a result of tissue heating, or stimulation of tissue at lower frequencies by induced electric fields. Scientists in the first group, representing a minority opinion, suggest that these adverse biological effects would occur at exposure levels lower than would be required to heat tissues. Scientists in the second group suggest that the scientific data does not support the conclusion that there is sufficient reliable evidence for adverse effects at levels below those that produce tissue heating.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 21                               |

1.1.1.2 The range of opinion among scientists who have concluded that the adequate protection from potential adverse effects of radiofrequency exposure is achieved by compliance with so-called thermally-based limits can be examined by consulting reviews of the research prepared by national and international health and scientific agencies.

1.1.1.3 The range of opinion suggesting that adequate protection from radiofrequency fields is not provided by compliance with thermally-based exposure limits is for the most part represented by the authors of the Bioinitiative report, which was cited in the response to CSTS IR No. 1 Q24. This minority opinion is not shared by scientists who have performed reviews for national and international health and scientific agencies as explained in the response to 1.1.1.2.

## **24.0 Follow up to response to CSTS IR#1 - 24.1 & 24.2**

*24.0 Reference - Application - Appendix C-5 - non-thermal effects - p.17*

*24.1 Particularize the reference to "some studies" that have reported effects occurring with RF exposures below the level that raises the body temperature ("the Nonthermal Studies").*

*Response:*

*Please refer to the references on p. 21 of Appendix C-5 of the Application (Exhibit B-1), where studies were noted. Please also refer to the response to CSTS IR No. 1 Q21.3.*

*24.2 Provide a copy of each of the Nonthermal Studies.*

*Response:*

*No compilation of studies based upon just one group of potential mechanisms has been performed. Please also refer to the response to CSTS IR No. 1 Q24.1.*

24.1 You have answered question 24.1 by referring us to the references on p. 21 of Appendix C-5 of the Application as well as the response to CSTS IR No. 1 Q21.3. We did not find the answer to our question at these references. Without referring us to another source, please particularize the reference to "some studies" that have reported effects occurring with RF exposures below the level that raises the body temperature ("the Nonthermal Studies"). By asking you to particularize the reference, we are requesting that you name and describe the Nonthermal studies. By way of question 24.2, we have asked you to provide a copy of each of the Nonthermal Studies. Please do so, regardless of whether or not a compilation of such studies exists.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 22                               |

1

2 **Response:**

3 One compilation of such studies is the Bioinitiative report at [www. Bioinitiative.com](http://www.Bioinitiative.com). Copies of  
4 studies published in scientific journals cannot be distributed because of copyright restrictions;  
5 other studies cited are typically available on the internet.

6

7

8 **25.0 Follow up to response to CSTS IR#1 - 24.4**

9 *24.4 Has each and every review ever done of the Nonthermal Studies found the data*  
10 *in the Nonthermal Studies to be unreliable?*

11 *Response:*

12 *No survey of “each and every review” in the scientific literature on RF field has been*  
13 *performed to address this question.*

14 25.1 At page 17 of Appendix C-5, Exponent states:

15 Some studies have reported effects occurring with RF exposures below the level  
16 that raises body temperature, often called non-thermal effects. Non-thermal  
17 effects or low level effects refer to effects that occur at levels not believed to  
18 cause tissue heating. **These studies have been reviewed by scientific and**  
19 **regulatory agencies, which have not accepted this data as reliable** because  
20 the observed biological effects attributed to non-thermal levels were not  
21 consistent or reproducible, are not supported by any plausible biological  
22 explanation as to how they could occur, and in some studies the biological  
23 effects reported are not known to be linked to adverse effects on health (IEEE,  
24 2005; ICNIRP, 2009; HCN, 2009; NRPB, 2004; SCENIHR, 2009; SSM, 2009,  
25 2010).

26 [emphasis added]

27 CSTS IR#1 - 24.4 addresses the studies that have reported effects occurring with  
28 RF exposures below the level that raises body temperature (“the Nonthermal  
29 Studies”). In particular, CSTS IR#1 - 24.4 addresses the statement by Exponent  
30 that the Nonthermal Studies have “been reviewed by scientific and regulatory  
31 agencies, which have not accepted this data as reliable”.

32 CSTS IR#1 - 24.4 queries whether each and every review ever done (“by  
33 scientific and regulatory agencies”) of the Nonthermal Studies have found the  
34 data in the Nonthermal Studies to be unreliable. Is that really the case? Or is it  
35 the case that only some of the reviews done (“by scientific and regulatory



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 23                               |

agencies”) of the Nonthermal Studies have found the data in the Nonthermal Studies to be unreliable? Please answer these questions as well as CSTS IR#1 - 24.4.

It is FortisBC that is relying on the statement that “these studies have been reviewed by scientific and regulatory agencies, which have not accepted this data as reliable”. This statement has been made by Exponent and relied on by Fortis without the benefit of the non-existent survey referred to in your answer to CSTS IR#1 - 24.4. If you made such a statement without the benefit of such a survey, then you can clarify and elaborate on your statement without the benefit of such a survey. Please do so.

**Response:**

Reviews of radiofrequency health research and regulatory standards by health agencies worldwide have reviewed studies of thermal and non-thermal effects. They have identified established adverse thermal effects of radiofrequency exposure as being sufficiently reliable as to provide a basis for setting exposure limits to protect public health. Each of the reviews referenced has drawn conclusions based on the weight of the evidence that is considered reliable. None of the reviews have cited athermal or non-thermal effects as a basis for its conclusions about health effects or for setting exposure limits. Some of the reviews have been more explicit and detailed in their discussion of this question than others.

**26.0 Follow up to response to CSTS IR#1 - 24.5**

*24.5 Has any review done of the Nonthermal Studies denied the occurrence of biological effects at nonthermal levels of exposure?*

*Response:*

*No survey of “any review done” in the scientific literature on RF fields has been performed to address this question.*

*As noted in Appendix C-5 from the Application, known adverse health effects can be caused by high exposures to RF, with the effect that would occur first, given sufficient exposure, being an increase in the body temperature. This is the basis of the applicable public exposure limit.*

26.1 Exponent has referred to the Nonthermal Studies and has represented, at page 17 of Appendix C-5, that “these studies have been reviewed by scientific and regulatory agencies, which have not accepted this data as reliable.”

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 24                               |

Exponent has vaguely alluded to scientific reviews that have allegedly undermined the validity of the Nonthermal Studies (“the Undermining Reviews”).

CSTS IR#1 - 24.5 seeks particulars of the Undermining Reviews and, specifically, asks whether any such review has denied the occurrence of biological effects at nonthermal levels of exposure. We fail to see why FortisBC cannot answer this question. If you can rely on the Undermining Reviews to cast aspersions on the Nonthermal Studies, then why is it that you cannot provide further particulars regarding the findings of the Undermining Reviews? Please answer CSTS IR#1 - 24.5.

If you can rely on the Undermining Reviews (without the benefit of a “survey”) to cast aspersions on the Nonthermal Studies, then you can be expected particularize the findings of the Undermining Reviews without the benefit of such a “survey”.

**Response:**

The excerpts below provide information on the nature of reviews of *in vitro* studies (cellular studies) by scientific agencies. The excerpts below are from recent comprehensive sources (IEEE, 2005; SCENIHR, 2009; SSM, 2009; AGNIR, 2012). The source and page is indicated after the excerpt.

**IEEE Std C95.1-2005 – IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (2005)**

Despite more than 50 years of RF research, low-level<sup>[1]</sup> biological effects have not been established. No theoretical mechanism has been established that supports the existence of any effect characterized by trivial heating other than microwave heating. Moreover, the relevance of reported low-level effects to health remains speculative and such effects are not useful for standard setting (p. 82)

**Scientific Committee on Emerging and Newly Identified Health Risks – Health Effects of Exposure to EMF (2009)**

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<sup>1</sup> IEEE prefers to use the term “low-level effects” rather than “non-thermal effects” (IEEE C95.1-2005, p. 8).

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 25                               |

In the previous opinion of 2007 a detailed description of in vitro studies was presented and discussed. Most of the studies did not provide evidence for any effect of RF field exposure at non-thermal intensity levels on cellular systems (p. 21).

Different biological endpoints have been investigated in vitro after RF field exposure using a variety of cell types and exposure conditions with diverse outcome. In the majority of studies no genotoxic effects were shown. A few studies suggest various biological effects (including genotoxic effects) from RF fields, alone or in combination with other factors, mostly at higher SAR values (above 2 W/kg). The biological relevance of these findings is however unclear. Inconsistent in vitro findings and a lack of dose response relationships render any mechanistic understanding of potential non-thermal interactions between RF and living systems difficult. For RF fields below the recommended limits (2 W/kg) for energy absorption due to mobile phones, in vitro studies have not identified reproducible effects by which carcinogenicity in living systems could be explained (p. 26)

Furthermore, the in vitro studies regarding genotoxicity fail to provide evidence for an involvement of RF field exposure in DNA-damage (p. 35).

**Swedish Radiation Safety Authority (SSM) - Recent Research on EMF and Health Risks: Sixth annual Report from the SSM's independent Expert Group on Electromagnetic Fields (2009).**

There are no new positive findings from cellular studies that have been well established in terms of experimental quality and replication. Potential heating of the samples is still seen as a major source of artefacts. Moreover, these few positive results are not related to each other and/or are not relevant for health risk assessment. It is warranted that further *in vitro* studies that are well designed will help fill the remaining gaps such as effects on transformation (p.15).

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 26                               |

**Advisory Group on Non-Ionizing Radiation (AGNIR) for the Health Protection Agency of Great Britain – Health Effects from Radiofrequency Electromagnetic Fields, Report of the independent Advisory Group on Non-Ionising Radiation (2012)<sup>2</sup>**

Many more studies have been added to the scientific literature since 2003, with more studies using similar cell types and exposure condition, thus potentially making comparisons and conclusions easier. However, the results of the additional findings still remain divergent with no obvious reason as to why some researchers find effects and others do not. There is still a lack of independent replication of results, and where replications have been undertaken they do not support the original findings. This continued lack of robust evidence makes the possibility of an effect of RF fields on cells more unlikely (p.105).

Following further discussion they conclude:

In general, there is no coherent pattern of exposure conditions or *in vitro* cell system that consistently shows effects of exposure to RF fields below international guideline levels. The reported studies are still mostly diverse in terms of exposure and biological system tested; furthermore the reported effects lack independent verification. Even in cases where there are several studies using similar cell types, as in the case of lymphocytes, the results for the effect of RF field exposure are conflicting (p.106).

**27.0 Follow up to response to CSTS IR#1 - 26.1**

*26.1 How is “intensity (strength)” defined. Has there been consideration of the amount / extent of fluctuation of RF levels with respect to the proposed meters? Has there been consideration of the power of emissions during the signalling phase with respect to the proposed meters?*

*Response:*

*The “intensity (strength)” of a RF field is commonly expressed in units of power density defined as Watts per square meter (W/m<sup>2</sup>) or equivalent units.*

<sup>2</sup> The AGNIR report includes an assessment of cellular studies to update its report from 2003 (AGNIR, 2012, pp. 80-106). The main topics reviewed in this section are genotoxic effects, effects that could lead to carcinogenesis, and other changes in cellular processes.

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 27                               |

*The questions regarding RF levels and power during signalling are covered by Safety Code 6. Please also refer to the response to BCSEA IR No. 1 Q55.5.*

27.1 Your reference to Safety Code 6 and BCSEA IR No. 1 Q55.5 did not answer our question as to whether there has been consideration by FortisBC of the amount / extent of fluctuation of RF levels with respect to the proposed meters. Kindly answer this question directly without reference to further materials.

**Response:**

FortisBC was aware that the exposure characteristics of the proposed meters would comply with Safety Code 6 before submitting its Application but did not make a specific study of how the RF levels would vary over time. It is not clear what may be meant by the “amount / extent of fluctuation of RF levels with respect to the proposed meters” beyond the responses provided. Please also refer to the response to CSTS IR No. 2 Q18.1.

**28.0 Follow up to response to CSTS IR#1 - 29.1**

29.1 *Who are the referenced third party cellular providers that will provide backhaul service for the AMI Project?*

*Response:*

*FortisBC has not committed to any third party provider for cellular service related to the proposed AMI project.*

28.1 In your response to BCUC IR1 32.2, you refer to third party cellular providers. Who are these third party cellular providers, whether you have committed to them or not?

**Response:**

TELUS and Rogers are the only known third party cellular providers in much of the FortisBC service area, so these are the providers who were considered when determining whether cellular backhaul was available at the preliminary AMI collector locations.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 28                               |

1    **29.0    Follow up to response to CSTS IR#1 - 30.1**

2            *30.1    What wired technologies are “perfectly capable” of meeting the requirement of*  
3            *hourly consumption reads?*

4            *Response:*

5            *FortisBC understands that newer PLC technologies (that would have been commercially*  
6            *available during the FortisBC RFP) are capable of hourly consumption reads.*

7            29.1    What other wired communication technologies are “perfectly capable” of meeting  
8            the requirement of hourly consumption reads?

9

10    **Response:**

11    Excluding Power Line Carrier, no other wired options are realistically capable of providing hourly  
12    consumption reads economically. FortisBC is aware of only one other wired interface that is  
13    currently available for meter forms in North America, RJ-45. This type of interface is usually  
14    associated with Ethernet or IP based networks and would have sufficient bandwidth for hourly  
15    reads.

16    The use of this interface would assume that there is an underlying utility network existing at the  
17    customer premise to physically connect the meter to, and this could be provided by:

18            • Fibre to the home (FTTH) – Fibre to the home does not exist in the vast majority of the  
19            FortisBC service territory, and is not expected to in the foreseeable future. As evidenced  
20            in the response to CSTS IR No. 1 Q12.5, even if the infrastructure existed it would not  
21            be economical to lease. It is also clear from the same response that it is not economical  
22            for FortisBC to build this infrastructure.

23            • Existing copper infrastructure – It would be possible to lease existing copper  
24            infrastructure from the local carriers. The monthly costs of these “local loops” are  
25            covered under the CRTC 1017-105 tariff, and are estimated to be almost \$300 per  
26            meter, per year. This does not include any capital or recurring costs for modem  
27            equipment to convert the meter information for transmission to the local  
28            telecommunication central office and to be passed to FortisBC. It is clear that the  
29            monthly local loop lease cost alone makes this option too expensive to consider further.

30    For reference, excluding the cost of the meters it is estimated to cost approximately \$10 per  
31    year per meter to install, operate and maintain the LAN and WAN segments of the network  
32    using the proposed RF AMI solution. The options discussed above would be alternatives to this  
33    proposed LAN/WAN and are not economically viable.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 29                               |

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3 **30.0 Follow up to response to CSTS IR#1 - 34.1**

4 *34.1 Will FortisBC suspend service for those customers refusing installation of an AMI*  
5 *meter until such time that an AMI meter is installed?*

6 *Response:*

7 *As stated in the Application (Exhibit B-1) at page 142:*

8 *Regardless of FortisBC's efforts, some customers may continue to refuse the installation*  
9 *of an advanced meter. In these cases, FortisBC intends to follow the following process:*

- 10 • *Continue productive dialogue with the customer where possible, making an effort*  
11 *to address concerns and ensuring the customer is aware that they have the option of*  
12 *relocating the meter on their property at their expense.*
- 13 • *Continue to provide billing using estimated readings for up to six months.*
- 14 • *After three months of refusal to provide access to exchange the meter, and in*  
15 *absence of extenuating circumstances, suspension of the customer's service until the*  
16 *advanced meter is installed.*

17 *FortisBC does not take suspension of an individual customer's service lightly, but also*  
18 *cannot support ongoing manual meter reading or estimating once advanced metering*  
19 *has been deployed.*

20 30.1 What would constitute "extenuating circumstances"?

21

22 **Response:**

23 FortisBC has not identified any qualifying extenuating circumstances, factors, guidelines or  
24 principles at this time. Any request for such consideration would be evaluated on a case-by-  
25 case basis.

26  
27

28 30.2 Why is it that FortisBC "cannot support" ongoing manual meter reading or  
29 estimating via a customer-funded opt-out regime as is in place with various  
30 utilities as cited? What are the show-stoppers and/or obstacles associated with  
31 the implementation of such an opt-out program?





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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 30                               |

1

2 **Response:**

3 The referenced section of the Application assumes that there is no customer-funded opt-out  
4 tariff.

5 FortisBC discusses a possible opt-out solution in its response to BCUC IR No. 2 Q50.2,  
6 although it does not believe such a solution is required.

7

8

9 **31.0 Follow up to response to CSTS IR#1 - 34.2**

10 *34.2 Particularize the reference to the provisions in the Terms and Conditions of the*  
11 *Electric Tariff on which FortisBC relies for its asserted right to suspend service for those*  
12 *customers refusing installation of an AMI meter until such time that an AMI meter is*  
13 *installed.*

14 31.1 What specific phrase, clause or language within Article 8.2 of the Tariff does  
15 FortisBC rely on for its asserted right to suspend service for those customers  
16 refusing installation of an AMI meter until such time that an AMI meter is  
17 installed?

18

19 **Response:**

20 Section 8.2 of FortisBC's Electric Tariff provides the following:

21 *The Company shall have the right to suspend Service to make repairs or improvements*  
22 *to its electrical system. . . (underlined for emphasis)*

23

24

25 **32.0 Follow up to response to CSTS IR#1 - 34.4**

26 *34.4 Has FortisBC considered providing hard-wired communication technology*  
27 *solutions for those customers who refuse an RF emitting meter on the basis of health*  
28 *concerns or disability requiring accommodation?*

29 *Response:*



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 31                               |

*In matters related to health, FortisBC relies on the expertise of the Provincial Health Officer, Health Canada, and World Health Organization, who have all confirmed that wireless meters pose no known health risk or reason for concern.*

*In situations requiring accommodation, FortisBC will assess extenuating circumstances for individual customers on a case-by-case basis.*

32.1 What factors, guidelines or policy principles will apply to FortisBC's assessment of extenuating circumstances?

**Response:**

Please refer to the response to CSTS IR No. 2 Q30.1.

**33.0 Follow up to response to CSTS IR#1 - 34.5**

34.5 *Is FortisBC aware that there have been concerns about the potential impact of RF communication technology on pacemakers and other medical equipment?*

*Response:*

*Medical equipment such as pacemakers are [sic] designed to operate in 900 MHz and 2.4 GHz RF environments since these are common frequencies for baby monitors, cordless phones and WiFi routers for example. These are the same frequencies on which advanced meters transmit and receive, so FortisBC believes any concerns would be unfounded.*

*Please also refer to the response to WKCC IR No. 1 Q7.*

33.1 The question has not been answered. The question goes to FortisBC's awareness that such concerns exist. The question does not go to the validity of such concerns, from the perspective of FortisBC. Was FortisBC, at the time of the application, aware that there have been concerns about the potential impact of RF communication technology on pacemakers and other medical equipment?

**Response:**

Respectfully, the referenced questions asked whether FortisBC "is aware", not "was aware", which was answered. At the time of its Application FortisBC was aware that some customers may have concerns about RF communication technology, including its alleged interaction with pacemakers. FortisBC had not heard about alleged interactions with other medical equipment.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 32                               |

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3 **34.0 Follow up to response to CSTS IR#1 - 34.7**

4 *34.7 Will FortisBC enter private property of a customer for the purpose of installing an*  
5 *RF emitting AMI meter where the customer has posted signage explicitly denying*  
6 *FortisBC access to the private property for the purpose of installing an RF emitting AMI*  
7 *meter?*

8 *Response:*

9 *The FortisBC process for customers refusing the installation of an advanced meter is*  
10 *described in Exhibit B-1 Section 8.5. It may not be possible for an installer to assess the*  
11 *intent of the customer without accessing private property.*

12 34.1 FortisBC's reference to Exhibit B-1 Section 8.5 does not answer the question.  
13 Assuming it is possible, by way of a visible sign, for FortisBC to assess the intent  
14 of the customer without accessing private property, will FortisBC enter private  
15 property of a customer for the purpose of installing an RF emitting AMI meter  
16 where the customer has posted signage explicitly denying FortisBC access to the  
17 private property for the purpose of installing an RF emitting AMI meter?

18

19 **Response:**

20 The Company respectfully submits that it did answer the question. FortisBC would not access  
21 the customer property to install an AMI meter if it was clear, without accessing the property, that  
22 the customer did not wish that meter to be installed.

23  
24

25 **35.0 Follow up to response to CSTS IR#1 - 57.4**

26 *57.4 How many times per day on average will an AMI meter transmit billing data?*

27 *Response:*

28 *FortisBC will determine this during the Define/Design phase of the proposed AMI*  
29 *Project. However, typical deployments return consumption interval data 2 or 3 times per*  
30 *day.*

31 35.1 If billing data will transmit only 2 or 3 times per day, then why do the proposed  
32 AMI meters emit RF once every minute or so on a 24/7 basis? Can RF emissions  
33 be suspended overnight while residents are sleeping?

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 33                               |

1

2 **Response:**

3 The meters communicate more frequently than required for the transmission of consumption  
4 data in order to transmit high-priority information such as power outages and tamper alerts, as  
5 well as control and command messages integral to the efficient operation of a meshed network.  
6 The meters also transmit keep-alive messages typical of many data transmitting systems, and  
7 these transmissions cannot be omitted without compromising the wireless network. These  
8 intermittent transmissions are typical of other messaging systems, such as Wifi, which typically  
9 beacons 10 times per second compared to the proposed smart meters keep-alive period of  
10 greater than a minute at steady-state.

11

12

13 **36.0 Follow up to response to CSTS IR#1 - 13.1**

14 *13.1 Is FortisBC aware that there has been concern over the fire risk associated with*  
15 *smart meters?*

16 *Response:*

17 *Yes. Please refer to the response to Tatangelo IR No. 1 Q59 [which refers to a report*  
18 *prepared by Len Garis, Fire Chief for the City of Surrey, BC].*

19 36.1 Can FortisBC confirm that BC Hydro commissioned Mr. Garis' report and paid  
20 Mr. Garis \$15,000 to prepare his report?

21

22 **Response:**

23 FortisBC is unable to confirm this information.

24

25

26 36.2 Is it true that there are no fire designation codes specific to smart meters? Is it  
27 true that there is a general fire designation code for "electric" fires?

28

29 **Response:**

30 FortisBC is unable to confirm this information as the responsibility for fire designation codes is  
31 not within the Company's jurisdiction.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 34                               |

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2

3           36.3   Has Fortis reviewed incidents of alleged smart meter fires that have occurred  
4                   elsewhere (e.g. California, Florida, Texas, Ontario) as well as those associated  
5                   with BC Hydro's smart meters that have been reported in the BC media?

6

7    **Response:**

8    Yes, FortisBC has reviewed reports of alleged smart meter fires in other jurisdictions.  
9    Investigations to date indicate that the smart meters themselves aren't causing the problems;  
10   the problems relate to faulty customer equipment and inadequate installation processes. The  
11   FortisBC advanced meter installation procedures will identify faulty customer equipment  
12   requiring repair or replacement, ensuring the premise is left safe.

13

14

15   **37.0   Follow up to response to CSTS IR#1 - 13.2**

16           13.2   *What consideration has FortisBC given to fire risk associated with its prospective*  
17           *AMI Project?*

18           *Response:*

19           *FortisBC considered the risk of fire from energy theft, and the reduction of this risk*  
20           *resulting from AMI, in Section 5.3.2 of Exhibit B-1.*

21           *Please also refer to response to BCUC IR No. 1 Q47.3.*

22           37.1   Measurement Canada's LMB-EG-07 requires that meter construction shall be  
23                   mechanically and electrically sound, and materials, finish, etc. shall be such as to  
24                   provide assurance of long life and sustained accuracy. Has FortisBC received  
25                   confirmation that a plastic meter with no ground neutral meets Measurement  
26                   Canada's standards with regard to construction, electrical soundness and long  
27                   life?

28

29    **Response:**

30    FortisBC cannot use a measuring device for revenue metering unless the manufacturer has  
31    received 'type approval' from Measurement Canada. Measurement Canada states 'a type  
32    approval is granted for a particular class, type or design of measuring device once it has been  
33    confirmed that the class, type or design complies with all applicable legal requirements'. Type

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 35                               |

approval would require compliance with LMB-EG-07 as applicable, and the FortisBC AMI meters have all obtained type approval. FortisBC notes that no 240 volt residential meter has ever had a neutral ground connection.

### **38.0 Determining power density**

38.1 Does Fortis BC accept U.S. FCC computer modelling as the standard used for determining power density for transmitters in Canada?

#### **Response:**

The physics of signal transmission is not country dependent. FortisBC accepts Health Canada's Guidelines, which are the same as the U.S. FCC guidelines (and other related standards) since they describe methods for the computation of power density that are applicable anywhere.

### **39.0 Time of use ("TOU") billing**

39.1 Could TOU billing become mandatory?

#### **Response:**

As noted in the response to CSTS IR No. 1 Q5.1, FortisBC has no current plans to make time-based rates mandatory. The completion of the AMI project would allow for a practical and more cost effective implementation of TOU rates (whether mandatory or optional) in the future.

Beyond this current position, it is not possible to state exactly how those rates would be structured, what the pricing differential would be between the blocks, or what the impact to customers who choose, under an optional TOU program, to not participate would be.

The Company understands that customers would like certainty in advance of implementation on the attributes of a TOU implementation; however the information does not exist at this point in time and any such rates would require Commission approval prior to forming part of the FortisBC tariff.



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 36                               |

1           39.2   Will FortisBC guarantee that the pre-TOU rate will remain in place to those  
2                   customers who wish not to use TOU rates?

3

4   **Response:**

5   Please refer to the response to CSTS IR No. 2 Q39.1.

6

7

8           39.3   Will customers be surcharged if they do not accept TOU billing?

9

10   **Response:**

11   Please refer to the response to CSTS IR No. 2 Q39.1.

12

13

14           39.4   Will pre-pay customers be given preference in any way over non-TOU  
15                   customers?

16

17   **Response:**

18   A pre-pay option is not a rate, but is instead a different method of payment for existing rate  
19   structures.

20

21

22           39.5   Can FortisBC provide verifiable statistics to show that customers in an  
23                   established AMI grid have saved money as a general outcome of the enhanced  
24                   features of TOU billing?

25

26   **Response:**

27   The efficacy of TOU billing is not directly related to the implementation of AMI. TOU billing and  
28   AMI can and have been implemented separately. AMI is considered an enabling technology  
29   that is required for a broad implementation of TOU rates.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 37                               |

The impacts of TOU billing, both on customer bills, and on electrical system loads, are well documented. There are numerous reports on the impact of TOU pricing available on the Smart Grid Information Clearinghouse (<http://www.sgiclearinghouse.org>) website.

The implementation of TOU rates provides customers with the opportunity to save money by shifting consumption to lower cost periods. TOU rates can also lead to a lower revenue requirement by reducing generation, transmission, distribution and power purchase costs.

#### **40.0 Application - Power Line Carrier AMI Systems - pg. 112 - lines 8-13**

40.1 Please explain the problems with PLC volume.

#### **Response:**

PLC technology is similar to other radio frequency technologies, with the distinction that instead of coupling the signal onto the air using an antenna, it is coupled onto the power distribution or transmission line using specialized equipment.

For AMI systems, the customer meters are on distribution feeder lines which typically have many “taps” as the network branches off to serve customers on different streets or in other geographic areas. For the PLC signal, each of these branches represents a loss in signal power. In addition, the PLC signal is also attenuated when passed between the primary and secondary windings of the transformers that step the distribution line voltage down to a voltage suitable for service to a customer. These attributes make a distribution feeder a poor medium for transmission of PLC signals. Combined with the long length of the lines, the consequence of these losses is a low signal level at the AMI meter.

The amount of data a radiofrequency signal (including PLC signals) is capable of transmitting is proportional to the received signal level. A higher signal level allows a more efficient modulation scheme to be used, and this means higher data rates. As discussed above, the poor propagation characteristics inherent on a distribution feeder line cause losses in the system and a resultant low RF signal level at the meter. This limits the data bandwidth capacity of the system.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 38                               |

1     **41.0   Application - Alternatives - pg. 113-114 - Tables 7.3.a and 7.3.b**

2             41.1   Please explain why projections for wired meters are \$20 million dollars higher  
3                    than wireless.

4

5     **Response:**

6     FortisBC has offered possible explanations as to why estimates for PLC meters are \$7-\$20  
7     million higher (please also refer to the response to BCUC IR No. 2 Q32.2.1) than the proposed  
8     wireless AMI meter in the responses to BCUC IR No. 1 Q113.1.2, CEC IR No. 1 Q44.2 and  
9     BCUC IR No. 2 Q35.3.

10

11

12             41.2   Explain the relatively high cost of the meter (\$576.00).

13

14     **Response:**

15     Please refer to the response to CSTS IR No. 2 Q41.1.

16

17

18     **42.0   Application - AMI PROJECTS IN CANADA - pg. 126   lines    9-15**

19             42.1   How much has energy consumption been reduced since Smart Meters were  
20                    introduced in Ontario?

21

22     **Response:**

23     As part of the province's Long-Term Energy Plan and the government's energy efficiency  
24     efforts, Ontario has saved more than 1,700 megawatts of electricity since 2005, equivalent to  
25     more than half a million homes being taken off the grid. Using advanced meters as a tool,  
26     Ontario has been able to implement rate design and conservation programs which provide  
27     incentives for reducing energy use and using more energy efficient products. Please see the  
28     following link:

29     [http://www.energy.gov.on.ca/en/results\\_2011/](http://www.energy.gov.on.ca/en/results_2011/)



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 39                               |

1  
2

3 **43.0 Application - Electro Magnetic Fields - pages 133-135**

4 43.1 Has FortisBC studied any independent, peer reviewed, non-industry funded  
5 studies of the research on non-ionizing RF radiation and its biological effects? If  
6 so, which studies?

7

8 **Response:**

9 FortisBC has not undertaken its own interpretation of individual studies; rather FortisBC relies  
10 upon regulations, e.g., Health Canada's Safety Code 6, and guidance from Health Canada and  
11 British Columbia including the Provincial Health Services Authority, the BC Centre for Disease  
12 Control, and the BC Cancer Agency that have reviewed and considered published research  
13 literature on radiofrequency fields and health. The conclusions of these sources regarding  
14 radiofrequency fields and health are similar to those of other national and international health  
15 agencies.

16  
17

18 43.2 Please clarify, explain and elaborate on the statement on page 134, line 26,  
19 regarding frequencies.

20

21 **Response:**

22 The Application states on p. 134, line 26 "Frequency – The frequency of operation of the meters  
23 is relatively low (902-928 27 MHz) when compared to other ubiquitous technologies such as  
24 cellular phones, 28 microwave ovens and Wi-Fi." There are several common sources of RF  
25 exposure in the communication frequency range of 3 kHz to 300 GHz. Specifically, cell phones  
26 and other portable/mobile consumer electronic devices produce signals in the frequency range  
27 of 450 MHz to 3 GHz. WiFi and many cellular phones operate at frequencies of 1,700 MHz to  
28 2.45 GHz, which are higher than the 900 MHz frequency utilized by the AMI meters

29  
30

31 43.3 Does FortisBC know how many meters will be placed on bedroom walls, mere  
32 inches from heads of the beds of the occupants?

33

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 40                               |

1 **Response:**

2 No, although any exposure in such circumstances is expected to be below the applicable Safety  
3 Code 6 limits.

4  
5

6 43.4 Please explain duty cycle. Who or what controls the duration the meter is  
7 signalling?

8

9 **Response:**

10 The duty cycle is the percentage of time a transmitter is “on” and therefore emitting an RF  
11 signal. The duty cycle is a function of the amount of data that needs to be sent by the  
12 transmitter; more data sent corresponds to a higher duty cycle. The following affect the amount  
13 of data a meter will need to send:

- 14 • meters relaying data for other meters will have more data to send;
- 15 • poor signal quality at the receiver will cause errors and a need for the meter to resend  
16 data; and
- 17 • an increased read frequency will require more data to be sent from the meter.

18 In all situations, the duty cycle is very low. Please refer to the responses to CSTS IR No. 2  
19 Q43.7, CEC IR No. 2 Q34.1 and BCSEA IR No. 1 Q55.4 for details on the minimum, maximum  
20 and average duty cycles expected for the proposed AMI meters.

21  
22

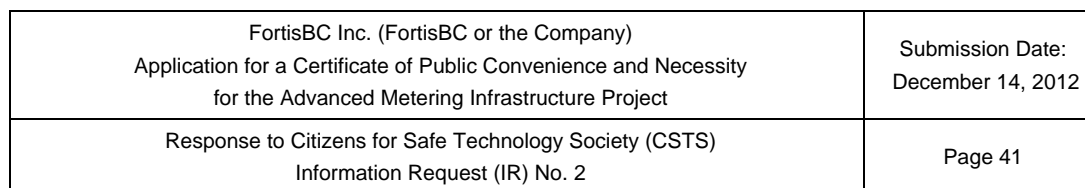
23 43.5 Disregarding the average, what are the peak power densities during signalling?

24

25 **Response:**

26 Please refer to the response to CSTS IR No. 1 Q57.7. Note that this peak power density is  
27 instantaneous and assuming 100% duty cycle and cannot be compared to Health Canada  
28 Safety Code 6 or other thresholds with a defined averaging window. Empirical peak power  
29 density based on the Health Canada measurement standard would be significantly less. Even  
30 at the theoretically supported maximum duty cycle of 5%, peak power density would be 5% of  
31 0.227 mW/cm<sup>2</sup> or 0.011 mW/cm<sup>2</sup>.

32  
33



3

5 Even with the small duty cycle, the Itron OpenWay meters are capable of transmitting all the  
6 meter data several times a day. From the conclusion of the white paper titled “An Examination  
7 of Itron OpenWay® Wireless Transmissions in a 24-hour Duty Cycle”, included as BCSEA IR  
8 No. 1 Q55.5:

14

15

17

19 Please refer to the response to BCSEA IR No. 1 Q55.6.

26

27

29

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 42                               |

1

2 **Response:**

3 Please refer to Appendix BCSEA IR1 55.5, Appendix BCSEA IR1 55.8, and Appendix C-5 –  
4 Exponent Status of Research on RF Exposure and Health, p. A-2 (Exhibit B-1).

5

6

7 **44.0 Application - Exponent Report**

8 44.1 In vitro studies are plentiful and are considered expert means of performing  
9 research. Please explain further why Exponent is discounting them and  
10 substantiate the statement that epidemiological studies and in vivo studies  
11 provide more direct information on human health.

12

13 **Response:**

14 In its description of the hazard identification step of a human health risk assessment, the  
15 Exponent report states “This process considers epidemiology studies of humans in their natural  
16 environment, experimental laboratory studies of humans or laboratory animals (*in vivo* studies),  
17 and laboratory studies of cells and tissues (*in vitro*) that may provide evidence for a  
18 mechanism—the way in which the exposure interacts with biological tissues. These three types  
19 of studies provide different but complementary information to determine how an exposure  
20 affects biological organisms. Only human and animal studies of RF exposure are considered in  
21 this report because they provide more direct information on human health than in vitro studies”  
22 (pp. 3-4).

23 Thus, in vitro studies are but one part of the weight of the evidence considered in a standard  
24 health risk assessment. Regarding RF fields in particular, consider the comments of ICNIRP  
25 (2009) and the AGNIR (2012) regarding the contribution of in vitro studies to their assessments  
26 of potential health risks of radiofrequency fields. Please also see the response to CSTS IR No.  
27 2 Q26.1.

28 **ICNIRP – Exposure to high frequency electromagnetic fields, biological effects and**  
29 **health consequences (2009)**

30 ... when using simplistic cell-based [*in vitro*] systems to  
31 assess toxicity, it is important to recognize that cells are finely-  
32 balanced homeostatic machines that respond to external stimuli  
33 through complex pathways. As toxicity can be the result of a  
34 multitude of cellular events, and because cell culture systems

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 43                               |

often lack essential systemic contributors to overall absorption, distribution, metabolism and excretion, as well as to the complex interactions and effects of the immune, endocrine and nervous system, it is clear that no *in vitro* assays can completely mimic the *in situ* condition in animals and humans of complex interactions between stem cells, proliferating progenitor cells and terminally differentiated cells within a tissue and between tissues (Bhagal et al 2005). *In vitro* investigations therefore only contribute to toxicity testing and risk assessment but, standing alone, they are insufficient predictors of toxicity and hazard. This is certainly also true with respect to investigations of cellular effects from RF radiation and this should be kept in mind when evaluating these data (p. 97).

Over the last 30 years there have been many *in vitro* studies on potential cellular effects of RF. These studies gave insight into the basic mechanisms by which effects might be induced in more complex animal or human organisms. Interpretation is, however, limited by anomalous cell behavior generated by the culture conditions and other factors which limit the extrapolation to humans. The studies conducted so far have not provided consistent evidence of biological effects under non-thermal RF exposure conditions (p. 148).

**Advisory Group on Non-Ionizing Radiation (AGNIR) for the Health Protection Agency of Great Britain – Health Effects from Radiofrequency Electromagnetic Fields, Report of the independent Advisory Group on Non-Ionising Radiation (2012)<sup>3</sup>**

However, these [in vitro] studies have their limitations. The main disadvantage is that isolated cells do not experience the many interactions that would normally take place in a whole organism and hence their response to stimuli is not necessarily the same as it would have been in an experimental animal or human....adverse cellular changes may not be harmful to the whole organism as organisms have protection and repair mechanisms. Hence a cellular change does not imply an effect on the whole organism and neither a change at the cellular level nor a change of the whole organism necessarily results in a health effect (p. 80).

<sup>3</sup> [http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb\\_C/1317133826368](http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1317133826368)

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 44                               |

1           The *in vitro* biological changes due to RF field exposure reported  
2           so far are relatively small, which makes experimental confirmation  
3           difficult. Even if these changes were confirmed the health  
4           implications would be hard to assess and would require further  
5           studies using experimental animals or humans. However, the  
6           results from *in vitro* studies can be useful to suggest possible  
7           mechanisms and indicate areas of further research (p. 81).

8  
9

10           44.2   Does dose response assessment take into consideration length of time of the  
11           exposure to lower doses?

12

13   **Response:**

14   An examination of dose response would include consideration of how biological responses to  
15   radiofrequency fields would vary with the intensity and duration of exposure.

16  
17

18           44.3   Does dose response assessment take into consideration cumulative effects of  
19           prolonged exposure to low doses?

20

21   **Response:**

22   Cumulative effects may be considered as part of a dose response assessment or separately.  
23   Cumulative effects of exposure to RF fields, except relating to the time-dependent dispersion of  
24   thermal energy, have not been established.

25  
26

27           44.4   Does exposure assessment, as discussed in the Exponent Report at pages 8, 9  
28           & 47, take into consideration cumulative effects of prolonged exposure to low  
29           doses?

30

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 45                               |

1 **Response:**

2 The evaluation of potential health effects of any exposure considers the duration of exposure  
3 with regard to the potential for biological changes or health effects to evolve over time. Safety  
4 Code 6 addresses the potential cumulative build-up of heat in tissues by time-averaging  
5 exposure to radiofrequency fields and so prevents adverse effects of exposure.

6  
7

8 44.5 Several studies have been performed showing that funding source is a relevant  
9 and important consideration in scientific assessment. Was funding source one  
10 of the criteria used in your evaluation of scientific evidence? If not, why not?

11

12 **Response:**

13 The scientific quality and reliability of the studies were important considerations in Exponent's  
14 review as they are for all valid risk assessments. Funding sources of individual studies were not  
15 a criterion in the scientific assessment. One can judge the scientific quality and relevance from  
16 the published study but assessing the potential influence of hidden variables whatever their  
17 nature is problematic. Replication of studies is the best insurance against the potential  
18 influence of scientific, social, economic, and political factors on science. With respect to reviews  
19 of the scientific research literature organized by a national or international health and scientific  
20 agencies, their procedures are designed to minimize the potential effect of funding source.

21  
22

23 44.6 Given that microwave radiation has not been at the current levels for very many  
24 years, (e.g. even 10 years ago the numbers of cell phones and cell transmitters  
25 were mere fractions of what they are today); and given that cancers can take 20-  
26 30 years to develop, explain why you believe cohort studies are more credible  
27 than in vitro studies.

28

29 **Response:**

30 Although some cancers can take as long as 20 or 30 years to develop, some cancers could  
31 develop, or progress to a detectable level, in a shorter time. Therefore human epidemiology  
32 studies, including cohort studies, provide important information. In vitro studies are conducted  
33 on cells and tissues outside of the body, and their results do not provide definitive information of  
34 what would occur in an intact living organism. In vivo studies of laboratory animals, conducted

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 46                               |

over long time periods, are considered more relevant to human health than in vitro studies.  
Please also refer to the responses to CSTS IR No. 2 Q26.1 and CSTS IR No. 2 Q44.1.

44.7 Are some persons more vulnerable to RF exposures than others?

**Response:**

Research has not indicated that some people are more vulnerable to the effects of RF exposure than others at levels below the recommended exposure limits. The guidelines that recommend exposure limits have been based on known effects on people, identifying levels where effects are minor, and then further reducing these exposure levels for additional assurance of safety.

44.8 Are children more vulnerable to RF exposures than adults?

**Response:**

Children are not more vulnerable to the potential effects of RF exposures at levels below the guidelines. The guidelines have factored in the relative size of children compared to adults. Potential exposures from the proposed AMI meters are far below the recommended exposure limits.

44.9 Do the exposure limits accepted by FortisBC take cumulative exposure into consideration? If yes, please substantiate.

**Response:**

Yes. The recognized effects of RF exposure are threshold acting, which means that sufficient intensity of exposure must be present over a certain time period to affect human health. Exposure limits are set by Health Canada well below the conditions where the threshold might be reached.





|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Citizens for Safe Technology Society (CSTS)<br>Information Request (IR) No. 2  | Page 47                               |

1

2

3        44.10 Most exposure to cell transmitters, cell phones and radio transmitters occurs  
4                while the object of exposure is moving, during the day. Most exposure to smart  
5                meters will be while people are at home sleeping. What studies were reviewed  
6                that would pertain to the latter pattern and circumstance of exposure? What  
7                consideration is being given to people who are in one location, e.g. their home,  
8                all day every day, e.g. mothers with young children, the elderly and the  
9                disabled?

10

11    **Response:**

12    It is not clear that the two assumptions regarding exposure are valid generalizations or  
13    inferences about exposure of the population to radiofrequency fields. Research on potential  
14    effects radiofrequency exposures has not indicated that members of these groups would not be  
15    protected under compliance with Safety Code 6.

Health  
CanadaSanté  
Canada*Your health and  
safety... our priority.**Votre santé et votre  
sécurité... notre priorité.*

Smart Meters

Updated:

December 2011

# IT'S YOUR HEALTH

## Smart Meters



### THE ISSUE

In recent years, utility companies in several provinces have started installing wireless smart meters in Canadian businesses and residences. Some people have expressed concern about the possibility of health effects from exposure to the [radiofrequency \(RF\) energy](#) that these devices emit.

### SMART METERS

Smart meters are relatively new wireless devices that transmit information using RF signals to let utility companies know how much water, gas or electricity a household or business is using. The signals emitted by smart meters are of relatively low power, similar to [cell phones](#) and [wireless internet routers](#). The maximum amount of power that a smart meter device can transmit must comply with [Industry Canada regulations](#).

### HEALTH RISKS

As with any wireless device, some of the RF energy emitted by smart meters will be absorbed by anyone who is nearby. The amount of energy absorbed depends largely on how close your body is to a smart meter. Unlike cellular phones, where the transmitter is held close to the head and much of the RF energy that is absorbed is localised to one specific area, RF energy from smart meters is typically transmitted at a much greater distance from the human body. This results in very low RF exposure levels across the entire body, much like exposure to AM or FM radio broadcast signals.

Survey results have shown that smart meters transmit data in short bursts, and when not transmitting data, the smart meter does not emit RF energy. Furthermore, indoor and outdoor survey measurements of RF energy from smart meters during transmission bursts were found to be far below the human exposure limits specified in Health Canada's [Safety Code 6](#).

Based on this information, Health Canada has concluded that exposure to RF energy from smart meters does not pose a public health risk.



## REDUCE YOUR RISK

Since RF energy exposure levels are far below Canadian and international safety limits, Health Canada does not consider that any precautionary measures are needed to reduce RF energy exposure from smart meters.

In cases where multiple smart meters are installed together, as in some townhouses or high-rise buildings, the total exposure levels from multiple smart meters will still be far below Health Canada's RF energy exposure limits, due to the infrequent nature of transmissions.

## THE GOVERNMENT OF CANADA'S ROLE

Health Canada has developed guidelines for safe human exposure to RF energy. The current version of these exposure guidelines is specified in a document called *Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz* – Safety Code 6 (2009).

The limits specified in these guidelines are based on an ongoing review of published scientific studies on the health impacts of RF energy. Using data from these studies, Health Canada set the general exposure limits far below the threshold for potentially adverse health effects.

Health Canada continues to monitor the science regarding RF exposure and will take action if future research establishes that RF energy exposure poses a health risk to Canadians.

## FOR MORE INFORMATION

- World Health Organization, *Electromagnetic fields and public health: base stations and wireless technologies* at : [www.who.int/media-centre/factsheets/fs304/en/index.html](http://www.who.int/media-centre/factsheets/fs304/en/index.html)
- International Agency for Research on Cancer *electromagnetic fields news release* at: [www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208\\_E.pdf](http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf)
- World Health Organization, *Electromagnetic Fields* at: [www.who.int/peh-emf/en/](http://www.who.int/peh-emf/en/)

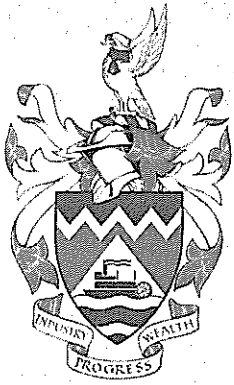
## FOR INDUSTRY AND PROFESSIONALS

- Health Canada's *Consumer and Clinical Radiation Protection Bureau* at: [www.hc-sc.gc.ca/ahc-asc/branch-dirigen/hecs-dgsesc/psp-ppsp/ccrpb-bpcrpcc-eng.php](http://www.hc-sc.gc.ca/ahc-asc/branch-dirigen/hecs-dgsesc/psp-ppsp/ccrpb-bpcrpcc-eng.php)
- Health Canada's RF exposure guidelines (Safety Code 6) at: [www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio\\_guide-lignes\\_direct-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct-eng.php)
- Industry Canada's *Radio Standards Specification 102* at: [www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01904.html](http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01904.html)
- Industry Canada's *Client Procedures Circular CPC-2-0-03* at: [www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08777.html](http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08777.html)
- Industry Canada's *Guidelines for the Protection of the General Public in Compliance with Safety Code 6* at: [www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf05990.html](http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf05990.html)

## RELATED RESOURCES

- For safety information about food, health and consumer products, visit the *Healthy Canadians* website at: [www.healthycanadians.gc.ca](http://www.healthycanadians.gc.ca)
- For more articles on health and safety issues go to the *It's Your Health* web section at: [www.health.gc.ca/iyh](http://www.health.gc.ca/iyh)

You can also call toll free at 1-866-225-0709 or TTY at 1-800-267-1245



## Village of Kaslo

2012.08.01

Blair Weston  
FortisBC  
RR1 S2 C1 3100 Station Road  
SOUTH SLOCAN, B.C. V0G 2G0

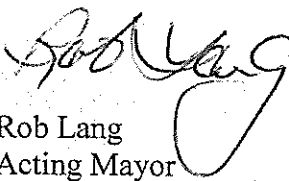
Dear Mr. Weston:

Please be advised the following resolution was adopted by the Council of the Village of Kaslo at its most recent Regular meeting, held 24 July 2012:

*That staff be directed to send a letter to FortisBC and the Province of BC in support of optional refusal of installation of Smart Meters.*

Kaslo does support freedom of choice being available to our community members and to your clients, and we look forward to your acknowledgement of our perspective.

Sincerely,

  
Rob Lang  
Acting Mayor



Toll Free: 1-888-495-6515

Phone: 250-495-6515

Fax: 250-495-2400

Website: www.osoyoos.ca

July 16, 2012

Bob Gibney  
Manager, Aboriginal Affairs  
Corporate Relations  
FortisBC Inc.  
Suite 100, 1975 Springfield Drive  
Kelowna BC V1Y 7V7

Dear Bob:

**Re: Advanced Metering Infrastructure (AMI)**  
**Our File Number: CR-766**

Thank you for the informative Advanced Metering Infrastructure (AMI) presentation to Council on July 3, 2012. Council reviewed your request for a letter of support and passed the motion listed below:

*MOTION 542/12 Moved by Councillor Rhodes and seconded by Councillor Ryan and resolved that Council approves providing Fortis with a letter that informs Fortis that given conflicting issues, information and the intensity of technical assessment needed, the installation of advanced metering infrastructure (smart meters) in Osoyoos is best left to the business relationship between Fortis and its customers; However, if a smart metering program is approved Council sees it as essential to provide an opt out clause and time of use program information.*

Council's opinion is that the installation of AMI will be reviewed by the Public Utilities Board as part of Fortis application process; therefore, the technical arguments will be addressed at that time by personnel that are knowledgeable in that area. Council also expressed the need to provide people with the option to "opt out" of the program and any proposed AMI program include the energy and cost saving linked to a "time-of-use" pricing system.

If you require any additional information on this matter please contact me at 250-495-6515.

Yours truly,

Barry Romanko, CLGM  
Chief Administrative Officer

BR/dc

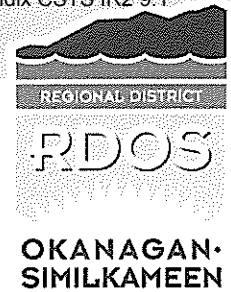
cc: Council

101 Martin Street, Penticton, British Columbia V2A 5J9

Tel: 250.492.0237 Fax: 250.492.0063

Toll Free: 877.610.3737

Email: info@rdos.bc.ca



October 30, 2012

File: 0400.30

FortisBC  
Suite 100, 1975 Springfield Road  
Kelowna, BC  
V1Y 7V7

Dear Sirs:

**Re: Smart Meters**

At the October 18, 2012 Regular Board Meeting, the Board of Directors passed the following motion (B391/12):

"WHEREAS there are significant health concerns amongst residents throughout BC regarding FortisBC's plans to replace all current residential electrical meters with new "Smart Meter" wireless devices;

WHEREAS there is growing evidence that electromagnetic radiation (EMR) emitted by wireless smart meters and other electronic devices may have negative health impacts on some individuals under certain circumstances, and the World Health Organization has recently deemed radio frequency electromagnetic radiation as a class 2b carcinogenic, the same category as lead and DDT;

AND WHEREAS these meters will be placed on the homes without consultation or consent of local residents;

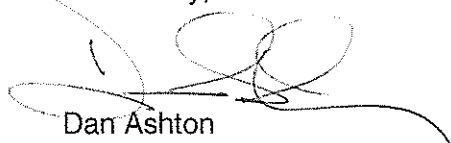
WHEREAS the utility meters being installed by FortisBC can achieve all of the potential energy reduction benefits of the "smart grid" without actually needing to operate wirelessly;

AND WHEREAS Provincial Bill 23-2008 of the Public Health Act, section 83 (1) requires a local government to take action should it become "aware of a health hazard or health impediment within its jurisdiction";

BE IT SO MOVED that the Regional District write FortisBC and relevant Provincial Ministers to ask for a moratorium on the installation of smart meters in British Columbia until an "opt-out" option is made available to jurisdictions. – Carried"

The Board of Directors respectfully requests your consideration of such a moratorium.

Yours truly,



Dan Ashton  
RDOS Chair

cc: B. Newell, CAO  
Hon. Terry Lake, Minister of Environment  
Hon. Rich Coleman, Minister of Energy, Mines and Natural Gas





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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Keith Miles<br>Information Request (IR) No. 2  | Page 1                                |

As a registered intervener reviewing the Responses to Intervener Information Request No. 1 received at my home November 16th, and in my absence from the process out of B.C. on personal business from November 6th through 11th, I was concerned because I have not had adequate time as an individual to review and fully consider the scope of the 946 pages of the FortisBC Responses to Intervener Information Request No. 1 and prepare a meaningful Request #2.

However I can extract several items that I feel have not been adequately developed. I am attaching support the documents as to these elements. Referring to Responses to Intervener Information Request No. 1, Miles IRI1, p2, Response Line 34, it would seem to me irresponsible to not have sought and developed and an alternate RFP for a PLC solution when, within the full corporate environment of Fortis Inc., corporate documents suggest that this is a proven solution that would avoid the RF controversy and safety concerns.

In Advanced Metering Infrastructure (AMI) Phase II – Full Deployment Business Case 2008/2009 Phase I Tariff Application (2007, p.4), FortisAlberta determined that:

“In summary, FortisAlberta has demonstrated in Phase I that PLC AMI technology, provided by Hunt has proven itself to be beneficial to customers by demonstrating that it will have a positive NPV over the life of the AMI System when compared to manual bi-monthly or monthly manual reads; deliver timely and accurate monthly or more frequent meter reads; and provide additional functionality both immediately and in the future for the benefit of FortisAlberta customers.”

Further, in the Idaho Power Company, Direct Testimony Of Mak C. Heintzelma, (2008 p.3-5), it was determined that,

“The RFI evaluation reduced the field of thirteen AMI technology providers down to two. The Company then issued a Request for Proposals ("RFP") to the two remaining technology providers, one of which was Aclara. The analysis of the proposals was performed by the same cross-functional Idaho Power team, again with the assistance of a strategic sourcing consultant. The proposals were evaluated against our functional requirements, financial requirements, and our physical electrical system requirements. The team concluded that the Aclara TWACS power line carrier system was the best match to our requirements and provided the best value to Idaho Power and its customers. Aclara's proposed solution demonstrated superior system performance at scale, the functional capability to retrieve hourly data at scale, and the proven ability to deliver successful system performance economically in low customer density applications.”

1. What was the detailed procedure and timetable for FortisBC to seek AMI solutions?

**Response:**

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Keith Miles<br>Information Request (IR) No. 2  | Page 2                                |

The two primary components of the AMI system were the MDMS software solution and the AMI hardware infrastructure. The procurement of these solutions was similar in that FortisBC used a competitive RFP process for each.

The RFPs established the system products and services that FortisBC wished to acquire. The RFPs were openly distributed. The vendors were asked to respond to all questions within the RFP, confirm compliancy with the functionality requested and fill out a detailed Pricing Functionality spreadsheet.

Once all proposals were received for each of the RFPs, the AMI project team and AMI Steering Team evaluated each proposal using a scoring method which included various criteria which FortisBC considered relevant. The scoring method allowed a fair and unbiased way of determining the top three vendors for the MDMS software solution and the AMI hardware infrastructure. There were considerations for total capital cost, operating cost and system functionality.

The top 3 vendors for each RFP were informed of FortisBC's wish for them to carry out a demonstration of their solution at an on-site meeting. After the demonstrations, FortisBC completed a re-scoring using any new information that was received in the demonstrations. A final score was calculated for the vendors and the successful vendor for each RFP was then selected to continue on into contract negotiations.

Timetable of Significant Dates:

#### **MDMS**

| Task  | Date                                   |
|---|--|
| MDMS RFP issued                               | October 1, 2010                        |
| Received Vendor Responses                     | November 15, 2010                      |
| MDMS Consensus Scoring with AMI Steering Team | January 4, 2011 to January 6, 2011     |
| MDMS top three vendor demos                   | February 15, 2011 to February 17, 2011 |
| Decision on MDMS software solution            | March 3, 2011                          |





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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Keith Miles<br>Information Request (IR) No. 2  | Page 3                                |

1 **AMI**

| Task  | Date                           |
|---|--------------------------------|
| AMI RFP issued  | December 17, 2010              |
| Received Vendor Responses   | February 4, 2011               |
| AMI Consensus Scoring with AMI Steering Team                                | April 4, 2011 to April 7, 2011 |
| AMI top three vendor demos  | May 4, 2011 to May 6, 2011     |
| Decision on AMI hardware infrastructure                                     | May 31, 2011                   |
| Contract Negotiations for a combined Itron MDMS/AMI Infrastructure Solution | June – November 2011           |

2  
3

4 2. What in the FortisBC RFI process, if there was such a process, would have  
5 excluded PLC solutions when such a solution was known to the Fortis Inc. entity?  
6

7 **Response:**

8 The procurement process is described in the Application, Exhibit B-1, Section 4.2.1.

9 The procurement process did not specify or exclude any particular meter-to-collector  
10 communications technology. Please refer to the response to BCUC IR No. 1 Q38.2.  
11  
12

13 3. Why then, would FortisBC exclude an RFP seeking a comparative PLC solution  
14 when it was missing from the responses and yet already proven adequate to  
15 serve a million customers in the peripheral states of Alberta and Idaho?  
16

17 **Response:**

18 Please refer to the response to Miles IR No. 2 Q2.  
19  
20

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Keith Miles<br>Information Request (IR) No. 2  | Page 4                                |

1           4.     Was the RFP then developed to specifically exclude PLC solutions, which  
2                     appears to have been the end result? Was a determination made by FortisBC  
3                     internally to go only in the RF direction?

4

5     **Response:**

6     Please refer to the response to Miles IR No. 2 Q2.

7

8

9           5.     There is no legislative or regulatory requirements for an RF proposal or hourly  
10                    readings, according to the BC Clean energy act.

11                   Why is it necessary, then, to pursue such a high end approach when more  
12                    conventional approaches appear to serve well in other jurisdictions?

13

14     **Response:**

15     FortisBC did not pursue a “high-end” or an “unconventional” approach. Very few PLC systems  
16     have been selected in North America since 2008, and few are expected to be selected in the  
17     future, as indicated in the response to Shadrack IR No. 2 Q12.

18

19

20           6.     I have not time at this point to research and query the Application section 8.5 with  
21                    its onerous and invasive ‘no option’ approach to alternatives to the RF proposal  
22                    and would appreciate the opportunity to do this. Suffice it to say, with the  
23                    customer base being forced into a single RF solution as proposed with a single  
24                    service provider of our basic electrical needs, why is FortisBC permitted to take  
25                    such an aggressive stance?

26

27     **Response:**

28     The FortisBC application for a Certificate of Public Convenience and Necessity for approval of  
29     an AMI project does not represent an “aggressive stance”. The application is reasonable,  
30     prudent and subject to a (vigorous) public, independently-arbitrated review and approval  
31     process.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Keith Miles<br>Information Request (IR) No. 2  | Page 5                                |

1

2

3           7.     I have not time at this point to research and query the response to Mr. Tatangelo  
4                 IRI1, page 2, where the \$50 Million investment is only going to provide a 1% rate  
5                 reduction over 20 years. Why is it worth it to forecast that and subject the  
6                 customers to a controversial and unnecessary method o data collection?

7

8     **Response:**

9     Please refer to the Application, Exhibit B-1, Section 3 and the response to BCUC IR No. 1 Q2.1.

10

11

12           8.     Finally on health, what gives FortisBC the absolute ability in Responses to  
13                 Intervener Information Request No. 1, Miles IRI1, p3, line 22, to determine for all  
14                 there is no risk when, on viewing the recent comments by Mr. Atamenenko  
15                 regarding the RDKB Nelson-Creston Suspension Requests, there is risk?

16

17     **Response:**

18     FortisBC relies upon the competent authorities with jurisdiction over health issues in Canada to  
19     set limits that protect public safety. These authorities include the B.C. Chief Medical Officer and  
20     Health Canada. The proposed AMI project complies with all known worldwide RF exposure  
21     limits and with the applicable legal framework established in Canada.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 1                                |

## Security and Electrical Data Consumption Collection

1. With reference to evidence found at Hop Hacking Hedy (<http://www.cutawaysecurity.com/blog/archives/844>), why does FortisBC claim that Frequency Hopping Spread Spectrum (FHSS) is secure when it is only a data transmission protocol with no encryption in place?

### **Response:**

FortisBC contends that FHSS is a technique used for interference avoidance but it does inherently provide some security because receivers need to have knowledge of the hopping sequence to successfully demodulate long streams of data.

However, the proposed AMI meters do not rely on this attribute of FHSS as a security mechanism. Instead, meter to Head End System (end-to-end) encryption is used in combination with authentication/authorization controls on the collectors to provide a secure system.

2. FortisBC claims that they can legally use the 900-928 MHz ISM band, which is, in some instances, known to interfere with others using the same transmission protocols within that band. Why cannot others similarly use a transmission system within the same band that will interfere and block FortisBC smart meters?

### **Response:**

FortisBC can legally use the unlicensed 900-928 MHz band, as can the millions of other meters and devices using the same band throughout North America. The equipment to be used in the proposed AMI project is designed to operate in the presence of interference generated by other devices operating in the band under the rules set out in Industry Canada's RSS-210.

There is no provision in RSS-210 allowing purposeful interference in the 902-928 MHz band.

3. Attached is a real time and minute-by-minute screen print readout and log of what can be collected from any meter, electro-mechanical analog, digital or smart meter, over a number of days. This information was sent to me by a constituent

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 2                                |

in Electoral Area D, of the Regional District Central Kootenay, in early September 2012. The device, a Blueline innovations unit, was attached and can be installed in a wireless or wired form:

<http://www.bluelineinnovations.com/Products/>

It is an inexpensive device that will attach in minutes and give the type of readout and monitoring capability, as per the attached readout, and can monitor this constituent's power consumption at their Area D home, over the internet, from anywhere in the world the customer can use their personal computer.

- i. Will FortisBC please confirm that any customer can monitor the data produced by any meter using this device and that therefore there is no need for a customer to purchase an IHD from FortisBC?
- ii. Can FortisBC please explain, in layman's terms that could be understood by any customer, why they would go to the expense of installing wireless smart meters when other technology would allow them to use the existing meters and attach a wired or wireless monitoring option at a fraction of the cost?
- iii. Will FortisBC please confirm that over time a customer could determine, from reading their smart meter log, which appliances and equipment were using what amount of electricity, gas or water, and consequently so could anyone else using the same kind of device?
- iv. Will FortisBC please now confirm that it is totally unnecessary for a customer to have a smart meter installed at their residence, industrial site or commercial enterprise since a Blueline innovation unit or any other such device will supply the consumption data that FortisBC claims they need over the Internet from a customer's computer, and that therefore opting out from FortisBC's smart meter program will in no way prevent FortisBC from receiving the consumption data they need at an appropriate information portal set up by FortisBC at their data processing centre?
- v. Will FortisBC please explain, in layman's terms that could be understood by any customer, what services an Itron Open Way smart meter will perform for FortisBC that a Blueline innovation unit or any other similar kind of device could not?



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 3                                |

1

2 **Response:**

3 A Blueline in-home display is a viable alternative to a ZigBee-based in-home display, but is not  
4 a substitute for an advanced meter for the reasons articulated here.

5 A Blueline device can provide only the benefits related to In-Home Displays (which are currently  
6 not quantified in the AMI financial analysis), and will not provide any other financial or non-  
7 financial benefits outlined in the business case, including:

- 8 • Meter reading savings;
- 9 • Theft reduction savings;
- 10 • Remote disconnect/reconnect savings;
- 11 • Measurement Canada compliance savings;
- 12 • Contact centre savings; and
- 13 • Ability to display gas and water consumption information.

14 FortisBC would not be able to use consumption data from these devices for two main reasons:

- 15 • The expense related to requiring a secure, reliable link to the device at each premise;  
16 and
- 17 • The fact that these devices cannot record register data from the meters, making the data  
18 unusable for billing purposes.

19 Please also refer to the response to BCSEA IR2 Q87.3.

20

21

22

23 **Wired Electrical Data Consumption Collection Vs Wireless**

24 4. On page 13 of the RFP, at a box entitled "Service area map - substations -  
25 repeaters - fiber optic. pdf", FortisBC acknowledges that it has maps that show  
26 fiber optic links shown by red lines, and planned fiber optic links are shown by  
27 blue.

28 Please indicate both the red and blue lines on a map of the service area

29



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 4                                |

1    **Response:**

2    Please see the response to CSTS IR2 Q15.1 for maps detailing existing FortisBC fibre optic  
3    routes.

4    FortisBC expects to seek BCUC approval for an additional fibre optic link between its Okanagan  
5    and West Kootenay fibre optic systems in the near future. This route would connect Grand  
6    Forks to Warfield.

7  
8

9           5.    Please then create a map that adds in to the map in 4, existing commercial and  
10           industrial customers for which FortisBC is using PLC electrical consumption data  
11           collection.

12

13   **Response:**

14   FortisBC is not currently using PLC technology to collect electrical consumption data collection  
15   for any customers.

16  
17

18           6.    Have any of the existing and proposed fibre optic links and existing PLC been  
19           included in implementation of the AMI wireless application currently before the  
20           BCUC?

21

22   **Response:**

23   As discussed in section 4.1.3 of the Application, FortisBC does plan on using existing or  
24   planned fibre optic infrastructure for backhaul of AMI meter data.

25  
26

27           7.    If no please explain, in layman's terms that can be understood by the average  
28           residential customer, why these existing options have not been considered  
29           and/or are being discarded.

30



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 5                                |

1 **Response:**

2 Please refer to the response to WKCC IR2 Q6.

3  
4

5 8. Specifically please outline, in layman's terms, what such a proposal would fail to  
6 do that a RF mesh/AMI wireless one could do.

7

8 **Response:**

9 As stated in the response to BCUC IR No. 1 Q38.1:

10 *Although FortisBC cannot say with certainty that the [AMI system] requirements did not*  
11 *eliminate non-RF communication technologies from being proposed, the Company is*  
12 *confident that the requirements in the RFP were reasonable, prudent and did not*  
13 *needlessly restrict vendor proposals. For example, FortisBC required that proposals*  
14 *should support hourly consumption reads to ensure that time-based rates could be*  
15 *supported. Although older PLC technologies might be challenged to meet this*  
16 *requirement, FortisBC understands that wired technologies exist that are perfectly*  
17 *capable of meeting the requirement.*

18  
19

20 9. At CEC IR#1 40.4 (page 55, lines 8 to 10) FortisBC states that a presence of  
21 between 18 to 28 meters is necessary to form an RFmesh/AMI wireless network  
22 that can connect to a satellite backhaul collector and be economical and efficient.

23 Can FortisBC please confirm that the lower number of meters per square  
24 kilometre required for RF mesh/AMI wireless to work economically and effectively  
25 is 18, and if not what is the correct number required?

26

27 **Response:**

28 As discussed in the referenced response, an 18 meter cluster is the smallest size for which data  
29 collection may be more economical with satellite backhaul than manual meter reading. The  
30 numbers of square kilometers that 18 meters may cover depends on the RF propagation  
31 environment in which the meters are located. FortisBC provided a maximum coverage radius  
32 for meters and collectors of approximately 1 km in the response to WKCC IR1 Q1.





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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 6                                |

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2

3           10.     Can FortisBC please provide a map of its service area where the concentration  
4                   of meters is sufficient to make deployment of RF mesh/AMI wireless economical  
5                   and efficient, and can FortisBC please state what percentage of the service area  
6                   is covered?

7

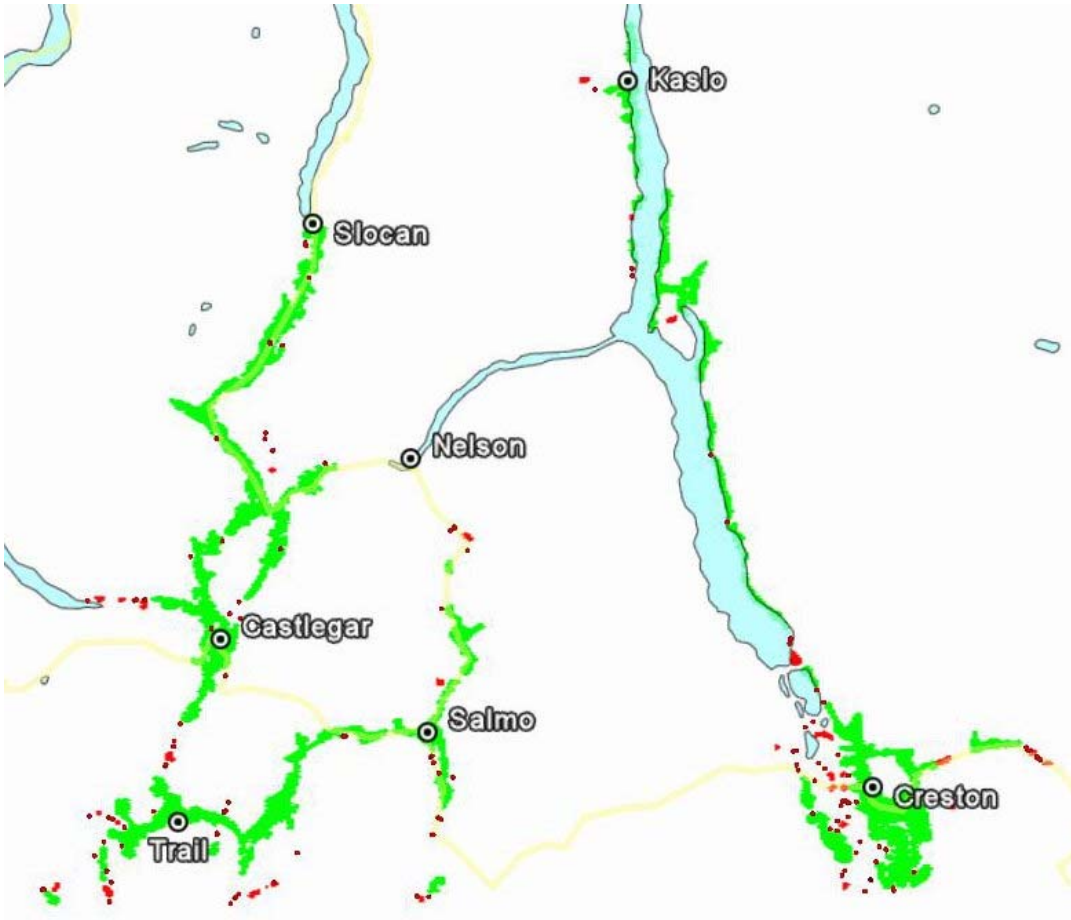
8     **Response:**

9     Please refer to CEC IR1 Q40.4 for a discussion on the number of customers required to be in  
10    proximity to each other to make the proposed FortisBC AMI RF mesh solution economically  
11    viable. The following maps illustrate the FortisBC electric service area and have depicted areas  
12    where the solution is economically viable in green (more than 99% of customer meters) and  
13    where an alternative solution may be needed in red (less than 1% of customer meters).  
14    However, previous experience suggests that many of the meters appearing as red will form into  
15    the RF mesh when deployed in the field.

16

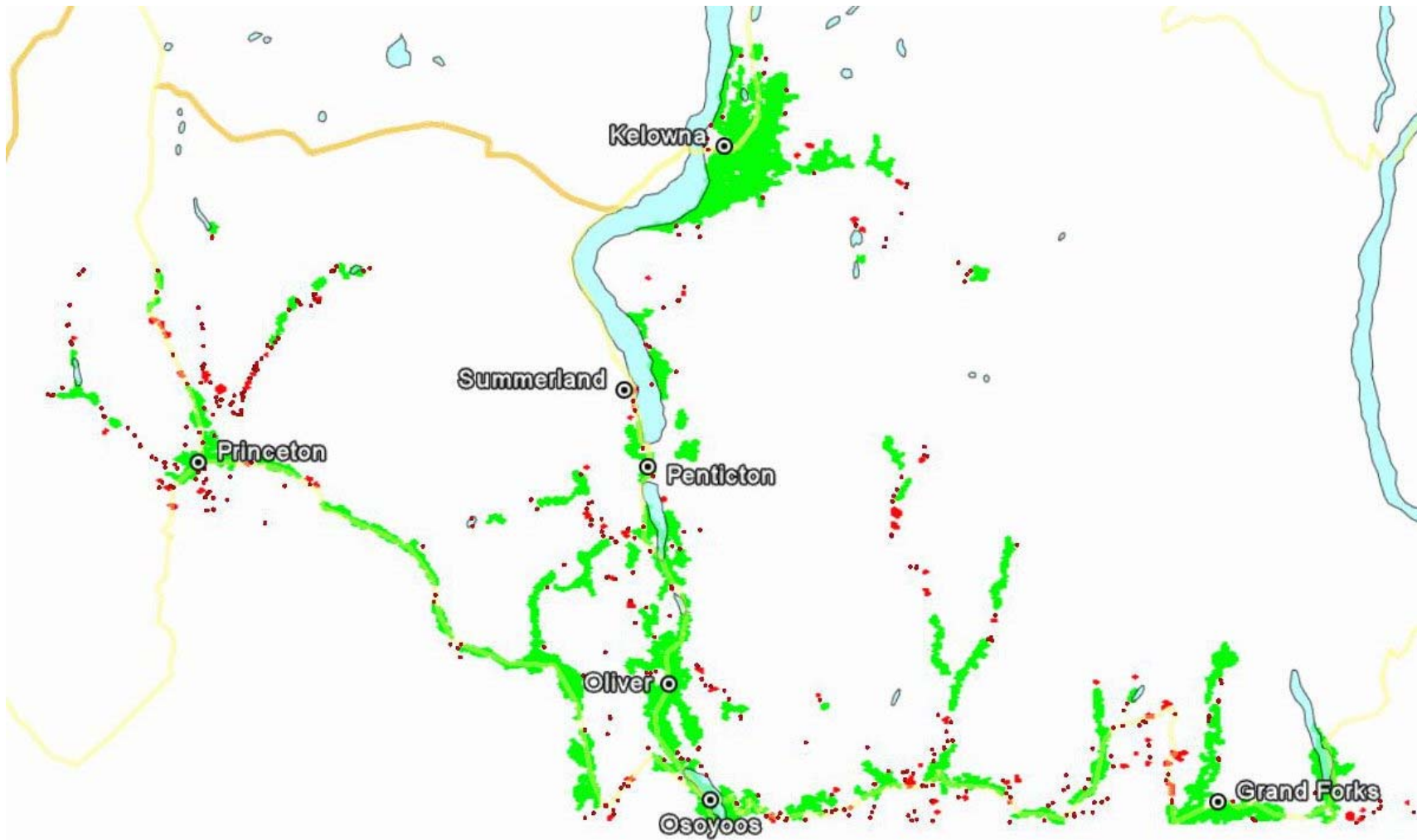
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 7                                |

**Figure Shadrack IR2 Q10a - Viability of FortisBC Proposed AMI RF Mesh Solution - Kootenay Region**



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 8                                |

1 **Figure Shadrack IR2 Q10b - Viability of FortisBC Proposed AMI RF Mesh Solution - Okanagan/Similkameen/Boundary**  
2 **Regions**



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 9                                |

11. At BCUC IR#1 (page 277, lines 30 to 33) FortisBC states:

PLC technology is best suited for utilities with low meter density per square kilometer...Lower meter density negatively impacts the economics of an RF mesh solution relative to a PLC solution since RF mesh technologies rely on meter to meter communication

And at CEC IR#1 40.2 (page 54, lines 8 and 9 and 14 and 15) FortisBC further states:

"No, FortisBC does not expect that the expected economies of scale referred to in CEC IR#1 40.1 will make the RF mesh system significantly more economical for very sparsely populated areas...more likely that alternative technologies such as direct connect cellular or PLC will prove economical in 'hard to reach' areas".

Can FortisBC please provide a map of its service area where deployment of PLC AMI and/or a wired option (including fibre optic) is economical, and can FortisBC please state what percentage of the service area is covered?

**Response:**

As stated in CSTS IR2 Q29.1 PLC is the only wired solution that can be considered as a viable alternative to the proposed AMI RF mesh solution. Fibre optic technology in particular is not a viable option due to the high cost of either installing or leasing the infrastructure.

No PLC solutions were proposed in response to the AMI RFP, so FortisBC presumes that PLC vendors believed their solutions were not economic or could not meet the requirements. FortisBC has provided possible reasons as to why costs for PLC meters may be higher than the proposed wireless AMI system in the responses to BCUC IR1 Q113.1.2, CEC IR1 Q44.2 and BCUC IR2 Q35.3.

12. Can FortisBC please provide a list of utilities in North America, and in Europe, the Middle East and Asia, where PLC AMI and/or wired smart meters have been deployed and in which year deployment occurred?

**Response:**

The structure of the LV (low voltage) distribution grid in North America, in particular the small number of overall meters per transformer segment when compared to Europe, makes RF-based solutions preferable and more cost-effective compared to PLC solutions. In addition, the higher



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 10                               |

speeds available with emerging RF mesh networks (exceeding 100-300 Kbps link speeds) are seen as better matching the needs associated with the much higher percentage of advanced meters used in North America.

Another key point to consider is that while PLC was a highly-adopted technology in the electric cooperative market, the vast majority of it would be considered 1-way AMR functionality. Two-way AMI technology in the PLC market is newer and was introduced after many cooperatives had already installed their 1-way AMR systems. This makes the task of discerning which technology an electric cooperative has in place (one or two way) even more difficult. As well, most of these systems were installed so long ago that they aren't listed on utility/cooperative/vendor websites anymore as they are old news.

Given that the information that has been requested would be considered by vendors as proprietary, at least in the form of an exhaustive client list, this information is not readily available without individually visiting utility and cooperative websites and trying to discern if they are using PLC AMI. What has been provided below is a list of primarily electric cooperatives, that based on news releases have implemented a two-way AMI PLC solution. The lack of recent press releases (i.e. last couple of years) also indicates that AMI PLC going forward is not expected to be a technology that is adopted by utilities/cooperatives in North America

#### Europe

1. Spain
  - a. Iberdrola
2. Sweden
  - a. Vattenfall (2004-2006)
3. France
  - a. ERDF, Electricite Reseau Distribution France (2010)

#### North America

The news release below shows that the Landis+Gyr PLC system was chosen by 10 customers in 2008. Eight existing customers upgraded from the TS1 one-way system and two customers selected the TS2 system for the first time.

1. United States
  - a. Ohio, Indiana, Kentucky
    - i. Duke Energy (Broadband over Power Line – BPL) *still underway*
  - b. Arizona
    - i. Sulphur Springs Valley Electric - Landis+Gyr's TS2 (2008)
  - c. Colorado
    - i. Sangre De Cristo Electric - Landis+Gyr's TS2 (2008)
    - ii. Intermountain REA - Landis+Gyr's TS2 (unknown)
  - d. Idaho

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 11                               |

- 1 i. Idaho Power DCSI – Aclara TWACS (2004)
- 2 e. Mississippi
- 3 i. Holly Springs Municipal - Landis+Gyr's TS2 (2008)
- 4 ii. Monroe County Electric Power Association - Landis+Gyr's TS2 (2008)
- 5 iii. Yazoo Valley Electric – Cellnet (RF) +Hunt TS2 For AMI System
- 6 Deployment (unknown)
- 7 f. Nevada
- 8 i. Wells REC - Landis+Gyr's TS2 (2008)
- 9 g. Pennsylvania
- 10 i. Claverack REC - Landis+Gyr's TS2 (2008)
- 11 h. Tennessee
- 12 i. Sequachee Valley Electric Co-op - Landis+Gyr's TS2 (2008)
- 13 i. Wisconsin
- 14 i. Barron Electric Co-op - Landis+Gyr's TS2 (2008)
- 15 j. Wyoming
- 16 i. Niobrara Electric Association - Landis+Gyr's TS2 (2008)
- 17 2. Canada
- 18 a. FortisAlberta (selection made in 2006 - BCSEA IR1 Q74.3)

19  
20

- 21 13. Can FortisBC please provide a list of the companies that supplied the PLC AMI
- 22 and/or wired smart meters and the necessary adjunct equipment in these
- 23 deployments?

24

25 **Response:**

26 Please refer to the response to WKCC IR2 Q12.

27  
28

- 29 14. Can FortisBC please identify to which of these companies it sent its RFP?

30

31 **Response:**

32 Of the companies listed in Shadrack IR Q13, the AMI RFP was sent to the following companies  
33 (not all of which are listed in the response to WKCC IR2 Q12). FortisBC believes the list of  
34 vendors was comprehensive and was in any case open to any other proposals.

- 35 1. Aclara
- 36 2. Cooper Power Systems



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 12                               |

- 1        3. Echelon Corp.
- 2        4. Itron Inc.
- 3        5. Landis + Gyr

4  
5

- 6            15.    Has FortisBC considered deploying PLC AMI and/or wired smart meters as part
- 7                    of the implementation of this application, should it be successful, and when was
- 8                    FortisBC planning to tell FortisBC customers of this decision - before or after
- 9                    these proceedings have concluded?

10

11    **Response:**

12    FortisBC has made its intent clear with respect to AMI generally and specifically with respect to

13    possible use of PLC and other technologies in the AMI project in the Application and in

14    responses to Information Requests such as BCUC IR1 Q32.2.4 and Q106.1.

15  
16

- 17            16.    Does FortisBC believe that its customers have a right to know which kind of
- 18                    smart meter it is considering deploying on their property and why, and if not why
- 19                    not?

20

21    **Response:**

22    FortisBC has always determined the type of meter to be installed on a customer's property (for

23    example, electromechanical, digital, remote dial-up or drive-by). FortisBC is clear and

24    transparent in its communication with customers (including with respect to this Application), and

25    will answer any technical questions a customer may have regarding their meter.

26  
27

- 28            17.    Can FortisBC please provide the exact wording of any and all federal and/or
- 29                    provincial statutes and/or regulations that specifically grants FortisBC permission
- 30                    to place any of its equipment, including meters, on property not owned, leased or
- 31                    rented by FortisBC?

32



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 13                               |

1 **Response:**

2 The placement of equipment, including meters, on customer property is a condition of service as  
3 provided in FortisBC's Electric Tariff No. 2, pursuant to section 60 of the UCA. Specifically:

4 Section 5.1

5 *The Company shall provide all meters necessary for measuring the Customer's use of*  
6 *the electric Service provided by the Company. The meters shall remain the property of*  
7 *the Company and shall be maintained in accurate operating condition in accordance with*  
8 *the regulations of Measurement Canada.*

9 *The Customer may furnish, install and maintain at its expense a meter system to verify*  
10 *the accuracy of the Company's meter system. The Customer's meter system and the*  
11 *manner of its installation shall be approved by the Company.*

12 Section 5.2

13 *The Customer shall provide a service entrance and meter socket location in accordance*  
14 *with Company requirements, and where required a metering equipment enclosure.*

15 *The meter socket shall be located on an outside wall and be within 1 m. of the corner*  
16 *nearest the point of supply except, in the case of metering over 300 volts, the meter*  
17 *socket shall be installed on the load side of the Service box, and shall be accessible to*  
18 *Company personnel*

19 Section 9.1

20 *By applying for electric Service, the Customer agrees to grant to the Company such*  
21 *rights-of-way, easements and any applicable permits on, over and under the property of*  
22 *the Customer as may be necessary for the construction, installation, maintenance or*  
23 *removal of facilities.*

24 *On request, the Customer at their own expense shall deliver to the Company documents*  
25 *satisfactory to the Company in registrable form granting the rights-of-way, easements*  
26 *and executed permits. The Customer shall at their own expense be responsible for*  
27 *obtaining rights-of-way, easements and any applicable permits on other properties*  
28 *necessary for the Company to provide Service to the Customer.*

29 *Notwithstanding payment by the Customer towards the cost of electrical facilities*  
30 *installed by the Company or that electrical facilities may be affixed to the Customer's*  
31 *property, all electrical facilities installed by the Company up to the Point of Delivery shall*  
32 *remain the property of the Company, and the Company shall have the right to safe and*





|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Andy Shadrack<br>Information Request (IR) No. 2  | Page 14                               |

- 1 *ready access to upgrade, renew, replace or remove any facilities on the Customer's*
- 2 *property at any time.*

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 1                                |

1 **1.0 Reference: Exhibit B-11, CEC 1.1 and Exhibit B-1-1, Application Errata Updated,**  
2 **Page 69**

12 FortisBC confirms that the outcomes noted above will be achieved by the proposed AMI Project.  
13 Further, it should be noted that these outcomes are inextricably linked to the significant financial  
14 and non-financial benefits (outcomes) that result from the proposed Project. It is these benefits,  
15 as identified in the Application, which drive the need for the implementation of AMI at this time.

11 The summary table below displays the total savings to FortisBC customers between 2015  
12 and 2030 and calculates the net present value of these savings in 2012 dollars.

13 **Table 5.0 - AMI Cost and Benefit Summary**

| Benefits                    | 2012 NPV (\$000s) |
|-----------------------------|-------------------|
| Meter Reading               | (23,785)          |
| Theft Reduction             | (38,386)          |
| Remote Disconnect/Reconnect | (5,466)           |
| Meter Exchanges             | (1,478)           |
| Contact Centre              | (441)             |
| <b>Costs</b>                |                   |
| Operating Costs             | 14,320            |
| Depreciation Costs          | 16,464            |
| Carrying Costs              | 17,163            |
| Income Tax                  | 3,982             |
| <b>Total</b>                | <b>(17,629)</b>   |

4 **QUANTIFIED BENEFITS INCLUDED IN THE APPLICATION**  
5

| <i>Functionality (A)</i>   | <i>Means (B)</i>   | <i>Benefit(C)</i>                            | <i>Financial NPV (D)</i>          | <i>Reference (E)</i>              | <i>Duration (F)Note 1.</i> |
|--|--|--|-----------------------------------|-----------------------------------|----------------------------|
| Transition from analogue to digital meters   | Installation of 115,000 new digital meters throughout FortisBC territory   | 1. Cost avoidance related to meter exchanges | 1. \$1.478 million                | 1. B-1-1 Appl Errata Updated p.69 | 1.*                        |
| Energy balancing and loss management; Increased granularity and synchronicity of customer electricity consumption ; multiple attribute sensing | Feeder, transformer and portable meters; Customer meters with near real-time information recording; additional sensors | 1. Theft loss detection and deterrence       | 1. Theft benefit \$38.386 million | 1. B-1-1 Appl Errata Updated p.69 | 1. **                      |

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 2                                |

|  |              |   |                     |                                   |       |
|--|--------------|---|---------------------|-----------------------------------|-------|
| Two way communication between the customer and utility | Radio signal | 1.Reduced manual meter reading expenses | 1.\$23.785 million  | 1.B-1-1 Appl. Errata Updated p.69 | 1.*** |
|  |              | 2.Reduced Contact Centre costs          | 2.\$441 million     | 2.B-1-1 Appl Errata Updated p.69  | 2.*** |
|  |              | 3.Remote disconnect/reconnect           | 3.\$5.466 million   | 3.B-1-1 Appl Errata Updated p. 69 | 3.*** |
| <b>TOTAL</b>   |              |   | \$69,556,000        |                                   |       |
| <b>COSTS</b>   |              |   | \$51,929,000        |                                   |       |
| <b>NET Quantified Ben.</b>                             |              |   | <b>\$17,629,000</b> | B-1-1 Appl Errata updated p.69    |       |
| <b>Add'l Benefits Note 2.</b>                          |              |   |                     |                                   |       |
| Meas. Canada   |              |   | \$9,800,000         | B-1 Appl p.94                     | 1.*   |
| Cust.Inf.Portal  |              |   | \$3,800,000         | B-11 CEC IR1 1.61.1               | 2.*** |
| In-Home Display  |              |   | \$9,800,000         | B-11 CEC IR1 1.61.1               | 3.*** |

Note 1:\*One time reduction; \*\* Reduction over project life \*\*\* Enduring benefit

Note 2:Additional benefits are those that have been Quantified by FortisBC but not incorporated into the NPV customer benefit calculation.

1.1. The above table categorizes the FortisBC AMI project Financial benefits into three classifications (by functionality) as follows: Functionality (Column A); the Means by which the functionality is achieved (Column B); the types of Benefit that will be derived(Column C); the financial value of each benefit (Column D); source reference (Column E) and the duration for which the benefits can be expected accrue.(Column F). Duration is characterized as being a one-time saving; saving over the project life or an enduring benefit which can be expected to last beyond 20 years providing sustaining capital replacements are made as necessary. Please complete and/or adjust the table to include all the quantified Financial Benefits, the Total Benefits and Total Costs in the event anything is missing or misrepresented.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 3                                |

## **Response:**

Please see amended table below:

**Table CEC IR2 Q1.1 – Quantified Benefits**

| <i>Functionality (A)</i>  | <i>Means (B)</i>   | <i>Benefit(C)</i>  | <i>Financial -NPV (D)</i>        | <i>Reference (E)</i>                   | <i>Duration (F)Note 1.</i> |
|---|--|--|----------------------------------|--|----------------------------|
| Transition from existing analogue and digital meters to AMI meters          | Installation of 115,000 new AMI meters throughout FortisBC territory | 1.Cost avoidance related to meter exchanges                          | 1. \$1.478 million               | 1. B-1-1 Appl Errata Updated p.69      | 1.**                       |
| Energy balancing and loss management;;                                      | Feeder, transformer and portable meters;                             | 1. Theft loss detection and deterrence                               | 1.Theft benefit \$38.386 million | 1.B-1-1 Appl Errata Updated p.69       | 1.***                      |
| Increased granularity and synchronicity of customer electricity consumption | Customer meters with near real-time information recording;           |  |                                  |  |                            |
| multiple attribute sensing  | additional sensors   |  |                                  |  |                            |
| Two way communication between the customer and utility                      | Radio signal   | 1.Reduced manual meter reading expenses                              | 1.\$23.785 million               | 1.B-1-1 Appl. Errata Updated p.69      | 1.***                      |
|   |  | 2.Reduced Contact Centre costs                                       | 2.\$,441 million                 | 2.B-1-1 Appl Errata Updated p.69       | 2.***                      |
|   |  | 3.Remote disconnect/reconnect  | 3.\$5.466 million                | 3.B-1-1 Appl Errata Updated p. 69      | 3.***                      |
| Meas. Canada  | Installation of 115,000 new AMI meters throughout FortisBC territory | Avoided Capital Cost (included as a reduction to "cost" noted below) | \$9.800 million                  | B-1 Appl p.94                          | 1.**                       |
| TOTAL   |  |  | \$69.556 million                 |  |                            |
| COSTS   |  |  | \$51.929 million                 |  |                            |
| NET Quantified Ben.   |  |  | <b>\$17.629 million</b>          | B-1-1 Appl Errata updated p.69         |                            |
| Add'l Benefits Note 2.  |  |  |                                  |  |                            |
| Cust.Inf.Portal   | internet-based secure log-in CIP                                     | energy savings   | \$3.8 million                    | B-11 CEC IR1 1.61.1                    | 2.***                      |
| In-Home Display   | Customer owned IHD   | energy savings   | \$7.4 million                    | B-11 CEC IR1 1.61.1 and BCUC IR2 Q72.2 | 3.***                      |

### Notes:

Yellow highlights indicate a change from the table provided in the questions

- Meter exchange benefits are considered a "life of the project" (2013 – 2032) benefit
- Theft detection benefits are considered "enduring benefits"
- The avoided cost benefits that AMI affords Measurement Canada compliance are considered "Quantified" benefits
- Measurement Canada compliance benefits are considered a "life of the project" (2013 – 2032) benefit

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 4                                |

## 2.0 Reference: Exhibit B-6, BCUC 1.14.1 and Exhibit B-11, CEC 1.61.1

6 Non-financial customer service benefits are detailed in Exhibit B-1, Tab 3.0, Section 3.2.5:  
7 Conservation Rate Structures, Enhanced Billing Information, Improved Billing Accuracy,  
8 Consolidated Billing for Multiple Customer Locations, Flexible Billing Date and Reduced Need to  
9 Access Customer Premises.

10 Non-financial operational benefits are detailed in Exhibit B-1, Tab 3.0, Section 3.2.5: Enhanced  
11 System Modeling, Improved Financial Reporting, Load Forecast and Cost of Service Analyses,  
12 Improved Safety, Reduced GHG Emissions, Immediate Notification of Power Outage and  
13 Restoration and Improved Power Quality Monitoring.

10 Information Portal (CIP), the NPV of the net benefit to customers improves by approximately  
11 \$3.8 million to \$21.4 million; and  
14 In-Home Display (IHD), the NPV of the net benefit to customers improves by approximately  
15 \$9.8 million to \$27.4 million.

### NON-QUANTIFIED BENEFITS

| <i>Functionality</i>  | <i>Means</i>  | <i>Benefit</i>  | <i>Notes</i>  | <i>Reference</i>   | <i>Duration<br/>Note 1</i>                         |
|---|---|---|---|--|--|
| Transition from analogue to digital meters  | Installation of 115,000 new digital meters throughout FortisBC territory  | 1.Improved accuracy of metered consumption<br>2. Measurement Canada avoided cost of capital   | 1.Fairness for all rate payers<br><br>2.\$9.8 million   | 1.B-1 Appl p.2<br><br>2. B-1 Appl p.94   | 1.***<br><br>2.*                                   |
| Energy balancing and loss management; Increased granularity and synchronicity of customer electricity consumption information; multiple attribute sensing | Feeder, transformer and portable meters<br><br>Customer meters with near real-time information recording<br><br>Software infrastructure; additional sensors | 1.Improved system planning<br>2.Improved financial reporting/fcsting<br><br>3.Enhanced billing options such as flexible dates and consolidated bills<br><br>4.Customer portal benefits and IHD information for customers<br><br>5.Improved power quality monitoring<br><br><br>6.Improved outage management | 1.May have \$ value<br>2.Public interest<br><br>3.Customer service<br><br><br>4. Estimated savings of \$3.8 mil for Customer Info portal<br>5.May have \$ value<br><br><br>6.Customer service | 1.B-1 Appl p.35<br>2.B-1 Appl p.36<br><br>3.B-1 Appl. p32<br><br>4.B-11 CEC IR 1 61.1<br><br>5.B-1 Appl p.39<br><br>6.B-1 Appl.p38 | 1.***<br>2.***<br>3.***<br>4.***<br>5.***<br>6.*** |

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 5                                |

|   |              |   |   |  |   |
|---|--------------|---|---|--|---|
|   |              | /restoration<br>7.Theft and grow<br>op deterrence   | 7.Health and<br>public safety   | 7.B-1 Appl<br>p 83   | 7.**  |
| Two way<br>communication<br>between the customer<br>and utility | Radio signal | 1. Reduction of<br>170 tonnes of GHG<br>per year<br>2.Facilitation of<br>Conservation rate<br>structures with<br>IHD<br>3.Reduced need to<br>access customer<br>premises<br>4.Improved safety | 1.Environment<br>and public<br>health<br>2. Est.\$9.8 mil<br>NPV<br>3.Customer<br>service<br>4.Safety and<br>public health<br>derived from<br>vehicle use | 1.B-11 CEC<br>IR 1 25.1<br><br>2.B-11 CEC<br>IR 61.1 &<br>Appl p.31<br><br>3.B-1,Appl<br>pg.34<br><br>4.B-1 Appl<br>p.36 | 1.**<br><br>2.***<br><br>3.***<br><br>4.*** |

Note 1: \*One time reduction \*\* Reduction over project life \*\*\* Enduring benefit

2.1. The above table categorizes the FortisBC AMI project Non- Quantified benefits into three classifications (by functionality) as follows: Functionality (Column A); Means by which the functionality is achieved (Column B); the types of benefit (Column C); Notes with characterization as to where the benefit may be attributed and any predicted financial value of each benefit (Column D); source reference (Column E) and the duration for which the benefits can be expected accrue (Column F). Duration is characterized as being a one-time saving; saving over the project life or an enduring benefit which can be expected to last beyond 20 years providing sustaining capital replacements are made as necessary. In the event information is missing or misrepresented, please complete and/or adjust the table to include any and all Non-Quantified benefits that FortisBC expects to achieve with the AMI project.

**Response:**

Please see amended table below:

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 6                                |

1

**Table CEC IR2 Q1.1 – Non Quantified Benefits**

| Functionality   | Means  | Benefit   | Notes   | Reference                      | Duration<br>Note 1 |
|---|--|---|---|--------------------------------|--------------------|
| Transition from existing analogue and digital meters to AMI meters  | Installation of 115,000 new AMI meters throughout FortisBC territory | 1.Improved accuracy of metered consumption, improved billing accuracy                   | 1.Fairness for all rate payers  | 1.B-1 Appl p.2 and p.33        | 1.***              |
| Energy balancing and loss management; Increased granularity and synchronicity of customer electricity consumption information; multiple attribute sensing | Feeder, transformer and portable meters                              | 1.Improved system planning  | 1.May have \$ value   | 1.B-1 Appl p.35                | 1.***              |
|   | Customer meters with near real-time information recording            | 2.Improved financial reporting/fcsting  | 2.Public interest   | 2.B-1 Appl p.36                | 2.***              |
|   | Software infrastructure;   | 3.Enhanced billing options such as flexible dates and consolidated bills                | 3.Customer service  | 3.B-1 Appl. p.33 and p.34      | 3.***              |
|   | additional sensors   | 4.Customer portal benefits and IHD information for customers                            | 4. Estimated savings of \$3.8 million NPV for CIP and \$9.8 million NPV for IHD | 4.B-11 CEC IR 1 61.1           | 4.***              |
|   |  | 5.Improved power quality monitoring   | 5.May have \$ value   | 5.B-1 Appl p.39                | 5.***              |
|   |  | 6.Improved outage management /restoration   | 6.Customer service  | 6.B-1 Appl p.38                | 6.***              |
|   |  | 7.Theft and grow op deterrence  | 7.Health and public safety  | 7.B-1 Appl p 83                | 7.***              |
| Two way communication between the customer and utility  | Radio signal   | 1. Reduction of 171 tonnes of GHG per year during project life, and enduring thereafter | 1.Environment and public health   | 1.B-11 CEC IR 1 25.1           | 1.***              |
|   |  | 2.Facilitation of Conservation rate structures with IHD                                 | 2. Est.\$9.8 million NPV  | 2.B-11 CEC IR 61.1 & Appl p.31 | 2.***              |
|   |  | 3.Reduced need to access customer premises  | 3.Customer service  | 3.B-1,Appl pg.34               | 3.***              |
|   |  | 4.Improved safety   | 4.Safety and public health derived from vehicle use                             | 4.B-1 Appl p.36                | 4.***              |

2

3 Notes:

4 Yellow highlights indicate a change from the table provided in the question.

5 - Measurement Canada compliance has been removed from the list of “non-quantified benefits”

6 - All of these benefits are considered “enduring benefits”

7

8

9

10 2.2. Please confirm that those non-quantified benefits for which a dollar value may or  
11 may not be assigned may be considered in the customer or public interest and  
12 thereby a worthwhile objective for FortisBC to pursue.

13



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 7                                |

# **Response:**

Confirmed.

2.2.1. Please also confirm that many of the non-quantified benefits for which a dollar value may or may not be assigned are not insignificant and contribute considerable value to the AMI project.

# **Response:**

Confirmed. In many cases the non-quantified benefits are expected to provide significant financial value to customers, but are hard to quantify. One such benefit is “improved power quality monitoring”, which may turn up a variety of issues (voltage sags at certain times of the day, for example) that can be fixed inexpensively by the Company or its customers, and translate into financial savings.

## **3.0 Reference: Exhibit B-1, Application, Page 97**

**Table 6.0 – Future Benefit Implementation**

| Future Benefit                      | Trigger Type | Trigger  |
|-------------------------------------|--------------|--|
| Distribution Loss Reduction         | Event        | After AMI Project is implemented and distribution losses are accurately established. |
| Power Grid Voltage Optimization     | Event        | Higher power purchase costs or lower implementation costs make the project economic  |
| Outage Management                   | Date         | Possible regulatory application in 2015  |
| Customer Pre-Pay Tariff             | Date         | Possible regulatory application in 2015  |
| Future Conservation Rate Structures | Date         | Possible regulatory application in 2016  |

## **FUTURE BENEFITS**

| <i>Functionality</i> | <i>Means</i> | <i>Benefit</i> | <i>Possible Benefit</i> | <i>Reference</i> | <i>Duration</i> |
|----------------------|--------------|----------------|-------------------------|------------------|-----------------|
|----------------------|--------------|----------------|-------------------------|------------------|-----------------|



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 8                                |

|  |   |   |   |  |  |
|--|---|---|---|--|--|
| Transition from analogue to digital meters   | Installation of 115,000 new digital meters  |   |   |  |  |
| Energy balancing and loss management via Increased granularity and synchronicity of customer electricity consumption information; multiple attribute sensing | Customer, Feeder, and transformer meters; Meters with near real-time inforecording<br>Tap changers, voltage regulators,<br>Software infrastructure; addit'l sensors | 1. Distribution loss reduction<br>2. Conservation Voltage Regulation<br>3. Outage management<br>4. Distribution automation<br>5. Real time transmission line rating<br>6. Work system mgt               | 1. \$3.3 mill/year @1% reduction<br>2. May have \$ value<br>3. May have \$ value; customer service<br>4. May have \$ value<br>5. May have \$ value<br>6. May have \$ value  | 1. B-1 Appl. P.97<br>2. B-1 Appl p.98<br>3. B-1 Appl p.101<br>4. B-6 BCUC 1.12.3<br>5. B-6 BCUC 1.12.3<br>6. B-6 BCUC 1.12.3                       | 1.***<br>2.***<br>3.***<br>4.***<br>5.***<br>6.*** |
| Two way communication between the customer and utility   | Radio signal  | 1. Future conservation rate structures<br>2. customer pre-pay<br>3. Improved outage management<br>4. Distribuion generation<br>5. Electric vehicle integration<br>6. HAN (Zigbee)<br>7. Demand Response | 1. May have \$ value<br>2. May have \$ value<br>3. May have \$ value; customer service<br>4. May have \$ value; customer service; env't;<br>5. env't; cust. Service; may have \$ value<br>6. cust. service Env't<br>7. \$ value; customer service | 1. B-1 Applic p.103<br>2. B-1 Applic p.103<br>3. B-1 Applic p.101<br>4. B-6 BCUC 1.12.3<br>5. B-6 BCUC 1.12.3<br>6. B-11 CEC 1.51.1<br>7. B-11 CEC | 1.***<br>2.***<br>3.***<br>4.***<br>5.***          |



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 9                                |

|  |  |  |  |        |                    |
|--|--|--|--|--------|--------------------|
|  |  |  |  | 1.23.5 | 6.***<br><br>7.*** |
|--|--|--|--|--------|--------------------|

Note: \*One time reduction; \*\* Reduction over project life \*\*\* Enduring benefit

3.1. The above table categorizes the FortisBC AMI project Future benefits into three classifications by functionality as follows: Functionality of the existing AMI as a foundation for benefits which may be pursued in the future(Column A); Means by which the functional foundation is achieved (Column B); description of the possible future benefit (Column C); a characterization of the possible benefits and any predicted financial value of each benefit (Column D); source reference (Column E) and the duration for which the benefits can be expected accrue if undertaken (Column F). Duration is characterized as being a one-time saving; saving over the project life or an enduring benefit which can be expected to last beyond 20 years providing sustaining capital replacements are made as necessary. Please complete and/or adjust the table to include all Future Benefits and any available quantification in the event anything is missing or misrepresented.

**Response:**

Please see amended table below:

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 10                               |

**Table CEC IR2 Q3.1 – Future Benefits**

| <i>Functionality</i>  | <i>Means</i>   | <i>Benefit</i>                        | <i>Possible Benefit</i>                        | <i>Reference</i>   | <i>Duration</i> |
|---|--|---------------------------------------|--|--------------------|-----------------|
| Transition from existing analogue and digital meters to AMI meters  | Installation of 115,000 new digital meters   | foundational for all benefits         |  |                    |                 |
| Energy balancing and loss management via Increased granularity and synchronicity of customer electricity consumption information; | Customer, Feeder, and transformer meters; Meters with near real-time electricity consumption recording | 1. Distribution loss reduction        | 1. May have \$ value                           | 1.B-1 Appl. P.97   | 1.***           |
| multiple attribute sensing  | Tap changers, voltage regulators,  | 2.Conservation Voltage Regulation     | 2.May have \$ value                            | 2.B-1 Appl p.98    | 2.***           |
|   | Software infrastructure; addit'l sensors   | 3.Distribution automation             | 3.May have \$ value                            | 3.B-6 BCUC 1.12.3  | 3.***           |
|   |  | 4.Real time transmission line rating  | 4.May have \$ value                            | 4. B-6 BCUC 1.12.3 | 4.***           |
| Two way communication between the customer and utility  | Radio signal   | 1.Future conservation rate structures | 1.May have \$ value                            | 1.B-1 Applic p.103 | 1.***           |
|   |  | 2.customer pre-pay                    | 2.May have \$ value                            | 2.B-1 Applic p.103 | 2.***           |
|   |  | 3.Improved outage management          | 3.May have \$ value; customer service          | 3.B-1 Applic p.101 | 3.***           |
|   |  | 4.Distribution generation             | 4. May have \$ value; customer service; env't; | 4. B-6 BCUC 1.12.3 | 4.***           |
|   |  | 5.Electric vehicle integration        | 5.env't; cust. Service; may have \$ value      | 5. B-6 BCUC 1.12.3 | 5.***           |
|   |  | 6.HAN (Zigbee)                        | 6.cust. service                                | 6.B-11 CEC 1.51.1  | 6.***           |
|   |  | 7.Demand Response                     | 7.\$ value; customer service                   | 7.B-11 CEC 1.23.5  | 7.***           |

**Notes:**

Yellow highlights indicate a change from the table provided in the question

- Clarified "Meters with near real-time electricity consumption. . .", as opposed to "info recording" in Means column
- Have removed "Work mgmt system" from Benefit column
- Have removed notional \$ benefit from Distribution loss reduction as it is premature until after AMI provides data (Possible Benefit column).

3.2. Please confirm that those non-quantified Future benefits for which a dollar value may or may not be assigned may be considered in the customer or public interest and thereby a worthwhile objective for FortisBC to pursue including the AMI project's role as foundation for the Smart Grid and the Smart Home.



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 11                               |

1 **Response:**

2 Confirmed.

3

4

5 3.2.1. Please also confirm that many of the non-quantified benefits for which a dollar  
6 value may or may not be assigned are not insignificant and contribute considerable  
7 value to the AMI project.

8

9 **Response:**

10 FortisBC agrees that non-quantified benefits may not be insignificant.

11

12

13

14 **4. Reference: Exhibit B-11, CEC 1.1**

12 FortisBC confirms that the outcomes noted above will be achieved by the proposed AMI Project.  
13 Further, it should be noted that these outcomes are inextricably linked to the significant financial  
14 and non-financial benefits (outcomes) that result from the proposed Project. It is these benefits,  
15 as identified in the Application, which drive the need for the implementation of AMI at this time.

15

16 4.1. Would FortisBC agree that the physical implementation will be conducted in  
17 accordance with accepted corporate guidelines and will also result in a visual  
18 examination of every meter base during the exchange?

19

20 **Response:**

21 Yes, FortisBC agrees that the physical implementation of the proposed AMI meters will be  
22 conducted in accordance with accepted corporate guidelines and will also result in a visual  
23 examination of every meter base during the exchange.

24 Please refer to BCUC IR No. 1 Q47.1 for a description of the meter exchange process.

25

26



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 12                               |

4.2. Would FortisBC agree that by employing wireless technology for communication FortisBC is utilizing a cost-effective and widely accepted technology that has been in use globally for decades?

**Response:**

FortisBC agrees with this statement.

4.2.1. Would FortisBC agree that similar wireless technology is ubiquitous in North America for a vast array of applications in a vast array of industries including those in which the security of information transmitted is paramount? If not, please explain in what way the wireless technology employed is novel or unique.

**Response:**

FortisBC agrees with the statement.

4.2.2. Would FortisBC agree that the use of wireless technology is continuing to grow and can be expected to continue to grow world-wide?

**Response:**

FortisBC agrees with the statement.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 13                               |

5. **Reference: Government of Canada website: <http://www.climatechange.gc.ca/dialogue/default.asp?lang=En&n=E47AAD1C-1> and Exhibit B-11 BCSEA 1.3.1 Appendix 'The Canadian Smart Grid Standards Roadmap', Foreword, Exhibit B-11, BCPSO 1.4.1 and Exhibit B-11, CEC 1.10.1**

"The Clean Energy Dialogue (CED) was established between Canada and the United States in February 2009 to enhance joint collaboration on the development of clean energy science and technologies to reduce greenhouse gases and combat climate change.

This Dialogue is an important initiative in support of our ongoing efforts towards building a low-carbon economy."

This project supports a number of key government objectives, including expanding Canada-United States collaboration under the Clean Energy Dialogue. By identifying a path forward on

- Existing provincial energy policy and legislation articulating the government's desire to have advanced meters and a smart grid in place for customers of other public utilities other than BC Hydro;
- The transition by the electric industry towards the use of advanced meters as the standard form of metering technology;

The CPCN Application assumes a stable regulatory and legislative environment. The Company believes the additional considerations related to the decision to proceed with the Application at this time as articulated in the responses to BCUC IR No. 1 Q2.1 and BCPSO IR No. 1 Q4.1 clearly underscore the fact that the proposed Project ought to be considered as being in the public interest.

5.1. Would FortisBC agree that the Smart Grid is a key element of an international technological trend in advancing clean energy and conserving energy?

**Response:**

In general, FortisBC agrees that the Smart Grid is a key element of an international technological trend in advancing clean energy and conserving energy.

For clarity however, FortisBC does not consider that all potential Smart Grid technologies are applicable to or cost-effective for customers in its service area. FortisBC intends to propose Smart Grid projects only where an analysis demonstrates a customer benefit.

5.2. Does FortisBC believe that the Smart Electric Grid may be considered part of the collaborative efforts articulated in the Clean Energy Dialogue? If so, would

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 14                               |

1 FortisBC agree that the development of the Smart Electric Grid is in the national  
2 as well as the provincial interest?

3

4 **Response:**

5 FortisBC agrees that the development of the Smart Electric Grid could be considered part of the  
6 collaborative efforts articulated in the Clean Energy Dialogue, specifically the emphasis placed  
7 on collaboration and sharing best practices to improve energy efficiency.

8 In general, FortisBC agrees that development of the Smart Electric Grid is in the national as well  
9 as the provincial interest. Please also refer to the response to CEC IR No. 2 Q5.1.

10

11

12 5.3. Please confirm that in FortisBC's view the AMI project and the Smart Electric  
13 Grid is in the public interest regardless of a change in the regulatory and  
14 legislative environment because in addition to supporting environmental  
15 objectives the AMI project is cost effective for FortisBC customers?

16

17 **Response:**

18 Yes – FortisBC considers the AMI Project as being in the public interest, regardless of a change  
19 in the regulatory and legislative environment because in addition to supporting environmental  
20 objectives the AMI project is cost effective for FortisBC customers.

21 Future Smart Grid projects will be evaluated and proposed if it can be demonstrated that they  
22 are in the best interests of customers.

23

24

25 6. **Reference: Exhibit B-11, BCSEA 1.3.2 and Exhibit B-11, BCSEA 1.3.1, Appendix**  
26 **- The Canadian Smart Grid Standards Roadmap: A Strategic**  
27 **Planning Document, (The Canadian Smart Grid Standards Roadmap)**  
28 **Foreword**

22 In general, FortisBC agrees that the referenced document is helpful in establishing a common  
23 reference point for utilities and manufacturers.

29

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 15                               |

The transition to a smarter electric grid holds significant promise for the achievement of a number of important public policy objectives. Smart grid technologies will enhance the reliability, resiliency and efficiency of the electric network, as well as improve environmental performance by enabling consumers to play a more active role in their energy use decisions and helping to integrate renewable resources such as wind.

inform consumers of the amount of energy they consume, and at what cost. It will spur infrastructure development and investment in related technologies such as plug-in electric vehicles. Importantly, an effective standards regime enhances Canada's competitiveness by

Continental alignment in this regard is critical, given the interconnectedness of our trading relationship and electrical infrastructure.

6.1. Does FortisBC agree with the above three excerpts from the 'The Canadian Smart Grid Standards Roadmap'?

**Response:**

In general, FortisBC agrees with the above three excerpts from the 'The Canadian Smart Grid Standards Roadmap'.

6.2. Does FortisBC believe that the AMI project will provide the foundation and beginning or continuing steps of the Smart Electric Grid in its territory?

**Response:**

Yes – FortisBC considers the AMI Project to be a key foundational component which will support the development of a Smart Electric Grid in its service territory.

6.3. Does FortisBC believe that an Electric Smart Grid has already or will become standard throughout North America within the next 10 years?

**Response:**

FortisBC agrees that many North American utilities are already implementing Smart Grid technologies (such as AMI) in order to improve the safety, reliability, efficiency and cost-effectiveness of the power system. On that basis, FortisBC expects the Smart Grid to become a *de facto* standard at most North American utilities within the next 10 years.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 16                               |

6.4. Does FortisBC believe that the AMI project contributes to the 'continental alignment' of standards for the electrical infrastructure? If so, please elaborate and include commentary on whether or not the AMI project using wireless Itron OpenWay smart meters can be expected to capitalize on the technological development trends by serving as a typical platform and interfacing appropriately with Smart Grid developments throughout the continent.

**Response:**

FortisBC considers the AMI Project to be consistent with the 'continental alignment' of standards for electrical infrastructure. The proposed AMI system is based on open industry standards (such as IPv6, ANSI C12.22 and ZigBee) which are world-wide standards. The communications system is extensible and will support the integration of equipment from other vendors. Further, the fact that FortisBC has selected the same AMI vendor as BC Hydro will help ensure consistent electric metering systems and functionality throughout the province of BC.

**7. Reference: Exhibit B-11, CEC 1.16.1, CEC 1.16.2, CEC 1.16.3 and CEC 1.61.1**

- The forecast adoption rate, and therefore the demand calculated from it, was derived primarily from residential studies. However, it is not unreasonable to assume (for IHDs and the customer information portal) that adoption rates for commercial customers would be in similar proportion to the residential rates.
- Commercial users can use the information to help manage their consumption in the same manner that residential customers can: by changing their consumption behaviour (turning lights off when not in use, for example) or by investing in energy efficiency equipment (more efficient lighting).
- Commercial customers that are subject to a demand charge can use hourly (or more frequent from an in-home display) information to find out when their power use is highest to try and reduce their peak use and thereby manage their bill.
- Yes, through requests made to the Commercial PowerSense representatives. It is useful information that helps customers mitigate demand spikes (and thereby helps them manage their bills).
- As discussed in the response to BCSEA IR No. 1 Q44.2, if the proposed AMI Project financial analysis took into account the potential savings resulting from customer use of the In-Home Display (IHD), the NPV of the net benefit to customers improves by approximately \$9.8 million to \$27.4 million.

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 17                               |

1           7.1.    Given that some commercial customers have specifically requested more  
2               detailed consumption information, would FortisBC agree that commercial  
3               customers may be more likely than residential customers to adopt IHDs and  
4               employ conservation measures to manage their electricity bills?

5  
6    **Response:**

7    Please refer to the response to CEC IR No. 2 Q40.3. FortisBC has no information other than  
8    the quoted statement above on which to base a higher IHD adoption rate for commercial  
9    customers, but the assertion is not unreasonable.

10  
11

12           7.2.    Please calculate the NPV of the potential value of the In-Home Display  
13               incorporating commercial customer participation or, if already included, please  
14               confirm \$9.8 million as the potential savings from all customer groups  
15               participating.

16

17    **Response:**

18    The estimated NPV of IHD deployment to commercial customers, assuming the same adoption  
19    and savings rates as for residential customers, is \$3.8 million.

20  
21  
22

23    **8.       Reference: Exhibit B-11, CEC 1.23.8, CEC 1.24.1 and CEC 1.24.2**

24           13    Demand Response control refers to the ability for the utility to dynamically push information on  
14               power purchase pricing or system capacity constraints to customers in order to modify their  
15               consumption patterns. A simple example would be the ability to send critical-peak pricing  
16               information to a customer's thermostat (via the AMI meter and wireless HAN) to automatically  
17               increase the temperature setpoint during the summer peak hours when high power purchase  
18               costs were being experienced.

25           4    Confirmed. Some individual customers may be able to reduce their total annual billings if they  
5               are able to alter their consumption patterns to take advantage of the conservation rate  
6               structures. Customers in general may benefit if the aggregate customer response results in  
7               cost savings to the utility.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 18                               |

Table ES-1: Per Participant Savings for Possible AMI Future Programs

| Program Type       |           | Peak  | Energy | Source                            |
|--------------------|-----------|-------|--------|-----------------------------------|
| Conservation Rates | TOU       | 11%   | 5.5%   | BC Hydro CRI <sup>1</sup>         |
|                    | CPP/CPR   | 10%   | 0      |                                   |
|                    | Inclining | 1.8%  | 1.8%   | BC Hydro CRI <sup>2</sup>         |
| Pre-Pay            |           | 5.8%* | 11.7%  | Woodstock Hydro 2004 <sup>3</sup> |
| Load Control       |           | 13.3% | 0      | FERC 2009                         |
| In-Home Displays   |           | 2.7%  | 5.4%   | ACEEE 2010                        |

\* Assumed that the peak period savings are half of the annual savings

8.1. Would FortisBC agree that Demand Response control would enable customers to reduce their consumption with less effort than would be required to actively manage consumption such as by adjusting thermostats or turning off lights?

**Response:**

FortisBC agrees that some customers would find demand response control beneficial and lower effort than making the same adjustments manually. Any demand response programs would be offered on an optional tariff rate subject to Commission approval.

8.2. Would FortisBC agree that an individual commercial building owner with multiple tenants could aggregate significant savings with Demand Response control and conservation rates that might otherwise go unaddressed by individual tenants because of the smaller impact on their electricity bill?

**Response:**

Yes, insofar as the building owner has control over major building systems (common area lighting and heating/cooling/ventilation).

8.2.1. Has FortisBC identified any industries where Demand Response Control and conservation rates would be of particular benefit to commercial users? If so, please state the industries and explain why it may be of particular benefit.

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 19                               |

1

2 **Response:**

3 FortisBC has not done such an analysis. However, demand response programs can generally  
4 be of value to commercial customers that have large loads that can be interrupted or reduced  
5 on relatively short notice. Commercial users that can adjust their operations to shift load into  
6 less expensive off-peak hours may find time-based rates beneficial.

7

8

9 **8.3. Reference: Exhibit B-11, CEC 1.51.4 and CEC 1.89.1.1 and CEC 1.89.1.1.2**

10 25 Confirmed, assuming that "Smart Home" applications require a HAN (Home Area Network) that  
26 can provide electricity consumption and pricing information.

3 89.1 Does FortisBC agree that customer adoption of conservation practices will likely  
4 increase with familiarity of conservation rate programs and the technology that  
5 supports them?

6 **Response:**

11 7 Yes.

20 If the question is referring to the participation rate in TOU programs, FortisBC believes the most  
21 effective means to increase customer participation is education and the implementation of DSM  
22 programs designed to help customers take advantage of the pricing periods.

12

13 8.3.1. Would FortisBC agree that the future 'Smart Home' technologies can be  
14 expected minimize the effort associated with reducing electricity  
15 consumption?

16

17 **Response:**

18 Yes, FortisBC agrees that 'smart home' technologies can be expected to help all types of  
19 customers reduce energy consumption with less effort.

20 For example, although programmable thermostats have been available for some time, a  
21 significant majority of them are never programmed. From Wikipedia  
22 [http://en.wikipedia.org/wiki/Programmable\\_thermostat](http://en.wikipedia.org/wiki/Programmable_thermostat):

23 *While programmable thermostats may be able to save energy when used correctly, little*  
24 *or no average energy savings has been demonstrated in residential field studies.*  
25 *Difficulty with usability in residential environments appears to lead to lack of persistence*  
26 *of energy savings in homes. According to the US EPA regarding residential*  
27 *programmable thermostat, "Available studies indicate no savings from programmable*

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 20                               |

*thermostat (PT) installation. Some studies indicate slight increased consumption.<sup>1</sup> This is supported with studies by Nevius and Pigg<sup>2</sup>, Cross and Judd<sup>3</sup> and others and Pepper et al.<sup>4</sup> has a recent review of the topic.*

Smart home and business technologies that automatically adjust energy consuming devices (as defined by the customer) will greatly assist customers by removing barriers to behaviour change.

8.3.2. Would FortisBC agree that pricing incentives contribute to electricity conservation by financially rewarding a customer for their 'effort' in reducing electricity consumption?

**Response:**

Agreed.

8.3.3. Please identify any ways in which the AMI project will contribute to the advancement of conservation practices or technologies in the absence of pricing signals by building a culture of conservation in society.

**Response:**

The AMI project will contribute to building a conservation culture by enabling the customer information portal (CIP) and in-home displays (IHD) which will better inform customers of their electricity usage and patterns. Coupled with the appropriate education outreach (BCSEA IR No. 1 Q43.3, NCGPCA IR No. 1 Q5, Q6), customers will be made aware of how they can reduce or change their consumption and patterns thereof.

<sup>1</sup>[http://www.energystar.gov/ia/partners/prod\\_development/revisions/downloads/thermostats/Proposal\\_011106.pdf](http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/thermostats/Proposal_011106.pdf)

<sup>2</sup><http://www.ecw.org/ecwresults/199-1.pdf>

<sup>3</sup>[http://www.cee1.org/eval/db\\_pdf\\_es/953es.pdf](http://www.cee1.org/eval/db_pdf_es/953es.pdf)

<sup>4</sup>[http://eec.ucdavis.edu/publications/How\\_people\\_use\\_thermostats\\_in\\_homes.pdf](http://eec.ucdavis.edu/publications/How_people_use_thermostats_in_homes.pdf)

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 21                               |

1  
2

3 **9. Reference Exhibit B-11, CSTS 1.37.1**

25 The proposed AMI meters are manufactured to the ANSI C12.20 standard which specifies  
26 increased accuracy over the ANSI 12.1 standard that the existing electro-mechanical meters  
27 were required to meet. The new meters are required to be accurate to within 0.5% compared to  
28 2% for the electro-mechanical fleet.

4  
5  
6

9.1. Do electro-mechanical meters become less accurate over time?

7 **Response:**

8 It is FortisBC's experience that electro-mechanical meters may not pass Measurement Canada  
9 testing protocol percentages over the course of time installed. Therefore, electro-mechanical  
10 meters have been known to become less accurate over time.

11  
12

13 9.1.1. If so, is FortisBC aware of whether or not aging electro-mechanical  
14 meters can be expected to record more or less than actual consumption  
15 over time and as they age?

16

17 **Response:**

18 FortisBC is aware that electro-mechanical meters may result in anomalies in recorded  
19 consumption data as the meter ages.

20  
21

22 9.1.2. If so, could a 1.5% increase in accuracy alone translate into savings for  
23 FortisBC or would better accuracy improve fairness in billing to  
24 customers? Please explain.

25

26 **Response:**

27 Any increase in meter accuracy would not have any impact on FortisBC, but could have an  
28 impact on individual customers. Improved accuracy could cause rates to decrease if measured  
29 consumption from the electromechanical meters was too low on average. However, the



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 22                               |

revenue requirement would not change, and customers would pay the same amount on average.

**10. Reference: Exhibit B-11, CEC 1.2.1 and Exhibit B-11, CEC 1.3.1**

There would have to be a significant change in the composition of the meter population through obsolescence, technological change or the like that would materially change either the useful life of new meters or the average life of the population.

10.1. Please confirm that FortisBC would consider the risk of the above circumstances occurring to be extremely low.

**Response:**

Confirmed.

**11. Reference: Exhibit B-11, CEC 1.31.**

Would Fortis BC consider not revising the depreciation rate and continuing with 5 percent over the 20-year period?

18. Yes.

The advantage of a stable depreciation rate is that it supports stable customer rates.

11.1. Please confirm that FortisBC does not see any disadvantages in having a stable depreciation rate.

**Response:**

Confirmed.

11.1.1. If not confirmed, what are the disadvantages of not revising the depreciation rate?



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 23                               |

1 **Response:**

2 Please refer to the response to CEC IR No. 2 Q11.1.

3

4

5 11.1.2. Does FortisBC consider stable customer rates as an objective?

6

7 **Response:**

8 Yes, all else being equal, stable rates are desirable since they provide customers with more  
9 price certainty.

10

11

12

13 **12. Reference: Exhibit B-11, CEC 1.61.1.**

5 FortisBC believes the assumptions it has provided in the Application as related to the benefits  
6 associated with the implementation of AMI are reasonable. However, changes in the following  
7 assumptions could be reasonably foreseen as potentially likely to occur. In each case below,  
8 the assumption is made while also assuming that all other variables within the proposed AMI  
9 Project remain constant.

14



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 24                               |

- 10 • As discussed in the response to BCUC IR No. 1 Q87.2.1, an increase from the 2 percent  
11 annual growth rate of marijuana production sites to 5 percent and a decrease in the  
12 deterrence rate from 75 percent in 2012 to 60 percent by 2019 for the status quo theft  
13 reduction scenario. Such a change increases the NPV of the net benefit related to theft  
14 reduction from \$38 million to \$47 million;
- 15 • As discussed in the response to BCUC IR No. 1 Q87.2.7, that grow operations diverting  
16 electricity are 50 percent larger on average compared to grow operations not diverting  
17 electricity. Such a change increases the NPV of the net benefit related to theft reduction  
18 from \$38 million to \$50 million;
- 19 • As discussed in Section 5.3.2 of the CPCN Application (page 85), an increase in the annual  
20 growth rate of marijuana production sites from 2 percent to 3 percent in the Status Quo  
21 model from 2013 to 2017, plus an increase from 30 to 36 lights per site in both the Status  
22 Quo and AMI-potential models, and the theft deterrence factor continues to increase above  
23 95 percent beyond 2021 in the potential AMI forecast. Such a change increases the NPV of  
24 the net benefit related to theft reduction from \$38 million to \$52 million;
- 25 • As discussed in the response to BCUC IR No. 1 Q52.2.1, a change in the discount rate from  
26 8% to 6%. Such a change increases the NPV of the net benefit to customers from \$17.6  
27 million to \$23.6 million;
- 28 • As discussed in the response to BCUC IR No. 1 Q58.1.2.2, and CEC IR No. 1 Q66.3.1,  
29 currently FortisBC is forecasting customer growth based upon PEOPLE35 from BC Stats  
30 (PEOPLE = Population Extrapolation for Organizational Planning with Less Error). If,  
31 instead, PEOPLE36 were adopted, the forecast customer growth rate would drop from  
32 approximately 1.8% (starting in 2016) to approximately 1.2% (starting in 2016) with the  
33 impact being a decrease in the NPV of the net benefit to customers from \$17.6 million to  
34 \$15.9 million;
- 1 • As discussed in the response to BCUC IR No. 1 Q96.2, if New Operating Costs were to  
2 grow at 3% instead of the 1.8% assumed in the model, the NPV of the net benefit to  
3 customers decreases from \$17.6 million to \$16.5 million. However, also noted in the same  
4 response was the unlikelihood that New Operating Costs would appreciate at a rate unlike  
5 that used to escalate all other model costs. If it is assumed that 3% replace 1.8% for all  
6 model inflationary escalations, the NPV of the net benefit to customers improves from \$17.6  
7 million to \$20.7 million;
- 8 • As discussed in the response to BCUC IR No. 1 Q16.1, if the proposed AMI Project financial  
9 analysis took into account the potential savings resulting from customer use of the Customer  
10 Information Portal (CIP), the NPV of the net benefit to customers improves by approximately  
11 \$3.8 million to \$21.4 million; and
- 12 • As discussed in the response to BCSEA IR No. 1 Q44.2, if the proposed AMI Project  
13 financial analysis took into account the potential savings resulting from customer use of the  
14 In-Home Display (IHD), the NPV of the net benefit to customers improves by approximately  
15 \$9.8 million to \$27.4 million.

12.1. Please confirm that in FortisBC's view one could calculate a maximum potential Net Present Value of the net benefit to customers of the AMI project by including the following assumptions each of which 'could be reasonably foreseen as potentially likely' to occur:

- a) 5% growth of marijuana production sites
- b) Theft deterrence rate increasing to 95% and above
- c) Grow operations diverting electricity as 50% larger on average than grow operations not diverting electricity

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 25                               |

- 1 d) A change in the discount rate from 8% to 6%
- 2 e) Continued population increase at 1.8%
- 3 f) Replacing the inflationary model of 1.8% with 3% in all instances
- 4 g) Including potential savings from the Customer Information Portal
- 5 h) Including the potential savings resulting from customer use of the IHD
- 6 i) Including the Measurement Canada compliance related savings.
- 7

8 **Response:**

9 FortisBC agrees that each of the above items is reasonably probable on its own. FortisBC  
10 notes that the Measurement Compliance related savings have already been included in the AMI  
11 financial model.

12  
13

14 12.1.1. If not, what additional assumptions or changes in the above assumptions  
15 would FortisBC believe necessary to calculate the maximum reasonable  
16 NPV benefit to customers? Please provide an explanation with each  
17 change or added assumption.

18

19 **Response:**

20 Please see the response to CEC IR No. 2 Q12.1.

21  
22

23 12.1.2. Please calculate the total maximum NPV for the project and for customer  
24 benefits based on all the above assumptions, and please calculate the  
25 total maximum NPV for the project and for customer benefits based on  
26 any changes to the assumptions FortisBC has identified.

27

28 **Response:**

29 FortisBC has aggregated the following assumptions from those listed in the response to CEC IR  
30 No. 1 Q61.1, in aggregate:

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 26                               |

- An increase from the 2 percent annual growth rate of marijuana production sites to 5 percent and a decrease in the deterrence rate from 75 percent in 2012 to 60 percent by 2019 for the status quo theft reduction scenario;
- Grow operations diverting electricity are 50 percent larger on average compared to grow operations not diverting electricity;
- Changed the discount rate from 8 percent to 6 percent;
- The forecast customer growth rate changed from approximately 1.8 percent (starting in 2016) to approximately 1.2 (starting in 2016);
- 3 percent replaces 1.8 percent for all model inflationary escalations; and
- CIP and IHD benefits are included.

The resulting net project benefits and customer benefits are described in the table below:

| <b>AMI Costs and Benefits</b> |                             |                              |
|-------------------------------|-----------------------------|------------------------------|
| <b>Benefits</b>               |                             | <b>2012 NPV<br/>(\$000s)</b> |
|                               | Meter Reading               | (32,391)                     |
|                               | Theft Reduction             | (110,509)                    |
|                               | Customer Information Portal | (3,978)                      |
|                               | In-Home Display             | (8,610)                      |
|                               | Remote Disconnect/Reconnect | (7,038)                      |
|                               | Meter Exchanges             | (1,560)                      |
|                               | Contact Centre              | (589)                        |
|                               |                             |                              |
| <b>Costs</b>                  |                             |                              |
|                               | Operating Costs             | 17,167                       |
|                               | Depreciation Costs          | 18,776                       |
|                               | Carrying Costs              | 19,812                       |
|                               | Income Tax                  | 5,141                        |
|                               |                             |                              |
| <b>Total</b>                  |                             | <b>(103,779)</b>             |

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 27                               |

**13. Reference: Exhibit B-6, BCUC 1.3.1 and Exhibit B-11, CEC 1.9.1**

The contract does not contemplate, 1) FortisBC failure to exit the contract prior to August 1, 2013 without proceeding with the contract after that date or 2) renegotiating any terms of the contract prior to August 1, 2013. The outcome in both of these circumstances is therefore uncertain.

If the project start date was delayed in a predictable manner, personnel decisions could be made with clarity, allowing FortisBC to allocate internal resources appropriately, and limiting delay costs. If the time delay is unknown or uncertain, FortisBC will have to release personnel to other projects with variable assignment terms, potentially hindering a restart of the project and/or increasing costs.

13.1. Please confirm that in the event of regulatory delay resulting in a lack of decision by July 20th, 2013 as requested, FortisBC would be in the position of having to decide from the following options: a) Exit the contract with Itron, and either abandon the AMI Application or attempt to negotiate a new contract with Itron or others, and submit a revised Application based on a new contract and time frames. b) Attempt to revise the contract with Itron prior to August 1, 2013 allowing for and estimating additional regulatory time, c) Defer the decision, and if a BCUC decision is rendered prior to August 1, 2013, make a decision whether or not to proceed under increased time pressures.

**Response:**

Confirmed.

13.2. Does FortisBC agree that all three options place FortisBC in an unfavourable position that could be expected to diminish the value of the AMI project if it were ever to proceed?

**Response:**

FortisBC agrees that the termination or attempted renegotiation of the contract with Itron could diminish the value of the AMI project if the negotiated prices were to increase. The delay would also permanently reduce some of the benefits, such as the Measurement Canada compliance benefits since existing electromechanical and small-batch digital meters failing compliance would have to be replaced with new digital meters rather than AMI meters during the delay.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 28                               |

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13.2.1. Would FortisBC expect to incur additional costs if they were to attempt to renegotiate additional regulatory time for the existing contract with Itron?

**Response:**  
Yes.

13.2.1.1. Please identify and quantify all additional costs FortisBC could reasonably predict would be incurred.

**Response:**  
The cost of renegotiation is difficult to predict and would depend (if FortisBC chose to pursue such an option) to a great extent on Itron and its willingness to extend the dates within the contract without any other changes. The cost could range from a few thousand dollars to more than one million.

13.2.2. Please confirm that clarity and containment of regulatory time frames are and will remain crucial for any suitable contract with Itron or other AMI suppliers.

**Response:**  
Clarity and containment of regulatory time frames are highly desirable with respect to the AMI application, not just for the contract with Itron, but also for overall regulatory cost management.

13.3. Would FortisBC agree that early identification and limitation of any potential regulatory delays is important to minimizing the costs of the project.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 29                               |

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**Response:**

Agreed.

**14. Reference: Exhibit B-11, CEC 12.3 and Exhibit B-11, CEC 1.12.4**

4 Itron produced their last electro-mechanical meter in 2005. It is expected that Elster would have  
5 stopped production around the same time to allow them to compete with the other vendors.  
13 The Company anticipates that under the new Measurement Canada S-S-06 regulations that  
14 FortisBC would be fully converted to digital meters in a 21 year period if the AMI project did not  
15 proceed.

14.1. Would FortisBC agree that while electro-mechanical meters may remain as an  
installed base for a period of years in certain jurisdictions, the North American  
market and production of new meters is going to be exclusively digital?

**Response:**

FortisBC agrees with the statement.

**15. Reference: Exhibit B-11, CEC 1.13.2**

4 Given the significant deterrent effect of the proposed AMI-enabled theft reduction program, the  
5 associated benefits may or may not be impacted if deployment is less than 100 percent.

15.1. Would FortisBC agree that 100% deployment would likely result in the highest  
deterrent effect of the AMI enabled theft reduction program?

**Response:**

FortisBC agrees, although if AMI meters are still deployed where an economic WAN solution  
does not exist or where customers are permitted to “opt-out”, the theft detection benefit will be  
preserved.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 30                               |

1           15.2. Would FortisBC agree that the deterrent effect of the proposed AMI enabled theft  
2           reduction program could be reasonably considered as directly related to potential  
3           thieves' perception of its efficacy?

4

5    **Response:**

6    FortisBC agrees that a significant portion of the theft deterrence benefit is related to its  
7    perceived efficacy. FortisBC notes that perceived efficacy will ultimately result from proven  
8    results.

9

10

11           15.3. Would FortisBC agree that incomplete deployment could reasonably detract from  
12           thieves' perceptions of the AMI enabled theft reduction program as being  
13           efficacious and that perceptions of efficacy would diminish as the deployment  
14           declined? If not, why not?

15

16   **Response:**

17    Incomplete deployment may impact producers' perception of the efficacy of AMI to identify theft.  
18    However, if customers are aware that AMI meters will be installed regardless of whether they  
19    are communicating in real-time via RF, the perception (and reality) of the efficacy of the program  
20    would be preserved.

21

22

23           15.4. Would FortisBC agree that the provision of opt-out could negatively impact  
24           thieves' perception of the efficacy of the theft reduction program?

25

26   **Response:**

27    Please see the response to CEC IR No. 2 Q15.3.

28

29



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 31                               |

1 **16. Reference: Exhibit B-11, CEC 1.32.3**

17 The Itron OpenWay meters operate in temperatures up to 85°C in the base. The temperature  
18 increase in the base versus ambient (outside) temperature is approximately 10°C, leading to a  
19 maximum ambient temperature of approximately 75°C for correct operation. As the ambient  
20 temperature rises above 75°C, or if the temperature within the base rises above 85°C, the meter  
21 will fail.

2

3 16.1. Are there minimum temperatures at which the Itron OpenWay meters can  
4 function effectively? Please identify the minimum ambient temperature at which  
5 the Itron OpenWay meters can operate.

6

7 **Response:**

8 OpenWay CENTRON meters operate effectively from -40°C to +85°C.

9

10

11 **17. Reference: Exhibit B-11, CEC 1.34.2**

12 25 A UPC of 12.7 MWh/yr was used in the payback calculation.

13 17.1. Please confirm that the Average Use per Customer was based on residential use  
14 and explain how the average Use Per Customer of 12.7 MWh/yr was derived.

15

16 **Response:**

17 Confirmed. It is calculated taking the aggregate direct residential energy sales in a calendar  
18 year and dividing by the direct residential customer count.

19

20

21 17.2. Please identify and quantify any changes that would result from using  
22 commercial customers as the basis.

23

24 **Response:**

25 The average UPC for Commercial customers was 57.2 MWh as of YE 2011. Assuming the  
26 same savings rate (5.4%) as a residential customer, i.e. IHD savings of 3 MWh/yr, the average





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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 32                               |

commercial customer will achieve a 0.5 year payback based on the average commercial rate of \$0.095/kWh.

**18. Reference: Exhibit B-11, CEC 1.45.2**

Based upon information currently available to FortisBC, there is not currently a market for the resale and/or refurbishment of digital meters. However, FortisBC would resell the digital meters if it provided more value to customers than scrapping or recycling the digital meters.

18.1. Does FortisBC believe that there is not currently a market for resale/refurbishment of used digital meters because it is being replaced by demand for two-way communicating meters?

**Response:**

FortisBC does not have the data that would confirm the statement, but the North American transition to AMI it is likely to be part of the reason.

According to a report from Berg Insight<sup>5</sup>:

*Smart electricity meters are being introduced all over the developed world. North America and Asia-Pacific are two of the most dynamic market regions that will see massive projects realised over the next five to ten years. Berg Insight forecasts that the installed base of smart electricity meters in North America will grow at a compound annual growth rate of 22.5 percent between 2010 and 2016 to reach 87.4 million units at the end of the period. Asia-Pacific is projected to see the installed base of smart meters soar from a low level to 378.1 million units by 2016. North America has the world's highest penetration of automatic meter reading, exceeding 50 percent.*

The increase in smart metering is expected to be almost entirely with RF-based AMI technology, as shown in this graph from Pike Research:

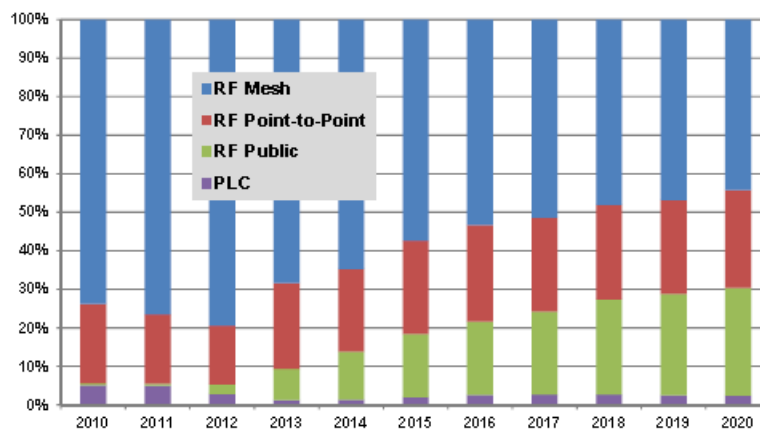
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<sup>5</sup> <http://www.berginsight.com/ReportPDF/ProductSheet/bi-smseries2-ps.pdf>

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 33                               |

The North American deployments are led by private RF technologies, with greater than approximately 90% of the total through the first half of the forecast period. However, RF public is forecast to take significant share from 2013 and beyond, though recall this will be a period of significantly lower overall shipments. This reflects that ongoing efforts by public carriers are expected gain traction. The structure of the LV distribution grid in North America, in particular the small number of overall meters per transformer segment when compared to Europe, makes RF-based solutions preferable and more cost-effective compared to PLC solutions. In addition, the higher speeds available with emerging RF mesh networks (exceeding 100-300 Kbps link speeds) are seen as better matching the needs associated with the much higher percentage of advanced smart meters used in North America. Consumer pushback citing potential health concerns with RF radiation could trigger greater adoption of PLC technologies, but Pike Research does not currently see this as a major trend.

**Chart 6.15 Smart Meter Unit Shipments by NAN Technology, North America: 2010-2020**



(Source: Pike Research)

18.1.1. If so, does FortisBC believe that there will ever be a market for used digital meters in North America?

**Response:**

FortisBC does not have data that would enable it to predict whether there will ever be a market for used digital meters in North America.

18.1.2. Does FortisBC believe that non-two-way communicating digital meters will be obsolete in the North American market within the next twenty-five years?

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 34                               |

**Response:**

It seems likely that the transition to AMI meters will continue in North America, eventually eliminating all other types of metering.

18.1.3. If not, please identify the main reasons underlying FortisBC's understanding of why there is not currently a market for used digital meters.

**Response:**

Please see the response for CEC IR No. 2 Q18.1.2

**19. Reference: Exhibit B-11, CEC 1.71.2 and CEC 1.71.3**

Please refer to the below table.

| Option | Advantage  | Disadvantage  |
|--------|--|---|
| One    | <ul style="list-style-type: none"> <li>Would not require an accounting variance from the BCUC</li> </ul> | <ul style="list-style-type: none"> <li>Has the highest rate impact of the three options</li> </ul>  |
| Two    | <ul style="list-style-type: none"> <li>Has a lower rate impact than Option One</li> </ul>                | <ul style="list-style-type: none"> <li>Would require an accounting variance from the BCUC</li> <li>Would have a higher rate impact than Option Three</li> </ul> |
| Three  | <ul style="list-style-type: none"> <li>Has the lowest rate impact of the three options</li> </ul>        | <ul style="list-style-type: none"> <li>Would require an accounting variance from the BCUC</li> </ul>  |

Both Option 2 and Option 3 would result in lower customer rates as compared to Option 1.

19.1. Please provide a quantitative comparison of the proposed customer rates under Option 1 to Options 2 and 3.



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 35                               |

1 **Response:**

2 Please refer to the table below:

| Option | Net Present Value<br>of Revenue<br>Requirements<br>(\$000s) | Savings over Option<br>One<br>(\$000s) |
|--------|---|--|
| One    | (17,629)  | n/a                                    |
| Two    | (19,114)  | 1,485                                  |
| Three  | (21,954)  | 4,325                                  |

3

4

5 19.2. Does FortisBC believe that an accounting variance would be difficult to receive  
6 from the BCUC?

7

8 **Response:**

9 As long as the Company can demonstrate that an accounting treatment is in the customer's  
10 best interest the Company believes the BCUC would agree to an accounting variance. The  
11 Company has received various accounting variances from the Commission in the past. US  
12 GAAP recognizes that rate regulated entities might request or be ordered to account for costs in  
13 a manner not consistent with US GAAP and allows for the variance in the accounting treatment.

14

15

16 19.2.1. What costs does FortisBC believe would be incurred in seeking an  
17 accounting variance from the BCUC? Please identify and quantify where  
18 possible.

19

20 **Response:**

21 There would be little if any incremental costs in seeking an accounting variance in this context.  
22 The Company expects that the accounting treatment of the existing meters would be a matter  
23 disposed of within the overall AMI project CPCN regulatory proceeding and the Commission  
24 would issue a directive with regard to the accounting treatment in the final decision.



|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 36                               |

**20. Reference: Exhibit B-11, BCRUCA 1.1.2**

1. Cost savings / improved operating efficiency;
  2. Reliability improvements; and
  3. Customer uptake of new technologies.
- In addition to providing many customer and utility benefits, the AMI component of the FortisBC Smart Grid focuses primarily on the first driver which is reducing costs by improving meter reading efficiency and reducing power theft.

20.1. Please specify all the ways in which the AMI project that can be considered as contributing to 'reliability improvements' and identify which elements of the AMI project infrastructure would be employed to improve reliability.

**Response:**

The primary way in which the AMI project will contribute to 'reliability improvements' is by providing real-time indication of outages down to the individual customer level. Experience has shown that most customers do not realize that FortisBC currently has no way of knowing whether the power is on or off at an individual customer premise.

Today, FortisBC only has visibility of the transmission and distribution system down to the individual distribution feeder level. In other words, unless a distribution system fault results in the operation of a circuit breaker at a substation, there is currently no direct way for FortisBC to realize that a distribution outage has occurred. If a failure results in opening of one of over 30,000 fuses or 300 fault interrupters in the distribution system, all customers downstream of that point will be without power – and FortisBC has no immediate indication that this outage has occurred. It is only when customer outage calls are received does the Company become aware that customers are without power.

Following the installation of AMI, outage information at the individual premise level will be made available. By analyzing exactly which meters are without power, FortisBC will be able to quickly determine which protective element has operated and hence dispatch a repair crew to the correct location – even before a customer call is received.

Another significant reliability benefit is the ability to detect "nested outages". During major weather events (snow or wind storms) numerous faults often occur on the same distribution feeder. For example, a tree could contact a distribution feeder line resulting in a complete outage to that feeder. Crews would then be dispatched to locate and repair the tree damage.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 37                               |

However, subsequent to that initial fault additional tree contacts could occur downstream of the initial failure. Since the crew is unaware of this additional damage they would simply repair the initial failure and – believing that all customers are restored – return to the office. At some point, the customers in the small areas that remain without power become frustrated by the extended duration of the outage and then phone FortisBC to inquire about a restoration time estimate. It is only at that time that FortisBC becomes aware that some customers are still out. The crews must then be re-dispatched to repair any downstream faults to restore these remaining customers. The AMI system would essentially eliminate these situations as it would be possible to ping downstream meters to confirm that all expected customers are back on after repairs are completed. This would significantly reduce the duration of some customer outages with a consequent improvement in customer satisfaction.

For clarity, to achieve all the benefits described above in an automated manner would require the future implementation of an Outage Management System at an additional cost. Please refer also to the response to BCUC IR No. 1 Q102.2.

Beyond the benefits described above, additional reliability improvements would be enabled by the installation of the AMI Project. For example, the AMI communications network will provide a secure and reliable method to monitor and control the several hundred distribution field devices such as reclosers and capacitors switches at a low incremental cost. Additionally, the analytic capabilities provided by the AMI system will permit the identification of potentially overloaded pole-mount and pad-mount transformers. This would allow FortisBC to either upgrade the transformer equipment or otherwise resolve the cause of the problem prior to the equipment failing due to overload.

20.1.1. Please provide the costs associated with each element and if possible attribute percentage costs to the reliability aspects of these elements.

**Response:**

The costs associated with the reliability improvements described in the response to CEC IR No. 2 Q20.1 are contained either in the AMI total project cost of \$47.7 million or in the future OMS cost, which is forecast at \$0.83 million. FortisBC is unable to allocate percentages of these costs to the associated reliability benefits; in general, the total project implementations (and hence total project costs) are required to achieve all of the benefits described.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 38                               |

20.2. Does FortisBC believe 'customer uptake of new technologies' is an objective, and if so, why?

**Response:**

FortisBC sees its role as enabling and supporting 'customer uptake of new technologies' as opposed to driving the adoption of new technologies. FortisBC agrees that if customers choose to purchase or use new technology that results in more efficient use of energy, that is a desirable outcome.

20.3. Please identify all the elements of the AMI project that can be expected to contribute to 'customer uptake of new technologies' and identify which elements of the AMI project infrastructure would be employed .

**Response:**

As discussed in the response to CEC IR No. 2 Q20.2, FortisBC considers its role to be a supporter (as opposed to a driver) in enabling 'customer uptake of new technologies'. Salient examples of these technologies would be installation of distributed generation at customer premises and integration of charging systems for electric vehicles. In both cases, the AMI system would be a pre-requisite to support wide-scale integration of either technology if it were demanded by customers.

**21. Reference: Exhibit B-11, CEC 1.59.2 and Exhibit B-11, CEC 1.59.6**

FortisBC agrees, assuming an analysis of all costs and benefits related to a new and superior technology, including the write-off of any remaining net book value of assets being replaced, indicates a positive and significant benefit in Net Present Value terms.

Yes, FortisBC believes that advanced (non-manual) metering reading will be industry standard at the end of 20 years and will continue to be into the future.

21.1. Please confirm that, if approved, the twenty year economic life of the AMI project is the only time the financial benefits of transitioning to non-manual meter reading will be captured by FortisBC.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 39                               |

1 **Response:**

2 Not confirmed. The financial benefits of transitioning to non-manual benefits are expected to be  
3 permanently embedded in revenue requirements after the implementation of AMI.

4  
5

6 21.2. Please confirm that on-going sustaining capital replacements of meters will  
7 preserve the benefits of the AMI project at a minimum and that on-going  
8 sustaining capital replacement does not generally require or result in business  
9 case justification being required.

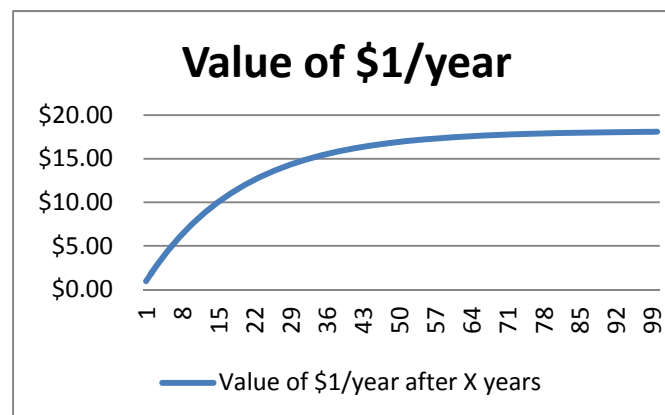
10

11 **Response:**

12 Confirmed.

13  
14

15 21.3. The following graph presents the terminal value of a \$1 annual savings over  
16 approximately 100 years and discounted at a real discount rate of 5.5%. Would  
17 FortisBC agree that the value of savings such as those derived from non-manual  
18 meter reading, which extend beyond the twenty year project life and continue  
19 indefinitely into the future, can be quantified over a longer period than the project  
20 life to reflect the benefit of the change in technology being implemented?



21  
22



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 40                               |

1 **Response:**

2 The Company agrees that the majority of the present value, approximately 66%, would result  
3 from the first 20 years and that the balance of the value accrues indefinitely into the future.

4  
5

6 21.4. Would FortisBC agree that a twenty year time horizon limits the capture of on-  
7 going benefits to about 66% of their terminal value assuming zero growth in the  
8 underlying cost structure?

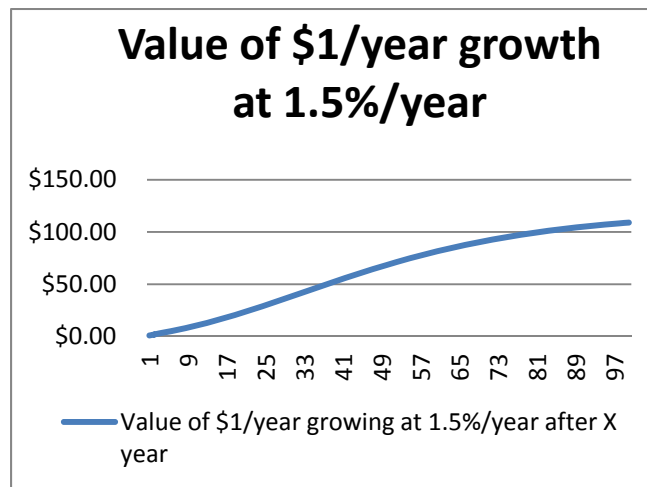
9

10 **Response:**

11 The Company agrees. Please also see the response to CEC IR No. 2 Q21.3.

12  
13

14 21.5. The following Table presents the terminal value of a \$1 annual savings growing  
15 at 1.5% over approximately 100 years and discounted at a real discount rate of  
16 5.5%. Would FortisBC agree that a twenty year time horizon limits the capture of  
17 on-going benefits to about 20% of their terminal value under these assumptions?



18

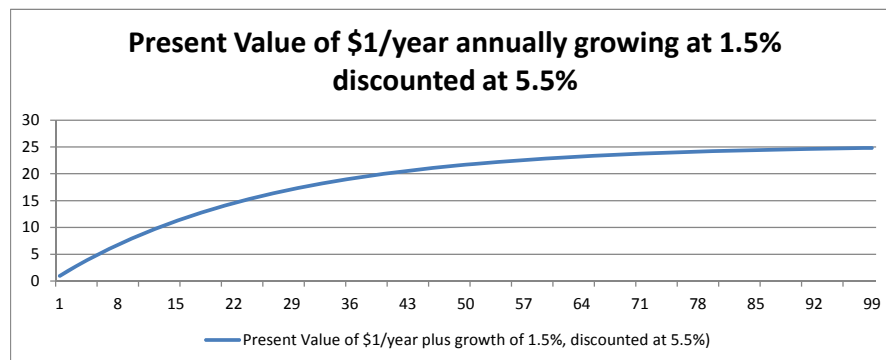
19

20 **Response:**

21 The present value of receiving \$1 annually plus 1.5% growth, discounted at 5.5% should mirror  
22 annually receiving \$1 discounted at 4.0% (5.5%-1.5%) and so the graph should be fairly similar

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 41                               |

1 to the graph provided in CEC IR No. 2 Q21.3, yet, adjusted upward for the lower discount rate  
2 as shown in the table below. In this case, the majority of the present value, approximately 55%,  
3 would result from the first 20 years and that the balance of the value accrues indefinitely into the  
4 future.



5  
6  
7

## 8 22. Reference: Exhibit B-11, CEC 1.66.2

1 additional meter readers are required to maintain a consistent average number of reads per  
2 meter reader per year.

| Time Period | Customer Growth | Additional Reads from Customer Growth | Average Reads per Meter Reader |
|-------------|-----------------|---------------------------------------|--------------------------------|
| 2014 - 2016 | 6887            | 43870                                 | 38572                          |
| 2017 - 2019 | 6653            | 42380                                 | 38766                          |
| 2020 - 2022 | 6494            | 41367                                 | 38902                          |
| 2023 - 2025 | 6437            | 41004                                 | 38997                          |
| 2026 - 2028 | 6325            | 40290                                 | 39064                          |
| 2029 - 2031 | 7986            | 50871                                 | 39244                          |

3

4 The additional reads are attributable to forecast customer growth.

9

10 22.1. Please confirm that the customer growth rate is forecast at an average of  
11 approximately 1.8% for the duration of the project.

12

### 13 Response:

14 Confirmed.

15

16

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 42                               |

1           22.2. Would FortisBC agree that it would be reasonable to assume continued  
2           population growth in the order of 1.8% beyond 2031 and into the future? If not,  
3           please explain why not and please provide a rate FortisBC would believe is  
4           reasonable to assume and cite the source.

5

6    **Response:**

7    FortisBC agrees that it is reasonable to assume continued average population growth in the  
8    order of 1.8 percent beyond 2031.

9

10

11   **23.     Reference: Exhibit B-6, BCUC 1.53.7**

- 12           12     • Inflation at 1.8 percent per year, on all aspects of the project not covered by fixed unit or  
13           13     fixed price contract; and

13

14           23.1. Please confirm that 1.8% is an appropriate predicted rate of inflation for the AMI  
15           project.

16

17   **Response:**

18    Confirmed.

19

20

21           23.2. Would FortisBC agree that it would be reasonable to assume continued inflation  
22           in the order of 1.8% beyond 2031 and into the future? If not, please explain why  
23           not and please provide a rate FortisBC would believe is reasonable to assume  
24           and cite the source.

25

26   **Response:**

27    The Company agrees that it would be reasonable to assume continued inflation in the order of  
28    1.8% beyond 2031 and into the future.

29

30



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 43                               |

**24. Reference: Exhibit B-1, Page 17**

**3.1 Description of Existing System**

FortisBC currently has two types of metering systems:

- For residential, commercial, and some industrial customers:
  - Electro-mechanical meters, (approximately 80,000);
  - Solid-state (or digital) meters (non-AMI) for the remaining meter population in the Company's service territory. This includes several hundred interval Time-of-Use meters, as well as wireless Encoder/Receiver/Transmitter (ERT) meters used for hard-to-access meter locations; and
- MV-90, a cellular modem based system, used to collect reads for approximately 60 industrial customers who require interval metering data (typically collected by hour).

24.1. Please describe the ERT technology from the point of view of the transmitter signals and their similarity and/or differences to the AMI communication technology.

**Response:**

FortisBC ERT meters are similar to the AMR meters installed by Nelson Hydro. Please see the response to CSTS IR No. 2 Q5.2.

24.2. How long has the ERT technology been in place within the FortisBC Inc. system?

**Response:**

The ERT technology has been used by FortisBC for approximately 20 years.

24.3. Please describe the MV-90 collection and communications system relative to the AMI communications technology and their similarity to and/or differences from the AMI technology.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 44                               |

1 **Response:**

2 MV-90 is a software tool, not a meter data transmission technology. FortisBC uses cellular  
3 modems to transmit data from large power meters to its MV-90 systems. Each MV-90-  
4 connected meter is served by its own dedicated cellular modem. The technologies are not  
5 similar aside from the use of Radio Frequency to transmit consumption data back to the utility.

6  
7

8 24.4. How long has the MV-90 collection and communication system been in place  
9 within the FortisBC Inc. system?

10

11 **Response:**

12 FortisBC began using the MV-90 system in 2001.

13  
14

15 24.5. Please describe any relevant BCUC approval processes which may have been  
16 applicable to approving of the ERT and or MV-90 technology applications within  
17 the FortisBC Inc. system

18

19 **Response:**

20 FortisBC did not require, nor seek specific BCUC approval for either the ERT or MV-90 systems  
21 at the time of installation. Both systems have been in use for more than 10 years. BCUC is  
22 aware of the use of ERT meters, and has approved amendments to the Tariff (section 9.2) for  
23 their use.

24  
25

26 **25. Reference: Exhibit B-11, BCSEA 1.42.1**

28 42.2 Please provide a table similar to Table BCUC IR Q16.1 showing electricity and  
29 cost savings attributable to In-Home Displays.

30 **Response:**

31 The savings from IHDs results from reaching the 30% adoption rate explained in the response  
32 to BCSEA IR No. 1 Q15.3 and the 5.4% savings rate (Exhibit B-1, p44).

27

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 45                               |

| Residential IHD Savings (MWh) |                         |                    |
|-------------------------------|-------------------------|--------------------|
| Year                          | IHD<br>Gross<br>Savings | Value @\$85<br>MWh |
| 2014                          | 150                     | \$ 12,700          |
| 2015                          | 500                     | \$ 42,500          |
| 2016                          | 1,100                   | \$ 93,400          |
| 2017                          | 2,100                   | \$ 178,400         |
| 2018                          | 3,700                   | \$ 314,300         |
| 2019                          | 6,600                   | \$ 560,600         |
| 2020                          | 10,200                  | \$ 866,400         |
| 2021                          | 13,800                  | \$ 1,172,200       |
| 2022                          | 17,100                  | \$ 1,452,500       |
| 2023                          | 16,400                  | \$ 1,390,000       |
| 2024                          | 16,400                  | \$ 1,390,000       |
| 2025                          | 16,400                  | \$ 1,390,000       |
| 2026                          | 16,400                  | \$ 1,390,000       |
| 2027                          | 16,400                  | \$ 1,390,000       |
| 2028                          | 16,400                  | \$ 1,390,000       |
| 2029                          | 16,400                  | \$ 1,390,000       |
| 2030                          | 16,400                  | \$ 1,390,000       |
| 2031                          | 16,400                  | \$ 1,390,000       |
| 2032                          | 16,400                  | \$ 1,390,000       |
|                               |                         | \$ 18,593,000      |

25.1. While Fortis has limited the growth of the IHD savings as of 2023, would it be logical to expect that the IHD benefit may have a relationship to growth in the Fortis customer base and therefore may increase over time?

**Response:**

Yes the IHD benefits would be expected to increase with load growth. The modelling tool used a constant residential customer count, when in fact customer count will likely grow over time. The analysis is consistent with the conservative approach to benefit estimation used throughout this Application.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 46                               |

1           25.2. Please confirm that as of 2023 there would be no reason to expect that the IHD  
2           benefits would not continue into the future, because it would be highly likely that  
3           replacement meters would support such functionality or may improve upon the  
4           functionality but would not likely return to having no functionality?

5  
6           **Response:**

7           Confirmed that IHD benefits are expected to continue. The analysis is consistent with the  
8           conservative approach to benefit estimation used throughout this Application.

9  
10

11       **26.     Reference: Exhibit B-11, BCSEA 1.59.2**

28           59.2     If a customer was particularly interested in reducing the RF signal within the  
29           premises, would placing a dense barrier of some type on the inside wall opposite  
30           the meter further reduce the RF signal?

31           **Response:**

32           Considering that an AMI meter mounted on a building or a house already has a metal backplate  
33           that reduces the RF signal that enters the house, it is unlikely that the addition of a dense barrier  
34           of some type would improve that reduction significantly.

12

13           26.1. Please confirm that the metal plate backing on the AMI meters reduces the RF  
14           exposure significantly (up to a factor of 10 reduction) because the signal to which  
15           people in the home would be exposed to must travel much farther to reach the  
16           person than if they were to stand the same distance directly in front of the AMI  
17           meter.

18

19           **Response:**

20           FortisBC confirms that the metal plate backing AMI meters will reduce exposure to RF within the  
21           home by an approximate factor of 10. This reduction occurs because of signal reflection away  
22           from the back of the meter and from absorption by the plate. Furthermore, the wall behind the  
23           metal plate will provide an additional reduction in exposure.

24           As indicated in the March 2011 report titled "A Discussion of Smart Meters and RF Exposure  
25           Issues" published by the Edison Electric Institute, located at:  
26           [http://www.aeic.org/meter\\_service/smartmetersandrf031511.pdf](http://www.aeic.org/meter_service/smartmetersandrf031511.pdf) on page 3 of the Executive  
27           Summary:

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 47                               |

*Due to shielding of the meter enclosure and signal patterns, RF exposure from the rear of a metering location is nominally 10 times less than in front of the meter and dramatically below FCC limits, not including the spatial averaging and building material attenuation reductions.*

**27. Reference: Exhibit B-11, BCSEA, 1.61.5**

61.5 Please discuss how the RF exposure of RF-Lan in the 902-928 MHz range and ZigBee in the 2400-2482 MHz range compare with exposure at similar distances to the electric and magnetic fields of electric current at 60 Hz at the customer meter.

**Response:**

A customer meter would not be a significant source of 60-Hz electric or magnetic fields.

27.1. Please show the level of exposure from the electric current in wiring in the walls of a home and in appliances operating in a home in comparison to the RF-Lan.

**Response:**

Electric currents carried on wiring in the wall and in appliances are a negligible source of RF exposure. The wiring, by its very purpose in carrying electricity within the home, is a source of exposure to very low, non-RF, 60 Hz, electric and magnetic fields. The exposures to 60 Hz-fields and RF fields both are much lower than prescribed by the safety standards, but there is no obvious way to directly compare the exposures to the 60-Hz fields and RF fields.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 48                               |

1    **28.    Reference: Exhibit B-11, CSTS 1.12.5**

7            12.5    What would be the hard costs for connecting smart meters to fibre optics when a)  
8                    fibre optic cabling is already in place; and b) when fibre optic cable is not in  
9                    place? What would be the cost of using of a fibre optic network as an alternative  
10                  to the RF mesh LAN solution and how would that cost be reflected in rate  
11                  increases over a long term period? Provide cost analysis of connecting all Fortis  
12                  BC AMI meters in the province to fibre optic versus the cost of continually  
13                  replacing wireless components every 7 to 10 years.

14    **Response:**

15    FortisBC does not agree with the assertion that wireless components require replacing every 7-  
16    10 years. While it has been acknowledged in section 4.1.3 of the Application (Exhibit B-1) that  
17    some technologies, particularly those offered as services by third parties, may have shorter  
18    useful lives; the bulk of the wireless equipment to be installed during the proposed AMI project  
19    is expected to last 20+ years. All expected upgrades, battery replacements and device  
20    replacements have been accounted for in the original financial analysis of the project.

2

3            28.1.    Please provide the technical physical life expectancy for the AMI meters.

4

5    **Response:**

6    As provided in BCUC IR No. 1 Q90.5, the average service life or alternatively stated in this  
7    question the “technical physical life expectancy” for the AMI meters is 20 years.

8

9

10           28.2.    Please confirm that while FortisBC has an expected project life of 20 years it is  
11                  quite possible that some or many of the meters may last more than 20 years and  
12                  that this is the reason FortisBC has included the expectation of 20+ years.

13

14    **Response:**

15    FortisBC confirms that many of the proposed AMI meters are expected to last longer than 20  
16    years.

17

18

19           28.3.    Please confirm that even if the meters are replaced early it would most likely be  
20                  because some technological development would have occurred to provide  
21                  greater functionality and benefits than the proposed AMI meters, which would be

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 49                               |

1                   assessed as to its benefit cost at the time and would be based on increased  
2                   incremental benefits justifying replacement of the meters early.

3

4    **Response:**

5    Confirmed.

6    However, the meters and system chosen by FortisBC for the proposed AMI project have  
7    sufficient spare network capacity and the functionality to collect data needed for all future  
8    applications anticipated by FortisBC.

9

10

11           28.4. Please confirm that FortisBC does not know of any improvement in technology  
12           which would lead it to believe that the AMI meters will need imminent  
13           replacement to capture a new benefit not supported by the AMI meters proposed.

14

15   **Response:**

16   Confirmed. Please refer to the response to CEC IR No. 2 Q28.3.

17

18

19   **29. Reference: Exhibit B-11, CSTS 1.17.1**

7    **17.0 Reference - Application - Environment - page 134, line 24**

8           17.1 In evaluating the EMF risks posted by the proposed meters, does FortisBC  
9           consider it important to consider the following specifics?

10           A. The frequency and extent of fluctuation of RF levels?

11           B. The duration of each instance of an RF emission?

12           C. The frequency with which an RF emission occurs?

13   **Response:**

14   The factors that FortisBC considers important in evaluating EMF exposure are described in the  
15   referenced section of the Application, Exhibit B-1, Section 8.4.2, p134-135

16   All items listed above are considered in determining compliance with Health Canada Safety  
17   Code 6.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 50                               |

29.1. Please confirm that in addition to the criteria listed in the question answered that FortisBC would also consider the following criteria relevant.

- a) Intensity of the RF signal
- b) Average distance away from the RF signal source
- c) The existence of a back plate between the individuals who may be exposed and the source of the RF signal
- d) The existence of walls and other barriers which may lessen the RF signal intensity.
- e) The lack of any substantiated scientific evidence that low levels of RF signals could be harmful to human health
- f) The proportional diminutive RF signal from the AMI meters relative to all manner of other RF signals permeating modern society generally and the FortisBC service territory in specific.
- g) The substantive and authoritative research and findings of those responsible for reviewing health issues related to RF signals and their conclusion that it is not a public health issue at this time.

**Response:**

Yes, these are also factors that would be considered in the assessment of RF exposures and potential risks to health of AMI meters.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 51                               |

1 **30. Reference: Exhibit B-11, CSTS 1.34.1**

1 **34.0 Reference - Response to BCUC IR1 117.4**

2 34.1 Will FortisBC suspend service for those customers refusing installation of an AMI  
3 meter until such time that an AMI meter is installed?

4 **Response:**

5 As stated in the Application (Exhibit B-1) at page 142:

6 *Regardless of FortisBC's efforts, some customers may continue to refuse the installation of an*  
7 *advanced meter. In these cases, FortisBC intends to follow the following process:*

- 8 • *Continue productive dialogue with the customer where possible, making an effort to*  
9 *address concerns and ensuring the customer is aware that they have the option of*  
10 *relocating the meter on their property at their expense.*
- 11 • *Continue to provide billing using estimated readings for up to six months.*
- 12 • *After three months of refusal to provide access to exchange the meter, and in absence*  
13 *of extenuating circumstances, suspension of the customer's service until the advanced*  
14 *meter is installed.*

15 *FortisBC does not take suspension of an individual customer's service lightly, but also cannot*  
16 *support ongoing manual meter reading or estimating once advanced metering has been*  
17 *deployed.*

2  
3

4 30.1. Would it be technically feasible to install a PLC meter and intercept the signal  
5 further out on the electrical system away from the customer's premises and then  
6 transmit the signal to the RF-Lan mesh via a transmitter?

7

8 **Response:**

9 Yes, this is technically feasible (although FortisBC is not aware of a commercially available  
10 system).

11  
12

13 30.2. If it were technically feasible could this be done at the customer's cost to obviate  
14 the need to deny service but still enable FortisBC to collect all the data required  
15 and to communicate with the customer's meter?

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 52                               |

1

2 **Response:**

3 Yes, this would be technically feasible, but a system capable of transmitting data between a  
4 PLC meter and an RF-LAN mesh device is not commercially available.

5

6

7 **31. Reference: Exhibit B-11, CSTS 1.36.1**

17 **36.0 Reference - Executive Summary (CPCN Application) Page 2 Lines 3-6**  
18 Green house gas (GHG) emissions will be reduced as well. FortisBC meter reading  
19 vehicles drive approximately 500,000 kilometres per year and consume approximately  
20 80,000 litres of gasoline. The associated 191 tonnes of resulting GHG emissions will be  
21 reduced with the reduction in meter reading vehicles.  
22 36.1 Provide evidence that GHG smog is less hazardous than electromagnetic (RF)  
23 smog since both have been classified as 2b carcinogens by the World Health  
24 Organization.

25 **Response:**

26 FortisBC could not find "GHG smog", "GHG" or "smog" on the list of 2b carcinogens. FortisBC  
27 has not made any assertions regarding the hazards of GHG emissions that would require it to  
28 provide evidence in any case.

8 29 If "electromagnetic (RF) smog" refers to RF emissions, please see Exhibit B-1, Appendix C-5.

9 31.1. Please confirm that classification of RF signal as a class 2B does not in any way  
10 presume evidence that the RF signals are carcinogenic, particularly the low  
11 levels for the FortisBC AMI meter communications, but rather is a classification  
12 system used to organize what subjects may be examined as a priority area for  
13 some future research.

14

15 **Response:**

16 The IARC evaluation of epidemiologic evidence of mobile phone use as providing "limited"  
17 evidence automatically classifies RF fields as "possibly carcinogenic to humans" (Group 2B).  
18 IARC has not called for additional research but even prior to the publication of the IARC report  
19 the WHO had published a Research Agenda to promote research to reduce scientific  
20 uncertainties in the existing database (WHO, 2010).

21 A classification in Group 1 is required to characterize an exposure as "carcinogenic to humans."

22

23

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 53                               |

31.2. Please confirm that while GHG emissions from vehicles are not known or thought to be carcinogenic that other automobile emissions (SOx, NOx, VOx and PM) are known to have serious health effects including known impacts on human mortality.

**Response:**

FortisBC confirms that GHG emissions are not known or thought to be carcinogenic.

A document on the BC Government website<sup>6</sup> entitled “How Vehicle Emissions Affect Us” states:

*Vehicle emissions contribute to the formation of smog. Nitrogen oxides (NOx) and volatile organic compounds (VOCs) in vehicle emissions can react to form ground level ozone and other secondary pollutants during the spring and summer months. During the winter months, vehicle emissions can be trapped near the ground by temperature inversions. This can lead to high levels of primary pollutants including nitrogen dioxide (NO2), carbon monoxide (CO) and particulate matter (PM2.5). Extensive studies link smog to a variety of respiratory and cardiovascular symptoms and illnesses.*

*A number of studies have shown that pollutant exposures near major roadways are greater than for other areas in cities. Other studies have linked this increased exposure to an increased prevalence of a wide variety of illnesses including asthma, chronic bronchitis, emphysema, pneumonia and heart disease.*

31.3. Please provide a quantification of the approximate reductions of these other automobile emissions based on the same quantities of reductions of 80,000 litres of gasoline.

**Response:**

FortisBC provides the following life-cycle estimate of the annual reductions in the emissions of carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), sulfur oxides (SOx), and particulate matter (PM) associated with vehicle usage for the current manual meter reading function:

---

<sup>6</sup> <http://www.env.gov.bc.ca/epd/bcairquality/topics/vehicle-emissions-impacts.html>

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 54                               |

**Table CEC IR2 Q31.3 – Estimated Annual Reduction in Other Emissions**

| <b>Emission</b> | <b>(kg)</b> |
|-----------------|-------------|
| CO              | 5,800       |
| NOx             | 250         |
| VOCs            | 210         |
| SOx             | 180         |
| PM              | 34          |

31.4. Please confirm that studies such as the one done for the City of Toronto (supplied in Appendix A) to quantify the health impacts of the smog emissions in the city provide a useful proxy for evaluating the additional benefits of reducing automobile trips and truck rolls, which the FortisBC AMI meters will enable FortisBC to do.

**Response:**

Confirmed.

31.5. Please provide any better information with regard to other automobile emissions and their potential health impacts to which FortisBC may have access for the purpose of better evaluating this issue.

**Response:**

Please see the following link:

<http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/enviro/smog-eng.php#po>

31.6. Please confirm that the fact that we live with risks such as those related to automobile emissions provides a proxy context for understanding the way society deals with the trade-off between benefit and risk.



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 55                               |

1

2 **Response:**

3 Confirmed with respect to automobile emissions, however FortisBC does not believe there is  
4 any “trade-off” between benefit and risk associated with the proposed Project, particularly with  
5 respect to any perceived health effects associated with the communications technology  
6 employed.

7

8

9 31.7. Given that RF signals related to the FortisBC AMI meters are many orders of  
10 magnitude less risky than the approved regulatory thresholds for RF signal risks  
11 and even many more orders of magnitude less risky than risks society lives with  
12 every day, would it be fair to conclude that there is a possible case to be made  
13 that the AMI meters FortisBC is proposing to introduce may be on balance a  
14 public health benefit.

15

16 **Response:**

17 Regulatory and health authorities have determined that RF exposures at the levels associated  
18 with FortisBC advanced meters do not have any known adverse effects on human health,  
19 whereas vehicle accidents and non-GHG emissions (please refer to the response to CSTS IR  
20 No. 2 Q31.2) certainly increase the risk to FortisBC employees and members of the public.  
21 Therefore, it is possible that installation of the AMI system represents an overall lower risk to the  
22 employees and the public.

23

24

25 31.8. Please confirm that the benefits from reduction of these other automobile  
26 emissions can be linked to the functionality introduced by the communication  
27 capability being introduced with the AMI meters and that this functionality would  
28 be intended to be retained by FortisBC continuously into the future with  
29 replacements of meters and would not be restricted to just the initial AMI meters  
30 being installed.

31

32 **Response:**

33 Confirmed.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 56                               |

1  
2

3 **32. Reference: Exhibit B-11, CSTS 1.36.2**

1 36.2 Explain how the environment is better served by producing layers of RF smog  
2 rather than having the meter readers drive electric cars?

3 **Response:**

4 Please refer to the response to CSTS IR No. 1 Q36.1 and the response to Tatangelo IR No. 1  
5 Q42.

4

5 32.1. Given that the need for meter reading vehicles will be completely removed and  
6 the FortisBC will no longer use or operate a fleet for this purpose, please confirm  
7 that this will result in a reduction in environmental emissions related to the supply  
8 chain required to build and deliver automobiles to the fleet.

9

10 **Response:**

11 Confirmed. Please also refer to the response to BCSEA IR No. 1 Q48.1 which details an  
12 estimated annual reduction of 234 tonnes of GHG emissions associated with the Project, which  
13 reflects the additional environmental considerations identified in the question.

14

15

16 32.2. Please describe the concept to life cycle analysis of product environmental  
17 impacts such as emissions of various pollutants.

18

19 **Response:**

20 The concept of a life cycle analysis refers to the investigation and valuation of the environmental  
21 impacts of a given product or service caused or necessitated by its existence (please also see  
22 the response to BCUC IR No. 2 Q20.3). In the case of the reduced vehicle requirements  
23 associated with AMI, these considerations can include the GHG impacts associated with the  
24 production, transport, and end-use of gasoline, as reflected in the response to BCSEA IR No. 1  
25 Q48.1.

26

27

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 57                               |

1           32.3. Please confirm that the manufacture of electric vehicles, just like the manufacture  
2           of internal combustion vehicles has environmental emissions impacts associated  
3           with it.

4  
5           **Response:**

6           Confirmed.

7  
8  
9           32.4. Please confirm that the Institute of Lifecycle Environmental Assessment data  
10          (Appendix B) represents a reasonable proxy for an evaluation of this additional  
11          benefit of reduced automobile and truck rolls in the absence of any better  
12          information.

13  
14          **Response:**

15          Confirmed.

16  
17  
18          32.5. Please provide any information FortisBC has with respect to the life cycle  
19          emissions associated with the production and delivery of automobiles to a fleet.

20  
21          **Response:**

22          Please refer to the responses to BCSEA IR No. 1 Q48.1 and the CEC IR No. 2 Q31.3 which  
23          reflect a life-cycle estimate (includes the impact of production and delivery of vehicles) of the  
24          reduction in GHG emissions and other emissions (CO, NOx, SOx, VOCs, PM) associated with  
25          the elimination of vehicles used for the current manual meter reading function.

26  
27  
28          32.6. Please confirm that the fleet required for maintenance of the entire AMI  
29          infrastructure would be significantly less than that required for the meter reading  
30          and truck rolls, which will be saved with the introduction of the AMI project.

31



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 58                               |

1    **Response:**

2    Confirmed.

3  
4

5           32.7.   Please provide an approximate or rough estimate of the vehicle requirements for  
6                   maintenance of the AMI infrastructure.

7

8    **Response:**

9    FortisBC estimates that there will be a requirement for the equivalent of approximately 2.5  
10   vehicles required for ongoing maintenance of the AMI infrastructure. This includes the  
11   approximate 1.2 vehicles forecast to meter read those customer premises for which there may  
12   not be an economical WAN solution. It is expected that the above vehicle requirements will be  
13   supplied from the existing fleet.

14  
15

16           32.8.   Please confirm that the emissions, direct and full life cycle, related to the one  
17                   time installation of the AMI meters and infrastructure as well as to ongoing  
18                   needed replacements will be substantially, over an order of magnitude, less than  
19                   the emissions savings.

20

21   **Response:**

22   FortisBC confirms that the emissions related to the one time installation of the AMI meters and  
23   infrastructure will be substantially less (over an order of magnitude) than the emissions  
24   otherwise associated with the existing manually read metering system.

25  
26

27           32.9.   Exhibit B-11 Please confirm that the emissions, direct and life cycle, related to the  
28                   one time installation of the AMI meters and infrastructure and ongoing  
29                   replacements will be comparable to the ongoing replacement of the existing  
30                   meters and related infrastructure over a long term future beyond the initial  
31                   installation of the AMI project.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 59                               |

1

2 **Response:**

3 Confirmed.

4

5

6 **33. Reference: Exhibit B-11, CSTS 1.37.1**

16 37.1 What are the new Measurement Canada regulations (S-S-06) and what  
17 provisions of those regulations require wireless meters? In what way are the  
18 proposed AMI meters more accurate than FortisBC's present mechanical  
19 meters?

20 **Response:**

21 Section 5.3.4 of the Application (Exhibit B-1) discusses FortisBC's interpretation of S-S-06 and  
22 its implications on Fortis BC operations. FortisBC has not stated that S-S-06 regulations require  
23 existing meters to be replaced with wireless meters. A copy of the S-S-06 Regulations is  
24 provided as Appendix B-7 to the Application (Exhibit B-1).

25 The proposed AMI meters are manufactured to the ANSI C12.20 standard which specifies  
26 increased accuracy over the ANSI 12.1 standard that the existing electro-mechanical meters  
27 were required to meet. The new meters are required to be accurate to within 0.5% compared to  
28 2% for the electro-mechanical fleet.

7

8 33.1. Please confirm that the EPRI study (Appendix C) with respect to meter accuracy  
9 is in part a reasonable set of evidence upon which to evaluate the issue of the  
10 accuracy of meters.

11

12 **Response:**

13 Confirmed. The Electric Power Research Institute is a well respected research entity whose  
14 area of expertise includes electrical consumption meters.

15

16

17 33.2. Please confirm that the consequence of the increased accuracy of the AMI  
18 meters FortisBC is expecting to introduce and the consequent compliance with  
19 Measurement Canada regulations will provide increased fairness for FortisBC  
20 customers in measurement of electrical consumption and the consequent billings  
21 for the same.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 60                               |

1

2 **Response:**

3 Please refer to the response to CEC IR No. 2 Q9.1.2.

4

5

6 33.3. Please confirm that the mechanical analog meters being replaced would have a  
7 steady decline in accuracy over their lifetimes due to degradation of the  
8 mechanical performance.

9

10 **Response:**

11 Please see the response to CEC IR No. 2 Q9.1.1.

12

13

14 **34. Reference: Exhibit B-11, CSTS 1.57.2**

26 57.2 Considering all signal types, not just data signals, on average how many signals  
27 per day will an AMI meter transmit?

28 **Response:**

29 The average number of 900 MHz RF transmissions in a 24 hour period is ~1,268 (less than one  
30 time per minute). This includes all types of signals.

15

16 34.1. Please provide the duration of each type of RF com and the approximate quantity  
17 for each type such that the total quantity adds to the 1268 average.

18

19 **Response:**

20 It is to be noted that the individual behaviour of meters within large scale RF mesh deployments  
21 will vary based upon a number of parameters including read schedules, read profiles and meter  
22 management schedules along with a meter's position within the RF mesh and the general RF  
23 environment. It is therefore more meaningful to analyze statistical averages within a large  
24 population of meters rather than individual meters. Further, it is not practical to analyze every  
25 signal and every signal type for a large population of meters (~6800) and therefore the data  
26 presented is based on data gathered from a large population of meters while grouping similar



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 61                               |

transmission types into categories with common attributes. The data provided below is from a stable, large scale deployment.

The total number of transmissions includes the scheduled reads, on-demand reads, alarms/alerts, plus the network traffic needed for command/control (synchronization, security, data integrity and dynamic network resiliency).

The duration of each transmission is a function of the number of bytes being transmitted. A possible expected duration for each of the transmission types is summarized below based on transmission categories with common attributes:

- Command and Control Signals, Alarms/alerts:

- These transmissions are shorter in size/duration and range between 242 and 274 bytes;

- This results in transmission durations between 29 and 33 milliseconds;

- Scheduled and on-demand meter reads:

- These transmissions are larger in size/duration and range between 498 and 965 bytes;

- This results in transmission durations between 53 and 103 milliseconds.

Analysis of sample data indicates that the segmentation of transmission types is expected to be:

- Command and Control Signals, Alarms/alerts: 90% of transmissions

- Scheduled and on-demand meter reads: 10% of transmissions

For an average meter, this results in the following expected number of transmissions in a 24 hour period by category:

- Command and Control Signals, Alarms/alerts: 1,141 transmissions/day

- Scheduled and on-demand meter reads: 127 transmissions/day

It should be noted that meters will “relay” the data from meters that are downstream from them. Typically each meter originates only 2 to 4 meter read transmissions per day.

BC Hydro has commissioned reports to further quantify the duty cycle and number of transmissions for the same Itron meters that FortisBC has selected for use in the proposed AMI project. The real-world measured data collected during these studies suggests that the total duty cycle and the number of transmissions for the max, min and average meter will be reduced

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 62                               |

from the numbers FortisBC has provided in this response. Please refer to Appendix CEC IR2 34.1 for these studies and their conclusions.

34.2. Please provide the range of RF duration periods if any applicable to each type of communication.

**Response:**

Please see the response for CEC IR No. 2 Q34.1

34.3. Please provide the range of frequency of communication by each type as applicable around the average provided and if possible please provide an appropriate distribution curve for the range (ie normal distribution).

**Response:**

The expected frequency of communication for each of the two categories of transmissions is described below:

- Command and Control Signals, Alarms/alerts:
  - These transmissions are fairly evenly distributed over time throughout the day;
  - This results in a frequency of communication of approximately 47.5 transmission per hour;
- Scheduled and on-demand meter reads:
  - These transmissions are a function of the daily ready scheduled set up by the Company. The daily read schedule will be finalized during the Define/Design phase of the project;
  - However, as an example, a typical read schedule will include three reads per day which results in three 8 hour windows for meter data to be sent back to the utility;

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 63                               |

- 1                     ▪ A typical 8 hour read window would plan for meters to send data back
- 2                     over a 6 hour window and use the other 2 hours for point to point reads of
- 3                     meters that did not successfully respond;
- 4                     ▪ This would result in a distribution of transmissions mainly aggregated into
- 5                     three 6 hour windows each day;
- 6                     ▪ The frequency of communication during each of these 6 hour windows
- 7                     will be approximately 7.1 transmissions per hour.

8 BC Hydro has commissioned reports to further quantify the duty cycle and number of  
9 transmissions for the same Itron meters that FortisBC has selected for use in the proposed AMI  
10 project. The real-world measured data collected during these studies suggests that the total  
11 duty cycle and the number of transmissions for the maximum, minimum and average meter will  
12 be reduced from the numbers FortisBC has provided in this response. Please refer to Appendix  
13 CEC IR2 34.1 for these studies and their conclusions.

14

15             34.4. Please confirm that the total energy involved in the aggregate of all of the types  
16             of RF communication over the day is the small fraction of the Safety Code 6  
17             thresholds that FortisBC has claimed and includes all types of RF signals.

18

19 **Response:**

20 Confirmed. Please see Exhibit B-1, Appendix C-5, Appendix A.

21

22

23 **35. Reference: Exhibit B-11, JT 1.49**

1 **Pages 99 – 101**

2             49. Are not the cost savings you speak of on these pages not already done without  
3             AMI meters? You will require many different meters to carry out these scenarios.

4 **Response:**

5 The future potential benefit described in the referenced section of the Application refers to  
6 power grid voltage optimization. Table 6.2.a. sets out the estimated costs and potential benefits  
7 for the various voltage optimization options available. The potential benefits noted cannot be  
8 achieved with existing Company technology, and all would require additional investment, as  
9 estimated in the table.

24



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 64                               |

1           35.1. Please confirm that there would not be requirement for additional or different  
2 meters at the customer premises and that the AMI meters installed will be part of  
3 the process for achieving voltage optimization but that additional investment in  
4 such functionality as voltage regulation equipment may be required.

5

6 **Response:**

7 Confirmed.

8

9

10

11 **36. Reference: Exhibit B-11, NCGP 12**

3           12. Do any of the references consulted in question 11 include research by Cindy  
4 Sage and David O. Carpenter?

5 **Response:**

6 FortisBC believes that neither Ms. Sage nor Dr. Carpenter have published any original, peer-  
7 reviewed, health research studies of radiofrequency fields. Both have offered opinions on  
8 published health research studies of radiofrequency fields in documents posted to the internet  
9 and some published reviews of research. Exponent scientists have reviewed and considered  
10 these opinions.

12

13           36.1. Please confirm that the EPRI report (Appendix D) on the Sage claims is the more  
14 credible evidence dealing with the issues raised by Ms. Sage.

15

16 **Response:**

17 The EPRI report contained in Appendix D provides a well-documented critique of the Sage  
18 January 1 2011 internet posting that characterized exposures and FCC compliance of smart  
19 meters. The comments in the EPRI report were based on FCC documents, measurements of  
20 smart meters, and input from well-known experts in RF engineering. The Sage posting does not  
21 reflect a good understanding of RF engineering exposure issues and no engineer is cited as a  
22 contributor to her report.

23

24

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 65                               |

1    **37.    Reference: Exhibit B-1, Appendix C-5, Page 28 of 47**

**Brain cancer rates over time**

If the increased risks suggested by the INTERPHONE Study Group (2010, 2011) in the highest use group and the Hardell study data (Hardell, 2006a, 2006b; Hardell et al., 2011) were correct, we might expect to see some increase in annual rates of brain cancer, particularly 10 years after mobile use became widespread. The period of 10 years or more would allow for the development of tumors, and if causal, would show increases in brain cancer rates as more people had a longer period of exposure through mobile phone use. No increase in brain cancer rates over time was seen in the combined populations of Denmark, Norway, Sweden, and Finland from 1973 to 2003 (Deltour et al., 2009), or in Switzerland from 1969 to 2002 (Röösli et al., 2007). It is important to assess these trends in data extended to longer time periods—the most recent analyses examined trends in England from 1998 to 2007 (de Vocht et al., 2011) and in the United States from 1992 to 2006 (Inskip et al., 2010). These data also did not indicate that the occurrence of brain cancer has increased over the years since the use of mobile phones became increasingly widespread (the late 1980s and 1990s).

2  
3            37.1.    Please confirm that the rates for brain cancer in Canada over time are reported  
4                    by Statistic Canada and others, which shows on page 44 of the 2012 report  
5                    (Appendix E) that brain cancer in Canada both in terms of incidence and  
6                    mortality has been decreasing over the 10 year time frame reported and that this,  
7                    while not an epidemiological study would support the proposition that there is not  
8                    an increasing rate of brain cancer in Canada but in fact a decreasing rate of brain  
9                    cancer in Canada.

10  
11    **Response:**

12    The Canadian Cancer Statistics 2012 report<sup>7</sup>, in Table 4.5 **Time Trends in Incidence and**  
13    **Mortality** indicates that the trend in brain cancer incidence in Canada from 1998 to 2007  
14    measured as the annual percent change (APC) has not increased but declined slightly. The  
15    trend to decrease was not significantly changed (Men – APC = -0.4%; Women – APC = -0.8%).

---

<sup>7</sup> [Hhttps://www.cancer.ca/Canada-wide/About%20cancer/~/\\_media/CCS/Canada%20wide/Files%20List/English%20files%20heading/PDF%20-%20Policy%20-%20Canadian%20Cancer%20Statistics%20-%20English/Canadian%20Cancer%20Statistics%202012%20-%20English.ashx](https://www.cancer.ca/Canada-wide/About%20cancer/~/_media/CCS/Canada%20wide/Files%20List/English%20files%20heading/PDF%20-%20Policy%20-%20Canadian%20Cancer%20Statistics%20-%20English/Canadian%20Cancer%20Statistics%202012%20-%20English.ashx)H

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 66                               |

Slightly larger reductions in mortality from brain cancer over that same period were reported (Men – APC= -0.7%; Women – APC = -0.1.4%) but only the decline in the mortality of women was statistically significant trend. The absence of an increase in the incidence of brain cancer in Canada does not support the idea that mobile phone use is a cause of brain cancer. Mortality rates unlike incidence rates, however, may reflect advances in treatment as well as changes in risk factors over time.

37.2. Please confirm that the study done by Little et al (Appendix F) shows no effective support for the proposition that cell phones are causing glioma cancers in the US population studied and that while there are limits to the study the authors have not found support for the two studies which indicated that cell phones might cause these cancers.

**Response:**

Investigators at the U.S. National Cancer Institute (Little et al., 2012) reported that the observed rate of glioma incidence reported from 12 cancer registries in the United States from 1997 to 2008 was not consistent with that predicted by the risk estimates in the Swedish case control study (Hardell et al., 2011) as applied to the US population. The observed glioma rate was more similar to that predicted from the lower risk estimates on the highly exposed population from the INTERPHONE Study Group (2010). Note that Little et al. assumed risk estimates greater than 1.0 for the analysis of the Interphone study for the following reason, “Because many relative risks of exposed people, compared with non-exposed people, were less than 1 in the Interphone study (implying an unexpected protective effect of phone use), we also estimated rates assuming that Interphone study risks were 1 or more (thus setting all relative risks less than 1 to 1), which assumes no protective effects in any category.” (p. 3)

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 67                               |

1     **38.     Reference: Exhibit B-1, Appendix C-5, Page 17 of 47**

Many organizations such as the International Commission on Non-Ionising Radiation Protection (ICNIRP), the Health Council of the Netherlands (HCN), the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), the Swedish Radiation Safety Authority (SSM), and Health Canada have reviewed the research and have independently supported the derivation of exposure limits on the basis of tissue heating, or developed a set of exposure limits for RF energy in various frequency ranges (ICNIRP, 2009; HCN, 2009; SCENIHR, 2009; SSM, 2009; Health Canada, 2009). These organizations have reviewed all of the available research through 2009 and have not concluded that RF exposure below the exposure limits developed by ICNIRP, which are similar to those of Health Canada, causes any type of cancer, other chronic disease, adverse physiologic changes, or symptoms that affect well-being.

38.1. Please confirm that the recent Norwegian study (Appendix G) is another one of the many organizations having reviewed these issue of RF signals and health risks and found no scientific basis for changing the standards governing RF radiation and like Health Canada have not concluded that RF exposures below the threshold standards cause any of the alleged health effects listed above.

**Response:**

In 2010 the Norwegian Institute of Public Health assembled a panel of 16 scientists in an Expert Committee to “summarize the knowledge regarding exposure to weak high-frequency fields.” The Committee was “composed of individuals with expertise in environmental and occupational medicine, biology, physics, metrology, biophysics, biochemistry, epidemiology and philosophy, as well as expertise in administration and risk management.” Among the findings contained in the Committee’s report<sup>8</sup> at pp. 43-44 released in their September 2012 were:

**Overall Conclusion**

“A large number of studies have examined the possible effects of exposure to weak RF fields (i.e., exposure within the ICNIRP’s reference values). The studies have been performed on cells and tissues, and in animals and humans. The effects that have been studied apply to changes in organ systems, functions and

<sup>8</sup> <http://www.fhi.no/dokumenter/545eea7147.pdf>

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 68                               |

other effects. There are also a large number of population studies with an emphasis on studies of cancer risk. The large total number of studies provides no evidence that exposure to weak RF fields causes adverse health effects. Some measurable biological / physiological effects cannot be ruled out.”

## **Characterization of risk and uncertainty**

“As typical exposure lies far below the ICNIRP’s recommended reference values, and since it is not scientifically proven that adverse health effects may occur after exposure under the ICNIRP reference levels, there is no reason to assume that the low typical exposure in Norway is associated with health risks. On this basis the Expert Committee considers that the general public is well protected against adverse health effects from RF exposure.....

The remaining uncertainties in the risk assessment mainly relate to health effects arising after a very long time, and to situations that produce the highest exposure (i.e., personal use of a mobile phone). This uncertainty in the risk assessment is considered to be low. There is negligible uncertainty in the risk assessment associated with other sources, such as base stations, wireless networks, television transmitters and the use of mobile phones by other individuals.”

## **Health problems attributed to electromagnetic fields**

“A large number of scientific studies provide evidence that electromagnetic fields do not cause the symptoms.... Scientific knowledge gives no basis to recommend measures to reduce or avoid exposure to electromagnetic fields..... A common feature for the group of patients who attribute their health problems to electromagnetic fields, and patients who attribute their health problems to other environmental factors is that they often have a strong belief in a causal relationship, but scientific studies are unable to demonstrate or to confirm this....There is no reason to recommend reduce exposure to RF fields as a tool to reduce general concerns about the hazardous effects of electromagnetic fields.”

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 69                               |

1 **39. Reference: Exhibit B-1, Pages 134 and 135**

13 The following specifics of the chosen technology are important to consider when evaluating  
14 the EMF risks posed by the proposed meters:

- 15 • Power – The proposed meters are low power at a maximum of 1 Watt. The low  
16 power minimizes the EMF.
- 17 • Distance – The strength of an EMF is inversely proportional to the square of the  
18 distance, meaning that the level drops off very quickly as the distance to the meter  
19 increases. As meters are intentionally installed outside the home, it is unlikely for  
20 customers to be in close proximity to a meter for prolonged periods of time.  
21 However, there are a number of meters located inside customer residences, typically  
22 a result of home renovations after the meter install, or older installations. Enclosed  
23 meters are difficult to access for repair, replacement and reading. FortisBC intends  
24 to work with customers before and during the AMI implementation to relocate these  
25 meters as necessary. This will benefit both the Company and the customer.

- 26 • Frequency – The frequency of operation of the meters is relatively low (902-928  
27 MHz) when compared to other ubiquitous technologies such as cellular phones,  
28 microwave ovens and Wi-Fi.

- 29 • Duty Cycle – The duty cycle is the percentage of time that the transmitter is on and  
30 therefore radiating an EMF. The proposed AMI solution only requires a very limited

1 amount of data from each meter, with an average total transmission time of about  
2 one minute per day.

3 The estimate of emission from the proposed AMI metering system and the relevant Health  
4 Canada exposure limit are provided in Table 8.4.2.a below. The table indicates that the  
5 average (or "mean") exposure from an AMI meter will be approximately 10,000 times below  
6 the Health Canada Safety Code 6 limit of 0.6 mW/cm<sup>2</sup>.

7 **Table 8.4.2.a - RF Exposure at 902 MHz to 928 MHz**

| Condition                                       | Exposure at<br>0.5 meters<br>(mW/cm <sup>2</sup> ) |
|---|--|
| Health Canada Safety Code 6 Limit <sup>19</sup> | 0.6  |
| Mean duty cycle 0.06%                           | 0.000056   |
| Maximum typical duty cycle 0.58%                | 0.00054  |
| Maximum supported duty cycle 5%                 | 0.0047   |

4  
5 39.1. Please confirm that in addition to the duty cycle and frequency used in the table  
6 above that these exposure levels are for exposure in front of the meter and that  
7 because of the backing on the meter and other material between the meter and  
8 anyone likely being exposed to the meter the exposure levels are further reduced



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 70                               |

by an amount in the range of a factor of 10, as shown in the EPRI study of Itron Smart Meters (Appendix H) in their conclusions on page 17-1.

**Response:**

Confirmed.

BC Hydro has commissioned reports to further quantify the duty cycle and number of transmissions for the same Itron meters that FortisBC has selected for use in the proposed AMI project. The real-world measured data collected during these studies suggests that the total duty cycle and the number of transmissions for the max, min and average meter will be reduced from the numbers FortisBC has provided in the Application and in response to CEC IR2 Q34.1. Please refer to Appendix CEC IR2 34.1 for these studies and their conclusions.

39.2. Please confirm that on average people are much further away from their Smart Meter locations than .5 meters such that the average or “mean” exposure to an AMI meter RF signal would likely be substantially less than 10000 times below the Health Canada Safety Code 6 limit.

**Response:**

Confirmed.

39.3. Please confirm that the claim in the text and table above is in fact extraordinarily conservative and that the exposure risk to 99.99% of the population will be at substantially lower levels because of average distance away from the meter and normal orientation behind the meter backing plate.

**Response:**

FortisBC confirms that the text and table shows higher RF exposure levels than those to which the population will actually be exposed.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 71                               |

39.4. Please confirm that it would not be inappropriate to say that the typical exposure risk could be expected to be approximately 1000000 times below the safety code limits but may in some cases be approximately 10000 times below the safety code limits providing sound factual evidence supporting Provincial Health Officer assertions that the Smart Meters are not a public health risk.

**Response:**

Confirmed, assuming that the exposure is measured from at least 0.5 meters away from and behind the smart meter (thereby achieving the additional reduction factor of 10 as described in the response to CEC IR No. 2 Q39.1). These exposure values, being such a tiny fraction of Health Canada's Safety Code 6 limits on general public exposure, and the weight of the scientific evidence summarized by national and international agencies, clearly supports the assertion that advanced meters are not a public health risk.

**40. Reference: Exhibit B-11, CEC 1.51.1**

51.1 Please identify the types of home automation devices that are currently available, that can be installed at the customer's discretion, and are facilitated by the Zigbee or other wireless communication protocols?

**Response:**

The ZigBee™ Alliance website<sup>2</sup> states: ZigBee Home Automation offers a global standard for interoperable products enabling smart homes that can control the following product categories:

- Appliances;
- Audio;
- Cards & Readers;
- Closures, e.g. window shades;
- Energy Efficiency;
- Health & Fitness;
- Information Systems;
- Lighting;



|  |                                       |
|--|---------------------------------------|
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| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 72                               |

- 1      • Networking Devices;
- 2      • Payment Equipment; and
- 3      • Security
- 4      Their website offers a searchable directory of certified products that meet the Alliance standards
- 5      and protocol.

40.1. Please identify any comparable global standard for interoperable products enabling smart business/commercial sector premises and the kinds of product categories using electricity, which they may assist in controlling for the purposes of reducing wasted consumption.

**Response:**

FortisBC is not aware of any other comparable global standard.

40.2. Please confirm that the ACEEE report on Long-term Energy Efficiency Potential (Appendix H) which shows, on pages 27 through 34, scenarios for savings which indicate that the potential over the next forty years or so can be quite significant and that savings of this nature and significance would be expected to be similarly possible in BC and in the FortisBC jurisdiction.

**Response:**

Confirmed. The ACEEE report referenced shows significant potential savings in the Commercial sector, and FortisBC has no reason to believe similar savings couldn't be expected in its BC service territory.

40.3. Please provide any estimates of savings potential which FortisBC may have regarding developments which may take advantage of the AMI meters being proposed and if FortisBC does not have any estimates please provide any references to studies which may have a better comprehensive perspective than the ACEEE report, for both residential and commercial applications.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Commercial Energy Consumers Association (CEC)<br>Information Request (IR) No. 2  | Page 73                               |

1 **Response:**

2 Please see the response to BCUC IR No. 1 Q110.2a for estimated savings from Commercial  
3 customers for various Rate structures enabled by AMI, assuming similar penetration and  
4 percent savings as for Residential customers.

5 Also if the IHD penetration and savings rate, as provided in BCSEA IR No. 1 Q42.2, were  
6 assumed to apply to Commercial customers then the additional NPV savings are estimated to  
7 be \$3.8 million.

8

9

10 40.4. Please confirm that even though there may not be specific estimates available  
11 this does not mean there is not likely beneficial value to come from these  
12 developments and does not mean that the value would be non-substantial.

13

14 **Response:**

15 Confirmed. Please also see response to CEC IR No. 2 Q40.3.

16

17

18 40.5. Please confirm that over the next forty years both the in home and in commercial  
19 premises developments may be expected to provide some quite significant  
20 savings potential and that the AMI meter and communications base platform is  
21 likely to play a significant role in enabling the realization of the benefits.

22

23 **Response:**

24 Confirmed. There is significant savings potential available, as evidenced in the FortisBC 2010  
25 Conservation Demand Potential Report. It is expected that AMI will play a significant role in  
26 realizing those savings and benefits.

# UNDERSTANDING RADIO FREQUENCY AND BC HYDRO'S SMART METERS

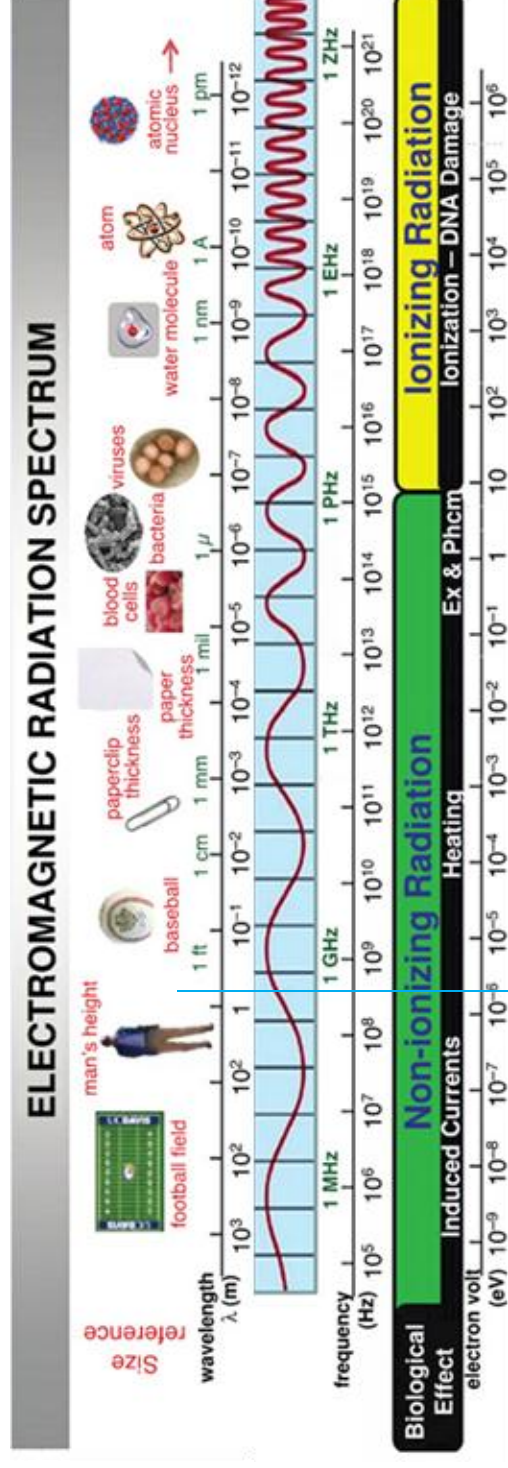


# SUMMARY

- Radio frequency (RF) technology has been around for over 100 years and is a part of everyday life – radios, TVs and medic alert systems are examples.
- BC Hydro’s smart meters use an RF-based wireless communication technology to send consumption information back to BC Hydro.
- B.C.’s Provincial Health Officer, Health Canada and the World Health Organization (WHO) have confirmed that wireless meters pose no known health risk or reason for concern.
- There are three things to consider with respect to radio frequency: *signal strength*, *transmission duration* and *distance* from the source.
- Smart meters are located outside of the home and transmit for a total of less than a minute a day, at a signal strength level below the precautionary limits set by Switzerland – the country with the most rigorous standard in the world.
- Planetworks, an independent telecommunications engineering firm, has confirmed that a smart meter communicates for 2 to 3 seconds a day at RF signal levels less than 0.5% of Health Canada standards.

# THE ELECTROMAGNETIC SPECTRUM

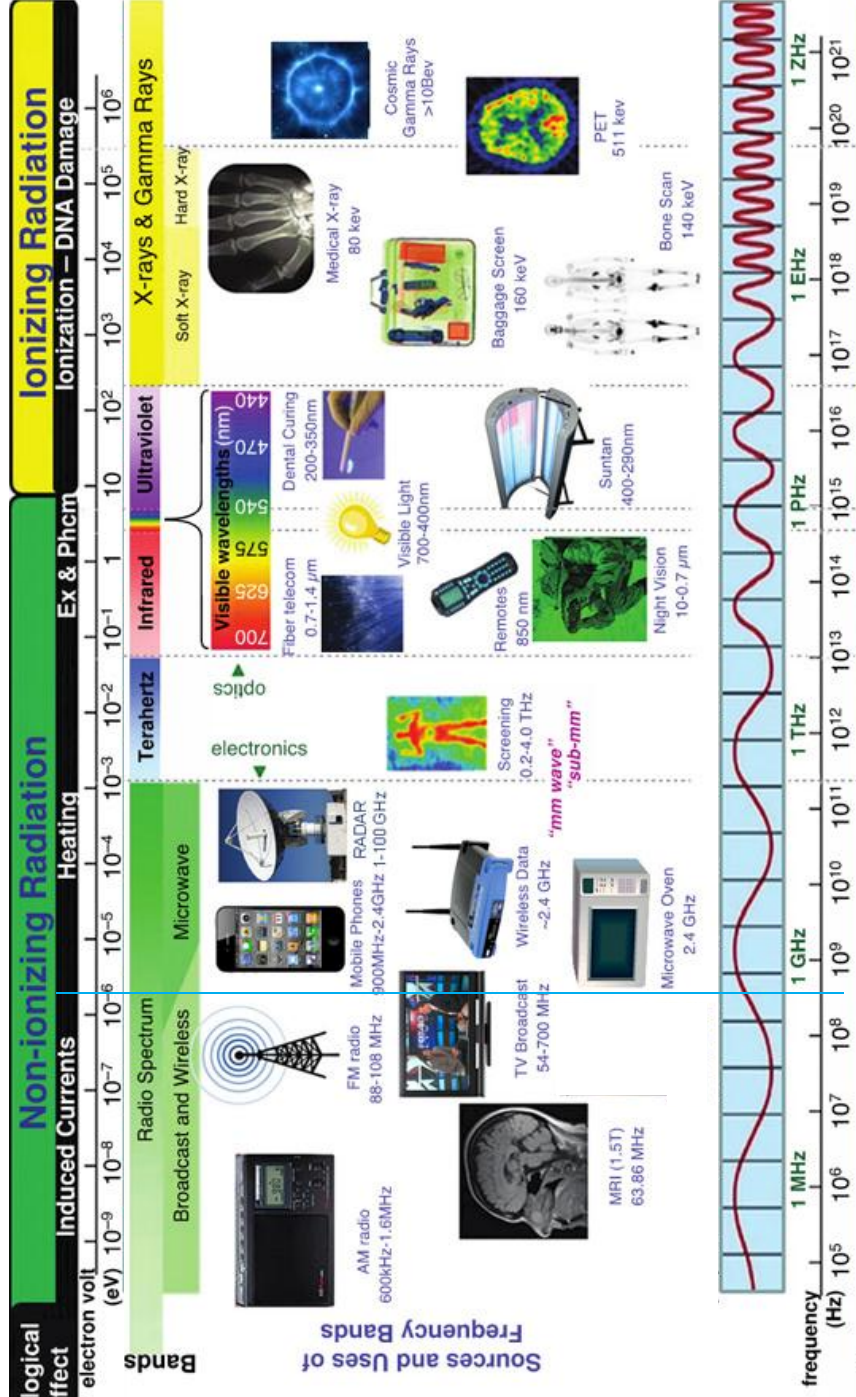
- Electromagnetic (EM) waves are produced by vibrating electric charges that give off packets of energy called photons. Unlike ocean or sound waves, EM waves transfer energy through electric and magnetic fields, not through matter such as water or air.
- The electromagnetic spectrum allows physicists to classify different types of electromagnetic waves on the basis of their wavelengths and frequencies.
- What determines the wavelength and frequency is the amount of energy each wave carries – specifically, the level of energy in each photon.
- This [video](#) from an education resource website explains the different properties of electromagnetic waves at different frequencies.





# THE ELECTROMAGNETIC SPECTRUM

- Some forms of electromagnetic radiation, like light, are essential to life while others such radio waves simply make life more convenient.
- Radio waves are in the low-frequency end, gamma waves are in the high-frequency end, and visible light is in the middle.



# DEFINING RADIO FREQUENCY

- Radio waves are electromagnetic waves which travel at the speed of light, or 186,000 miles per second (300,000 km/s).
- Radio waves are also referred to as radio frequency (RF), defined as a particular rate of oscillation of photons.
- The frequencies of RF waves are slower than those of visible light, making RF waves invisible to the human eye.



# HEALTH CANADA

- Federal department responsible for oversight of national health issues
- Draws on knowledge and research generated around the world to make informed, effective choices as Canada's health regulator
- Establishes safety limits for exposure to things such as leisure noise, ultraviolet rays from the sun, and also radio frequency
- Safety Code 6 is the specific regulation that establishes public and occupational exposure limits to radio frequency
- Safety Code 6 is reviewed and updated regularly (most recently August 2009))



# HEALTH AUTHORITIES CONFIRM SMART METERS ARE SAFE

## Health Canada

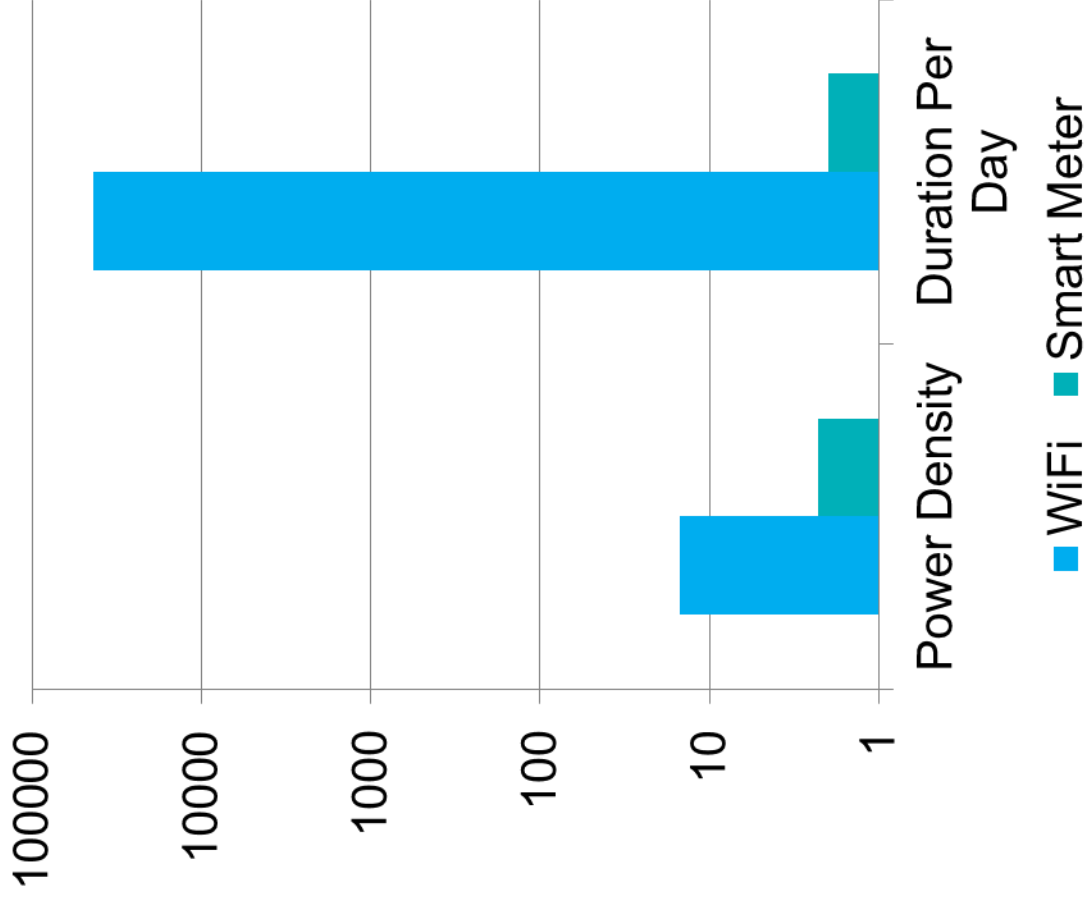
- “In the case of RF fields, health effects research on the subject has been ongoing for over 50 years and there are thousands of published studies. There is a great weight of evidence that RF field intensities below Safety Code 6 are not harmful. This conclusion is based upon the bulk of scientific evidence from animal, in-vitro and epidemiological studies that have been carried out worldwide, including at a Health Canada laboratory.”

## World Health Organization

- “(We are) concerned about cell phones, but not smart meters. ‘It sort of sounds, I wouldn’t say specious, but far-fetched, really,’ said Daniel Epstein, spokesman for the WHO’s Americas region.” (Jan 2011)
- “(The Danish cohort) study showed no link between mobile phone use, including longer term use of more than 10 years, and the risk of glioma or any other brain tumour. These are new results that were not available at the time of the IARC Monographs meeting.” (Oct 2011)

Appendix C IR2 34.1a

# WIFI ON FERRY TRIP



Horseshoe Bay to Departure Bay  
1 hour and 40 minutes

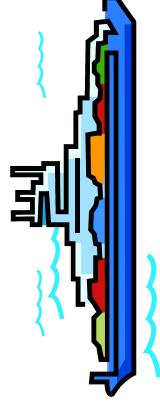


$$1 \text{ trip} = 60,000 \frac{\mu W}{cm^2} sec$$



$$1 \text{ year} = 1,679 \frac{\mu W}{cm^2} sec$$

$$1 \text{ trip} = 35 \text{ years}$$



=



# STANDARDS AROUND THE WORLD

- Electromagnetic regulations and standards in 235 countries reveal different approaches
- Most restrictive RF regulation, based on precautionary principle\*, is found in Switzerland

| Regulation** (900MHz)                | Limit ( $\mu\text{W}/\text{cm}^2$ ) |
|--------------------------------------|-------------------------------------|
| Canada – Health Canada Safety Code 6 | 600                                 |
| Germany (ICNIRP)                     | 450                                 |
| Luxembourg                           | 22.5                                |
| Italy (precautionary*)               | 9                                   |
| Poland                               | 9                                   |
| Switzerland (precautionary*)         | 4.5                                 |
| <b>BC Hydro’s Smart Meter</b>        | <b>2</b>                            |

\* Designed to reduce potential long term risks due to limited knowledge

\*\* All regulations are based on a distance of 20cm away from transmission antenna

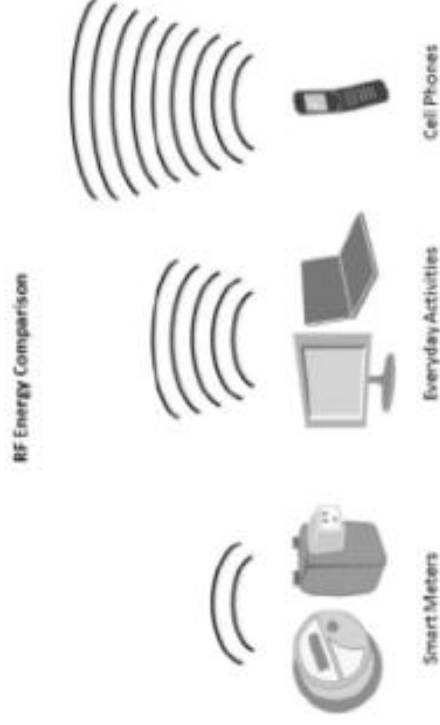
Source:

Mazar, H. “A Global Survey and Comparison of Different Regulatory Approaches to Non-Ionizing RADHAZ and Spurious Emissions.” Ministry of Communications, Israel.

Baumann, J., Goldberg, G., “Regulation for the protection of the general population in Switzerland.” Swiss Agency for the Environment, Switzerland.

# RADIO FREQUENCY AND SMART METERS

- Power signal less than 0.5% of Health Canada Safety Code 6 ( $2 \mu\text{W}/\text{cm}^2$  vs  $600 \mu\text{W}/\text{cm}^2$  )
- 50% below world's strictest regulation - Switzerland's precautionary limits for highly sensitive areas such as schools and hospitals ( $4.5 \mu\text{W}/\text{cm}^2$ )
- Equipped with a radio that is  $1/5^{\text{th}}$  of the power of handheld 2-way radio
- Communicates seconds a day
- Installed in existing meter sockets outside customer homes
- Radio frequency from a smart meter—over its entire 20-year life span—is equivalent to the exposure during a single 30 minute cell phone call.



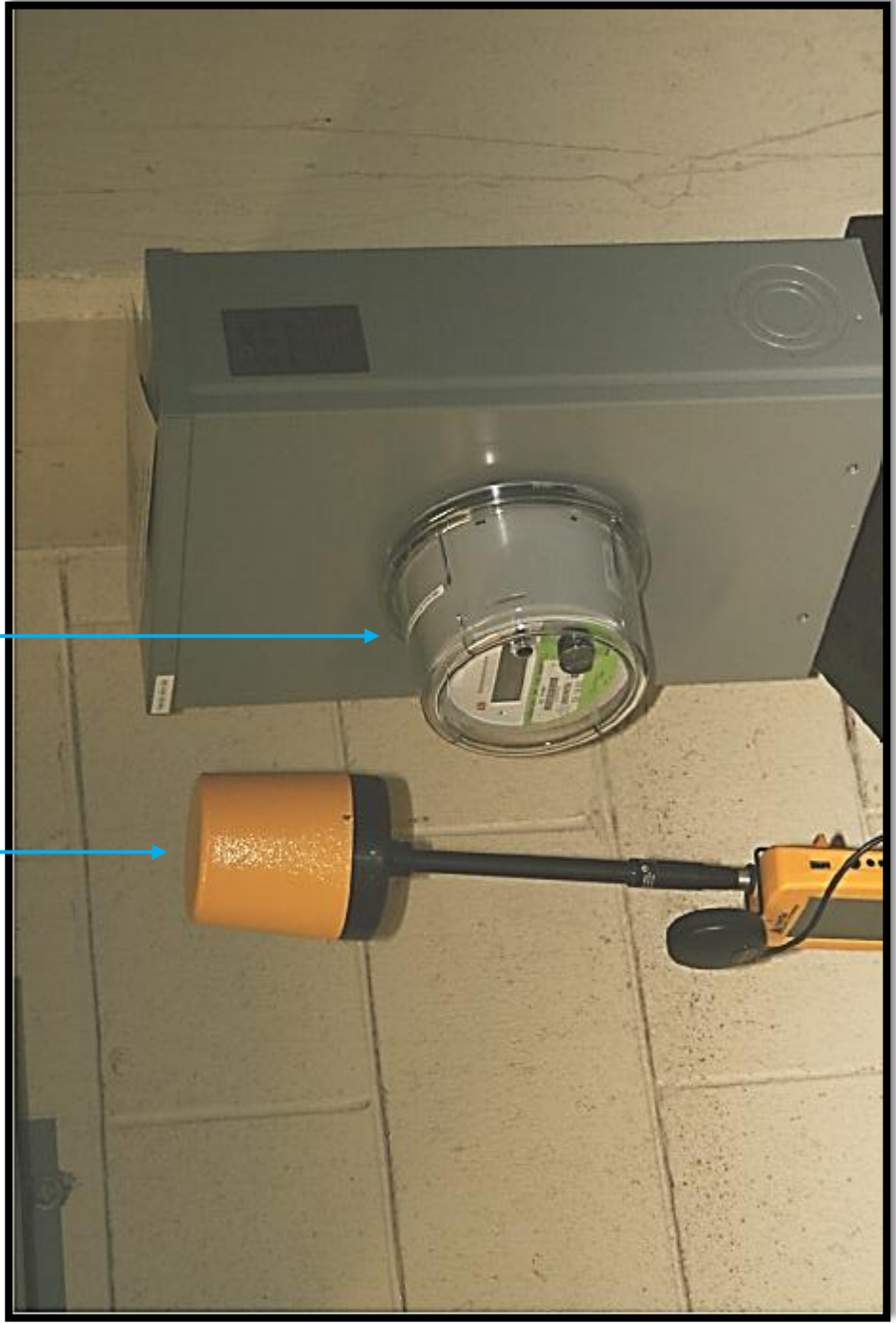
# PLANETWORKS CONSULTING CORPORATION

- Independent telecommunications engineering firm based in North Vancouver
- Specialize in certification of products and environments against Health Canada Safety Code 6 standards for electromagnetic profiles
- Contracted by BC Hydro to undertake independent compliance testing of BC Hydro's new wireless meters
- Use high-end, specialized measurement equipment – the Narda NDM-550 Broadband Field Probe
- All results and findings indicate that BC Hydro's meters are well within Health Canada Safety Code 6 limits
- Compliance testing completed on:
  - Single smart meter in a BC Hydro testing facility
  - Bank of 10 smart meters in a BC Hydro's operations facility
  - Bank of 40 smart meters in a apartment building meter room, in Victoria B.C.

# SINGLE METER IN BC HYDRO METER SHOP

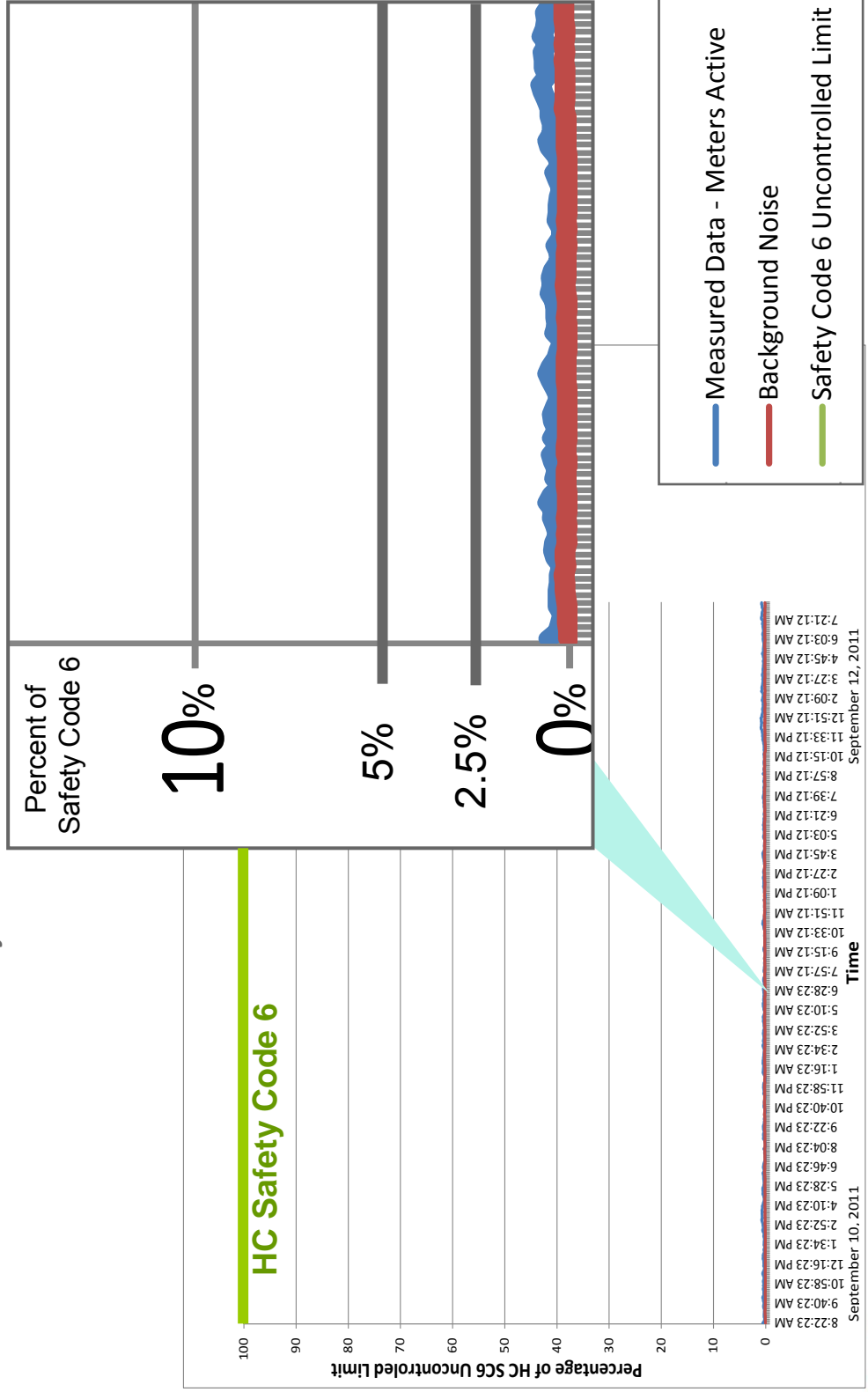
RF measurement probe

Single active smart meter

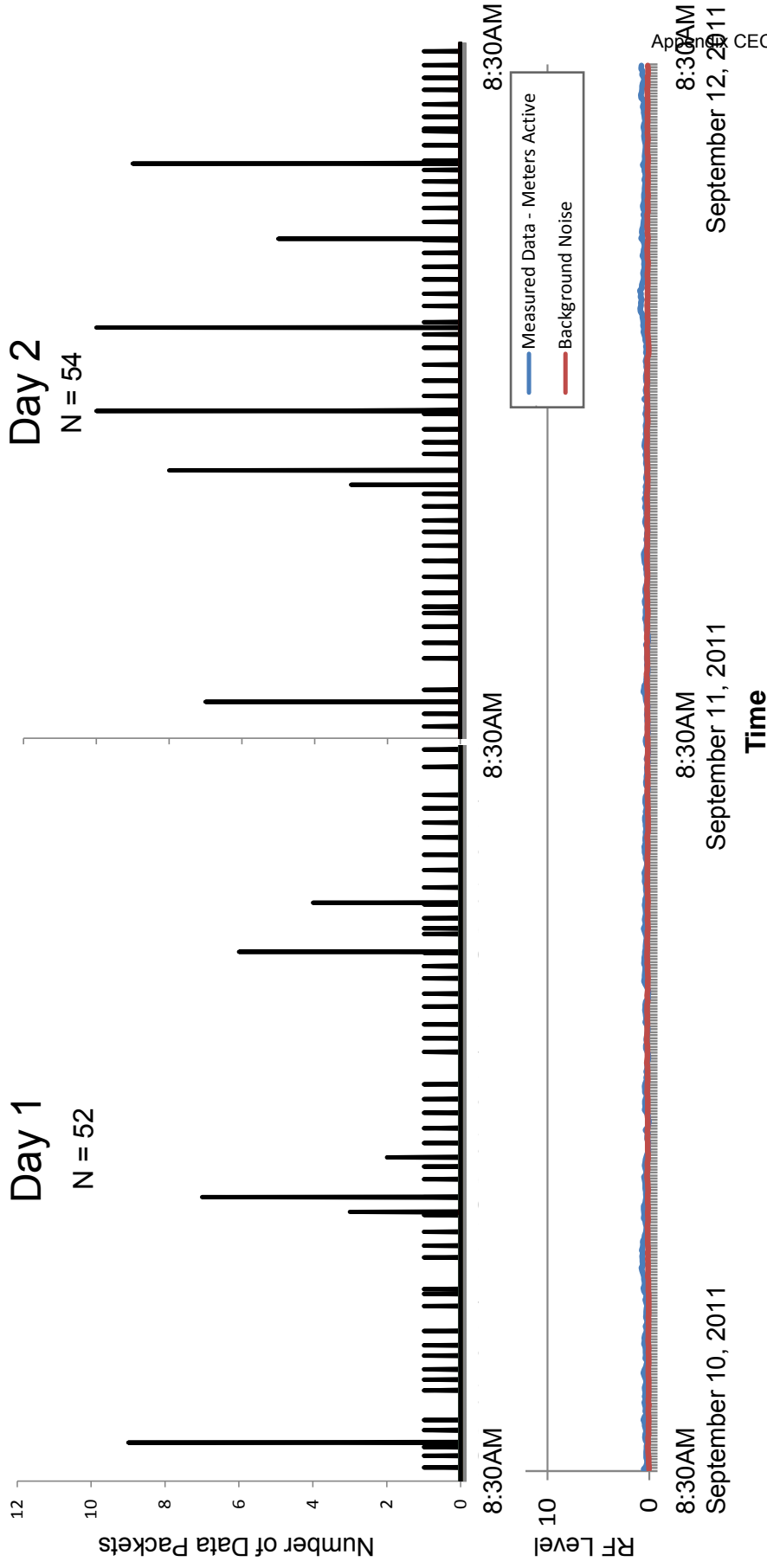


# SINGLE METER – RADIO FREQUENCY PROFILE

- At 20 cm from the meter, the average strength of a meter is 0.3795% of Health Canada's Safety Code 6.



# SINGLE METER – TRANSMISSION PROFILE RESULTS



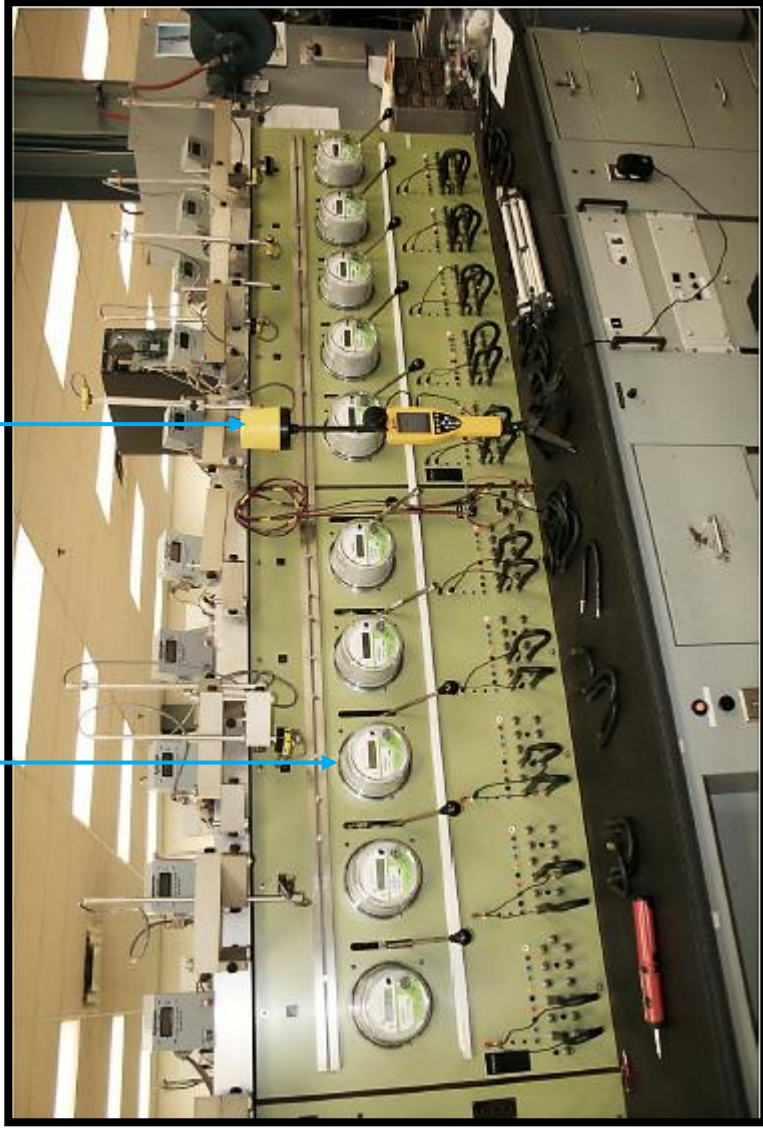
- The actual bytes transferred is 26,064 bytes (26kb), which is roughly half the file size of BC Hydro's logo on the bottom left (46kb)
- The total transmission time is 2.734 seconds for both days or 1.37 seconds per meter per day.



# 10 METER BANK IN BC HYDRO METER SHOP

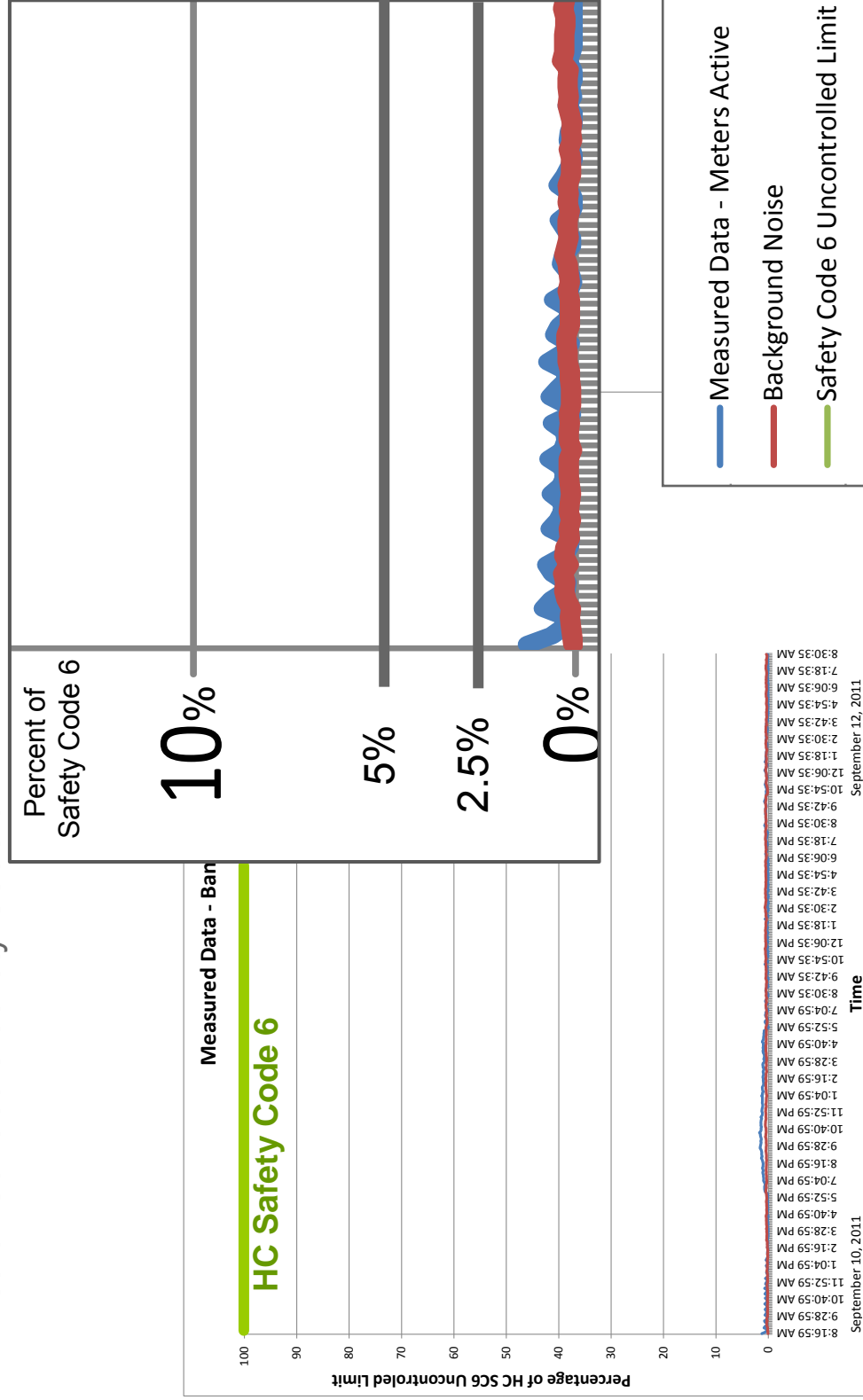
10 meter bank

RF measurement probe

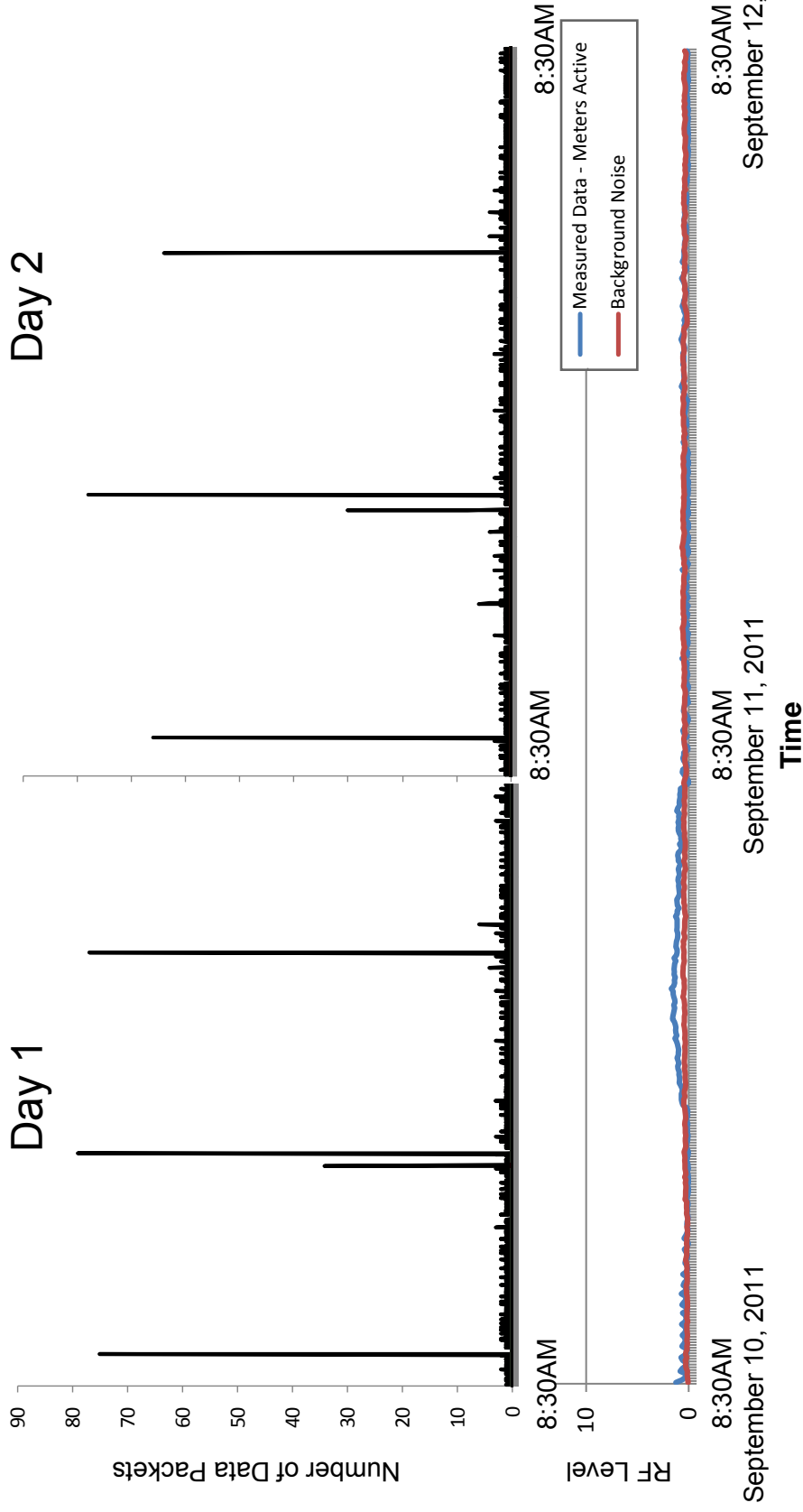


# 10 METER BANK – RADIO FREQUENCY PROFILE

- At 20 cm from the meters, the average strength of a meter is 0.4643% of Health Canada's Safety Code 6.



# 10 METER BANK – DATA TRANSMISSION PROFILE



Appendix CEC IR2 34.1a

- The actual bytes transferred is 188,114 bytes (188kb) for 10 meters or 18.8kb per meter, less than the amount of data for a single meter.
- Total transmission time is 19.756 seconds for both days or 0.99 seconds per meter per day

# 40 METER BANK IN VICTORIA, B.C.

40 meters bank

RF measurement probe

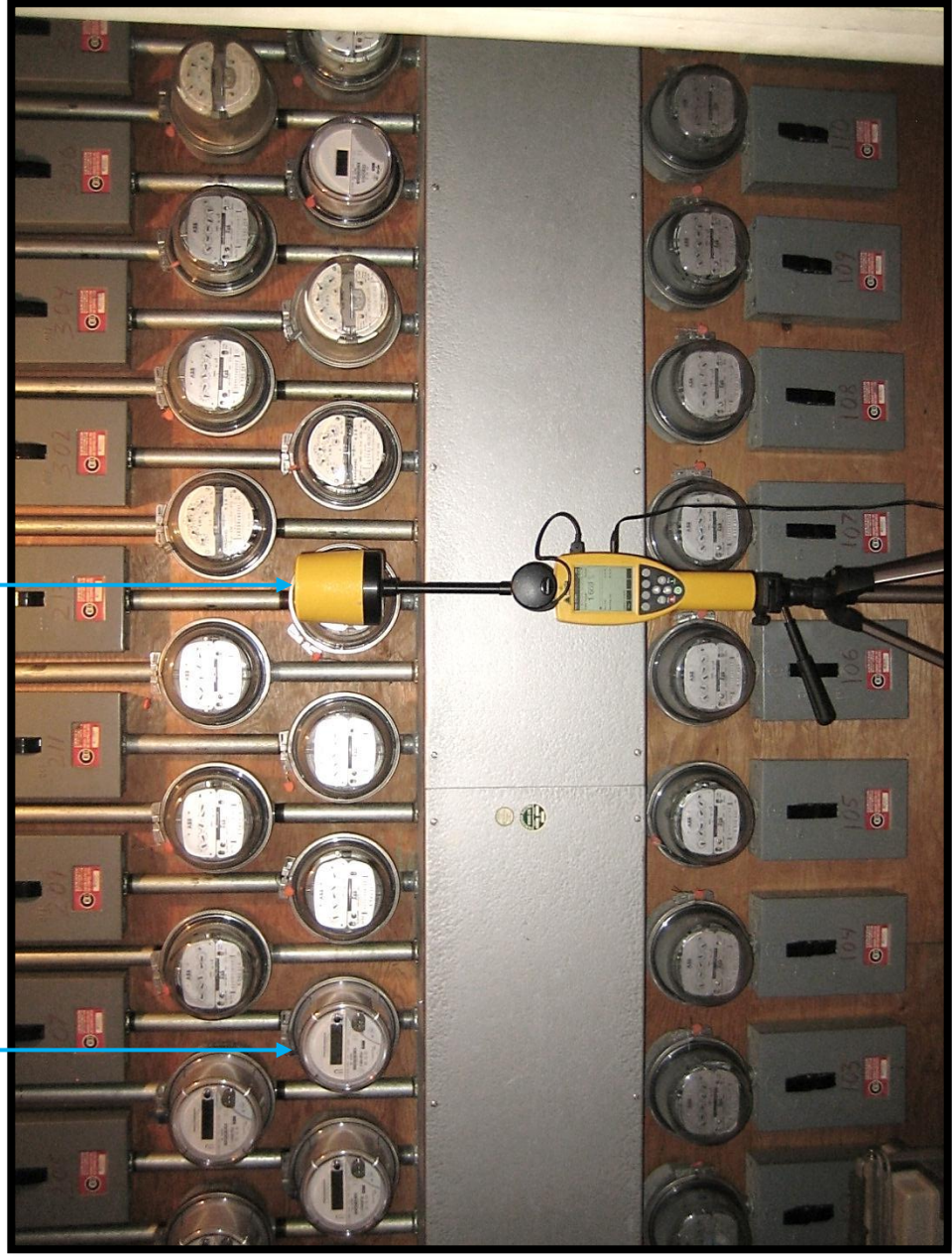


Image from day 1 of 5 - Baseline of existing environment

# 40 METER BANK VICTORIA – TEST CONDITIONS

- Day 1 - Baseline of existing environment (“background measure”)
- Day 2 - Installation of smart meters
- Day 3 - Stabilizing the network (“meters establishing their network”)
- Day 4 - Simulated network interruption (“exception event”)
- Day 5 - Operational steady-state (stable environment, one month later)

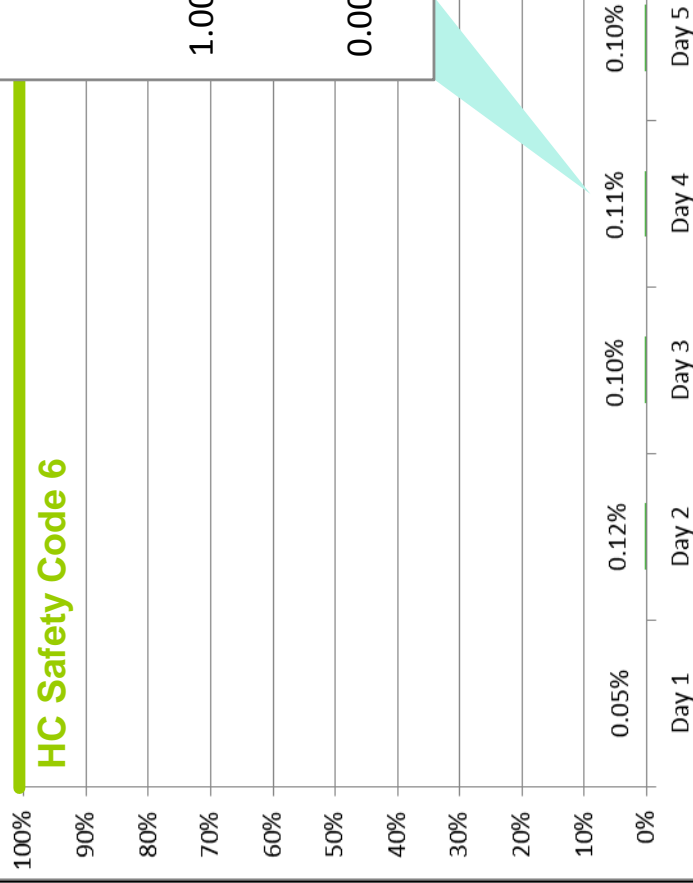


# 40 METER BANK VICTORIA – RADIO FREQUENCY PROFILE

- At 20 cm from the meter, the average strength of a meter is 0.1083% of Health Canada's Safety Code 6.
- Real life RF profile is less than testing environment because BC Hydro's facilities have more operational background levels.

**Average RF Level Measured by Day, Relative to**

**HC Safety Code 6**



Smart meter bank (40 meters) with background levels

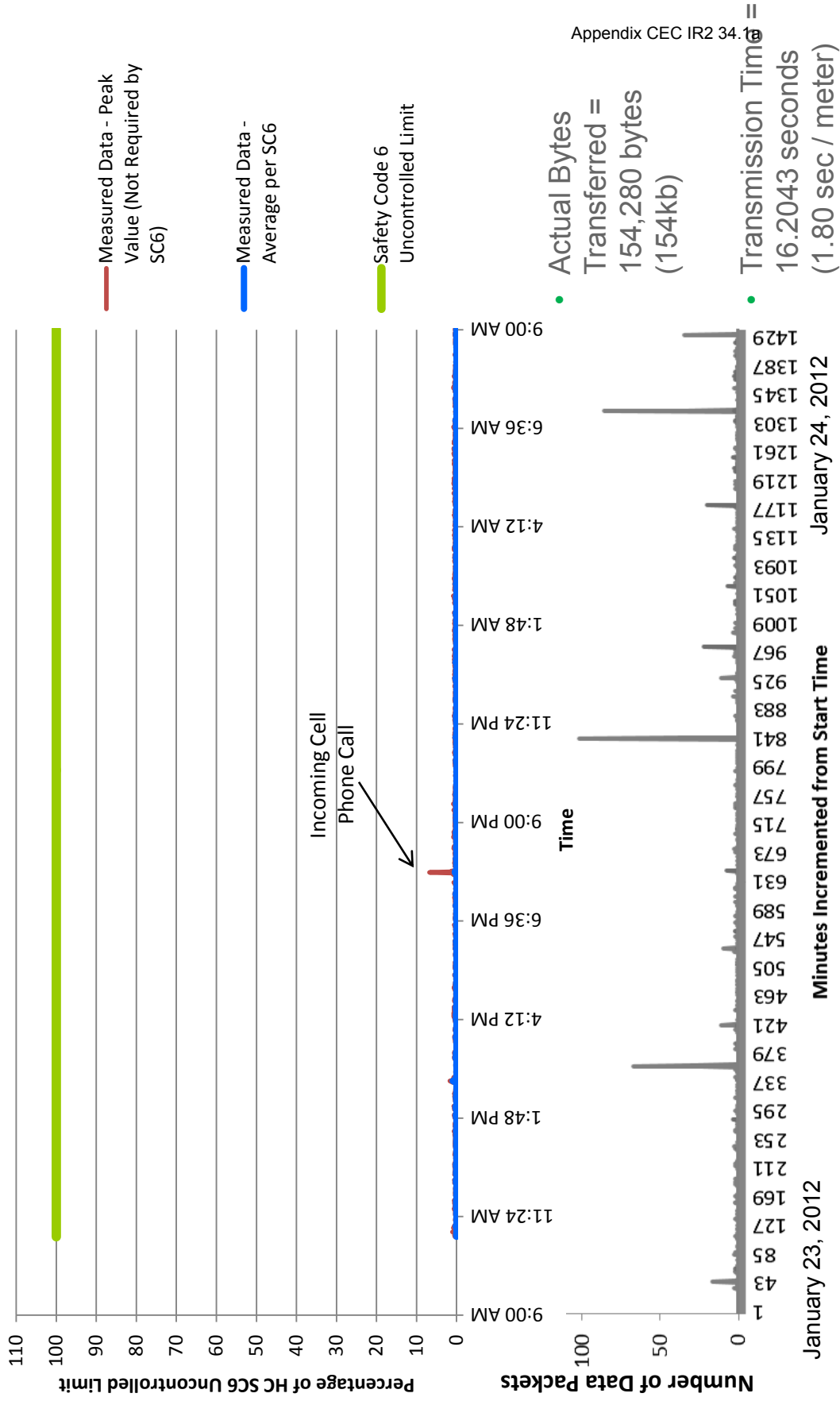
Baseline (Background levels with 9 smart meters and 31 electromechanical meters)



# 40 METER BANK IN VICTORIA

## – DAY 1 BASELINE TRANSMISSION

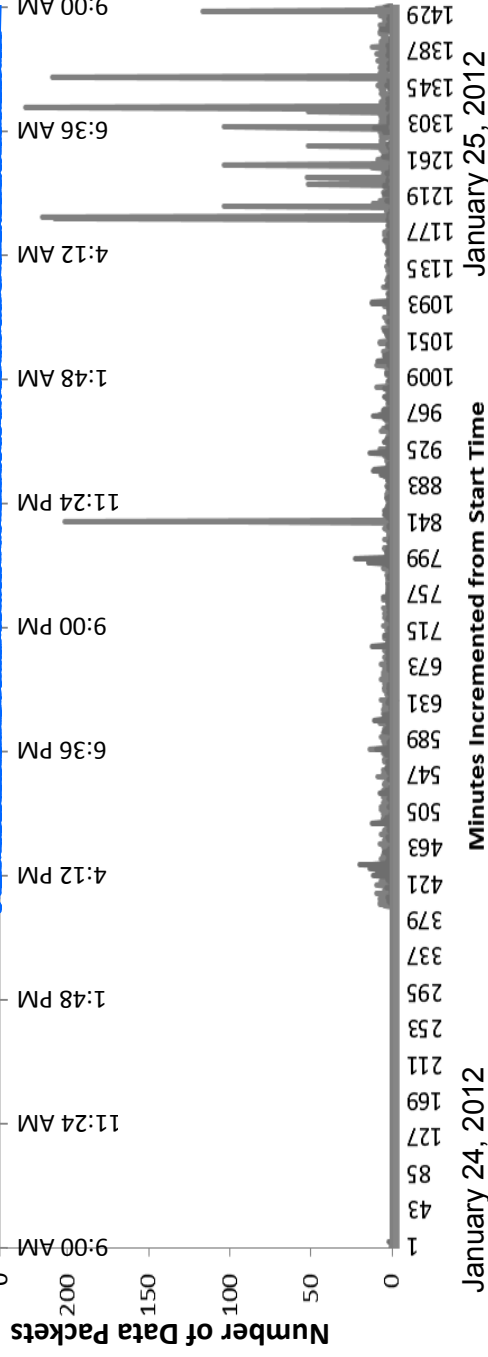
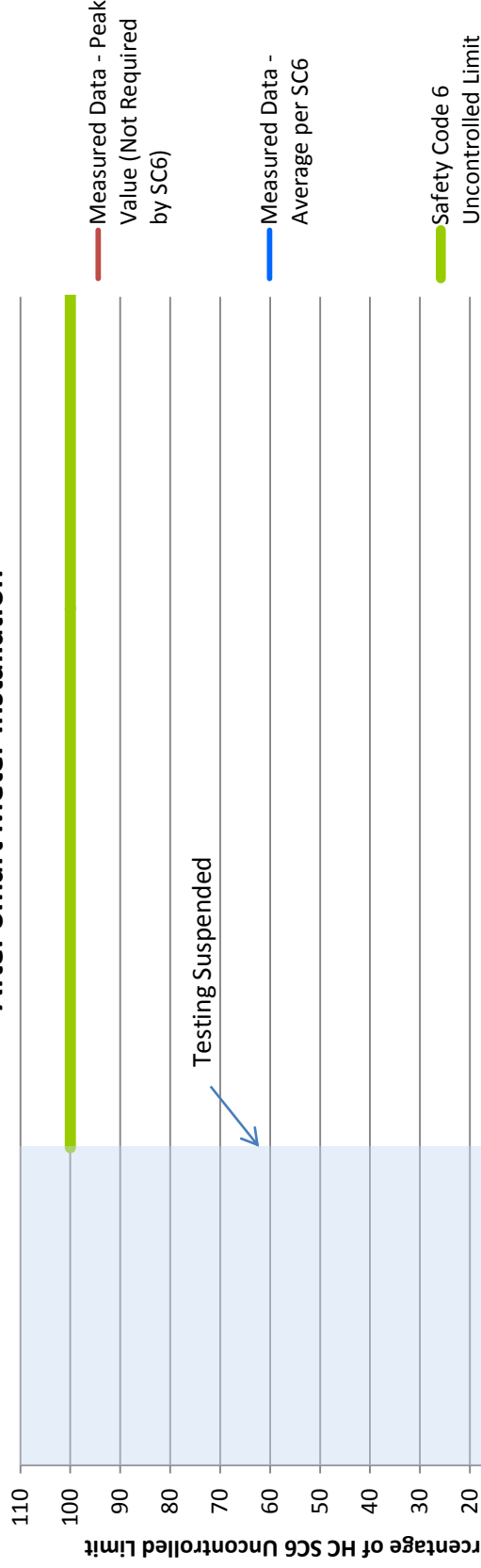
Prior to Smart Meter Installation



# 40 METER BANK IN VICTORIA

## – DAY 2 INSTALLATION OF SMART METERS

### After Smart Meter Installation



Actual Bytes Transferred = 432,170 bytes (432kb)

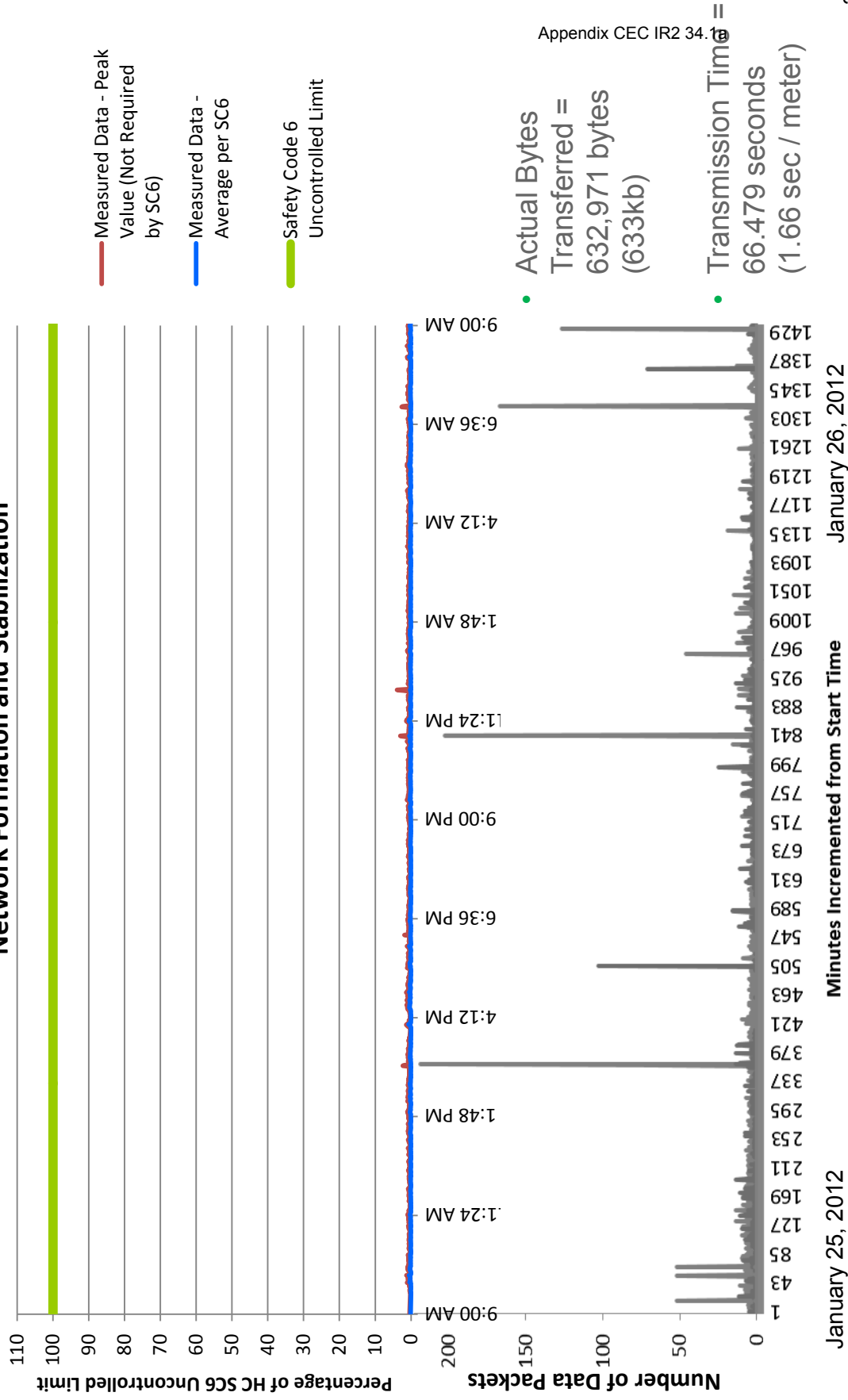
Transmission Time = 45.389 seconds (1.13 sec / meter)

Appendix CEC IR2 34.1



# 40 METER BANK IN VICTORIA – DAY 3 STABILIZING

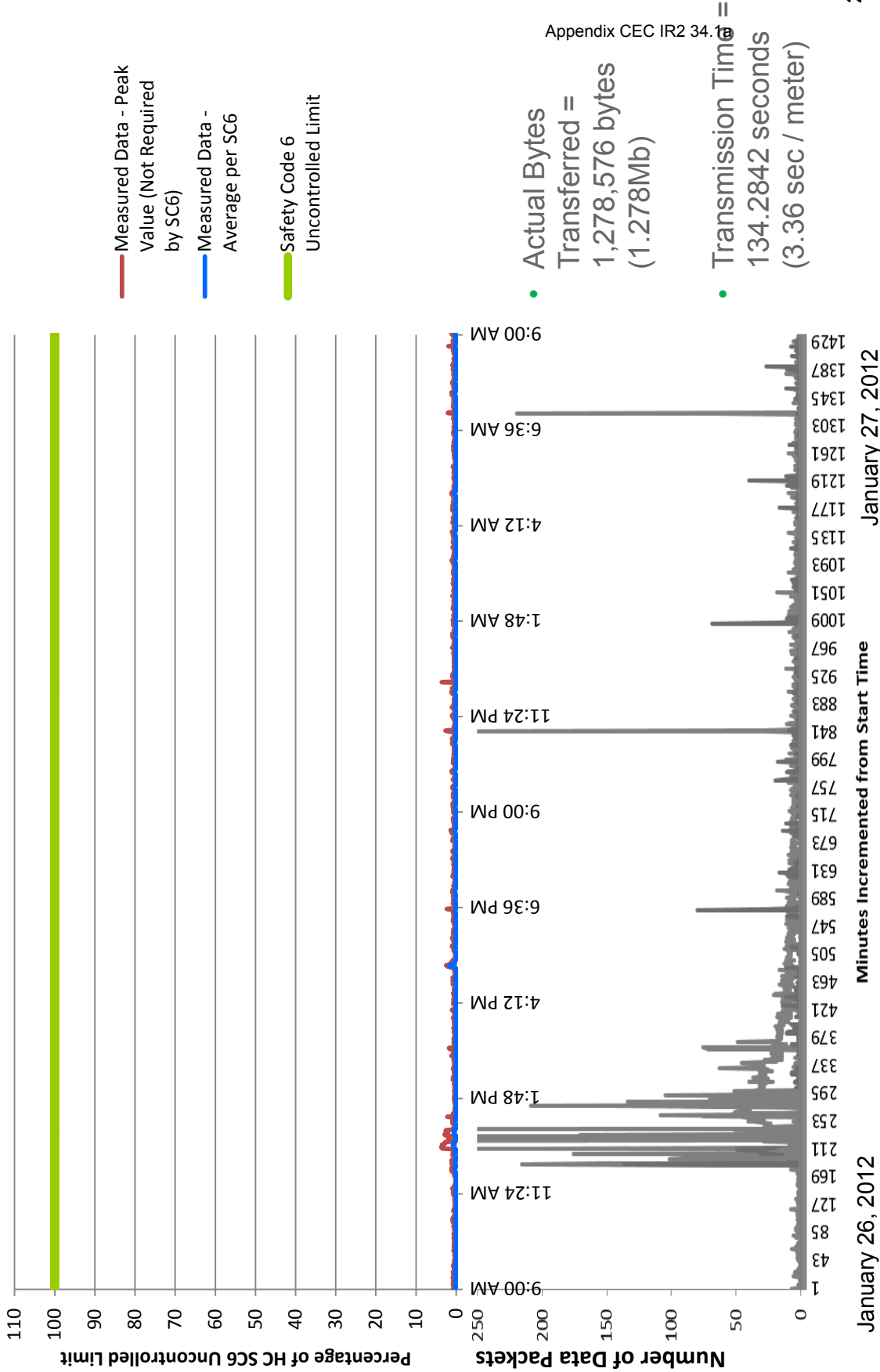
## Network Formation and Stabilization



# 40 METER BANK IN VICTORIA

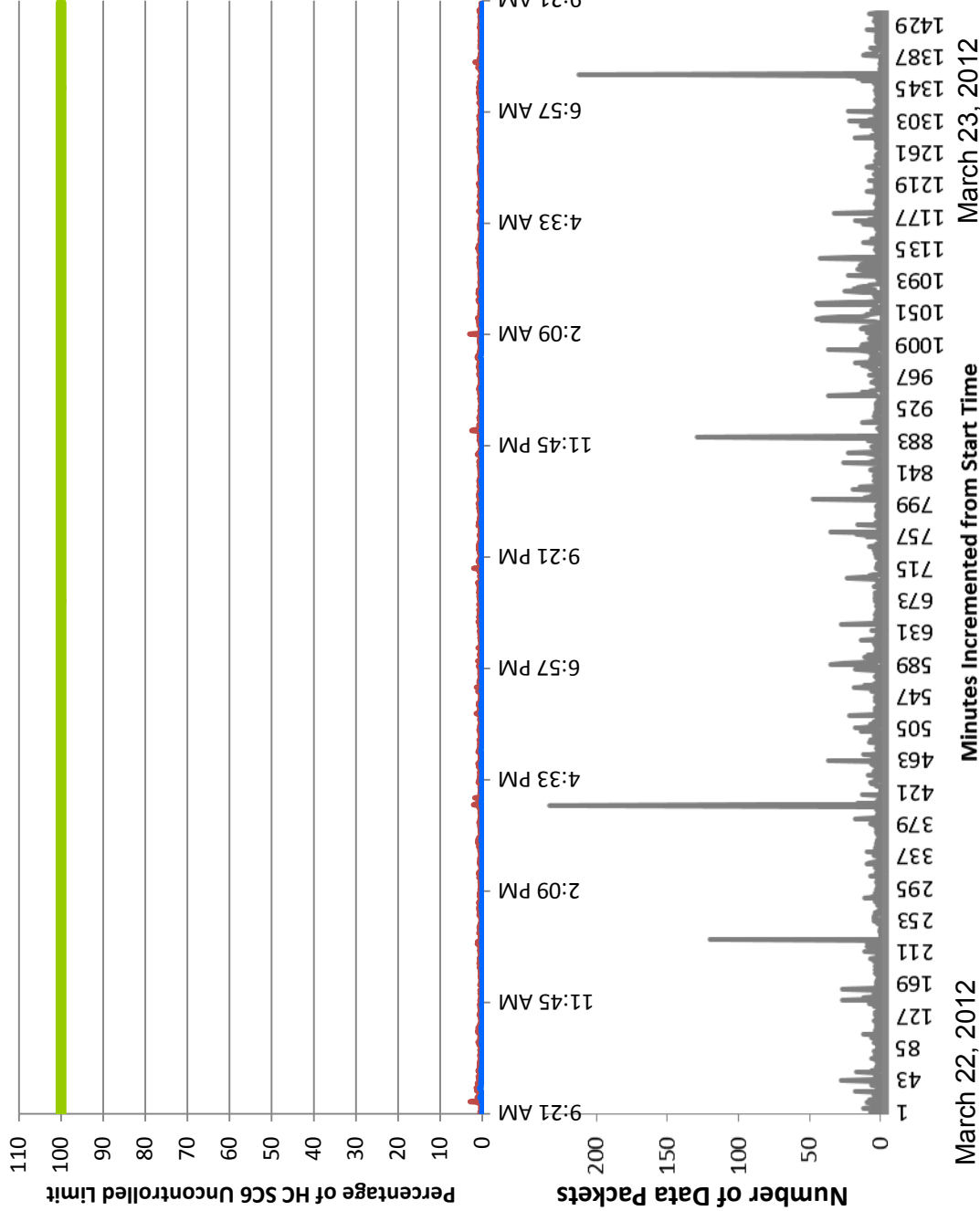
## – DAY 4 SIMULATED NETWORK DISRUPTION

After Simulated Network Disruption



# 40 METER BANK IN VICTORIA – DAY 5 OPERATIONAL STEADY-STATE

## After Smart Meters Reached Steady-State



Transmission time per meter is 2 to 3 seconds a day including days with higher traffic such as network formation and simulated network disruption.

Measured Data - Peak Value

Measured Data - Average per SC6

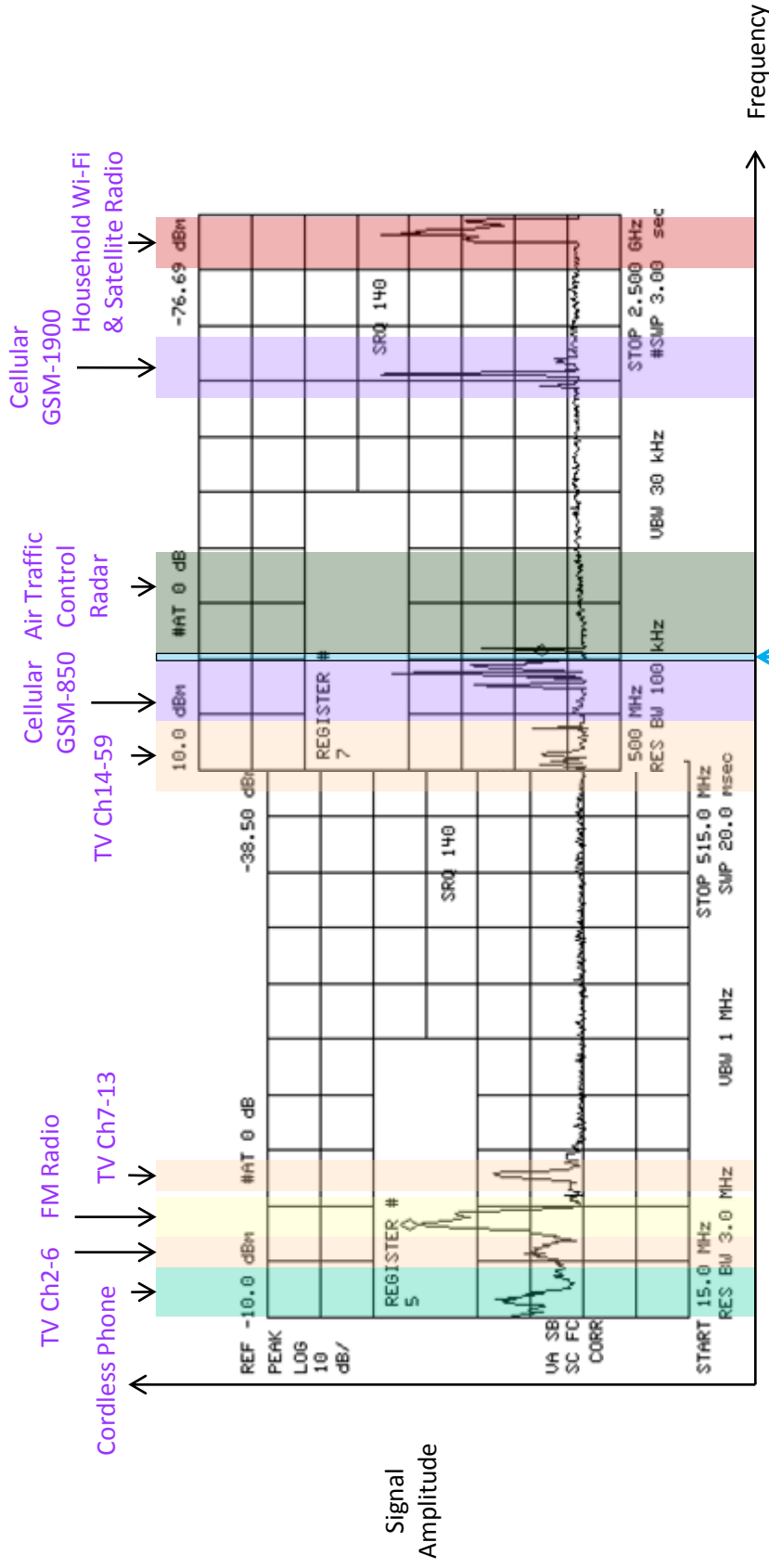
Safety Code 6 Uncontrolled Limit

Appendix CEC IR2 34.1a =

- Actual Bytes Transferred = 844,540 bytes (844kb)
- Transmission Time = 88.69 seconds (2.22 sec / meter)

# 40 METER BANK IN VICTORIA – SPECTRUM ANALYZER

- BC Hydro's meters use a narrow frequency band between 902 and 928 MHz
- More radio frequency activity and output is detected from other sources including FM radio and broadcast TV stations, cordless phones, and household Wi-Fi (personal internet)





# Questions?



[SmartMeters@bchydro.com](mailto:SmartMeters@bchydro.com)  
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| REVISIONS |     |               |                  |          |
|-----------|-----|---------------|------------------|----------|
|           | REV | DESCRIPTION   | DATE             | APPROVED |
|           | A   | Issued Report | October 11, 2011 | SMR      |
|           |     |               |                  |          |
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|   |  |     |             |  |   |                 |
|---|--|-----|-------------|--|---|-----------------|
|    | DRAWN  |     |             |  | Planetworks Consulting Corporation<br>North Vancouver, BC, Canada |                 |
|   | CHECKED  | SMR |             |  |   |                 |
| <b>BC Hydro – Single Smart Meter</b><br><b>Safety Code 6 Report</b><br><i>Prepared for BC Hydro</i>   |  |     |             |  |   |                 |
| THIS DOCUMENT HAS BEEN<br>ELECTRONICALLY SIGNED WHEN<br>STAMP IS VISIBLE. REFER TO THE<br>ELECTRONIC VERSION FOR<br>SIGNATURE AND DOCUMENT<br>VERIFICATION. | Prepared by: Karl Reardon, P.Eng.<br>Tel: 604 638 3018<br>Email: kreardon@planetnetworks.ca<br>Report date: October 11, 2011 |     | SIZE        |  | DWG. NO.<br>BC Hydro – Single Meter                               | REV<br><b>A</b> |
|   |  |     | SCALE: None |  |   | PAGE 1 OF 45    |

|            |  |           |
|------------|--|-----------|
| <b>1</b>   | <b>SUMMARY .....</b>   | <b>4</b>  |
| <b>1.1</b> | <b>SITE LOCATION/ DETAILS .....</b>                                      | <b>4</b>  |
| <b>1.2</b> | <b>ATTESTATION .....</b>   | <b>4</b>  |
| <b>1.3</b> | <b>SAFETY CODE 6 DEFINITIONS .....</b>                                   | <b>5</b>  |
| <b>1.4</b> | <b>REVIEW OF FINDINGS, CONCLUSIONS AND REMEDIAL ACTIONS .....</b>        | <b>7</b>  |
|            | 1.3.1 Meter Inventories.....   | 7         |
|            | 1.3.2 Findings.....  | 7         |
|            | 1.3.3 Next Steps and Required Remedial Actions .....                     | 9         |
| <b>2</b>   | <b>MEASUREMENT PROCEDURE.....</b>  | <b>10</b> |
|            | <b>2.1 DESCRIPTION OF PROCEDURE USED.....</b>                            | <b>10</b> |
|            | <b>2.2 TEST EQUIPMENT DESCRIPTION.....</b>                               | <b>10</b> |
| <b>3</b>   | <b>SITE PLAN AND PHOTOGRAPHS.....</b>                                    | <b>11</b> |
| <b>4</b>   | <b>TRAFFIC CONFIRMATION – METER UNDER TEST .....</b>                     | <b>12</b> |
| <b>5</b>   | <b>TRAFFIC CONFIRMATION – ALL METERS .....</b>                           | <b>14</b> |
| <b>6</b>   | <b>NBM-550 CALIBRATION CERTIFICATE .....</b>                             | <b>16</b> |
| <b>7</b>   | <b>PROBE CALIBRATION CERTIFICATE .....</b>                               | <b>19</b> |
| <b>8</b>   | <b>FIELD PROBE LOG FILES – METERS ACTIVE.....</b>                        | <b>25</b> |
| <b>9</b>   | <b>FIELD PROBE LOG FILES – BACKGROUND NOISE (NO METERS ACTIVE) .....</b> | <b>34</b> |
| <b>10</b>  | <b>INDEPENDENT REVIEW – EXOTEK SYSTEMS .....</b>                         | <b>45</b> |

## Executive Summary

### Objective

To certify the compliance of BC Hydro's smart meter (Itron's Openway Centron Meter, Hardware Profile 3.1) against Canadian federal regulations as specified by Health Canada Safety Code 6. This report describes the testing results for a single smart meter under test. A separate report describes the testing results for a meter bank of 10 meters.

### Approach

Planetworks, a telecommunication engineering consulting firm, has been contracted to conduct independent testing of BC Hydro's smart meters. Planetworks uses the Narda Broadband Field Meters (NDM-550) together with a shaped isotropic field probe, which is the most accurate field meter solution available for broadband radio-frequency (RF) exposure limit measurements. The testing environment has been constructed to be as realistic representation of usage environment as possible, with multiple meters located throughout the test area to simulate a full network environment. Although care was taken to ensure no other intentional emitters of RF energy were present in the testing environment, it was not possible to eliminate the secondary sources of RF such as fluorescent lighting, electrical transformers, external Wi-Fi hotspots, signals from cellular sites, broadcast sources, etc. Therefore, some level of background RF energy is included in all the measurement results.

All testing has been conducted in conformance to procedures defined in Health Canada's Safety Code 6. At the operational frequencies of the smart meter, Safety Code 6 defines a maximum permissible power density of  $6 \text{ W/m}^2$  (averaged over a 6 minute period) for uncontrolled areas (i.e. public areas). Using the relationship that  $1 \text{ W/m}^2$  equals  $100 \mu\text{W/cm}^2$ , the Safety Code 6 permissible limit for 900 MHz emissions can be converted to  $600 \mu\text{W/cm}^2$ .

### Findings

1. At 20 centimetres from the meter, the average power density measured over a 2 day period is 0.3795% of Health Canada Safety Code 6 limit for public areas (uncontrolled environments). As noted above, this measured value includes the background radio-frequency signals originating from other internal or external sources.
2. The Narda Field Meter measures the cumulative emissions across a very wide frequency range and automatically applies measurements against the Health Canada Safety Code 6 limit appropriate for each frequency. While this approach provides a very accurate assessment of percentage of Safety Code 6 limit attained, it is not possible to accurately convert this value into a power density due to the presence of the background RF sources. However, if it is assumed that all measured emissions originated from the smart meter during the test, the attained percentage value of 0.3795% can be converted to a power density of  $2.3 \mu\text{W/cm}^2$  (2.3 microwatts per square centimetre). The actual power density attributed to the smart meter only would be less than this value.
3. The range of power densities measured over the 2 day period was 0.034% to 0.916% of Safety Code 6 limits for public areas (uncontrolled environments).
4. The active transmission time for the one meter under test was 0.904 seconds on Day 1 and 1.83 seconds on Day 2 for a total cumulative transmission time of 2.734 seconds over the 2 day testing period. This includes all transmissions from the meter.



## 1 Summary

### 1.1 Site Location/ Details

|                      |   |
|----------------------|---|
| Site Street Address  | BC Hydro Meter Shop   |
| Location of Antennas | Single Itron Smart Meter with AMI7 Radio Located in the Building Basement |

|                  |                        |                       |                        |
|------------------|------------------------|-----------------------|------------------------|
| Test Start       | Sept 10, 2011 08:16:23 | Test Stop             | Sept 12, 2011 08:33:12 |
| Site Plan Attch. | Yes                    | Antenna Photos Attch. | Single Meter Photo     |
| Site Photo Attch | Yes                    | Log Files Attch.      | Yes                    |

### 1.2 Attestation

I, Karl Reardon, a Professional Engineer registered in the Province of British Columbia, certify that, at the time of testing, the radio frequency field levels for a single Itron Smart Meter with AMI7 radio complies with Health Canada regulations based on the specified documentation below:

- (HC Pub. 091029) Limits of Human Exposure to Radio frequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz - Safety Code 6 (2009)
- (HC Pub. 091031) Technical Guide for Interpretation and Compliance Assessment of Health Canada's Radio frequency Exposure Guidelines

|   |   |
|---|---|
| Measured Results Below Health Canada Safety Code 6 Exposure Limits for Uncontrolled Environments<br>(General Public, not trained in radio frequency hazards, exposed to RF and Microwave emissions) | Within Safe Limits Defined by Health Canada |
| Induced Currents are below HC-SC6 Requirements  | Yes   |
| Signage Meets HC-SC6 Requirements   | n/a   |

#### Notes

(1) This test involved a single Itron meter in the basement of the meter shop. There were multiple meters located on the floor above, simulating a full network environment as shown in Section 3.

(2) The 900 MHz RF transmitter was active in the meter during testing. Consistent with BC Hydro's planned deployment practice, the ZigBee RF section was disabled during testing (i.e. the ZigBee radio was in its default, off state).

(3) The Narda probe was placed to ensure that the path between the Itron meter's antenna and the Narda Probe was unobstructed, as shown in Section 3. This placement ensured maximum readings from the meter under test.

(4) The Narda meter records cumulative RF emissions from all RF sources in the spectral range from 0.3 MHz to 50,000 MHz. Care was taken to ensure no other RF sources were active in the building during the test. It should be noted that buildings typically contain many secondary RF sources such as fluorescent lighting, electrical transformers, motors, etc. Additionally, most populated areas contain many external RF sources that cannot be controlled, including Wi-Fi hotspots, signals from cellular sites and devices, two-way radio communication and broadcast sources.

### 1.3 Safety Code 6 Definitions

Prior to the 2009 dated release of the Health Canada Safety Code 6 specifications, the documentation defined exposure limits for "RF and occupationally exposed workers" and exposure limits for the "general public." The general public was defined as any individual who may be exposed to RF emissions and has no knowledge or training in radio technology. Consequently exposure limits for the general public are five times lower than that for the RF worker who must have adequate safety training to work with antenna systems.

Challenges arose when defining "occupationally exposed workers." In the 2009 edition of the Safety-Code 6 guidelines, Health Canada attempted to address the ambiguities in these definitions by categorizing sites as "controlled" and "uncontrolled" where "uncontrolled" replaced the definition for the general public.

The following text is lifted from current Health Canada's Safety Code 6 documentation and defines controlled versus uncontrolled environments.

#### **Controlled and Uncontrolled Environments**

"For the purpose of this code, controlled environments are defined as those where all of the following conditions are satisfied:

- (a) The RF field intensities in the controlled area have been adequately characterized by means of measurements, calculations or modeling (such as with the use of FDTD [finite difference time domain] software),
- (b) The exposure is incurred by persons who are aware of the potential for RF exposure and are cognizant of the intensity of the RF energy in their environment and,
- (c) The exposure is incurred by persons who are aware of the potential health risks associated with RF energy exposures and whom can control their risk using mitigation strategies.

All situations that do not meet the specifications above are considered to be uncontrolled environments. Uncontrolled environments are defined as areas where either insufficient assessment of RF energy has been conducted or where persons who are allowed access to these areas have not received proper RF awareness training and have no means to assess or, if required, mitigate their exposure to RF energy."<sup>1</sup>

Exposure limits for controlled and uncontrolled environments is defined by Health Canada in the following tables.

---

<sup>1</sup> "Chapter 2, Maximum Exposure Limits", Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz, HC Pub.: 091029

Table 5. Exposure Limits for Controlled Environments.

| 1<br>Frequency<br>(MHz) | 2<br>Electric Field<br>Strength; rms<br>(V/m) | 3<br>Magnetic Field<br>Strength; rms<br>(A/m)  | 4<br>Power<br>Density<br>(W/m <sup>2</sup> ) | 5<br>Averaging<br>Time<br>(min)   |
|-------------------------|---|--|--|-----------------------------------|
| 0.003 - 1               | 600   | 4.9  |  | 6                                 |
| 1 - 10                  | 600/ <i>f</i>                                 | 4.9/ <i>f</i>                                  |  | 6                                 |
| 10 - 30                 | 60  | 4.9/ <i>f</i>                                  |  | 6                                 |
| 30 - 300                | 60  | 0.163  | 10*  | 6                                 |
| 300 - 1 500             | 3.54 <i>f</i> <sup>0.5</sup>                  | 0.0094 <i>f</i> <sup>0.5</sup>                 | <i>f</i> /30                                 | 6                                 |
| 1 500 - 15 000          | 137   | 0.364  | 50   | 6                                 |
| 15 000 - 150 000        | 137   | 0.364  | 50   | 616 000 / <i>f</i> <sup>1.2</sup> |
| 150 000 - 300 000       | 0.354 <i>f</i> <sup>0.5</sup>                 | 9.4 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup> | 3.33 x 10 <sup>-4</sup> <i>f</i>             | 616 000 / <i>f</i> <sup>1.2</sup> |

\* 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/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.

3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

Table 6. Exposure Limits for Uncontrolled Environments.

| 1<br>Frequency<br>(MHz) | 2<br>Electric Field<br>Strength; rms<br>(V/m) | 3<br>Magnetic Field<br>Strength; rms<br>(A/m)   | 4<br>Power<br>Density<br>(W/m <sup>2</sup> ) | 5<br>Averaging<br>Time<br>(min)   |
|-------------------------|---|---|--|-----------------------------------|
| 0.003 - 1               | 280   | 2.19  |  | 6                                 |
| 1 - 10                  | 280/ <i>f</i>                                 | 2.19/ <i>f</i>                                  |  | 6                                 |
| 10 - 30                 | 28  | 2.19/ <i>f</i>                                  |  | 6                                 |
| 30 - 300                | 28  | 0.073   | 2*   | 6                                 |
| 300 - 1 500             | 1.585 <i>f</i> <sup>0.5</sup>                 | 0.0042 <i>f</i> <sup>0.5</sup>                  | <i>f</i> /150                                | 6                                 |
| 1 500 - 15 000          | 61.4  | 0.163   | 10   | 6                                 |
| 15 000 - 150 000        | 61.4  | 0.163   | 10   | 616 000 / <i>f</i> <sup>1.2</sup> |
| 150 000 - 300 000       | 0.158 <i>f</i> <sup>0.5</sup>                 | 4.21 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup> | 6.67 x 10 <sup>-5</sup> <i>f</i>             | 616 000 / <i>f</i> <sup>1.2</sup> |

\* 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/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.

3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

Applying the exposure limits from these standards to BC Hydro's smart meters – which use an AMI7 radio operating at 900 MHz – the limits are:

- **Uncontrolled Environments** – 6 watts/meter squared (W/m<sup>2</sup>) or 600 microwatts per centimeter squared (μW/cm<sup>2</sup>)
- **Controlled Environments** – 30 W/m<sup>2</sup> or 3,000 μW/cm<sup>2</sup>

Conversion between W/m<sup>2</sup> and μW/cm<sup>2</sup> is performed using the relationship that 1 W/m<sup>2</sup> equals 100 μW/cm<sup>2</sup>.

## 1.4 Review of Findings, Conclusions and Remedial Actions

Planetnetworks conducted testing to Health Canada Safety Code 6 for a single smart meter installation deployed in a realistic field simulation, with multiple meters at further distances.

### 1.3.1 Meter Inventories

A single meter was present in the immediate test area. A total of 21 Smart Meters and one Collector were located within 50 metres of the test location on the floor above. The meter inventories are listed below. The meter under test was badge # 3,990,096, however all other meters were also active.

| Badge #          | Meter Type  | Location     |
|------------------|-------------|--------------|
| 3,990,002        | P261        | POR 19       |
| 3,990,003        | P261        | POR 18       |
| 3,990,028        | P263        | Panel 9      |
| 3,990,029        | P263        | Panel 9      |
| 3,990,030        | P263        | Panel 9      |
| 3,990,031        | P263        | Panel 9      |
| 3,990,032        | P263        | Panel 9      |
| 3,990,033        | P263        | Panel 9      |
| 3,990,034        | P263        | Panel 9      |
| 3,990,035        | P263        | Panel 9      |
| 3,990,040        | P263        | Panel 9      |
| 3,990,041        | P263        | Panel 9      |
| <b>3,990,096</b> | <b>P264</b> | <b>POR20</b> |
| 3,990,099        | P264        | POR21        |
| 3,990,124        | P264        | POR22        |
| 3,990,125        | P264        | POR23        |
| 3,990,126        | P264        | POR24        |
| 3,990,127        | P264        | POR25        |
| 3,990,101        | P264        | POR26        |
| 3,990,102        | P264        | POR27        |
| 3,990,103        | P264        | POR28        |

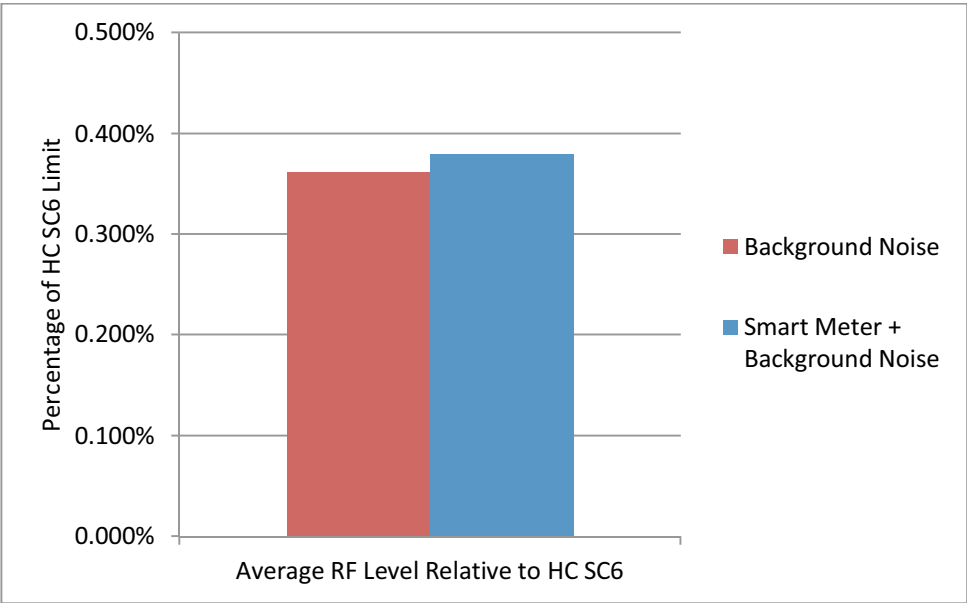
Details regarding the meter locations and Collector (SGCR) location are included in Section 3.

### 1.3.2 Findings

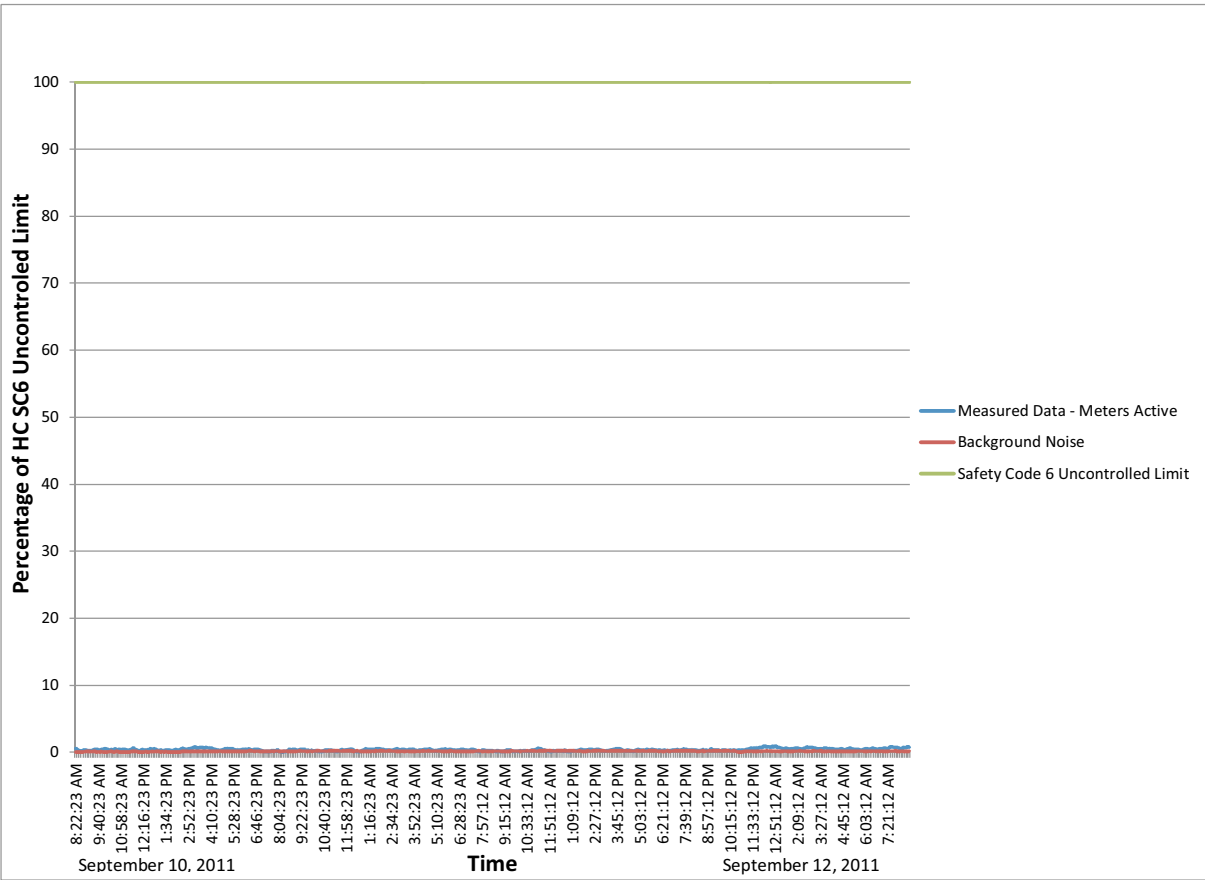
Testing showed that even in close proximity (20 centimetres) to the meter, RF emissions from the meter are more than 250 times less than Health Canada limits for the general public in uncontrolled environments. The cumulative effect of both the meter under test, other meters in the building, and all background emissions from other internal (e.g. fluorescent lighting) and external sources (e.g. cell sites), resulted in an average level of 0.3795% of the Health Canada Safety Code 6 (HC SC-6) in an uncontrolled environment standard (i.e.  $1/263^{\text{rd}}$  of the limit).

Background measurements were also taken at the same site location one week later (Measurement start: Sept 16, 2011 15:54:09 Measurement Stop: Sept 19, 2011 11:24:09). During these background tests all meters and associated hubs and router were confirmed to be off and not transmitting. The measured average across this time period was 0.3615% of the HC SC-6 limit for the general public in uncontrolled environments. While one cannot draw a full correlation between the two tests as they occurred over different time periods, it is noted that a low level of background emissions are present at the location without the Smart Meter system active, and that the level recorded when the Smart Meters were active was not significantly different.

These results are illustrated in the following chart:



Detailed testing results are provided in Section 8, and illustrated in the following table:



The Narda field strength probe uses a frequency shaped head which measures RF emission limits at different frequencies and presents a cumulative total of all emissions as a percentage of Safety Code 6. While this approach provides a very accurate assessment of percentage of Safety Code 6 limit, it is not possible to accurately convert this

into a power density value at a single frequency due to the presence of the background RF sources. However, if it is assumed that all measured emissions originated around 900 MHz, the attained percentage value of 0.3795% can be converted to a power density of 2.3  $\mu\text{W}/\text{cm}^2$  (2.3 microwatts per square centimetre).

NOTE: At this time, the Narda unit represents the most accurate broadband, cumulative field metering solution available for RF exposure limit measurements in operational environments. The average emissions measured are below a field strength of 4.340 V/m, which is the lower limit rating of the Narda unit. At measurements below this level, the accuracy of the results may not be within the tolerance specified in the meter calibration certificate (Section 6) and the results obtained may also include internal noise generated by the Narda meter. It is therefore likely that the emissions from the Itron Smart meter is actually lower than those measured in this report.

### 1.3.3 Next Steps and Required Remedial Actions

No remedial actions are required.

## 2 Measurement Procedure

### 2.1 Description of Procedure Used

Field measurements used to determine conformity with the limits specified in SC6 are performed with the field sensor (probe) placed at least 20 centimetres away from any object or person with measurements averaged over 6 minutes as per SC6. The following measurements were taken at 20 centimetres from the meter over a 48 hour period. The probe was located in a position to receive maximum emissions from the Smart Meter (i.e. just above the Smart Meter' top housing) as shown in Section 3.

The spatially averaged values are calculated based on the RMS average of the electric and magnetic field strengths of the samples.

RF field strengths measured included all active transmitters (meter under test as well as meters on upper floor and other RF sources) at the time of testing.

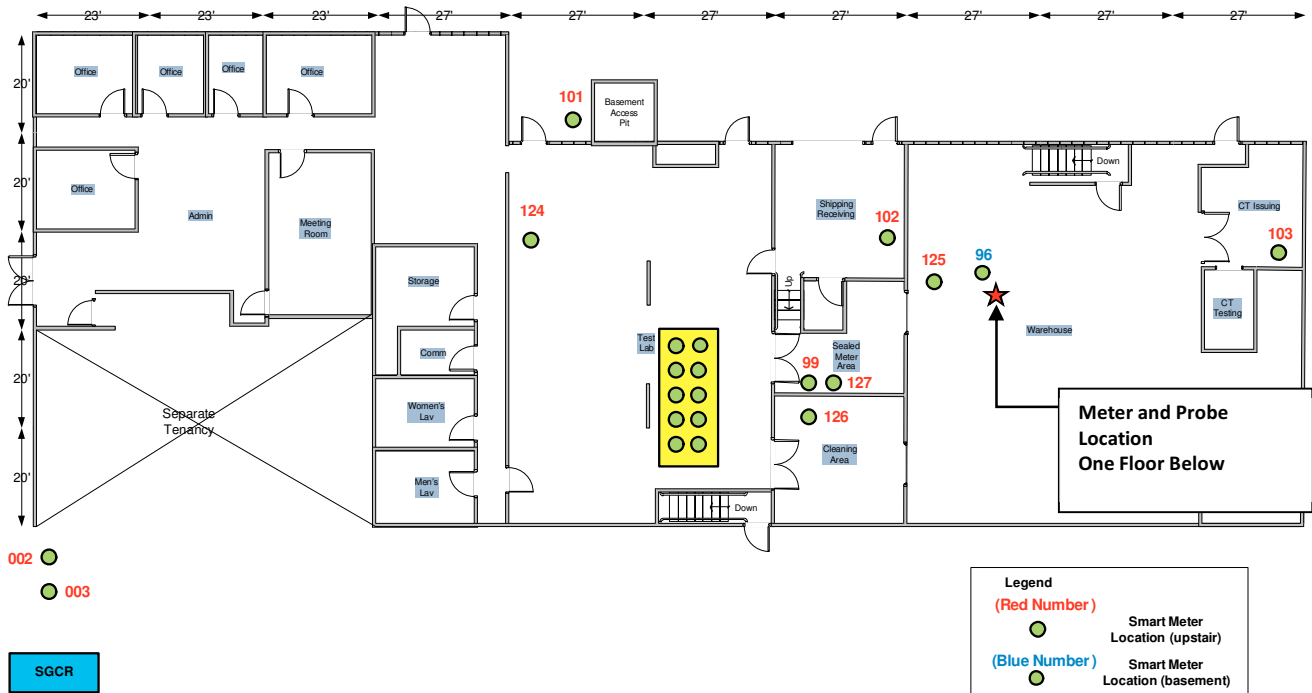
### 2.2 Test Equipment Description

|       |               |                  |                             |
|-------|---------------|------------------|-----------------------------|
| Meter | Narda NBM-550 | Serial #: D-0146 | Calibration due: 2013-01-28 |
| Probe | Narda EC5091  | Serial #: 01025  | Calibration due: 2013-06-06 |

The following list of parameters was downloaded from the meter and was used as the basis of the testing:

|                               |            |
|-------------------------------|------------|
| Device Product Name           | NBM-550    |
| Device Serial Number          | D-0146     |
| Device Cal Due Date           | 28/01/2013 |
| Probe Product Name            | EC5091     |
| Probe Serial Number           | 01025      |
| Probe Cal Due Date            | 06/06/2013 |
| Probe Field Type              | E          |
| Probe Connection Type         | C          |
| Probe Lower Frequency Limit A | 300 kHz    |
| Probe Upper Frequency Limit A | 50 GHz     |
| Probe Lower Frequency Limit B | 300 kHz    |
| Probe Upper Frequency Limit B | 50 GHz     |
| Probe Emin A                  | 4.340 V/m  |
| Probe Emax A                  | 150.0 V/m  |
| Probe Emin B                  | 4.340 V/m  |
| Probe Emax B                  | 150.0 V/m  |
| Shaped Probe                  | YES        |
| Standard ID                   | 5          |
| Standard Name                 | Canada,occ |
| Apply Standard                | ON         |
| Frequency                     | 1.8 GHz    |
| Apply Correction Frequency    | OFF        |
| Eref_E(f)                     | 137.0 V/m  |
| Eref_H(f)                     | 137.2 V/m  |
| Combi Probe Use               | E_H        |
| Unit                          | A/m        |
| Results Format                | FIXED      |
| Auto-Zero Interval            | OFF        |

3 Site Plan and Photographs



The following photograph indicates positioning of the Narda probe in relation to the meter under test:





#### 4 Traffic Confirmation – Meter under Test

To confirm that all meters were active and transmitting during the test period, an external packet sniffer was used to verify traffic levels. The following two result files show the traffic for the meter under test for the 2 day time period. Note that this information only shows how often the meter is active during a 24-hour period, and the relative amount of information transmitted during each broadcast (i.e. number of packets). These graphs are not an indicator of the transmitter power output.

##### Conditions of Test (Day 1)

**MAC Address = 7496813**

Beginning of Packet Sniffer Data = 9/10/2011 8:00:00 AM

Interrogations:

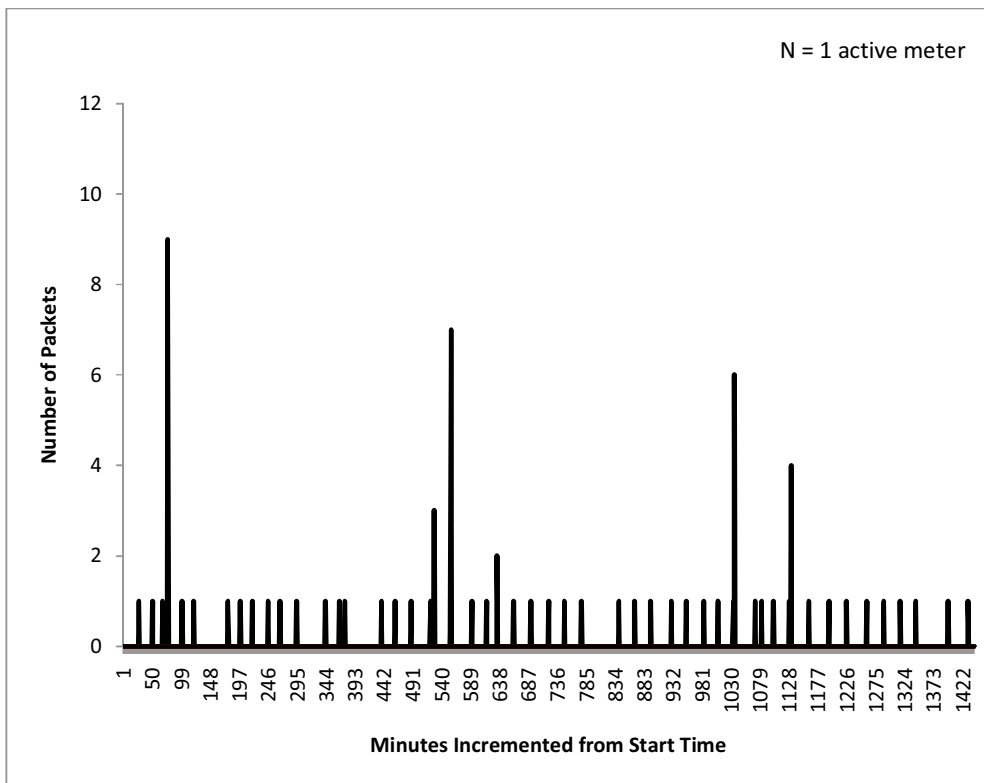
9/10/2011 9:15:07 AM

9/10/2011 5:15:12 PM

9/11/2011 1:15:11 AM

Ending of Packet Sniffer Data = 9/11/2011 8:00:00 AM

##### Packets Per Minute Starting at 9/10/2011 08:00:00 AM



\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

##### Data Transmission Information

Actual Bytes Transferred = 8611

Total Transfer Time = 0.904 Seconds

**Conditions of Test (Day 2)****MAC Address = 7496813**

Beginning of Packet Sniffer Data = 9/11/2011 8:00:00 AM

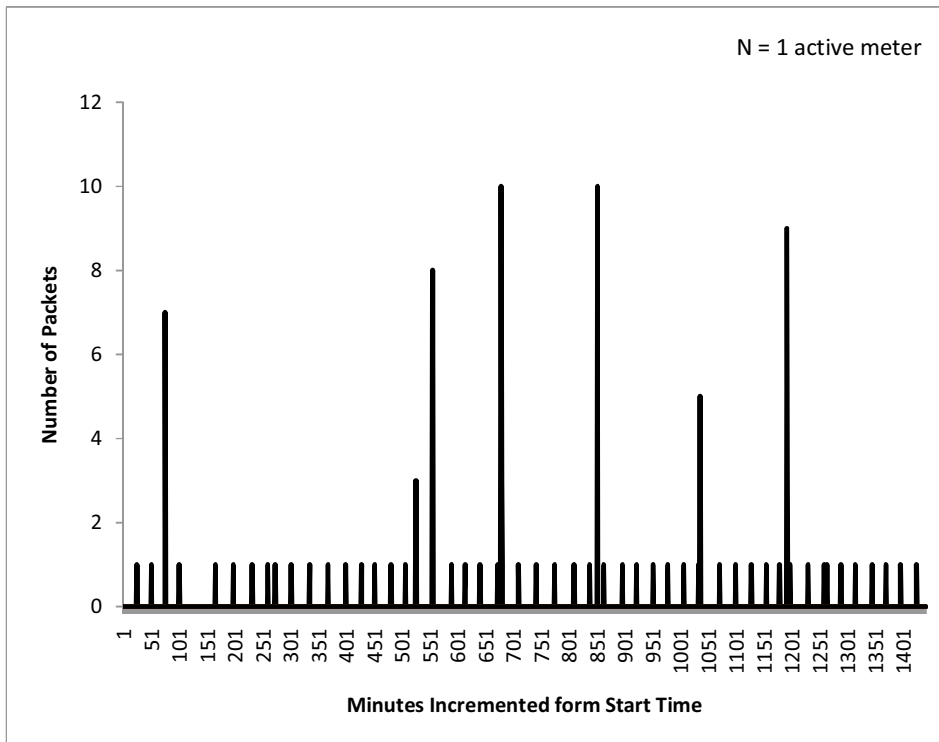
Interrogations:

9/11/2011 9:15:07 AM

9/11/2011 5:15:12 PM

9/12/2011 1:15:11 AM

Ending of Packet Sniffer Data = 9/12/2011 8:00:00 AM

**Packets Per Minute Starting at 9/11/2011 08:00:00 AM**

\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

**Data Transmission Information**

Actual Bytes Transferred = 17453

**Total Transmission Time = 1.83 Seconds**

Note that the number of consumption data transmission or time synchronization is higher due to transmission retries. This is likely caused by external interference and the environment of the meter, which is located in a concrete basement where radio coverage is challenged.

## 5 Traffic Confirmation – All Meters

While this test report deals with a single meter, it is recognized that nearby meters may also be present and contribute to the overall RF levels in a typical user environment. The following two results files show the traffic for all 21 meters present in the general vicinity for the 2 day time period. Again, this information only shows how often the meters are active during a 24-hour period, and the relative amount of information transmitted. These graphs are not an indicator of the transmitter power output.

### Conditions of Test (Day 1)

#### **ALL UNITS**

Beginning of Packet Sniffer Data = 9/10/2011 8:00:00 AM

Interrogations:

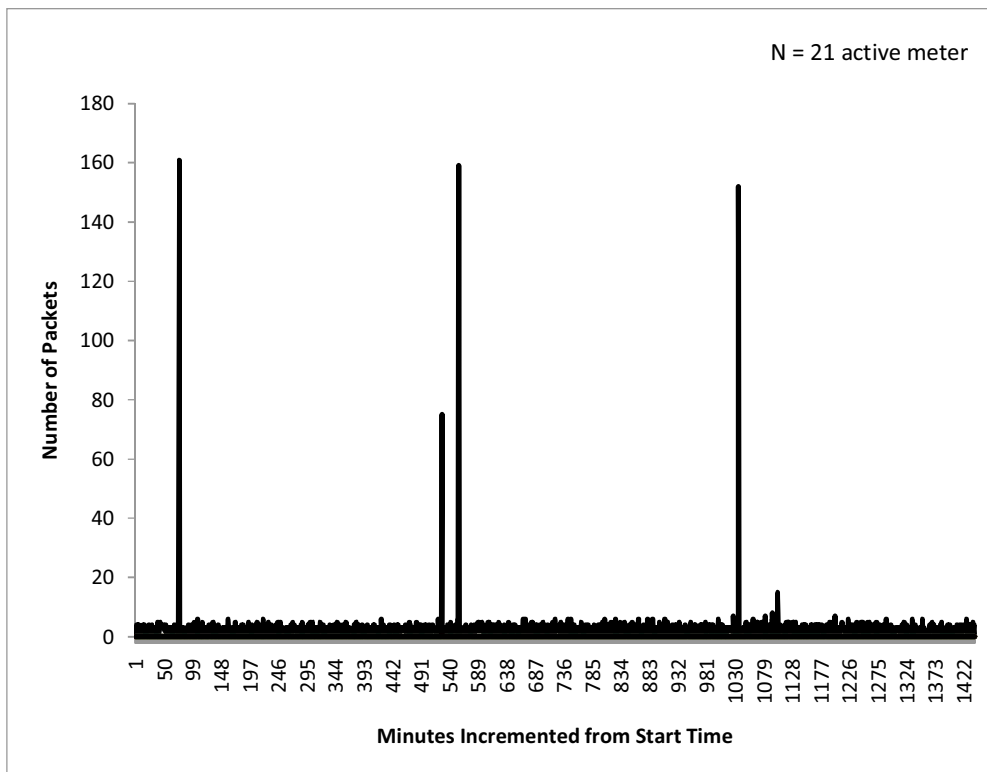
9/10/2011 9:15:07 AM

9/10/2011 5:15:12 PM

9/11/2011 1:15:11 AM

Ending of Packet Sniffer Data = 9/11/2011 8:00:00 AM

### Packets Per Minute Starting at 9/10/2011 08:00:00 AM



\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

### Data Transmission Information

Actual Bytes Transferred = 301667

**Total Transfer Time = 31.684 Seconds**

**Conditions of Test (Day 2)****ALL UNITS**

Beginning of Packet Sniffer Data = 9/11/2011 8:00:00 AM

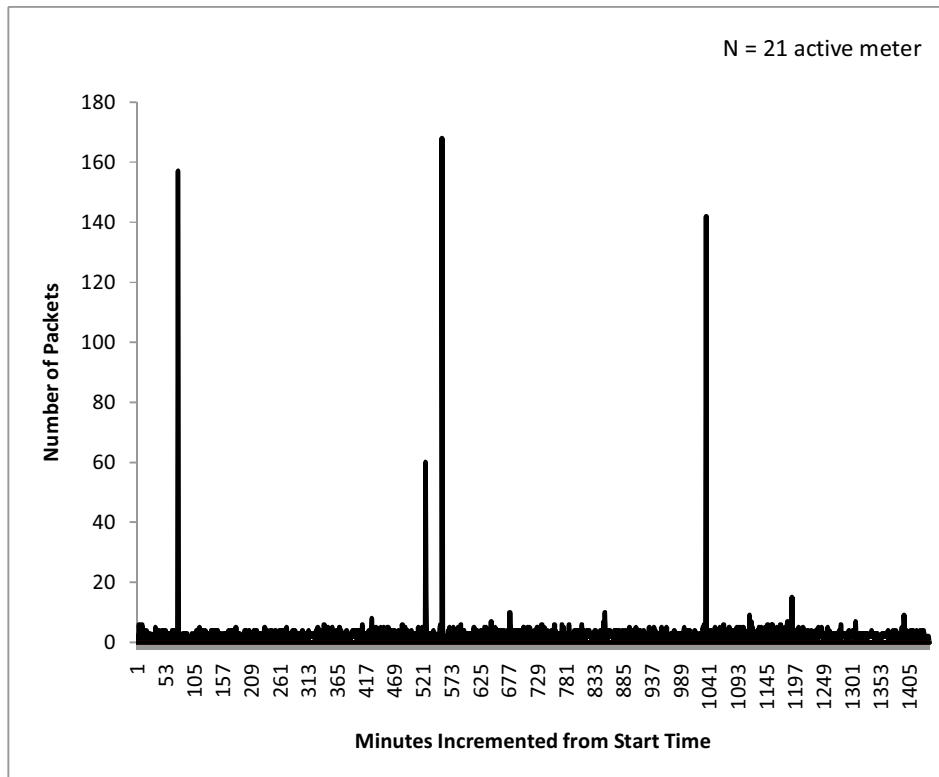
Interrogations:

9/11/2011 9:15:07 AM

9/11/2011 5:15:12 PM

9/12/2011 1:15:11 AM

Ending of Packet Sniffer Data = 9/12/2011 8:00:00 AM

**Packets Per Minute Starting at 9/11/2011 08:00:00 AM**

\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

**Data Transmission Information**

Actual Bytes Transferred = 307971

**Total Transfer Time = 32.345 Seconds**

## 6 NBM-550 Calibration Certificate

Narda Safety Test Solutions GmbH  
Sandwiesenstrasse 7 - 72793 Pfullingen - Germany  
Phone: +49 7121 9732 0 - Fax: +49 7121 9732 790

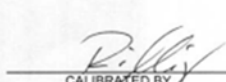


## Calibration Certificate

Narda Safety Test Solutions hereby certifies that the object referenced to this certificate has been calibrated by qualified personnel using Narda's approved procedures. The calibration was carried out in accordance with a certified quality management system which conformed to ISO 9001.

|                       |   |
|-----------------------|---|
| OBJECT                | <b>Broadband Field Meter<br/>NBM-550</b>                    |
| MANUFACTURER          | Narda Safety Test Solutions GmbH                            |
| PART NUMBER (P/N)     | <b>2401/01B</b>   |
| SERIAL NUMBER (S/N)   | <b>D-0146</b>   |
| CUSTOMER              |   |
| CALIBRATION DATE      | 2011-01-28  |
| RESULT ASSESSMENT     | within specifications                                       |
| AMBIENT CONDITIONS    | Temperature: (23 ± 3) °C<br>Relative humidity: (20 to 60) % |
| CALIBRATION PROCEDURE | 2401-8700-00A   |

ISSUE DATE: 2011-01-28

  
CALIBRATED BY  
E. Rilling

  
AUTHORIZED SIGNATORY

This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates without signature are not valid.

MANAGEMENT  
SYSTEM



Certified by DQS according  
to ISO 9001:2008  
(Reg.-No. 099379 QM08)

CERTIFICATE: NBM-550-D-0146-110128-1816

PAGE 1 OF 3

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## Method of Measurement

The device under test (DUT) represents a three-channel voltage meter offering high accuracy and high resolution. The DUT is calibrated by applying a known DC voltage to each of the inputs.

## Uncertainty of Measurement

The measurement uncertainty stated in this document is the expanded uncertainty with a coverage factor of 2 (corresponding, in the case of normal distribution, to a confidence probability of 95 %).

The uncertainty analysis for this calibration was done in accordance with the ISO/TAG-Guide (Guide to the expression of uncertainty in measurement). The measurement uncertainties are derived from contributions from the measurement of power, reflection, attenuation and frequency, mismatch, stability of instrumentation and repeatability of handling.

This statement of uncertainty applies to the measured values only and does not include effects like temperature response and long term stability of the calibrated device.

## Traceability of Measuring Equipment

The calibration results are traceable to SI-units according to ISO/IEC 17025. Physical units, which are not included in the list of accredited measured quantities such as field strength or power density, are traced to the basic units via approved measurement and computational methods.

The equipment used for this calibration is traceable to the reference listed below and the traceability is guaranteed by ISO 9001 Narda internal procedure.

| Reference- /<br>Working- Standard | Manufacturer | Model  | Serial Number | Certificate Number | Cal Due<br>Date | Trace   |
|-----------------------------------|--------------|--------|---------------|--------------------|-----------------|---------|
| Digital Multimeter                | Agilent      | 34401A | US36121450    | 1-1960925007-1     | 2011-01         | UKAS147 |

CERTIFICATE: NBM-550-D-0146-110128-1816

PAGE 2 OF 3

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## Results

### Voltage display uncertainty

| Channel | Input voltage applied | Specified voltage display | Meas. Uncertainty | Meas. voltage display |
|---------|-----------------------|---------------------------|-------------------|-----------------------|
| X       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.370 V               |
| Y       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.370 V               |
| Z       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.370 V               |

Note: Because of an internal voltage divider the nominal indication is 2.376 V.

## 7 Probe Calibration Certificate

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### Calibration Certificate

Narda Safety Test Solutions hereby certifies that the referenced equipment has been calibrated by qualified personnel to Narda's approved procedures. The calibration was carried out within a certified quality management system conforming to ISO 9001:2000.

The metrological confirmation system for test equipment complies with ISO 10012-1.

|                                     |   |
|-------------------------------------|---|
| Object                              | Electric Field Probe EC5091             |
| Part Number (P/N)                   | 2402/09                                 |
| Serial Number (S/N)                 | 01025                                   |
| Manufacturer                        | Narda Safety Test Solutions             |
| Date of Calibration                 | Mon 06/Dec/2010 13:39:20                |
| Results of Calibration              | Test Results within Specification       |
| Confirmation interval (recommended) | 24 Months                               |
| Ambient Conditions                  | (23 +/-3)°C<br>(40...60)% rel. humidity |
| Calibration Procedure               | ATE Software 990199 Ver. 1.50           |
| Probe Definition File Set           | P/N 990199-06 Ver. 1.04                 |
| Results Filed Under                 | EC5091_01025_06Dec2010.txt              |

Hauppauge, NY

  
 \_\_\_\_\_  
 Calibrated by



\_\_\_\_\_  
 Quality Assurance

This certificate may only be published in full, unless permission for the publication of an approved extract has been obtained in writing from the Director of Quality Assurance.

Certificate No. 01025\_06Dec2010.txt

Date of issue: 06/Dec/2010

Page 1 of 6



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### Method of Measurement

The calibration of RF field strength probes involves the generation of a calculable linearly polarized electromagnetic field - approximating to a plane wave - into which the device under test is placed. The probe is calibrated separately from the base meter.

The probe is aligned for maximum interception of the field, i.e. the probe's pole is orientated in the analytic angle (54.74 degrees to vertical E-field vector) above 200 MHz. Below 200 MHz the probe handle is oriented perpendicular to both, the direction of propagation and the direction of the E-field vector. The meter indicates the results in %STD units, i.e. the power related ratio of the field and the reference level (MPE = maximum permissible exposure limit) from the Standard. At each test frequency the probe is rotated by 360 deg while taking readings continuously. The results are calculated from the minimum and maximum response during rotation.

$$\%STD_{mean} = \sqrt{\%STD_{min} * \%STD_{max}}$$

$$EllipseRatio = 5 * \log \left( \frac{\%STD_{max}}{\%STD_{min}} \right)$$

### Frequency Response:

The correction factor  $K$  is a numerical factor to compensate the systematic error due to frequency response.

$$K = \sqrt{\%STD_{actual} / \%STD_{mean}}$$

The correction factors are stored in the probe memory. When combined with the NBM-5xx Field Meter the frequency response correction may be enabled.

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## Field Generation

### Setup "A" (1600 MHz ...):

Calibration using calculated field strength. The probe is positioned with the boresight of a linearly polarized horn antenna. The field strength is derived from the horn's gain  $g$ , the transmitted power of the antenna and the distance  $d$ . The power measurement includes the power meter's response  $P_m \cdot F_m$  and a fixed attenuation  $D$ .

$$E = \sqrt{\eta \cdot \frac{P_m \cdot F_m \cdot D \cdot g}{4 \cdot \pi \cdot d^2}}$$

with  $\eta$  : intrinsic impedance of propagation medium in Ohms.

Reference: IEEE Std. 1309-1996

### Setup "B" (200 MHz ... 1600 MHz):

Calibration using a transfer standard. The probe is mounted in front of a double balanced ridge horn antenna. The field strength is set to a known value based on the power meter reading  $P_m$  in reference to a calibrated sensor ( $E_{ref}$ ,  $P_{ref}$ ).

$$E = E_{ref} \cdot \sqrt{\frac{P_m}{P_{ref}}}$$

### Setup "C" (... 200 MHz):

Calibration using calculated field strength. A Crawford TEM cell is used to generate the known field strength  $E$ . The field strength is derived from TEM cell's septum height  $b$ , impedance  $Z_0$  and from the output power  $P_{ref}$  of the cell. The output power measurement includes the power meter's response  $P_m \cdot F_m$  and a fixed attenuation  $D$ .

$$E = \frac{\sqrt{P_m \cdot F_m \cdot D \cdot Z_0}}{b}$$

## Uncertainties

The measurement uncertainty stated in this document is the expanded uncertainty with a coverage factor of 1.96 (corresponding, in the case of normal distribution, to a confidence probability of 95%).

The uncertainty analysis for this calibration was done in accordance with the ISO-Guide (Guide to the expression of Uncertainty in Measurement). The measurement uncertainties are derived from contributions from the measurement of power, impedance, attenuation, mismatch, length, frequency, stability of instrumentation, repeatability of handling and field uniformity in the field generators (TEM cell and anechoic chamber).

This statement of uncertainty applies to the measured values only and does not make any implementation or include any estimation as to the long-term stability of the calibrated device.

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### Test Equipment and Traceability

The calibration results are traceable to SI-units according to ISO 9001. Physical units, which are not included in the list of accredited measured quantities such as field strength or power density, are traced to the basic units via approved measurement and computational methods.

The equipment used for this calibration is traceable to the reference listed below and the traceability is guaranteed by ISO 9001 Narda internal procedure.

| Reference- / Working- Standard          | Manufacturer | Model         | Asset Number | Certificate Number | Cal Due Date | Trace (*) |
|---|--------------|---------------|--------------|--------------------|--------------|-----------|
| <b>Setup "A" (0.001 MHz to 200 MHz)</b> |              |               |              |                    |              |           |
| Power Meter, Two Channel                | Agilent      | E4419B        | 003431       |                    | 2012-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A         | 004323       |                    | 2011-11      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A         | 001389       |                    | 2011-11      |           |
| Attenuator 30dB                         | Narda        | 769-30        | 003241       | -                  | 2011-06      | (1)       |
| Attenuator 30dB                         | Narda        | 769-30        | 003386       | -                  | 2011-03      | (1)       |
| Attenuator 6dB                          | Narda        | 766-6         | 005030       | -                  | 2011-01      | (1)       |
| Attenuator 6dB                          | Narda        | 766-6         | 005031       | -                  | 2011-01      | (1)       |
| <b>Setup "B" (300 MHz to 3000 MHz)</b>  |              |               |              |                    |              |           |
| Power Meter, Two Channel                | Agilent      | E4419B        | 003768       |                    | 2011-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A         | 003757       |                    | 2011-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A         | 003758       |                    | 2011-06      |           |
| Dir. Coupler 0.3-2.2GHz                 | Narda        | 3042SP        | 005118       | -                  | 2011-10      | (1)       |
| Dir. Cpl. 0.9-2.2GHz + 10dB             | Narda        | 3042B/771-10  | 005118       | -                  | 2011-10      | (1)       |
| Dir. Coupler 1.7-4.2GHz                 | Narda        | 3043B-30      | 005119       | -                  | 2011-10      | (1)       |
| Dir. Coupler 1.7-4.2GHz                 | Narda        | 3043B-30      | 005119       | -                  | 2011-10      | (1)       |
| <b>Setup "C" (1.7 to 60 GHz)</b>        |              |               |              |                    |              |           |
| Power Sensor 18GHz                      | Agilent      | 8481A         | 003237       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A         | 003236       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A         | 003235       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A         | 003234       |                    | 2011-07      |           |
| Power Sensor 26.5-40GHz                 | Agilent      | R8486A        | 002020       |                    | 2011-09      |           |
| Power Sensor 33-50GHz                   | Agilent      | C8486A        | 002846       |                    | 2011-01      |           |
| Power Sensor 50-75GHz                   | Agilent      | V8486A        | 004679       |                    | 2011-06      |           |
| Power Meter                             | Agilent      | EPM-441A      | 003210       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A      | 003212       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A      | 003231       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A      | 003214       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A      | 003213       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A      | 003211       |                    | 2011-01      |           |
| Dir. Coupler 4-8GHz & 10dB              | Narda        | 3022/777C-10  | 003270       | -                  | 2011-10      | (1)       |
| Dir. Coupler 4-8GHz & 20dB              | Narda        | 3024/777C-20  | 003271       | -                  | 2011-10      | (1)       |
| Dir. Coupler 8.2-12.4GHz                | Narda        | 3293-2        | 003272       | -                  | 2011-10      | (1)       |
| Dir. Coupler 12.4-18GHz                 | Narda        | 1079          | 003274       | -                  | 2013-03      | (1)       |
| Dir. Coupler 26.5-40GHz                 | Narda        | R752D         | 002747       | -                  | 2011-10      | (1)       |
| Dir. Coupler 33-50GHz                   | Millitech    | CL3-22-R2000  | 004756       | -                  | 2011-01      | (1)       |
| Dir. Coupler 60GHz                      | Millitech    | C/GC-15-RL300 | 004757       | -                  | 2011-01      | (1)       |

(\*) For details on accredited laboratories please refer to the corresponding homepage:

<http://www.dkds.info/> DKD  
<http://sit.imgc.to.cnir.it/> SIT  
<http://www.ukas.com/> UKAS

(1) An accredited calibration of the directional couplers is not available due to multiple-sex connectors. Calibration is performed as an in-house calibration based on state of the art techniques (non-traceable).

Certificate No. 01025\_06Dec2010.txt

Date of issue: 06/Dec/2010

Page 4 of 6

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## Results

### Frequency response and Ellipticity

The frequency response is measured with instrument setting: Apply Correction Frequency = OFF.

| Frequency in MHz | $E_{actual}$ in V/M | Meas. Uncertainty in dB | Applied %STD actual | Displayed %STD mean | Correction Factor K (*) | Ellipse Ratio in dB |
|------------------|---------------------|-------------------------|---------------------|---------------------|-------------------------|---------------------|
| 0.3              | 307.00              | 0.8                     | 25.00               | 17.77               | 1.186                   | 0.62                |
| 3                | 102.33              | 0.8                     | 25.00               | 20.40               | 1.107                   | 0.24                |
| 10               | 30.70               | 0.8                     | 25.00               | 15.82               | 1.257                   | 0.22                |
| 30               | 30.70               | 0.8                     | 25.00               | 27.41               | 0.955                   | 0.20                |
| 100              | 30.70               | 0.8                     | 25.00               | 26.79               | 0.966                   | 0.17                |
| 300              | 30.70               | 0.8                     | 25.00               | 20.74               | 1.098                   | 0.37                |
| 750              | 48.54               | 0.8                     | 25.00               | 35.69               | 0.837                   | 0.31                |
| 1000             | 56.05               | 0.8                     | 25.00               | 39.56               | 0.795                   | 0.21                |
| 1800             | 68.65               | 0.7                     | 25.00               | 25.61               | 0.988                   | 0.28                |
| 2450             | 68.65               | 0.7                     | 25.00               | 24.31               | 1.014                   | 0.27                |
| 4000             | 68.65               | 0.7                     | 25.00               | 26.96               | 0.963                   | 0.33                |
| 8200             | 68.65               | 0.7                     | 25.00               | 28.60               | 0.935                   | 0.61                |
| 10000            | 68.65               | 0.7                     | 25.00               | 24.22               | 1.016                   | 0.97                |
| 18000            | 68.65               | 0.7                     | 25.00               | 29.35               | 0.923                   | 0.86                |
| 26500            | 68.65               | 0.7                     | 25.00               | 34.20               | 0.855                   | 0.88                |
| 40000            | 68.65               | 0.7                     | 25.00               | 24.80               | 1.004                   | 0.69                |
| 45500            | 68.65               | 0.7                     | 25.00               | 18.26               | 1.170                   | 0.83                |

Flatness (1800 - 40000 MHz):  $\pm 0.75$  dB **Pass**

Flatness (.3 - 45500 MHz):  $\pm 1.99$  dB **Pass**

Max. Ellipse Ratio (.3 - 45500 MHz):  $\pm 0.97$  dB **Pass**

(\*) The frequency response correction data is stored in the probe memory. When the probe is connected to a NBM-550 Field Meter the implemented frequency response correction may be enabled. This is done by selecting the desired frequency and the setting: Apply Correction Frequency = ON.

#### Adjustment (informative):

This probe has two sensor modules, one for high frequency (HF) and one for low frequency (LF).

LF Gain multiplier =  $K_{0, LF} = 0.7269$

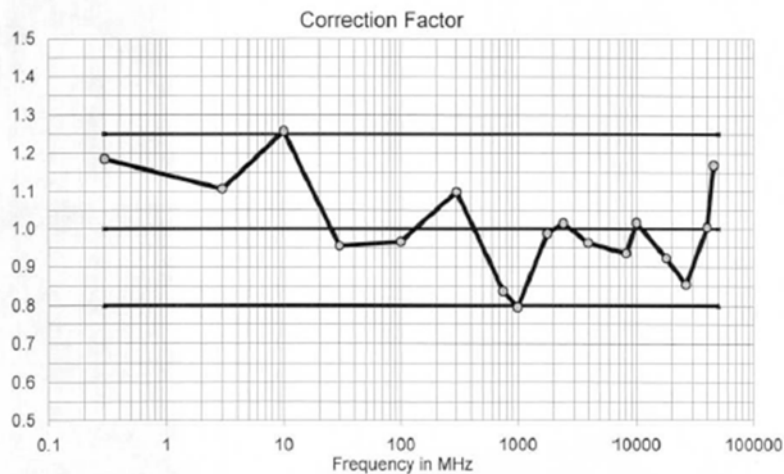
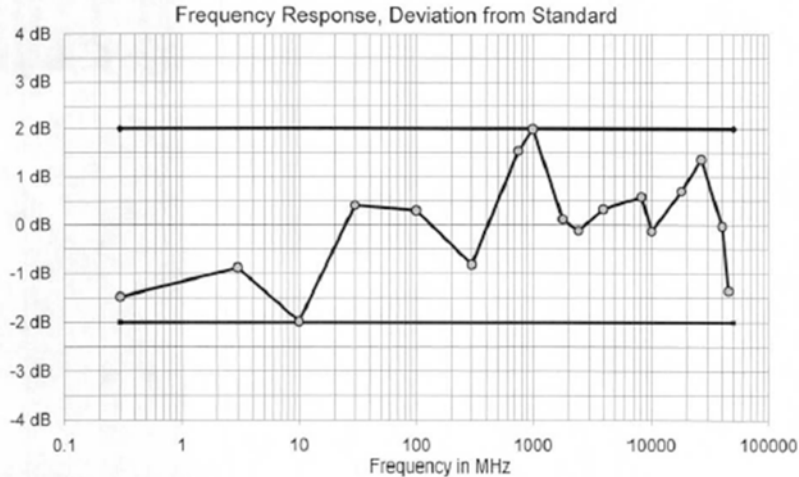
HF Gain multiplier =  $K_{0, HF} = 1.1777$

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### Frequency Response Graph

Frequency response data with setting: Apply Correction Frequency = OFF.



Certificate No. 01025\_06Dec2010.txt

Date of issue: 06/Dec/2010

Page 6 of 6

## 8 Field Probe Log Files – Meters Active

Note that all average values presented below are relative to Health Canada Safety Code 6's controlled environments. These are multiplied by a factor of 5 to convert to Health Canada Safety Code 6 values for uncontrolled environments (public levels). The scaled uncontrolled environment values are used in this report.

|                                  |                   |                       |
|----------------------------------|-------------------|-----------------------|
| Number of Sub Indices            | 234               |                       |
| Storing Date                     | 10/09/2011        |                       |
| Storing Time                     | 8:16:23           |                       |
| Dataset Type                     | TIM               |                       |
| Voice Comment Available          | NO                |                       |
| Dataset Fine Type                | T1                |                       |
| GPS Flag                         | NO                |                       |
| Device Product Name              | NBM-550           |                       |
| Device Serial Number             | D-0146            |                       |
| Device Cal Due Date              | 28/01/2013        |                       |
| Probe Product Name               | EC5091            |                       |
| Probe Serial Number              | 01025             |                       |
| Probe Cal Due Date               | 06/06/2013        |                       |
| Probe Field Type                 | E                 |                       |
| Probe Connection Type            | C                 |                       |
| Probe Lower Frequency Limit A    | 300 kHz           |                       |
| Probe Upper Frequency Limit A    | 50 GHz            |                       |
| Probe Lower Frequency Limit B    | 300 kHz           |                       |
| Probe Upper Frequency Limit B    | 50 GHz            |                       |
| Probe Emin A                     | 4.340 V/m         |                       |
| Probe Emax A                     | 150.0 V/m         |                       |
| Probe Emin B                     | 4.340 V/m         |                       |
| Probe Emax B                     | 150.0 V/m         |                       |
| Shaped Probe                     | YES               |                       |
| Standard ID                      | 5                 |                       |
| Standard Name                    | Canada,occ        |                       |
| Apply Standard                   | ON                |                       |
| Frequency                        | 1.8 GHz           |                       |
| Apply Correction Frequency       | OFF               |                       |
| Eref_E(f)                        | 137.0 V/m         |                       |
| Eref_H(f)                        | 137.2 V/m         |                       |
| Combi Probe Use                  | E_H               |                       |
| Unit                             | A/m               |                       |
| Results Format                   | FIXED             |                       |
| Auto-Zero Interval               | OFF               |                       |
| Result Type                      | -                 |                       |
| Averaging Time                   | -                 |                       |
| Average Progress                 | -                 |                       |
| Spatial AVG Mode                 | -                 |                       |
| Store Condition                  | -                 |                       |
| Storing Range                    | -                 |                       |
| Cond. Stop Time                  | -                 |                       |
| Upper Threshold                  | -                 |                       |
| Lower Threshold                  | -                 |                       |
| Timer Interval                   | 360 sec           |                       |
| Timer Duration                   | 99:10:00          |                       |
| History Time Scale               | -                 |                       |
| Time progress of current segment | -                 |                       |
| Index                            | Date/Time         | Avg (E-Field) [% STD] |
| 1                                | 9/10/2011 8:22:23 | 0.1081                |
| 2                                | 9/10/2011 8:28:23 | 0.0607                |
| 3                                | 9/10/2011 8:34:23 | 0.0479                |
| 4                                | 9/10/2011 8:40:23 | 0.0384                |
| 5                                | 9/10/2011 8:46:23 | 0.0615                |
| 6                                | 9/10/2011 8:52:23 | 0.0604                |
| 7                                | 9/10/2011 8:58:23 | 0.0617                |
| 8                                | 9/10/2011 9:04:23 | 0.0573                |
| 9                                | 9/10/2011 9:10:23 | 0.0529                |
| 10                               | 9/10/2011 9:16:23 | 0.0439                |
| 11                               | 9/10/2011 9:22:23 | 0.0731                |

|    |                    |        |
|----|--------------------|--------|
| 12 | 9/10/2011 9:28:23  | 0.0832 |
| 13 | 9/10/2011 9:34:23  | 0.0795 |
| 14 | 9/10/2011 9:40:23  | 0.0625 |
| 15 | 9/10/2011 9:46:23  | 0.0719 |
| 16 | 9/10/2011 9:52:23  | 0.0894 |
| 17 | 9/10/2011 9:58:23  | 0.0858 |
| 18 | 9/10/2011 10:04:23 | 0.1144 |
| 19 | 9/10/2011 10:10:23 | 0.0921 |
| 20 | 9/10/2011 10:16:23 | 0.0509 |
| 21 | 9/10/2011 10:22:23 | 0.0808 |
| 22 | 9/10/2011 10:28:23 | 0.0682 |
| 23 | 9/10/2011 10:34:23 | 0.0836 |
| 24 | 9/10/2011 10:40:23 | 0.0958 |
| 25 | 9/10/2011 10:46:23 | 0.0579 |
| 26 | 9/10/2011 10:52:23 | 0.0889 |
| 27 | 9/10/2011 10:58:23 | 0.0647 |
| 28 | 9/10/2011 11:04:23 | 0.0865 |
| 29 | 9/10/2011 11:10:23 | 0.0901 |
| 30 | 9/10/2011 11:16:23 | 0.0761 |
| 31 | 9/10/2011 11:22:23 | 0.0552 |
| 32 | 9/10/2011 11:28:23 | 0.0758 |
| 33 | 9/10/2011 11:34:23 | 0.0971 |
| 34 | 9/10/2011 11:40:23 | 0.1159 |
| 35 | 9/10/2011 11:46:23 | 0.0976 |
| 36 | 9/10/2011 11:52:23 | 0.0699 |
| 37 | 9/10/2011 11:58:23 | 0.0556 |
| 38 | 9/10/2011 12:04:23 | 0.0381 |
| 39 | 9/10/2011 12:10:23 | 0.0796 |
| 40 | 9/10/2011 12:16:23 | 0.0696 |
| 41 | 9/10/2011 12:22:23 | 0.0716 |
| 42 | 9/10/2011 12:28:23 | 0.0733 |
| 43 | 9/10/2011 12:34:23 | 0.0763 |
| 44 | 9/10/2011 12:40:23 | 0.1058 |
| 45 | 9/10/2011 12:46:23 | 0.0927 |
| 46 | 9/10/2011 12:52:23 | 0.0987 |
| 47 | 9/10/2011 12:58:23 | 0.0873 |
| 48 | 9/10/2011 13:04:23 | 0.0521 |
| 49 | 9/10/2011 13:10:23 | 0.0531 |
| 50 | 9/10/2011 13:16:23 | 0.0751 |
| 51 | 9/10/2011 13:22:23 | 0.0433 |
| 52 | 9/10/2011 13:28:23 | 0.0394 |
| 53 | 9/10/2011 13:34:23 | 0.0685 |
| 54 | 9/10/2011 13:40:23 | 0.0634 |
| 55 | 9/10/2011 13:46:23 | 0.0626 |
| 56 | 9/10/2011 13:52:23 | 0.0562 |
| 57 | 9/10/2011 13:58:23 | 0.0391 |
| 58 | 9/10/2011 14:04:23 | 0.0603 |
| 59 | 9/10/2011 14:10:23 | 0.0804 |
| 60 | 9/10/2011 14:16:23 | 0.0502 |
| 61 | 9/10/2011 14:22:23 | 0.0678 |
| 62 | 9/10/2011 14:28:23 | 0.1051 |
| 63 | 9/10/2011 14:34:23 | 0.1174 |
| 64 | 9/10/2011 14:40:23 | 0.0925 |
| 65 | 9/10/2011 14:46:23 | 0.0923 |
| 66 | 9/10/2011 14:52:23 | 0.1043 |
| 67 | 9/10/2011 14:58:23 | 0.1012 |
| 68 | 9/10/2011 15:04:23 | 0.1226 |
| 69 | 9/10/2011 15:10:23 | 0.1387 |
| 70 | 9/10/2011 15:16:23 | 0.1528 |
| 71 | 9/10/2011 15:22:23 | 0.1192 |
| 72 | 9/10/2011 15:28:23 | 0.1333 |
| 73 | 9/10/2011 15:34:23 | 0.132  |
| 74 | 9/10/2011 15:40:23 | 0.1429 |
| 75 | 9/10/2011 15:46:23 | 0.1171 |
| 76 | 9/10/2011 15:52:23 | 0.1454 |
| 77 | 9/10/2011 15:58:23 | 0.1273 |
| 78 | 9/10/2011 16:04:23 | 0.1247 |
| 79 | 9/10/2011 16:10:23 | 0.1311 |

|     |                    |        |
|-----|--------------------|--------|
| 80  | 9/10/2011 16:16:23 | 0.0961 |
| 81  | 9/10/2011 16:22:23 | 0.0888 |
| 82  | 9/10/2011 16:28:23 | 0.0654 |
| 83  | 9/10/2011 16:34:23 | 0.0612 |
| 84  | 9/10/2011 16:40:23 | 0.0529 |
| 85  | 9/10/2011 16:46:23 | 0.076  |
| 86  | 9/10/2011 16:52:23 | 0.0822 |
| 87  | 9/10/2011 16:58:23 | 0.1085 |
| 88  | 9/10/2011 17:04:23 | 0.0982 |
| 89  | 9/10/2011 17:10:23 | 0.1053 |
| 90  | 9/10/2011 17:16:23 | 0.112  |
| 91  | 9/10/2011 17:22:23 | 0.1103 |
| 92  | 9/10/2011 17:28:23 | 0.0814 |
| 93  | 9/10/2011 17:34:23 | 0.0727 |
| 94  | 9/10/2011 17:40:23 | 0.0636 |
| 95  | 9/10/2011 17:46:23 | 0.0657 |
| 96  | 9/10/2011 17:52:23 | 0.0664 |
| 97  | 9/10/2011 17:58:23 | 0.0771 |
| 98  | 9/10/2011 18:04:23 | 0.082  |
| 99  | 9/10/2011 18:10:23 | 0.0788 |
| 100 | 9/10/2011 18:16:23 | 0.0935 |
| 101 | 9/10/2011 18:22:23 | 0.1054 |
| 102 | 9/10/2011 18:28:23 | 0.0625 |
| 103 | 9/10/2011 18:34:23 | 0.0608 |
| 104 | 9/10/2011 18:40:23 | 0.0824 |
| 105 | 9/10/2011 18:46:23 | 0.0896 |
| 106 | 9/10/2011 18:52:23 | 0.0782 |
| 107 | 9/10/2011 18:58:23 | 0.0721 |
| 108 | 9/10/2011 19:04:23 | 0.0519 |
| 109 | 9/10/2011 19:10:23 | 0.0386 |
| 110 | 9/10/2011 19:16:23 | 0.0201 |
| 111 | 9/10/2011 19:22:23 | 0.0257 |
| 112 | 9/10/2011 19:28:23 | 0.0279 |
| 113 | 9/10/2011 19:34:23 | 0.0187 |
| 114 | 9/10/2011 19:40:23 | 0.0422 |
| 115 | 9/10/2011 19:46:23 | 0.0391 |
| 116 | 9/10/2011 19:52:23 | 0.0211 |
| 117 | 9/10/2011 19:58:23 | 0.0709 |
| 118 | 9/10/2011 20:04:23 | 0.0282 |
| 119 | 9/10/2011 20:10:23 | 0.0159 |
| 120 | 9/10/2011 20:16:23 | 0.0068 |
| 121 | 9/10/2011 20:22:23 | 0.024  |
| 122 | 9/10/2011 20:28:23 | 0.0228 |
| 123 | 9/10/2011 20:34:23 | 0.057  |
| 124 | 9/10/2011 20:40:23 | 0.0927 |
| 125 | 9/10/2011 20:46:23 | 0.0712 |
| 126 | 9/10/2011 20:52:23 | 0.0874 |
| 127 | 9/10/2011 20:58:23 | 0.0831 |
| 128 | 9/10/2011 21:04:23 | 0.0683 |
| 129 | 9/10/2011 21:10:23 | 0.0443 |
| 130 | 9/10/2011 21:16:23 | 0.084  |
| 131 | 9/10/2011 21:22:23 | 0.085  |
| 132 | 9/10/2011 21:28:23 | 0.089  |
| 133 | 9/10/2011 21:34:23 | 0.0786 |
| 134 | 9/10/2011 21:40:23 | 0.0512 |
| 135 | 9/10/2011 21:46:23 | 0.058  |
| 136 | 9/10/2011 21:52:23 | 0.0349 |
| 137 | 9/10/2011 21:58:23 | 0.0598 |
| 138 | 9/10/2011 22:04:23 | 0.0331 |
| 139 | 9/10/2011 22:10:23 | 0.0438 |
| 140 | 9/10/2011 22:16:23 | 0.0512 |
| 141 | 9/10/2011 22:22:23 | 0.026  |
| 142 | 9/10/2011 22:28:23 | 0.0171 |
| 143 | 9/10/2011 22:34:23 | 0.0223 |
| 144 | 9/10/2011 22:40:23 | 0.0412 |
| 145 | 9/10/2011 22:46:23 | 0.0694 |
| 146 | 9/10/2011 22:52:23 | 0.0646 |
| 147 | 9/10/2011 22:58:23 | 0.0409 |



|     |                    |        |
|-----|--------------------|--------|
| 148 | 9/10/2011 23:04:23 | 0.0591 |
| 149 | 9/10/2011 23:10:23 | 0.049  |
| 150 | 9/10/2011 23:16:23 | 0.0422 |
| 151 | 9/10/2011 23:22:23 | 0.0272 |
| 152 | 9/10/2011 23:28:23 | 0.0297 |
| 153 | 9/10/2011 23:34:23 | 0.0489 |
| 154 | 9/10/2011 23:40:23 | 0.0813 |
| 155 | 9/10/2011 23:46:23 | 0.056  |
| 156 | 9/10/2011 23:52:23 | 0.0658 |
| 157 | 9/10/2011 23:58:23 | 0.0743 |
| 158 | 9/11/2011 0:04:23  | 0.0854 |
| 159 | 9/11/2011 0:10:23  | 0.0774 |
| 160 | 9/11/2011 0:16:23  | 0.0801 |
| 161 | 9/11/2011 0:22:23  | 0.0663 |
| 162 | 9/11/2011 0:28:23  | 0.0266 |
| 163 | 9/11/2011 0:34:23  | 0.0215 |
| 164 | 9/11/2011 0:40:23  | 0.0169 |
| 165 | 9/11/2011 0:46:23  | 0.0216 |
| 166 | 9/11/2011 0:52:23  | 0.0463 |
| 167 | 9/11/2011 0:58:23  | 0.0784 |
| 168 | 9/11/2011 1:04:23  | 0.1041 |
| 169 | 9/11/2011 1:10:23  | 0.0887 |
| 170 | 9/11/2011 1:16:23  | 0.0945 |
| 171 | 9/11/2011 1:22:23  | 0.0886 |
| 172 | 9/11/2011 1:28:23  | 0.0821 |
| 173 | 9/11/2011 1:34:23  | 0.0766 |
| 174 | 9/11/2011 1:40:23  | 0.1054 |
| 175 | 9/11/2011 1:46:23  | 0.0965 |
| 176 | 9/11/2011 1:52:23  | 0.0954 |
| 177 | 9/11/2011 1:58:23  | 0.0849 |
| 178 | 9/11/2011 2:04:23  | 0.0857 |
| 179 | 9/11/2011 2:10:23  | 0.0743 |
| 180 | 9/11/2011 2:16:23  | 0.0737 |
| 181 | 9/11/2011 2:22:23  | 0.0692 |
| 182 | 9/11/2011 2:28:23  | 0.0578 |
| 183 | 9/11/2011 2:34:23  | 0.0454 |
| 184 | 9/11/2011 2:40:23  | 0.075  |
| 185 | 9/11/2011 2:46:23  | 0.0937 |
| 186 | 9/11/2011 2:52:23  | 0.1117 |
| 187 | 9/11/2011 2:58:23  | 0.0806 |
| 188 | 9/11/2011 3:04:23  | 0.0722 |
| 189 | 9/11/2011 3:10:23  | 0.0947 |
| 190 | 9/11/2011 3:16:23  | 0.0781 |
| 191 | 9/11/2011 3:22:23  | 0.0694 |
| 192 | 9/11/2011 3:28:23  | 0.0706 |
| 193 | 9/11/2011 3:34:23  | 0.0809 |
| 194 | 9/11/2011 3:40:23  | 0.0922 |
| 195 | 9/11/2011 3:46:23  | 0.0769 |
| 196 | 9/11/2011 3:52:23  | 0.0795 |
| 197 | 9/11/2011 3:58:23  | 0.0525 |
| 198 | 9/11/2011 4:04:23  | 0.052  |
| 199 | 9/11/2011 4:10:23  | 0.0647 |
| 200 | 9/11/2011 4:16:23  | 0.0693 |
| 201 | 9/11/2011 4:22:23  | 0.0672 |
| 202 | 9/11/2011 4:28:23  | 0.0893 |
| 203 | 9/11/2011 4:34:23  | 0.0885 |
| 204 | 9/11/2011 4:40:23  | 0.0882 |
| 205 | 9/11/2011 4:46:23  | 0.0977 |
| 206 | 9/11/2011 4:52:23  | 0.0737 |
| 207 | 9/11/2011 4:58:23  | 0.0518 |
| 208 | 9/11/2011 5:04:23  | 0.045  |
| 209 | 9/11/2011 5:10:23  | 0.0505 |
| 210 | 9/11/2011 5:16:23  | 0.0735 |
| 211 | 9/11/2011 5:22:23  | 0.0663 |
| 212 | 9/11/2011 5:28:23  | 0.0937 |
| 213 | 9/11/2011 5:34:23  | 0.0941 |
| 214 | 9/11/2011 5:40:23  | 0.0995 |
| 215 | 9/11/2011 5:46:23  | 0.0699 |

|     |                   |        |
|-----|-------------------|--------|
| 216 | 9/11/2011 5:52:23 | 0.0793 |
| 217 | 9/11/2011 5:58:23 | 0.0782 |
| 218 | 9/11/2011 6:04:23 | 0.0655 |
| 219 | 9/11/2011 6:10:23 | 0.0712 |
| 220 | 9/11/2011 6:16:23 | 0.0556 |
| 221 | 9/11/2011 6:22:23 | 0.0722 |
| 222 | 9/11/2011 6:28:23 | 0.0754 |
| 223 | 9/11/2011 6:34:23 | 0.0864 |
| 224 | 9/11/2011 6:40:23 | 0.0844 |
| 225 | 9/11/2011 6:46:23 | 0.0629 |
| 226 | 9/11/2011 6:52:23 | 0.0725 |
| 227 | 9/11/2011 6:58:23 | 0.0455 |
| 228 | 9/11/2011 7:04:23 | 0.0624 |
| 229 | 9/11/2011 7:10:23 | 0.0797 |
| 230 | 9/11/2011 7:16:23 | 0.0789 |
| 231 | 9/11/2011 7:22:23 | 0.0741 |
| 232 | 9/11/2011 7:28:23 | 0.0443 |
| 233 | 9/11/2011 7:34:23 | 0.0286 |
| 234 | 9/11/2011 7:40:23 | 0.0266 |

|                               |            |
|-------------------------------|------------|
| Number of Sub Indices         | 247        |
| Storing Date                  | 11/09/2011 |
| Storing Time                  | 7:51:12    |
| Dataset Type                  | TIM        |
| Voice Comment Available       | NO         |
| Dataset Fine Type             | T1         |
| GPS Flag                      | NO         |
| Device Product Name           | NBM-550    |
| Device Serial Number          | D-0146     |
| Device Cal Due Date           | 28/01/2013 |
| Probe Product Name            | EC5091     |
| Probe Serial Number           | 01025      |
| Probe Cal Due Date            | 06/06/2013 |
| Probe Field Type              | E          |
| Probe Connection Type         | C          |
| Probe Lower Frequency Limit A | 300 kHz    |
| Probe Upper Frequency Limit A | 50 GHz     |
| Probe Lower Frequency Limit B | 300 kHz    |
| Probe Upper Frequency Limit B | 50 GHz     |
| Probe Emin A                  | 4.340 V/m  |
| Probe Emax A                  | 150.0 V/m  |
| Probe Emin B                  | 4.340 V/m  |
| Probe Emax B                  | 150.0 V/m  |
| Shaped Probe                  | YES        |
| Standard ID                   | 5          |
| Standard Name                 | Canada,occ |
| Apply Standard                | ON         |
| Frequency                     | 1.8 GHz    |
| Apply Correction Frequency    | OFF        |
| Eref_E(f)                     | 137.0 V/m  |
| Eref_H(f)                     | 137.2 V/m  |
| Combi Probe Use               | E_H        |
| Unit                          | A/m        |
| Results Format                | FIXED      |
| Auto-Zero Interval            | OFF        |
| Result Type                   | -          |
| Averaging Time                | -          |
| Average Progress              | -          |
| Spatial AVG Mode              | -          |
| Store Condition               | -          |
| Storing Range                 | -          |
| Cond. Stop Time               | -          |
| Upper Threshold               | -          |
| Lower Threshold               | -          |
| Timer Interval                | 360 sec    |
| Timer Duration                | 99:10:00   |
| History Time Scale            | -          |

| Time progress of current segment | -                  |                       |
|----------------------------------|--------------------|-----------------------|
| Index                            | Date/Time          | Avg (E-Field) [% STD] |
| 1                                | 9/11/2011 7:57:12  | 0.0578                |
| 2                                | 9/11/2011 8:03:12  | 0.0646                |
| 3                                | 9/11/2011 8:09:12  | 0.0522                |
| 4                                | 9/11/2011 8:15:12  | 0.0529                |
| 5                                | 9/11/2011 8:21:12  | 0.0435                |
| 6                                | 9/11/2011 8:27:12  | 0.0412                |
| 7                                | 9/11/2011 8:33:12  | 0.0474                |
| 8                                | 9/11/2011 8:39:12  | 0.0354                |
| 9                                | 9/11/2011 8:45:12  | 0.0255                |
| 10                               | 9/11/2011 8:51:12  | 0.0554                |
| 11                               | 9/11/2011 8:57:12  | 0.0303                |
| 12                               | 9/11/2011 9:03:12  | 0.0208                |
| 13                               | 9/11/2011 9:09:12  | 0.0212                |
| 14                               | 9/11/2011 9:15:12  | 0.0303                |
| 15                               | 9/11/2011 9:21:12  | 0.0589                |
| 16                               | 9/11/2011 9:27:12  | 0.0737                |
| 17                               | 9/11/2011 9:33:12  | 0.0662                |
| 18                               | 9/11/2011 9:39:12  | 0.0386                |
| 19                               | 9/11/2011 9:45:12  | 0.0266                |
| 20                               | 9/11/2011 9:51:12  | 0.0367                |
| 21                               | 9/11/2011 9:57:12  | 0.038                 |
| 22                               | 9/11/2011 10:03:12 | 0.0292                |
| 23                               | 9/11/2011 10:09:12 | 0.0415                |
| 24                               | 9/11/2011 10:15:12 | 0.0373                |
| 25                               | 9/11/2011 10:21:12 | 0.048                 |
| 26                               | 9/11/2011 10:27:12 | 0.0446                |
| 27                               | 9/11/2011 10:33:12 | 0.0357                |
| 28                               | 9/11/2011 10:39:12 | 0.0315                |
| 29                               | 9/11/2011 10:45:12 | 0.0487                |
| 30                               | 9/11/2011 10:51:12 | 0.0695                |
| 31                               | 9/11/2011 10:57:12 | 0.0729                |
| 32                               | 9/11/2011 11:03:12 | 0.0816                |
| 33                               | 9/11/2011 11:09:12 | 0.1147                |
| 34                               | 9/11/2011 11:15:12 | 0.1056                |
| 35                               | 9/11/2011 11:21:12 | 0.097                 |
| 36                               | 9/11/2011 11:27:12 | 0.0517                |
| 37                               | 9/11/2011 11:33:12 | 0.0598                |
| 38                               | 9/11/2011 11:39:12 | 0.0526                |
| 39                               | 9/11/2011 11:45:12 | 0.0333                |
| 40                               | 9/11/2011 11:51:12 | 0.0304                |
| 41                               | 9/11/2011 11:57:12 | 0.0285                |
| 42                               | 9/11/2011 12:03:12 | 0.0504                |
| 43                               | 9/11/2011 12:09:12 | 0.0346                |
| 44                               | 9/11/2011 12:15:12 | 0.0474                |
| 45                               | 9/11/2011 12:21:12 | 0.0501                |
| 46                               | 9/11/2011 12:27:12 | 0.0451                |
| 47                               | 9/11/2011 12:33:12 | 0.0419                |
| 48                               | 9/11/2011 12:39:12 | 0.0315                |
| 49                               | 9/11/2011 12:45:12 | 0.0659                |
| 50                               | 9/11/2011 12:51:12 | 0.0252                |
| 51                               | 9/11/2011 12:57:12 | 0.0249                |
| 52                               | 9/11/2011 13:03:12 | 0.0231                |
| 53                               | 9/11/2011 13:09:12 | 0.0376                |
| 54                               | 9/11/2011 13:15:12 | 0.0521                |
| 55                               | 9/11/2011 13:21:12 | 0.0516                |
| 56                               | 9/11/2011 13:27:12 | 0.056                 |
| 57                               | 9/11/2011 13:33:12 | 0.0682                |
| 58                               | 9/11/2011 13:39:12 | 0.0847                |
| 59                               | 9/11/2011 13:45:12 | 0.0671                |
| 60                               | 9/11/2011 13:51:12 | 0.0727                |
| 61                               | 9/11/2011 13:57:12 | 0.0736                |
| 62                               | 9/11/2011 14:03:12 | 0.0488                |
| 63                               | 9/11/2011 14:09:12 | 0.0837                |
| 64                               | 9/11/2011 14:15:12 | 0.0948                |
| 65                               | 9/11/2011 14:21:12 | 0.0639                |
| 66                               | 9/11/2011 14:27:12 | 0.0577                |

|     |                    |        |
|-----|--------------------|--------|
| 67  | 9/11/2011 14:33:12 | 0.0793 |
| 68  | 9/11/2011 14:39:12 | 0.0767 |
| 69  | 9/11/2011 14:45:12 | 0.0691 |
| 70  | 9/11/2011 14:51:12 | 0.0463 |
| 71  | 9/11/2011 14:57:12 | 0.0335 |
| 72  | 9/11/2011 15:03:12 | 0.0377 |
| 73  | 9/11/2011 15:09:12 | 0.057  |
| 74  | 9/11/2011 15:15:12 | 0.0544 |
| 75  | 9/11/2011 15:21:12 | 0.0657 |
| 76  | 9/11/2011 15:27:12 | 0.0545 |
| 77  | 9/11/2011 15:33:12 | 0.0888 |
| 78  | 9/11/2011 15:39:12 | 0.0951 |
| 79  | 9/11/2011 15:45:12 | 0.1017 |
| 80  | 9/11/2011 15:51:12 | 0.109  |
| 81  | 9/11/2011 15:57:12 | 0.0852 |
| 82  | 9/11/2011 16:03:12 | 0.0528 |
| 83  | 9/11/2011 16:09:12 | 0.049  |
| 84  | 9/11/2011 16:15:12 | 0.0401 |
| 85  | 9/11/2011 16:21:12 | 0.0581 |
| 86  | 9/11/2011 16:27:12 | 0.043  |
| 87  | 9/11/2011 16:33:12 | 0.0466 |
| 88  | 9/11/2011 16:39:12 | 0.0291 |
| 89  | 9/11/2011 16:45:12 | 0.0432 |
| 90  | 9/11/2011 16:51:12 | 0.0686 |
| 91  | 9/11/2011 16:57:12 | 0.0837 |
| 92  | 9/11/2011 17:03:12 | 0.0731 |
| 93  | 9/11/2011 17:09:12 | 0.0476 |
| 94  | 9/11/2011 17:15:12 | 0.063  |
| 95  | 9/11/2011 17:21:12 | 0.0564 |
| 96  | 9/11/2011 17:27:12 | 0.0847 |
| 97  | 9/11/2011 17:33:12 | 0.0644 |
| 98  | 9/11/2011 17:39:12 | 0.0756 |
| 99  | 9/11/2011 17:45:12 | 0.0914 |
| 100 | 9/11/2011 17:51:12 | 0.053  |
| 101 | 9/11/2011 17:57:12 | 0.0734 |
| 102 | 9/11/2011 18:03:12 | 0.0542 |
| 103 | 9/11/2011 18:09:12 | 0.0727 |
| 104 | 9/11/2011 18:15:12 | 0.0458 |
| 105 | 9/11/2011 18:21:12 | 0.0495 |
| 106 | 9/11/2011 18:27:12 | 0.0676 |
| 107 | 9/11/2011 18:33:12 | 0.0535 |
| 108 | 9/11/2011 18:39:12 | 0.0393 |
| 109 | 9/11/2011 18:45:12 | 0.0489 |
| 110 | 9/11/2011 18:51:12 | 0.0484 |
| 111 | 9/11/2011 18:57:12 | 0.068  |
| 112 | 9/11/2011 19:03:12 | 0.0579 |
| 113 | 9/11/2011 19:09:12 | 0.0614 |
| 114 | 9/11/2011 19:15:12 | 0.0767 |
| 115 | 9/11/2011 19:21:12 | 0.0514 |
| 116 | 9/11/2011 19:27:12 | 0.0716 |
| 117 | 9/11/2011 19:33:12 | 0.0993 |
| 118 | 9/11/2011 19:39:12 | 0.091  |
| 119 | 9/11/2011 19:45:12 | 0.0805 |
| 120 | 9/11/2011 19:51:12 | 0.0499 |
| 121 | 9/11/2011 19:57:12 | 0.0711 |
| 122 | 9/11/2011 20:03:12 | 0.0619 |
| 123 | 9/11/2011 20:09:12 | 0.0639 |
| 124 | 9/11/2011 20:15:12 | 0.0753 |
| 125 | 9/11/2011 20:21:12 | 0.0558 |
| 126 | 9/11/2011 20:27:12 | 0.0516 |
| 127 | 9/11/2011 20:33:12 | 0.0544 |
| 128 | 9/11/2011 20:39:12 | 0.0811 |
| 129 | 9/11/2011 20:45:12 | 0.0539 |
| 130 | 9/11/2011 20:51:12 | 0.0612 |
| 131 | 9/11/2011 20:57:12 | 0.0491 |
| 132 | 9/11/2011 21:03:12 | 0.0442 |
| 133 | 9/11/2011 21:09:12 | 0.1004 |
| 134 | 9/11/2011 21:15:12 | 0.0383 |

|     |                    |        |
|-----|--------------------|--------|
| 135 | 9/11/2011 21:21:12 | 0.0637 |
| 136 | 9/11/2011 21:27:12 | 0.073  |
| 137 | 9/11/2011 21:33:12 | 0.0634 |
| 138 | 9/11/2011 21:39:12 | 0.0366 |
| 139 | 9/11/2011 21:45:12 | 0.0593 |
| 140 | 9/11/2011 21:51:12 | 0.0652 |
| 141 | 9/11/2011 21:57:12 | 0.0697 |
| 142 | 9/11/2011 22:03:12 | 0.0565 |
| 143 | 9/11/2011 22:09:12 | 0.0445 |
| 144 | 9/11/2011 22:15:12 | 0.0587 |
| 145 | 9/11/2011 22:21:12 | 0.0555 |
| 146 | 9/11/2011 22:27:12 | 0.0744 |
| 147 | 9/11/2011 22:33:12 | 0.0531 |
| 148 | 9/11/2011 22:39:12 | 0.0417 |
| 149 | 9/11/2011 22:45:12 | 0.0655 |
| 150 | 9/11/2011 22:51:12 | 0.0507 |
| 151 | 9/11/2011 22:57:12 | 0.0659 |
| 152 | 9/11/2011 23:03:12 | 0.0393 |
| 153 | 9/11/2011 23:09:12 | 0.0806 |
| 154 | 9/11/2011 23:15:12 | 0.0819 |
| 155 | 9/11/2011 23:21:12 | 0.0958 |
| 156 | 9/11/2011 23:27:12 | 0.1186 |
| 157 | 9/11/2011 23:33:12 | 0.096  |
| 158 | 9/11/2011 23:39:12 | 0.1232 |
| 159 | 9/11/2011 23:45:12 | 0.1144 |
| 160 | 9/11/2011 23:51:12 | 0.1226 |
| 161 | 9/11/2011 23:57:12 | 0.1335 |
| 162 | 9/12/2011 0:03:12  | 0.1358 |
| 163 | 9/12/2011 0:09:12  | 0.1745 |
| 164 | 9/12/2011 0:15:12  | 0.1808 |
| 165 | 9/12/2011 0:21:12  | 0.1607 |
| 166 | 9/12/2011 0:27:12  | 0.1648 |
| 167 | 9/12/2011 0:33:12  | 0.1457 |
| 168 | 9/12/2011 0:39:12  | 0.1711 |
| 169 | 9/12/2011 0:45:12  | 0.1602 |
| 170 | 9/12/2011 0:51:12  | 0.1831 |
| 171 | 9/12/2011 0:57:12  | 0.1416 |
| 172 | 9/12/2011 1:03:12  | 0.1493 |
| 173 | 9/12/2011 1:09:12  | 0.1282 |
| 174 | 9/12/2011 1:15:12  | 0.1089 |
| 175 | 9/12/2011 1:21:12  | 0.11   |
| 176 | 9/12/2011 1:27:12  | 0.121  |
| 177 | 9/12/2011 1:33:12  | 0.1131 |
| 178 | 9/12/2011 1:39:12  | 0.0832 |
| 179 | 9/12/2011 1:45:12  | 0.1018 |
| 180 | 9/12/2011 1:51:12  | 0.0991 |
| 181 | 9/12/2011 1:57:12  | 0.106  |
| 182 | 9/12/2011 2:03:12  | 0.1378 |
| 183 | 9/12/2011 2:09:12  | 0.1191 |
| 184 | 9/12/2011 2:15:12  | 0.1106 |
| 185 | 9/12/2011 2:21:12  | 0.0896 |
| 186 | 9/12/2011 2:27:12  | 0.0984 |
| 187 | 9/12/2011 2:33:12  | 0.1184 |
| 188 | 9/12/2011 2:39:12  | 0.1581 |
| 189 | 9/12/2011 2:45:12  | 0.1271 |
| 190 | 9/12/2011 2:51:12  | 0.1489 |
| 191 | 9/12/2011 2:57:12  | 0.1421 |
| 192 | 9/12/2011 3:03:12  | 0.1248 |
| 193 | 9/12/2011 3:09:12  | 0.1179 |
| 194 | 9/12/2011 3:15:12  | 0.1101 |
| 195 | 9/12/2011 3:21:12  | 0.0945 |
| 196 | 9/12/2011 3:27:12  | 0.1163 |
| 197 | 9/12/2011 3:33:12  | 0.0883 |
| 198 | 9/12/2011 3:39:12  | 0.1193 |
| 199 | 9/12/2011 3:45:12  | 0.1312 |
| 200 | 9/12/2011 3:51:12  | 0.1116 |
| 201 | 9/12/2011 3:57:12  | 0.1009 |
| 202 | 9/12/2011 4:03:12  | 0.1016 |

|     |                   |        |
|-----|-------------------|--------|
| 203 | 9/12/2011 4:09:12 | 0.1019 |
| 204 | 9/12/2011 4:15:12 | 0.0898 |
| 205 | 9/12/2011 4:21:12 | 0.0935 |
| 206 | 9/12/2011 4:27:12 | 0.0827 |
| 207 | 9/12/2011 4:33:12 | 0.0777 |
| 208 | 9/12/2011 4:39:12 | 0.1    |
| 209 | 9/12/2011 4:45:12 | 0.0816 |
| 210 | 9/12/2011 4:51:12 | 0.0744 |
| 211 | 9/12/2011 4:57:12 | 0.0951 |
| 212 | 9/12/2011 5:03:12 | 0.0911 |
| 213 | 9/12/2011 5:09:12 | 0.1271 |
| 214 | 9/12/2011 5:15:12 | 0.0985 |
| 215 | 9/12/2011 5:21:12 | 0.0868 |
| 216 | 9/12/2011 5:27:12 | 0.0911 |
| 217 | 9/12/2011 5:33:12 | 0.0866 |
| 218 | 9/12/2011 5:39:12 | 0.0776 |
| 219 | 9/12/2011 5:45:12 | 0.0706 |
| 220 | 9/12/2011 5:51:12 | 0.0702 |
| 221 | 9/12/2011 5:57:12 | 0.0864 |
| 222 | 9/12/2011 6:03:12 | 0.1008 |
| 223 | 9/12/2011 6:09:12 | 0.1032 |
| 224 | 9/12/2011 6:15:12 | 0.0897 |
| 225 | 9/12/2011 6:21:12 | 0.1047 |
| 226 | 9/12/2011 6:27:12 | 0.1136 |
| 227 | 9/12/2011 6:33:12 | 0.1015 |
| 228 | 9/12/2011 6:39:12 | 0.0789 |
| 229 | 9/12/2011 6:45:12 | 0.0903 |
| 230 | 9/12/2011 6:51:12 | 0.0987 |
| 231 | 9/12/2011 6:57:12 | 0.113  |
| 232 | 9/12/2011 7:03:12 | 0.103  |
| 233 | 9/12/2011 7:09:12 | 0.1314 |
| 234 | 9/12/2011 7:15:12 | 0.1083 |
| 235 | 9/12/2011 7:21:12 | 0.1002 |
| 236 | 9/12/2011 7:27:12 | 0.1568 |
| 237 | 9/12/2011 7:33:12 | 0.163  |
| 238 | 9/12/2011 7:39:12 | 0.1504 |
| 239 | 9/12/2011 7:45:12 | 0.1406 |
| 240 | 9/12/2011 7:51:12 | 0.1441 |
| 241 | 9/12/2011 7:57:12 | 0.129  |
| 242 | 9/12/2011 8:03:12 | 0.0999 |
| 243 | 9/12/2011 8:09:12 | 0.1098 |
| 244 | 9/12/2011 8:15:12 | 0.1383 |
| 245 | 9/12/2011 8:21:12 | 0.1299 |
| 246 | 9/12/2011 8:27:12 | 0.1571 |
| 247 | 9/12/2011 8:33:12 | 0.1507 |

**9 Field Probe Log Files – Background Noise (No Meters Active)**

| Number of Sub Indices            | 676                |                       |
|----------------------------------|--------------------|-----------------------|
| Storing Date                     | 16/09/2011         |                       |
| Storing Time                     | 15:48:09           |                       |
| Dataset Type                     | TIM                |                       |
| Voice Comment Available          | NO                 |                       |
| Dataset Fine Type                | T1                 |                       |
| GPS Flag                         | NO                 |                       |
| Device Product Name              | NBM-550            |                       |
| Device Serial Number             | B-0670             |                       |
| Device Cal Due Date              | 21/04/2013         |                       |
| Probe Product Name               | EC5091             |                       |
| Probe Serial Number              | 01009              |                       |
| Probe Cal Due Date               | 25/04/2013         |                       |
| Probe Field Type                 | E                  |                       |
| Probe Connection Type            | C                  |                       |
| Probe Lower Frequency Limit A    | 300 kHz            |                       |
| Probe Upper Frequency Limit A    | 50 GHz             |                       |
| Probe Lower Frequency Limit B    | 300 kHz            |                       |
| Probe Upper Frequency Limit B    | 50 GHz             |                       |
| Probe Emin A                     | 4.340 V/m          |                       |
| Probe Emax A                     | 150.0 V/m          |                       |
| Probe Emin B                     | 4.340 V/m          |                       |
| Probe Emax B                     | 150.0 V/m          |                       |
| Shaped Probe                     | YES                |                       |
| Standard ID                      | 5                  |                       |
| Standard Name                    | Canada,occ         |                       |
| Apply Standard                   | ON                 |                       |
| Frequency                        | 2.1325 GHz         |                       |
| Apply Correction Frequency       | OFF                |                       |
| Eref_E(f)                        | 137.0 V/m          |                       |
| Eref_H(f)                        | 137.2 V/m          |                       |
| Combi Probe Use                  | E                  |                       |
| Unit                             | mW/cm <sup>2</sup> |                       |
| Results Format                   | FIXED              |                       |
| Auto-Zero Interval               | OFF                |                       |
| Result Type                      | -                  |                       |
| Averaging Time                   | -                  |                       |
| Average Progress                 | -                  |                       |
| Spatial AVG Mode                 | -                  |                       |
| Store Condition                  | -                  |                       |
| Storing Range                    | -                  |                       |
| Cond. Stop Time                  | -                  |                       |
| Upper Threshold                  | -                  |                       |
| Lower Threshold                  | -                  |                       |
| Timer Interval                   | 360 sec            |                       |
| Timer Duration                   | 99:00:00           |                       |
| History Time Scale               | -                  |                       |
| Time progress of current segment | -                  |                       |
| Index                            | Date/Time          | Avg (E-Field) [% STD] |
| 1                                | 9/16/2011 15:54:09 | 0.0096                |
| 2                                | 9/16/2011 16:00:09 | 0.0167                |
| 3                                | 9/16/2011 16:06:09 | 0.0226                |
| 4                                | 9/16/2011 16:12:09 | 0.03                  |
| 5                                | 9/16/2011 16:18:09 | 0                     |
| 6                                | 9/16/2011 16:24:09 | 0.0438                |
| 7                                | 9/16/2011 16:30:09 | 0.0561                |
| 8                                | 9/16/2011 16:36:09 | 0.0501                |
| 9                                | 9/16/2011 16:42:09 | 0.063                 |
| 10                               | 9/16/2011 16:48:09 | 0.0354                |
| 11                               | 9/16/2011 16:54:09 | 0.056                 |
| 12                               | 9/16/2011 17:00:09 | 0.0503                |
| 13                               | 9/16/2011 17:06:09 | 0.0302                |
| 14                               | 9/16/2011 17:12:09 | 0.034                 |
| 15                               | 9/16/2011 17:18:09 | 0.021                 |
| 16                               | 9/16/2011 17:24:09 | 0.0348                |
| 17                               | 9/16/2011 17:30:09 | 0.0295                |

|    |                    |        |
|----|--------------------|--------|
| 18 | 9/16/2011 17:36:09 | 0.0245 |
| 19 | 9/16/2011 17:42:09 | 0.0302 |
| 20 | 9/16/2011 17:48:09 | 0.0331 |
| 21 | 9/16/2011 17:54:09 | 0.0358 |
| 22 | 9/16/2011 18:00:09 | 0.033  |
| 23 | 9/16/2011 18:06:09 | 0.0176 |
| 24 | 9/16/2011 18:12:09 | 0.0335 |
| 25 | 9/16/2011 18:18:09 | 0.0341 |
| 26 | 9/16/2011 18:24:09 | 0.031  |
| 27 | 9/16/2011 18:30:09 | 0.0317 |
| 28 | 9/16/2011 18:36:09 | 0.0221 |
| 29 | 9/16/2011 18:42:09 | 0.0246 |
| 30 | 9/16/2011 18:48:09 | 0.0252 |
| 31 | 9/16/2011 18:54:09 | 0.0311 |
| 32 | 9/16/2011 19:00:09 | 0.03   |
| 33 | 9/16/2011 19:06:09 | 0.0418 |
| 34 | 9/16/2011 19:12:09 | 0.0393 |
| 35 | 9/16/2011 19:18:09 | 0.0433 |
| 36 | 9/16/2011 19:24:09 | 0.0454 |
| 37 | 9/16/2011 19:30:09 | 0.0273 |
| 38 | 9/16/2011 19:36:09 | 0.0288 |
| 39 | 9/16/2011 19:42:09 | 0.0301 |
| 40 | 9/16/2011 19:48:09 | 0.0291 |
| 41 | 9/16/2011 19:54:09 | 0.0376 |
| 42 | 9/16/2011 20:00:09 | 0.0278 |
| 43 | 9/16/2011 20:06:09 | 0.0321 |
| 44 | 9/16/2011 20:12:09 | 0.0382 |
| 45 | 9/16/2011 20:18:09 | 0.0592 |
| 46 | 9/16/2011 20:24:09 | 0.046  |
| 47 | 9/16/2011 20:30:09 | 0.0336 |
| 48 | 9/16/2011 20:36:09 | 0.04   |
| 49 | 9/16/2011 20:42:09 | 0.0377 |
| 50 | 9/16/2011 20:48:09 | 0.026  |
| 51 | 9/16/2011 20:54:09 | 0.0423 |
| 52 | 9/16/2011 21:00:09 | 0.0322 |
| 53 | 9/16/2011 21:06:09 | 0.0397 |
| 54 | 9/16/2011 21:12:09 | 0.0218 |
| 55 | 9/16/2011 21:18:09 | 0.0247 |
| 56 | 9/16/2011 21:24:09 | 0.0241 |
| 57 | 9/16/2011 21:30:09 | 0.0315 |
| 58 | 9/16/2011 21:36:09 | 0.02   |
| 59 | 9/16/2011 21:42:09 | 0.0223 |
| 60 | 9/16/2011 21:48:09 | 0.0199 |
| 61 | 9/16/2011 21:54:09 | 0.029  |
| 62 | 9/16/2011 22:00:09 | 0.0422 |
| 63 | 9/16/2011 22:06:09 | 0.0362 |
| 64 | 9/16/2011 22:12:09 | 0.042  |
| 65 | 9/16/2011 22:18:09 | 0.0412 |
| 66 | 9/16/2011 22:24:09 | 0.036  |
| 67 | 9/16/2011 22:30:09 | 0.0655 |
| 68 | 9/16/2011 22:36:09 | 0.0593 |
| 69 | 9/16/2011 22:42:09 | 0.0568 |
| 70 | 9/16/2011 22:48:09 | 0.0569 |
| 71 | 9/16/2011 22:54:09 | 0.0508 |
| 72 | 9/16/2011 23:00:09 | 0.0528 |
| 73 | 9/16/2011 23:06:09 | 0.0618 |
| 74 | 9/16/2011 23:12:09 | 0.0489 |
| 75 | 9/16/2011 23:18:09 | 0.072  |
| 76 | 9/16/2011 23:24:09 | 0.0529 |
| 77 | 9/16/2011 23:30:09 | 0.0555 |
| 78 | 9/16/2011 23:36:09 | 0.066  |
| 79 | 9/16/2011 23:42:09 | 0.0686 |
| 80 | 9/16/2011 23:48:09 | 0.0664 |
| 81 | 9/16/2011 23:54:09 | 0.0735 |
| 82 | 9/17/2011 0:00:09  | 0.0703 |
| 83 | 9/17/2011 0:06:09  | 0.0726 |
| 84 | 9/17/2011 0:12:09  | 0.085  |
| 85 | 9/17/2011 0:18:09  | 0.0679 |



|     |                   |        |
|-----|-------------------|--------|
| 86  | 9/17/2011 0:24:09 | 0.0537 |
| 87  | 9/17/2011 0:30:09 | 0.0579 |
| 88  | 9/17/2011 0:36:09 | 0.062  |
| 89  | 9/17/2011 0:42:09 | 0.0635 |
| 90  | 9/17/2011 0:48:09 | 0.0537 |
| 91  | 9/17/2011 0:54:09 | 0.061  |
| 92  | 9/17/2011 1:00:09 | 0.061  |
| 93  | 9/17/2011 1:06:09 | 0.0634 |
| 94  | 9/17/2011 1:12:09 | 0.0714 |
| 95  | 9/17/2011 1:18:09 | 0.068  |
| 96  | 9/17/2011 1:24:09 | 0.057  |
| 97  | 9/17/2011 1:30:09 | 0.0577 |
| 98  | 9/17/2011 1:36:09 | 0.0625 |
| 99  | 9/17/2011 1:42:09 | 0.0662 |
| 100 | 9/17/2011 1:48:09 | 0.0762 |
| 101 | 9/17/2011 1:54:09 | 0.0904 |
| 102 | 9/17/2011 2:00:09 | 0.091  |
| 103 | 9/17/2011 2:06:09 | 0.0891 |
| 104 | 9/17/2011 2:12:09 | 0.0675 |
| 105 | 9/17/2011 2:18:09 | 0.0775 |
| 106 | 9/17/2011 2:24:09 | 0.0781 |
| 107 | 9/17/2011 2:30:09 | 0.061  |
| 108 | 9/17/2011 2:36:09 | 0.056  |
| 109 | 9/17/2011 2:42:09 | 0.059  |
| 110 | 9/17/2011 2:48:09 | 0.0645 |
| 111 | 9/17/2011 2:54:09 | 0.0682 |
| 112 | 9/17/2011 3:00:09 | 0.0632 |
| 113 | 9/17/2011 3:06:09 | 0.0701 |
| 114 | 9/17/2011 3:12:09 | 0.0789 |
| 115 | 9/17/2011 3:18:09 | 0.07   |
| 116 | 9/17/2011 3:24:09 | 0.077  |
| 117 | 9/17/2011 3:30:09 | 0.0814 |
| 118 | 9/17/2011 3:36:09 | 0.073  |
| 119 | 9/17/2011 3:42:09 | 0.073  |
| 120 | 9/17/2011 3:48:09 | 0.0681 |
| 121 | 9/17/2011 3:54:09 | 0.0666 |
| 122 | 9/17/2011 4:00:09 | 0.0765 |
| 123 | 9/17/2011 4:06:09 | 0.0616 |
| 124 | 9/17/2011 4:12:09 | 0.0622 |
| 125 | 9/17/2011 4:18:09 | 0.0746 |
| 126 | 9/17/2011 4:24:09 | 0.0676 |
| 127 | 9/17/2011 4:30:09 | 0.0653 |
| 128 | 9/17/2011 4:36:09 | 0.0737 |
| 129 | 9/17/2011 4:42:09 | 0.0819 |
| 130 | 9/17/2011 4:48:09 | 0.0927 |
| 131 | 9/17/2011 4:54:09 | 0.0794 |
| 132 | 9/17/2011 5:00:09 | 0.0816 |
| 133 | 9/17/2011 5:06:09 | 0.0786 |
| 134 | 9/17/2011 5:12:09 | 0.0654 |
| 135 | 9/17/2011 5:18:09 | 0.0714 |
| 136 | 9/17/2011 5:24:09 | 0.0775 |
| 137 | 9/17/2011 5:30:09 | 0.0739 |
| 138 | 9/17/2011 5:36:09 | 0.0768 |
| 139 | 9/17/2011 5:42:09 | 0.0829 |
| 140 | 9/17/2011 5:48:09 | 0.105  |
| 141 | 9/17/2011 5:54:09 | 0.0926 |
| 142 | 9/17/2011 6:00:09 | 0.088  |
| 143 | 9/17/2011 6:06:09 | 0.0814 |
| 144 | 9/17/2011 6:12:09 | 0.0788 |
| 145 | 9/17/2011 6:18:09 | 0.0844 |
| 146 | 9/17/2011 6:24:09 | 0.0821 |
| 147 | 9/17/2011 6:30:09 | 0.104  |
| 148 | 9/17/2011 6:36:09 | 0.105  |
| 149 | 9/17/2011 6:42:09 | 0.1096 |
| 150 | 9/17/2011 6:48:09 | 0.102  |
| 151 | 9/17/2011 6:54:09 | 0.0993 |
| 152 | 9/17/2011 7:00:09 | 0.0895 |
| 153 | 9/17/2011 7:06:09 | 0.0774 |

|     |                    |        |
|-----|--------------------|--------|
| 154 | 9/17/2011 7:12:09  | 0.0889 |
| 155 | 9/17/2011 7:18:09  | 0.0911 |
| 156 | 9/17/2011 7:24:09  | 0.0846 |
| 157 | 9/17/2011 7:30:09  | 0.0921 |
| 158 | 9/17/2011 7:36:09  | 0.1    |
| 159 | 9/17/2011 7:42:09  | 0.0924 |
| 160 | 9/17/2011 7:48:09  | 0.0996 |
| 161 | 9/17/2011 7:54:09  | 0.074  |
| 162 | 9/17/2011 8:00:09  | 0.0756 |
| 163 | 9/17/2011 8:06:09  | 0.0905 |
| 164 | 9/17/2011 8:12:09  | 0.0803 |
| 165 | 9/17/2011 8:18:09  | 0.0742 |
| 166 | 9/17/2011 8:24:09  | 0.0738 |
| 167 | 9/17/2011 8:30:09  | 0.0743 |
| 168 | 9/17/2011 8:36:09  | 0.0675 |
| 169 | 9/17/2011 8:42:09  | 0.0539 |
| 170 | 9/17/2011 8:48:09  | 0.0689 |
| 171 | 9/17/2011 8:54:09  | 0.0751 |
| 172 | 9/17/2011 9:00:09  | 0.0776 |
| 173 | 9/17/2011 9:06:09  | 0.0729 |
| 174 | 9/17/2011 9:12:09  | 0.0895 |
| 175 | 9/17/2011 9:18:09  | 0.0855 |
| 176 | 9/17/2011 9:24:09  | 0.0912 |
| 177 | 9/17/2011 9:30:09  | 0.0895 |
| 178 | 9/17/2011 9:36:09  | 0.0972 |
| 179 | 9/17/2011 9:42:09  | 0.0782 |
| 180 | 9/17/2011 9:48:09  | 0.0782 |
| 181 | 9/17/2011 9:54:09  | 0.095  |
| 182 | 9/17/2011 10:00:09 | 0.09   |
| 183 | 9/17/2011 10:06:09 | 0.1    |
| 184 | 9/17/2011 10:12:09 | 0.0823 |
| 185 | 9/17/2011 10:18:09 | 0.0776 |
| 186 | 9/17/2011 10:24:09 | 0.0595 |
| 187 | 9/17/2011 10:30:09 | 0.066  |
| 188 | 9/17/2011 10:36:09 | 0.0711 |
| 189 | 9/17/2011 10:42:09 | 0.0886 |
| 190 | 9/17/2011 10:48:09 | 0.068  |
| 191 | 9/17/2011 10:54:09 | 0.0688 |
| 192 | 9/17/2011 11:00:09 | 0.0812 |
| 193 | 9/17/2011 11:06:09 | 0.069  |
| 194 | 9/17/2011 11:12:09 | 0.0651 |
| 195 | 9/17/2011 11:18:09 | 0.0608 |
| 196 | 9/17/2011 11:24:09 | 0.0643 |
| 197 | 9/17/2011 11:30:09 | 0.0733 |
| 198 | 9/17/2011 11:36:09 | 0.077  |
| 199 | 9/17/2011 11:42:09 | 0.0727 |
| 200 | 9/17/2011 11:48:09 | 0.0855 |
| 201 | 9/17/2011 11:54:09 | 0.0896 |
| 202 | 9/17/2011 12:00:09 | 0.088  |
| 203 | 9/17/2011 12:06:09 | 0.0834 |
| 204 | 9/17/2011 12:12:09 | 0.0944 |
| 205 | 9/17/2011 12:18:09 | 0.0866 |
| 206 | 9/17/2011 12:24:09 | 0.0765 |
| 207 | 9/17/2011 12:30:09 | 0.0823 |
| 208 | 9/17/2011 12:36:09 | 0.0807 |
| 209 | 9/17/2011 12:42:09 | 0.0761 |
| 210 | 9/17/2011 12:48:09 | 0.0806 |
| 211 | 9/17/2011 12:54:09 | 0.0832 |
| 212 | 9/17/2011 13:00:09 | 0.0658 |
| 213 | 9/17/2011 13:06:09 | 0.0719 |
| 214 | 9/17/2011 13:12:09 | 0.0712 |
| 215 | 9/17/2011 13:18:09 | 0.0697 |
| 216 | 9/17/2011 13:24:09 | 0.0735 |
| 217 | 9/17/2011 13:30:09 | 0.0913 |
| 218 | 9/17/2011 13:36:09 | 0.0792 |
| 219 | 9/17/2011 13:42:09 | 0.0598 |
| 220 | 9/17/2011 13:48:09 | 0.0505 |
| 221 | 9/17/2011 13:54:09 | 0.0475 |

|     |                    |        |
|-----|--------------------|--------|
| 222 | 9/17/2011 14:00:09 | 0.0477 |
| 223 | 9/17/2011 14:06:09 | 0.0536 |
| 224 | 9/17/2011 14:12:09 | 0.061  |
| 225 | 9/17/2011 14:18:09 | 0.0665 |
| 226 | 9/17/2011 14:24:09 | 0.072  |
| 227 | 9/17/2011 14:30:09 | 0.0568 |
| 228 | 9/17/2011 14:36:09 | 0.0642 |
| 229 | 9/17/2011 14:42:09 | 0.0628 |
| 230 | 9/17/2011 14:48:09 | 0.067  |
| 231 | 9/17/2011 14:54:09 | 0.0798 |
| 232 | 9/17/2011 15:00:09 | 0.0781 |
| 233 | 9/17/2011 15:06:09 | 0.0901 |
| 234 | 9/17/2011 15:12:09 | 0.0806 |
| 235 | 9/17/2011 15:18:09 | 0.0646 |
| 236 | 9/17/2011 15:24:09 | 0.0713 |
| 237 | 9/17/2011 15:30:09 | 0.0756 |
| 238 | 9/17/2011 15:36:09 | 0.0589 |
| 239 | 9/17/2011 15:42:09 | 0.072  |
| 240 | 9/17/2011 15:48:09 | 0.0861 |
| 241 | 9/17/2011 15:54:09 | 0.0717 |
| 242 | 9/17/2011 16:00:09 | 0.0773 |
| 243 | 9/17/2011 16:06:09 | 0.082  |
| 244 | 9/17/2011 16:12:09 | 0.0854 |
| 245 | 9/17/2011 16:18:09 | 0.0788 |
| 246 | 9/17/2011 16:24:09 | 0.0736 |
| 247 | 9/17/2011 16:30:09 | 0.074  |
| 248 | 9/17/2011 16:36:09 | 0.0733 |
| 249 | 9/17/2011 16:42:09 | 0.062  |
| 250 | 9/17/2011 16:48:09 | 0.0622 |
| 251 | 9/17/2011 16:54:09 | 0.0728 |
| 252 | 9/17/2011 17:00:09 | 0.0944 |
| 253 | 9/17/2011 17:06:09 | 0.0853 |
| 254 | 9/17/2011 17:12:09 | 0.0816 |
| 255 | 9/17/2011 17:18:09 | 0.0845 |
| 256 | 9/17/2011 17:24:09 | 0.0775 |
| 257 | 9/17/2011 17:30:09 | 0.0719 |
| 258 | 9/17/2011 17:36:09 | 0.0827 |
| 259 | 9/17/2011 17:42:09 | 0.079  |
| 260 | 9/17/2011 17:48:09 | 0.0859 |
| 261 | 9/17/2011 17:54:09 | 0.0913 |
| 262 | 9/17/2011 18:00:09 | 0.0802 |
| 263 | 9/17/2011 18:06:09 | 0.0954 |
| 264 | 9/17/2011 18:12:09 | 0.1028 |
| 265 | 9/17/2011 18:18:09 | 0.091  |
| 266 | 9/17/2011 18:24:09 | 0.0752 |
| 267 | 9/17/2011 18:30:09 | 0.088  |
| 268 | 9/17/2011 18:36:09 | 0.091  |
| 269 | 9/17/2011 18:42:09 | 0.1032 |
| 270 | 9/17/2011 18:48:09 | 0.1036 |
| 271 | 9/17/2011 18:54:09 | 0.1029 |
| 272 | 9/17/2011 19:00:09 | 0.1077 |
| 273 | 9/17/2011 19:06:09 | 0.1215 |
| 274 | 9/17/2011 19:12:09 | 0.0958 |
| 275 | 9/17/2011 19:18:09 | 0.0914 |
| 276 | 9/17/2011 19:24:09 | 0.0858 |
| 277 | 9/17/2011 19:30:09 | 0.0822 |
| 278 | 9/17/2011 19:36:09 | 0.1001 |
| 279 | 9/17/2011 19:42:09 | 0.0965 |
| 280 | 9/17/2011 19:48:09 | 0.1    |
| 281 | 9/17/2011 19:54:09 | 0.1003 |
| 282 | 9/17/2011 20:00:09 | 0.1047 |
| 283 | 9/17/2011 20:06:09 | 0.1046 |
| 284 | 9/17/2011 20:12:09 | 0.089  |
| 285 | 9/17/2011 20:18:09 | 0.1046 |
| 286 | 9/17/2011 20:24:09 | 0.1094 |
| 287 | 9/17/2011 20:30:09 | 0.098  |
| 288 | 9/17/2011 20:36:09 | 0.098  |
| 289 | 9/17/2011 20:42:09 | 0.084  |

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| 290 | 9/17/2011 20:48:09 | 0.0881 |
| 291 | 9/17/2011 20:54:09 | 0.0934 |
| 292 | 9/17/2011 21:00:09 | 0.0873 |
| 293 | 9/17/2011 21:06:09 | 0.07   |
| 294 | 9/17/2011 21:12:09 | 0.0659 |
| 295 | 9/17/2011 21:18:09 | 0.0706 |
| 296 | 9/17/2011 21:24:09 | 0.0909 |
| 297 | 9/17/2011 21:30:09 | 0.0875 |
| 298 | 9/17/2011 21:36:09 | 0.0812 |
| 299 | 9/17/2011 21:42:09 | 0.0999 |
| 300 | 9/17/2011 21:48:09 | 0.1005 |
| 301 | 9/17/2011 21:54:09 | 0.1033 |
| 302 | 9/17/2011 22:00:09 | 0.1245 |
| 303 | 9/17/2011 22:06:09 | 0.1135 |
| 304 | 9/17/2011 22:12:09 | 0.1026 |
| 305 | 9/17/2011 22:18:09 | 0.0941 |
| 306 | 9/17/2011 22:24:09 | 0.0881 |
| 307 | 9/17/2011 22:30:09 | 0.0789 |
| 308 | 9/17/2011 22:36:09 | 0.086  |
| 309 | 9/17/2011 22:42:09 | 0.1023 |
| 310 | 9/17/2011 22:48:09 | 0.0971 |
| 311 | 9/17/2011 22:54:09 | 0.098  |
| 312 | 9/17/2011 23:00:09 | 0.1082 |
| 313 | 9/17/2011 23:06:09 | 0.0994 |
| 314 | 9/17/2011 23:12:09 | 0.1032 |
| 315 | 9/17/2011 23:18:09 | 0.1062 |
| 316 | 9/17/2011 23:24:09 | 0.0949 |
| 317 | 9/17/2011 23:30:09 | 0.0881 |
| 318 | 9/17/2011 23:36:09 | 0.0902 |
| 319 | 9/17/2011 23:42:09 | 0.0836 |
| 320 | 9/17/2011 23:48:09 | 0.094  |
| 321 | 9/17/2011 23:54:09 | 0.0811 |
| 322 | 9/18/2011 0:00:09  | 0.086  |
| 323 | 9/18/2011 0:06:09  | 0.0832 |
| 324 | 9/18/2011 0:12:09  | 0.0916 |
| 325 | 9/18/2011 0:18:09  | 0.0909 |
| 326 | 9/18/2011 0:24:09  | 0.088  |
| 327 | 9/18/2011 0:30:09  | 0.0968 |
| 328 | 9/18/2011 0:36:09  | 0.0939 |
| 329 | 9/18/2011 0:42:09  | 0.09   |
| 330 | 9/18/2011 0:48:09  | 0.0829 |
| 331 | 9/18/2011 0:54:09  | 0.0976 |
| 332 | 9/18/2011 1:00:09  | 0.1005 |
| 333 | 9/18/2011 1:06:09  | 0.0926 |
| 334 | 9/18/2011 1:12:09  | 0.104  |
| 335 | 9/18/2011 1:18:09  | 0.101  |
| 336 | 9/18/2011 1:24:09  | 0.0862 |
| 337 | 9/18/2011 1:30:09  | 0.0737 |
| 338 | 9/18/2011 1:36:09  | 0.0767 |
| 339 | 9/18/2011 1:42:09  | 0.0628 |
| 340 | 9/18/2011 1:48:09  | 0.0717 |
| 341 | 9/18/2011 1:54:09  | 0.0866 |
| 342 | 9/18/2011 2:00:09  | 0.0907 |
| 343 | 9/18/2011 2:06:09  | 0.0684 |
| 344 | 9/18/2011 2:12:09  | 0.084  |
| 345 | 9/18/2011 2:18:09  | 0.082  |
| 346 | 9/18/2011 2:24:09  | 0.0954 |
| 347 | 9/18/2011 2:30:09  | 0.0939 |
| 348 | 9/18/2011 2:36:09  | 0.0944 |
| 349 | 9/18/2011 2:42:09  | 0.0932 |
| 350 | 9/18/2011 2:48:09  | 0.1082 |
| 351 | 9/18/2011 2:54:09  | 0.1061 |
| 352 | 9/18/2011 3:00:09  | 0.0999 |
| 353 | 9/18/2011 3:06:09  | 0.0988 |
| 354 | 9/18/2011 3:12:09  | 0.0901 |
| 355 | 9/18/2011 3:18:09  | 0.1    |
| 356 | 9/18/2011 3:24:09  | 0.1095 |
| 357 | 9/18/2011 3:30:09  | 0.0909 |

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| 359 | 9/18/2011 3:42:09  | 0.0714 |
| 360 | 9/18/2011 3:48:09  | 0.0657 |
| 361 | 9/18/2011 3:54:09  | 0.0875 |
| 362 | 9/18/2011 4:00:09  | 0.096  |
| 363 | 9/18/2011 4:06:09  | 0.0738 |
| 364 | 9/18/2011 4:12:09  | 0.0768 |
| 365 | 9/18/2011 4:18:09  | 0.0847 |
| 366 | 9/18/2011 4:24:09  | 0.0956 |
| 367 | 9/18/2011 4:30:09  | 0.0892 |
| 368 | 9/18/2011 4:36:09  | 0.0916 |
| 369 | 9/18/2011 4:42:09  | 0.0994 |
| 370 | 9/18/2011 4:48:09  | 0.1068 |
| 371 | 9/18/2011 4:54:09  | 0.1071 |
| 372 | 9/18/2011 5:00:09  | 0.0924 |
| 373 | 9/18/2011 5:06:09  | 0.0832 |
| 374 | 9/18/2011 5:12:09  | 0.0917 |
| 375 | 9/18/2011 5:18:09  | 0.0935 |
| 376 | 9/18/2011 5:24:09  | 0.0999 |
| 377 | 9/18/2011 5:30:09  | 0.0955 |
| 378 | 9/18/2011 5:36:09  | 0.083  |
| 379 | 9/18/2011 5:42:09  | 0.0791 |
| 380 | 9/18/2011 5:48:09  | 0.0919 |
| 381 | 9/18/2011 5:54:09  | 0.084  |
| 382 | 9/18/2011 6:00:09  | 0.0466 |
| 383 | 9/18/2011 6:06:09  | 0.0277 |
| 384 | 9/18/2011 6:12:09  | 0.0264 |
| 385 | 9/18/2011 6:18:09  | 0.0316 |
| 386 | 9/18/2011 6:24:09  | 0.036  |
| 387 | 9/18/2011 6:30:09  | 0.043  |
| 388 | 9/18/2011 6:36:09  | 0.0545 |
| 389 | 9/18/2011 6:42:09  | 0.0673 |
| 390 | 9/18/2011 6:48:09  | 0.0861 |
| 391 | 9/18/2011 6:54:09  | 0.0729 |
| 392 | 9/18/2011 7:00:09  | 0.0661 |
| 393 | 9/18/2011 7:06:09  | 0.0639 |
| 394 | 9/18/2011 7:12:09  | 0.0569 |
| 395 | 9/18/2011 7:18:09  | 0.0788 |
| 396 | 9/18/2011 7:24:09  | 0.0659 |
| 397 | 9/18/2011 7:30:09  | 0.0765 |
| 398 | 9/18/2011 7:36:09  | 0.086  |
| 399 | 9/18/2011 7:42:09  | 0.1004 |
| 400 | 9/18/2011 7:48:09  | 0.0882 |
| 401 | 9/18/2011 7:54:09  | 0.0791 |
| 402 | 9/18/2011 8:00:09  | 0.0686 |
| 403 | 9/18/2011 8:06:09  | 0.0804 |
| 404 | 9/18/2011 8:12:09  | 0.0683 |
| 405 | 9/18/2011 8:18:09  | 0.079  |
| 406 | 9/18/2011 8:24:09  | 0.0687 |
| 407 | 9/18/2011 8:30:09  | 0.0611 |
| 408 | 9/18/2011 8:36:09  | 0.0663 |
| 409 | 9/18/2011 8:42:09  | 0.079  |
| 410 | 9/18/2011 8:48:09  | 0.077  |
| 411 | 9/18/2011 8:54:09  | 0.0665 |
| 412 | 9/18/2011 9:00:09  | 0.0691 |
| 413 | 9/18/2011 9:06:09  | 0.0502 |
| 414 | 9/18/2011 9:12:09  | 0.0498 |
| 415 | 9/18/2011 9:18:09  | 0.0767 |
| 416 | 9/18/2011 9:24:09  | 0.0771 |
| 417 | 9/18/2011 9:30:09  | 0.0829 |
| 418 | 9/18/2011 9:36:09  | 0.0946 |
| 419 | 9/18/2011 9:42:09  | 0.0791 |
| 420 | 9/18/2011 9:48:09  | 0.0845 |
| 421 | 9/18/2011 9:54:09  | 0.0673 |
| 422 | 9/18/2011 10:00:09 | 0.0545 |
| 423 | 9/18/2011 10:06:09 | 0.0697 |
| 424 | 9/18/2011 10:12:09 | 0.0801 |
| 425 | 9/18/2011 10:18:09 | 0.0731 |

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| 426 | 9/18/2011 10:24:09 | 0.0941 |
| 427 | 9/18/2011 10:30:09 | 0.0843 |
| 428 | 9/18/2011 10:36:09 | 0.0879 |
| 429 | 9/18/2011 10:42:09 | 0.0873 |
| 430 | 9/18/2011 10:48:09 | 0.0898 |
| 431 | 9/18/2011 10:54:09 | 0.0545 |
| 432 | 9/18/2011 11:00:09 | 0.0736 |
| 433 | 9/18/2011 11:06:09 | 0.066  |
| 434 | 9/18/2011 11:12:09 | 0.0742 |
| 435 | 9/18/2011 11:18:09 | 0.079  |
| 436 | 9/18/2011 11:24:09 | 0.0599 |
| 437 | 9/18/2011 11:30:09 | 0.0585 |
| 438 | 9/18/2011 11:36:09 | 0.0662 |
| 439 | 9/18/2011 11:42:09 | 0.0637 |
| 440 | 9/18/2011 11:48:09 | 0.072  |
| 441 | 9/18/2011 11:54:09 | 0.0573 |
| 442 | 9/18/2011 12:00:09 | 0.0626 |
| 443 | 9/18/2011 12:06:09 | 0.051  |
| 444 | 9/18/2011 12:12:09 | 0.0532 |
| 445 | 9/18/2011 12:18:09 | 0.0624 |
| 446 | 9/18/2011 12:24:09 | 0.0713 |
| 447 | 9/18/2011 12:30:09 | 0.0693 |
| 448 | 9/18/2011 12:36:09 | 0.06   |
| 449 | 9/18/2011 12:42:09 | 0.06   |
| 450 | 9/18/2011 12:48:09 | 0.0548 |
| 451 | 9/18/2011 12:54:09 | 0.0798 |
| 452 | 9/18/2011 13:00:09 | 0.0791 |
| 453 | 9/18/2011 13:06:09 | 0.0831 |
| 454 | 9/18/2011 13:12:09 | 0.0772 |
| 455 | 9/18/2011 13:18:09 | 0.0741 |
| 456 | 9/18/2011 13:24:09 | 0.0602 |
| 457 | 9/18/2011 13:30:09 | 0.0651 |
| 458 | 9/18/2011 13:36:09 | 0.0786 |
| 459 | 9/18/2011 13:42:09 | 0.0638 |
| 460 | 9/18/2011 13:48:09 | 0.0767 |
| 461 | 9/18/2011 13:54:09 | 0.0853 |
| 462 | 9/18/2011 14:00:09 | 0.0678 |
| 463 | 9/18/2011 14:06:09 | 0.0847 |
| 464 | 9/18/2011 14:12:09 | 0.0745 |
| 465 | 9/18/2011 14:18:09 | 0.0778 |
| 466 | 9/18/2011 14:24:09 | 0.0689 |
| 467 | 9/18/2011 14:30:09 | 0.0646 |
| 468 | 9/18/2011 14:36:09 | 0.0643 |
| 469 | 9/18/2011 14:42:09 | 0.068  |
| 470 | 9/18/2011 14:48:09 | 0.0815 |
| 471 | 9/18/2011 14:54:09 | 0.0881 |
| 472 | 9/18/2011 15:00:09 | 0.0828 |
| 473 | 9/18/2011 15:06:09 | 0.0908 |
| 474 | 9/18/2011 15:12:09 | 0.0694 |
| 475 | 9/18/2011 15:18:09 | 0.0679 |
| 476 | 9/18/2011 15:24:09 | 0.0615 |
| 477 | 9/18/2011 15:30:09 | 0.0795 |
| 478 | 9/18/2011 15:36:09 | 0.0565 |
| 479 | 9/18/2011 15:42:09 | 0.0519 |
| 480 | 9/18/2011 15:48:09 | 0.05   |
| 481 | 9/18/2011 15:54:09 | 0.071  |
| 482 | 9/18/2011 16:00:09 | 0.0714 |
| 483 | 9/18/2011 16:06:09 | 0.0756 |
| 484 | 9/18/2011 16:12:09 | 0.0321 |
| 485 | 9/18/2011 16:18:09 | 0.0462 |
| 486 | 9/18/2011 16:24:09 | 0.0972 |
| 487 | 9/18/2011 16:30:09 | 0.1096 |
| 488 | 9/18/2011 16:36:09 | 0.0910 |
| 489 | 9/18/2011 16:42:09 | 0.0909 |
| 490 | 9/18/2011 16:48:09 | 0.0803 |
| 491 | 9/18/2011 16:54:09 | 0.0561 |
| 492 | 9/18/2011 17:00:09 | 0.0505 |
| 493 | 9/18/2011 17:06:09 | 0.0288 |

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| 494 | 9/18/2011 17:12:09 | 0.0842 |
| 495 | 9/18/2011 17:18:09 | 0.0536 |
| 496 | 9/18/2011 17:24:09 | 0.0882 |
| 497 | 9/18/2011 17:30:09 | 0.0769 |
| 498 | 9/18/2011 17:36:09 | 0.098  |
| 499 | 9/18/2011 17:42:09 | 0.0741 |
| 500 | 9/18/2011 17:48:09 | 0.0912 |
| 501 | 9/18/2011 17:54:09 | 0.0659 |
| 502 | 9/18/2011 18:00:09 | 0.042  |
| 503 | 9/18/2011 18:06:09 | 0.0909 |
| 504 | 9/18/2011 18:12:09 | 0.0317 |
| 505 | 9/18/2011 18:18:09 | 0.0781 |
| 506 | 9/18/2011 18:24:09 | 0.0712 |
| 507 | 9/18/2011 18:30:09 | 0.0965 |
| 508 | 9/18/2011 18:36:09 | 0.0226 |
| 509 | 9/18/2011 18:42:09 | 0.0905 |
| 510 | 9/18/2011 18:48:09 | 0.1032 |
| 511 | 9/18/2011 18:54:09 | 0.105  |
| 512 | 9/18/2011 19:00:09 | 0.043  |
| 513 | 9/18/2011 19:06:09 | 0.082  |
| 514 | 9/18/2011 19:12:09 | 0.09   |
| 515 | 9/18/2011 19:18:09 | 0.0775 |
| 516 | 9/18/2011 19:24:09 | 0.0913 |
| 517 | 9/18/2011 19:30:09 | 0.0418 |
| 518 | 9/18/2011 19:36:09 | 0.0241 |
| 519 | 9/18/2011 19:42:09 | 0.0768 |
| 520 | 9/18/2011 19:48:09 | 0.0776 |
| 521 | 9/18/2011 19:54:09 | 0.1082 |
| 522 | 9/18/2011 20:00:09 | 0.091  |
| 523 | 9/18/2011 20:06:09 | 0.0622 |
| 524 | 9/18/2011 20:12:09 | 0.022  |
| 525 | 9/18/2011 20:18:09 | 0.0944 |
| 526 | 9/18/2011 20:24:09 | 0.0241 |
| 527 | 9/18/2011 20:30:09 | 0.0665 |
| 528 | 9/18/2011 20:36:09 | 0.0418 |
| 529 | 9/18/2011 20:42:09 | 0.0376 |
| 530 | 9/18/2011 20:48:09 | 0.0638 |
| 531 | 9/18/2011 20:54:09 | 0.103  |
| 532 | 9/18/2011 21:00:09 | 0.0418 |
| 533 | 9/18/2011 21:06:09 | 0.0762 |
| 534 | 9/18/2011 21:12:09 | 0.08   |
| 535 | 9/18/2011 21:18:09 | 0.0768 |
| 536 | 9/18/2011 21:24:09 | 0.0693 |
| 537 | 9/18/2011 21:30:09 | 0.0291 |
| 538 | 9/18/2011 21:36:09 | 0.101  |
| 539 | 9/18/2011 21:42:09 | 0.0798 |
| 540 | 9/18/2011 21:48:09 | 0.0773 |
| 541 | 9/18/2011 21:54:09 | 0.01   |
| 542 | 9/18/2011 22:00:09 | 0.0658 |
| 543 | 9/18/2011 22:06:09 | 0.0866 |
| 544 | 9/18/2011 22:12:09 | 0.0828 |
| 545 | 9/18/2011 22:18:09 | 0.0965 |
| 546 | 9/18/2011 22:24:09 | 0.0357 |
| 547 | 9/18/2011 22:30:09 | 0.0645 |
| 548 | 9/18/2011 22:36:09 | 0.056  |
| 549 | 9/18/2011 22:42:09 | 0.0807 |
| 550 | 9/18/2011 22:48:09 | 0.0736 |
| 551 | 9/18/2011 22:54:09 | 0.0691 |
| 552 | 9/18/2011 23:00:09 | 0.0741 |
| 553 | 9/18/2011 23:06:09 | 0.1003 |
| 554 | 9/18/2011 23:12:09 | 0.0761 |
| 555 | 9/18/2011 23:18:09 | 0.0916 |
| 556 | 9/18/2011 23:24:09 | 0.0741 |
| 557 | 9/18/2011 23:30:09 | 0.0288 |
| 558 | 9/18/2011 23:36:09 | 0.0726 |
| 559 | 9/18/2011 23:42:09 | 0.0743 |
| 560 | 9/18/2011 23:48:09 | 0.0706 |
| 561 | 9/18/2011 23:54:09 | 0.0548 |

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| 562 | 9/19/2011 0:00:09 | 0.0438 |
| 563 | 9/19/2011 0:06:09 | 0.0711 |
| 564 | 9/19/2011 0:12:09 | 0.059  |
| 565 | 9/19/2011 0:18:09 | 0.0686 |
| 566 | 9/19/2011 0:24:09 | 0.0682 |
| 567 | 9/19/2011 0:30:09 | 0.0676 |
| 568 | 9/19/2011 0:36:09 | 0.0775 |
| 569 | 9/19/2011 0:42:09 | 0.0264 |
| 570 | 9/19/2011 0:48:09 | 0.0226 |
| 571 | 9/19/2011 0:54:09 | 0.0926 |
| 572 | 9/19/2011 1:00:09 | 0.1    |
| 573 | 9/19/2011 1:06:09 | 0.1095 |
| 574 | 9/19/2011 1:12:09 | 0.0829 |
| 575 | 9/19/2011 1:18:09 | 0.0737 |
| 576 | 9/19/2011 1:24:09 | 0.073  |
| 577 | 9/19/2011 1:30:09 | 0.0742 |
| 578 | 9/19/2011 1:36:09 | 0.0949 |
| 579 | 9/19/2011 1:42:09 | 0.0847 |
| 580 | 9/19/2011 1:48:09 | 0.0741 |
| 581 | 9/19/2011 1:54:09 | 0.0892 |
| 582 | 9/19/2011 2:00:09 | 0.094  |
| 583 | 9/19/2011 2:06:09 | 0.0679 |
| 584 | 9/19/2011 2:12:09 | 0.0501 |
| 585 | 9/19/2011 2:18:09 | 0.0806 |
| 586 | 9/19/2011 2:24:09 | 0.0403 |
| 587 | 9/19/2011 2:30:09 | 0.0689 |
| 588 | 9/19/2011 2:36:09 | 0.073  |
| 589 | 9/19/2011 2:42:09 | 0.036  |
| 590 | 9/19/2011 2:48:09 | 0.0687 |
| 591 | 9/19/2011 2:54:09 | 0.0599 |
| 592 | 9/19/2011 3:00:09 | 0.0768 |
| 593 | 9/19/2011 3:06:09 | 0.0875 |
| 594 | 9/19/2011 3:12:09 | 0.0829 |
| 595 | 9/19/2011 3:18:09 | 0.0466 |
| 596 | 9/19/2011 3:24:09 | 0.0537 |
| 597 | 9/19/2011 3:30:09 | 0.1071 |
| 598 | 9/19/2011 3:36:09 | 0.0736 |
| 599 | 9/19/2011 3:42:09 | 0.0393 |
| 600 | 9/19/2011 3:48:09 | 0.0776 |
| 601 | 9/19/2011 3:54:09 | 0.1077 |
| 602 | 9/19/2011 4:00:09 | 0.0686 |
| 603 | 9/19/2011 4:06:09 | 0.0508 |
| 604 | 9/19/2011 4:12:09 | 0.091  |
| 605 | 9/19/2011 4:18:09 | 0.0226 |
| 606 | 9/19/2011 4:24:09 | 0.0397 |
| 607 | 9/19/2011 4:30:09 | 0.0865 |
| 608 | 9/19/2011 4:36:09 | 0.0675 |
| 609 | 9/19/2011 4:42:09 | 0.036  |
| 610 | 9/19/2011 4:48:09 | 0.0907 |
| 611 | 9/19/2011 4:54:09 | 0.0403 |
| 612 | 9/19/2011 5:00:09 | 0.0462 |
| 613 | 9/19/2011 5:06:09 | 0.0895 |
| 614 | 9/19/2011 5:12:09 | 0.073  |
| 615 | 9/19/2011 5:18:09 | 0.1028 |
| 616 | 9/19/2011 5:24:09 | 0.0735 |
| 617 | 9/19/2011 5:30:09 | 0.0907 |
| 618 | 9/19/2011 5:36:09 | 0.0241 |
| 619 | 9/19/2011 5:42:09 | 0.0788 |
| 620 | 9/19/2011 5:48:09 | 0.062  |
| 621 | 9/19/2011 5:54:09 | 0.0739 |
| 622 | 9/19/2011 6:00:09 | 0.06   |
| 623 | 9/19/2011 6:06:09 | 0.028  |
| 624 | 9/19/2011 6:12:09 | 0.0855 |
| 625 | 9/19/2011 6:18:09 | 0.0733 |
| 626 | 9/19/2011 6:24:09 | 0.0751 |
| 627 | 9/19/2011 6:30:09 | 0.053  |
| 628 | 9/19/2011 6:36:09 | 0.083  |
| 629 | 9/19/2011 6:42:09 | 0.0842 |



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| 630 | 9/19/2011 6:48:09  | 0.0984 |
| 631 | 9/19/2011 6:54:09  | 0.0713 |
| 632 | 9/19/2011 7:00:09  | 0.1048 |
| 633 | 9/19/2011 7:06:09  | 0.096  |
| 634 | 9/19/2011 7:12:09  | 0.067  |
| 635 | 9/19/2011 7:18:09  | 0.0295 |
| 636 | 9/19/2011 7:24:09  | 0.0791 |
| 637 | 9/19/2011 7:30:09  | 0.0791 |
| 638 | 9/19/2011 7:36:09  | 0.0944 |
| 639 | 9/19/2011 7:42:09  | 0.1029 |
| 640 | 9/19/2011 7:48:09  | 0.0954 |
| 641 | 9/19/2011 7:54:09  | 0.0812 |
| 642 | 9/19/2011 8:00:09  | 0.0602 |
| 643 | 9/19/2011 8:06:09  | 0.0853 |
| 644 | 9/19/2011 8:12:09  | 0.0768 |
| 645 | 9/19/2011 8:18:09  | 0.079  |
| 646 | 9/19/2011 8:24:09  | 0.0348 |
| 647 | 9/19/2011 8:30:09  | 0.0438 |
| 648 | 9/19/2011 8:36:09  | 0.0778 |
| 649 | 9/19/2011 8:42:09  | 0.0765 |
| 650 | 9/19/2011 8:48:09  | 0.0792 |
| 651 | 9/19/2011 8:54:09  | 0.0679 |
| 652 | 9/19/2011 9:00:09  | 0.0662 |
| 653 | 9/19/2011 9:06:09  | 0.0691 |
| 654 | 9/19/2011 9:12:09  | 0.0965 |
| 655 | 9/19/2011 9:18:09  | 0.1062 |
| 656 | 9/19/2011 9:24:09  | 0.0984 |
| 657 | 9/19/2011 9:30:09  | 0.031  |
| 658 | 9/19/2011 9:36:09  | 0.0573 |
| 659 | 9/19/2011 9:42:09  | 0.083  |
| 660 | 9/19/2011 9:48:09  | 0.0433 |
| 661 | 9/19/2011 9:54:09  | 0.0778 |
| 662 | 9/19/2011 10:00:09 | 0.0694 |
| 663 | 9/19/2011 10:06:09 | 0.0881 |
| 664 | 9/19/2011 10:12:09 | 0.0845 |
| 665 | 9/19/2011 10:18:09 | 0.0616 |
| 666 | 9/19/2011 10:24:09 | 0.028  |
| 667 | 9/19/2011 10:30:09 | 0.0895 |
| 668 | 9/19/2011 10:36:09 | 0.0422 |
| 669 | 9/19/2011 10:42:09 | 0.03   |
| 670 | 9/19/2011 10:48:09 | 0.0673 |
| 671 | 9/19/2011 10:54:09 | 0.0769 |
| 672 | 9/19/2011 11:00:09 | 0.0984 |
| 673 | 9/19/2011 11:06:09 | 0.0881 |
| 674 | 9/19/2011 11:12:09 | 0.0879 |
| 675 | 9/19/2011 11:18:09 | 0.0905 |
| 676 | 9/19/2011 11:24:09 | 0.0696 |

## 10 Independent Review – Exotek Systems

**EXOTEKSYSTEMS**TELECOMMUNICATIONS ENGINEERING  
10457 ALLBAY ROAD

SIDNEY, BC

V8L 2P2

604-551-8400

Vern Kwiatkowski

BC Hydro, Smart Metering &amp; Infrastructure

6911 Southpoint Drive

Burnaby, BC V3N 4X8

11 October 2011

Re: Safety Code Six Report: Single Smart Meter by K.Reardon, P.Eng Planetworks Consulting

Dear Sir,

In accordance with your request, I have conducted an exhaustive review of the work done by Mr. Karl Reardon, P.Eng. which is contained in his report entitled "BC Hydro – Single Smart Meter Safety Code 6 Report, Rev. A" dated 11 October 2011. That report describes the power density, measured by a Narda probe and meter, resulting from the radio frequency transmissions from the Itron "smart" meter described in the report in accordance with Safety Code 6.

Attestation:

I, Anton van Wouw, a Professional Engineer registered in the Province of British Columbia, state that the work done by Mr. Karl Reardon, P.Eng., in preparing the aforementioned report, was done in accordance with best practices in the field of radio frequency engineering and that the methodology, reporting and interpretation of the readings from the test equipment was done with sound scientific principles. The results, which approach the lower limit of measurement of the test equipment, fairly report that at a distance of 20 cm from the meter tested, the power density, averaged over six minute intervals for a period of several days, was less than 0.5% of the allowable Safety Code 6 limit for "uncontrolled environments" i.e. the general public.

Furthermore, I am familiar with the Narda equipment in general and the specifically the Broadband Field Meter and Electric Field Probe used by Mr. Reardon to obtain the measurements contained in the report. I have personally inspected the equipment and found it to be in good working condition; I have no reason to suspect that the December 2010 calibration is at all compromised.

Sincerely Yours,



A. Tony van Wouw, P.Eng.

President, Exotek Systems.

604-551-8400

[www.exotek.ca](http://www.exotek.ca)

| REVISIONS |     |               |                  |          |
|-----------|-----|---------------|------------------|----------|
|           | REV | DESCRIPTION   | DATE             | APPROVED |
|           | A   | Issued Report | October 11, 2011 | SMR      |
|           |     |               |                  |          |
|           |     |               |                  |          |



BC Hydro – Bank of 10 Smart Meters  
Safety Code 6 Report  
*Prepared for BC Hydro*

PAGE 1 OF 56

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SIGNATURE AND DOCUMENT  
VERIFICATION.

|            |   |           |
|------------|---|-----------|
| <b>1</b>   | <b>SUMMARY .....</b>  | <b>5</b>  |
| <b>1.1</b> | <b>SITE LOCATION/ DETAILS .....</b>                                   | <b>5</b>  |
| <b>1.2</b> | <b>ATTESTATION .....</b>  | <b>5</b>  |
| <b>1.3</b> | <b>SAFETY CODE 6 DEFINITIONS .....</b>                                | <b>6</b>  |
| <b>1.4</b> | <b>REVIEW OF FINDINGS, CONCLUSIONS AND REMEDIAL ACTIONS .....</b>     | <b>8</b>  |
|            | 1.3.1 Meter Inventories .....   | 8         |
|            | 1.3.2 Findings .....  | 8         |
|            | 1.3.3 Next Steps and Required Remedial Actions .....                  | 10        |
| <b>2</b>   | <b>MEASUREMENT PROCEDURE .....</b>                                    | <b>11</b> |
| <b>2.1</b> | <b>DESCRIPTION OF PROCEDURE USED .....</b>                            | <b>11</b> |
| <b>2.2</b> | <b>TEST EQUIPMENT DESCRIPTION.....</b>                                | <b>11</b> |
| <b>3</b>   | <b>SITE PLAN AND PHOTOGRAPHS .....</b>                                | <b>12</b> |
| <b>4</b>   | <b>TRAFFIC CONFIRMATION – TEN METERS UNDER TEST.....</b>              | <b>13</b> |
| <b>5</b>   | <b>TRAFFIC CONFIRMATION – ALL METERS .....</b>                        | <b>15</b> |
| <b>6</b>   | <b>NBM-550 CALIBRATION CERTIFICATE .....</b>                          | <b>17</b> |
| <b>7</b>   | <b>PROBE CALIBRATION CERTIFICATE .....</b>                            | <b>20</b> |
| <b>8</b>   | <b>FIELD PROBE LOG FILES – ALL METERS ACTIVE .....</b>                | <b>26</b> |
| <b>9</b>   | <b>FIELD PROBE LOG FILES – BACKGROUND NOISE (ALL METERS OFF).....</b> | <b>39</b> |
| <b>10</b>  | <b>INDEPENDENT REVIEW – EXOTEK SYSTEMS .....</b>                      | <b>56</b> |

## Executive Summary

### Objective

To certify the compliance of BC Hydro's smart meter (Itron's Openway Centron Meter, Hardware Profile 3.1) against Canadian federal regulations as specified by Health Canada Safety Code 6. This report describes the testing results for a meter bank of 10 meters. A separate report describes the testing results for a single meter.

### Approach

Planetworks, a telecommunication engineering consulting firm, has been contracted to conduct independent testing of BC Hydro's smart meters. Planetworks uses the Narda Broadband Field Meters (NDM-550) together with a shaped isotropic field probe, which is the most accurate field meter solution available for broadband radio-frequency (RF) exposure limit measurements. The testing environment has been constructed to be as realistic a representation of usage environment as possible, with multiple meters located throughout the test area to simulate a full network environment. Although care was taken to ensure no other intentional emitters of RF energy were present in the testing environment, it was not possible to eliminate the secondary sources of RF energy such as fluorescent lighting, electrical transformers, external Wi-Fi hotspots, signals from cellular sites, broadcast sources, etc. Therefore, some level of background RF energy is included in all the measurement results.

All testing has been conducted in conformance to procedures defined in Health Canada's Safety Code 6. At the operational frequencies of the smart meters, Safety Code 6 defines a maximum permissible power density of  $6 \text{ W/m}^2$  (averaged over a 6 minute period) for uncontrolled areas (i.e. public areas). Using the relationship that  $1 \text{ W/m}^2$  equals  $100 \mu\text{W/cm}^2$ , the Safety Code 6 permissible limit for 900 MHz emissions can be converted to  $600 \mu\text{W/cm}^2$ .

### Findings

1. At 20 centimetre distance from the meter in the centre of a bank of ten smart meters, the average power density measured over a 2 day period is 0.4507% of Health Canada Safety Code 6 limit for public areas (uncontrolled environments). This measured value includes the background radio-frequency signals originating from other internal or external sources.
2. The Narda Field Meter measures the cumulative emissions across a very wide frequency range and automatically applies measurements against the Health Canada Safety Code 6 limit appropriate for each frequency. While this approach provides a very accurate assessment of percentage of Safety Code 6 limit attained, it is not possible to accurately convert this value into a power density due to the presence of the background RF sources. However, if it is assumed that all measured emissions originated from the smart meters during the test, the attained percentage value of 0.4507% can be converted to a power density of  $2.7 \mu\text{W/cm}^2$  (2.7 microwatts per square centimetre). The power density attributed to the smart meters only would be less than this value.
3. Relative to a single meter, the average power density of a meter bank with ten meters is 1.2 times of a single meter. Meters do not typically communicate all at the same time and communication protocols minimize the amount of concurrent traffic.
4. The range of power densities measured over the 2 day period was 0.0015% to 1.6835% of Safety Code 6 limits for public areas (uncontrolled environments).
5. The active transmission time for the meter bank was 10.150 seconds on Day 1 and 9.606 seconds on Day 2 for a total cumulative transmission time of 19.756 seconds over the 2 day testing period. This includes all

transmissions from the 10 meters during this period of time. From these results, the average transmission time per meter is 0.9878 seconds per day or 1.9756 seconds over the 2 days – in alignment with the single meter results.

## 1 Summary

### 1.1 Site Location/ Details

|                      |  |
|----------------------|--|
| Site Street Address  | BC Hydro Meter Shop  |
| Location of Antennas | Bank of 10 Itron Smart Meters with AMI7 Radios Located on the Main Floor |

|                  |                        |                       |                        |
|------------------|------------------------|-----------------------|------------------------|
| Test Start       | Sept 10, 2011 08:10:59 | Test Stop             | Sept 12, 2011 08:30:35 |
| Site Plan Attch. | Yes                    | Antenna Photos Attch. | Meter Bank Photo       |
| Site Photo Attch | Yes                    | Log Files Attch.      | Yes                    |

### 1.2 Attestation

I, Karl Reardon, a Professional Engineer registered in the Province of British Columbia, certify that, at the time of testing, the radio frequency field levels for a bank of ten Itron Smart Meters with AMI7 radios complies with Health Canada regulations based on the specified documentation below:

- (HC Pub. 091029) Limits of Human Exposure to Radio frequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz - Safety Code 6 (2009)
- (HC Pub. 091031) Technical Guide for Interpretation and Compliance Assessment of Health Canada's Radio frequency Exposure Guidelines

|   |   |
|---|---|
| Measured Results Below Health Canada Safety Code 6 Exposure Limits for Uncontrolled Environments<br>(General Public, not trained in radio frequency hazards, exposed to RF and Microwave emissions) | Within Safe Limits Defined by Health Canada |
| Induced Currents are below HC-SC6 Requirements  | Yes   |
| Signage Meets HC-SC6 Requirements   | n/a   |

#### Notes

(1) This test involved a bank of ten Itron meters on the main floor of the meter shop. There were multiple other meters located on this floor and a floor below, simulating a full network environment.

(2) The 900 MHz RF transmitter was active in the meters during testing. Consistent with BC Hydro's planned deployment practice, the ZigBee RF section was disabled during testing (i.e. the ZigBee radio was in its default, off state).

(3) The Narda probe was placed to ensure the path between the Itron meter antennas and the Narda Probe was unobstructed, as shown in Section 3. This placement ensured maximum readings from the meter bank under test.

(4) The Narda meter records cumulative RF emissions from all RF sources in the spectral range from 0.3 MHz to 50,000 MHz. Care was taken to ensure no other RF sources were active in the building during the test. It should be noted that buildings typically contain many secondary RF sources such as fluorescent lighting, electrical transformers, motors, etc. Additionally, most populated areas contain many external RF sources that cannot be controlled, including Wi-Fi hotspots, signals from cellular sites and devices, two-way radio communication and broadcast sources.

### 1.3 Safety Code 6 Definitions

Prior to the 2009 dated release of the Health Canada Safety Code 6 specifications, the documentation defined exposure limits for "RF and occupationally exposed workers" and exposure limits for the "general public." The general public was defined as any individual who may be exposed to RF emissions and has no knowledge or training in radio technology. Consequently exposure limits for the general public are five times lower than that for the RF worker who must have adequate safety training to work with antenna systems.

Challenges arose when defining "occupationally exposed workers." In the 2009 edition of the Safety-Code 6 guidelines, Health Canada attempted to address the ambiguities in these definitions by categorizing sites as "controlled" and "uncontrolled" where "uncontrolled" replaced the definition for the general public.

The following text is lifted from current Health Canada's Safety Code 6 documentation and defines controlled versus uncontrolled environments.

#### **Controlled and Uncontrolled Environments**

"For the purpose of this code, controlled environments are defined as those where all of the following conditions are satisfied:

- (a) The RF field intensities in the controlled area have been adequately characterized by means of measurements, calculations or modeling (such as with the use of FDTD [finite difference time domain] software),
- (b) The exposure is incurred by persons who are aware of the potential for RF exposure and are cognizant of the intensity of the RF energy in their environment and,
- (c) The exposure is incurred by persons who are aware of the potential health risks associated with RF energy exposures and whom can control their risk using mitigation strategies.

All situations that do not meet the specifications above are considered to be uncontrolled environments. Uncontrolled environments are defined as areas where either insufficient assessment of RF energy has been conducted or where persons who are allowed access to these areas have not received proper RF awareness training and have no means to assess or, if required, mitigate their exposure to RF energy."<sup>1</sup>

Exposure limits for controlled and uncontrolled environments is defined by Health Canada in the following tables.

---

<sup>1</sup> "Chapter 2, Maximum Exposure Limits", Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz, HC Pub.: 091029



Table 5. Exposure Limits for Controlled Environments.

| 1<br>Frequency<br>(MHz) | 2<br>Electric Field<br>Strength; rms<br>(V/m) | 3<br>Magnetic Field<br>Strength; rms<br>(A/m) | 4<br>Power<br>Density<br>(W/m <sup>2</sup> ) | 5<br>Averaging<br>Time<br>(min) |
|-------------------------|---|---|--|---------------------------------|
| 0.003 - 1               | 600   | 4.9   |  | 6                               |
| 1 - 10                  | $600/f$                                       | $4.9/f$                                       |  | 6                               |
| 10 - 30                 | 60  | $4.9/f$                                       |  | 6                               |
| 30 - 300                | 60  | 0.163   | 10*  | 6                               |
| 300 - 1 500             | $3.54f^{0.5}$                                 | $0.0094f^{0.5}$                               | $f/30$                                       | 6                               |
| 1 500 - 15 000          | 137   | 0.364   | 50   | 6                               |
| 15 000 - 150 000        | 137   | 0.364   | 50   | $616\,000/f^{1.2}$              |
| 150 000 - 300 000       | $0.354f^{0.5}$                                | $9.4 \times 10^{-4}f^{0.5}$                   | $3.33 \times 10^{-4}f$                       | $616\,000/f^{1.2}$              |

\* 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/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.

3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

Table 6. Exposure Limits for Uncontrolled Environments.

| 1<br>Frequency<br>(MHz) | 2<br>Electric Field<br>Strength; rms<br>(V/m) | 3<br>Magnetic Field<br>Strength; rms<br>(A/m) | 4<br>Power<br>Density<br>(W/m <sup>2</sup> ) | 5<br>Averaging<br>Time<br>(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/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.

3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

Applying the exposure limits from these standards to BC Hydro's smart meters – which use an AMI7 radio operating at 900 MHz – the limits are:

- **Uncontrolled Environments** – 6 Watts/meter squared (W/m<sup>2</sup>) or 600 microwatts per square centimetre (μW/cm<sup>2</sup>)
- **Controlled Environments** – 30 W/m<sup>2</sup> or 3,000 μW/cm<sup>2</sup>

Conversion between W/m<sup>2</sup> and μW/cm<sup>2</sup> is performed using the relationship that 1 W/m<sup>2</sup> equals 100 μW/cm<sup>2</sup>.

## 1.4 Review of Findings, Conclusions and Remedial Actions

Planetworks conducted testing to Health Canada Safety Code 6 for a bank of ten smart meters deployed in a realistic field simulation, with multiple other meters located at further distances.

### 1.3.1 **Meter Inventories**

A bank of ten meters were present in the immediate test area. A total of 21 Smart Meters and one Collector were located within 50 metres of the test location on the same floor and one floor below. The meter inventories are listed below. The meters under test were badge numbers 3,990,028 through 3,990,041, however all other meters were also active.

| Badge #   | Meter Type | Location |
|-----------|------------|----------|
| 3,990,002 | P261       | POR 19   |
| 3,990,003 | P261       | POR 18   |
| 3,990,028 | P263       | Panel 9  |
| 3,990,029 | P263       | Panel 9  |
| 3,990,030 | P263       | Panel 9  |
| 3,990,031 | P263       | Panel 9  |
| 3,990,032 | P263       | Panel 9  |
| 3,990,033 | P263       | Panel 9  |
| 3,990,034 | P263       | Panel 9  |
| 3,990,035 | P263       | Panel 9  |
| 3,990,040 | P263       | Panel 9  |
| 3,990,041 | P263       | Panel 9  |
| 3,990,096 | P264       | POR20    |
| 3,990,099 | P264       | POR21    |
| 3,990,124 | P264       | POR22    |
| 3,990,125 | P264       | POR23    |
| 3,990,126 | P264       | POR24    |
| 3,990,127 | P264       | POR25    |
| 3,990,101 | P264       | POR26    |
| 3,990,102 | P264       | POR27    |
| 3,990,103 | P264       | POR28    |

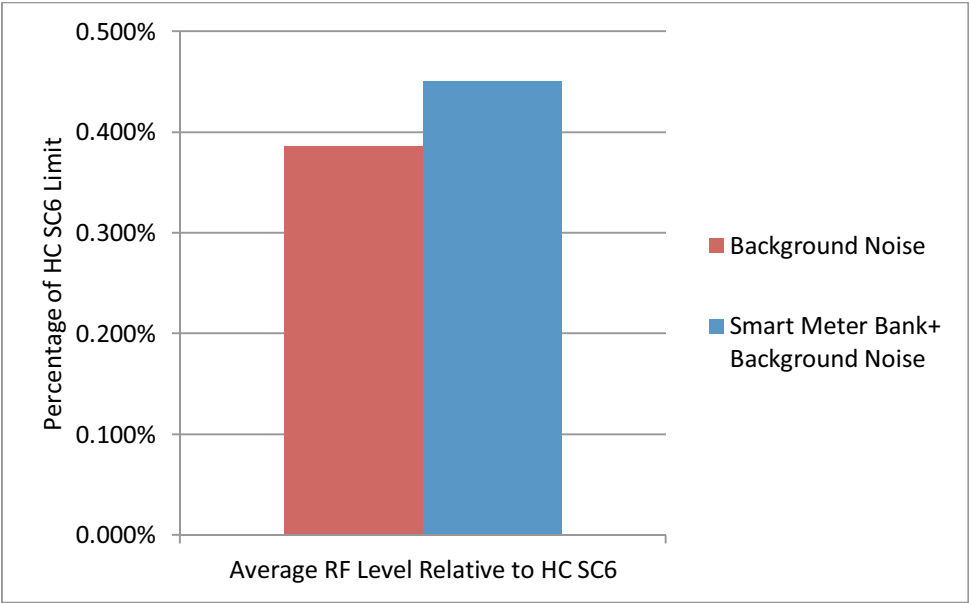
Details regarding the meter locations and Collector (SGCR) location are included in Section 3.

### 1.3.2 **Findings**

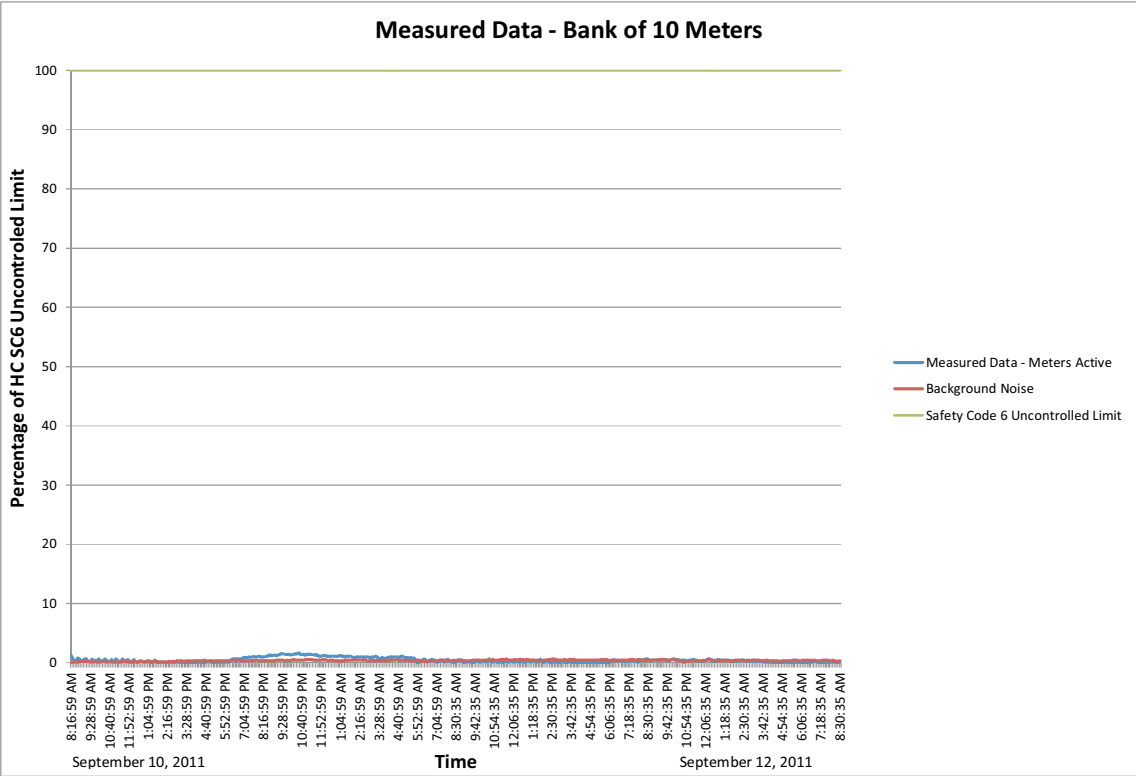
Testing showed that even in close proximity (20 centimetre) to the bank of ten meters, RF emissions from the meters are more than 220 times less than Health Canada limits for the general public in uncontrolled environments. The cumulative effect of the meter bank under test, other meters in the building, and all background emissions from other internal (e.g. fluorescent lighting) and external sources (e.g. cell sites), resulted in an average level of 0.4507% of the Health Canada Safety Code 6 (HC SC-6) in an uncontrolled environment standard (i.e. 1/222<sup>nd</sup> of the limit).

Background measurements were also taken at the same site location one week later (Measurement start: Sept 16, 2011 15:50:18 Measurement Stop: Sept 19, 2011 11:32:18). During these background tests all meters and associated hubs and router were confirmed to be off and not transmitting. The measured average across this time period was 0.3866% of the HC SC-6 limit for the general public in uncontrolled environments. While one cannot draw a full correlation between the two tests as they occurred over different time periods, it is noted that a low level of background emissions are present at the location without the Smart Meter system active, and that the level recorded when the Smart Meters were active was not significantly different.

These results are illustrated in the following chart:



Detailed testing results are provided in Section 8 and illustrated in the following table:



The Narda field strength probe uses a frequency shaped head which measures RF emission limits at different frequencies and presents a cumulative total of all emissions as a percentage of Safety Code 6. While this approach provides a very accurate assessment of percentage of Safety Code 6 limit, it is not possible to accurately convert this into a power density value at a single frequency due to the presence of the background RF sources. However, if it is assumed that all measured emissions originated around 900 MHz, the attained percentage value of 0.4507% can be converted to a power density of  $2.7 \mu\text{W}/\text{cm}^2$  (2.7 microwatts per square centimeter).

NOTE: At this time, the Narda unit represents the most accurate broadband, cumulative field metering solution available for RF exposure limit measurements in operational environments. The average emissions measured are below a field strength of 4.340 V/m, which is the lower limit rating of the Narda unit. At measurements below this level, the accuracy of the results may not be within the tolerance specified in the meter calibration certificate (Section 6) and the results obtained may also include internal noise generated by the Narda meter. It is therefore likely that the emissions from the Itron Smart meters are actually lower than those measured in this report.

### 1.3.3 Next Steps and Required Remedial Actions

No remedial actions are required.

## 2 Measurement Procedure

### 2.1 Description of Procedure Used

Field measurements used to determine conformity with the limits specified in SC6 are performed with the field sensor (probe) placed at least 20 centimetres away from any object or person with measurements averaged over 6 minutes as per SC6. The following measurements were taken at 20 cm from the meter bank over a 48 hour period. The probe was located in a position to receive maximum emissions from the Smart Meter bank (i.e. just above the Smart Meter' top housing, in the middle of the meter bank), as shown in Section 3.

The spatially averaged values are calculated based on the RMS average of the electric and magnetic field strengths of the samples.

RF Field strengths measured included all active transmitters (meter bank under test as well as other meters on the same floor, lower floor and other RF sources) at the time of testing.

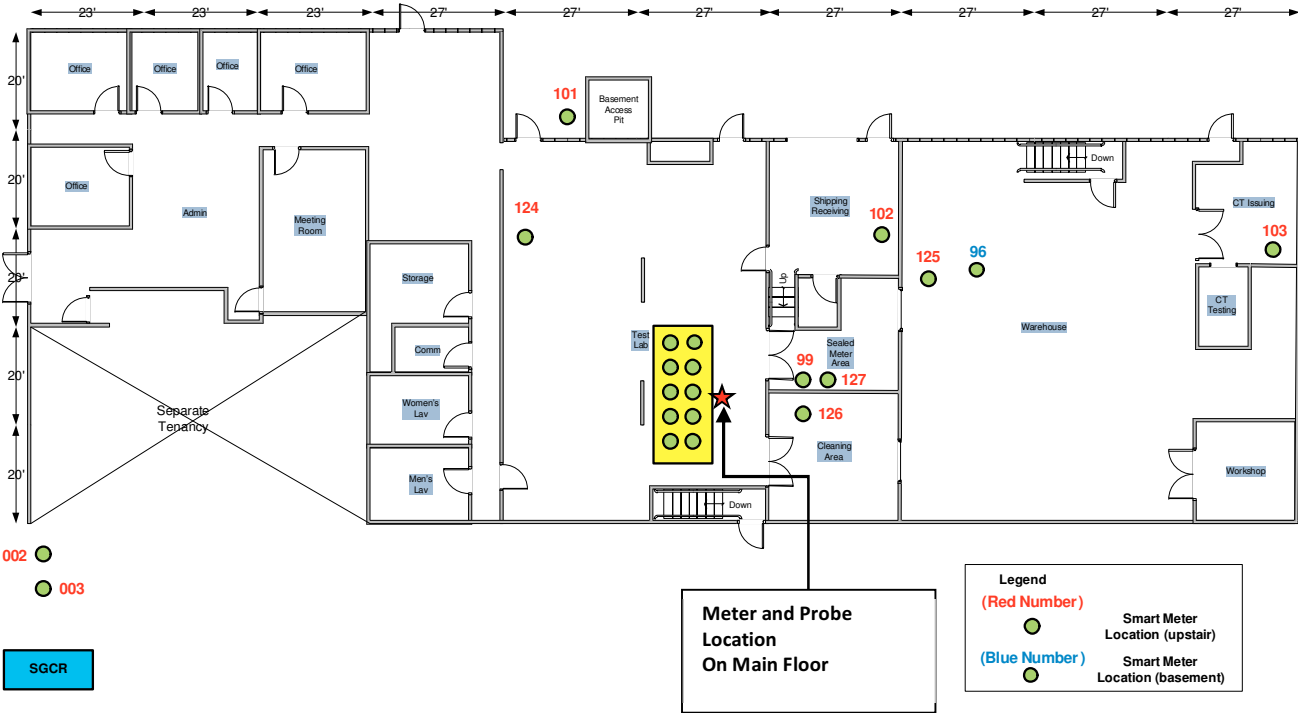
### 2.2 Test Equipment Description

|       |               |                  |                             |
|-------|---------------|------------------|-----------------------------|
| Meter | Narda NBM-550 | Serial #: B-0670 | Calibration due: 2013-04-21 |
| Probe | Narda EC5091  | Serial #: 01009  | Calibration due: 2013-04-25 |

The following list of parameters was downloaded from the meter and was used as the basis of the testing:

|                               |                    |
|-------------------------------|--------------------|
| Device Product Name           | NBM-550            |
| Device Serial Number          | B-0670             |
| Device Cal Due Date           | 21/04/2013         |
| Probe Product Name            | EC5091             |
| Probe Serial Number           | 01009              |
| Probe Cal Due Date            | 25/04/2013         |
| Probe Field Type              | E                  |
| Probe Connection Type         | C                  |
| Probe Lower Frequency Limit A | 300 kHz            |
| Probe Upper Frequency Limit A | 50 GHz             |
| Probe Lower Frequency Limit B | 300 kHz            |
| Probe Upper Frequency Limit B | 50 GHz             |
| Probe Emin A                  | 4.340 V/m          |
| Probe Emax A                  | 150.0 V/m          |
| Probe Emin B                  | 4.340 V/m          |
| Probe Emax B                  | 150.0 V/m          |
| Shaped Probe                  | YES                |
| Standard ID                   | 5                  |
| Standard Name                 | Canada,occ         |
| Apply Standard                | ON                 |
| Frequency                     | 2.1325 GHz         |
| Apply Correction Frequency    | OFF                |
| Eref_E(f)                     | 137.0 V/m          |
| Eref_H(f)                     | 137.2 V/m          |
| Combi Probe Use               | E                  |
| Unit                          | mW/cm <sup>2</sup> |
| Results Format                | FIXED              |
| Auto-Zero Interval            | OFF                |

3 Site Plan and Photographs



The following photograph indicates positioning of the Narda probe in relation to the meter bank under test:



#### 4 Traffic Confirmation – Ten Meters Under Test

To confirm that all meters were active and transmitting during the test period, an external packet sniffer was used to verify traffic levels. The following two results files show the traffic for the 10 meters under test for the 2 day time period. Note that this information only shows how often the meter is active during a 24-hour period, and the relative amount of information transmitted during each broadcast (i.e. number of packets). These graphs are not an indicator of the transmitter power output.

##### Conditions of Test (Day 1)

**MAC Addresses = 7496583, 7490057, 7490052, 7490078, 7497348, 7496599, 7486508, 7486531, 7486501, 7496594**

Beginning of Packet Sniffer Data = 9/10/2011 8:00:00 AM

Interrogations:

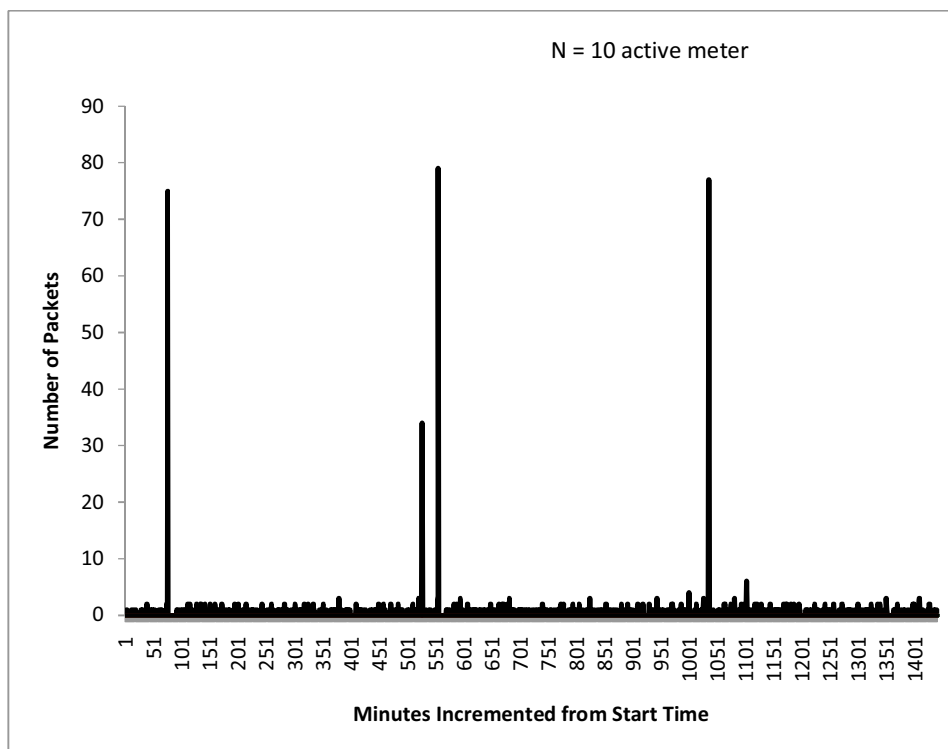
9/10/2011 9:15:07 AM

9/10/2011 5:15:12 PM

9/11/2011 1:15:11 AM

Ending of Packet Sniffer Data = 9/11/2011 8:00:00 AM

##### Packets Per Minute Starting at 9/10/2011 08:00:00 AM



\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

##### Data Transmission Information

Actual Bytes Transferred = 96650

Total Transmission Time = 10.150 Seconds

**Conditions of Test (Day 2)**

**MAC Addresses = 7496583, 7490057, 7490052, 7490078, 7497348, 7496599, 7486508, 7486531, 7486501, 7496594**

Beginning of Packet Sniffer Data = 9/11/2011 8:00:00 AM

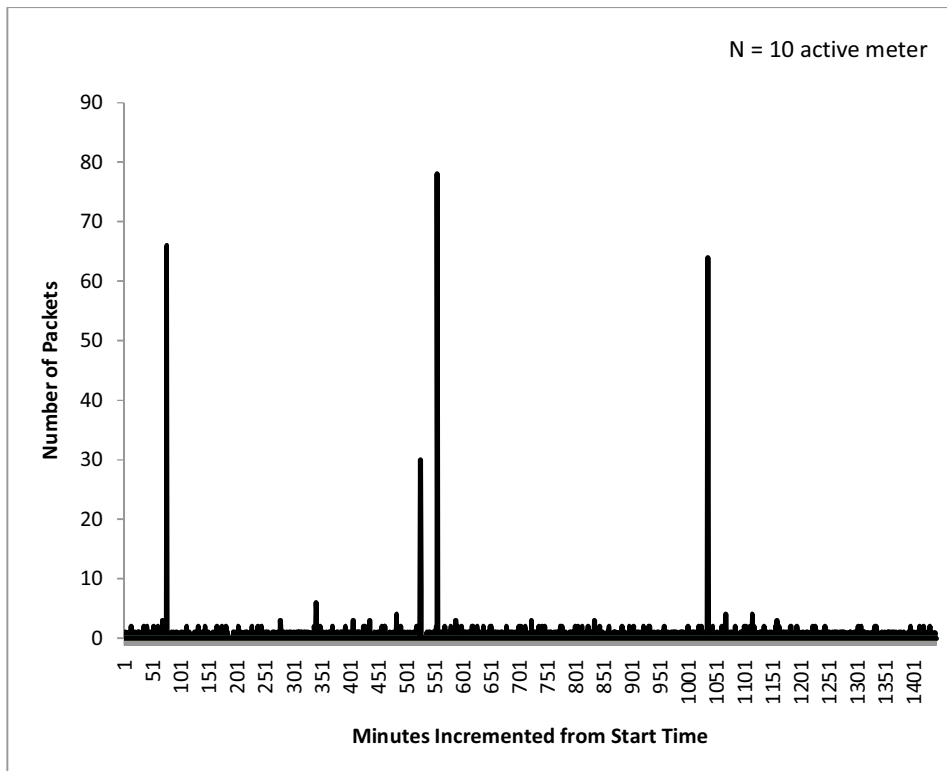
Interrogations:

9/11/2011 9:15:07 AM

9/11/2011 5:15:12 PM

9/12/2011 1:15:11 AM

Ending of Packet Sniffer Data = 9/12/2011 8:00:00 AM

**Packets Per Minute Starting at 9/11/2011 08:00:00 AM**

\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

**Data Transmission Information**

Actual Bytes Transferred = 91464

Total Transmission Time = 9.606 Seconds



## 5 Traffic Confirmation – All Meters

While this test report deals with a bank of 10 meters, it should be recognized that nearby meters may also be present and contribute to the overall RF levels in a typical user environment. The following two results files show the traffic for all 21 meters present in the general vicinity for the 2 day time period. Again, this information only shows how often the meters are active during a 24-hour period, and the relative amount of information transmitted. These graphs are not an indicator of the transmitter power output.

### Conditions of Test (Day 1)

#### **ALL UNITS**

Beginning of Packet Sniffer Data = 9/10/2011 8:00:00 AM

Interrogations:

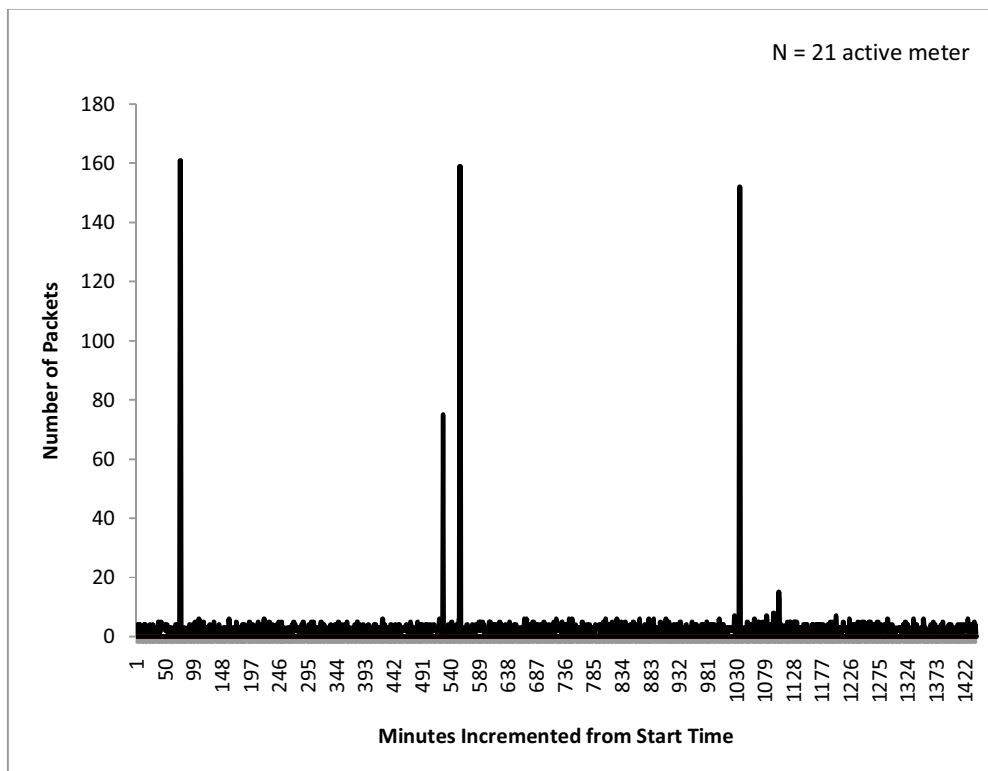
9/10/2011 9:15:07 AM

9/10/2011 5:15:12 PM

9/11/2011 1:15:11 AM

Ending of Packet Sniffer Data = 9/11/2011 8:00:00 AM

### Packets Per Minute Starting at 9/10/2011 08:00:00 AM



\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

### Data Transmission Information

Actual Bytes Transferred = 301667

**Total Transfer Time = 31.684 Seconds**

**Conditions of Test (Day 2)****ALL UNITS**

Beginning of Packet Sniffer Data = 9/11/2011 8:00:00 AM

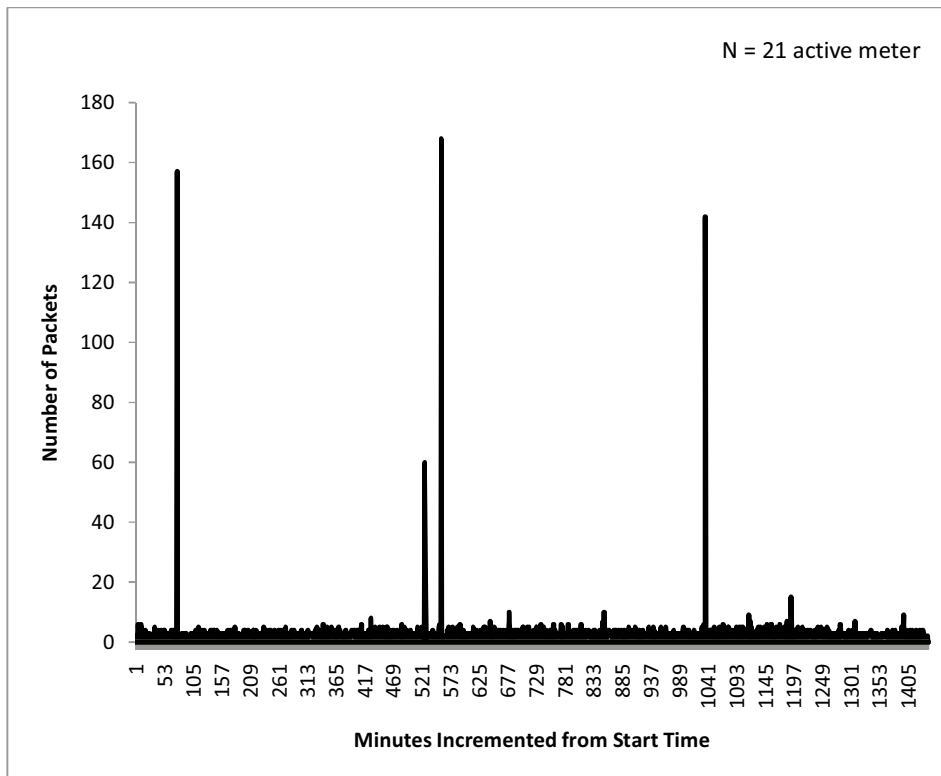
Interrogations:

9/11/2011 9:15:07 AM

9/11/2011 5:15:12 PM

9/12/2011 1:15:11 AM

Ending of Packet Sniffer Data = 9/12/2011 8:00:00 AM

**Packets Per Minute Starting at 9/11/2011 08:00:00 AM**

\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

**Data Transmission Information**

Actual Bytes Transferred = 307971

**Total Transfer Time = 32.345 Seconds**

6 **NBM-550 Calibration Certificate**

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## Calibration Certificate

Narda Safety Test Solutions hereby certifies that the referenced equipment has been calibrated by qualified personnel to Narda's approved procedures. The calibration was carried out within a certified quality management system conforming to ISO 9001:2000.

The metrological confirmation system for test equipment complies with ISO 10012-1.

|                                     |   |
|-------------------------------------|---|
| Object                              | <b>Broadband Field Meter<br/>NBM-550</b>  |
| Part Number (P/N)                   | <b>2401/01</b>                            |
| Serial Number (S/N)                 | <b>B-0670</b>                             |
| Manufacturer                        | Narda Safety Test Solutions               |
| Date of Calibration                 | 2011-04-21                                |
| Results of Calibration              | Test results within specifications        |
| Confirmation interval (recommended) | 24 months                                 |
| Ambient conditions                  | (23 ± 3)°C<br>(20 ... 60) % rel. humidity |
| Calibration procedure               | 2401-8700-00A                             |

Hauppauge NY, 2011-04-21

  
 .....  
 Calibrated by  
 C. Rios



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Certificate No. NBM-550-B-0670-110421-90

Date of issue: 2011-04-21

Page 1 of 3

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## Method of Measurement

The device under test (DUT) represents a three-channel voltage meter offering high accuracy and high resolution. The DUT is calibrated by applying a known DC voltage to each of the inputs.

## Uncertainty of Measurement

The measurement uncertainty stated in this document is the expanded uncertainty with a coverage factor of 2 (corresponding, in the case of normal distribution, to a confidence probability of 95 %).

The uncertainty analysis for this calibration was done in accordance with the ISO/TAG-Guide (Guide to the expression of uncertainty in measurement). The measurement uncertainties are derived from contributions from the measurement of power, reflection, attenuation and frequency, mismatch, stability of instrumentation and repeatability of handling.

This statement of uncertainty applies to the measured values only and does not include effects like temperature response and long term stability of the calibrated device.

## Traceability of Measuring Equipment

The calibration results are traceable to SI-units according to ISO 9001. Physical units, which are not included in the list of accredited measured quantities such as field strength or power density, are traced to the basic units via approved measurement and computational methods.

The equipment used for this calibration is traceable to the reference listed below and the traceability is guaranteed by ISO 9001 Narda internal procedure.

| Reference- / Working- Standard | Manufacturer | Model  | Serial Number | Certificate Number | Cal. Due Date | Trace (*) |
|--------------------------------|--------------|--------|---------------|--------------------|---------------|-----------|
| Digital Multimeter             | Agilent      | 34410A | US36109164    |                    | 06-2011       | DKD       |

Note (\*): For details on accredited laboratories please refer to the corresponding homepage:

<http://www.dkf.info/> DKD  
<http://www.imgc.cnr.it/> SIT  
<http://www.ukas.com/> UKAS

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## Results

### Voltage display uncertainty

| Channel | Input voltage applied | Specified voltage display | Meas. Uncertainty | Meas. voltage display |
|---------|-----------------------|---------------------------|-------------------|-----------------------|
| X       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.371 V               |
| Y       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.371 V               |
| Z       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.372 V               |

Note: Because of an internal divider the nominal value of the voltage display is 2.376 V.

7 **Probe Calibration Certificate**

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## Calibration Certificate

Narda Safety Test Solutions hereby certifies that the referenced equipment has been calibrated by qualified personnel to Narda's approved procedures. The calibration was carried out within a certified quality management system conforming to ISO 9001:2000.

The metrological confirmation system for test equipment complies with ISO 10012-1.

|                                     |   |
|-------------------------------------|---|
| Object                              | <b>Electric Field Probe EC5091</b>      |
| Part Number (P/N)                   | <b>2402/09</b>                          |
| Serial Number (S/N)                 | <b>01009</b>                            |
| Manufacturer                        | Narda Safety Test Solutions             |
| Date of Calibration                 | Mon 25/Apr/2011 16:23:24                |
| Results of Calibration              | Test Results within Specification       |
| Confirmation interval (recommended) | 24 Months                               |
| Ambient Conditions                  | (23 +/-3)*C<br>(40...60)% rel. humidity |
| Calibration Procedure               | ATE Software 990199 Ver. 1.50           |
| Probe Definition File Set           | P/N 990199-06 Ver. 1.04                 |
| Results Filed Under                 | EC5091_01009_25Apr2011.txt              |

Hauppauge, NY

\_\_\_\_\_  
 Calibrated by

\_\_\_\_\_  
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Page 1 of 6

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### Method of Measurement

The calibration of RF field strength probes involves the generation of a calculable linearly polarized electromagnetic field - approximating to a plane wave - into which the device under test is placed. The probe is calibrated separately from the base meter.

The probe is aligned for maximum interception of the field, i.e. the probe's pole is orientated in the analytic angle (54.74 degrees to vertical E-field vector) above 200 MHz. Below 200 MHz the probe handle is oriented perpendicular to both, the direction of propagation and the direction of the E-field vector. The meter indicates the results in %STD units, i.e. the power related ratio of the field and the reference level (MPE = maximum permissible exposure limit) from the Standard. At each test frequency the probe is rotated by 360 deg while taking readings continuously. The results are calculated from the minimum and maximum response during rotation.

$$\%STD_{mean} = \sqrt{\%STD_{min} * \%STD_{max}}$$

$$EllipseRatio = 5 * \log \left( \frac{\%STD_{max}}{\%STD_{min}} \right)$$

### Frequency Response:

The correction factor  $K$  is a numerical factor to compensate the systematic error due to frequency response.

$$K = \sqrt{\%STD_{actual} / \%STD_{mean}}$$

The correction factors are stored in the probe memory. When combined with the NBM-5xx Field Meter the frequency response correction may be enabled.

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## Field Generation

### Setup "A" (1600 MHz ...):

Calibration using calculated field strength. The probe is positioned with the boresight of a linearly polarized horn antenna. The field strength is derived from the horn's gain  $g$ , the transmitted power of the antenna and the distance  $d$ . The power measurement includes the power meter's response  $P_m * F_{th}$  and a fixed attenuation  $D$ .

$$E = \sqrt{\eta * \frac{P_m * F_{th} * D * g}{4 * \pi * d^2}}$$

with  $\eta$  : intrinsic impedance of propagation medium in Ohms.

Reference: IEEE Std. 1309-1996

### Setup "B" (200 MHz ... 1600 MHz):

Calibration using a transfer standard. The probe is mounted in front of a double balanced ridge horn antenna. The field strength is set to a known value based on the power meter reading  $P_m$  in reference to a calibrated sensor ( $E_{ref}, P_{ref}$ ).

$$E = E_{ref} * \sqrt{\frac{P_m}{P_{ref}}}$$

### Setup "C" (... 200 MHz):

Calibration using calculated field strength. A Crawford TEM cell is used to generate the known field strength  $E$ . The field strength is derived from TEM cell's septum height  $b$ , impedance  $Z_0$  and from the output power  $P_{net}$  of the cell. The output power measurement includes the power meter's response  $P_m * F_{th}$  and a fixed attenuation  $D$ .

$$E = \frac{\sqrt{P_m * F_{th} * D * Z_0}}{b}$$

## Uncertainties

The measurement uncertainty stated in this document is the expanded uncertainty with a coverage factor of 1.96 (corresponding, in the case of normal distribution, to a confidence probability of 95%).

The uncertainty analysis for this calibration was done in accordance with the ISO-Guide (Guide to the expression of Uncertainty in Measurement). The measurement uncertainties are derived from contributions from the measurement of power, impedance, attenuation, mismatch, length, frequency, stability of instrumentation, repeatability of handling and field uniformity in the field generators (TEM cell and anechoic chamber).

This statement of uncertainty applies to the measured values only and does not make any implementation or include any estimation as to the long-term stability of the calibrated device.



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## Test Equipment and Traceability

The calibration results are traceable to SI-units according to ISO 9001. Physical units, which are not included in the list of accredited measured quantities such as field strength or power density, are traced to the basic units via approved measurement and computational methods.

The equipment used for this calibration is traceable to the reference listed below and the traceability is guaranteed by ISO 9001 Narda internal procedure.

| Reference- / Working- Standard          | Manufacturer | Model        | Asset Number | Certificate Number | Cal Due Date | Trace (*) |
|---|--------------|--------------|--------------|--------------------|--------------|-----------|
| <b>Setup "A" (0.001 MHz to 200 MHz)</b> |              |              |              |                    |              |           |
| Power Meter, Two Channel                | Agilent      | E4419B       | 003431       |                    | 2012-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A        | 004323       |                    | 2011-11      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A        | 001389       |                    | 2011-11      |           |
| Attenuator 30dB                         | Narda        | 769-30       | 003241       | -                  | 2011-06      | (1)       |
| Attenuator 30dB                         | Narda        | 769-30       | 003396       | -                  | 2012-03      | (1)       |
| Attenuator 6dB                          | Narda        | 766-6        | 005030       | -                  | 2012-01      | (1)       |
| Attenuator 6dB                          | Narda        | 766-6        | 005031       | -                  | 2012-01      | (1)       |
| <b>Setup "B" (300 MHz to 3000 MHz)</b>  |              |              |              |                    |              |           |
| Power Meter, Two Channel                | Agilent      | E4419B       | 003768       |                    | 2011-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A        | 003757       |                    | 2011-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A        | 003758       |                    | 2011-06      |           |
| Dir. Coupler 0.3-2.2GHz                 | Narda        | 3042SP       | 005118       | -                  | 2011-10      | (1)       |
| Dir. Cpl. 0.9-2.2GHz + 10dB             | Narda        | 3042B/771-10 | 005118       | -                  | 2011-10      | (1)       |
| Dir. Coupler 1.7-4.2GHz                 | Narda        | 3043B-30     | 005119       | -                  | 2011-10      | (1)       |
| Dir. Coupler 1.7-4.2GHz                 | Narda        | 3043B-30     | 005119       | -                  | 2011-10      | (1)       |
| <b>Setup "C" (1.7 to 60 GHz)</b>        |              |              |              |                    |              |           |
| Power Sensor 18GHz                      | Agilent      | 8481A        | 003237       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A        | 003236       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A        | 003235       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A        | 003234       |                    | 2011-07      |           |
| Power Sensor 26.5-40GHz                 | Agilent      | R8486A       | 002020       |                    | 2011-09      |           |
| Power Sensor 33-50GHz                   | Agilent      | Q8486A       | 003257       |                    | 2011-07      |           |
| Power Sensor 50-75GHz                   | Agilent      | V8486A       | 004679       |                    | 2011-06      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003210       |                    | 2012-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003212       |                    | 2012-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003231       |                    | 2012-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003214       |                    | 2012-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003213       |                    | 2012-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003211       |                    | 2012-01      |           |
| Dir. Coupler 4-8GHz & 10dB              | Narda        | 3022/777C-10 | 003270       | -                  | 2011-10      | (1)       |
| Dir. Coupler 4-8GHz & 20dB              | Narda        | 3024/777C-20 | 003271       | -                  | 2011-10      | (1)       |
| Dir. Coupler 8.2-12.4GHz                | Narda        | 3293-2       | 003272       | -                  | 2011-10      | (1)       |
| Dir. Coupler 12.4-18GHz                 | Narda        | 1079         | 003274       | -                  | 2013-03      | (1)       |
| Dir. Coupler 26.5-40GHz                 | Narda        | R752D        | 002747       | -                  | 2011-10      | (1)       |
| Dir. Coupler 33-50GHz                   | Millitech    | CL3-22-R2000 | 004756       | -                  | 2013-02      | (1)       |
| Dir. Coupler 60GHz                      | Millitech    | CGC-15-RL300 | 004757       | -                  | 2013-02      | (1)       |

(\*) For details on accredited laboratories please refer to the corresponding homepage:

<http://www.dkdl.info/> DKD  
<http://sit.imgc.to.cnir.it/> SIT  
<http://www.ukas.com/> UKAS

(1) An accredited calibration of the directional couplers is not available due to multiple-sex connectors. Calibration is performed as an in-house calibration based on state of the art techniques (non-traceable).

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Page 4 of 6

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## Results

### Frequency response and Ellipticity

The frequency response is measured with instrument setting: Apply Correction Frequency = OFF.

| Frequency in MHz | $E_{actual}$ in V/M | Meas. Uncertainty in dB | Applied %STD actual | Displayed %STD mean | Correction Factor K (*) | Ellipse Ratio in dB |
|------------------|---------------------|-------------------------|---------------------|---------------------|-------------------------|---------------------|
| 0.3              | 307.00              | 0.8                     | 25.00               | 16.36               | 1.236                   | 0.63                |
| 3                | 102.33              | 0.8                     | 25.00               | 19.72               | 1.126                   | 0.27                |
| 10               | 30.70               | 0.8                     | 25.00               | 16.74               | 1.222                   | 0.17                |
| 30               | 30.70               | 0.8                     | 25.00               | 24.61               | 1.008                   | 0.06                |
| 100              | 30.70               | 0.8                     | 25.00               | 25.20               | 0.996                   | 0.07                |
| 300              | 30.70               | 0.8                     | 25.00               | 19.86               | 1.122                   | 0.15                |
| 750              | 48.54               | 0.8                     | 25.00               | 33.03               | 0.870                   | 0.18                |
| 1000             | 56.05               | 0.8                     | 25.00               | 38.20               | 0.809                   | 0.15                |
| 1800             | 68.65               | 0.7                     | 25.00               | 25.05               | 0.999                   | 0.37                |
| 2450             | 68.65               | 0.7                     | 25.00               | 23.20               | 1.038                   | 0.42                |
| 4000             | 68.65               | 0.7                     | 25.00               | 23.38               | 1.034                   | 0.41                |
| 8200             | 68.65               | 0.7                     | 25.00               | 26.57               | 0.970                   | 0.63                |
| 10000            | 68.65               | 0.7                     | 25.00               | 22.38               | 1.057                   | 1.14                |
| 18000            | 68.65               | 0.7                     | 25.00               | 33.65               | 0.862                   | 0.89                |
| 26500            | 68.65               | 0.7                     | 25.00               | 33.49               | 0.864                   | 1.05                |
| 40000            | 68.65               | 0.7                     | 25.00               | 22.38               | 1.057                   | 0.65                |
| 45500            | 68.65               | 0.7                     | 25.00               | 18.61               | 1.159                   | 0.74                |

Flatness (1800 - 40000 MHz): +/-0.89 dB **Pass**

Flatness (.3 - 45500 MHz): +/-1.84 dB **Pass**

Max. Ellipse Ratio (.3 - 45500 MHz): +/-1.14 dB **Pass**

(\*) The frequency response correction data is stored in the probe memory. When the probe is connected to a NBM-550 Field Meter the implemented frequency response correction may be enabled. This is done by selecting the desired frequency and the setting: Apply Correction Frequency = ON.

#### Adjustment (informative):

This probe has two sensor modules, one for high frequency (HF) and one for low frequency (LF).

LF Gain multiplier =  $K_{0, LF}$  = 0.7218

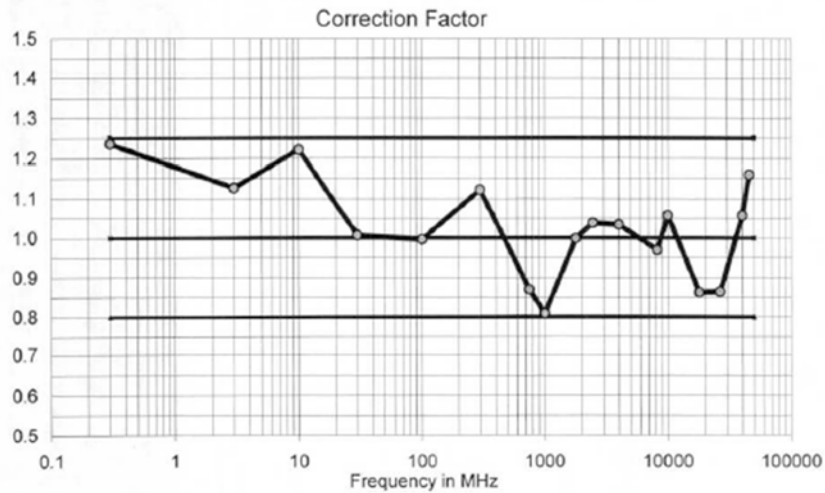
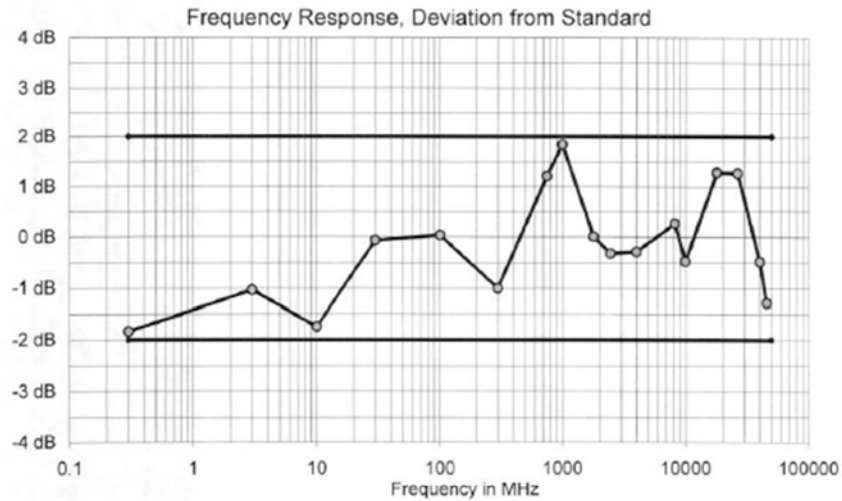
HF Gain multiplier =  $K_{0, HF}$  = 1.2482

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### Frequency Response Graph

Frequency response data with setting: Apply Correction Frequency = OFF.



## 8 Field Probe Log Files – All Meters Active

Note that all average values presented relative to Health Canada Safety Code 6's controlled environments. These are multiplied by a factor of 5 to convert to Health Canada Safety Code 6 values for uncontrolled environments (Public Levels). The scaled uncontrolled environment values are used in this report.

|                               |                    |
|-------------------------------|--------------------|
| Number of Sub Indices         | 233                |
| Storing Date                  | 10/09/2011         |
| Storing Time                  | 8:10:59            |
| Dataset Type                  | TIM                |
| Voice Comment Available       | NO                 |
| Dataset Fine Type             | T1                 |
| GPS Flag                      | NO                 |
| Device Product Name           | NBM-550            |
| Device Serial Number          | B-0670             |
| Device Cal Due Date           | 21/04/2013         |
| Probe Product Name            | EC5091             |
| Probe Serial Number           | 01009              |
| Probe Cal Due Date            | 25/04/2013         |
| Probe Field Type              | E                  |
| Probe Connection Type         | C                  |
| Probe Lower Frequency Limit A | 300 kHz            |
| Probe Upper Frequency Limit A | 50 GHz             |
| Probe Lower Frequency Limit B | 300 kHz            |
| Probe Upper Frequency Limit B | 50 GHz             |
| Probe Emin A                  | 4.340 V/m          |
| Probe Emax A                  | 150.0 V/m          |
| Probe Emin B                  | 4.340 V/m          |
| Probe Emax B                  | 150.0 V/m          |
| Shaped Probe                  | YES                |
| Standard ID                   | 5                  |
| Standard Name                 | Canada,occ         |
| Apply Standard                | ON                 |
| Frequency                     | 2.1325 GHz         |
| Apply Correction Frequency    | OFF                |
| Eref_E(f)                     | 137.0 V/m          |
| Eref_H(f)                     | 137.2 V/m          |
| Combi Probe Use               | E                  |
| Unit                          | mW/cm <sup>2</sup> |
| Results Format                | FIXED              |
| Auto-Zero Interval            | OFF                |
| Result Type                   | -                  |
| Averaging Time                | -                  |
| Average Progress              | -                  |
| Spatial AVG Mode              | -                  |
| Store Condition               | -                  |

Storing Range -  
 Cond. Stop Time -  
 Upper Threshold -  
 Lower Threshold -  
 Timer Interval 360 sec  
 Timer Duration 99:00:00  
 History Time Scale -  
 Time progress of current segment -

| Index | Date/Time          | Avg (E-Field) [% STD] |
|-------|--------------------|-----------------------|
| 1     | 9/10/2011 8:16:59  | 0.2483                |
| 2     | 9/10/2011 8:22:59  | 0.1258                |
| 3     | 9/10/2011 8:28:59  | 0.0595                |
| 4     | 9/10/2011 8:34:59  | 0.0475                |
| 5     | 9/10/2011 8:40:59  | 0.167                 |
| 6     | 9/10/2011 8:46:59  | 0.1246                |
| 7     | 9/10/2011 8:52:59  | 0.0517                |
| 8     | 9/10/2011 8:58:59  | 0.0489                |
| 9     | 9/10/2011 9:04:59  | 0.1215                |
| 10    | 9/10/2011 9:10:59  | 0.1501                |
| 11    | 9/10/2011 9:16:59  | 0.0635                |
| 12    | 9/10/2011 9:22:59  | 0.033                 |
| 13    | 9/10/2011 9:28:59  | 0.0313                |
| 14    | 9/10/2011 9:34:59  | 0.1326                |
| 15    | 9/10/2011 9:40:59  | 0.0889                |
| 16    | 9/10/2011 9:46:59  | 0.0669                |
| 17    | 9/10/2011 9:52:59  | 0.0625                |
| 18    | 9/10/2011 9:58:59  | 0.1247                |
| 19    | 9/10/2011 10:04:59 | 0.07                  |
| 20    | 9/10/2011 10:10:59 | 0.0507                |
| 21    | 9/10/2011 10:16:59 | 0.0656                |
| 22    | 9/10/2011 10:22:59 | 0.1342                |
| 23    | 9/10/2011 10:28:59 | 0.0674                |
| 24    | 9/10/2011 10:34:59 | 0.047                 |
| 25    | 9/10/2011 10:40:59 | 0.0564                |
| 26    | 9/10/2011 10:46:59 | 0.1173                |
| 27    | 9/10/2011 10:52:59 | 0.0252                |
| 28    | 9/10/2011 10:58:59 | 0.0434                |
| 29    | 9/10/2011 11:04:59 | 0.1313                |
| 30    | 9/10/2011 11:10:59 | 0.0872                |
| 31    | 9/10/2011 11:16:59 | 0.0439                |
| 32    | 9/10/2011 11:22:59 | 0.0515                |
| 33    | 9/10/2011 11:28:59 | 0.143                 |
| 34    | 9/10/2011 11:34:59 | 0.0573                |
| 35    | 9/10/2011 11:40:59 | 0.0301                |
| 36    | 9/10/2011 11:46:59 | 0.1051                |

|    |                    |        |
|----|--------------------|--------|
| 37 | 9/10/2011 11:52:59 | 0.0819 |
| 38 | 9/10/2011 11:58:59 | 0.0324 |
| 39 | 9/10/2011 12:04:59 | 0.0335 |
| 40 | 9/10/2011 12:10:59 | 0.1116 |
| 41 | 9/10/2011 12:16:59 | 0.0365 |
| 42 | 9/10/2011 12:22:59 | 0.0189 |
| 43 | 9/10/2011 12:28:59 | 0.0296 |
| 44 | 9/10/2011 12:34:59 | 0.071  |
| 45 | 9/10/2011 12:40:59 | 0.06   |
| 46 | 9/10/2011 12:46:59 | 0.0218 |
| 47 | 9/10/2011 12:52:59 | 0.0268 |
| 48 | 9/10/2011 12:58:59 | 0.0541 |
| 49 | 9/10/2011 13:04:59 | 0.0812 |
| 50 | 9/10/2011 13:10:59 | 0.024  |
| 51 | 9/10/2011 13:16:59 | 0.007  |
| 52 | 9/10/2011 13:22:59 | 0.0246 |
| 53 | 9/10/2011 13:28:59 | 0.0862 |
| 54 | 9/10/2011 13:34:59 | 0.052  |
| 55 | 9/10/2011 13:40:59 | 0.0276 |
| 56 | 9/10/2011 13:46:59 | 0.0127 |
| 57 | 9/10/2011 13:52:59 | 0.0256 |
| 58 | 9/10/2011 13:58:59 | 0.0375 |
| 59 | 9/10/2011 14:04:59 | 0.0287 |
| 60 | 9/10/2011 14:10:59 | 0.0144 |
| 61 | 9/10/2011 14:16:59 | 0.0131 |
| 62 | 9/10/2011 14:22:59 | 0.0393 |
| 63 | 9/10/2011 14:28:59 | 0.0195 |
| 64 | 9/10/2011 14:34:59 | 0.0285 |
| 65 | 9/10/2011 14:40:59 | 0.0134 |
| 66 | 9/10/2011 14:46:59 | 0.0161 |
| 67 | 9/10/2011 14:52:59 | 0.0439 |
| 68 | 9/10/2011 14:58:59 | 0.021  |
| 69 | 9/10/2011 15:04:59 | 0.0104 |
| 70 | 9/10/2011 15:10:59 | 0.0089 |
| 71 | 9/10/2011 15:16:59 | 0.0058 |
| 72 | 9/10/2011 15:22:59 | 0.0157 |
| 73 | 9/10/2011 15:28:59 | 0.0067 |
| 74 | 9/10/2011 15:34:59 | 0.0083 |
| 75 | 9/10/2011 15:40:59 | 0.0064 |
| 76 | 9/10/2011 15:46:59 | 0.0105 |
| 77 | 9/10/2011 15:52:59 | 0.0294 |
| 78 | 9/10/2011 15:58:59 | 0.0077 |
| 79 | 9/10/2011 16:04:59 | 0.0125 |
| 80 | 9/10/2011 16:10:59 | 0.0201 |
| 81 | 9/10/2011 16:16:59 | 0.0479 |

|     |                    |        |
|-----|--------------------|--------|
| 82  | 9/10/2011 16:22:59 | 0.021  |
| 83  | 9/10/2011 16:28:59 | 0.0138 |
| 84  | 9/10/2011 16:34:59 | 0.0042 |
| 85  | 9/10/2011 16:40:59 | 0.0252 |
| 86  | 9/10/2011 16:46:59 | 0.0556 |
| 87  | 9/10/2011 16:52:59 | 0.0386 |
| 88  | 9/10/2011 16:58:59 | 0.0247 |
| 89  | 9/10/2011 17:04:59 | 0.0197 |
| 90  | 9/10/2011 17:10:59 | 0.0146 |
| 91  | 9/10/2011 17:16:59 | 0.0257 |
| 92  | 9/10/2011 17:22:59 | 0.025  |
| 93  | 9/10/2011 17:28:59 | 0.0285 |
| 94  | 9/10/2011 17:34:59 | 0.0172 |
| 95  | 9/10/2011 17:40:59 | 0.0326 |
| 96  | 9/10/2011 17:46:59 | 0.0478 |
| 97  | 9/10/2011 17:52:59 | 0.0189 |
| 98  | 9/10/2011 17:58:59 | 0.0258 |
| 99  | 9/10/2011 18:04:59 | 0.017  |
| 100 | 9/10/2011 18:10:59 | 0.0357 |
| 101 | 9/10/2011 18:16:59 | 0.1155 |
| 102 | 9/10/2011 18:22:59 | 0.1332 |
| 103 | 9/10/2011 18:28:59 | 0.1401 |
| 104 | 9/10/2011 18:34:59 | 0.1429 |
| 105 | 9/10/2011 18:40:59 | 0.1409 |
| 106 | 9/10/2011 18:46:59 | 0.1167 |
| 107 | 9/10/2011 18:52:59 | 0.133  |
| 108 | 9/10/2011 18:58:59 | 0.1563 |
| 109 | 9/10/2011 19:04:59 | 0.1864 |
| 110 | 9/10/2011 19:10:59 | 0.1781 |
| 111 | 9/10/2011 19:16:59 | 0.1803 |
| 112 | 9/10/2011 19:22:59 | 0.1899 |
| 113 | 9/10/2011 19:28:59 | 0.1827 |
| 114 | 9/10/2011 19:34:59 | 0.2085 |
| 115 | 9/10/2011 19:40:59 | 0.2115 |
| 116 | 9/10/2011 19:46:59 | 0.1893 |
| 117 | 9/10/2011 19:52:59 | 0.205  |
| 118 | 9/10/2011 19:58:59 | 0.2281 |
| 119 | 9/10/2011 20:04:59 | 0.2043 |
| 120 | 9/10/2011 20:10:59 | 0.2047 |
| 121 | 9/10/2011 20:16:59 | 0.1948 |
| 122 | 9/10/2011 20:22:59 | 0.21   |
| 123 | 9/10/2011 20:28:59 | 0.2205 |
| 124 | 9/10/2011 20:34:59 | 0.2398 |
| 125 | 9/10/2011 20:40:59 | 0.2645 |
| 126 | 9/10/2011 20:46:59 | 0.2317 |

|     |                    |        |
|-----|--------------------|--------|
| 127 | 9/10/2011 20:52:59 | 0.252  |
| 128 | 9/10/2011 20:58:59 | 0.2568 |
| 129 | 9/10/2011 21:04:59 | 0.2467 |
| 130 | 9/10/2011 21:10:59 | 0.263  |
| 131 | 9/10/2011 21:16:59 | 0.2792 |
| 132 | 9/10/2011 21:22:59 | 0.3137 |
| 133 | 9/10/2011 21:28:59 | 0.3071 |
| 134 | 9/10/2011 21:34:59 | 0.2959 |
| 135 | 9/10/2011 21:40:59 | 0.2866 |
| 136 | 9/10/2011 21:46:59 | 0.271  |
| 137 | 9/10/2011 21:52:59 | 0.2936 |
| 138 | 9/10/2011 21:58:59 | 0.2668 |
| 139 | 9/10/2011 22:04:59 | 0.2728 |
| 140 | 9/10/2011 22:10:59 | 0.2895 |
| 141 | 9/10/2011 22:16:59 | 0.3028 |
| 142 | 9/10/2011 22:22:59 | 0.3036 |
| 143 | 9/10/2011 22:28:59 | 0.3367 |
| 144 | 9/10/2011 22:34:59 | 0.2927 |
| 145 | 9/10/2011 22:40:59 | 0.2734 |
| 146 | 9/10/2011 22:46:59 | 0.2779 |
| 147 | 9/10/2011 22:52:59 | 0.2591 |
| 148 | 9/10/2011 22:58:59 | 0.2822 |
| 149 | 9/10/2011 23:04:59 | 0.2773 |
| 150 | 9/10/2011 23:10:59 | 0.2856 |
| 151 | 9/10/2011 23:16:59 | 0.2815 |
| 152 | 9/10/2011 23:22:59 | 0.2708 |
| 153 | 9/10/2011 23:28:59 | 0.2464 |
| 154 | 9/10/2011 23:34:59 | 0.282  |
| 155 | 9/10/2011 23:40:59 | 0.2381 |
| 156 | 9/10/2011 23:46:59 | 0.2272 |
| 157 | 9/10/2011 23:52:59 | 0.2242 |
| 158 | 9/10/2011 23:58:59 | 0.2515 |
| 159 | 9/11/2011 0:04:59  | 0.2439 |
| 160 | 9/11/2011 0:10:59  | 0.2364 |
| 161 | 9/11/2011 0:16:59  | 0.2192 |
| 162 | 9/11/2011 0:22:59  | 0.215  |
| 163 | 9/11/2011 0:28:59  | 0.2139 |
| 164 | 9/11/2011 0:34:59  | 0.2305 |
| 165 | 9/11/2011 0:40:59  | 0.2257 |
| 166 | 9/11/2011 0:46:59  | 0.2243 |
| 167 | 9/11/2011 0:52:59  | 0.2281 |
| 168 | 9/11/2011 0:58:59  | 0.2242 |
| 169 | 9/11/2011 1:04:59  | 0.2577 |
| 170 | 9/11/2011 1:10:59  | 0.217  |
| 171 | 9/11/2011 1:16:59  | 0.2232 |



|     |                   |        |
|-----|-------------------|--------|
| 172 | 9/11/2011 1:22:59 | 0.1916 |
| 173 | 9/11/2011 1:28:59 | 0.2205 |
| 174 | 9/11/2011 1:34:59 | 0.223  |
| 175 | 9/11/2011 1:40:59 | 0.2336 |
| 176 | 9/11/2011 1:46:59 | 0.199  |
| 177 | 9/11/2011 1:52:59 | 0.1797 |
| 178 | 9/11/2011 1:58:59 | 0.1853 |
| 179 | 9/11/2011 2:04:59 | 0.1876 |
| 180 | 9/11/2011 2:10:59 | 0.1969 |
| 181 | 9/11/2011 2:16:59 | 0.1907 |
| 182 | 9/11/2011 2:22:59 | 0.2067 |
| 183 | 9/11/2011 2:28:59 | 0.2018 |
| 184 | 9/11/2011 2:34:59 | 0.1763 |
| 185 | 9/11/2011 2:40:59 | 0.1917 |
| 186 | 9/11/2011 2:46:59 | 0.2025 |
| 187 | 9/11/2011 2:52:59 | 0.1816 |
| 188 | 9/11/2011 2:58:59 | 0.155  |
| 189 | 9/11/2011 3:04:59 | 0.2003 |
| 190 | 9/11/2011 3:10:59 | 0.2039 |
| 191 | 9/11/2011 3:16:59 | 0.2134 |
| 192 | 9/11/2011 3:22:59 | 0.2004 |
| 193 | 9/11/2011 3:28:59 | 0.1496 |
| 194 | 9/11/2011 3:34:59 | 0.1452 |
| 195 | 9/11/2011 3:40:59 | 0.1783 |
| 196 | 9/11/2011 3:46:59 | 0.1384 |
| 197 | 9/11/2011 3:52:59 | 0.157  |
| 198 | 9/11/2011 3:58:59 | 0.1478 |
| 199 | 9/11/2011 4:04:59 | 0.1862 |
| 200 | 9/11/2011 4:10:59 | 0.2028 |
| 201 | 9/11/2011 4:16:59 | 0.2047 |
| 202 | 9/11/2011 4:22:59 | 0.1817 |
| 203 | 9/11/2011 4:28:59 | 0.2087 |
| 204 | 9/11/2011 4:34:59 | 0.1866 |
| 205 | 9/11/2011 4:40:59 | 0.1933 |
| 206 | 9/11/2011 4:46:59 | 0.1798 |
| 207 | 9/11/2011 4:52:59 | 0.2294 |
| 208 | 9/11/2011 4:58:59 | 0.212  |
| 209 | 9/11/2011 5:04:59 | 0.1784 |
| 210 | 9/11/2011 5:10:59 | 0.185  |
| 211 | 9/11/2011 5:16:59 | 0.181  |
| 212 | 9/11/2011 5:22:59 | 0.1639 |
| 213 | 9/11/2011 5:28:59 | 0.1731 |
| 214 | 9/11/2011 5:34:59 | 0.1602 |
| 215 | 9/11/2011 5:40:59 | 0.162  |
| 216 | 9/11/2011 5:46:59 | 0.0689 |

|     |                   |        |
|-----|-------------------|--------|
| 217 | 9/11/2011 5:52:59 | 0.0003 |
| 218 | 9/11/2011 5:58:59 | 0.0044 |
| 219 | 9/11/2011 6:04:59 | 0.0399 |
| 220 | 9/11/2011 6:10:59 | 0.0892 |
| 221 | 9/11/2011 6:16:59 | 0.1271 |
| 222 | 9/11/2011 6:22:59 | 0.1146 |
| 223 | 9/11/2011 6:28:59 | 0.0325 |
| 224 | 9/11/2011 6:34:59 | 0.0368 |
| 225 | 9/11/2011 6:40:59 | 0.0969 |
| 226 | 9/11/2011 6:46:59 | 0.1148 |
| 227 | 9/11/2011 6:52:59 | 0.0934 |
| 228 | 9/11/2011 6:58:59 | 0.0954 |
| 229 | 9/11/2011 7:04:59 | 0.0152 |
| 230 | 9/11/2011 7:10:59 | 0.0178 |
| 231 | 9/11/2011 7:16:59 | 0.0784 |
| 232 | 9/11/2011 7:22:59 | 0.0889 |
| 233 | 9/11/2011 7:28:59 | 0.0859 |

|                               |            |
|-------------------------------|------------|
| Number of Sub Indices         | 248        |
| Storing Date                  | 11/09/2011 |
| Storing Time                  | 7:42:35    |
| Dataset Type                  | TIM        |
| Voice Comment Available       | NO         |
| Dataset Fine Type             | T1         |
| GPS Flag                      | NO         |
| Device Product Name           | NBM-550    |
| Device Serial Number          | B-0670     |
| Device Cal Due Date           | 21/04/2013 |
| Probe Product Name            | EC5091     |
| Probe Serial Number           | 01009      |
| Probe Cal Due Date            | 25/04/2013 |
| Probe Field Type              | E          |
| Probe Connection Type         | C          |
| Probe Lower Frequency Limit A | 300 kHz    |
| Probe Upper Frequency Limit A | 50 GHz     |
| Probe Lower Frequency Limit B | 300 kHz    |
| Probe Upper Frequency Limit B | 50 GHz     |
| Probe Emin A                  | 4.340 V/m  |
| Probe Emax A                  | 150.0 V/m  |
| Probe Emin B                  | 4.340 V/m  |
| Probe Emax B                  | 150.0 V/m  |
| Shaped Probe                  | YES        |
| Standard ID                   | 5          |
| Standard Name                 | Canada,occ |
| Apply Standard                | ON         |

|                                  |                    |
|----------------------------------|--------------------|
| Frequency                        | 2.1325 GHz         |
| Apply Correction Frequency       | OFF                |
| Eref_E(f)                        | 137.0 V/m          |
| Eref_H(f)                        | 137.2 V/m          |
| Combi Probe Use                  | E                  |
| Unit                             | mW/cm <sup>2</sup> |
| Results Format                   | FIXED              |
| Auto-Zero Interval               | OFF                |
| Result Type                      | -                  |
| Averaging Time                   | -                  |
| Average Progress                 | -                  |
| Spatial AVG Mode                 | -                  |
| Store Condition                  | -                  |
| Storing Range                    | -                  |
| Cond. Stop Time                  | -                  |
| Upper Threshold                  | -                  |
| Lower Threshold                  | -                  |
| Timer Interval                   | 360 sec            |
| Timer Duration                   | 99:00:00           |
| History Time Scale               | -                  |
| Time progress of current segment | -                  |

| Index | Date/Time          | Avg (E-Field) [% STD] |
|-------|--------------------|-----------------------|
| 1     | 9/11/2011 7:48:35  | 0.0291                |
| 2     | 9/11/2011 7:54:35  | 0.0979                |
| 3     | 9/11/2011 8:00:35  | 0.1134                |
| 4     | 9/11/2011 8:06:35  | 0.0787                |
| 5     | 9/11/2011 8:12:35  | 0.0585                |
| 6     | 9/11/2011 8:18:35  | 0.0254                |
| 7     | 9/11/2011 8:24:35  | 0.0069                |
| 8     | 9/11/2011 8:30:35  | 0.0192                |
| 9     | 9/11/2011 8:36:35  | 0.0545                |
| 10    | 9/11/2011 8:42:35  | 0.1027                |
| 11    | 9/11/2011 8:48:35  | 0.0947                |
| 12    | 9/11/2011 8:54:35  | 0.0767                |
| 13    | 9/11/2011 9:00:35  | 0.008                 |
| 14    | 9/11/2011 9:06:35  | 0.0151                |
| 15    | 9/11/2011 9:12:35  | 0.0273                |
| 16    | 9/11/2011 9:18:35  | 0.0506                |
| 17    | 9/11/2011 9:24:35  | 0.06                  |
| 18    | 9/11/2011 9:30:35  | 0.0135                |
| 19    | 9/11/2011 9:36:35  | 0.0083                |
| 20    | 9/11/2011 9:42:35  | 0.0378                |
| 21    | 9/11/2011 9:48:35  | 0.0712                |
| 22    | 9/11/2011 9:54:35  | 0.0386                |
| 23    | 9/11/2011 10:00:35 | 0.0173                |

|    |                    |        |
|----|--------------------|--------|
| 24 | 9/11/2011 10:06:35 | 0.0284 |
| 25 | 9/11/2011 10:12:35 | 0.0623 |
| 26 | 9/11/2011 10:18:35 | 0.0475 |
| 27 | 9/11/2011 10:24:35 | 0.0287 |
| 28 | 9/11/2011 10:30:35 | 0.0592 |
| 29 | 9/11/2011 10:36:35 | 0.1314 |
| 30 | 9/11/2011 10:42:35 | 0.0369 |
| 31 | 9/11/2011 10:48:35 | 0.0174 |
| 32 | 9/11/2011 10:54:35 | 0.0583 |
| 33 | 9/11/2011 11:00:35 | 0.0679 |
| 34 | 9/11/2011 11:06:35 | 0.0187 |
| 35 | 9/11/2011 11:12:35 | 0.0132 |
| 36 | 9/11/2011 11:18:35 | 0.035  |
| 37 | 9/11/2011 11:24:35 | 0.0166 |
| 38 | 9/11/2011 11:30:35 | 0.0077 |
| 39 | 9/11/2011 11:36:35 | 0.0468 |
| 40 | 9/11/2011 11:42:35 | 0.0729 |
| 41 | 9/11/2011 11:48:35 | 0.0196 |
| 42 | 9/11/2011 11:54:35 | 0.0485 |
| 43 | 9/11/2011 12:00:35 | 0.0991 |
| 44 | 9/11/2011 12:06:35 | 0.0301 |
| 45 | 9/11/2011 12:12:35 | 0.0205 |
| 46 | 9/11/2011 12:18:35 | 0.0885 |
| 47 | 9/11/2011 12:24:35 | 0.0428 |
| 48 | 9/11/2011 12:30:35 | 0.0117 |
| 49 | 9/11/2011 12:36:35 | 0.0685 |
| 50 | 9/11/2011 12:42:35 | 0.0695 |
| 51 | 9/11/2011 12:48:35 | 0.0121 |
| 52 | 9/11/2011 12:54:35 | 0.0427 |
| 53 | 9/11/2011 13:00:35 | 0.0968 |
| 54 | 9/11/2011 13:06:35 | 0.0489 |
| 55 | 9/11/2011 13:12:35 | 0.0299 |
| 56 | 9/11/2011 13:18:35 | 0.0552 |
| 57 | 9/11/2011 13:24:35 | 0.0977 |
| 58 | 9/11/2011 13:30:35 | 0.0313 |
| 59 | 9/11/2011 13:36:35 | 0.0313 |
| 60 | 9/11/2011 13:42:35 | 0.0742 |
| 61 | 9/11/2011 13:48:35 | 0.1256 |
| 62 | 9/11/2011 13:54:35 | 0.0344 |
| 63 | 9/11/2011 14:00:35 | 0.0091 |
| 64 | 9/11/2011 14:06:35 | 0.0392 |
| 65 | 9/11/2011 14:12:35 | 0.1008 |
| 66 | 9/11/2011 14:18:35 | 0.0341 |
| 67 | 9/11/2011 14:24:35 | 0.0038 |
| 68 | 9/11/2011 14:30:35 | 0.0045 |

|     |                    |        |
|-----|--------------------|--------|
| 69  | 9/11/2011 14:36:35 | 0.0174 |
| 70  | 9/11/2011 14:42:35 | 0.0745 |
| 71  | 9/11/2011 14:48:35 | 0.0177 |
| 72  | 9/11/2011 14:54:35 | 0.0017 |
| 73  | 9/11/2011 15:00:35 | 0.0046 |
| 74  | 9/11/2011 15:06:35 | 0.0383 |
| 75  | 9/11/2011 15:12:35 | 0.0671 |
| 76  | 9/11/2011 15:18:35 | 0.0091 |
| 77  | 9/11/2011 15:24:35 | 0.001  |
| 78  | 9/11/2011 15:30:35 | 0.0139 |
| 79  | 9/11/2011 15:36:35 | 0.089  |
| 80  | 9/11/2011 15:42:35 | 0.0424 |
| 81  | 9/11/2011 15:48:35 | 0.002  |
| 82  | 9/11/2011 15:54:35 | 0.0042 |
| 83  | 9/11/2011 16:00:35 | 0.033  |
| 84  | 9/11/2011 16:06:35 | 0.017  |
| 85  | 9/11/2011 16:12:35 | 0.0018 |
| 86  | 9/11/2011 16:18:35 | 0.013  |
| 87  | 9/11/2011 16:24:35 | 0.0512 |
| 88  | 9/11/2011 16:30:35 | 0.0117 |
| 89  | 9/11/2011 16:36:35 | 0.0125 |
| 90  | 9/11/2011 16:42:35 | 0.0086 |
| 91  | 9/11/2011 16:48:35 | 0.0165 |
| 92  | 9/11/2011 16:54:35 | 0.0085 |
| 93  | 9/11/2011 17:00:35 | 0.0059 |
| 94  | 9/11/2011 17:06:35 | 0.0447 |
| 95  | 9/11/2011 17:12:35 | 0.0173 |
| 96  | 9/11/2011 17:18:35 | 0.0068 |
| 97  | 9/11/2011 17:24:35 | 0.0124 |
| 98  | 9/11/2011 17:30:35 | 0.0335 |
| 99  | 9/11/2011 17:36:35 | 0.0024 |
| 100 | 9/11/2011 17:42:35 | 0.0009 |
| 101 | 9/11/2011 17:48:35 | 0.044  |
| 102 | 9/11/2011 17:54:35 | 0.017  |
| 103 | 9/11/2011 18:00:35 | 0.0046 |
| 104 | 9/11/2011 18:06:35 | 0.0255 |
| 105 | 9/11/2011 18:12:35 | 0.0655 |
| 106 | 9/11/2011 18:18:35 | 0.0803 |
| 107 | 9/11/2011 18:24:35 | 0.1072 |
| 108 | 9/11/2011 18:30:35 | 0.0638 |
| 109 | 9/11/2011 18:36:35 | 0.0543 |
| 110 | 9/11/2011 18:42:35 | 0.0589 |
| 111 | 9/11/2011 18:48:35 | 0.0631 |
| 112 | 9/11/2011 18:54:35 | 0.0798 |
| 113 | 9/11/2011 19:00:35 | 0.0368 |

|     |                    |        |
|-----|--------------------|--------|
| 114 | 9/11/2011 19:06:35 | 0.0395 |
| 115 | 9/11/2011 19:12:35 | 0.0502 |
| 116 | 9/11/2011 19:18:35 | 0.0705 |
| 117 | 9/11/2011 19:24:35 | 0.0799 |
| 118 | 9/11/2011 19:30:35 | 0.0645 |
| 119 | 9/11/2011 19:36:35 | 0.0614 |
| 120 | 9/11/2011 19:42:35 | 0.0469 |
| 121 | 9/11/2011 19:48:35 | 0.0424 |
| 122 | 9/11/2011 19:54:35 | 0.024  |
| 123 | 9/11/2011 20:00:35 | 0.0645 |
| 124 | 9/11/2011 20:06:35 | 0.0739 |
| 125 | 9/11/2011 20:12:35 | 0.1065 |
| 126 | 9/11/2011 20:18:35 | 0.0959 |
| 127 | 9/11/2011 20:24:35 | 0.1431 |
| 128 | 9/11/2011 20:30:35 | 0.1191 |
| 129 | 9/11/2011 20:36:35 | 0.0784 |
| 130 | 9/11/2011 20:42:35 | 0.0863 |
| 131 | 9/11/2011 20:48:35 | 0.0949 |
| 132 | 9/11/2011 20:54:35 | 0.0926 |
| 133 | 9/11/2011 21:00:35 | 0.0923 |
| 134 | 9/11/2011 21:06:35 | 0.0878 |
| 135 | 9/11/2011 21:12:35 | 0.1109 |
| 136 | 9/11/2011 21:18:35 | 0.0928 |
| 137 | 9/11/2011 21:24:35 | 0.094  |
| 138 | 9/11/2011 21:30:35 | 0.0934 |
| 139 | 9/11/2011 21:36:35 | 0.1105 |
| 140 | 9/11/2011 21:42:35 | 0.0831 |
| 141 | 9/11/2011 21:48:35 | 0.076  |
| 142 | 9/11/2011 21:54:35 | 0.0876 |
| 143 | 9/11/2011 22:00:35 | 0.1266 |
| 144 | 9/11/2011 22:06:35 | 0.1458 |
| 145 | 9/11/2011 22:12:35 | 0.1223 |
| 146 | 9/11/2011 22:18:35 | 0.1095 |
| 147 | 9/11/2011 22:24:35 | 0.0945 |
| 148 | 9/11/2011 22:30:35 | 0.0691 |
| 149 | 9/11/2011 22:36:35 | 0.0913 |
| 150 | 9/11/2011 22:42:35 | 0.0603 |
| 151 | 9/11/2011 22:48:35 | 0.0892 |
| 152 | 9/11/2011 22:54:35 | 0.0675 |
| 153 | 9/11/2011 23:00:35 | 0.0592 |
| 154 | 9/11/2011 23:06:35 | 0.0862 |
| 155 | 9/11/2011 23:12:35 | 0.1024 |
| 156 | 9/11/2011 23:18:35 | 0.1256 |
| 157 | 9/11/2011 23:24:35 | 0.1018 |
| 158 | 9/11/2011 23:30:35 | 0.0976 |

|     |                    |        |
|-----|--------------------|--------|
| 159 | 9/11/2011 23:36:35 | 0.072  |
| 160 | 9/11/2011 23:42:35 | 0.0599 |
| 161 | 9/11/2011 23:48:35 | 0.0406 |
| 162 | 9/11/2011 23:54:35 | 0.0518 |
| 163 | 9/12/2011 0:00:35  | 0.0732 |
| 164 | 9/12/2011 0:06:35  | 0.081  |
| 165 | 9/12/2011 0:12:35  | 0.1093 |
| 166 | 9/12/2011 0:18:35  | 0.1386 |
| 167 | 9/12/2011 0:24:35  | 0.1032 |
| 168 | 9/12/2011 0:30:35  | 0.0876 |
| 169 | 9/12/2011 0:36:35  | 0.0457 |
| 170 | 9/12/2011 0:42:35  | 0.0421 |
| 171 | 9/12/2011 0:48:35  | 0.0705 |
| 172 | 9/12/2011 0:54:35  | 0.1227 |
| 173 | 9/12/2011 1:00:35  | 0.0923 |
| 174 | 9/12/2011 1:06:35  | 0.0894 |
| 175 | 9/12/2011 1:12:35  | 0.0897 |
| 176 | 9/12/2011 1:18:35  | 0.097  |
| 177 | 9/12/2011 1:24:35  | 0.0659 |
| 178 | 9/12/2011 1:30:35  | 0.0855 |
| 179 | 9/12/2011 1:36:35  | 0.0782 |
| 180 | 9/12/2011 1:42:35  | 0.068  |
| 181 | 9/12/2011 1:48:35  | 0.0648 |
| 182 | 9/12/2011 1:54:35  | 0.0527 |
| 183 | 9/12/2011 2:00:35  | 0.0525 |
| 184 | 9/12/2011 2:06:35  | 0.0483 |
| 185 | 9/12/2011 2:12:35  | 0.0555 |
| 186 | 9/12/2011 2:18:35  | 0.0793 |
| 187 | 9/12/2011 2:24:35  | 0.095  |
| 188 | 9/12/2011 2:30:35  | 0.0816 |
| 189 | 9/12/2011 2:36:35  | 0.0697 |
| 190 | 9/12/2011 2:42:35  | 0.0808 |
| 191 | 9/12/2011 2:48:35  | 0.063  |
| 192 | 9/12/2011 2:54:35  | 0.0571 |
| 193 | 9/12/2011 3:00:35  | 0.0454 |
| 194 | 9/12/2011 3:06:35  | 0.0408 |
| 195 | 9/12/2011 3:12:35  | 0.0363 |
| 196 | 9/12/2011 3:18:35  | 0.0403 |
| 197 | 9/12/2011 3:24:35  | 0.0617 |
| 198 | 9/12/2011 3:30:35  | 0.0768 |
| 199 | 9/12/2011 3:36:35  | 0.079  |
| 200 | 9/12/2011 3:42:35  | 0.0461 |
| 201 | 9/12/2011 3:48:35  | 0.0314 |
| 202 | 9/12/2011 3:54:35  | 0.0309 |
| 203 | 9/12/2011 4:00:35  | 0.0299 |

|     |                   |        |
|-----|-------------------|--------|
| 204 | 9/12/2011 4:06:35 | 0.0492 |
| 205 | 9/12/2011 4:12:35 | 0.0199 |
| 206 | 9/12/2011 4:18:35 | 0.0102 |
| 207 | 9/12/2011 4:24:35 | 0.0081 |
| 208 | 9/12/2011 4:30:35 | 0.016  |
| 209 | 9/12/2011 4:36:35 | 0.0216 |
| 210 | 9/12/2011 4:42:35 | 0.0144 |
| 211 | 9/12/2011 4:48:35 | 0.0143 |
| 212 | 9/12/2011 4:54:35 | 0.0083 |
| 213 | 9/12/2011 5:00:35 | 0.0132 |
| 214 | 9/12/2011 5:06:35 | 0.0274 |
| 215 | 9/12/2011 5:12:35 | 0.01   |
| 216 | 9/12/2011 5:18:35 | 0.0073 |
| 217 | 9/12/2011 5:24:35 | 0.0109 |
| 218 | 9/12/2011 5:30:35 | 0.0045 |
| 219 | 9/12/2011 5:36:35 | 0.0118 |
| 220 | 9/12/2011 5:42:35 | 0.0098 |
| 221 | 9/12/2011 5:48:35 | 0.0172 |
| 222 | 9/12/2011 5:54:35 | 0.0204 |
| 223 | 9/12/2011 6:00:35 | 0.0149 |
| 224 | 9/12/2011 6:06:35 | 0.0037 |
| 225 | 9/12/2011 6:12:35 | 0.0234 |
| 226 | 9/12/2011 6:18:35 | 0.0126 |
| 227 | 9/12/2011 6:24:35 | 0.0087 |
| 228 | 9/12/2011 6:30:35 | 0.0216 |
| 229 | 9/12/2011 6:36:35 | 0.0173 |
| 230 | 9/12/2011 6:42:35 | 0.0165 |
| 231 | 9/12/2011 6:48:35 | 0.0234 |
| 232 | 9/12/2011 6:54:35 | 0.0329 |
| 233 | 9/12/2011 7:00:35 | 0.0419 |
| 234 | 9/12/2011 7:06:35 | 0.0177 |
| 235 | 9/12/2011 7:12:35 | 0.0146 |
| 236 | 9/12/2011 7:18:35 | 0.0276 |
| 237 | 9/12/2011 7:24:35 | 0.0076 |
| 238 | 9/12/2011 7:30:35 | 0.0047 |
| 239 | 9/12/2011 7:36:35 | 0.0168 |
| 240 | 9/12/2011 7:42:35 | 0.0199 |
| 241 | 9/12/2011 7:48:35 | 0.0136 |
| 242 | 9/12/2011 7:54:35 | 0.0226 |
| 243 | 9/12/2011 8:00:35 | 0.0155 |
| 244 | 9/12/2011 8:06:35 | 0.0182 |
| 245 | 9/12/2011 8:12:35 | 0.0265 |
| 246 | 9/12/2011 8:18:35 | 0.0246 |
| 247 | 9/12/2011 8:24:35 | 0.0137 |
| 248 | 9/12/2011 8:30:35 | 0.0294 |



**9      Field Probe Log Files – Background Noise (All Meters Off)**

|                               |                    |
|-------------------------------|--------------------|
| Number of Sub Indices         | 677                |
| Storing Date                  | 16/09/2011         |
| Storing Time                  | 15:50:18           |
| Dataset Type                  | TIM                |
| Voice Comment Available       | NO                 |
| Dataset Fine Type             | T1                 |
| GPS Flag                      | NO                 |
| Device Product Name           | NBM-550            |
| Device Serial Number          | D-0146             |
| Device Cal Due Date           | 28/01/2013         |
| Probe Product Name            | EC5091             |
| Probe Serial Number           | 01025              |
| Probe Cal Due Date            | 06/06/2013         |
| Probe Field Type              | E                  |
| Probe Connection Type         | C                  |
| Probe Lower Frequency Limit A | 300 kHz            |
| Probe Upper Frequency Limit A | 50 GHz             |
| Probe Lower Frequency Limit B | 300 kHz            |
| Probe Upper Frequency Limit B | 50 GHz             |
| Probe Emin A                  | 4.340 V/m          |
| Probe Emax A                  | 150.0 V/m          |
| Probe Emin B                  | 4.340 V/m          |
| Probe Emax B                  | 150.0 V/m          |
| Shaped Probe                  | YES                |
| Standard ID                   | 5                  |
| Standard Name                 | Canada,occ         |
| Apply Standard                | ON                 |
| Frequency                     | 1.8 GHz            |
| Apply Correction Frequency    | OFF                |
| Eref_E(f)                     | 137.0 V/m          |
| Eref_H(f)                     | 137.2 V/m          |
| Combi Probe Use               | E_H                |
| Unit                          | mW/cm <sup>2</sup> |
| Results Format                | FIXED              |
| Auto-Zero Interval            | OFF                |
| Result Type                   | -                  |
| Averaging Time                | -                  |
| Average Progress              | -                  |
| Spatial AVG Mode              | -                  |
| Store Condition               | -                  |
| Storing Range                 | -                  |
| Cond. Stop Time               | -                  |
| Upper Threshold               | -                  |
| Lower Threshold               | -                  |

|                                  |                    |                       |
|----------------------------------|--------------------|-----------------------|
| Timer Interval                   | 360 sec            |                       |
| Timer Duration                   | 99:10:00           |                       |
| History Time Scale               | -                  |                       |
| Time progress of current segment | -                  |                       |
| Index                            | Date/Time          | Avg (E-Field) [% STD] |
| 1                                | 9/16/2011 15:56:18 | 0.021                 |
| 2                                | 9/16/2011 16:02:18 | 0.0366                |
| 3                                | 9/16/2011 16:08:18 | 0.0493                |
| 4                                | 9/16/2011 16:14:18 | 0.0656                |
| 5                                | 9/16/2011 16:20:18 | 0.0437                |
| 6                                | 9/16/2011 16:26:18 | 0.0957                |
| 7                                | 9/16/2011 16:32:18 | 0.1225                |
| 8                                | 9/16/2011 16:38:18 | 0.1094                |
| 9                                | 9/16/2011 16:44:18 | 0.1376                |
| 10                               | 9/16/2011 16:50:18 | 0.0774                |
| 11                               | 9/16/2011 16:56:18 | 0.1215                |
| 12                               | 9/16/2011 17:02:18 | 0.11                  |
| 13                               | 9/16/2011 17:08:18 | 0.0661                |
| 14                               | 9/16/2011 17:14:18 | 0.0742                |
| 15                               | 9/16/2011 17:20:18 | 0.045                 |
| 16                               | 9/16/2011 17:26:18 | 0.0761                |
| 17                               | 9/16/2011 17:32:18 | 0.0644                |
| 18                               | 9/16/2011 17:38:18 | 0.0535                |
| 19                               | 9/16/2011 17:44:18 | 0.066                 |
| 20                               | 9/16/2011 17:50:18 | 0.0724                |
| 21                               | 9/16/2011 17:56:18 | 0.0782                |
| 22                               | 9/16/2011 18:02:18 | 0.0721                |
| 23                               | 9/16/2011 18:08:18 | 0.0384                |
| 24                               | 9/16/2011 18:14:18 | 0.0731                |
| 25                               | 9/16/2011 18:20:18 | 0.0745                |
| 26                               | 9/16/2011 18:26:18 | 0.0677                |
| 27                               | 9/16/2011 18:32:18 | 0.0692                |
| 28                               | 9/16/2011 18:38:18 | 0.0483                |
| 29                               | 9/16/2011 18:44:18 | 0.0538                |
| 30                               | 9/16/2011 18:50:18 | 0.055                 |
| 31                               | 9/16/2011 18:56:18 | 0.068                 |
| 32                               | 9/16/2011 19:02:18 | 0.0612                |
| 33                               | 9/16/2011 19:08:18 | 0.0913                |
| 34                               | 9/16/2011 19:14:18 | 0.0858                |
| 35                               | 9/16/2011 19:20:18 | 0.0947                |
| 36                               | 9/16/2011 19:26:18 | 0.0992                |
| 37                               | 9/16/2011 19:32:18 | 0.0596                |
| 38                               | 9/16/2011 19:38:18 | 0.0629                |
| 39                               | 9/16/2011 19:44:18 | 0.0658                |
| 40                               | 9/16/2011 19:50:18 | 0.0635                |

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|----|--------------------|--------|
| 41 | 9/16/2011 19:56:18 | 0.0822 |
| 42 | 9/16/2011 20:02:18 | 0.0608 |
| 43 | 9/16/2011 20:08:18 | 0.0701 |
| 44 | 9/16/2011 20:14:18 | 0.0834 |
| 45 | 9/16/2011 20:20:18 | 0.1293 |
| 46 | 9/16/2011 20:26:18 | 0.101  |
| 47 | 9/16/2011 20:32:18 | 0.0735 |
| 48 | 9/16/2011 20:38:18 | 0.088  |
| 49 | 9/16/2011 20:44:18 | 0.0823 |
| 50 | 9/16/2011 20:50:18 | 0.0569 |
| 51 | 9/16/2011 20:56:18 | 0.0925 |
| 52 | 9/16/2011 21:02:18 | 0.0703 |
| 53 | 9/16/2011 21:08:18 | 0.0867 |
| 54 | 9/16/2011 21:14:18 | 0.0477 |
| 55 | 9/16/2011 21:20:18 | 0.0539 |
| 56 | 9/16/2011 21:26:18 | 0.0527 |
| 57 | 9/16/2011 21:32:18 | 0.0689 |
| 58 | 9/16/2011 21:38:18 | 0.0436 |
| 59 | 9/16/2011 21:44:18 | 0.0488 |
| 60 | 9/16/2011 21:50:18 | 0.0434 |
| 61 | 9/16/2011 21:56:18 | 0.063  |
| 62 | 9/16/2011 22:02:18 | 0.0923 |
| 63 | 9/16/2011 22:08:18 | 0.0791 |
| 64 | 9/16/2011 22:14:18 | 0.0918 |
| 65 | 9/16/2011 22:20:18 | 0.0901 |
| 66 | 9/16/2011 22:26:18 | 0.0786 |
| 67 | 9/16/2011 22:32:18 | 0.1431 |
| 68 | 9/16/2011 22:38:18 | 0.1295 |
| 69 | 9/16/2011 22:44:18 | 0.1241 |
| 70 | 9/16/2011 22:50:18 | 0.1244 |
| 71 | 9/16/2011 22:56:18 | 0.1109 |
| 72 | 9/16/2011 23:02:18 | 0.1153 |
| 73 | 9/16/2011 23:08:18 | 0.1351 |
| 74 | 9/16/2011 23:14:18 | 0.1068 |
| 75 | 9/16/2011 23:20:18 | 0.1573 |
| 76 | 9/16/2011 23:26:18 | 0.1157 |
| 77 | 9/16/2011 23:32:18 | 0.1212 |
| 78 | 9/16/2011 23:38:18 | 0.144  |
| 79 | 9/16/2011 23:44:18 | 0.1498 |
| 80 | 9/16/2011 23:50:18 | 0.1452 |
| 81 | 9/16/2011 23:56:18 | 0.1607 |
| 82 | 9/17/2011 0:02:18  | 0.1536 |
| 83 | 9/17/2011 0:08:18  | 0.1587 |
| 84 | 9/17/2011 0:14:18  | 0.1858 |
| 85 | 9/17/2011 0:20:18  | 0.1484 |

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| 86  | 9/17/2011 0:26:18 | 0.1173 |
| 87  | 9/17/2011 0:32:18 | 0.1266 |
| 88  | 9/17/2011 0:38:18 | 0.1354 |
| 89  | 9/17/2011 0:44:18 | 0.1387 |
| 90  | 9/17/2011 0:50:18 | 0.1173 |
| 91  | 9/17/2011 0:56:18 | 0.133  |
| 92  | 9/17/2011 1:02:18 | 0.134  |
| 93  | 9/17/2011 1:08:18 | 0.1386 |
| 94  | 9/17/2011 1:14:18 | 0.1561 |
| 95  | 9/17/2011 1:20:18 | 0.149  |
| 96  | 9/17/2011 1:26:18 | 0.125  |
| 97  | 9/17/2011 1:32:18 | 0.1261 |
| 98  | 9/17/2011 1:38:18 | 0.1365 |
| 99  | 9/17/2011 1:44:18 | 0.1446 |
| 100 | 9/17/2011 1:50:18 | 0.1666 |
| 101 | 9/17/2011 1:56:18 | 0.1976 |
| 102 | 9/17/2011 2:02:18 | 0.199  |
| 103 | 9/17/2011 2:08:18 | 0.1948 |
| 104 | 9/17/2011 2:14:18 | 0.1475 |
| 105 | 9/17/2011 2:20:18 | 0.1693 |
| 106 | 9/17/2011 2:26:18 | 0.1707 |
| 107 | 9/17/2011 2:32:18 | 0.1332 |
| 108 | 9/17/2011 2:38:18 | 0.1223 |
| 109 | 9/17/2011 2:44:18 | 0.1289 |
| 110 | 9/17/2011 2:50:18 | 0.1409 |
| 111 | 9/17/2011 2:56:18 | 0.149  |
| 112 | 9/17/2011 3:02:18 | 0.1382 |
| 113 | 9/17/2011 3:08:18 | 0.1532 |
| 114 | 9/17/2011 3:14:18 | 0.1723 |
| 115 | 9/17/2011 3:20:18 | 0.154  |
| 116 | 9/17/2011 3:26:18 | 0.168  |
| 117 | 9/17/2011 3:32:18 | 0.1778 |
| 118 | 9/17/2011 3:38:18 | 0.1596 |
| 119 | 9/17/2011 3:44:18 | 0.159  |
| 120 | 9/17/2011 3:50:18 | 0.1487 |
| 121 | 9/17/2011 3:56:18 | 0.1455 |
| 122 | 9/17/2011 4:02:18 | 0.1672 |
| 123 | 9/17/2011 4:08:18 | 0.1346 |
| 124 | 9/17/2011 4:14:18 | 0.1359 |
| 125 | 9/17/2011 4:20:18 | 0.1631 |
| 126 | 9/17/2011 4:26:18 | 0.1477 |
| 127 | 9/17/2011 4:32:18 | 0.1427 |
| 128 | 9/17/2011 4:38:18 | 0.161  |
| 129 | 9/17/2011 4:44:18 | 0.1789 |
| 130 | 9/17/2011 4:50:18 | 0.2025 |

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| 131 | 9/17/2011 4:56:18 | 0.1736 |
| 132 | 9/17/2011 5:02:18 | 0.1782 |
| 133 | 9/17/2011 5:08:18 | 0.1717 |
| 134 | 9/17/2011 5:14:18 | 0.1429 |
| 135 | 9/17/2011 5:20:18 | 0.1561 |
| 136 | 9/17/2011 5:26:18 | 0.1694 |
| 137 | 9/17/2011 5:32:18 | 0.1615 |
| 138 | 9/17/2011 5:38:18 | 0.1679 |
| 139 | 9/17/2011 5:44:18 | 0.1812 |
| 140 | 9/17/2011 5:50:18 | 0.2294 |
| 141 | 9/17/2011 5:56:18 | 0.2023 |
| 142 | 9/17/2011 6:02:18 | 0.1924 |
| 143 | 9/17/2011 6:08:18 | 0.1778 |
| 144 | 9/17/2011 6:14:18 | 0.1722 |
| 145 | 9/17/2011 6:20:18 | 0.1845 |
| 146 | 9/17/2011 6:26:18 | 0.1793 |
| 147 | 9/17/2011 6:32:18 | 0.2273 |
| 148 | 9/17/2011 6:38:18 | 0.229  |
| 149 | 9/17/2011 6:44:18 | 0.2394 |
| 150 | 9/17/2011 6:50:18 | 0.222  |
| 151 | 9/17/2011 6:56:18 | 0.2169 |
| 152 | 9/17/2011 7:02:18 | 0.1955 |
| 153 | 9/17/2011 7:08:18 | 0.1691 |
| 154 | 9/17/2011 7:14:18 | 0.1943 |
| 155 | 9/17/2011 7:20:18 | 0.1991 |
| 156 | 9/17/2011 7:26:18 | 0.1848 |
| 157 | 9/17/2011 7:32:18 | 0.2012 |
| 158 | 9/17/2011 7:38:18 | 0.219  |
| 159 | 9/17/2011 7:44:18 | 0.2018 |
| 160 | 9/17/2011 7:50:18 | 0.2176 |
| 161 | 9/17/2011 7:56:18 | 0.161  |
| 162 | 9/17/2011 8:02:18 | 0.1651 |
| 163 | 9/17/2011 8:08:18 | 0.1978 |
| 164 | 9/17/2011 8:14:18 | 0.1755 |
| 165 | 9/17/2011 8:20:18 | 0.1622 |
| 166 | 9/17/2011 8:26:18 | 0.1613 |
| 167 | 9/17/2011 8:32:18 | 0.1623 |
| 168 | 9/17/2011 8:38:18 | 0.1474 |
| 169 | 9/17/2011 8:44:18 | 0.1177 |
| 170 | 9/17/2011 8:50:18 | 0.1506 |
| 171 | 9/17/2011 8:56:18 | 0.1642 |
| 172 | 9/17/2011 9:02:18 | 0.1696 |
| 173 | 9/17/2011 9:08:18 | 0.1594 |
| 174 | 9/17/2011 9:14:18 | 0.1956 |
| 175 | 9/17/2011 9:20:18 | 0.1868 |

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| 176 | 9/17/2011 9:26:18  | 0.1993 |
| 177 | 9/17/2011 9:32:18  | 0.1956 |
| 178 | 9/17/2011 9:38:18  | 0.2125 |
| 179 | 9/17/2011 9:44:18  | 0.1709 |
| 180 | 9/17/2011 9:50:18  | 0.1709 |
| 181 | 9/17/2011 9:56:18  | 0.207  |
| 182 | 9/17/2011 10:02:18 | 0.2    |
| 183 | 9/17/2011 10:08:18 | 0.176  |
| 184 | 9/17/2011 10:14:18 | 0.1798 |
| 185 | 9/17/2011 10:20:18 | 0.1695 |
| 186 | 9/17/2011 10:26:18 | 0.1301 |
| 187 | 9/17/2011 10:32:18 | 0.1443 |
| 188 | 9/17/2011 10:38:18 | 0.1553 |
| 189 | 9/17/2011 10:44:18 | 0.1935 |
| 190 | 9/17/2011 10:50:18 | 0.1486 |
| 191 | 9/17/2011 10:56:18 | 0.1503 |
| 192 | 9/17/2011 11:02:18 | 0.1775 |
| 193 | 9/17/2011 11:08:18 | 0.1508 |
| 194 | 9/17/2011 11:14:18 | 0.1422 |
| 195 | 9/17/2011 11:20:18 | 0.1328 |
| 196 | 9/17/2011 11:26:18 | 0.1405 |
| 197 | 9/17/2011 11:32:18 | 0.1602 |
| 198 | 9/17/2011 11:38:18 | 0.168  |
| 199 | 9/17/2011 11:44:18 | 0.1589 |
| 200 | 9/17/2011 11:50:18 | 0.1868 |
| 201 | 9/17/2011 11:56:18 | 0.1958 |
| 202 | 9/17/2011 12:02:18 | 0.1923 |
| 203 | 9/17/2011 12:08:18 | 0.1822 |
| 204 | 9/17/2011 12:14:18 | 0.2063 |
| 205 | 9/17/2011 12:20:18 | 0.1893 |
| 206 | 9/17/2011 12:26:18 | 0.1671 |
| 207 | 9/17/2011 12:32:18 | 0.1798 |
| 208 | 9/17/2011 12:38:18 | 0.1763 |
| 209 | 9/17/2011 12:44:18 | 0.1663 |
| 210 | 9/17/2011 12:50:18 | 0.1761 |
| 211 | 9/17/2011 12:56:18 | 0.1817 |
| 212 | 9/17/2011 13:02:18 | 0.1437 |
| 213 | 9/17/2011 13:08:18 | 0.1571 |
| 214 | 9/17/2011 13:14:18 | 0.1555 |
| 215 | 9/17/2011 13:20:18 | 0.1523 |
| 216 | 9/17/2011 13:26:18 | 0.1605 |
| 217 | 9/17/2011 13:32:18 | 0.1994 |
| 218 | 9/17/2011 13:38:18 | 0.1731 |
| 219 | 9/17/2011 13:44:18 | 0.1306 |
| 220 | 9/17/2011 13:50:18 | 0.1104 |

|     |                    |        |
|-----|--------------------|--------|
| 221 | 9/17/2011 13:56:18 | 0.1038 |
| 222 | 9/17/2011 14:02:18 | 0.1043 |
| 223 | 9/17/2011 14:08:18 | 0.1172 |
| 224 | 9/17/2011 14:14:18 | 0.133  |
| 225 | 9/17/2011 14:20:18 | 0.1454 |
| 226 | 9/17/2011 14:26:18 | 0.157  |
| 227 | 9/17/2011 14:32:18 | 0.1242 |
| 228 | 9/17/2011 14:38:18 | 0.1403 |
| 229 | 9/17/2011 14:44:18 | 0.1373 |
| 230 | 9/17/2011 14:50:18 | 0.147  |
| 231 | 9/17/2011 14:56:18 | 0.1743 |
| 232 | 9/17/2011 15:02:18 | 0.1707 |
| 233 | 9/17/2011 15:08:18 | 0.1968 |
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| 610 | 9/19/2011 4:50:18 | 0.1707 |
| 611 | 9/19/2011 4:56:18 | 0.1414 |
| 612 | 9/19/2011 5:02:18 | 0.1534 |
| 613 | 9/19/2011 5:08:18 | 0.1522 |
| 614 | 9/19/2011 5:14:18 | 0.1375 |
| 615 | 9/19/2011 5:20:18 | 0.1513 |
| 616 | 9/19/2011 5:26:18 | 0.1751 |
| 617 | 9/19/2011 5:32:18 | 0.185  |
| 618 | 9/19/2011 5:38:18 | 0.1896 |
| 619 | 9/19/2011 5:44:18 | 0.1983 |
| 620 | 9/19/2011 5:50:18 | 0.2163 |
| 621 | 9/19/2011 5:56:18 | 0.1871 |
| 622 | 9/19/2011 6:02:18 | 0.1871 |
| 623 | 9/19/2011 6:08:18 | 0.2074 |
| 624 | 9/19/2011 6:14:18 | 0.2086 |
| 625 | 9/19/2011 6:20:18 | 0.2328 |

|     |                    |        |
|-----|--------------------|--------|
| 626 | 9/19/2011 6:26:18  | 0.2223 |
| 627 | 9/19/2011 6:32:18  | 0.2174 |
| 628 | 9/19/2011 6:38:18  | 0.2394 |
| 629 | 9/19/2011 6:44:18  | 0.2464 |
| 630 | 9/19/2011 6:50:18  | 0.2242 |
| 631 | 9/19/2011 6:56:18  | 0.2213 |
| 632 | 9/19/2011 7:02:18  | 0.2265 |
| 633 | 9/19/2011 7:08:18  | 0.2192 |
| 634 | 9/19/2011 7:14:18  | 0.2149 |
| 635 | 9/19/2011 7:20:18  | 0.218  |
| 636 | 9/19/2011 7:26:18  | 0.1943 |
| 637 | 9/19/2011 7:32:18  | 0.2126 |
| 638 | 9/19/2011 7:38:18  | 0.2431 |
| 639 | 9/19/2011 7:44:18  | 0.2279 |
| 640 | 9/19/2011 7:50:18  | 0.2332 |
| 641 | 9/19/2011 7:56:18  | 0.2194 |
| 642 | 9/19/2011 8:02:18  | 0.2198 |
| 643 | 9/19/2011 8:08:18  | 0.185  |
| 644 | 9/19/2011 8:14:18  | 0.1746 |
| 645 | 9/19/2011 8:20:18  | 0.1533 |
| 646 | 9/19/2011 8:26:18  | 0.1454 |
| 647 | 9/19/2011 8:32:18  | 0.1484 |
| 648 | 9/19/2011 8:38:18  | 0.1762 |
| 649 | 9/19/2011 8:44:18  | 0.1961 |
| 650 | 9/19/2011 8:50:18  | 0.2116 |
| 651 | 9/19/2011 8:56:18  | 0.185  |
| 652 | 9/19/2011 9:02:18  | 0.2104 |
| 653 | 9/19/2011 9:08:18  | 0.1392 |
| 654 | 9/19/2011 9:14:18  | 0.119  |
| 655 | 9/19/2011 9:20:18  | 0.1255 |
| 656 | 9/19/2011 9:26:18  | 0.1207 |
| 657 | 9/19/2011 9:32:18  | 0.1238 |
| 658 | 9/19/2011 9:38:18  | 0.1215 |
| 659 | 9/19/2011 9:44:18  | 0.1014 |
| 660 | 9/19/2011 9:50:18  | 0.0911 |
| 661 | 9/19/2011 9:56:18  | 0.1101 |
| 662 | 9/19/2011 10:02:18 | 0.0935 |
| 663 | 9/19/2011 10:08:18 | 0.0766 |
| 664 | 9/19/2011 10:14:18 | 0.0768 |
| 665 | 9/19/2011 10:20:18 | 0.0814 |
| 666 | 9/19/2011 10:26:18 | 0.0946 |
| 667 | 9/19/2011 10:32:18 | 0.1007 |
| 668 | 9/19/2011 10:38:18 | 0.0671 |
| 669 | 9/19/2011 10:44:18 | 0.0456 |
| 670 | 9/19/2011 10:50:18 | 0.0409 |



|     |                    |        |
|-----|--------------------|--------|
| 671 | 9/19/2011 10:56:18 | 0.0531 |
| 672 | 9/19/2011 11:02:18 | 0.0762 |
| 673 | 9/19/2011 11:08:18 | 0.098  |
| 674 | 9/19/2011 11:14:18 | 0.1219 |
| 675 | 9/19/2011 11:20:18 | 0.0936 |
| 676 | 9/19/2011 11:26:18 | 0.1002 |
| 677 | 9/19/2011 11:32:18 | 0.0656 |

10 Independent Review – Exotek Systems**EXOTEKSYSTEMS**

TELECOMMUNICATIONS ENGINEERING

10457 ALLBAY ROAD

SIDNEY, BC

V8L 2P2

604-551-8400

Vern Kwiatkowski

BC Hydro, Smart Metering &amp; Infrastructure

6911 Southpoint Drive

Burnaby, BC V3N 4X8

11 October 2011

Re: Safety Code Six Report: Bank of 10 Smart Meters by K.Reardon, P.Eng

Dear Sir,

In accordance with your request, I have conducted an exhaustive review of the work done by Mr. Karl Reardon, P.Eng. which is contained in his report entitled "BC Hydro – Bank of 10 Smart Meters Safety Code 6 Report, Rev. A" dated 11 October 2011. That report describes the power density, measured by a Narda probe and meter, resulting from the radio frequency transmissions from the Itron "smart" meter described in the report in accordance with Safety Code 6.

Attestation:

I, Anton van Wouw, a Professional Engineer registered in the Province of British Columbia, state that the work done by Mr. Karl Reardon, P.Eng., in preparing the aforementioned report, was done in accordance with best practices in the field of radio frequency engineering and that the methodology, reporting and interpretation of the readings from the test equipment was done with sound scientific principles. The results, which approach the lower limit of measurement of the test equipment, fairly report that at a distance of 20 cm from the meter tested, the power density, averaged over six minute intervals for a period of several days, was less than 0.5% of the allowable Safety Code 6 limit for "uncontrolled environments" i.e. the general public.

Furthermore, I am familiar with the Narda equipment in general and the specifically the Broadband Field Meter and Electric Field Probe used by Mr. Reardon to obtain the measurements contained in the report. I have personally inspected the equipment and found it to be in good working condition; I have no reason to suspect that the April 2011 calibration is in any way compromised.

Sincerely Yours,



A. Tony van Wouw, P.Eng.

President, Exotek Systems.

604-551-8400

[www.exotek.ca](http://www.exotek.ca)



|   |           |
|---|-----------|
| Executive Summary.....  | 3         |
| 1 Summary.....  | 5         |
| <b>1.1 SITE LOCATION/ DETAILS .....</b>   | <b>5</b>  |
| <b>1.2 ATTESTATION .....</b>  | <b>5</b>  |
| <b>1.3 SAFETY CODE 6 DEFINITIONS .....</b>  | <b>6</b>  |
| <b>1.4 TESTING APPROACH .....</b>   | <b>8</b>  |
| 1.4.1 Purpose.....  | 8         |
| 1.4.2 Network Environment.....  | 8         |
| 1.4.3 Meter Inventories.....  | 8         |
| <b>1.5 REVIEW OF FINDINGS, CONCLUSIONS AND REMEDIAL ACTIONS .....</b>   | <b>9</b>  |
| 1.5.1 Summary .....   | 9         |
| 1.5.2 Summary .....   | 9         |
| 1.5.3 Detailed Results – Day 1, Baseline Level with 9 Smart Meters and 31 Electromechanical Meters.....               | 11        |
| 1.5.4 Detailed Results – Day 2, Installation of 31 Additional Smart Meters going through Meter Network Discovery..... | 12        |
| 1.5.5 Detailed Results – Day 3, Continue Network Discovery, Formation, and Optimization.....                          | 13        |
| 1.5.6 Detailed Results – Day 4, Simulated Network Disruption.....   | 14        |
| 1.5.7 Detailed Results – Day 5, Steady State.....   | 15        |
| 1.5.8 Next Steps and Required Remedial Actions.....   | 16        |
| 2 Measurement Procedure.....  | 16        |
| <b>2.1 DESCRIPTION OF PROCEDURE USED .....</b>  | <b>16</b> |
| <b>2.2 TEST EQUIPMENT DESCRIPTION .....</b>   | <b>17</b> |
| 3 Photograph .....  | 18        |
| 4 Traffic Confirmation – Forty Meters Under Test .....  | 19        |
| 5 NBM-550 Calibration Certificate .....   | 24        |
| 6 EC5091 Calibration Certificate .....  | 27        |
| 7 Field Probe Log Files – Baseline (Nine SmartMeters) .....   | 32        |
| 8 Field Probe Log Files – Forty Meters Installed.....   | 36        |
| Annex A – Spectrum Analyzer Observations.....   | 49        |

## **Executive Summary**

### **Objective**

To certify compliance of BC Hydro's smart meter (Itron's Openway Centron Meter, Hardware Profile 3.1) against Canadian federal regulations on radio-frequency (RF) exposure, as specified by Health Canada Safety Code 6. This report describes the testing results for a meter bank of forty meters installed in a high density residential complex in Victoria, British Columbia. Additional, separate reports describe testing results for a single meter and for a meter bank of 10 meters in a controlled test environment.

### **Approach**

Planetworks, a telecommunication engineering consulting firm, was contracted to conduct independent testing of BC Hydro's smart meters. Planetworks uses the Narda Broadband Field Meters (NDM-550) together with a shaped isotropic field probe, which is the most accurate field meter solution available for broadband RF exposure limit measurements. Measuring full broadband exposure - as opposed to the specific band used by smart meters - is necessary for Safety Code 6 assessment to assess the cumulative RF exposure inclusive of other devices.

All testing has been conducted in conformance to procedures defined in Health Canada's Safety Code 6. At the 900 MHz operational frequency of the smart meters, Safety Code 6 defines a maximum permissible power density of  $6 \text{ W/m}^2$  (averaged over a 6 minute period) for uncontrolled areas (i.e. public areas). Based on the fact  $1 \text{ W/m}^2$  equals  $100 \mu\text{W/cm}^2$ , the Safety Code 6 permissible limit at 900 MHz is equivalent to  $600 \mu\text{W/cm}^2$ .

This testing was conducted in an actual field setting, not in a test environment. Although care was taken to minimize other intentional emitters of RF energy present in the testing environment, it was not possible to eliminate the secondary sources of RF energy such as fluorescent lighting, electrical transformers, external Wi-Fi hotspots, signals from cellular sites, broadcast sources, etc. Therefore, some level of background RF energy is included in all the measurement results.

In addition to measuring the RF emissions of a 40 meter bank and other sources, a spectrum analyzer was also used identify radio sources ranging from 15 MHz to 2.5 GHz. The observation shows that signals in the area include FM radio, TV stations, and WiFi that are all outside the 900 MHz range. Further, to correlate radio signal strength with the actual data transmission from BC Hydro's smart meters, a 'packet sniffer' from Itron was used to isolate data packets originating from smart meters.

The testing methodology used in this scenario covered five (5) days, as follows:

- Day 1: Establish Radio Strength Baseline – including any background activity levels;
- Day 2: Install Smart Meters – an additional 31 smart meters were added to the 9 previously installed;
- Day 3: Establish the Metering Network – monitor activity as meters stabilize on the network;
- Day 4: Simulate a Metering Network Interruption; and
- Day 5: Measure Operational Steady-State – observe the metering system about one month after installation.

## **Findings**

1. On Day 1, to establish a baseline, the RF field intensity levels were measured prior to the installation of the majority of smart meters. At 20 centimeters from the center of a bank of meter with nine smart meters and thirty-four analogue meters, the average power density measured over approximately 22 hours is 0.0474% of Health Canada Safety Code 6 limit for public areas. This measured value includes RF-signals originating from all internal and external sources.
2. After the installation of an additional thirty-one smart meters, testing was re-conducted. At 20 centimeter distance from the meter in the center of a bank of forty smart meters and three analogue meters, the average power density measured over Days 2 to 5 is 0.1083% of Health Canada Safety Code 6 limit for public areas, including background radio frequency signals.

The Narda Field Meter measures cumulative emissions across a very wide frequency range and automatically applies measurements against the Health Canada Safety Code 6 limit as appropriate for *each* frequency. While this approach provides a very accurate assessment of total compliance against Safety Code 6 limits, it is not possible to accurately convert this into a power density value for a single frequency due to the presence of the background RF sources. However, if it is assumed that all measured emissions were to have originated around the 900 MHz frequency of the smart meter communication band, then the total four-day attained average value of 0.1083% can be converted to a power density of  $0.65 \mu\text{W}/\text{cm}^2$  (0.65 microwatts per square centimeter). The power density actually attributable to the smart meters only would be less than this value.

3. The full range of power densities measured by the Narda Field Meter over the 89.5 hour period after smart meters are installed ranged from 0.005% to 0.9285% of Safety Code 6 limits for public areas – in all cases, less than 1% of Health Canada Safety Code 6 limits. Over 99% of the time, the measured value was less than half of the observed range; in other words, less than half a percentage point (0.4643%). These measurements included background radio frequency levels from the common laundry room adjacent to the meter room (active motors from washers and dryers, as well as fluorescent lighting), residents' wireless Internet routers and cell phone activities in the area.
4. In terms of data transmission, the active transmission time for the meter bank on Day 2 was 45.389 seconds, on Day 3 it was 66.479 second, on Day 4 it was 134.284 seconds, and on Day 5 it was 88.69 seconds. The total cumulative data transmission time for all 40 meters, for all four days of smart meter operations was 5.6 minutes. For individual meters, the average transmission time per meter was 2.25 seconds per day or 8.37 seconds over the nearly 4 days – consistent with the single meter test results.
5. Upon a metering network failure, as simulated by the removal of the collector on Day 4, results show that the RF emissions remain low with Day 4's signal strength level at 0.11% of Health Canada Safety Code 6 – still less than 0.5% of the Safety Code 6 standard. There is a temporary increase in communication packets being sent as the metering network is re-stabilized; this increased communication activity ends within 1.5 hours of the network failure event.
6. Day 5 – a month after initial testing – measures meter operations after all meters had been operating in steady-state for some time. Results from Day 5 are consistent with previous steady-state results.
7. Spectrum analyzer observations showed that radio, TV, cellular, and WiFi signals from other frequencies can be observed and measured from inside the meter bank room. These other signals originated from either inside the building or from other locations that may be several kilometers away. Even at peak levels, signals generated from smart meters measured immediately outside the meter room remain at or below the level of these other signals.

## 1 Summary

### 1.1 Site Location/ Details

|                      |   |
|----------------------|---|
| Site Street Address  | [REDACTED], Victoria, BC  |
| Location of Antennas | Bank of forty Itron Smart Meters with AMI7 radios located inside the electrical room of a high density housing complex. |

|                  |                      |                       |                      |
|------------------|----------------------|-----------------------|----------------------|
| Test 1 Start     | Jan 23, 2012 10:54am | Test 1 Stop           | Jan 27, 2012 09:10am |
| Test 2 Start     | Mar 22, 2012 09:17am | Test 2 Stop           | Mar 23, 2012 09:18am |
| Site Plan Attch. | Yes                  | Antenna Photos Attch. | Meter Bank Photo     |
| Site Photo Attch | Yes                  | Log Files Attch.      | Yes                  |

### 1.2 Attestation

I, Karl Reardon, a Professional Engineer registered in the Province of British Columbia, certify that, at the time of testing, the radio frequency field levels for a bank of forty Itron's Openway Centron Meter, Hardware Profile 3.1, Smart Meters with AMI7 radios complies with Health Canada regulations based on the specified documentation below:

- (HC Pub. 091029) Limits of Human Exposure to Radio frequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz - Safety Code 6 (2009)
- (HC Pub. 091031) Technical Guide for Interpretation and Compliance Assessment of Health Canada's Radio frequency Exposure Guidelines

|   |   |
|---|---|
| Measured Results Below Health Canada Safety Code 6 Exposure Limits for Uncontrolled Environments<br>(General Public, not trained in radio frequency hazards, exposed to RF and Microwave emissions) | Within Safe Limits Defined by Health Canada |
| Induced Currents are below HC-SC6 Requirements  | Yes   |
| Signage Meets HC-SC6 Requirements   | n/a   |

#### Notes

(1) This test involved a bank of forty Itron meters located in an electrical room. Each of the forty Itron meters service individual residential units but were centralized and contained within a single electrical room (vault). No other Itron meters were located within the confines of this high density living complex.

(2) The Itron meter's 900 MHz RF transmitter was active during testing. Consistent with BC Hydro's planned installation practice, the ZigBee RF section was disabled during testing (i.e. the ZigBee radio was in its default, off state).

(3) The Narda Broadband Field Meter (NDM-550) was placed on an unobstructed path 20 centimeters away from the closest Itron meter, as shown in Section 3. This placement ensured maximum readings from the meter bank under test.

(4) The Narda Field Meter records cumulative RF emissions from all RF sources in the spectral range from 300kHz (0.3 MHz) to 50GHz (50,000 MHz). Care was taken to minimize other RF sources active in the room during the test, but RF sources in the building or vicinity of the building could not be controlled. It should be noted that buildings typically contain many secondary RF sources such as fluorescent lighting, electrical transformers, motors, etc. Additionally, most populated areas contain many external RF sources that cannot be controlled, including Wi-Fi hotspots, signals from cellular sites and devices, two-way radio communication and broadcast sources. This background exposure was verified by spectrum analyzer

observations, included in Annex A, which shows similar RF signal levels in the vicinity coming from FM radio, paging, and WiFi signals.

### 1.3 **Safety Code 6 Definitions**

Prior to the 2009 dated release of the Health Canada Safety Code 6 specifications, the documentation defined exposure limits for "RF and occupationally exposed workers" and exposure limits for the "general public." The general public was defined as any individual who may generally be exposed to RF emissions and has no knowledge or training in radio technology. Consequently exposure limits for the general public are five times lower than for the RF worker who must have adequate safety training to work with antenna systems.

Challenges arose when defining "occupationally exposed workers." In the 2009 edition of the Safety-Code 6 guidelines, Health Canada attempted to address the ambiguities in these definitions by categorizing sites as "controlled" and "uncontrolled" where "uncontrolled" replaced the definition for the general public.

The following text is lifted from current Health Canada's Safety Code 6 documentation and defines controlled versus uncontrolled environments.

#### **Controlled and Uncontrolled Environments**

"For the purpose of this code, controlled environments are defined as those where all of the following conditions are satisfied:

- (a) The RF field intensities in the controlled area have been adequately characterized by means of measurements, calculations or modeling (such as with the use of FDTD [finite difference time domain] software),
- (b) The exposure is incurred by persons who are aware of the potential for RF exposure and are cognizant of the intensity of the RF energy in their environment and,
- (c) The exposure is incurred by persons who are aware of the potential health risks associated with RF energy exposures and whom can control their risk using mitigation strategies.

All situations that do not meet the specifications above are considered to be uncontrolled environments. Uncontrolled environments are defined as areas where either insufficient assessment of RF energy has been conducted or where persons who are allowed access to these areas have not received proper RF awareness training and have no means to assess or, if required, mitigate their exposure to RF energy."<sup>1</sup>

Exposure limits for controlled and uncontrolled environments is defined by Health Canada in the following tables.

---

<sup>1</sup> "Chapter 2, Maximum Exposure Limits", Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz, HC Pub.: 091029



Table 5. Exposure Limits for Controlled Environments.

| 1<br>Frequency<br>(MHz) | 2<br>Electric Field<br>Strength; rms<br>(V/m) | 3<br>Magnetic Field<br>Strength; rms<br>(A/m)  | 4<br>Power<br>Density<br>(W/m <sup>2</sup> ) | 5<br>Averaging<br>Time<br>(min)   |
|-------------------------|---|--|--|-----------------------------------|
| 0.003 - 1               | 600   | 4.9  |  | 6                                 |
| 1 - 10                  | 600/ <i>f</i>                                 | 4.9/ <i>f</i>                                  |  | 6                                 |
| 10 - 30                 | 60  | 4.9/ <i>f</i>                                  |  | 6                                 |
| 30 - 300                | 60  | 0.163  | 10*  | 6                                 |
| 300 - 1 500             | 3.54 <i>f</i> <sup>0.5</sup>                  | 0.0094 <i>f</i> <sup>0.5</sup>                 | <i>f</i> /30                                 | 6                                 |
| 1 500 - 15 000          | 137   | 0.364  | 50   | 6                                 |
| 15 000 - 150 000        | 137   | 0.364  | 50   | 616 000 / <i>f</i> <sup>1.2</sup> |
| 150 000 - 300 000       | 0.354 <i>f</i> <sup>0.5</sup>                 | 9.4 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup> | 3.33 x 10 <sup>-4</sup> <i>f</i>             | 616 000 / <i>f</i> <sup>1.2</sup> |

\* 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/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.

3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

Table 6. Exposure Limits for Uncontrolled Environments.

| 1<br>Frequency<br>(MHz) | 2<br>Electric Field<br>Strength; rms<br>(V/m) | 3<br>Magnetic Field<br>Strength; rms<br>(A/m)   | 4<br>Power<br>Density<br>(W/m <sup>2</sup> ) | 5<br>Averaging<br>Time<br>(min)   |
|-------------------------|---|---|--|-----------------------------------|
| 0.003 - 1               | 280   | 2.19  |  | 6                                 |
| 1 - 10                  | 280/ <i>f</i>                                 | 2.19/ <i>f</i>                                  |  | 6                                 |
| 10 - 30                 | 28  | 2.19/ <i>f</i>                                  |  | 6                                 |
| 30 - 300                | 28  | 0.073   | 2*   | 6                                 |
| 300 - 1 500             | 1.585 <i>f</i> <sup>0.5</sup>                 | 0.0042 <i>f</i> <sup>0.5</sup>                  | <i>f</i> /150                                | 6                                 |
| 1 500 - 15 000          | 61.4  | 0.163   | 10   | 6                                 |
| 15 000 - 150 000        | 61.4  | 0.163   | 10   | 616 000 / <i>f</i> <sup>1.2</sup> |
| 150 000 - 300 000       | 0.158 <i>f</i> <sup>0.5</sup>                 | 4.21 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup> | 6.67 x 10 <sup>-5</sup> <i>f</i>             | 616 000 / <i>f</i> <sup>1.2</sup> |

\* 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/m<sup>2</sup> is equivalent to 1 mW/cm<sup>2</sup>.

3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

Applying the exposure limits from these standards to BC Hydro's smart meters – which use an AMI7 radio operating at 900 MHz – the limits are:

- **Uncontrolled Environments** – 6 Watts/meter squared (W/m<sup>2</sup>) or 600 microwatts per square centimetre (μW/cm<sup>2</sup>)
- **Controlled Environments** – 30 W/m<sup>2</sup> or 3,000 μW/cm<sup>2</sup>

Conversion between W/m<sup>2</sup> and μW/cm<sup>2</sup> is performed using the relationship that 1 W/m<sup>2</sup> equals 100 μW/cm<sup>2</sup>.

## 1.4 **Testing Approach**

### 1.4.1 **Purpose**

Assess the RF strength level of BC Hydro's smart meters during initial network formation, after network disruption, and at steady-state relative to Health Canada Safety Code 6 in actual field setting for a meter bank of 40 meters.

### 1.4.2 **Network Environment**

The RF strength level measured on the Narda Field Probe will span a total of 111.5 hours across 5 days with different meter network environments:

- Day 1: Baseline Level with 9 Smart Meters and 31 Electromechanical Meters  
The meter bank already had 9 smart meters installed and in steady-state where the meters have only minimal operational communication. The RF strength level from this day will set the baseline for comparison with other days.
- Day 2, 3: Installation of 31 Additional Smart Meters, Meter Network Discovery, Formation, Optimization  
Completing the installation of smart meters in the 40 meter bank will result in network formation and optimization through day 2 and 3. The RF strength level from the two days will show the relative strength level of a bank of 40 smart meters, including the increased communication immediately following installation as the metering network stabilizes.
- Day 4: Simulated Network Disruption  
The collector (Itron cell router) that the meter bank is connected to will be replaced as part of a collector upgrade and replacement. The RF strength level from this day will show the relative strength level of 40 smart meters auto-reconfiguring the network after a disruption.
- Day 5: Calm (Steady-State) Measurements  
The RF strength level from this day will show the relative strength level of a 40 smart meter bank for an established and steady-state installation.

### 1.4.3 **Meter Inventories**

A bank of forty meters was present in the immediate test area. The meter inventories are listed below.

| Badge # | Meter Type | Note            |
|---------|------------|-----------------|
| 4180293 | P263       | Existing        |
| 4180269 | P263       | Existing        |
| 4180268 | P263       | Existing        |
| 4180267 | P263       | Existing        |
| 4180270 | P263       | Existing        |
| 4180908 | P263       | Existing        |
| 4180909 | P263       | Existing        |
| 4180907 | P263       | Existing        |
| 4180910 | P263       | Existing        |
| 4675212 | P263       | Installed 01/24 |
| 4675213 | P263       | Installed 01/24 |
| 4675211 | P263       | Installed 01/24 |
| 4675210 | P263       | Installed 01/24 |
| 4675120 | P263       | Installed 01/24 |

| Badge # | Meter Type | Note            |
|---------|------------|-----------------|
| 4675143 | P263       | Installed 01/24 |
| 4675168 | P263       | Installed 01/24 |
| 4675167 | P263       | Installed 01/24 |
| 4675169 | P263       | Installed 01/24 |
| 4675166 | P263       | Installed 01/24 |
| 4675190 | P263       | Installed 01/24 |
| 4675191 | P263       | Installed 01/24 |
| 4675117 | P263       | Installed 01/24 |
| 4675114 | P263       | Installed 01/24 |
| 4675192 | P263       | Installed 01/24 |
| 4675186 | P263       | Installed 01/24 |
| 4675187 | P263       | Installed 01/24 |
| 4675189 | P263       | Installed 01/24 |
| 4675188 | P263       | Installed 01/24 |

|         |      |                 |         |      |                 |
|---------|------|-----------------|---------|------|-----------------|
| 4675119 | P263 | Installed 01/24 | 4675207 | P263 | Installed 01/24 |
| 4675121 | P263 | Installed 01/24 | 4675206 | P263 | Installed 01/24 |
| 4675118 | P263 | Installed 01/24 | 4675208 | P263 | Installed 01/24 |
| 4675144 | P263 | Installed 01/24 | 4675209 | P263 | Installed 01/24 |
| 4675142 | P263 | Installed 01/24 | 4675116 | P263 | Installed 01/24 |
| 4675145 | P263 | Installed 01/24 | 4675193 | P263 | Installed 01/24 |

## 1.5 Review of Findings, Conclusions and Remedial Actions

Planetworks conducted compliance testing to Health Canada Safety Code 6 for a bank of forty smart meters in a single meter room located of a multiple dwelling residential complex.

### 1.5.1 Summary

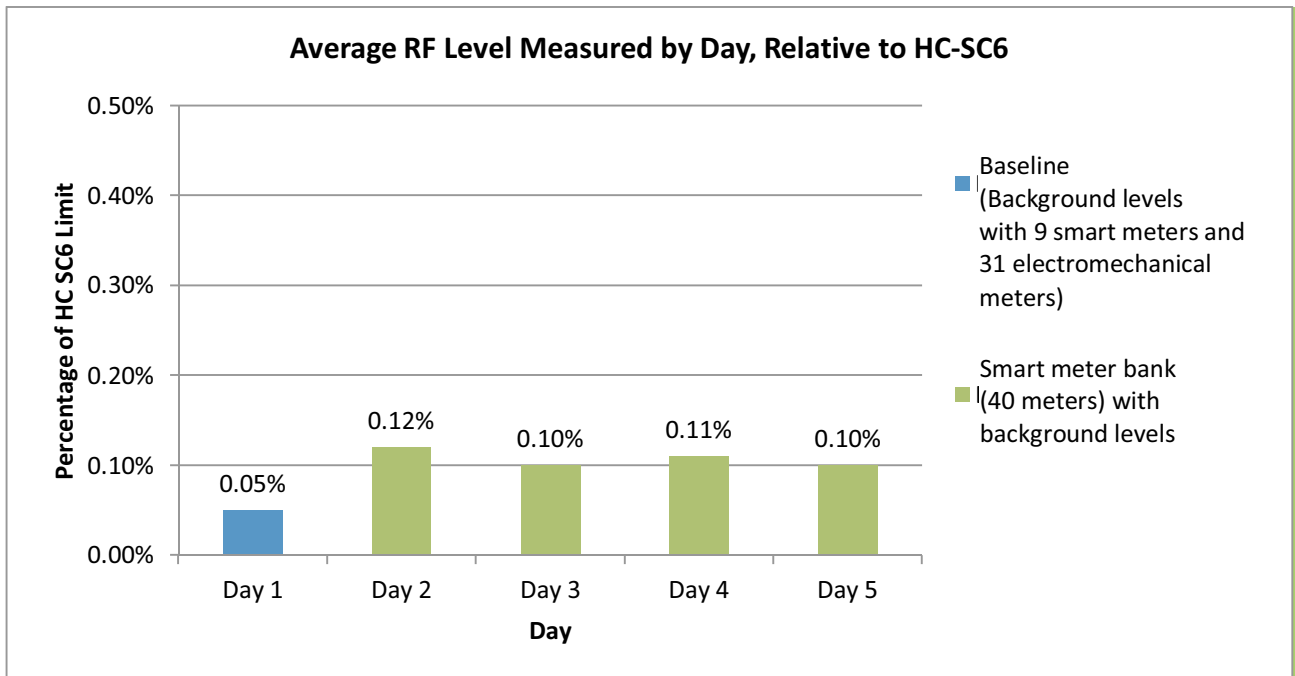
Testing showed that in close proximity (20 centimeter) to a bank of forty meters, the average RF emissions from the meters are more than 900 times less than Health Canada limits for the general public in uncontrolled environments. The combined effect of the meter bank under test, other meters in the area, and all background emissions from other internal (e.g. fluorescent lighting) and external sources (e.g. cell sites), resulted in an average level of 0.1083% of the Health Canada Safety Code 6 (HC SC-6) in an uncontrolled environment standard (i.e.  $1/900^{\text{th}}$  of the limit). It is interesting to note that the above value is far lower than the RF strength level from the 10 meter bank report (dated October 11, 2011), which had an average RF strength level of 0.4507%. This observation can be attributed to the lower background RF in the field compared to a BC Hydro facility operating with industrial equipment.

Background measurements were also taken at the same site location prior to the majority of Itron meters being installed. The measured average across the time period was 0.0474% of the HC SC-6 limit for the general public in uncontrolled environments. While one cannot draw a full correlation between the tests conducted before and after meter installation as they occurred over different time periods, it is noted that the levels increased slightly with the increase in the number of meters installed to 0.1083% of HC SC-6 for uncontrolled environments.

The Narda field strength probe uses a frequency shaped head which measures RF emission limits at different frequencies and presents a cumulative total of all emissions as a percentage of Safety Code 6. While this approach provides a very accurate assessment of percentage of Safety Code 6 limit, it is not possible to accurately convert this into a power density value at a single frequency due to the presence of the background RF sources. However, if it is assumed that *all* measured emissions originated around 900 MHz, then the four day attained 40 smart meter average value of 0.1083% can be converted to a power density of  $0.65 \mu\text{W}/\text{cm}^2$  (0.65 microwatts per square centimeter).

NOTE: At this time, the Narda unit represents the most accurate broadband, cumulative field metering solution available for RF exposure limit measurements in operational environments. The average emissions measured are below a field-strength of 4.340 V/m, which is the lower limit rating of the Narda unit. At measurements below this level, the accuracy of the results may not be within the tolerance specified in the meter calibration certificate (Section 6) and the results obtained may also include internal noise generated by the Narda meter. It is therefore likely that the emissions from the Itron smart meters are actually lower than those measured in this report.

The average RF level measured by day relative to Safety Code 6 is shown in the following chart:

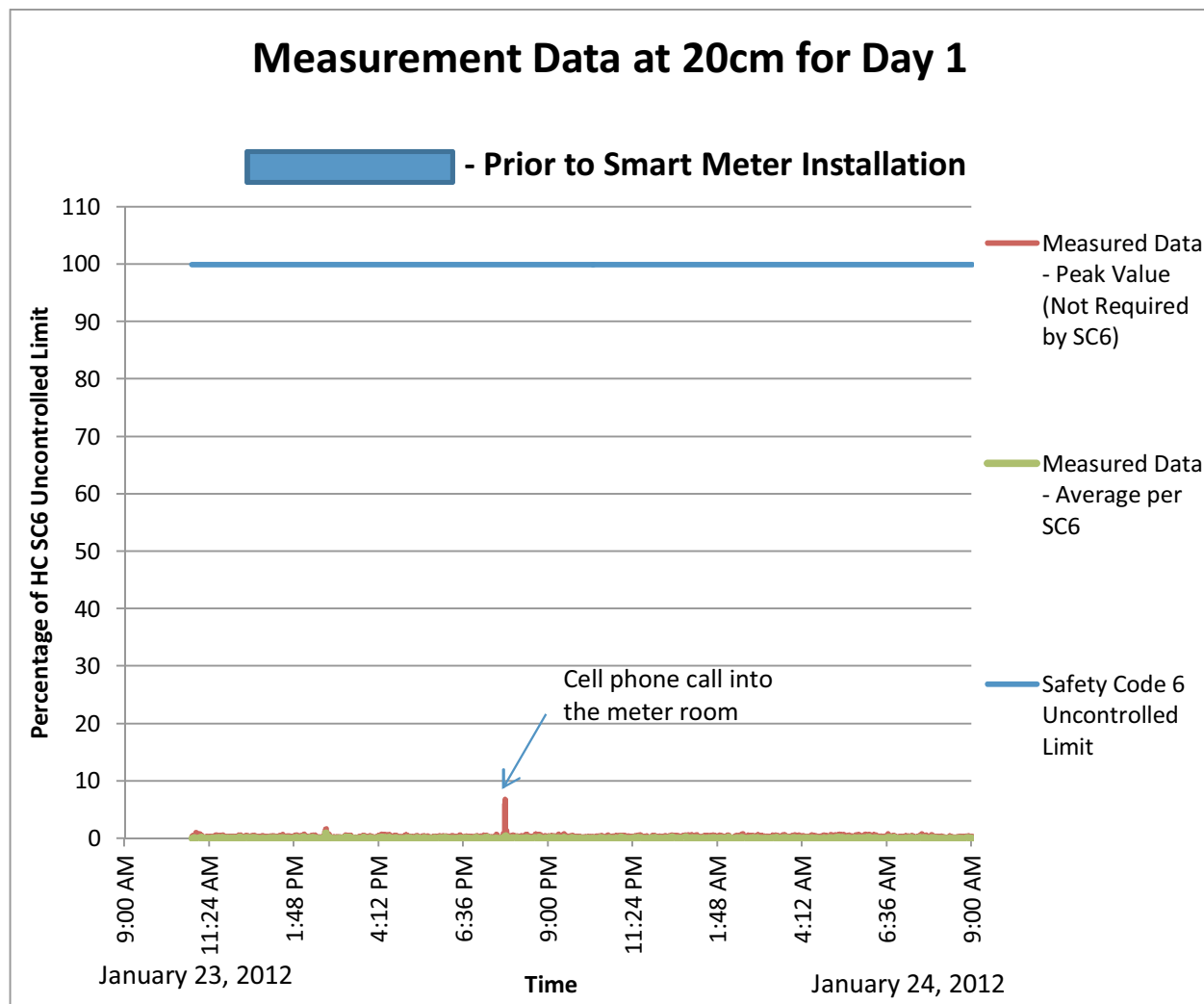


The range of power densities measured over the 113.5 hour (Day 1-5) period was 0.005% to 0.9285% of Safety Code 6 limits for public areas (uncontrolled environment). Over 99% of the time the measured value is less than 50% of the maximum peak measured (ie. 0.4643%). In other words, less than half a percentage point. It should be noted that a common laundry room is immediately adjacent to the meter room and the active motors used by washers and dryers can contribute to the radio frequency strength level in the lower frequency band detectable by Narda Field Meter. Further, residents' cell phone and WiFi transmissions may also be included in the measurements.

### 1.5.3 Detailed Results – Day 1, Baseline Level with 9 Smart Meters and 31 Electromechanical Meters

The graph below illustrates the measured RF strength level from the 40 meter bank prior to smart meters being installed for all 40 sockets. The RF strength level measured includes both the 6 minute averaged value as required by Health Canada, as well as peaks levels, over the 22 hour measurement period on Day 1. Both of these values are shown in relation to Health Canada Safety Code 6 limit for this frequency band.

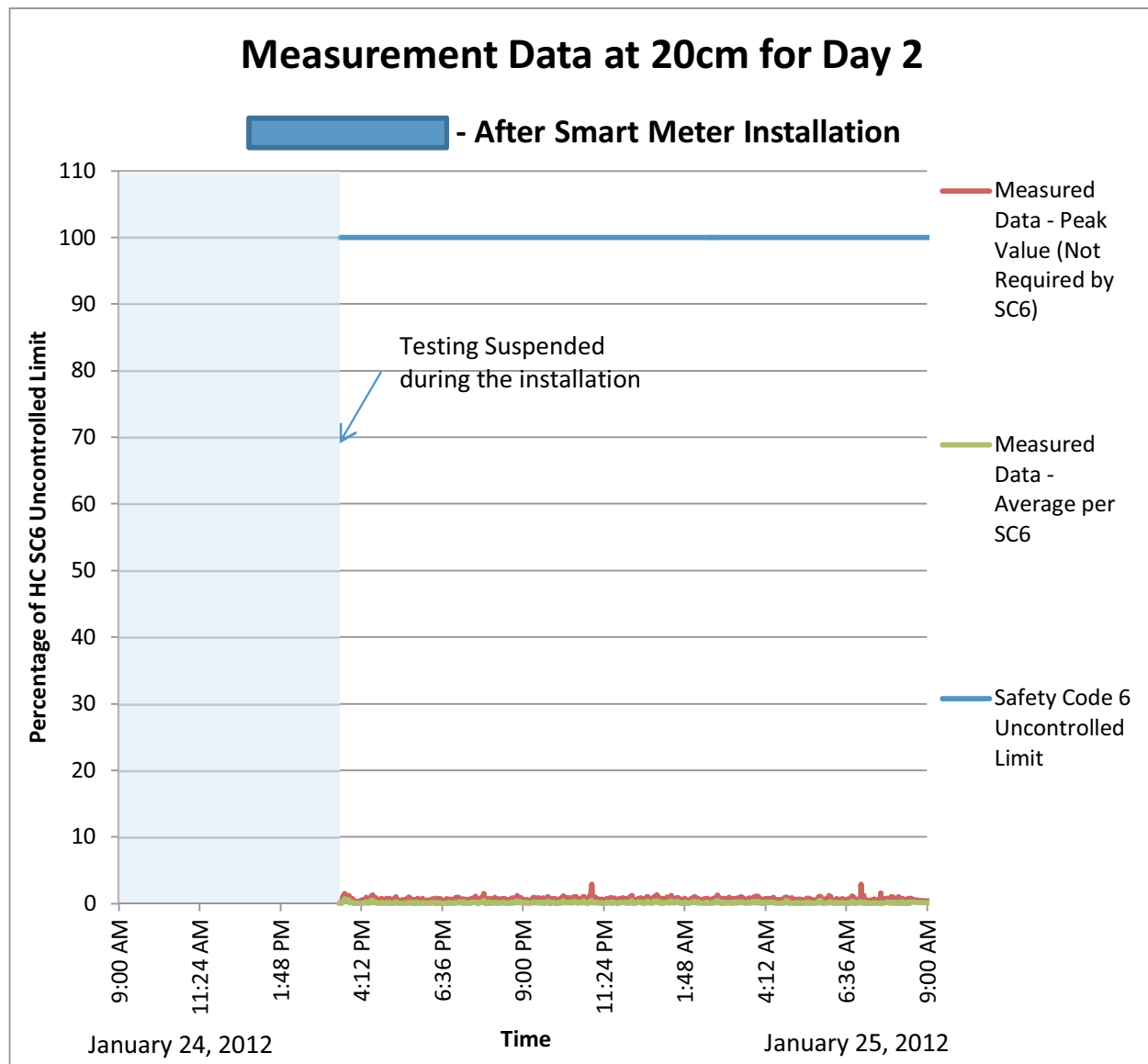
The graph for Day 1 shows that the average levels are near zero and even the instantaneous peaks also around the zero value. Please note at the 7% instantaneous peak is the result of a cell phone call into the meter room.



#### 1.5.4 Detailed Results – Day 2, Installation of 31 Additional Smart Meters going through Meter Network Discovery

The graph below illustrates the measured RF strength level from the 40 meter bank after smart meters were installed for all 40 sockets, which is an addition of 31 smart meters. The RF strength level measured includes both the 6 minute averaged value as required by Health Canada, as well as peaks levels, over the first 17.5 hours of the 89.5 hour total measurement period (Day 2). Both of these values are shown in relation to Health Canada Safety Code 6 limit for this frequency band.

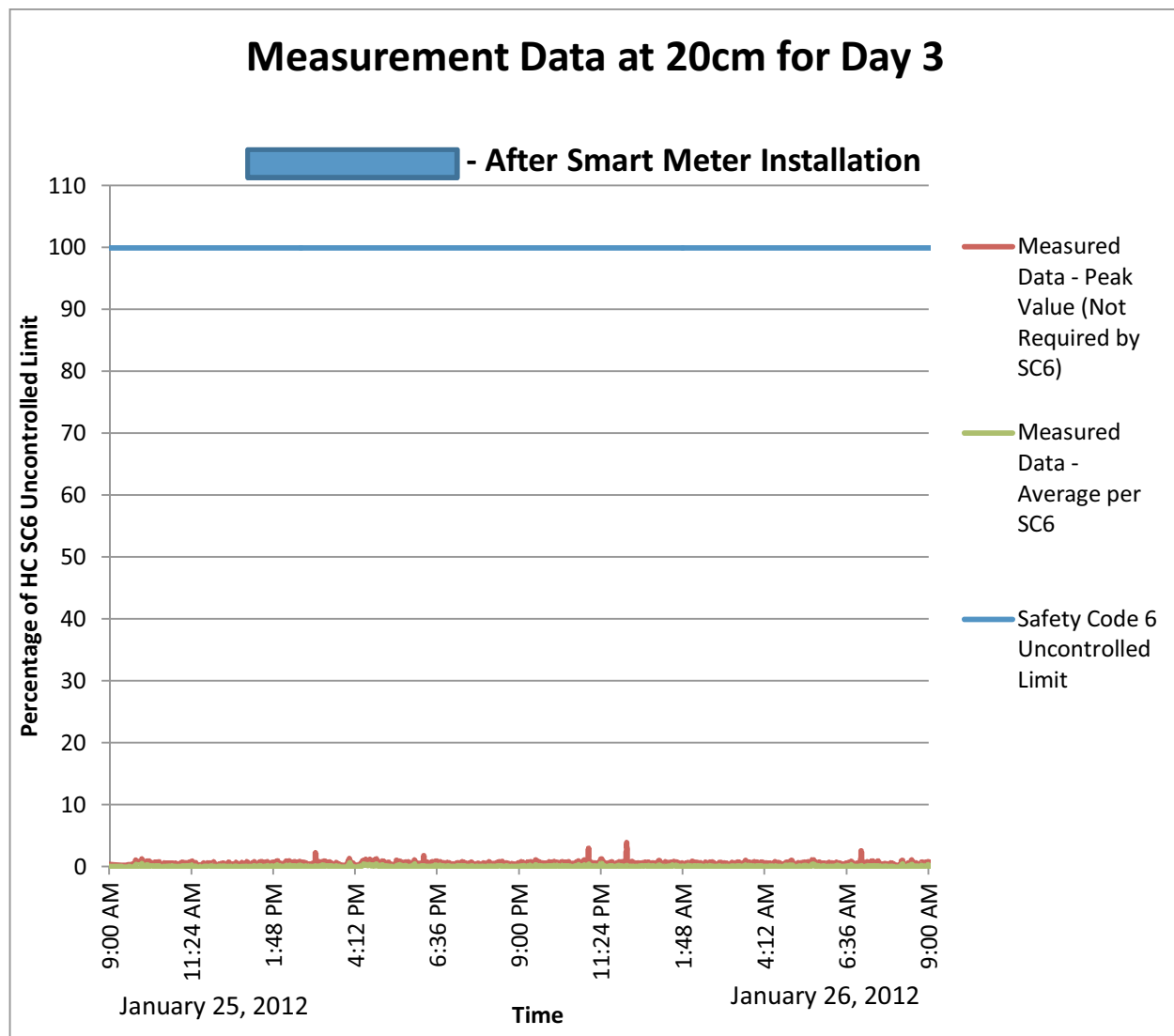
Day 2 focuses on the period right after the installation of new meters, when the data traffic is expected to be higher than steady-state. The RF strength assessment graph below shows that despite the increased traffic, the HC-SC6 specified average levels are still near zero and the peak level increased only slightly.



### 1.5.5 Detailed Results – Day 3, Continue Network Discovery, Formation, and Optimization

The graph below illustrates the measured RF strength level from the 40 meter bank after smart meters are installed for all 40 sockets, which is an addition of 31 smart meters. The RF strength level measured includes both the 6 minute averaged value as required by Health Canada, as well as peaks levels, over the second 24 hours of the 65.5 hour total measurement period. Both of these values are shown in relation to Health Canada Safety Code 6 limit for this frequency band.

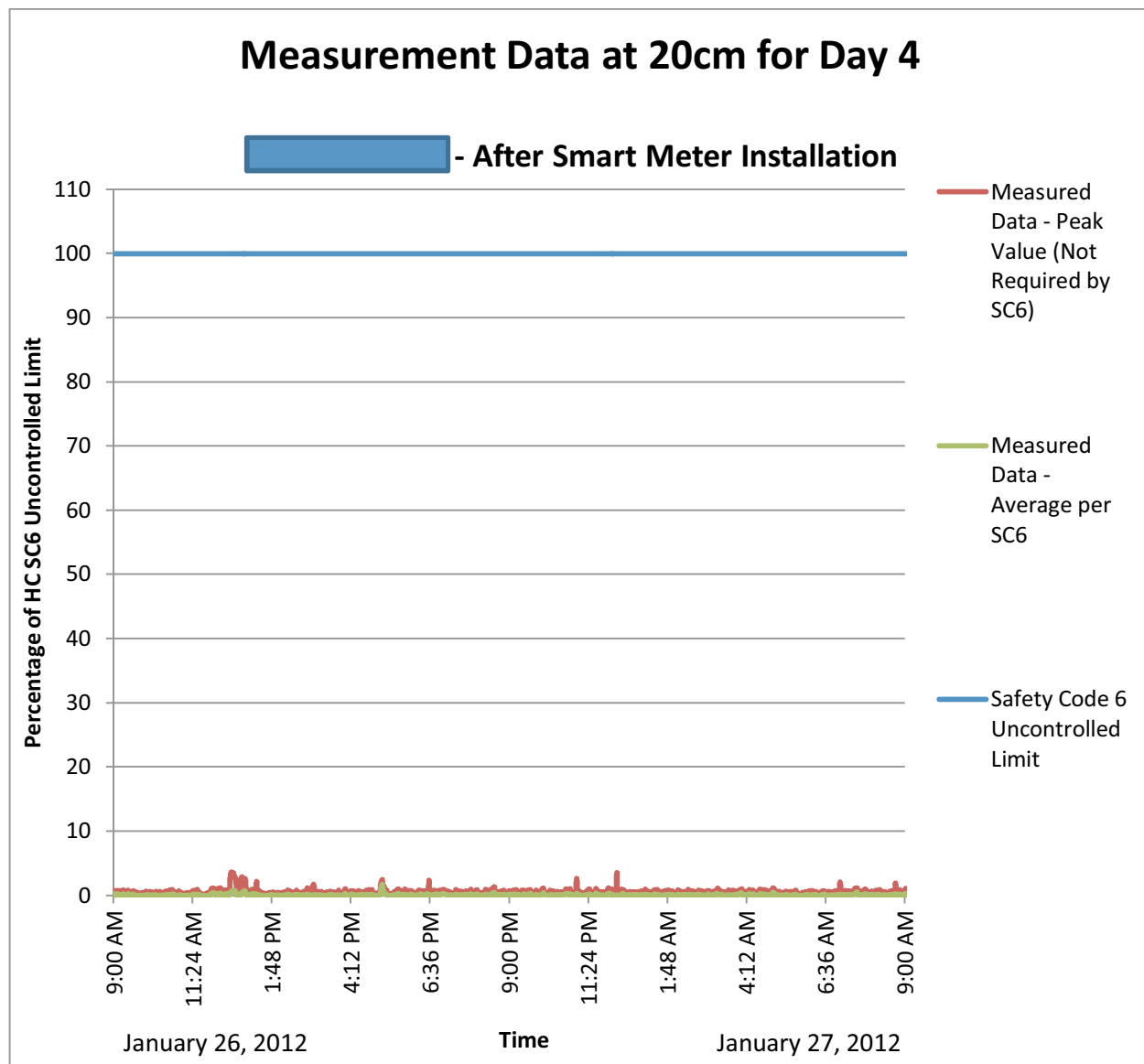
Day 3 starts approximately 9 hours after the installation of 31 additional smart meters. While the data traffic is expected to be higher than steady-state, relative to Day 2 there should be slightly less traffic as meters settle on the optimal communication path. The RF strength assessment graph below shows that despite the increased traffic, the HC-SC6 specified average levels are still near zero and the peak level increased only slightly.



### 1.5.6 Detailed Results – Day 4, Simulated Network Disruption

The graph below illustrates the measured RF strength level from the 40 meter bank after smart meters are installed for all 40 sockets, which is an addition of 31 smart meters. The RF strength level measured includes both the 6 minute averaged value as required by Health Canada, as well as peak levels, over the last 17.5 hours of the 65.5 hour total measurement period. Both of these values are shown in relation to Health Canada Safety Code 6 limit for this frequency band.

Note again that the HC-SC6 specified average levels are near zero and the peak level increased only slightly. At approximately 12 noon on Day 4 a collector (Itron cell router) in the neighbourhood was replaced as part of a collector upgrade and replacement. This simulates the case of a collector failure where the meter reroutes data automatically to other collectors. This event would be uncommon outside of current installation activities. The resulting increase in meter activity can be noted in the measurement data starting at noon.

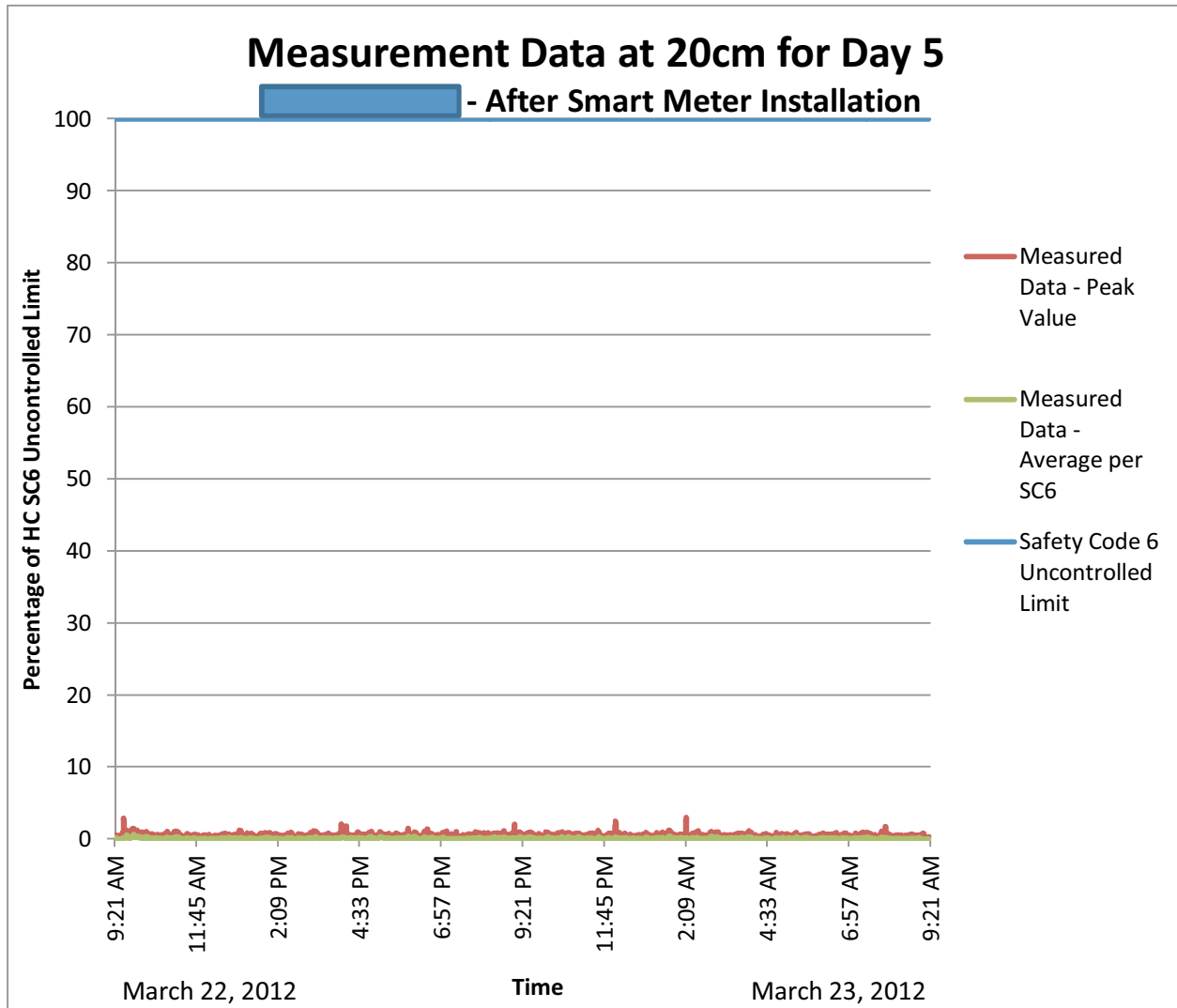




### 1.5.7 Detailed Results – Day 5, Steady State

The graph below illustrates the measured RF strength level from the 40 meter bank after smart meters have been installed for over a month. The RF strength level measured includes both the 6 minute averaged value as required by Health Canada, as well as peaks levels, over the last 24 hours of the 89.5 hour total measurement period. Both of these values are shown in relation to Health Canada Safety Code 6 limit for this frequency band.

Note again that the HC-SC6 specified average levels are near zero and the peak level increased only slightly.



### 1.5.8 Next Steps and Required Remedial Actions

No remedial actions are required.

## 2 Measurement Procedure

### 2.1 Description of Procedure Used

Field measurements used to determine conformity with the limits specified in SC6 are performed with the field sensor (probe) placed at least 20 centimetres away from any object or person with measurements averaged over 6 minutes as per SC6. Measurements were taken on three separate occasions:

| Test Date and Time   | Description of Test  |
|--|--|
| FROM: 2012-01-23 10:54:35<br>TO: 2012-01-24 09:01:00   | Baseline RF Measurements. Nine Itron electrical meters are present in test environment.  |
| FROM: 2012-01-24 15:31:21<br>TO: 2012-01-27 09:09:54<br>FROM: 2012-03-22 09:17:09<br>TO: 2012-03-23 09:18:11 | RF measurements taken immediately after the installation of thirty-one Itron electrical meters. All meters were attempting to synchronize with their mesh network. |

The aforementioned measurements were taken 20 cm from the meter bank over the specified period. The probe was located in a position to receive maximum emissions from the smart meter bank (i.e. at an elevation of approximately 1.8m and centered in the meter bank), as shown in Section 3.

The spatially averaged values are calculated based on the root-mean-square (RMS) average of the electric and magnetic field strengths of the samples.

RF Field strengths measured included all active transmitters (meter bank under test as well as any other RF emitting devices found in the vicinity) at the time of testing.

In addition to the tests conducted with the Narda meter, an analysis of the RF signals present in the vicinity of the meter room was undertaken. The results of this analysis are shown in Annex A.

## 2.2 Test Equipment Description

|       |               |                  |                             |
|-------|---------------|------------------|-----------------------------|
| Meter | Narda NBM-550 | Serial #: B-0670 | Calibration due: 2013-04-21 |
| Probe | Narda EC5091  | Serial #: 01009  | Calibration due: 2013-04-25 |

The following list of parameters was downloaded from the meter and was used as the basis of the testing:

|                                  |                    |
|----------------------------------|--------------------|
| Device Product Name              | NBM-550            |
| Device Serial Number             | B-0670             |
| Device Cal Due Date              | 21/04/2013         |
| Probe Product Name               | EC5091             |
| Probe Serial Number              | 01009              |
| Probe Cal Due Date               | 25/04/2013         |
| Probe Field Type                 | E                  |
| Probe Connection Type            | C                  |
| Probe Lower Frequency Limit A    | 300 kHz            |
| Probe Upper Frequency Limit A    | 50 GHz             |
| Probe Lower Frequency Limit B    | 300 kHz            |
| Probe Upper Frequency Limit B    | 50 GHz             |
| Probe Emin A                     | 4.340 V/m          |
| Probe Emax A                     | 150.0 V/m          |
| Probe Emin B                     | 4.340 V/m          |
| Probe Emax B                     | 150.0 V/m          |
| Shaped Probe                     | YES                |
| Standard ID                      | 5                  |
| Standard Name                    | Canada,occ         |
| Apply Standard                   | ON                 |
| Frequency                        | 2.1325 GHz         |
| Apply Correction Frequency       | OFF                |
| Eref_E(f)                        | 137.0 V/m          |
| Eref_H(f)                        | 137.2 V/m          |
| Combi Probe Use                  | E                  |
| Unit                             | mW/cm <sup>2</sup> |
| Results Format                   | FIXED              |
| Auto-Zero Interval               | 6 min              |
| Result Type                      | -                  |
| Averaging Time                   | -                  |
| Average Progress                 | -                  |
| Spatial AVG Mode                 | -                  |
| Store Condition                  | -                  |
| Storing Range                    | -                  |
| Cond. Stop Time                  | -                  |
| Upper Threshold                  | -                  |
| Lower Threshold                  | -                  |
| Timer Interval                   | 60 sec             |
| Timer Duration                   | 99:00:00           |
| History Time Scale               | -                  |
| Time progress of current segment | -                  |

### 3 Photograph



**Image 1. Test setup depicting the elevation of test meter with respect to Itron electrical meters. The test meter is centered within the bank at an approximate elevation of 1.8m.**

#### 4 Traffic Confirmation – Forty Meters Under Test

To confirm that all meters were active and transmitting during the test period, an external packet sniffer was used to verify traffic levels. The following two results files show the traffic for the forty meters under test for the four day test period (Days 2 through 5).

Note that this information only shows how often the meter is active during the recording period, and the relative amount of information transmitted during each broadcast (i.e. number of packets). These graphs are **not** an indicator of the transmitter power output.

##### Conditions of Test (Day 1, Baseline Level with 9 Smart Meters and 31 Electromechanical Meters)

MAC Addresses = 7832534,7832593,7832543,7832670,7832582,7837913,7839663,7841739,7839677

Beginning of Packet Sniffer Data = 01/23/2012 9:00:00 AM

Interrogations:

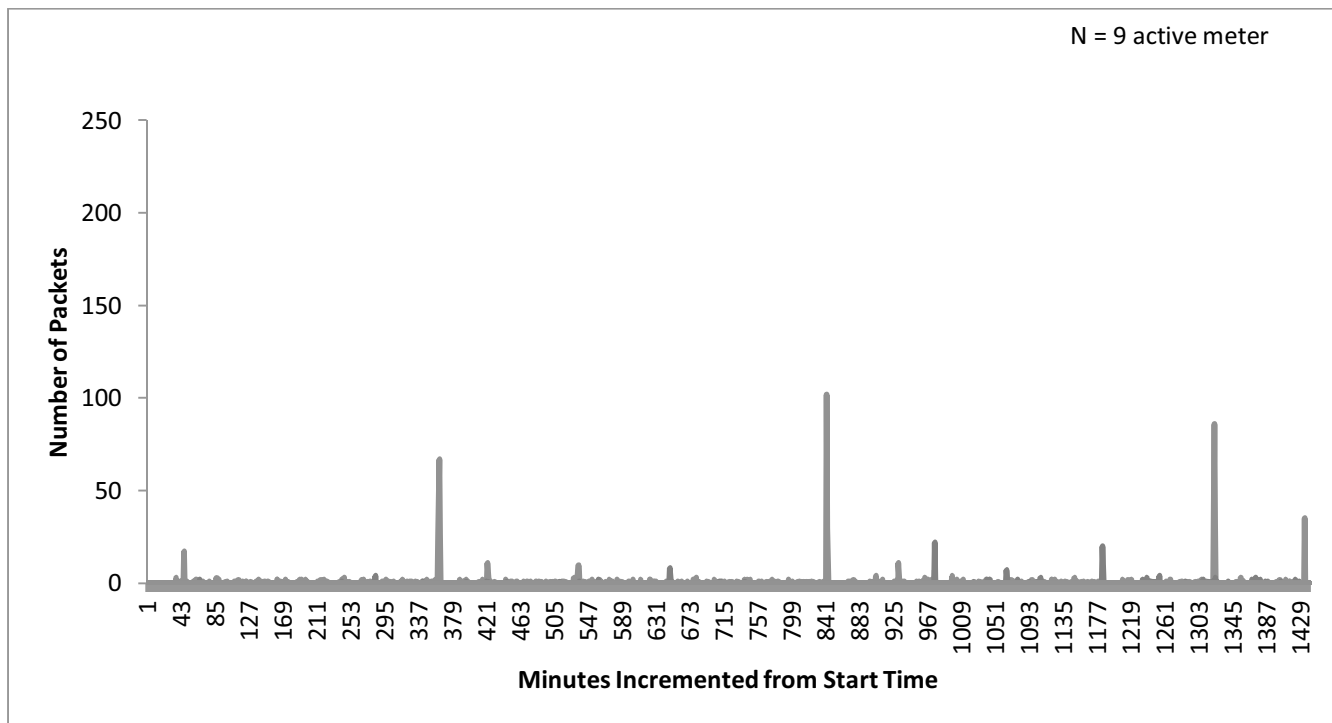
01/23/2012 03:01:00 PM

01/23/2012 11:02:00 PM

01/24/2012 07:02:00 AM

Ending of Packet Sniffer Data = 01/24/2012 9:00:00 AM

##### Packets Per Minute Starting at 01/23/2012 09:00:00 AM



\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

##### Data Transmission Information

Actual Bytes Transferred = 154,280 bytes (154kb)

**Total Transmission Time = 16.2043 Seconds**

**Conditions of Test (Day 2, Installation of 31 Additional Smart Meters going through Meter Network Discovery)**

MAC Addresses =

9587399,9441613,9587400,9587382,9587080,9441695,9441683,9441694,9587371,9587312,9587323,9587394,9596529,9441622,9587904,9441649,9441641,9587059,9587358,9587294,9587362,9587392,9587379,9587401,9441612,9587389,9587378,9587317,9441615,9441696,9587318,7832534,7832593,7832543,7832670,7832582,7837913,7839663,7841739,7839677

Beginning of Packet Sniffer Data = 01/24/2012 9:00:00 AM

Interrogations:

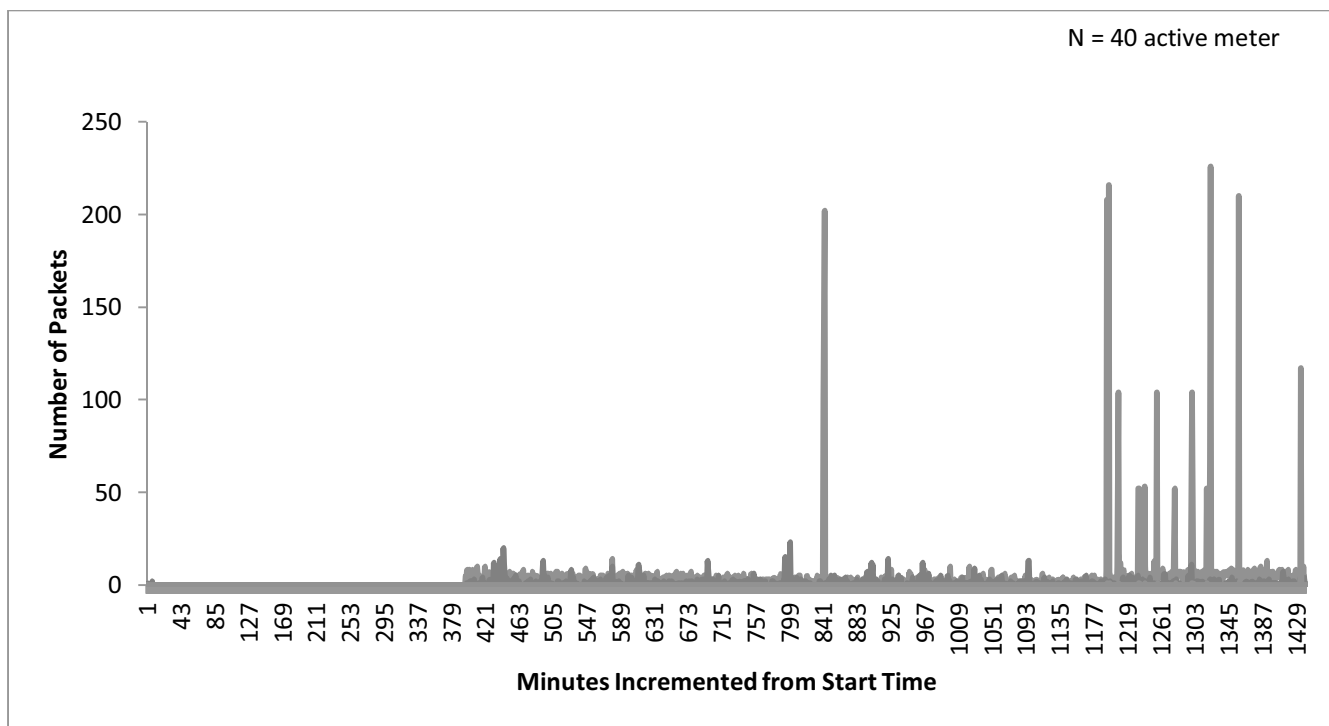
01/24/2012 03:01:00 PM

01/24/2012 11:02:00 PM

01/25/2012 07:02:00 AM

Ending of Packet Sniffer Data = 01/25/2012 9:00:00 AM

**Packets Per Minute Starting at 01/24/2012 09:00:00 AM**



\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

**Data Transmission Information**

Actual Bytes Transferred = 432,170 bytes (432kb)

**Total Transmission Time = 45.389 Seconds**

**Conditions of Test (Day 3, Continue Network Discovery, Formation, and Optimization)**

MAC Addresses =

9587399,9441613,9587400,9587382,9587080,9441695,9441683,9441694,9587371,9587312,9587323,9587394,9596529,9441622,9587904,9441649,9441641,9587059,9587358,9587294,9587362,9587392,9587379,9587401,9441612,9587389,9587378,9587317,9441615,9441696,9587318,7832534,7832593,7832543,7832670,7832582,7837913,7839663,7841739,7839677

Beginning of Packet Sniffer Data = 01/25/2012 9:00:00 AM

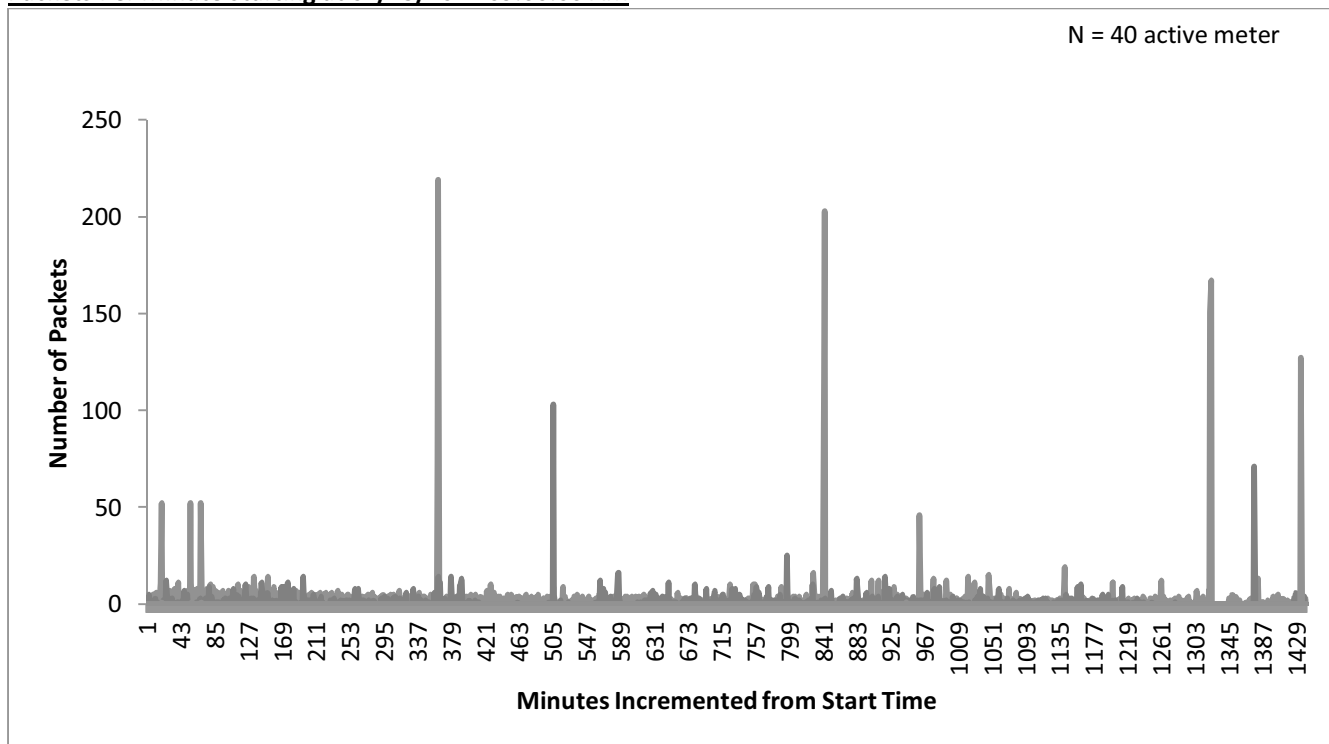
Interrogations:

01/25/2012 03:01:00 PM

01/25/2012 11:02:00 PM

01/26/2012 07:02:00 AM

Ending of Packet Sniffer Data = 01/26/2012 9:00:00 AM

**Packets Per Minute Starting at 01/25/2012 09:00:00 AM**

\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

**Data Transmission Information**

Actual Bytes Transferred = 632,971 bytes (633kb)

**Total Transmission Time = 66.479 Seconds**

**Conditions of Test (Day 4, Simulated Network Disruption)**

MAC Addresses =

9587399,9441613,9587400,9587382,9587080,9441695,9441683,9441694,9587371,9587312,9587323,9587394,9596529,9441622,9587904,9441649,9441641,9587059,9587358,9587294,9587362,9587392,9587379,9587401,9441612,9587389,9587378,9587317,9441615,9441696,9587318,7832534,7832593,7832543,7832670,7832582,7837913,7839663,7841739,7839677

Beginning of Packet Sniffer Data = 01/26/2012 9:00:00 AM

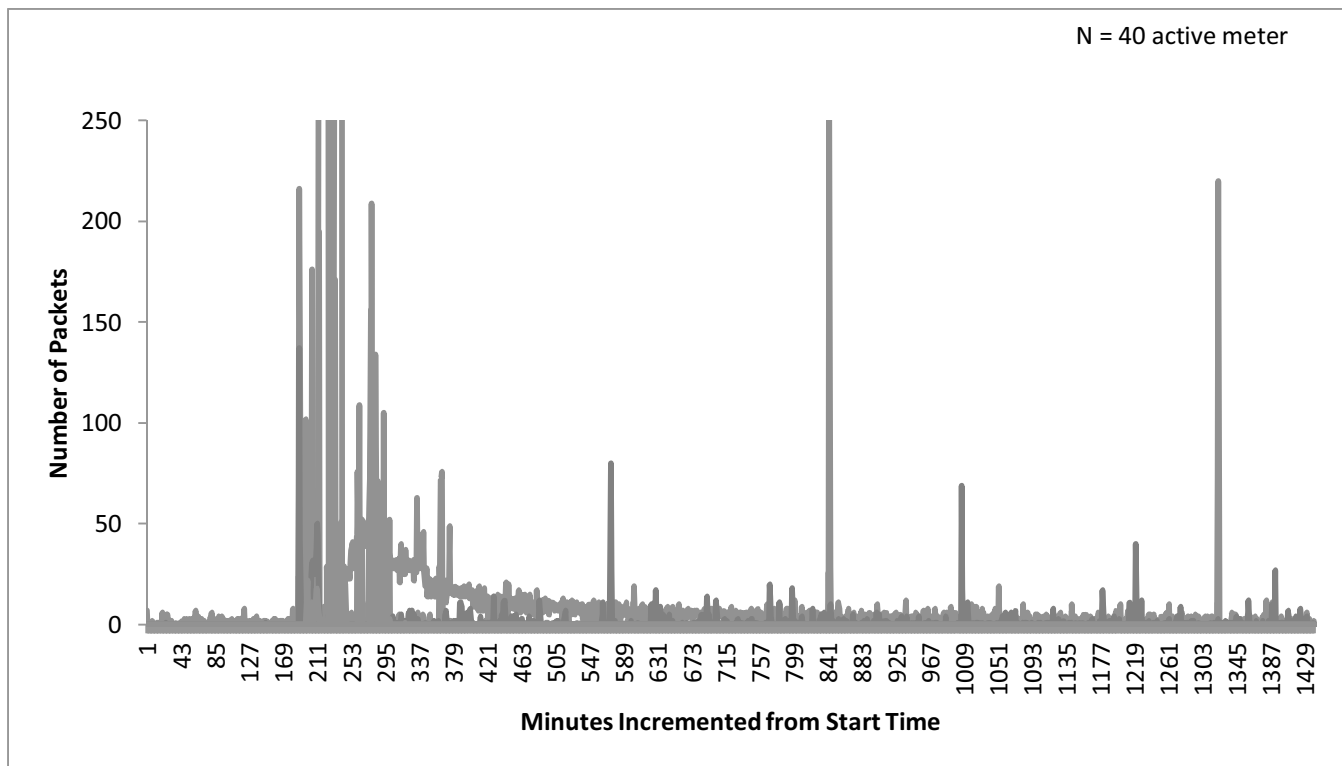
Interrogations:

01/26/2012 03:01:00 PM

01/26/2012 11:02:00 PM

01/27/2012 07:02:00 AM

Ending of Packet Sniffer Data = 01/27/2012 9:00:00 AM

**Packets Per Minute Starting at 01/26/2012 09:00:00 AM**

\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates) except for the main peak that occurred near noon. This traffic increase at 195 minutes to 275 minutes is the result of a Collector (Itron cell router) upgrade and replacement as noted previously. This demonstrates the self-healing communication network reforming when there is a Collector failure. This is an infrequent, non-typical event.

**Data Transmission Information**

Actual Bytes Transferred = 1,278,576 bytes (1.278Mb)

**Total Transmission Time = 134.2842 Seconds (2.238 minutes)**



**Conditions of Test (Day 5, Steady-State)****MAC Addresses =**

9587399,9441613,9587400,9587382,9587080,9441695,9441683,9441694,9587371,9587312,9587323,9587394,9596529,9441622,9587904,9441649,9441641,9587059,9587358,9587294,9587362,9587392,9587379,9587401,9441612,9587389,9587378,9587317,9441615,9441696,9587318,7832534,7832593,7832543,7832670,7832582,7837913,7839663,7841739,7839677

Beginning of Packet Sniffer Data = 3/22/2012 9:17:28 AM

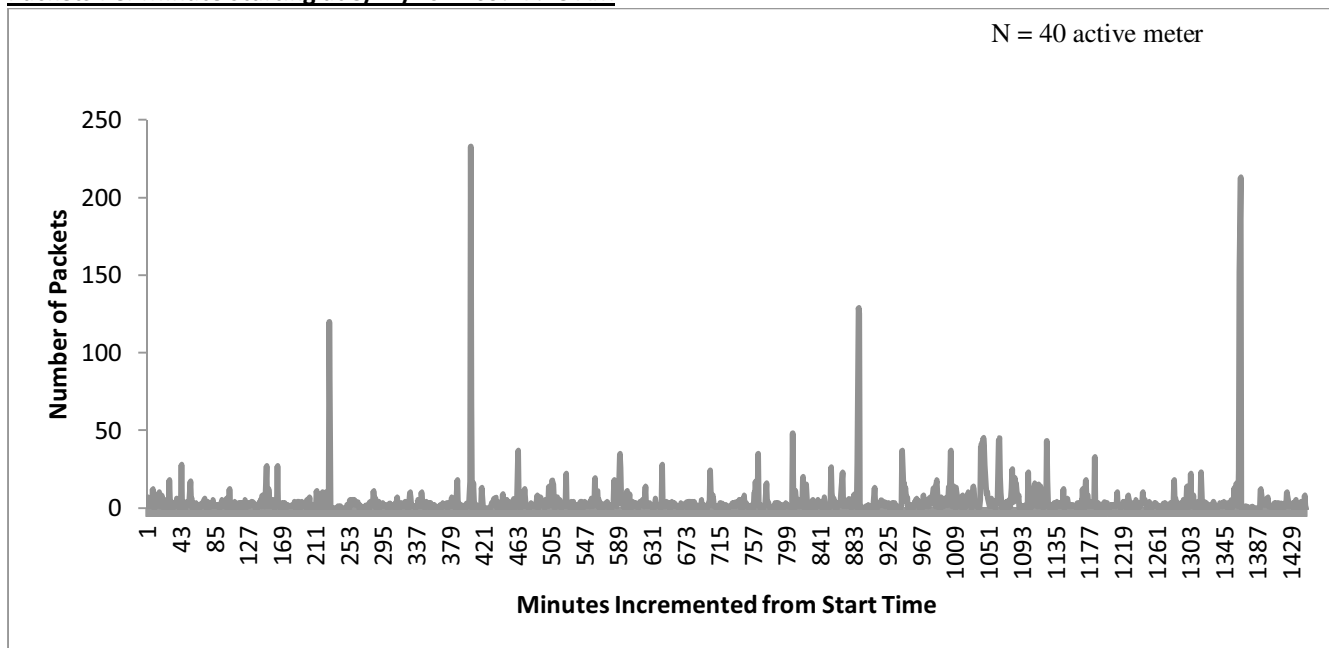
**Interrogations:**

3/22/2012 4:01:28 PM

3/23/2012 12:05:23 AM

3/23/2012 8:02:01 AM

Ending of Sniffer Data = 3/23/2012 9:24:27 AM

**Packets Per Minute Starting at 3/22/2012 09:17:28 AM**

\* Transmissions with 2 or more data packets are associated with consumption data transmission or time synchronization (time updates)

**Data Transmission Information**

Actual Bytes Transferred = 844,540 bytes (844kb)

**Total Transmission Time = 88.69 Seconds (1.478 minutes)**

## 5 NBM-550 Calibration Certificate

Narda Safety Test Solutions GmbH  
Sandwiesenstrasse 7 - 72793 Pflingen - Germany  
Phone: +49 7121 9732 0 - Fax: +49 7121 9732 790



# Calibration Certificate

Narda Safety Test Solutions hereby certifies that the object referenced to this certificate has been calibrated by qualified personnel using Narda's approved procedures. The calibration was carried out in accordance with a certified quality management system which conformed to ISO 9001.

|                       |   |
|-----------------------|---|
| OBJECT                | Broadband Field Meter<br>NBM-550                            |
| MANUFACTURER          | Narda Safety Test Solutions GmbH                            |
| PART NUMBER (P/N)     | 2401/01B  |
| SERIAL NUMBER (S/N)   | D-0146  |
| CUSTOMER              |   |
| CALIBRATION DATE      | 2011-01-28  |
| RESULT ASSESSMENT     | within specifications                                       |
| AMBIENT CONDITIONS    | Temperature: (23 ± 3) °C<br>Relative humidity: (20 to 60) % |
| CALIBRATION PROCEDURE | 2401-8700-00A   |

ISSUE DATE: 2011-01-28

  
CALIBRATED BY  
E. Rilling

  
AUTHORIZED SIGNATORY

This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates without signature are not valid.

MANAGEMENT  
SYSTEM



Certified by DQS according  
to ISO 9001:2008  
(Reg.-No. 099379 QM08)

CERTIFICATE: NBM-550-D-0146-110128-1816

PAGE 1 OF 3

**Narda Safety Test Solutions GmbH**  
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## Method of Measurement

The device under test (DUT) represents a three-channel voltage meter offering high accuracy and high resolution. The DUT is calibrated by applying a known DC voltage to each of the inputs.

## Uncertainty of Measurement

The measurement uncertainty stated in this document is the expanded uncertainty with a coverage factor of 2 (corresponding, in the case of normal distribution, to a confidence probability of 95 %).

The uncertainty analysis for this calibration was done in accordance with the ISO/TAG-Guide (Guide to the expression of uncertainty in measurement). The measurement uncertainties are derived from contributions from the measurement of power, reflection, attenuation and frequency, mismatch, stability of instrumentation and repeatability of handling.

This statement of uncertainty applies to the measured values only and does not include effects like temperature response and long term stability of the calibrated device.

## Traceability of Measuring Equipment

The calibration results are traceable to SI-units according to ISO/IEC 17025. Physical units, which are not included in the list of accredited measured quantities such as field strength or power density, are traced to the basic units via approved measurement and computational methods.

The equipment used for this calibration is traceable to the reference listed below and the traceability is guaranteed by ISO 9001 Narda internal procedure.

| Reference- /<br>Working- Standard | Manufacturer | Model  | Serial Number | Certificate Number | Cal Due<br>Date | Trace   |
|-----------------------------------|--------------|--------|---------------|--------------------|-----------------|---------|
| Digital Multimeter                | Agilent      | 34401A | US36121450    | 1-1960925007-1     | 2011-01         | UKAS147 |

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## Results

### Voltage display uncertainty

| Channel | Input voltage applied | Specified voltage display | Meas. Uncertainty | Meas. voltage display |
|---------|-----------------------|---------------------------|-------------------|-----------------------|
| X       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.370 V               |
| Y       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.370 V               |
| Z       | 2.400 V               | (2.376 $\pm$ 0.024) V     | $\pm$ 0.007 V     | 2.370 V               |

Note: Because of an internal voltage divider the nominal indication is 2.376 V.

6 **EC5091 Calibration Certificate**

**Narda Safety Test Solutions**  
 435 Moreland Road, Hauppauge, NY 11788  
 Phone: 631-231-1700 · Fax: 631-231-1711  
 E-mail: nardaeast@L-3com.com  
 www.nardamicrowave.com



## Calibration Certificate

Narda Safety Test Solutions hereby certifies that the referenced equipment has been calibrated by qualified personnel to Narda's approved procedures. The calibration was carried out within a certified quality management system conforming to ISO 9001:2000.

The metrological confirmation system for test equipment complies with ISO 10012-1.

|                                     |  |
|-------------------------------------|--|
| Object                              | Electric Field Probe EC5091                  |
| Part Number (P/N)                   | 2402/09                                      |
| Serial Number (S/N)                 | 01025  |
| Manufacturer                        | Narda Safety Test Solutions                  |
| Date of Calibration                 | Mon 06/Dec/2010 13:39:20                     |
| Results of Calibration              | Test Results within Specification            |
| Confirmation interval (recommended) | 24 Months                                    |
| Ambient Conditions                  | (23 $\pm$ 1.3)°C<br>(40...60)% rel. humidity |
| Calibration Procedure               | ATE Software 990199 Ver. 1.50                |
| Probe Definition File Set           | P/N 990199-06 Ver. 1.04                      |
| Results Filed Under                 | EC5091_01025_06Dec2010.txt                   |

Hauppauge, NY

  
 \_\_\_\_\_  
 Calibrated by



\_\_\_\_\_  
 Quality Assurance

This certificate may only be published in full, unless permission for the publication of an approved extract has been obtained in writing from the Director of Quality Assurance.

Certificate No. 01025\_06Dec2010.txt

Date of issue: 06/Dec/2010

Page 1 of 6

**Narda Safety Test Solutions**  
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 E-mail: nardaeast@i-3com.com  
 www.nardamicrowave.com



## Method of Measurement

The calibration of RF field strength probes involves the generation of a calculable linearly polarized electromagnetic field - approximating to a plane wave - into which the device under test is placed. The probe is calibrated separately from the base meter.

The probe is aligned for maximum interception of the field, i.e. the probe's pole is orientated in the analytic angle (54.74 degrees to vertical E-field vector) above 200 MHz. Below 200 MHz the probe handle is oriented perpendicular to both, the direction of propagation and the direction of the E-field vector. The meter indicates the results in %STD units, i.e. the power related ratio of the field and the reference level (MPE = maximum permissible exposure limit) from the Standard. At each test frequency the probe is rotated by 360 deg while taking readings continuously. The results are calculated from the minimum and maximum response during rotation.

$$\%STD_{mean} = \sqrt{\%STD_{min} * \%STD_{max}}$$

$$EllipseRatio = 5 * \lg \left( \frac{\%STD_{max}}{\%STD_{min}} \right)$$

### Frequency Response:

The correction factor  $K$  is a numerical factor to compensate the systematic error due to frequency response.

$$K = \sqrt{\%STD_{actual} / \%STD_{mean}}$$

The correction factors are stored in the probe memory. When combined with the NBM-5xx Field Meter the frequency response correction may be enabled.

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 www.nardamicrowave.com



## Field Generation

### Setup "A" (1600 MHz ...):

Calibration using calculated field strength. The probe is positioned with the boresight of a linearly polarized horn antenna. The field strength is derived from the horn's gain  $g$ , the transmitted power of the antenna and the distance  $d$ . The power measurement includes the power meter's response  $P_m * F_m$  and a fixed attenuation  $D$ .

$$E = \sqrt{\eta * \frac{P_m * F_m * D * g}{4 * \pi * d^2}}$$

with  $\eta$  : intrinsic impedance of propagation medium in Ohms.

Reference: IEEE Std. 1309-1996

### Setup "B" (200 MHz ... 1600 MHz):

Calibration using a transfer standard. The probe is mounted in front of a double balanced ridge horn antenna. The field strength is set to a known value based on the power meter reading  $P_m$  in reference to a calibrated sensor ( $E_{ref}$ ,  $P_{ref}$ ).

$$E = E_{ref} * \sqrt{\frac{P_m}{P_{ref}}}$$

### Setup "C" (... 200 MHz):

Calibration using calculated field strength. A Crawford TEM cell is used to generate the known field strength  $E$ . The field strength is derived from TEM cell's septum height  $b$ , impedance  $Z_0$  and from the output power  $P_{ref}$  of the cell. The output power measurement includes the power meter's response  $P_m * F_m$  and a fixed attenuation  $D$ .

$$E = \frac{\sqrt{P_m * F_m * D * Z_0}}{b}$$

## Uncertainties

The measurement uncertainty stated in this document is the expanded uncertainty with a coverage factor of 1.96 (corresponding, in the case of normal distribution, to a confidence probability of 95%).

The uncertainty analysis for this calibration was done in accordance with the ISO-Guide (Guide to the expression of Uncertainty in Measurement). The measurement uncertainties are derived from contributions from the measurement of power, impedance, attenuation, mismatch, length, frequency, stability of instrumentation, repeatability of handling and field uniformity in the field generators (TEM cell and anechoic chamber).

This statement of uncertainty applies to the measured values only and does not make any implementation or include any estimation as to the long-term stability of the calibrated device.

**Narda Safety Test Solutions**

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E-mail: [nardaeast@i-3com.com](mailto:nardaeast@i-3com.com)[www.nardamicrowave.com](http://www.nardamicrowave.com)**Test Equipment and Traceability**

The calibration results are traceable to SI-units according to ISO 9001. Physical units, which are not included in the list of accredited measured quantities such as field strength or power density, are traced to the basic units via approved measurement and computational methods.

The equipment used for this calibration is traceable to the reference listed below and the traceability is guaranteed by ISO 9001 Narda internal procedure.

| Reference- / Working- Standard          | Manufacturer | Model        | Asset Number | Certificate Number | Cal Due Date | Trace (*) |
|---|--------------|--------------|--------------|--------------------|--------------|-----------|
| <b>Setup "A" (0.001 MHz to 200 MHz)</b> |              |              |              |                    |              |           |
| Power Meter, Two Channel                | Agilent      | E4419B       | 003431       |                    | 2012-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A        | 004323       |                    | 2011-11      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A        | 001389       |                    | 2011-11      |           |
| Attenuator 30dB                         | Narda        | 769-30       | 003241       | -                  | 2011-06      | (1)       |
| Attenuator 30dB                         | Narda        | 769-30       | 003386       | -                  | 2011-03      | (1)       |
| Attenuator 6dB                          | Narda        | 766-6        | 006030       | -                  | 2011-01      | (1)       |
| Attenuator 6dB                          | Narda        | 766-6        | 006031       | -                  | 2011-01      | (1)       |
| <b>Setup "B" (300 MHz to 3000 MHz)</b>  |              |              |              |                    |              |           |
| Power Meter, Two Channel                | Agilent      | E4419B       | 003768       |                    | 2011-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A        | 003757       |                    | 2011-06      |           |
| Power Sensor 4GHz                       | Agilent      | 8482A        | 003758       |                    | 2011-06      |           |
| Dir. Coupler 0.3-2.2GHz                 | Narda        | 3042SP       | 005118       | -                  | 2011-10      | (1)       |
| Dir. Cpl. 0.9-2.2GHz + 10dB             | Narda        | 3042B/771-10 | 005118       | -                  | 2011-10      | (1)       |
| Dir. Coupler 1.7-4.2GHz                 | Narda        | 3043B-30     | 005119       | -                  | 2011-10      | (1)       |
| Dir. Coupler 1.7-4.2GHz                 | Narda        | 3043B-30     | 005119       | -                  | 2011-10      | (1)       |
| <b>Setup "C" (1.7 to 60 GHz)</b>        |              |              |              |                    |              |           |
| Power Sensor 18GHz                      | Agilent      | 8481A        | 003237       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A        | 003236       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A        | 003235       |                    | 2011-07      |           |
| Power Sensor 18GHz                      | Agilent      | 8481A        | 003234       |                    | 2011-07      |           |
| Power Sensor 26.5-40GHz                 | Agilent      | R8486A       | 002020       |                    | 2011-09      |           |
| Power Sensor 33-50GHz                   | Agilent      | O8486A       | 002846       |                    | 2011-01      |           |
| Power Sensor 50-75GHz                   | Agilent      | V8486A       | 004679       |                    | 2011-06      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003210       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003212       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003231       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003214       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003213       |                    | 2011-01      |           |
| Power Meter                             | Agilent      | EPM-441A     | 003211       |                    | 2011-01      |           |
| Dir. Coupler 4-8GHz & 10dB              | Narda        | 3022/777C-10 | 003270       | -                  | 2011-10      | (1)       |
| Dir. Coupler 4-8GHz & 20dB              | Narda        | 3024/777C-20 | 003271       | -                  | 2011-10      | (1)       |
| Dir. Coupler 8.2-12.4GHz                | Narda        | 3293-2       | 003272       | -                  | 2011-10      | (1)       |
| Dir. Coupler 12.4-18GHz                 | Narda        | 1079         | 003274       | -                  | 2013-03      | (1)       |
| Dir. Coupler 26.5-40GHz                 | Narda        | R752D        | 002747       | -                  | 2011-10      | (1)       |
| Dir. Coupler 33-50GHz                   | Militech     | CL3-22-R2000 | 004756       | -                  | 2011-01      | (1)       |
| Dir. Coupler 60GHz                      | Militech     | CGC-15-RL300 | 004757       | -                  | 2011-01      | (1)       |

(\*) For details on accredited laboratories please refer to the corresponding homepage:

<http://www.dkdi.info/> DKD

<http://sit.imgc.to.cnrl.it/> SIT

<http://www.ukas.com/> UKAS

(1) An accredited calibration of the directional couplers is not available due to multiple-sex connectors. Calibration is performed as an in-house calibration based on state of the art techniques (non-traceable).

Certificate No. 01025\_06Dec2010.txt

Date of issue: 06/Dec/2010

Page 4 of 6

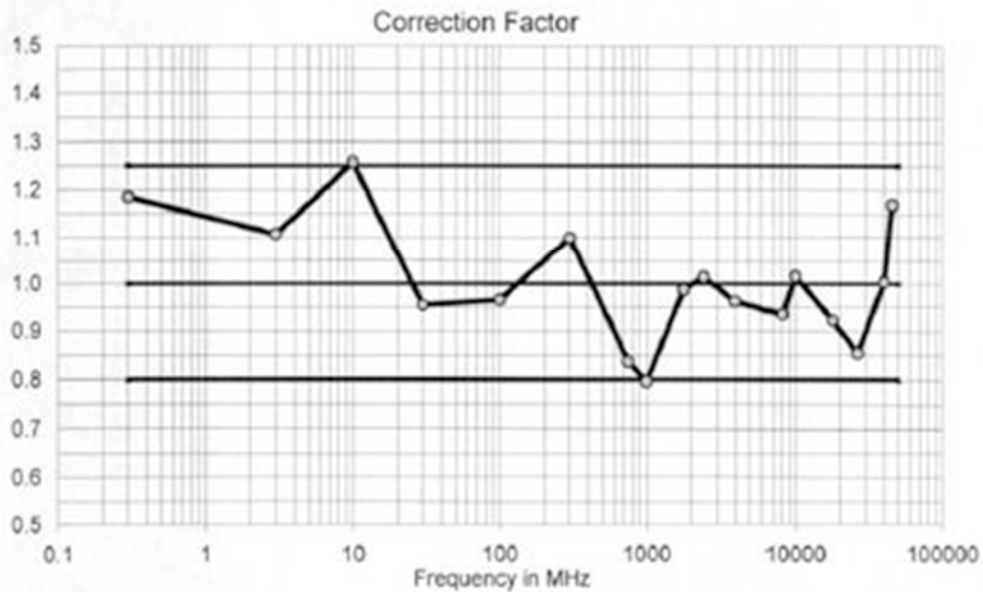
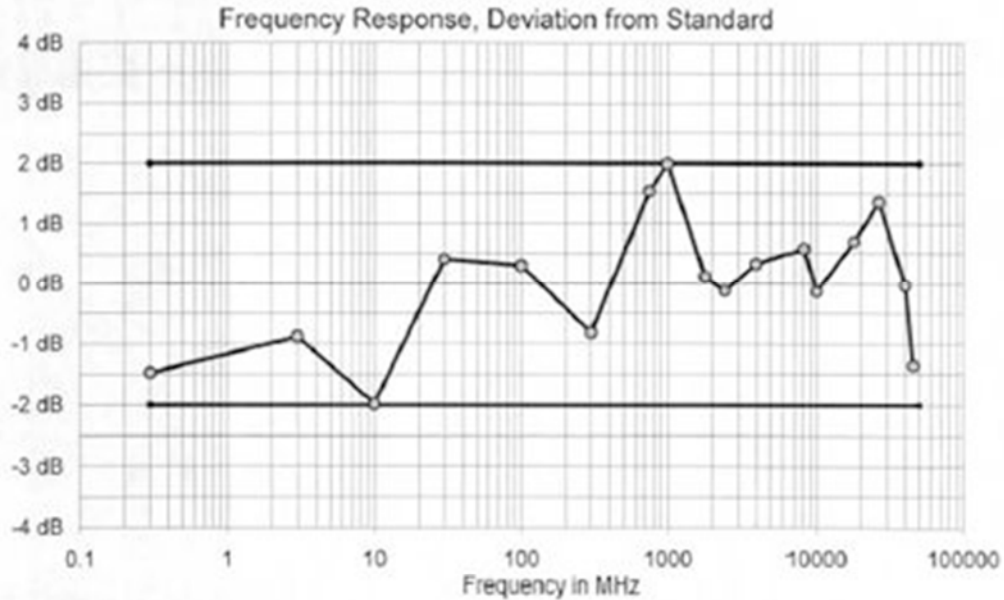


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 www.nardamicrowave.com



### Frequency Response Graph

Frequency response data with setting: Apply Correction Frequency = OFF.



## 7 Field Probe Log Files – Baseline (Nine SmartMeters)

Note that all average values presented relative to Health Canada Safety Code 6's controlled environments. These are multiplied by a factor of 5 to convert to Health Canada Safety Code 6 values for uncontrolled environments (Public Levels). The scaled uncontrolled environment values are used in this report.

| Date/Time          | Max (E-Field) [% STD] | Avg (E-Field) [% STD] | Min (E-Field) [% STD] |
|--------------------|-----------------------|-----------------------|-----------------------|
| 1/23/2012 10:58:35 | 0.0869                | 0.0107                | 0.0000                |
| 1/23/2012 11:04:35 | 0.0835                | 0.0075                | 0.0000                |
| 1/23/2012 11:10:35 | 0.0947                | 0.0179                | 0.0000                |
| 1/23/2012 11:16:35 | 0.0421                | 0.0055                | 0.0000                |
| 1/23/2012 11:22:35 | 0.0495                | 0.0028                | 0.0000                |
| 1/23/2012 11:28:35 | 0.0510                | 0.0046                | 0.0000                |
| 1/23/2012 11:34:35 | 0.0710                | 0.0081                | 0.0000                |
| 1/23/2012 11:40:35 | 0.0829                | 0.0130                | 0.0000                |
| 1/23/2012 11:46:35 | 0.0907                | 0.0169                | 0.0000                |
| 1/23/2012 11:52:35 | 0.0618                | 0.0086                | 0.0000                |
| 1/23/2012 11:58:35 | 0.0550                | 0.0052                | 0.0000                |
| 1/23/2012 12:04:35 | 0.0627                | 0.0060                | 0.0000                |
| 1/23/2012 12:10:35 | 0.0476                | 0.0040                | 0.0000                |
| 1/23/2012 12:16:35 | 0.0807                | 0.0195                | 0.0000                |
| 1/23/2012 12:22:35 | 0.0414                | 0.0083                | 0.0000                |
| 1/23/2012 12:28:35 | 0.0745                | 0.0170                | 0.0000                |
| 1/23/2012 12:34:35 | 0.0689                | 0.0118                | 0.0000                |
| 1/23/2012 12:40:35 | 0.0924                | 0.0221                | 0.0000                |
| 1/23/2012 12:46:35 | 0.0565                | 0.0069                | 0.0000                |
| 1/23/2012 12:52:35 | 0.0510                | 0.0043                | 0.0000                |
| 1/23/2012 12:58:35 | 0.0683                | 0.0061                | 0.0000                |
| 1/23/2012 13:04:35 | 0.0491                | 0.0035                | 0.0000                |
| 1/23/2012 13:10:35 | 0.0702                | 0.0111                | 0.0000                |
| 1/23/2012 13:16:35 | 0.0676                | 0.0121                | 0.0000                |
| 1/23/2012 13:22:35 | 0.0636                | 0.0081                | 0.0000                |
| 1/23/2012 13:28:35 | 0.0817                | 0.0110                | 0.0000                |
| 1/23/2012 13:34:35 | 0.0676                | 0.0119                | 0.0000                |
| 1/23/2012 13:40:35 | 0.0690                | 0.0058                | 0.0000                |
| 1/23/2012 13:46:35 | 0.0483                | 0.0036                | 0.0000                |
| 1/23/2012 13:52:35 | 0.0952                | 0.0258                | 0.0000                |
| 1/23/2012 13:58:35 | 0.0517                | 0.0071                | 0.0000                |
| 1/23/2012 14:04:35 | 0.0993                | 0.0344                | 0.0000                |
| 1/23/2012 14:10:35 | 0.0586                | 0.0094                | 0.0000                |
| 1/23/2012 14:16:35 | 0.0676                | 0.0123                | 0.0000                |
| 1/23/2012 14:22:35 | 0.0703                | 0.0114                | 0.0000                |
| 1/23/2012 14:40:19 | 0.0950                | 0.0214                | 0.0000                |
| 1/23/2012 14:46:19 | 0.2012                | 0.0854                | 0.0173                |
| 1/23/2012 14:52:19 | 0.0500                | 0.0095                | 0.0000                |
| 1/23/2012 14:58:19 | 0.0324                | 0.0016                | 0.0000                |
| 1/23/2012 15:04:19 | 0.0455                | 0.0027                | 0.0000                |
| 1/23/2012 15:10:19 | 0.0386                | 0.0032                | 0.0000                |
| 1/23/2012 15:16:19 | 0.0662                | 0.0184                | 0.0000                |
| 1/23/2012 15:22:19 | 0.0848                | 0.0225                | 0.0000                |
| 1/23/2012 15:28:19 | 0.0565                | 0.0117                | 0.0000                |
| 1/23/2012 15:34:19 | 0.0283                | 0.0004                | 0.0000                |
| 1/23/2012 15:40:19 | 0.0501                | 0.0030                | 0.0000                |
| 1/23/2012 15:46:19 | 0.0717                | 0.0138                | 0.0000                |
| 1/23/2012 15:52:19 | 0.0503                | 0.0071                | 0.0000                |
| 1/23/2012 15:58:19 | 0.0634                | 0.0078                | 0.0000                |
| 1/23/2012 16:04:19 | 0.0496                | 0.0050                | 0.0000                |
| 1/23/2012 16:10:19 | 0.0541                | 0.0052                | 0.0000                |
| 1/23/2012 16:16:19 | 0.0974                | 0.0199                | 0.0000                |
| 1/23/2012 16:22:19 | 0.1227                | 0.0244                | 0.0000                |
| 1/23/2012 16:28:19 | 0.0967                | 0.0220                | 0.0000                |
| 1/23/2012 16:34:19 | 0.0794                | 0.0147                | 0.0000                |
| 1/23/2012 16:40:19 | 0.0748                | 0.0083                | 0.0000                |
| 1/23/2012 16:46:19 | 0.0673                | 0.0085                | 0.0000                |

|                    |        |        |        |
|--------------------|--------|--------|--------|
| 1/23/2012 16:52:19 | 0.0485 | 0.0020 | 0.0000 |
| 1/23/2012 16:58:19 | 0.0762 | 0.0076 | 0.0000 |
| 1/23/2012 17:04:19 | 0.0755 | 0.0092 | 0.0000 |
| 1/23/2012 17:10:19 | 0.0540 | 0.0071 | 0.0000 |
| 1/23/2012 17:16:19 | 0.0596 | 0.0062 | 0.0000 |
| 1/23/2012 17:22:19 | 0.0546 | 0.0075 | 0.0000 |
| 1/23/2012 17:28:19 | 0.0579 | 0.0058 | 0.0000 |
| 1/23/2012 17:34:19 | 0.0680 | 0.0098 | 0.0000 |
| 1/23/2012 17:40:19 | 0.0451 | 0.0032 | 0.0000 |
| 1/23/2012 17:46:19 | 0.0579 | 0.0051 | 0.0000 |
| 1/23/2012 17:52:19 | 0.0535 | 0.0043 | 0.0000 |
| 1/23/2012 17:58:19 | 0.0612 | 0.0090 | 0.0000 |
| 1/23/2012 18:04:19 | 0.0770 | 0.0123 | 0.0000 |
| 1/23/2012 18:10:19 | 0.0597 | 0.0113 | 0.0000 |
| 1/23/2012 18:16:19 | 0.0551 | 0.0024 | 0.0000 |
| 1/23/2012 18:22:19 | 0.0587 | 0.0033 | 0.0000 |
| 1/23/2012 18:28:19 | 0.0564 | 0.0035 | 0.0000 |
| 1/23/2012 18:34:19 | 0.0540 | 0.0054 | 0.0000 |
| 1/23/2012 18:40:19 | 0.0593 | 0.0065 | 0.0000 |
| 1/23/2012 18:46:19 | 0.0602 | 0.0074 | 0.0000 |
| 1/23/2012 18:52:19 | 0.0545 | 0.0034 | 0.0000 |
| 1/23/2012 18:58:19 | 0.0607 | 0.0113 | 0.0000 |
| 1/23/2012 19:04:19 | 0.0632 | 0.0082 | 0.0000 |
| 1/23/2012 19:10:19 | 0.0717 | 0.0037 | 0.0000 |
| 1/23/2012 19:16:19 | 0.0848 | 0.0182 | 0.0000 |
| 1/23/2012 19:22:19 | 0.0455 | 0.0046 | 0.0000 |
| 1/23/2012 19:28:19 | 0.0397 | 0.0010 | 0.0000 |
| 1/23/2012 19:34:19 | 0.0681 | 0.0039 | 0.0000 |
| 1/23/2012 19:46:00 | 0.0955 | 0.0139 | 0.0000 |
| 1/23/2012 19:52:00 | 0.3222 | 0.0417 | 0.0000 |
| 1/23/2012 19:58:00 | 0.0477 | 0.0042 | 0.0000 |
| 1/23/2012 20:04:00 | 0.0797 | 0.0082 | 0.0000 |
| 1/23/2012 20:10:00 | 0.0665 | 0.0114 | 0.0000 |
| 1/23/2012 20:16:00 | 0.0730 | 0.0057 | 0.0000 |
| 1/23/2012 20:22:00 | 0.0766 | 0.0073 | 0.0000 |
| 1/23/2012 20:28:00 | 0.0864 | 0.0121 | 0.0000 |
| 1/23/2012 20:34:00 | 0.0552 | 0.0032 | 0.0000 |
| 1/23/2012 20:40:00 | 0.0876 | 0.0132 | 0.0000 |
| 1/23/2012 20:46:00 | 0.1123 | 0.0207 | 0.0000 |
| 1/23/2012 20:52:00 | 0.0725 | 0.0085 | 0.0000 |
| 1/23/2012 20:58:00 | 0.0708 | 0.0076 | 0.0000 |
| 1/23/2012 21:04:00 | 0.0705 | 0.0124 | 0.0000 |
| 1/23/2012 21:10:00 | 0.0749 | 0.0135 | 0.0000 |
| 1/23/2012 21:16:00 | 0.0696 | 0.0089 | 0.0000 |
| 1/23/2012 21:22:00 | 0.0809 | 0.0090 | 0.0000 |
| 1/23/2012 21:28:00 | 0.0946 | 0.0158 | 0.0000 |
| 1/23/2012 21:34:00 | 0.0733 | 0.0101 | 0.0000 |
| 1/23/2012 21:40:00 | 0.0676 | 0.0051 | 0.0000 |
| 1/23/2012 21:46:00 | 0.0772 | 0.0104 | 0.0000 |
| 1/23/2012 21:52:00 | 0.0658 | 0.0061 | 0.0000 |
| 1/23/2012 21:58:00 | 0.0528 | 0.0041 | 0.0000 |
| 1/23/2012 22:04:00 | 0.0455 | 0.0020 | 0.0000 |
| 1/23/2012 22:10:00 | 0.0450 | 0.0025 | 0.0000 |
| 1/23/2012 22:16:00 | 0.0482 | 0.0027 | 0.0000 |
| 1/23/2012 22:22:00 | 0.0488 | 0.0031 | 0.0000 |
| 1/23/2012 22:28:00 | 0.0649 | 0.0082 | 0.0000 |
| 1/23/2012 22:34:00 | 0.0643 | 0.0110 | 0.0000 |
| 1/23/2012 22:40:00 | 0.0477 | 0.0029 | 0.0000 |
| 1/23/2012 22:46:00 | 0.0815 | 0.0082 | 0.0000 |
| 1/23/2012 22:52:00 | 0.0538 | 0.0036 | 0.0000 |
| 1/23/2012 22:58:00 | 0.0681 | 0.0071 | 0.0000 |
| 1/23/2012 23:04:00 | 0.0788 | 0.0148 | 0.0000 |
| 1/23/2012 23:10:00 | 0.0813 | 0.0136 | 0.0000 |
| 1/23/2012 23:16:00 | 0.0668 | 0.0063 | 0.0000 |
| 1/23/2012 23:22:00 | 0.0554 | 0.0020 | 0.0000 |
| 1/23/2012 23:28:00 | 0.0648 | 0.0088 | 0.0000 |
| 1/23/2012 23:34:00 | 0.0851 | 0.0161 | 0.0000 |

|                    |        |        |        |
|--------------------|--------|--------|--------|
| 1/23/2012 23:40:00 | 0.0939 | 0.0196 | 0.0000 |
| 1/23/2012 23:46:00 | 0.0618 | 0.0049 | 0.0000 |
| 1/23/2012 23:52:00 | 0.0536 | 0.0024 | 0.0000 |
| 1/23/2012 23:58:00 | 0.0490 | 0.0052 | 0.0000 |
| 1/24/2012 0:04:00  | 0.0727 | 0.0105 | 0.0000 |
| 1/24/2012 0:10:00  | 0.0645 | 0.0036 | 0.0000 |
| 1/24/2012 0:16:00  | 0.0526 | 0.0039 | 0.0000 |
| 1/24/2012 0:22:00  | 0.0617 | 0.0034 | 0.0000 |
| 1/24/2012 0:28:00  | 0.0722 | 0.0123 | 0.0000 |
| 1/24/2012 0:34:00  | 0.0823 | 0.0233 | 0.0000 |
| 1/24/2012 0:40:00  | 0.0853 | 0.0081 | 0.0000 |
| 1/24/2012 0:46:00  | 0.0703 | 0.0073 | 0.0000 |
| 1/24/2012 0:52:00  | 0.0780 | 0.0088 | 0.0000 |
| 1/24/2012 0:58:00  | 0.1012 | 0.0239 | 0.0000 |
| 1/24/2012 1:04:00  | 0.0872 | 0.0119 | 0.0000 |
| 1/24/2012 1:10:00  | 0.0762 | 0.0110 | 0.0000 |
| 1/24/2012 1:16:00  | 0.0777 | 0.0121 | 0.0000 |
| 1/24/2012 1:22:00  | 0.0572 | 0.0051 | 0.0000 |
| 1/24/2012 1:28:00  | 0.0762 | 0.0078 | 0.0000 |
| 1/24/2012 1:34:00  | 0.0852 | 0.0082 | 0.0000 |
| 1/24/2012 1:40:00  | 0.0803 | 0.0112 | 0.0000 |
| 1/24/2012 1:46:00  | 0.0838 | 0.0113 | 0.0000 |
| 1/24/2012 1:52:00  | 0.0670 | 0.0059 | 0.0000 |
| 1/24/2012 1:58:00  | 0.0687 | 0.0077 | 0.0000 |
| 1/24/2012 2:04:00  | 0.0636 | 0.0117 | 0.0000 |
| 1/24/2012 2:10:00  | 0.0754 | 0.0148 | 0.0000 |
| 1/24/2012 2:16:00  | 0.0332 | 0.0007 | 0.0000 |
| 1/24/2012 2:22:00  | 0.0728 | 0.0091 | 0.0000 |
| 1/24/2012 2:28:00  | 0.0792 | 0.0111 | 0.0000 |
| 1/24/2012 2:34:00  | 0.0844 | 0.0132 | 0.0000 |
| 1/24/2012 2:40:00  | 0.0613 | 0.0041 | 0.0000 |
| 1/24/2012 2:46:00  | 0.0725 | 0.0067 | 0.0000 |
| 1/24/2012 2:52:00  | 0.0717 | 0.0117 | 0.0000 |
| 1/24/2012 2:58:00  | 0.0867 | 0.0092 | 0.0000 |
| 1/24/2012 3:04:00  | 0.0734 | 0.0040 | 0.0000 |
| 1/24/2012 3:10:00  | 0.0692 | 0.0056 | 0.0000 |
| 1/24/2012 3:16:00  | 0.0610 | 0.0048 | 0.0000 |
| 1/24/2012 3:22:00  | 0.0599 | 0.0039 | 0.0000 |
| 1/24/2012 3:28:00  | 0.0743 | 0.0115 | 0.0000 |
| 1/24/2012 3:34:00  | 0.0600 | 0.0079 | 0.0000 |
| 1/24/2012 3:40:00  | 0.0504 | 0.0084 | 0.0000 |
| 1/24/2012 3:46:00  | 0.0799 | 0.0156 | 0.0000 |
| 1/24/2012 3:52:00  | 0.0668 | 0.0070 | 0.0000 |
| 1/24/2012 3:58:00  | 0.0784 | 0.0093 | 0.0000 |
| 1/24/2012 4:04:00  | 0.0842 | 0.0077 | 0.0000 |
| 1/24/2012 4:10:00  | 0.0710 | 0.0074 | 0.0000 |
| 1/24/2012 4:16:00  | 0.0562 | 0.0052 | 0.0000 |
| 1/24/2012 4:22:00  | 0.0642 | 0.0093 | 0.0000 |
| 1/24/2012 4:28:00  | 0.0643 | 0.0059 | 0.0000 |
| 1/24/2012 4:34:00  | 0.0851 | 0.0058 | 0.0000 |
| 1/24/2012 4:40:00  | 0.0483 | 0.0036 | 0.0000 |
| 1/24/2012 4:46:00  | 0.0649 | 0.0043 | 0.0000 |
| 1/24/2012 4:52:00  | 0.0744 | 0.0063 | 0.0000 |
| 1/24/2012 4:58:00  | 0.0750 | 0.0070 | 0.0000 |
| 1/24/2012 5:04:00  | 0.0873 | 0.0139 | 0.0000 |
| 1/24/2012 5:10:00  | 0.0785 | 0.0135 | 0.0000 |
| 1/24/2012 5:16:00  | 0.1002 | 0.0149 | 0.0000 |
| 1/24/2012 5:22:00  | 0.1086 | 0.0206 | 0.0000 |
| 1/24/2012 5:28:00  | 0.0734 | 0.0078 | 0.0000 |
| 1/24/2012 5:34:00  | 0.0824 | 0.0102 | 0.0000 |
| 1/24/2012 5:40:00  | 0.0714 | 0.0066 | 0.0000 |
| 1/24/2012 5:46:00  | 0.0819 | 0.0084 | 0.0000 |
| 1/24/2012 5:52:00  | 0.0721 | 0.0085 | 0.0000 |
| 1/24/2012 5:58:00  | 0.0650 | 0.0094 | 0.0000 |
| 1/24/2012 6:04:00  | 0.1044 | 0.0147 | 0.0000 |
| 1/24/2012 6:10:00  | 0.0804 | 0.0171 | 0.0000 |
| 1/24/2012 6:16:00  | 0.0726 | 0.0060 | 0.0000 |

|                   |        |        |        |
|-------------------|--------|--------|--------|
| 1/24/2012 6:22:00 | 0.0788 | 0.0099 | 0.0000 |
| 1/24/2012 6:28:00 | 0.0745 | 0.0060 | 0.0000 |
| 1/24/2012 6:34:00 | 0.0628 | 0.0040 | 0.0000 |
| 1/24/2012 6:40:00 | 0.1082 | 0.0197 | 0.0000 |
| 1/24/2012 6:46:00 | 0.0771 | 0.0154 | 0.0000 |
| 1/24/2012 6:52:00 | 0.0653 | 0.0126 | 0.0000 |
| 1/24/2012 6:58:00 | 0.0429 | 0.0022 | 0.0000 |
| 1/24/2012 7:04:00 | 0.0507 | 0.0029 | 0.0000 |
| 1/24/2012 7:10:00 | 0.0579 | 0.0034 | 0.0000 |
| 1/24/2012 7:16:00 | 0.0704 | 0.0093 | 0.0000 |
| 1/24/2012 7:22:00 | 0.0745 | 0.0127 | 0.0000 |
| 1/24/2012 7:28:00 | 0.0476 | 0.0034 | 0.0000 |
| 1/24/2012 7:34:00 | 0.0882 | 0.0146 | 0.0000 |
| 1/24/2012 7:40:00 | 0.1166 | 0.0171 | 0.0000 |
| 1/24/2012 7:46:00 | 0.0758 | 0.0092 | 0.0000 |
| 1/24/2012 7:52:00 | 0.0787 | 0.0096 | 0.0000 |
| 1/24/2012 7:58:00 | 0.0800 | 0.0155 | 0.0000 |
| 1/24/2012 8:04:00 | 0.0690 | 0.0079 | 0.0000 |
| 1/24/2012 8:10:00 | 0.0482 | 0.0028 | 0.0000 |
| 1/24/2012 8:16:00 | 0.0324 | 0.0023 | 0.0000 |
| 1/24/2012 8:22:00 | 0.0241 | 0.0014 | 0.0000 |
| 1/24/2012 8:28:00 | 0.0538 | 0.0039 | 0.0000 |
| 1/24/2012 8:34:00 | 0.0393 | 0.0019 | 0.0000 |
| 1/24/2012 8:40:00 | 0.0558 | 0.0053 | 0.0000 |
| 1/24/2012 8:46:00 | 0.0613 | 0.0053 | 0.0000 |
| 1/24/2012 8:52:00 | 0.0572 | 0.0082 | 0.0000 |
| 1/24/2012 8:58:00 | 0.0634 | 0.0106 | 0.0000 |

## 8 Field Probe Log Files – Forty Meters Installed

Note that all average values presented relative to Health Canada Safety Code 6's controlled environments. These are multiplied by a factor of 5 to convert to Health Canada Safety Code 6 values for uncontrolled environments (Public Levels). The scaled uncontrolled environment values are used in this report.

| Date/Time          | Max (E-Field) [% STD] | Avg (E-Field) [% STD] | Min (E-Field) [% STD] |
|--------------------|-----------------------|-----------------------|-----------------------|
| 1/24/2012 15:35:21 | 0.0563                | 0.0080                | 0.0000                |
| 1/24/2012 15:41:21 | 0.1819                | 0.0603                | 0.0032                |
| 1/24/2012 15:47:21 | 0.2318                | 0.1013                | 0.0032                |
| 1/24/2012 15:53:21 | 0.1651                | 0.0540                | 0.0011                |
| 1/24/2012 15:59:21 | 0.1093                | 0.0239                | 0.0000                |
| 1/24/2012 16:05:21 | 0.0531                | 0.0037                | 0.0000                |
| 1/24/2012 16:11:21 | 0.0677                | 0.0067                | 0.0000                |
| 1/24/2012 16:17:21 | 0.1018                | 0.0165                | 0.0000                |
| 1/24/2012 16:23:21 | 0.1289                | 0.0254                | 0.0000                |
| 1/24/2012 16:29:21 | 0.1430                | 0.0402                | 0.0011                |
| 1/24/2012 16:35:21 | 0.1989                | 0.0619                | 0.0000                |
| 1/24/2012 16:41:21 | 0.1489                | 0.0351                | 0.0000                |
| 1/24/2012 16:47:21 | 0.1078                | 0.0167                | 0.0000                |
| 1/24/2012 16:53:21 | 0.0938                | 0.0152                | 0.0000                |
| 1/24/2012 16:59:21 | 0.1185                | 0.0178                | 0.0000                |
| 1/24/2012 17:05:21 | 0.0944                | 0.0150                | 0.0000                |
| 1/24/2012 17:11:21 | 0.1008                | 0.0178                | 0.0000                |
| 1/24/2012 17:17:21 | 0.1214                | 0.0261                | 0.0000                |
| 1/24/2012 17:23:21 | 0.0723                | 0.0057                | 0.0000                |
| 1/24/2012 17:29:21 | 0.0859                | 0.0095                | 0.0000                |
| 1/24/2012 17:35:21 | 0.1163                | 0.0168                | 0.0000                |
| 1/24/2012 17:41:21 | 0.1356                | 0.0240                | 0.0000                |
| 1/24/2012 17:47:21 | 0.0918                | 0.0131                | 0.0000                |
| 1/24/2012 17:53:21 | 0.1099                | 0.0176                | 0.0000                |
| 1/24/2012 17:59:21 | 0.0941                | 0.0088                | 0.0000                |
| 1/24/2012 18:05:21 | 0.0883                | 0.0146                | 0.0000                |
| 1/24/2012 18:11:21 | 0.0752                | 0.0093                | 0.0000                |
| 1/24/2012 18:17:21 | 0.0882                | 0.0114                | 0.0000                |
| 1/24/2012 18:23:21 | 0.1147                | 0.0212                | 0.0000                |
| 1/24/2012 18:29:21 | 0.1031                | 0.0163                | 0.0000                |
| 1/24/2012 18:35:21 | 0.1046                | 0.0135                | 0.0000                |
| 1/24/2012 18:41:21 | 0.0633                | 0.0061                | 0.0000                |
| 1/24/2012 18:47:21 | 0.1162                | 0.0166                | 0.0000                |
| 1/24/2012 18:53:21 | 0.0980                | 0.0182                | 0.0000                |
| 1/24/2012 18:59:21 | 0.1179                | 0.0195                | 0.0000                |
| 1/24/2012 19:05:21 | 0.1419                | 0.0251                | 0.0000                |
| 1/24/2012 19:11:21 | 0.1212                | 0.0262                | 0.0000                |
| 1/24/2012 19:17:21 | 0.1179                | 0.0236                | 0.0000                |
| 1/24/2012 19:23:21 | 0.0753                | 0.0076                | 0.0000                |
| 1/24/2012 19:29:21 | 0.1194                | 0.0202                | 0.0000                |
| 1/24/2012 19:35:21 | 0.1568                | 0.0325                | 0.0000                |
| 1/24/2012 19:41:21 | 0.1215                | 0.0199                | 0.0000                |
| 1/24/2012 19:47:21 | 0.1388                | 0.0295                | 0.0000                |
| 1/24/2012 19:53:21 | 0.1817                | 0.0480                | 0.0000                |
| 1/24/2012 19:59:21 | 0.0916                | 0.0128                | 0.0000                |
| 1/24/2012 20:05:21 | 0.1130                | 0.0215                | 0.0000                |
| 1/24/2012 20:11:21 | 0.1301                | 0.0265                | 0.0000                |
| 1/24/2012 20:17:21 | 0.1150                | 0.0167                | 0.0000                |
| 1/24/2012 20:23:21 | 0.1191                | 0.0234                | 0.0000                |
| 1/24/2012 20:29:21 | 0.1043                | 0.0185                | 0.0000                |
| 1/24/2012 20:35:21 | 0.0959                | 0.0128                | 0.0000                |
| 1/24/2012 20:41:21 | 0.1193                | 0.0206                | 0.0000                |
| 1/24/2012 20:47:21 | 0.1267                | 0.0333                | 0.0000                |
| 1/24/2012 20:53:21 | 0.1700                | 0.0517                | 0.0000                |
| 1/24/2012 20:59:21 | 0.1370                | 0.0323                | 0.0000                |
| 1/24/2012 21:05:21 | 0.0957                | 0.0181                | 0.0000                |
| 1/24/2012 21:11:21 | 0.0848                | 0.0134                | 0.0000                |
| 1/24/2012 21:17:21 | 0.0946                | 0.0147                | 0.0000                |
| 1/24/2012 21:23:21 | 0.1452                | 0.0332                | 0.0000                |
| 1/24/2012 21:29:21 | 0.1315                | 0.0276                | 0.0000                |
| 1/24/2012 21:35:21 | 0.1134                | 0.0218                | 0.0000                |
| 1/24/2012 21:41:21 | 0.1188                | 0.0228                | 0.0000                |
| 1/24/2012 21:47:21 | 0.1236                | 0.0336                | 0.0000                |

|                    |        |        |        |
|--------------------|--------|--------|--------|
| 1/24/2012 21:53:21 | 0.1000 | 0.0172 | 0.0000 |
| 1/24/2012 21:59:21 | 0.1012 | 0.0136 | 0.0000 |
| 1/24/2012 22:05:21 | 0.1036 | 0.0159 | 0.0000 |
| 1/24/2012 22:11:21 | 0.1390 | 0.0339 | 0.0000 |
| 1/24/2012 22:17:21 | 0.1710 | 0.0414 | 0.0000 |
| 1/24/2012 22:23:21 | 0.1499 | 0.0328 | 0.0000 |
| 1/24/2012 22:29:21 | 0.1492 | 0.0366 | 0.0000 |
| 1/24/2012 22:35:21 | 0.1733 | 0.0472 | 0.0000 |
| 1/24/2012 22:41:21 | 0.1119 | 0.0243 | 0.0000 |
| 1/24/2012 22:47:21 | 0.1521 | 0.0423 | 0.0000 |
| 1/24/2012 22:53:21 | 0.1389 | 0.0299 | 0.0000 |
| 1/24/2012 22:59:21 | 0.1378 | 0.0357 | 0.0000 |
| 1/24/2012 23:05:21 | 0.2918 | 0.0549 | 0.0000 |
| 1/24/2012 23:11:21 | 0.1502 | 0.0307 | 0.0000 |
| 1/24/2012 23:17:21 | 0.1175 | 0.0201 | 0.0000 |
| 1/24/2012 23:23:21 | 0.0978 | 0.0134 | 0.0000 |
| 1/24/2012 23:29:21 | 0.1166 | 0.0200 | 0.0000 |
| 1/24/2012 23:35:21 | 0.1282 | 0.0216 | 0.0000 |
| 1/24/2012 23:41:21 | 0.1247 | 0.0265 | 0.0000 |
| 1/24/2012 23:47:21 | 0.1101 | 0.0186 | 0.0000 |
| 1/24/2012 23:53:21 | 0.1290 | 0.0223 | 0.0000 |
| 1/24/2012 23:59:21 | 0.1492 | 0.0306 | 0.0000 |
| 1/25/2012 0:05:21  | 0.1171 | 0.0206 | 0.0000 |
| 1/25/2012 0:11:21  | 0.1301 | 0.0220 | 0.0000 |
| 1/25/2012 0:17:21  | 0.1307 | 0.0337 | 0.0000 |
| 1/25/2012 0:23:21  | 0.0849 | 0.0163 | 0.0000 |
| 1/25/2012 0:29:21  | 0.1434 | 0.0377 | 0.0000 |
| 1/25/2012 0:35:21  | 0.1296 | 0.0271 | 0.0000 |
| 1/25/2012 0:41:21  | 0.1279 | 0.0292 | 0.0000 |
| 1/25/2012 0:47:21  | 0.1393 | 0.0309 | 0.0000 |
| 1/25/2012 0:53:21  | 0.1397 | 0.0305 | 0.0000 |
| 1/25/2012 0:59:21  | 0.2046 | 0.0596 | 0.0000 |
| 1/25/2012 1:05:21  | 0.1306 | 0.0357 | 0.0000 |
| 1/25/2012 1:11:21  | 0.1233 | 0.0180 | 0.0000 |
| 1/25/2012 1:17:21  | 0.1363 | 0.0287 | 0.0000 |
| 1/25/2012 1:23:21  | 0.1489 | 0.0334 | 0.0000 |
| 1/25/2012 1:29:21  | 0.1461 | 0.0400 | 0.0000 |
| 1/25/2012 1:35:21  | 0.1466 | 0.0431 | 0.0000 |
| 1/25/2012 1:41:21  | 0.1116 | 0.0246 | 0.0000 |
| 1/25/2012 1:47:21  | 0.1078 | 0.0190 | 0.0000 |
| 1/25/2012 1:53:21  | 0.1072 | 0.0179 | 0.0000 |
| 1/25/2012 1:59:21  | 0.0948 | 0.0144 | 0.0000 |
| 1/25/2012 2:05:21  | 0.1669 | 0.0378 | 0.0000 |
| 1/25/2012 2:11:21  | 0.1451 | 0.0370 | 0.0000 |
| 1/25/2012 2:17:21  | 0.1024 | 0.0225 | 0.0000 |
| 1/25/2012 2:23:21  | 0.0991 | 0.0150 | 0.0000 |
| 1/25/2012 2:29:21  | 0.1284 | 0.0216 | 0.0000 |
| 1/25/2012 2:35:21  | 0.1065 | 0.0189 | 0.0000 |
| 1/25/2012 2:41:21  | 0.1271 | 0.0265 | 0.0000 |
| 1/25/2012 2:47:21  | 0.1752 | 0.0530 | 0.0007 |
| 1/25/2012 2:53:21  | 0.1326 | 0.0342 | 0.0000 |
| 1/25/2012 2:59:21  | 0.1153 | 0.0209 | 0.0000 |
| 1/25/2012 3:05:21  | 0.1111 | 0.0176 | 0.0000 |
| 1/25/2012 3:11:21  | 0.1088 | 0.0209 | 0.0000 |
| 1/25/2012 3:17:21  | 0.1248 | 0.0285 | 0.0000 |
| 1/25/2012 3:23:21  | 0.1165 | 0.0226 | 0.0000 |
| 1/25/2012 3:29:21  | 0.1456 | 0.0445 | 0.0000 |
| 1/25/2012 3:35:21  | 0.1362 | 0.0273 | 0.0000 |
| 1/25/2012 3:41:21  | 0.1068 | 0.0175 | 0.0000 |
| 1/25/2012 3:47:21  | 0.1349 | 0.0223 | 0.0000 |
| 1/25/2012 3:53:21  | 0.1592 | 0.0443 | 0.0000 |
| 1/25/2012 3:59:21  | 0.1777 | 0.0382 | 0.0000 |
| 1/25/2012 4:05:21  | 0.1328 | 0.0268 | 0.0000 |
| 1/25/2012 4:11:21  | 0.1117 | 0.0174 | 0.0000 |
| 1/25/2012 4:17:21  | 0.1336 | 0.0257 | 0.0000 |
| 1/25/2012 4:23:21  | 0.1218 | 0.0283 | 0.0000 |
| 1/25/2012 4:29:21  | 0.1338 | 0.0238 | 0.0000 |
| 1/25/2012 4:35:21  | 0.0702 | 0.0047 | 0.0000 |
| 1/25/2012 4:41:21  | 0.1004 | 0.0118 | 0.0000 |
| 1/25/2012 4:47:21  | 0.1122 | 0.0234 | 0.0000 |
| 1/25/2012 4:53:21  | 0.1523 | 0.0473 | 0.0000 |

|                    |        |        |        |
|--------------------|--------|--------|--------|
| 1/25/2012 4:59:21  | 0.1225 | 0.0176 | 0.0000 |
| 1/25/2012 5:05:21  | 0.0859 | 0.0108 | 0.0000 |
| 1/25/2012 5:11:21  | 0.1105 | 0.0196 | 0.0000 |
| 1/25/2012 5:17:21  | 0.1005 | 0.0110 | 0.0000 |
| 1/25/2012 5:23:21  | 0.0934 | 0.0118 | 0.0000 |
| 1/25/2012 5:29:21  | 0.1300 | 0.0266 | 0.0000 |
| 1/25/2012 5:35:21  | 0.0891 | 0.0115 | 0.0000 |
| 1/25/2012 5:41:21  | 0.0886 | 0.0133 | 0.0000 |
| 1/25/2012 5:47:21  | 0.1378 | 0.0328 | 0.0000 |
| 1/25/2012 5:53:21  | 0.1318 | 0.0457 | 0.0000 |
| 1/25/2012 5:59:21  | 0.0949 | 0.0088 | 0.0000 |
| 1/25/2012 6:05:21  | 0.1237 | 0.0186 | 0.0000 |
| 1/25/2012 6:11:21  | 0.1461 | 0.0328 | 0.0000 |
| 1/25/2012 6:17:21  | 0.1032 | 0.0189 | 0.0000 |
| 1/25/2012 6:23:21  | 0.0973 | 0.0154 | 0.0000 |
| 1/25/2012 6:29:21  | 0.1122 | 0.0184 | 0.0000 |
| 1/25/2012 6:35:21  | 0.0866 | 0.0148 | 0.0000 |
| 1/25/2012 6:41:21  | 0.1075 | 0.0153 | 0.0000 |
| 1/25/2012 6:47:21  | 0.1492 | 0.0377 | 0.0000 |
| 1/25/2012 6:53:21  | 0.1144 | 0.0188 | 0.0000 |
| 1/25/2012 6:59:21  | 0.1052 | 0.0175 | 0.0000 |
| 1/25/2012 7:05:21  | 0.1969 | 0.0300 | 0.0000 |
| 1/25/2012 7:11:21  | 0.1212 | 0.0157 | 0.0000 |
| 1/25/2012 7:17:21  | 0.0730 | 0.0078 | 0.0000 |
| 1/25/2012 7:23:21  | 0.0734 | 0.0083 | 0.0000 |
| 1/25/2012 7:29:21  | 0.0971 | 0.0154 | 0.0000 |
| 1/25/2012 7:35:21  | 0.0930 | 0.0087 | 0.0000 |
| 1/25/2012 7:41:21  | 0.1392 | 0.0122 | 0.0000 |
| 1/25/2012 7:47:21  | 0.1164 | 0.0252 | 0.0000 |
| 1/25/2012 7:53:21  | 0.1201 | 0.0278 | 0.0000 |
| 1/25/2012 7:59:21  | 0.1326 | 0.0239 | 0.0000 |
| 1/25/2012 8:05:21  | 0.1104 | 0.0203 | 0.0000 |
| 1/25/2012 8:11:21  | 0.1199 | 0.0183 | 0.0000 |
| 1/25/2012 8:17:21  | 0.1074 | 0.0188 | 0.0000 |
| 1/25/2012 8:23:21  | 0.1052 | 0.0184 | 0.0000 |
| 1/25/2012 8:29:21  | 0.1056 | 0.0159 | 0.0000 |
| 1/25/2012 9:31:47  | 0.0868 | 0.0201 | 0.0000 |
| 1/25/2012 9:37:47  | 0.0655 | 0.0075 | 0.0000 |
| 1/25/2012 9:43:47  | 0.0806 | 0.0070 | 0.0000 |
| 1/25/2012 9:49:47  | 0.1515 | 0.0396 | 0.0000 |
| 1/25/2012 9:55:47  | 0.1719 | 0.0535 | 0.0000 |
| 1/25/2012 10:01:47 | 0.1062 | 0.0237 | 0.0000 |
| 1/25/2012 10:07:47 | 0.1598 | 0.0484 | 0.0000 |
| 1/25/2012 10:13:47 | 0.1340 | 0.0253 | 0.0000 |
| 1/25/2012 10:19:47 | 0.1243 | 0.0236 | 0.0000 |
| 1/25/2012 10:25:47 | 0.1377 | 0.0261 | 0.0000 |
| 1/25/2012 10:31:47 | 0.0679 | 0.0095 | 0.0000 |
| 1/25/2012 10:37:47 | 0.0916 | 0.0125 | 0.0000 |
| 1/25/2012 10:43:47 | 0.0917 | 0.0094 | 0.0000 |
| 1/25/2012 10:49:47 | 0.1037 | 0.0176 | 0.0000 |
| 1/25/2012 10:55:47 | 0.0855 | 0.0131 | 0.0000 |
| 1/25/2012 11:01:47 | 0.0798 | 0.0073 | 0.0000 |
| 1/25/2012 11:07:47 | 0.0986 | 0.0115 | 0.0000 |
| 1/25/2012 11:13:47 | 0.1051 | 0.0194 | 0.0000 |
| 1/25/2012 11:19:47 | 0.1149 | 0.0208 | 0.0000 |
| 1/25/2012 11:25:47 | 0.1459 | 0.0321 | 0.0000 |
| 1/25/2012 11:31:47 | 0.0990 | 0.0143 | 0.0000 |
| 1/25/2012 11:37:47 | 0.0615 | 0.0041 | 0.0000 |
| 1/25/2012 11:43:47 | 0.0546 | 0.0054 | 0.0000 |
| 1/25/2012 11:49:47 | 0.0837 | 0.0110 | 0.0000 |
| 1/25/2012 11:55:47 | 0.1037 | 0.0159 | 0.0000 |
| 1/25/2012 12:01:47 | 0.1064 | 0.0197 | 0.0000 |
| 1/25/2012 12:07:47 | 0.0807 | 0.0074 | 0.0000 |
| 1/25/2012 12:13:47 | 0.0679 | 0.0122 | 0.0000 |
| 1/25/2012 12:19:47 | 0.1023 | 0.0162 | 0.0000 |
| 1/25/2012 12:25:47 | 0.0866 | 0.0123 | 0.0000 |
| 1/25/2012 12:31:47 | 0.1012 | 0.0130 | 0.0000 |
| 1/25/2012 12:37:47 | 0.0719 | 0.0074 | 0.0000 |
| 1/25/2012 12:43:47 | 0.1013 | 0.0143 | 0.0000 |
| 1/25/2012 12:49:47 | 0.0447 | 0.0045 | 0.0000 |
| 1/25/2012 12:55:47 | 0.0826 | 0.0080 | 0.0000 |



|                    |        |        |        |
|--------------------|--------|--------|--------|
| 1/25/2012 13:01:47 | 0.1010 | 0.0122 | 0.0000 |
| 1/25/2012 13:07:47 | 0.0656 | 0.0056 | 0.0000 |
| 1/25/2012 13:13:47 | 0.1076 | 0.0151 | 0.0000 |
| 1/25/2012 13:19:47 | 0.0788 | 0.0100 | 0.0000 |
| 1/25/2012 13:25:47 | 0.1211 | 0.0273 | 0.0000 |
| 1/25/2012 13:31:47 | 0.1211 | 0.0155 | 0.0000 |
| 1/25/2012 13:37:47 | 0.1198 | 0.0209 | 0.0000 |
| 1/25/2012 13:43:47 | 0.0804 | 0.0078 | 0.0000 |
| 1/25/2012 13:49:47 | 0.1017 | 0.0132 | 0.0000 |
| 1/25/2012 13:55:47 | 0.1593 | 0.0367 | 0.0000 |
| 1/25/2012 14:01:47 | 0.1017 | 0.0229 | 0.0000 |
| 1/25/2012 14:07:47 | 0.0887 | 0.0100 | 0.0000 |
| 1/25/2012 14:13:47 | 0.1470 | 0.0266 | 0.0000 |
| 1/25/2012 14:19:47 | 0.1526 | 0.0329 | 0.0000 |
| 1/25/2012 14:25:47 | 0.1307 | 0.0292 | 0.0000 |
| 1/25/2012 14:31:47 | 0.1162 | 0.0195 | 0.0000 |
| 1/25/2012 14:37:47 | 0.1441 | 0.0342 | 0.0000 |
| 1/25/2012 14:43:47 | 0.1152 | 0.0195 | 0.0000 |
| 1/25/2012 14:49:47 | 0.0870 | 0.0097 | 0.0000 |
| 1/25/2012 14:55:47 | 0.0785 | 0.0101 | 0.0000 |
| 1/25/2012 15:01:47 | 0.1288 | 0.0107 | 0.0000 |
| 1/25/2012 15:07:47 | 0.1325 | 0.0127 | 0.0000 |
| 1/25/2012 15:13:47 | 0.1357 | 0.0314 | 0.0000 |
| 1/25/2012 15:19:47 | 0.1532 | 0.0360 | 0.0000 |
| 1/25/2012 15:25:47 | 0.1296 | 0.0298 | 0.0000 |
| 1/25/2012 15:31:47 | 0.1182 | 0.0213 | 0.0000 |
| 1/25/2012 15:37:47 | 0.0923 | 0.0132 | 0.0000 |
| 1/25/2012 15:43:47 | 0.0870 | 0.0109 | 0.0000 |
| 1/25/2012 15:57:20 | 0.0581 | 0.0039 | 0.0000 |
| 1/25/2012 16:03:20 | 0.1801 | 0.0578 | 0.0000 |
| 1/25/2012 16:09:20 | 0.0927 | 0.0116 | 0.0000 |
| 1/25/2012 16:15:20 | 0.0483 | 0.0028 | 0.0000 |
| 1/25/2012 16:21:20 | 0.0695 | 0.0104 | 0.0000 |
| 1/25/2012 16:27:20 | 0.1736 | 0.0532 | 0.0000 |
| 1/25/2012 16:33:20 | 0.1949 | 0.0701 | 0.0000 |
| 1/25/2012 16:39:20 | 0.1900 | 0.0609 | 0.0000 |
| 1/25/2012 16:45:20 | 0.1605 | 0.0390 | 0.0000 |
| 1/25/2012 16:51:20 | 0.2028 | 0.0584 | 0.0000 |
| 1/25/2012 16:57:20 | 0.1367 | 0.0296 | 0.0000 |
| 1/25/2012 17:03:20 | 0.1629 | 0.0430 | 0.0000 |
| 1/25/2012 17:09:20 | 0.1010 | 0.0174 | 0.0000 |
| 1/25/2012 17:15:20 | 0.0974 | 0.0113 | 0.0000 |
| 1/25/2012 17:21:20 | 0.0618 | 0.0051 | 0.0000 |
| 1/25/2012 17:27:20 | 0.1444 | 0.0245 | 0.0000 |
| 1/25/2012 17:33:20 | 0.1609 | 0.0520 | 0.0000 |
| 1/25/2012 17:39:20 | 0.0992 | 0.0128 | 0.0000 |
| 1/25/2012 17:45:20 | 0.1344 | 0.0232 | 0.0000 |
| 1/25/2012 17:51:20 | 0.0903 | 0.0131 | 0.0000 |
| 1/25/2012 17:57:20 | 0.1431 | 0.0470 | 0.0007 |
| 1/25/2012 18:03:20 | 0.0760 | 0.0079 | 0.0000 |
| 1/25/2012 18:09:20 | 0.0977 | 0.0201 | 0.0000 |
| 1/25/2012 18:15:20 | 0.1555 | 0.0269 | 0.0000 |
| 1/25/2012 18:21:20 | 0.1069 | 0.0140 | 0.0000 |
| 1/25/2012 18:27:20 | 0.1081 | 0.0108 | 0.0000 |
| 1/25/2012 18:33:20 | 0.1321 | 0.0348 | 0.0000 |
| 1/25/2012 18:39:20 | 0.1273 | 0.0319 | 0.0000 |
| 1/25/2012 18:45:20 | 0.1356 | 0.0365 | 0.0000 |
| 1/25/2012 18:51:20 | 0.1022 | 0.0194 | 0.0000 |
| 1/25/2012 18:57:20 | 0.1214 | 0.0253 | 0.0000 |
| 1/25/2012 19:03:20 | 0.0832 | 0.0088 | 0.0000 |
| 1/25/2012 19:09:20 | 0.0576 | 0.0058 | 0.0000 |
| 1/25/2012 19:15:20 | 0.1186 | 0.0259 | 0.0000 |
| 1/25/2012 19:21:20 | 0.1279 | 0.0283 | 0.0000 |
| 1/25/2012 19:27:20 | 0.1143 | 0.0178 | 0.0000 |
| 1/25/2012 19:33:20 | 0.1037 | 0.0095 | 0.0000 |
| 1/25/2012 19:39:20 | 0.1111 | 0.0187 | 0.0000 |
| 1/25/2012 19:45:20 | 0.0701 | 0.0069 | 0.0000 |
| 1/25/2012 19:51:20 | 0.0816 | 0.0094 | 0.0000 |
| 1/25/2012 19:57:20 | 0.0892 | 0.0079 | 0.0000 |
| 1/25/2012 20:03:20 | 0.0760 | 0.0075 | 0.0000 |
| 1/25/2012 20:09:20 | 0.1228 | 0.0198 | 0.0000 |

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| 1/25/2012 20:15:20 | 0.0791 | 0.0080 | 0.0000 |
| 1/25/2012 20:21:20 | 0.0940 | 0.0102 | 0.0000 |
| 1/25/2012 20:27:20 | 0.1439 | 0.0311 | 0.0000 |
| 1/25/2012 20:33:20 | 0.1167 | 0.0228 | 0.0000 |
| 1/25/2012 20:39:20 | 0.1041 | 0.0160 | 0.0000 |
| 1/25/2012 20:45:20 | 0.0788 | 0.0096 | 0.0000 |
| 1/25/2012 20:51:20 | 0.0746 | 0.0071 | 0.0000 |
| 1/25/2012 20:57:20 | 0.0874 | 0.0094 | 0.0000 |
| 1/25/2012 21:03:20 | 0.1206 | 0.0153 | 0.0000 |
| 1/25/2012 21:09:20 | 0.1184 | 0.0229 | 0.0000 |
| 1/25/2012 21:15:20 | 0.1090 | 0.0156 | 0.0000 |
| 1/25/2012 21:21:20 | 0.1326 | 0.0318 | 0.0000 |
| 1/25/2012 21:27:20 | 0.0755 | 0.0073 | 0.0000 |
| 1/25/2012 21:33:20 | 0.1752 | 0.0426 | 0.0000 |
| 1/25/2012 21:39:20 | 0.1352 | 0.0302 | 0.0000 |
| 1/25/2012 21:45:20 | 0.1071 | 0.0171 | 0.0000 |
| 1/25/2012 21:51:20 | 0.1166 | 0.0224 | 0.0000 |
| 1/25/2012 21:57:20 | 0.1254 | 0.0264 | 0.0000 |
| 1/25/2012 22:03:20 | 0.1269 | 0.0331 | 0.0000 |
| 1/25/2012 22:09:20 | 0.1360 | 0.0326 | 0.0000 |
| 1/25/2012 22:15:20 | 0.1257 | 0.0200 | 0.0000 |
| 1/25/2012 22:21:20 | 0.1216 | 0.0245 | 0.0000 |
| 1/25/2012 22:27:20 | 0.1311 | 0.0285 | 0.0000 |
| 1/25/2012 22:33:20 | 0.0905 | 0.0099 | 0.0000 |
| 1/25/2012 22:39:20 | 0.0896 | 0.0080 | 0.0000 |
| 1/25/2012 22:45:20 | 0.1450 | 0.0412 | 0.0000 |
| 1/25/2012 22:51:20 | 0.0931 | 0.0145 | 0.0000 |
| 1/25/2012 22:57:20 | 0.1475 | 0.0312 | 0.0000 |
| 1/25/2012 23:03:20 | 0.2396 | 0.0373 | 0.0000 |
| 1/25/2012 23:09:20 | 0.1113 | 0.0186 | 0.0000 |
| 1/25/2012 23:15:20 | 0.1074 | 0.0198 | 0.0000 |
| 1/25/2012 23:21:20 | 0.1103 | 0.0142 | 0.0000 |
| 1/25/2012 23:27:20 | 0.2109 | 0.0803 | 0.0032 |
| 1/25/2012 23:33:20 | 0.0984 | 0.0118 | 0.0000 |
| 1/25/2012 23:39:20 | 0.0969 | 0.0142 | 0.0000 |
| 1/25/2012 23:45:20 | 0.1180 | 0.0242 | 0.0000 |
| 1/25/2012 23:51:20 | 0.0866 | 0.0103 | 0.0000 |
| 1/25/2012 23:57:20 | 0.1249 | 0.0272 | 0.0000 |
| 1/26/2012 0:03:20  | 0.1180 | 0.0174 | 0.0000 |
| 1/26/2012 0:09:20  | 0.2761 | 0.0201 | 0.0000 |
| 1/26/2012 0:15:20  | 0.0790 | 0.0066 | 0.0000 |
| 1/26/2012 0:21:20  | 0.0981 | 0.0148 | 0.0000 |
| 1/26/2012 0:27:20  | 0.0962 | 0.0109 | 0.0000 |
| 1/26/2012 0:33:20  | 0.1102 | 0.0182 | 0.0000 |
| 1/26/2012 0:39:20  | 0.1148 | 0.0245 | 0.0000 |
| 1/26/2012 0:45:20  | 0.1258 | 0.0253 | 0.0000 |
| 1/26/2012 0:51:20  | 0.1188 | 0.0251 | 0.0000 |
| 1/26/2012 0:57:20  | 0.1143 | 0.0200 | 0.0000 |
| 1/26/2012 1:03:20  | 0.0832 | 0.0093 | 0.0000 |
| 1/26/2012 1:09:20  | 0.1548 | 0.0377 | 0.0000 |
| 1/26/2012 1:15:20  | 0.0750 | 0.0109 | 0.0000 |
| 1/26/2012 1:21:20  | 0.1095 | 0.0110 | 0.0000 |
| 1/26/2012 1:27:20  | 0.1246 | 0.0229 | 0.0000 |
| 1/26/2012 1:33:20  | 0.1436 | 0.0431 | 0.0000 |
| 1/26/2012 1:39:20  | 0.1319 | 0.0302 | 0.0000 |
| 1/26/2012 1:45:20  | 0.0781 | 0.0084 | 0.0000 |
| 1/26/2012 1:51:20  | 0.0916 | 0.0136 | 0.0000 |
| 1/26/2012 1:57:20  | 0.1229 | 0.0230 | 0.0000 |
| 1/26/2012 2:03:20  | 0.1096 | 0.0172 | 0.0000 |
| 1/26/2012 2:09:20  | 0.1348 | 0.0222 | 0.0000 |
| 1/26/2012 2:15:20  | 0.1199 | 0.0191 | 0.0000 |
| 1/26/2012 2:21:20  | 0.1091 | 0.0200 | 0.0000 |
| 1/26/2012 2:27:20  | 0.1006 | 0.0115 | 0.0000 |
| 1/26/2012 2:33:20  | 0.1241 | 0.0254 | 0.0000 |
| 1/26/2012 2:39:20  | 0.1033 | 0.0176 | 0.0000 |
| 1/26/2012 2:45:20  | 0.0993 | 0.0161 | 0.0000 |
| 1/26/2012 2:51:20  | 0.0881 | 0.0159 | 0.0000 |
| 1/26/2012 2:57:20  | 0.1127 | 0.0174 | 0.0000 |
| 1/26/2012 3:03:20  | 0.0941 | 0.0124 | 0.0000 |
| 1/26/2012 3:09:20  | 0.0907 | 0.0133 | 0.0000 |
| 1/26/2012 3:15:20  | 0.0841 | 0.0117 | 0.0000 |

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| 1/26/2012 3:21:20  | 0.1056 | 0.0117 | 0.0000 |
| 1/26/2012 3:27:20  | 0.1409 | 0.0310 | 0.0000 |
| 1/26/2012 3:33:20  | 0.0799 | 0.0099 | 0.0000 |
| 1/26/2012 3:39:20  | 0.1395 | 0.0324 | 0.0000 |
| 1/26/2012 3:45:20  | 0.1140 | 0.0254 | 0.0000 |
| 1/26/2012 3:51:20  | 0.1037 | 0.0230 | 0.0000 |
| 1/26/2012 3:57:20  | 0.1189 | 0.0179 | 0.0000 |
| 1/26/2012 4:03:20  | 0.1249 | 0.0266 | 0.0000 |
| 1/26/2012 4:09:20  | 0.1280 | 0.0175 | 0.0000 |
| 1/26/2012 4:15:20  | 0.1059 | 0.0165 | 0.0000 |
| 1/26/2012 4:21:20  | 0.0973 | 0.0125 | 0.0000 |
| 1/26/2012 4:27:20  | 0.0929 | 0.0145 | 0.0000 |
| 1/26/2012 4:33:20  | 0.1312 | 0.0230 | 0.0000 |
| 1/26/2012 4:39:20  | 0.1159 | 0.0176 | 0.0000 |
| 1/26/2012 4:45:20  | 0.0671 | 0.0061 | 0.0000 |
| 1/26/2012 4:51:20  | 0.1216 | 0.0287 | 0.0000 |
| 1/26/2012 4:57:20  | 0.1486 | 0.0369 | 0.0000 |
| 1/26/2012 5:03:20  | 0.1501 | 0.0332 | 0.0000 |
| 1/26/2012 5:09:20  | 0.0626 | 0.0056 | 0.0000 |
| 1/26/2012 5:15:20  | 0.1149 | 0.0182 | 0.0000 |
| 1/26/2012 5:21:20  | 0.1187 | 0.0224 | 0.0000 |
| 1/26/2012 5:27:20  | 0.1132 | 0.0277 | 0.0000 |
| 1/26/2012 5:33:20  | 0.1293 | 0.0224 | 0.0000 |
| 1/26/2012 5:39:20  | 0.1791 | 0.0656 | 0.0000 |
| 1/26/2012 5:45:20  | 0.1123 | 0.0273 | 0.0000 |
| 1/26/2012 5:51:20  | 0.1178 | 0.0202 | 0.0000 |
| 1/26/2012 5:57:20  | 0.1023 | 0.0214 | 0.0000 |
| 1/26/2012 6:03:20  | 0.0842 | 0.0103 | 0.0000 |
| 1/26/2012 6:09:20  | 0.0934 | 0.0096 | 0.0000 |
| 1/26/2012 6:15:20  | 0.1079 | 0.0181 | 0.0000 |
| 1/26/2012 6:21:20  | 0.1167 | 0.0273 | 0.0000 |
| 1/26/2012 6:27:20  | 0.0893 | 0.0117 | 0.0000 |
| 1/26/2012 6:33:20  | 0.0746 | 0.0068 | 0.0000 |
| 1/26/2012 6:39:20  | 0.1111 | 0.0171 | 0.0000 |
| 1/26/2012 6:45:20  | 0.1472 | 0.0371 | 0.0000 |
| 1/26/2012 6:51:20  | 0.0910 | 0.0090 | 0.0000 |
| 1/26/2012 6:57:20  | 0.0944 | 0.0137 | 0.0000 |
| 1/26/2012 7:03:20  | 0.2167 | 0.0159 | 0.0000 |
| 1/26/2012 7:09:20  | 0.0596 | 0.0044 | 0.0000 |
| 1/26/2012 7:15:20  | 0.1333 | 0.0243 | 0.0000 |
| 1/26/2012 7:21:20  | 0.1504 | 0.0283 | 0.0000 |
| 1/26/2012 7:27:20  | 0.1353 | 0.0297 | 0.0000 |
| 1/26/2012 7:33:20  | 0.1377 | 0.0314 | 0.0000 |
| 1/26/2012 7:39:20  | 0.0672 | 0.0084 | 0.0000 |
| 1/26/2012 7:45:20  | 0.0889 | 0.0107 | 0.0000 |
| 1/26/2012 7:51:20  | 0.0778 | 0.0109 | 0.0000 |
| 1/26/2012 7:57:20  | 0.0989 | 0.0136 | 0.0000 |
| 1/26/2012 8:09:13  | 0.0481 | 0.0033 | 0.0000 |
| 1/26/2012 8:15:13  | 0.1357 | 0.0455 | 0.0022 |
| 1/26/2012 8:21:13  | 0.0421 | 0.0032 | 0.0000 |
| 1/26/2012 8:27:13  | 0.1007 | 0.0224 | 0.0000 |
| 1/26/2012 8:33:13  | 0.1435 | 0.0332 | 0.0000 |
| 1/26/2012 8:39:13  | 0.0901 | 0.0134 | 0.0000 |
| 1/26/2012 8:45:13  | 0.0764 | 0.0105 | 0.0000 |
| 1/26/2012 8:51:13  | 0.1284 | 0.0319 | 0.0000 |
| 1/26/2012 8:57:13  | 0.1274 | 0.0178 | 0.0000 |
| 1/26/2012 9:03:13  | 0.1470 | 0.0406 | 0.0000 |
| 1/26/2012 9:09:13  | 0.1319 | 0.0365 | 0.0000 |
| 1/26/2012 9:15:13  | 0.1317 | 0.0227 | 0.0000 |
| 1/26/2012 9:21:13  | 0.1168 | 0.0284 | 0.0000 |
| 1/26/2012 9:27:13  | 0.1176 | 0.0276 | 0.0000 |
| 1/26/2012 9:33:13  | 0.0796 | 0.0100 | 0.0000 |
| 1/26/2012 9:39:13  | 0.1289 | 0.0279 | 0.0000 |
| 1/26/2012 9:45:13  | 0.0807 | 0.0060 | 0.0000 |
| 1/26/2012 9:51:13  | 0.0657 | 0.0045 | 0.0000 |
| 1/26/2012 9:57:13  | 0.0522 | 0.0054 | 0.0000 |
| 1/26/2012 10:03:13 | 0.0939 | 0.0170 | 0.0000 |
| 1/26/2012 10:09:13 | 0.0961 | 0.0129 | 0.0000 |
| 1/26/2012 10:15:13 | 0.0855 | 0.0131 | 0.0000 |
| 1/26/2012 10:21:13 | 0.0919 | 0.0114 | 0.0000 |
| 1/26/2012 10:27:13 | 0.0967 | 0.0088 | 0.0000 |

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| 1/26/2012 10:33:13 | 0.0787 | 0.0094 | 0.0000 |
| 1/26/2012 10:39:13 | 0.1028 | 0.0157 | 0.0000 |
| 1/26/2012 10:45:13 | 0.1417 | 0.0286 | 0.0000 |
| 1/26/2012 10:51:13 | 0.1275 | 0.0326 | 0.0000 |
| 1/26/2012 10:57:13 | 0.0693 | 0.0082 | 0.0000 |
| 1/26/2012 11:03:13 | 0.0961 | 0.0126 | 0.0000 |
| 1/26/2012 11:09:13 | 0.0503 | 0.0025 | 0.0000 |
| 1/26/2012 11:15:13 | 0.0647 | 0.0036 | 0.0000 |
| 1/26/2012 11:21:13 | 0.0622 | 0.0058 | 0.0000 |
| 1/26/2012 11:27:13 | 0.1377 | 0.0323 | 0.0000 |
| 1/26/2012 11:33:13 | 0.1241 | 0.0272 | 0.0000 |
| 1/26/2012 11:39:13 | 0.0811 | 0.0158 | 0.0000 |
| 1/26/2012 11:45:13 | 0.0303 | 0.0010 | 0.0000 |
| 1/26/2012 11:51:13 | 0.0521 | 0.0028 | 0.0000 |
| 1/26/2012 11:57:13 | 0.1086 | 0.0166 | 0.0000 |
| 1/26/2012 12:03:13 | 0.2041 | 0.0675 | 0.0000 |
| 1/26/2012 12:09:13 | 0.1714 | 0.0398 | 0.0000 |
| 1/26/2012 12:15:13 | 0.1761 | 0.0476 | 0.0000 |
| 1/26/2012 12:21:13 | 0.1109 | 0.0155 | 0.0000 |
| 1/26/2012 12:27:13 | 0.1451 | 0.0407 | 0.0000 |
| 1/26/2012 12:33:13 | 0.3061 | 0.0466 | 0.0000 |
| 1/26/2012 12:39:13 | 0.6798 | 0.1431 | 0.0000 |
| 1/26/2012 12:45:13 | 0.3312 | 0.0684 | 0.0000 |
| 1/26/2012 12:51:13 | 0.1598 | 0.0137 | 0.0000 |
| 1/26/2012 12:57:13 | 0.5087 | 0.0902 | 0.0000 |
| 1/26/2012 13:03:13 | 0.3036 | 0.0702 | 0.0000 |
| 1/26/2012 13:09:13 | 0.0925 | 0.0108 | 0.0000 |
| 1/26/2012 13:15:13 | 0.1618 | 0.0452 | 0.0000 |
| 1/26/2012 13:21:13 | 0.1903 | 0.0310 | 0.0000 |
| 1/26/2012 13:27:13 | 0.1050 | 0.0149 | 0.0000 |
| 1/26/2012 13:33:13 | 0.0638 | 0.0033 | 0.0000 |
| 1/26/2012 13:39:13 | 0.0446 | 0.0018 | 0.0000 |
| 1/26/2012 13:45:13 | 0.0762 | 0.0089 | 0.0000 |
| 1/26/2012 13:51:13 | 0.0972 | 0.0139 | 0.0000 |
| 1/26/2012 13:57:13 | 0.0648 | 0.0071 | 0.0000 |
| 1/26/2012 14:03:13 | 0.0777 | 0.0109 | 0.0000 |
| 1/26/2012 14:09:13 | 0.0714 | 0.0043 | 0.0000 |
| 1/26/2012 14:15:13 | 0.0804 | 0.0110 | 0.0000 |
| 1/26/2012 14:21:13 | 0.1292 | 0.0258 | 0.0000 |
| 1/26/2012 14:27:13 | 0.0858 | 0.0082 | 0.0000 |
| 1/26/2012 14:33:13 | 0.1090 | 0.0185 | 0.0000 |
| 1/26/2012 14:39:13 | 0.1053 | 0.0136 | 0.0000 |
| 1/26/2012 14:45:13 | 0.0789 | 0.0078 | 0.0000 |
| 1/26/2012 14:51:13 | 0.1074 | 0.0144 | 0.0000 |
| 1/26/2012 14:57:13 | 0.1325 | 0.0245 | 0.0000 |
| 1/26/2012 15:03:13 | 0.1584 | 0.0094 | 0.0000 |
| 1/26/2012 15:09:13 | 0.1346 | 0.0153 | 0.0000 |
| 1/26/2012 15:15:13 | 0.0950 | 0.0145 | 0.0000 |
| 1/26/2012 15:21:13 | 0.0983 | 0.0132 | 0.0000 |
| 1/26/2012 15:27:13 | 0.0722 | 0.0052 | 0.0000 |
| 1/26/2012 15:33:13 | 0.0972 | 0.0111 | 0.0000 |
| 1/26/2012 15:39:13 | 0.0932 | 0.0161 | 0.0000 |
| 1/26/2012 15:45:13 | 0.0928 | 0.0117 | 0.0000 |
| 1/26/2012 15:51:13 | 0.1088 | 0.0148 | 0.0000 |
| 1/26/2012 15:57:13 | 0.0812 | 0.0086 | 0.0000 |
| 1/26/2012 16:03:13 | 0.1329 | 0.0322 | 0.0000 |
| 1/26/2012 16:09:13 | 0.0683 | 0.0073 | 0.0000 |
| 1/26/2012 16:15:13 | 0.1273 | 0.0296 | 0.0000 |
| 1/26/2012 16:21:13 | 0.0904 | 0.0112 | 0.0000 |
| 1/26/2012 16:27:13 | 0.1075 | 0.0125 | 0.0000 |
| 1/26/2012 16:33:13 | 0.0985 | 0.0181 | 0.0000 |
| 1/26/2012 16:39:13 | 0.0838 | 0.0088 | 0.0000 |
| 1/26/2012 16:45:13 | 0.1322 | 0.0190 | 0.0000 |
| 1/26/2012 16:51:13 | 0.1325 | 0.0281 | 0.0000 |
| 1/26/2012 17:02:54 | 0.0605 | 0.0041 | 0.0000 |
| 1/26/2012 17:08:54 | 0.3288 | 0.1857 | 0.0840 |
| 1/26/2012 17:14:54 | 0.2437 | 0.1006 | 0.0054 |
| 1/26/2012 17:20:54 | 0.0912 | 0.0126 | 0.0000 |
| 1/26/2012 17:26:54 | 0.0434 | 0.0014 | 0.0000 |
| 1/26/2012 17:32:54 | 0.0962 | 0.0232 | 0.0000 |
| 1/26/2012 17:38:54 | 0.1518 | 0.0428 | 0.0000 |

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| 1/26/2012 17:44:54 | 0.0763 | 0.0103 | 0.0000 |
| 1/26/2012 17:50:54 | 0.1301 | 0.0263 | 0.0000 |
| 1/26/2012 17:56:54 | 0.1218 | 0.0216 | 0.0000 |
| 1/26/2012 18:02:54 | 0.1362 | 0.0294 | 0.0000 |
| 1/26/2012 18:08:54 | 0.0711 | 0.0067 | 0.0000 |
| 1/26/2012 18:14:54 | 0.1099 | 0.0160 | 0.0000 |
| 1/26/2012 18:20:54 | 0.1368 | 0.0389 | 0.0000 |
| 1/26/2012 18:26:54 | 0.1006 | 0.0129 | 0.0000 |
| 1/26/2012 18:32:54 | 0.1661 | 0.0422 | 0.0000 |
| 1/26/2012 18:38:54 | 0.1578 | 0.0154 | 0.0000 |
| 1/26/2012 18:44:54 | 0.1314 | 0.0226 | 0.0000 |
| 1/26/2012 18:50:54 | 0.1306 | 0.0387 | 0.0000 |
| 1/26/2012 18:56:54 | 0.1209 | 0.0254 | 0.0000 |
| 1/26/2012 19:02:54 | 0.1719 | 0.0511 | 0.0000 |
| 1/26/2012 19:08:54 | 0.1198 | 0.0212 | 0.0000 |
| 1/26/2012 19:14:54 | 0.0731 | 0.0140 | 0.0000 |
| 1/26/2012 19:20:54 | 0.0592 | 0.0039 | 0.0000 |
| 1/26/2012 19:26:54 | 0.1446 | 0.0300 | 0.0000 |
| 1/26/2012 19:32:54 | 0.1101 | 0.0142 | 0.0000 |
| 1/26/2012 19:38:54 | 0.0956 | 0.0140 | 0.0000 |
| 1/26/2012 19:44:54 | 0.1119 | 0.0226 | 0.0000 |
| 1/26/2012 19:50:54 | 0.1435 | 0.0312 | 0.0000 |
| 1/26/2012 19:56:54 | 0.0781 | 0.0070 | 0.0000 |
| 1/26/2012 20:02:54 | 0.1356 | 0.0337 | 0.0000 |
| 1/26/2012 20:08:54 | 0.0816 | 0.0095 | 0.0000 |
| 1/26/2012 20:14:54 | 0.0541 | 0.0040 | 0.0000 |
| 1/26/2012 20:20:54 | 0.1620 | 0.0335 | 0.0000 |
| 1/26/2012 20:26:54 | 0.0864 | 0.0099 | 0.0000 |
| 1/26/2012 20:32:54 | 0.2243 | 0.0758 | 0.0000 |
| 1/26/2012 20:38:54 | 0.0993 | 0.0161 | 0.0000 |
| 1/26/2012 20:44:54 | 0.1017 | 0.0170 | 0.0000 |
| 1/26/2012 20:50:54 | 0.1422 | 0.0302 | 0.0000 |
| 1/26/2012 20:56:54 | 0.0764 | 0.0091 | 0.0000 |
| 1/26/2012 21:02:54 | 0.1132 | 0.0199 | 0.0000 |
| 1/26/2012 21:08:54 | 0.1491 | 0.0344 | 0.0000 |
| 1/26/2012 21:14:54 | 0.1356 | 0.0282 | 0.0000 |
| 1/26/2012 21:20:54 | 0.0888 | 0.0086 | 0.0000 |
| 1/26/2012 21:26:54 | 0.1385 | 0.0296 | 0.0000 |
| 1/26/2012 21:32:54 | 0.1189 | 0.0206 | 0.0000 |
| 1/26/2012 21:38:54 | 0.1540 | 0.0475 | 0.0000 |
| 1/26/2012 21:44:54 | 0.0596 | 0.0045 | 0.0000 |
| 1/26/2012 21:50:54 | 0.1116 | 0.0174 | 0.0000 |
| 1/26/2012 21:56:54 | 0.0622 | 0.0045 | 0.0000 |
| 1/26/2012 22:02:54 | 0.1862 | 0.0571 | 0.0000 |
| 1/26/2012 22:08:54 | 0.0859 | 0.0124 | 0.0000 |
| 1/26/2012 22:14:54 | 0.1026 | 0.0147 | 0.0000 |
| 1/26/2012 22:20:54 | 0.1283 | 0.0192 | 0.0000 |
| 1/26/2012 22:26:54 | 0.1038 | 0.0147 | 0.0000 |
| 1/26/2012 22:32:54 | 0.0970 | 0.0114 | 0.0000 |
| 1/26/2012 22:38:54 | 0.0929 | 0.0159 | 0.0000 |
| 1/26/2012 22:44:54 | 0.1564 | 0.0418 | 0.0000 |
| 1/26/2012 22:50:54 | 0.1670 | 0.0408 | 0.0000 |
| 1/26/2012 22:56:54 | 0.1031 | 0.0152 | 0.0000 |
| 1/26/2012 23:02:54 | 0.2160 | 0.0267 | 0.0000 |
| 1/26/2012 23:08:54 | 0.1112 | 0.0190 | 0.0000 |
| 1/26/2012 23:14:54 | 0.0722 | 0.0077 | 0.0000 |
| 1/26/2012 23:20:54 | 0.0815 | 0.0123 | 0.0000 |
| 1/26/2012 23:26:54 | 0.1610 | 0.0319 | 0.0000 |
| 1/26/2012 23:32:54 | 0.0720 | 0.0086 | 0.0000 |
| 1/26/2012 23:38:54 | 0.1427 | 0.0392 | 0.0000 |
| 1/26/2012 23:44:54 | 0.1052 | 0.0158 | 0.0000 |
| 1/26/2012 23:50:54 | 0.0890 | 0.0117 | 0.0000 |
| 1/26/2012 23:56:54 | 0.0740 | 0.0072 | 0.0000 |
| 1/27/2012 0:02:54  | 0.2041 | 0.0587 | 0.0000 |
| 1/27/2012 0:08:54  | 0.1220 | 0.0220 | 0.0000 |
| 1/27/2012 0:14:54  | 0.0746 | 0.0076 | 0.0000 |
| 1/27/2012 0:20:54  | 0.1958 | 0.0113 | 0.0000 |
| 1/27/2012 0:26:54  | 0.1536 | 0.0345 | 0.0000 |
| 1/27/2012 0:32:54  | 0.1140 | 0.0175 | 0.0000 |
| 1/27/2012 0:38:54  | 0.0898 | 0.0178 | 0.0000 |
| 1/27/2012 0:44:54  | 0.0871 | 0.0174 | 0.0000 |

|                   |        |        |        |
|-------------------|--------|--------|--------|
| 1/27/2012 0:50:54 | 0.1039 | 0.0163 | 0.0000 |
| 1/27/2012 0:56:54 | 0.0922 | 0.0135 | 0.0000 |
| 1/27/2012 1:02:54 | 0.1103 | 0.0164 | 0.0000 |
| 1/27/2012 1:08:54 | 0.1140 | 0.0180 | 0.0000 |
| 1/27/2012 1:14:54 | 0.1077 | 0.0199 | 0.0000 |
| 1/27/2012 1:20:54 | 0.0802 | 0.0083 | 0.0000 |
| 1/27/2012 1:26:54 | 0.1533 | 0.0419 | 0.0000 |
| 1/27/2012 1:32:54 | 0.1017 | 0.0169 | 0.0000 |
| 1/27/2012 1:38:54 | 0.0688 | 0.0062 | 0.0000 |
| 1/27/2012 1:44:54 | 0.1232 | 0.0163 | 0.0000 |
| 1/27/2012 1:50:54 | 0.1286 | 0.0268 | 0.0000 |
| 1/27/2012 1:56:54 | 0.1048 | 0.0209 | 0.0000 |
| 1/27/2012 2:02:54 | 0.0713 | 0.0060 | 0.0000 |
| 1/27/2012 2:08:54 | 0.1321 | 0.0221 | 0.0000 |
| 1/27/2012 2:14:54 | 0.1067 | 0.0130 | 0.0000 |
| 1/27/2012 2:20:54 | 0.0993 | 0.0153 | 0.0000 |
| 1/27/2012 2:26:54 | 0.1329 | 0.0244 | 0.0000 |
| 1/27/2012 2:32:54 | 0.0891 | 0.0133 | 0.0000 |
| 1/27/2012 2:38:54 | 0.0979 | 0.0151 | 0.0000 |
| 1/27/2012 2:44:54 | 0.1177 | 0.0261 | 0.0000 |
| 1/27/2012 2:50:54 | 0.1091 | 0.0153 | 0.0000 |
| 1/27/2012 2:56:54 | 0.0953 | 0.0105 | 0.0000 |
| 1/27/2012 3:02:54 | 0.1322 | 0.0348 | 0.0000 |
| 1/27/2012 3:08:54 | 0.0938 | 0.0119 | 0.0000 |
| 1/27/2012 3:14:54 | 0.1088 | 0.0157 | 0.0000 |
| 1/27/2012 3:20:54 | 0.1807 | 0.0508 | 0.0000 |
| 1/27/2012 3:26:54 | 0.1343 | 0.0250 | 0.0000 |
| 1/27/2012 3:32:54 | 0.0899 | 0.0092 | 0.0000 |
| 1/27/2012 3:38:54 | 0.1062 | 0.0154 | 0.0000 |
| 1/27/2012 3:44:54 | 0.1128 | 0.0132 | 0.0000 |
| 1/27/2012 3:50:54 | 0.1162 | 0.0173 | 0.0000 |
| 1/27/2012 3:56:54 | 0.1313 | 0.0299 | 0.0000 |
| 1/27/2012 4:02:54 | 0.1710 | 0.0605 | 0.0000 |
| 1/27/2012 4:08:54 | 0.0895 | 0.0156 | 0.0000 |
| 1/27/2012 4:14:54 | 0.1056 | 0.0196 | 0.0000 |
| 1/27/2012 4:20:54 | 0.1363 | 0.0305 | 0.0000 |
| 1/27/2012 4:26:54 | 0.1327 | 0.0287 | 0.0000 |
| 1/27/2012 4:32:54 | 0.0863 | 0.0086 | 0.0000 |
| 1/27/2012 4:38:54 | 0.1560 | 0.0378 | 0.0000 |
| 1/27/2012 4:44:54 | 0.1524 | 0.0341 | 0.0000 |
| 1/27/2012 4:50:54 | 0.1057 | 0.0169 | 0.0000 |
| 1/27/2012 4:56:54 | 0.1026 | 0.0130 | 0.0000 |
| 1/27/2012 5:02:54 | 0.2003 | 0.0699 | 0.0000 |
| 1/27/2012 5:08:54 | 0.0989 | 0.0157 | 0.0000 |
| 1/27/2012 5:14:54 | 0.0971 | 0.0131 | 0.0000 |
| 1/27/2012 5:20:54 | 0.0701 | 0.0077 | 0.0000 |
| 1/27/2012 5:26:54 | 0.1049 | 0.0220 | 0.0000 |
| 1/27/2012 5:32:54 | 0.0890 | 0.0078 | 0.0000 |
| 1/27/2012 5:38:54 | 0.1066 | 0.0144 | 0.0000 |
| 1/27/2012 5:44:54 | 0.1080 | 0.0159 | 0.0000 |
| 1/27/2012 5:50:54 | 0.0416 | 0.0022 | 0.0000 |
| 1/27/2012 5:56:54 | 0.0812 | 0.0080 | 0.0000 |
| 1/27/2012 6:02:54 | 0.0920 | 0.0139 | 0.0000 |
| 1/27/2012 6:08:54 | 0.1106 | 0.0171 | 0.0000 |
| 1/27/2012 6:14:54 | 0.1175 | 0.0213 | 0.0000 |
| 1/27/2012 6:20:54 | 0.1073 | 0.0187 | 0.0000 |
| 1/27/2012 6:26:54 | 0.0554 | 0.0041 | 0.0000 |
| 1/27/2012 6:32:54 | 0.1234 | 0.0260 | 0.0000 |
| 1/27/2012 6:38:54 | 0.0973 | 0.0118 | 0.0000 |
| 1/27/2012 6:44:54 | 0.0842 | 0.0086 | 0.0000 |
| 1/27/2012 6:50:54 | 0.0734 | 0.0064 | 0.0000 |
| 1/27/2012 6:56:54 | 0.1160 | 0.0151 | 0.0000 |
| 1/27/2012 7:02:54 | 0.1698 | 0.0181 | 0.0000 |
| 1/27/2012 7:08:54 | 0.1030 | 0.0183 | 0.0000 |
| 1/27/2012 7:14:54 | 0.1145 | 0.0153 | 0.0000 |
| 1/27/2012 7:20:54 | 0.1165 | 0.0220 | 0.0000 |
| 1/27/2012 7:26:54 | 0.1165 | 0.0182 | 0.0000 |
| 1/27/2012 7:32:54 | 0.1973 | 0.0691 | 0.0022 |
| 1/27/2012 7:38:54 | 0.0926 | 0.0117 | 0.0000 |
| 1/27/2012 7:44:54 | 0.1122 | 0.0214 | 0.0000 |
| 1/27/2012 7:50:54 | 0.1607 | 0.0437 | 0.0000 |

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|---------------------|--------|--------|-------------|
| 1/27/2012 7:56:54   | 0.0891 | 0.0154 | 0.0000      |
| 1/27/2012 8:02:54   | 0.1081 | 0.0233 | 0.0000      |
| 1/27/2012 8:08:54   | 0.1197 | 0.0207 | 0.0000      |
| 1/27/2012 8:14:54   | 0.1316 | 0.0252 | 0.0000      |
| 1/27/2012 8:20:54   | 0.1079 | 0.0103 | 0.0000      |
| 1/27/2012 8:26:54   | 0.0967 | 0.0146 | 0.0000      |
| 1/27/2012 8:32:54   | 0.0908 | 0.0149 | 0.0000      |
| 1/27/2012 8:38:54   | 0.1193 | 0.0182 | 0.0000      |
| 1/27/2012 8:44:54   | 0.2046 | 0.0377 | 0.0000      |
| 1/27/2012 8:50:54   | 0.1435 | 0.0284 | 0.0000      |
| 1/27/2012 8:56:54   | 0.0843 | 0.0058 | 0.0000      |
| 1/27/2012 9:02:54   | 0.1750 | 0.0445 | 0.0000      |
| 1/27/2012 9:08:54   | 0.0684 | 0.0082 | 0.0000      |
| 22/03/2012 9:21:09  | 0.0900 | 0.0086 | 0           |
| 22/03/2012 9:27:09  | 0.0817 | 0.0170 | 0           |
| 22/03/2012 9:33:09  | 0.0619 | 0.0022 | 0           |
| 22/03/2012 9:39:09  | 0.1856 | 0.0206 | 0           |
| 22/03/2012 9:45:09  | 0.1910 | 0.0670 | 0.003233333 |
| 22/03/2012 9:51:09  | 0.1608 | 0.0324 | 0           |
| 22/03/2012 9:57:09  | 0.2255 | 0.0789 | 0.0046      |
| 22/03/2012 10:03:09 | 0.1802 | 0.0544 | 0           |
| 22/03/2012 10:09:09 | 0.1645 | 0.0486 | 0           |
| 22/03/2012 10:15:09 | 0.1310 | 0.0323 | 0           |
| 22/03/2012 10:21:09 | 0.1465 | 0.0453 | 0           |
| 22/03/2012 10:27:09 | 0.1328 | 0.0248 | 0           |
| 22/03/2012 10:33:09 | 0.0942 | 0.0162 | 0           |
| 22/03/2012 10:39:09 | 0.0921 | 0.0144 | 0           |
| 22/03/2012 10:45:09 | 0.0908 | 0.0100 | 0           |
| 22/03/2012 10:51:09 | 0.0809 | 0.0120 | 0           |
| 22/03/2012 10:57:09 | 0.1384 | 0.0343 | 0           |
| 22/03/2012 11:03:09 | 0.1078 | 0.0182 | 0           |
| 22/03/2012 11:09:09 | 0.1679 | 0.0386 | 0           |
| 22/03/2012 11:15:09 | 0.1546 | 0.0399 | 0           |
| 22/03/2012 11:21:09 | 0.0884 | 0.0101 | 0           |
| 22/03/2012 11:27:09 | 0.0815 | 0.0085 | 0           |
| 22/03/2012 11:33:09 | 0.1165 | 0.0195 | 0           |
| 22/03/2012 11:39:09 | 0.0881 | 0.0093 | 0           |
| 22/03/2012 11:45:09 | 0.1039 | 0.0228 | 0           |
| 22/03/2012 11:51:09 | 0.0886 | 0.0113 | 0           |
| 22/03/2012 11:57:09 | 0.0777 | 0.0074 | 0           |
| 22/03/2012 12:03:09 | 0.0757 | 0.0075 | 0           |
| 22/03/2012 12:09:09 | 0.0550 | 0.0029 | 0           |
| 22/03/2012 12:15:09 | 0.0587 | 0.0067 | 0           |
| 22/03/2012 12:21:09 | 0.0756 | 0.0062 | 0           |
| 22/03/2012 12:27:09 | 0.0819 | 0.0101 | 0           |
| 22/03/2012 12:33:09 | 0.1092 | 0.0210 | 0           |
| 22/03/2012 12:39:09 | 0.1151 | 0.0193 | 0           |
| 22/03/2012 12:45:09 | 0.1186 | 0.0287 | 0           |
| 22/03/2012 12:51:09 | 0.0968 | 0.0141 | 0           |
| 22/03/2012 12:57:09 | 0.1079 | 0.0179 | 0           |
| 22/03/2012 13:03:09 | 0.1424 | 0.0184 | 0           |
| 22/03/2012 13:09:09 | 0.1135 | 0.0175 | 0           |
| 22/03/2012 13:15:09 | 0.0941 | 0.0099 | 0           |
| 22/03/2012 13:21:09 | 0.1089 | 0.0221 | 0           |
| 22/03/2012 13:27:09 | 0.1165 | 0.0156 | 0           |
| 22/03/2012 13:33:09 | 0.0673 | 0.0062 | 0           |
| 22/03/2012 13:39:09 | 0.0982 | 0.0108 | 0           |
| 22/03/2012 13:45:09 | 0.1314 | 0.0242 | 0           |
| 22/03/2012 13:51:09 | 0.1438 | 0.0395 | 0           |
| 22/03/2012 13:57:09 | 0.1327 | 0.0237 | 0           |
| 22/03/2012 14:03:09 | 0.0820 | 0.0082 | 0           |
| 22/03/2012 14:09:09 | 0.1091 | 0.0159 | 0           |
| 22/03/2012 14:15:09 | 0.0874 | 0.0105 | 0           |
| 22/03/2012 14:21:09 | 0.0814 | 0.0075 | 0           |
| 22/03/2012 14:27:09 | 0.1108 | 0.0217 | 0           |
| 22/03/2012 14:33:09 | 0.1381 | 0.0266 | 0           |
| 22/03/2012 14:39:09 | 0.0817 | 0.0091 | 0           |
| 22/03/2012 14:45:09 | 0.0906 | 0.0144 | 0           |
| 22/03/2012 14:51:09 | 0.1120 | 0.0171 | 0           |
| 22/03/2012 14:57:09 | 0.0801 | 0.0090 | 0           |
| 22/03/2012 15:03:09 | 0.1012 | 0.0190 | 0           |

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|---------------------|--------|--------|---|
| 22/03/2012 15:09:09 | 0.1228 | 0.0214 | 0 |
| 22/03/2012 15:15:09 | 0.1551 | 0.0323 | 0 |
| 22/03/2012 15:21:09 | 0.1434 | 0.0321 | 0 |
| 22/03/2012 15:27:09 | 0.0777 | 0.0055 | 0 |
| 22/03/2012 15:33:09 | 0.1052 | 0.0204 | 0 |
| 22/03/2012 15:39:09 | 0.1167 | 0.0183 | 0 |
| 22/03/2012 15:45:09 | 0.1037 | 0.0133 | 0 |
| 22/03/2012 15:51:09 | 0.0907 | 0.0117 | 0 |
| 22/03/2012 15:57:09 | 0.1081 | 0.0153 | 0 |
| 22/03/2012 16:03:09 | 0.2173 | 0.0353 | 0 |
| 22/03/2012 16:09:09 | 0.1595 | 0.0420 | 0 |
| 22/03/2012 16:18:11 | 0.1543 | 0.0270 | 0 |
| 22/03/2012 16:24:11 | 0.0958 | 0.0278 | 0 |
| 22/03/2012 16:30:11 | 0.1020 | 0.0139 | 0 |
| 22/03/2012 16:36:11 | 0.1246 | 0.0245 | 0 |
| 22/03/2012 16:42:11 | 0.1141 | 0.0185 | 0 |
| 22/03/2012 16:48:11 | 0.1010 | 0.0162 | 0 |
| 22/03/2012 16:54:11 | 0.1635 | 0.0481 | 0 |
| 22/03/2012 17:00:11 | 0.1137 | 0.0203 | 0 |
| 22/03/2012 17:06:11 | 0.0800 | 0.0101 | 0 |
| 22/03/2012 17:12:11 | 0.1623 | 0.0462 | 0 |
| 22/03/2012 17:18:11 | 0.1297 | 0.0348 | 0 |
| 22/03/2012 17:24:11 | 0.1078 | 0.0139 | 0 |
| 22/03/2012 17:30:11 | 0.0842 | 0.0109 | 0 |
| 22/03/2012 17:36:11 | 0.1126 | 0.0135 | 0 |
| 22/03/2012 17:42:11 | 0.1377 | 0.0313 | 0 |
| 22/03/2012 17:48:11 | 0.0916 | 0.0121 | 0 |
| 22/03/2012 17:54:11 | 0.1001 | 0.0218 | 0 |
| 22/03/2012 18:00:11 | 0.1691 | 0.0432 | 0 |
| 22/03/2012 18:06:11 | 0.1255 | 0.0277 | 0 |
| 22/03/2012 18:12:11 | 0.1489 | 0.0432 | 0 |
| 22/03/2012 18:18:11 | 0.0992 | 0.0174 | 0 |
| 22/03/2012 18:24:11 | 0.0743 | 0.0061 | 0 |
| 22/03/2012 18:30:11 | 0.1373 | 0.0290 | 0 |
| 22/03/2012 18:36:11 | 0.1382 | 0.0188 | 0 |
| 22/03/2012 18:42:11 | 0.1307 | 0.0307 | 0 |
| 22/03/2012 18:48:11 | 0.1020 | 0.0170 | 0 |
| 22/03/2012 18:54:11 | 0.0990 | 0.0159 | 0 |
| 22/03/2012 19:00:11 | 0.1267 | 0.0255 | 0 |
| 22/03/2012 19:06:11 | 0.1021 | 0.0174 | 0 |
| 22/03/2012 19:12:11 | 0.1174 | 0.0089 | 0 |
| 22/03/2012 19:18:11 | 0.1015 | 0.0131 | 0 |
| 22/03/2012 19:24:11 | 0.1042 | 0.0085 | 0 |
| 22/03/2012 19:30:11 | 0.0846 | 0.0130 | 0 |
| 22/03/2012 19:36:11 | 0.0724 | 0.0070 | 0 |
| 22/03/2012 19:42:11 | 0.0924 | 0.0093 | 0 |
| 22/03/2012 19:48:11 | 0.0965 | 0.0145 | 0 |
| 22/03/2012 19:54:11 | 0.1049 | 0.0205 | 0 |
| 22/03/2012 20:00:11 | 0.1310 | 0.0239 | 0 |
| 22/03/2012 20:06:11 | 0.1377 | 0.0321 | 0 |
| 22/03/2012 20:12:11 | 0.1136 | 0.0162 | 0 |
| 22/03/2012 20:18:11 | 0.1073 | 0.0149 | 0 |
| 22/03/2012 20:24:11 | 0.1114 | 0.0193 | 0 |
| 22/03/2012 20:30:11 | 0.1277 | 0.0339 | 0 |
| 22/03/2012 20:36:11 | 0.1396 | 0.0370 | 0 |
| 22/03/2012 20:42:11 | 0.1406 | 0.0269 | 0 |
| 22/03/2012 20:48:11 | 0.1621 | 0.0357 | 0 |
| 22/03/2012 20:54:11 | 0.0990 | 0.0138 | 0 |
| 22/03/2012 21:00:11 | 0.1007 | 0.0163 | 0 |
| 22/03/2012 21:06:11 | 0.1301 | 0.0266 | 0 |
| 22/03/2012 21:12:11 | 0.1473 | 0.0176 | 0 |
| 22/03/2012 21:18:11 | 0.1538 | 0.0365 | 0 |
| 22/03/2012 21:24:11 | 0.0973 | 0.0202 | 0 |
| 22/03/2012 21:30:11 | 0.1338 | 0.0343 | 0 |
| 22/03/2012 21:36:11 | 0.1530 | 0.0397 | 0 |
| 22/03/2012 21:42:11 | 0.1372 | 0.0289 | 0 |
| 22/03/2012 21:48:11 | 0.0971 | 0.0138 | 0 |
| 22/03/2012 21:54:11 | 0.0976 | 0.0126 | 0 |
| 22/03/2012 22:00:11 | 0.0834 | 0.0099 | 0 |
| 22/03/2012 22:06:11 | 0.1461 | 0.0375 | 0 |
| 22/03/2012 22:12:11 | 0.1181 | 0.0254 | 0 |



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|---------------------|--------|--------|---|
| 22/03/2012 22:18:11 | 0.1064 | 0.0189 | 0 |
| 22/03/2012 22:24:11 | 0.1188 | 0.0206 | 0 |
| 22/03/2012 22:30:11 | 0.1499 | 0.0386 | 0 |
| 22/03/2012 22:36:11 | 0.1258 | 0.0258 | 0 |
| 22/03/2012 22:42:11 | 0.1488 | 0.0349 | 0 |
| 22/03/2012 22:48:11 | 0.1281 | 0.0272 | 0 |
| 22/03/2012 22:54:11 | 0.1274 | 0.0191 | 0 |
| 22/03/2012 23:00:11 | 0.1373 | 0.0392 | 0 |
| 22/03/2012 23:06:11 | 0.1037 | 0.0199 | 0 |
| 22/03/2012 23:12:11 | 0.0988 | 0.0130 | 0 |
| 22/03/2012 23:18:11 | 0.1102 | 0.0198 | 0 |
| 22/03/2012 23:24:11 | 0.1376 | 0.0267 | 0 |
| 22/03/2012 23:30:11 | 0.0910 | 0.0071 | 0 |
| 22/03/2012 23:36:11 | 0.1589 | 0.0349 | 0 |
| 22/03/2012 23:42:11 | 0.0952 | 0.0169 | 0 |
| 22/03/2012 23:48:11 | 0.0671 | 0.0082 | 0 |
| 22/03/2012 23:54:11 | 0.1134 | 0.0227 | 0 |
| 23/03/2012 0:00:11  | 0.1106 | 0.0174 | 0 |
| 23/03/2012 0:06:11  | 0.2336 | 0.0325 | 0 |
| 23/03/2012 0:12:11  | 0.1243 | 0.0223 | 0 |
| 23/03/2012 0:18:11  | 0.0930 | 0.0152 | 0 |
| 23/03/2012 0:24:11  | 0.1245 | 0.0197 | 0 |
| 23/03/2012 0:30:11  | 0.0863 | 0.0147 | 0 |
| 23/03/2012 0:36:11  | 0.0925 | 0.0124 | 0 |
| 23/03/2012 0:42:11  | 0.0712 | 0.0102 | 0 |
| 23/03/2012 0:48:11  | 0.0916 | 0.0114 | 0 |
| 23/03/2012 0:54:11  | 0.0945 | 0.0118 | 0 |
| 23/03/2012 1:00:11  | 0.1312 | 0.0307 | 0 |
| 23/03/2012 1:06:11  | 0.0946 | 0.0173 | 0 |
| 23/03/2012 1:12:11  | 0.0810 | 0.0053 | 0 |
| 23/03/2012 1:18:11  | 0.1151 | 0.0214 | 0 |
| 23/03/2012 1:24:11  | 0.1115 | 0.0209 | 0 |
| 23/03/2012 1:30:11  | 0.1441 | 0.0320 | 0 |
| 23/03/2012 1:36:11  | 0.1215 | 0.0179 | 0 |
| 23/03/2012 1:42:11  | 0.1898 | 0.0604 | 0 |
| 23/03/2012 1:48:11  | 0.1285 | 0.0338 | 0 |
| 23/03/2012 1:54:11  | 0.1007 | 0.0177 | 0 |
| 23/03/2012 2:00:11  | 0.1049 | 0.0215 | 0 |
| 23/03/2012 2:06:11  | 0.1167 | 0.0248 | 0 |
| 23/03/2012 2:12:11  | 0.1837 | 0.0158 | 0 |
| 23/03/2012 2:18:11  | 0.0826 | 0.0113 | 0 |
| 23/03/2012 2:24:11  | 0.1347 | 0.0245 | 0 |
| 23/03/2012 2:30:11  | 0.1440 | 0.0275 | 0 |
| 23/03/2012 2:36:11  | 0.1002 | 0.0109 | 0 |
| 23/03/2012 2:42:11  | 0.0955 | 0.0094 | 0 |
| 23/03/2012 2:48:11  | 0.0955 | 0.0112 | 0 |
| 23/03/2012 2:54:11  | 0.1380 | 0.0337 | 0 |
| 23/03/2012 3:00:11  | 0.1215 | 0.0253 | 0 |
| 23/03/2012 3:06:11  | 0.1665 | 0.0400 | 0 |
| 23/03/2012 3:12:11  | 0.1035 | 0.0128 | 0 |
| 23/03/2012 3:18:11  | 0.0972 | 0.0157 | 0 |
| 23/03/2012 3:24:11  | 0.0919 | 0.0111 | 0 |
| 23/03/2012 3:30:11  | 0.1048 | 0.0284 | 0 |
| 23/03/2012 3:36:11  | 0.0987 | 0.0195 | 0 |
| 23/03/2012 3:42:11  | 0.1291 | 0.0278 | 0 |
| 23/03/2012 3:48:11  | 0.1219 | 0.0264 | 0 |
| 23/03/2012 3:54:11  | 0.1082 | 0.0225 | 0 |
| 23/03/2012 4:00:11  | 0.1322 | 0.0308 | 0 |
| 23/03/2012 4:06:11  | 0.1511 | 0.0333 | 0 |
| 23/03/2012 4:12:11  | 0.0844 | 0.0122 | 0 |
| 23/03/2012 4:18:11  | 0.0737 | 0.0109 | 0 |
| 23/03/2012 4:24:11  | 0.0672 | 0.0061 | 0 |
| 23/03/2012 4:30:11  | 0.1027 | 0.0150 | 0 |
| 23/03/2012 4:36:11  | 0.1032 | 0.0177 | 0 |
| 23/03/2012 4:42:11  | 0.0685 | 0.0052 | 0 |
| 23/03/2012 4:48:11  | 0.0830 | 0.0110 | 0 |
| 23/03/2012 4:54:11  | 0.0976 | 0.0130 | 0 |
| 23/03/2012 5:00:11  | 0.1173 | 0.0169 | 0 |
| 23/03/2012 5:06:11  | 0.0862 | 0.0138 | 0 |
| 23/03/2012 5:12:11  | 0.1173 | 0.0225 | 0 |
| 23/03/2012 5:18:11  | 0.0972 | 0.0133 | 0 |

|                    |        |        |   |
|--------------------|--------|--------|---|
| 23/03/2012 5:24:11 | 0.1275 | 0.0222 | 0 |
| 23/03/2012 5:30:11 | 0.0944 | 0.0198 | 0 |
| 23/03/2012 5:36:11 | 0.0982 | 0.0134 | 0 |
| 23/03/2012 5:42:11 | 0.1210 | 0.0302 | 0 |
| 23/03/2012 5:48:11 | 0.1053 | 0.0193 | 0 |
| 23/03/2012 5:54:11 | 0.0738 | 0.0115 | 0 |
| 23/03/2012 6:00:11 | 0.0716 | 0.0069 | 0 |
| 23/03/2012 6:06:11 | 0.0906 | 0.0144 | 0 |
| 23/03/2012 6:12:11 | 0.1331 | 0.0277 | 0 |
| 23/03/2012 6:18:11 | 0.1116 | 0.0191 | 0 |
| 23/03/2012 6:24:11 | 0.1188 | 0.0203 | 0 |
| 23/03/2012 6:30:11 | 0.1025 | 0.0141 | 0 |
| 23/03/2012 6:36:11 | 0.1238 | 0.0193 | 0 |
| 23/03/2012 6:42:11 | 0.0826 | 0.0112 | 0 |
| 23/03/2012 6:48:11 | 0.1165 | 0.0182 | 0 |
| 23/03/2012 6:54:11 | 0.1236 | 0.0226 | 0 |
| 23/03/2012 7:00:11 | 0.0884 | 0.0096 | 0 |
| 23/03/2012 7:06:11 | 0.0679 | 0.0063 | 0 |
| 23/03/2012 7:12:11 | 0.1108 | 0.0201 | 0 |
| 23/03/2012 7:18:11 | 0.1177 | 0.0184 | 0 |
| 23/03/2012 7:24:11 | 0.1570 | 0.0331 | 0 |
| 23/03/2012 7:30:11 | 0.1315 | 0.0292 | 0 |
| 23/03/2012 7:36:11 | 0.1161 | 0.0294 | 0 |
| 23/03/2012 7:42:11 | 0.0853 | 0.0114 | 0 |
| 23/03/2012 7:48:11 | 0.0630 | 0.0060 | 0 |
| 23/03/2012 7:54:11 | 0.1070 | 0.0143 | 0 |
| 23/03/2012 8:00:11 | 0.1141 | 0.0185 | 0 |
| 23/03/2012 8:06:11 | 0.1850 | 0.0258 | 0 |
| 23/03/2012 8:12:11 | 0.0907 | 0.0129 | 0 |
| 23/03/2012 8:18:11 | 0.0660 | 0.0059 | 0 |
| 23/03/2012 8:24:11 | 0.0968 | 0.0159 | 0 |
| 23/03/2012 8:30:11 | 0.0881 | 0.0097 | 0 |
| 23/03/2012 8:36:11 | 0.0770 | 0.0090 | 0 |
| 23/03/2012 8:42:11 | 0.0936 | 0.0104 | 0 |
| 23/03/2012 8:48:11 | 0.1073 | 0.0096 | 0 |
| 23/03/2012 8:54:11 | 0.0865 | 0.0126 | 0 |
| 23/03/2012 9:00:11 | 0.0962 | 0.0170 | 0 |
| 23/03/2012 9:06:11 | 0.0837 | 0.0130 | 0 |
| 23/03/2012 9:12:11 | 0.0854 | 0.0031 | 0 |
| 23/03/2012 9:18:11 | 0.0538 | 0.0047 | 0 |

|  |     |   |  |  |             |                   |  |          |             |
|--|-----|---|--|--|-------------|-------------------|--|----------|-------------|
|  |     |   |  |  |             |                   |  |          |             |
| REVISIONS  |     |   |  |  |             |                   |  |          |             |
|  | REV | DESCRIPTION   |  |  |             | DATE              |  | APPROVED |             |
|  | 0.1 | Preliminary Draft for Review  |  |  |             | February 13, 2012 |  |          |             |
|  | 0.2 | Updated Draft   |  |  |             | February 16, 2012 |  |          |             |
|  | 0.3 | Revised   |  |  |             | February 29, 2012 |  |          |             |
|  |     |   |  |  |             |                   |  |          |             |
|  |     | DRAWN   |  |  |             |                   | Tony van Wouw, P.Eng.<br>Exotek Consulting<br>Sidney, BC, Canada |          |             |
|  |     | CHECKED   |  |  |             |                   |  |          |             |
|  |     | <b>BC Hydro – Bank of 40 Smart Meters</b><br><b>Victoria, BC</b><br><b>Annex A – Spectrum Analyzer Observations</b><br><i>Prepared for BC Hydro</i> |  |  |             |                   |  |          |             |
| THIS DOCUMENT HAS BEEN<br>ELECTRONICALLY SIGNED<br>WHEN STAMP IS VISIBLE.<br>REFER TO THE ELECTRONIC<br>VERSION FOR SIGNATURE<br>AND DOCUMENT<br>VERIFICATION. |     | Measurements by: Tony van Wouw,<br>P.Eng.<br>Email: tony@exotek.ca<br>Report date: February 29, 2012  |  |  | SIZE        |                   | DWG. NO.   |          | REV         |
|  |     |   |  |  |             |                   | BC Hydro–40 Meter Bank   |          | 0.3         |
|  |     |   |  |  | SCALE: None |                   |  |          | PAGE 1 OF 6 |

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## **Introduction**

The purpose of the spectrum analyzer measurements is to illustrate the variety of signals present in the observed environment and their relative signal levels. This measurement was conducted by providing snapshots of the RF environment in the area of a bank of 40 smart meters where more rigorous Safety Code 6 compliance measurements were being undertaken.

These spectrum analyzer results are not meant to be a precise scientific assessment of BC Hydro's smart meter radio levels but instead a realistic view of radiofrequency environments typically found in most suburban environments. The data found herein supplements the Planetworks Safety Code 6 Report at [REDACTED], Victoria by providing additional visibility into the radiofrequency environment.

Spectrum analyzer measurements were taken at [REDACTED] taken during Safety Code 6 testing for a bank of Smart Meters as per Planetworks and BC Hydro by Tony van Wouw, P.Eng. during the period from January 23th to January 27<sup>th</sup>, 2012.

## **Equipment**

- Spectrum analyzer - Hewlett Packard 8593E
- Antenna - Log-periodic with nominal frequency response from 300-2500 MHz (measured gain 4 dB relative to a dipole) and an adjustable dipole capable of 50-400 MHz.

The spectrum analyzer is a device that measures the amplitude of radio waves within a specified frequency range of the instrument. These devices are widely used in telecommunication to determine occupied bandwidth and track possible interference sources. In this case, it can be used to determine the variety of signals present in a field environment, and their relative signal levels.

The graph produced by the spectrum analyzer shows the data on a *frequency-based horizontal axis*, as opposed to typical time-base horizontal axis. Therefore, specifying the range of the frequencies measured, allows for adjustment of the display to improve visibility of the individual signal levels. The *amplitude of the signal* is displayed on the vertical-axis and the maximum level of the vertical axis is adjusted using the Reference Level (REF on top left of screenshot). For example, signals at Reference Level of -10.0dBm would appear shorter than if the same signal is referenced at -50.0dBm. Conversely, signals at a -50dBm level would appear magnified compared to -10dBm. Note that the unit dBm is known as *decibels relative to one milliwatt* and therefore is a base-10 logarithmic view where every increment increases the value by 10.

Note: the operation frequency range of BC Hydro's smart meter is from 902 to 928MHz over 50 channels as per Industry Canada RSS-210 requirements.

## **Methodology and Calculations**

The spectrum analyzer and antenna were initially placed in the meter room within 75 centimetres of the meters, and a 20 dB gain amplifier was used to amplify the signals. The very small distance and pre-amplifier gain was necessary to clearly identify the smart meters signals, which could only be acquired after several hours of measurement using the max hold function.

Within the proximity of 75 centimetres, there were significant amounts of sheet metal and cables within the near-field of the spectrum analyzer antenna, which can significantly skew the results. Due to this fact and meter room space constraints, the equipment had to be relocated approximately 7 metres away from the meter bank, in the adjoining work-shop.

The spectrum analyzer data is represented in relative levels for comparing peak measures from other sources relative to the smart meters. Absolute levels cannot be directly determined from the graphs due to a mixture of antennas and pre-amplifiers used to capture the results.

As mentioned in the introduction, the purpose of the spectrum analyzer measurements is to illustrate the variety of signals present in the environment and their relative levels. They are displayed in logarithmic units relative to a milliwatt (dBm) and represent the signal power received by the test antenna presented at the input of the spectrum analyzer. Received power relative to a milliwatt (dBm) has a direct correlation with the field strength at the measured location.

Conversion to field strength from dBm can be readily done provided the antenna factor (AF) and frequency are considered as follows:

$$\mathbf{AF \text{ (for } 50 \, \Omega) = 20 \log f \text{ (MHz)} - G(dBi) - 29.78 \text{ dB.}}$$

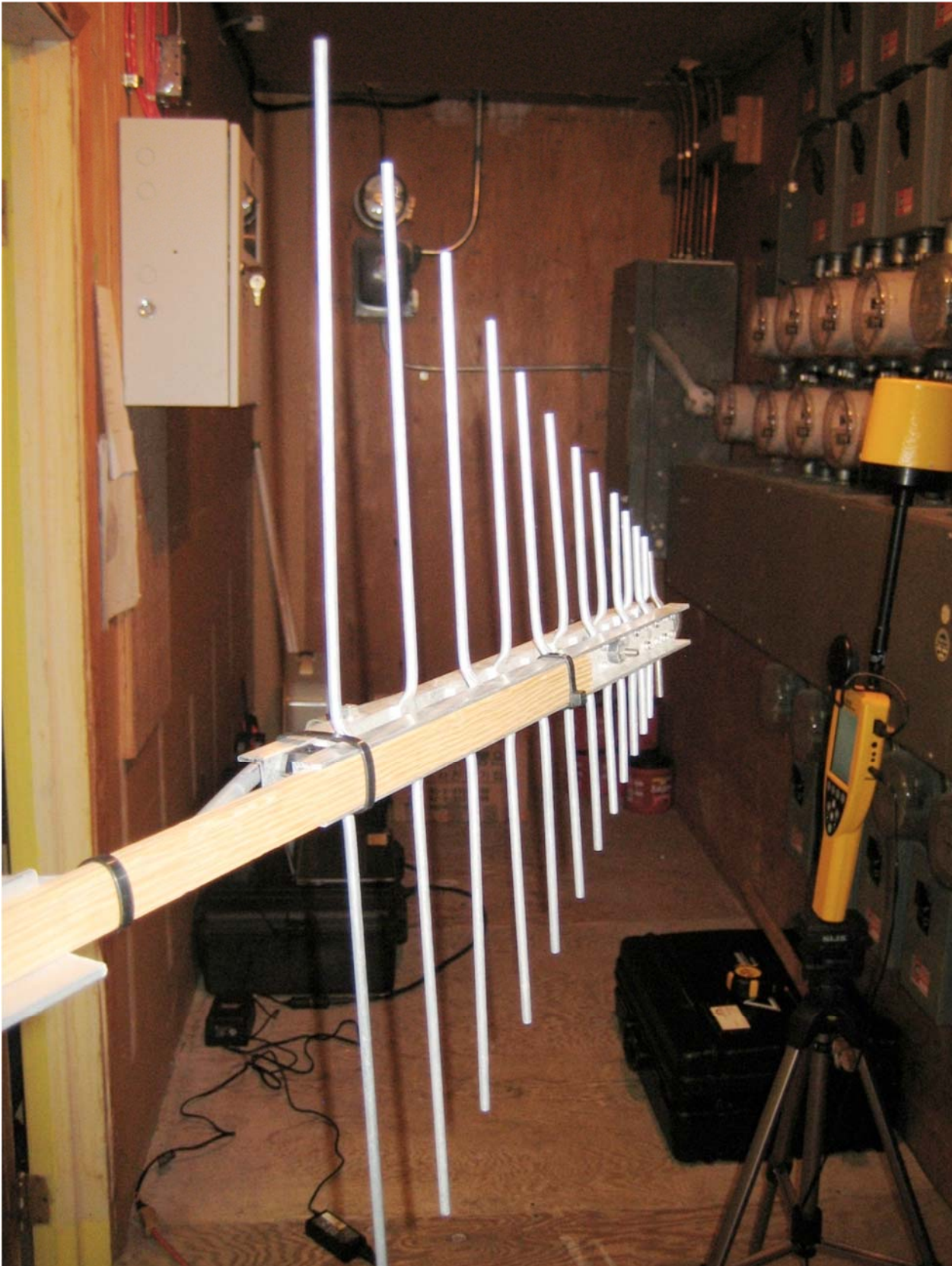
where f is the measured frequency (MHz), G is the antenna gain (dBi) over an isotropic radiator.

From this the electric field strength (E) can be calculated; note that the input to the spectrum analyzer is expressed as dB $\mu$ v. Conversion from the dBm scale is readily found on-line.

$$\mathbf{(E) \text{ dB}\mu\text{v/M} = (V_o) \text{ dB}\mu\text{v} + (AF) \text{ dB/M}}$$

The field strength can be expressed in multiple ways as described in Safety Code 6.

**Photograph**

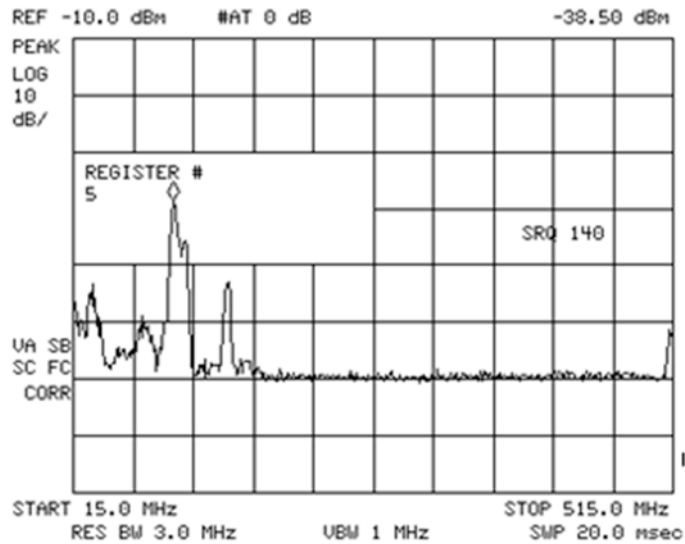


**Image 2. Alternate view of Narda location. Also showing temporary antenna used for spectrum measurements.**

## Measurement Results

The screenshots contained herein show graphs based on the measured signals' frequency and level components only.

### Background Levels – 15MHz to 515MHz



**Fig 1. Scan of 15MHz to 515MHz showing multiple signals**

Figure 1 data is measured with a simple dipole antenna resonant at about 200 MHz. Each horizontal division represents 50 MHz and the reference level is -10 dBm. This screen capture did not use the “max hold” feature and is an instantaneous snap-shot of the energy present from 15-515 MHz.

Measured data in the frequency range from 15 MHz to 515 MHz as shown in Figure 1 indicates that the dominant signals are between 88MHz and 108 MHz, in the band known as the “FM” radio band. The dominant signal is FM 98.5 followed by FM 103.1 and 107.3. These transmitters are located on Triangle Hill in Collwood and the peak amplitude is -36 dBm.

Below the FM band, additional shortwave signals and noise from electrical appliances are visible, especially fluorescent fixtures using electronic ballasts. At the far right, one of the local ATSC digital television channels is visible.



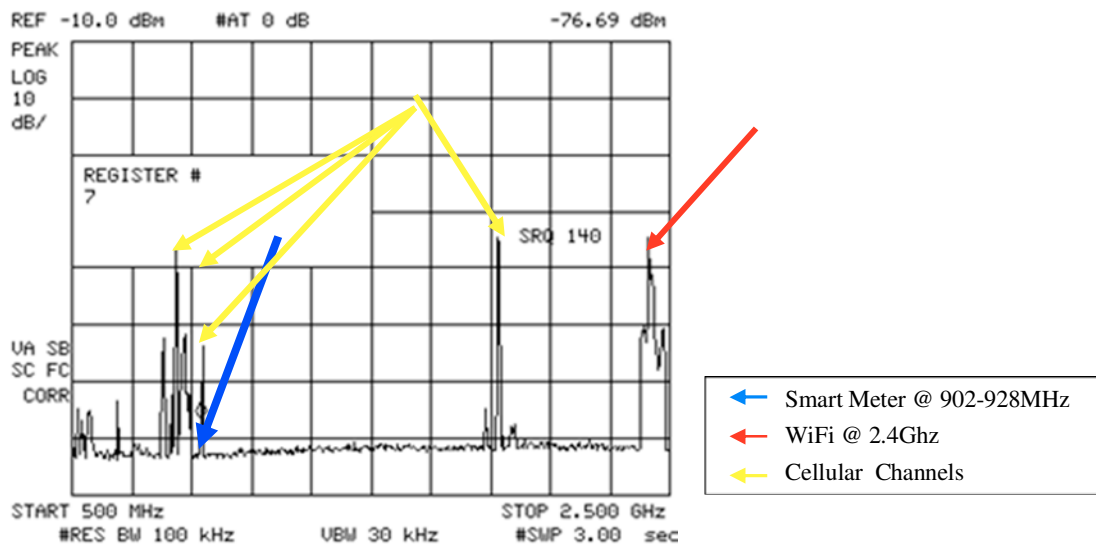
**Background Levels – 500MHz to 2500MHz****Fig 2. Scan of 500MHz to 2500MHz over 20 seconds**

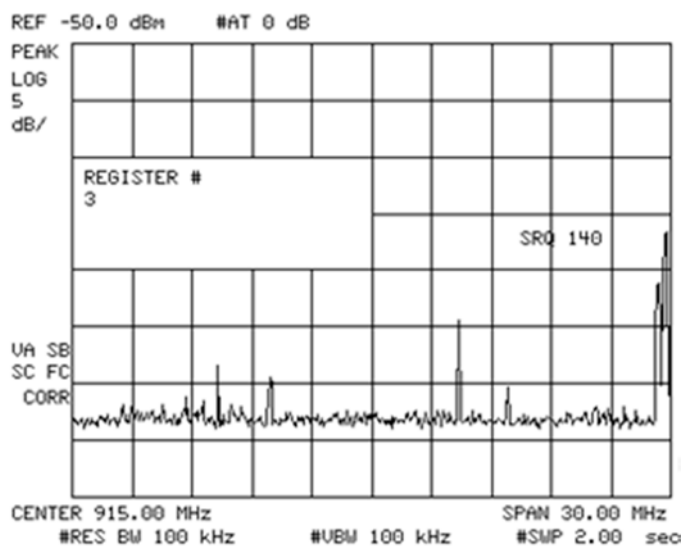
Figure 2 is a short-term, 20 seconds scan of the spectrum from 500 to 2500 MHz. Each horizontal division represents 200 MHz and the reference level is -10 dBm.

On the far left edge of the screen, not denoted by any arrows, are low power HDTV channels signals from local broadcasters (television channels 21 and 23). These signals originate from the Gonzales site several kilometres away.

The yellow arrows point to the dominant cellular and paging signals. These signals have typical amplitude of -45 dBm.

The blue arrow points to the band 902-928 MHz. Due to the short term period of the scan, no smart meter signals are visible since the meters only transmit for seconds per day.

The red arrow points to the WiFi signal band of 2.4 GHz. Due to the spread spectrum nature of the signals and the relatively short sampling period, the total energy of these signals is misrepresented and the peak levels are actually significantly higher.

**Smart Meter Levels – 900MHz to 930MHz**

**Figure 3a. Snapshot of 900MHz to 930Mhz,  
indicating other contributing signal source**

Figure 3a is a short-term detailed scan within the 902 to 928 MHz ISM unlicensed band. Each horizontal division represents 3MHz and the reference level is -50dBm, which the signal levels appear significantly magnified compared to the previous Reference Level of -10dbm. -50dBm is 10,000 lower than the -10 dBm reference used in the background scan.

Note that the screenshot from Figure 3a covers 900 to 930 MHz. Licensed paging signals are captured in the far right of the screen (from 928 to 930MHz).

The screenshot shows some possible smart meter signals as well as nearby baby monitors and cordless phones.

Long-term observation with a spectrum analyzer shows the peak signal levels of the smart meters as measured just outside the meter room is similar to or lower than the signals originating from other sources outside the building.

## **Conclusion**

The spectrum analyzer scan of the meter bank at [REDACTED] Victoria showed that at a modest distance away from the building's meter bank, the peak level of radio signals from smart meters is at around the same level as broadcast, cellular and WiFi signals that either originates from within the building or are from other locations up to several kilometers away.

It is worth noting that as a supplemental test for the Planetworks Safety Code 6 assessment, these measurements validate the radiofrequency levels captured by the NARDA probe at 20 cm away from the meter bank are predominately from the BC Hydro's smart meters. Furthermore, due to the broadband measuring capability of the NARDA probe, all signals – whether inside or outside the smart meters frequency of operation, including all measurable frequency sources from 300kHz to 50GHz - are also captured simultaneously in real time. These signals' measured power levels are frequency weighted and cumulatively added according to the Safety Code 6 standard and are presented as a total percentage of the Safety Code 6 acceptable standard. Please refer to the Planetworks Consulting Report "BC Hydro Bank of 40 Smart Meters, [REDACTED] Victoria Safety Code 6 Report" for the measured results.



|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 1                                |

1. In response to NCGPCA Information Request No. 1, FortisBC indicated an expenditure of \$14,336,000 in the years 2007 to 2011 to encourage business and residential customer energy efficiency and conservation measures. Please indicate the portion (if any) of this amount that included FortisBC employee salaries, hired contractor expenses, and administrative expenses. Please provide a breakdown of the expenditures to indicate what the \$14 million was spent on.

**Response:**

FortisBC confirms that PowerSense expenditures include internal costs directly related to the delivery of energy efficiency programs. Responding to this IR requires significant effort and relates to information already tested and approved in separate regulatory processes, most recently the 2012 – 2013 Revenue Requirements Application and Review of 2012 Integrated System Plan process. FortisBC does not consider the request directly relevant to the AMI application.

2. In response to NCGPCA Information Request No. 1, FortisBC indicated an expenditure of \$346,898,000 in the years 2007 to 2011 to purchase energy from a variety of sources including other utilities. If, as FortisBC states “demand-side management programs provide the same return on equity as supply-side investment” where is the incentive for FortisBC to reduce the cost of energy purchases?

**Response:**

As part of its 2012 – 2013 Revenue Requirements Application and Review of 2012 Integrated System Plan, FortisBC’s power purchase expense was comprehensively examined by the Commission and interveners participating in the review of the application. As well, a proposed Power Purchase Expense Variance Deferral Account was approved to capture any variances to the approved power purchase expense to be appropriately borne by the customer. Previously, under PBR regulation (2007-2011), FortisBC was incented to reduce approved power purchase expense through a variance sharing mechanism with customers.

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|--|---------------------------------------|
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| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 2                                |

3. Does FortisBC maintain that the expenditure of 4.132 percent of the amount of expenditures for energy purchases (over the years 2007 to 2011) is adequate to incent conservation?

**Response:**

Yes. Please also refer to the response to NCGPCA IR No. 2 Q1.

4. What is the estimated amount of energy saved as a result of FortisBC energy efficiency and conservation programs for both business and residential customers for the years 2007 to 2011?

**Response:**

Please see the following table:

**Table NCGPCA IR2 Q4 – Estimated Energy Conservation Savings**

| (GWh saved)  | 2007        | 2008        | 2009        | 2010        | 2011        |
|--------------|-------------|-------------|-------------|-------------|-------------|
| Residential  | 15.3        | 12.9        | 9.3         | 11.6        | 11.4        |
| Commercial   | 10.4        | 11.0        | 16.4        | 14.7        | 24.1        |
| Industrial   | 2.2         | 3.3         | 2.7         | 3.0         | 0.8         |
| <b>Total</b> | <b>27.9</b> | <b>27.3</b> | <b>28.5</b> | <b>29.3</b> | <b>36.3</b> |

5. Does FortisBC have a verified estimate of the energy savings for DSM projects on customer base load for the years 2007 to 2011 and can these energy savings be broken down by FortisBC-funded and customer-funded?

**Response:**

Energy savings from demand-side management programs cannot be directly verified since it is not possible to measure energy that has not been used. FortisBC does however conduct periodic measurement and evaluation reviews of PowerSense programs to verify savings on a



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|--|---------------------------------------|
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| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 3                                |

sample basis. Not all PowerSense programs require customers to provide the total cost of installed measures, so it is not possible provide the customer-funding levels. Please also refer to the response to NCGPCA IR No. 2 Q1.

6. Does FortisBC have verified data indicating whether greater energy savings were achieved by FortisBC-funded or customer-funded DSM projects?

**Response:**

Please refer to the response to NCGPCA IR No. 2 Q5.

7. In response to NCGPCA Information Request No. 1, FortisBC indicated an expenditure of \$11.91 per residential customer and \$143.82 per business customer in 2011 for program costs for energy efficiency and conservation measures. Does FortisBC have verifiable knowledge that the greater expenditure per business customer resulted in greater energy savings?

**Response:**

The following table demonstrates that the unit savings per customers are ten-fold higher for business customers at 60% of the unit cost in \$/MWh compared to residential customers.

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 4                                |

1                    **Table NCGPCA IR2 Q7 – Value of Estimate Energy Conservation Savings**

| <u>Residential</u> |                               |                        |               |
|--------------------|-------------------------------|------------------------|---------------|
| Year               | Unit<br>Savings<br>(kWh/cust) | Unit Costs<br>(\$/MWh) |               |
| 2007               | 113                           | \$                     | 85.16         |
| 2008               | 94                            | \$                     | 95.57         |
| 2009               | 67                            | \$                     | 174.55        |
| 2010               | 82                            | \$                     | 157.93        |
| 2011               | <u>80</u>                     | \$                     | <u>149.21</u> |
|                    | 87                            | \$                     | 127.15        |

| <u>Business (Commercial + Industrial)</u> |                               |                        |               |
|---|-------------------------------|------------------------|---------------|
| Year                                      | Unit<br>Savings<br>(kWh/cust) | Unit Costs<br>(\$/MWh) |               |
| 2007                                      | 654                           | \$                     | 58.65         |
| 2008                                      | 729                           | \$                     | 61.45         |
| 2009                                      | 979                           | \$                     | 55.63         |
| 2010                                      | 902                           | \$                     | 63.73         |
| 2011                                      | <u>1267</u>                   | \$                     | <u>113.48</u> |
|   | 907                           | \$                     | 74.91         |

- 2
- 3
- 4
- 5                    8.        Further to question 7, it is noted that FortisBC spent considerably more per
- 6                    business customer relative to residential customers on energy efficiency and
- 7                    conservation programs during the years 2007 to 2010. If no data is available for
- 8                    2011, does FortisBC have any indication that greater expenditure per business
- 9                    customer engendered greater energy savings in any of the other years?

10

11           **Response:**

12           Please refer to the response to NCGPCA IR No. 2 Q7.

13

14

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| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 5                                |

- 1            9.        Please provide a breakdown of customer base load (in GWh or other convenient  
2                   measurement) by community and/or region within FortisBC's service area and  
3                   indicate whether that community and/or region experienced a load increase or  
4                   decrease (by percentage) for the years 2007 to 2011.

5

6        **Response:**

- 7        The FortisBC customer load is divided into the following areas:

| Area Key  |             |            |          |            |          |            |           |
|-----------|-------------|------------|----------|------------|----------|------------|-----------|
| 10        | 20          | 30         | 40       | 50         | 60       | 70         | 80        |
| Trail     | Castlegar   | Bridesvill | Creston  | Kelowna    | Cawston  | Kaleden    | Coalmont  |
| Ainsworth | Appledale   | Greenwood  | Boswell  | Beaverdell | Keremeos | Naramata   | Hedley    |
| Cascade   | Balfour     | Midway     | Canyon   | Rutland    | Oliver   | OK Falls   | Princeton |
| Fruitvale | Bluberry    | Creek      | Crawford |            | Osoyoos  | Penticton  | Tulameen  |
| Genelle   | Bonnington  | Westbridge | Erickson |            |          | Summerland |           |
| Kaslo     | Brilliant   | Grand      | Grey     |            |          |            |           |
| Montrose  | Creston     | Forks      | Creek    |            |          |            |           |
| Nelway    | Vally       | Christina  | Kootenay |            |          |            |           |
| Rossland  | Fairview    |            | Lister   |            |          |            |           |
|           | Glade       |            | Riondel  |            |          |            |           |
| Salmo     | Lemon       |            |          |            |          |            |           |
| Warfield  | Creek       |            | Wynndel  |            |          |            |           |
| Ymir      | Pass Creek  |            |          |            |          |            |           |
|           | Passmore    |            |          |            |          |            |           |
|           | Perry Side  |            |          |            |          |            |           |
|           | Raspberry   |            |          |            |          |            |           |
|           | Robson      |            |          |            |          |            |           |
|           | Shoreacres  |            |          |            |          |            |           |
|           | Slocan City |            |          |            |          |            |           |
|           | Slocan Park |            |          |            |          |            |           |
|           | Slocan      |            |          |            |          |            |           |
|           | Valley      |            |          |            |          |            |           |
|           | South       |            |          |            |          |            |           |
|           | Slocan      |            |          |            |          |            |           |
|           | Thrums      |            |          |            |          |            |           |
|           | Vallican    |            |          |            |          |            |           |
|           | Winlaw      |            |          |            |          |            |           |



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| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 6                                |

- 1 Each area is responsible for the following approximate percentage of the total load:

| <b>Key Area Energy Usage Distribution (%)</b> |           |           |           |           |           |           |           |           |              |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|--------------|
|   | <b>10</b> | <b>20</b> | <b>30</b> | <b>40</b> | <b>50</b> | <b>60</b> | <b>70</b> | <b>80</b> | <b>Total</b> |
| 2011  | 6.5%      | 15.6%     | 6.2%      | 4.9%      | 39.1%     | 7.8%      | 16.9%     | 3.0%      | 100%         |
| 2010  | 6.7%      | 13.2%     | 6.4%      | 5.1%      | 40.0%     | 8.1%      | 17.5%     | 3.0%      | 100%         |
| 2009  | 6.7%      | 13.2%     | 6.0%      | 5.0%      | 40.6%     | 8.5%      | 17.2%     | 2.8%      | 100%         |
| 2008  | 6.7%      | 13.7%     | 6.2%      | 4.9%      | 39.5%     | 8.2%      | 18.0%     | 2.6%      | 100%         |
| 2007  | 7.1%      | 12.1%     | 7.9%      | 4.9%      | 39.4%     | 8.5%      | 19.6%     | 0.5%      | 100%         |

- 2 The area load growth year over year is as follows:

| <b>Key Area Growth (%)</b> |           |           |           |           |           |           |           |           |              |
|----------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|--------------|
|                            | <b>10</b> | <b>20</b> | <b>30</b> | <b>40</b> | <b>50</b> | <b>60</b> | <b>70</b> | <b>80</b> | <b>Total</b> |
| 2011                       | 2.9%      | 25.2%     | 2.1%      | 2.8%      | 3.5%      | 2.5%      | 2.3%      | 6.1%      | 6.0%         |
| 2010                       | -4.4%     | -3.4%     | 3.0%      | -2.4%     | -5.0%     | -8.7%     | -1.9%     | 2.0%      | -3.7%        |
| 2009                       | 2.9%      | -0.9%     | -0.3%     | 5.3%      | 6.0%      | 7.2%      | -1.6%     | 11.3%     | 3.3%         |
| 2008                       | -1.4%     | 16.6%     | -18.0%    | 3.0%      | 3.6%      | 0.3%      | -4.9%     | 413.8%    | 3.3%         |
| 2007                       | -37.3%    | 12.7%     | 11.0%     | 11.7%     | 1.7%      | 10.5%     | -11.6%    | n/a       | -2.1%        |

3  
4  
5

- 6 10. Please provide a breakdown of GWh (or other convenient measurement) of  
7 electricity purchased from FortisBC by the municipal electric utilities within its  
8 service territory (Cities of Kelowna, Penticton, and Grand Forks, District of  
9 Summerland, and Nelson Hydro) and indicate whether that municipal utility  
10 purchased an increased or decreased amount of energy (by percentage) for the  
11 years 2007 to 2011.

12

13 **Response:**

14 Please see the following table:

15

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 7                                |

1

**Table NCGPCA IR2 Q10 – Wholesale Electricity Sales**

|                    | 2012<br>(10 Months) | 2011      | 2010      | 2009      | 2008      | 2007      | 2006      |
|--------------------|---------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Kelowna</b>     |                     |           |           |           |           |           |           |
| GWh                | 270,120.0           | 329,265.6 | 301,320.0 | 330,672.0 | 314,197.0 | 291,393.6 | 314,222.4 |
| Change             |                     | 9.27%     | -8.88%    | 5.24%     | 7.83%     | -7.27%    |           |
| <b>Penticton</b>   |                     |           |           |           |           |           |           |
| GWh                | 275,615.2           | 343,760.8 | 335,542.4 | 353,283.2 | 347,655.6 | 346,945.3 | 347,662.6 |
| Change             |                     | 2.45%     | -5.02%    | 1.62%     | 0.20%     | -0.21%    |           |
| <b>Summerland</b>  |                     |           |           |           |           |           |           |
| GWh                | 75,763.2            | 96,216.0  | 95,176.8  | 79,116.0  | 92,318.4  | 97,622.4  | 95,032.8  |
| Change             |                     | 1.09%     | 20.30%    | -14.30%   | -5.43%    | 2.72%     |           |
| <b>Grand Forks</b> |                     |           |           |           |           |           |           |
| GWh                | 32,936.0            | 41,192.0  | 39,996.8  | 41,624.0  | 41,489.6  | 41,116.8  | 40,616.0  |
| Change             |                     | 2.99%     | -3.91%    | 0.32%     | 0.91%     | 1.23%     |           |
| <b>Nelson</b>      |                     |           |           |           |           |           |           |
| GWh                | 59,565.9            | 88,064.6  | 88,082.7  | 111,106.9 | 107,979.9 | 85,234.9  | 80,100.0  |
| Change             |                     | -0.02%    | -20.72%   | 2.90%     | 26.69%    | 6.41%     |           |

2

3

4

5           11.     What was the reason that copies of the FortisBC 2012 Integrated System Plan  
6                   and Volume 2 2012 Long Term Resource Plan were not supplied to interveners?  
7                   These documents seem to be vital to understanding FortisBC's long term  
8                   objectives and goals.

9

10    **Response:**

11   FortisBC's 2012 Integrated System Plan and Long Term Resource Plan (the 2012 ISP) was  
12   submitted and reviewed as part of the Company's 2012 – 2013 Revenue Requirements  
13   Application and Review of 2012 Integrated System Plan. The 2012 ISP was filed pursuant to  
14   section 44.1 (6) of the UCA. While the 2012 ISP describes and informs aspects of the proposed  
15   AMI Project, its inclusion in the Application was not considered necessary to support the  
16   proposed project, which is filed pursuant to sections 45 and 46 of the UCA.

17   The 2012 Integrated System Plan including the Long Term Resource Plan are available  
18   publically on both FortisBC's website as well as the BCUC's website.

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 8                                |

1  
2  
3       12.     In the FortisBC 2012 Integrated System Plan, Volume 2 2012 Long Term  
4             Resource Plan, the Company states that it has a goal of “obtaining firm power  
5             resources over time to achieve 100 percent self sufficiency”. Has FortisBC made  
6             any verifiable progress to doing so?

7  
8     **Response:**

9     The FortisBC 100% self sufficiency objective is a long term objective. As stated in the 2012  
10    Long Term Resource Plan in Section 6.4, page 85, row 3:

11       “While it is FortisBC’s objective to achieve 100 percent self sufficiency through a owned  
12       or long term contracted power supply resource stack, as a result of this comparison and  
13       based on the forecast expected capacity and energy gaps following the commencement  
14       of the WAX CAPA, in the short to medium term the Build Strategy is not expected to be  
15       cost competitive compared to buying these products in the wholesale marketplace.  
16       Specifically, given the modest size of the forecast energy and capacity gaps that  
17       FortisBC expects to fill in the next decade and especially considering that there are few  
18       actual hours of exposure to capacity gaps, purchasing from the Wholesale market in the  
19       short to medium term is the economically prudent solution for FortisBC and its  
20       ratepayers.”

21    However, the Company continues to pursue short-to medium term opportunities to fill these  
22    immediate gaps with generation from within the Province as power is available.

23  
24  
25       13.     In the FortisBC 2012 Integrated System Plan, Volume 2 2012 Long Term  
26             Resource Plan, the Company states it “is targeting to meet 50 percent of its  
27             annual energy load growth through DSM”. If FortisBC agrees with the Canadian  
28             Electricity Association (and others) that projected electricity load growth is  
29             expected to be about 1.2 percent annually, a 50 percent target of 1.2 percent  
30             seems low. Please comment.

31  
32     **Response:**

33    The 50 percent target refers to DSM program savings only. The AMI project will enable  
34    additional energy savings through the Customer Information Portal and In-Home Display. In the

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 9                                |

future, these additional savings from AMI may be complemented by new conservation rates, distribution loss reduction, power grid voltage optimization and a pre-pay tariff (please see Exhibit B-1, Section 6.0 for more detail on these future benefits).

14. Question 13 is asked in the context that:

- o According to research by Robert Ayres at the American Council for an Energy Efficient Economy, 87 percent of all the energy that is used to support economic activity in the U.S. is wasted.
- o In the 2009 report Unlocking Energy Efficiency in the U.S. Economy, McKinsey and Company said American individuals and businesses waste \$130 billion a year on energy.
- o The ACEEE placed Canada at No. 11 out of 12 countries in its energy efficiency score card issued in July 2012.
- o Half of the average Canadian household's energy usage is wasted due to inefficient infrastructure.
- o Enerdata and the Economist Intelligence Unit found Canada has no quantitative target for energy efficiency.

Therefore, does FortisBC agree that there is much greater scope for energy efficiency and conservation to achieve reductions in the amount of energy purchases the Company has to make each year?

**Response:**

Through the combination of DSM programs, and the additional instruments listed in response to NCGPCA IR No. 2 Q13, FortisBC believes it will achieve an offset approaching the 66%<sup>1</sup> of load growth objective specified in the 2010 provincial Clean Energy Act.

As referenced in the decision G-110-12, related to the FortisBC Inc 2012-2013 Revenue Requirements and Review of ISP:

*BCSEA's expert witness, Mr. Plunkett, provided testimony explaining his analysis of DSM programs in various jurisdictions across North America. Mr. Plunkett advised that he grouped the jurisdictions he reviewed into four tiers, based on energy sales avoided through DSM, with the first tier being the best. In Mr. Plunkett's analysis, only three*

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<sup>1</sup> Clean Energy Act [SBC 2010] Part 1 2.(b). This objective is directed at the BC Hydro Authority.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to Nelson-Creston Green Party Constituency Association (NCGPCA)<br>Information Request (IR) No. 2   | Page 10                               |

1        *jurisdictions were in Tier 1, California, Vermont and Connecticut. These jurisdictions*  
2        *were able to achieve one and one half per cent or more of energy sales being avoided*  
3        *through DSM. Mr. Plunkett placed FortisBC squarely in Tier 2, along with nine other*  
4        *jurisdictions which succeeded in achieving approximately one percent of energy sales*  
5        *being avoided through DSM.*

6        FortisBC believes that its PowerSense program is one of the leading demand-side management  
7        programs in North America.

8  
9

10        15.        Why does FortisBC not provide a highlighted “Meter Reading Information” box on  
11        its residential bills (like BC Hydro – see [https://www.bchydro.com/accounts-](https://www.bchydro.com/accounts-billing/customer-service-residential/residential-rates/residential-bills.html)  
12        [billing/customer-service-residential/residential-rates/residential-bills.html](https://www.bchydro.com/accounts-billing/customer-service-residential/residential-rates/residential-bills.html)) which  
13        gives customers a graphic of power consumption over a one-year period and  
14        highlights a comparison of daily average consumption year over year?

15

16        **Response:**

17        FortisBC agrees that a consumption graph is useful for customers, and is exploring the  
18        feasibility of implementing it in conjunction with an upcoming bill redesign. FortisBC does  
19        already include meter reading information including a comparison of the current period’s daily  
20        average usage versus the same time period in the previous year.

21  
22

23        16.        If this question has been answered before, please indicate where I can find the  
24        answer. What is the acceptable opt-out rate that still makes AMI feasible and is  
25        there any difference in the acceptable opt-out rate between a wireless AMI and a  
26        hard-wired AMI system?

27

28        **Response:**

29        FortisBC has not considered what an acceptable opt-out rate for a hard-wired AMI system might  
30        be, but it is unlikely to be different than that for a wireless system. Please also refer to the  
31        response to BCUC IR No. 2 Q50.2.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 1                                |

- 1 1. Does FortisBC agree that humans are controlled by electricity—human bodies are  
2 made up of a vast network of interactive electrical components that surely surpass in  
3 intricacy those of any supercomputer? Electrical signals are used throughout the  
4 nervous system to activate muscles, cells and our consciousness; basically the  
5 electrical system in the human body is responsible for all thinking and movement? If  
6 FortisBC does not agree with this premise, please explain.

7  
8 **Response:**

9 Cells and tissues have electrical properties and the nervous system components communicate  
10 by both electrical and chemical signals.

- 11  
12  
13 2. Does FortisBC agree that the human body is conductive and that exposure to:  
14 – electric fields  
15 – magnetic fields  
16 – electro–magnetic radiation (such as from smart meters, cell phones, cell phone  
17 transmitter towers, wireless household gadgets etc.) induces currents in human  
18 bodies which, in turn, create an internal alternating body– voltage? If not, please  
19 provide any corrections and clarifications.

20  
21 **Response:**

22 The human body is conductive. Oscillating electric, magnetic, and electromagnetic fields at  
23 intensities and radiofrequencies characteristic of wireless communication devices, e.g.,  
24 advanced meters, cell phones, and other wireless devices can induce tiny currents and voltages  
25 in the body.

- 26  
27  
28 3. Does external electromagnetic radiation induce changes in cellular functions in  
29 human bodies? If yes, please explain briefly.

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 2                                |

1 **Response:**

2 The question is too general to answer. However, it is established that exposure to  
3 radiofrequency field levels well above exposure limits in Health Canada's Safety Code 6 can  
4 lead to changes in cellular functions.

5  
6

7 4. Please state the recommended threshold of induced AC body-voltage for humans  
8 and cite your reference.

9

10 **Response:**

11 Limits on induced voltages in the body vary as a function of frequency and are presented in  
12 Table 3 of Health Canada's Safety Code 6 (Appendix B-6 to the Application).

13  
14

15 5. Please state the minimum radio wave/microwave electromagnetic energy exposure  
16 (in  $\mu$  watts/cm<sup>2</sup>) at which excitable human biological tissue can be stimulated.

17

18 **Response:**

19 The frequency of the radiofrequency exposure is not stated and thresholds for stimulation of  
20 excitable biological tissues vary with frequency. For example, reported thresholds for sensory  
21 stimulation are several hundred volts per metre at frequencies below 3 MHz (Chatterjee et al.,  
22 1986). An instantaneous electric field of 120 V/m corresponds to 3820  $\mu$ W/cm<sup>2</sup>. At higher  
23 radiofrequencies characteristic of wireless devices, tissue heating, not stimulation of excitable  
24 human tissues, is observed.

25  
26

27 6. Please name the guideline and out of there provide the value for the recommended  
28 maximum allowable radio wave/microwave electromagnetic stimulation of human  
29 biological tissue.

30

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 3                                |

1 **Response:**

2 Please refer to Health Canada's Safety Code 6 (Appendix B-6 to the Application), Table 5 for  
3 the maximum recommended allowable exposure of human tissue. Lower limits on exposure of  
4 the general public are found in Table 6.

5  
6

7 7. X-ray exposures have cumulative biological effects. Please state your position on  
8 whether radio wave/microwave radiation exposure also has cumulative effects.  
9 Please provide references for your position.

10

11 **Response:**

12 Health Canada's Safety Code 6 states "At present, there is no scientific basis for the premise of  
13 chronic and/or cumulative health risks from RF energy at levels below the limits outlined in  
14 Safety Code 6." (p. 9)

15  
16

17 8. Does FortisBC agree that biological effects are associated with  
18 radiowave/microwave energy radiation below the US and Canada regulatory limit as  
19 stated in the studies in Biological Effects Of Microwave Below U.S. & Canada's  
20 Regulatory Limit in the link [http://citizensforsafetechnology.org/Biological-effects-of-](http://citizensforsafetechnology.org/Biological-effects-of-microwaves-below-US-and-Canadas-regulatory-limit,8,1195)  
21 [microwaves-below-US-and-Canadas-regulatory-limit,8,1195](http://citizensforsafetechnology.org/Biological-effects-of-microwaves-below-US-and-Canadas-regulatory-limit,8,1195) If you do not agree,  
22 please state why not.

23

24 **Response:**

25 A variety of biological responses of bacteria, plants, mice, chickens, rats, pine needles, trees,  
26 rabbits, cows, frogs, guinea pigs to radiofrequency fields are listed, and associations of human  
27 neuropsychological responses with sources of radiofrequency fields in communities. It is not  
28 clear that the effects reported have been confirmed or that all effects if confirmed are adverse.

29  
30

31 9. Is FortisBC aware and do you agree that the Royal Panel's report "Review of the  
32 Potential Health Risks of Radiofrequency Fields from Wireless  
33 Telecommunication Devices" <http://www.rsc.ca/documents/RFreport-en.pdf>



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 4                                |

admits that Safety Code 6 (SC6) does not apply to non–thermal biological effect protection? If not, please state where and how SC6 does, indeed, take into account non–thermal effect protection.

**Response:**

FortisBC is aware of the cited report. The question regarding the relationship of Safety Code 6 to non-thermal biological effects is answered in the Royal Panel’s 1999 report:

***What are the implications for Safety Code 6 of the panel’s scientific review of the currently available data on biological effects and the potential adverse health effects of exposure to radiofrequency fields? In particular, should the phenomenon of non-thermal effects be considered in Safety Code 6?***

*Based on its review of the currently available scientific data, the panel concluded that Safety Code 6 generally protects both workers and the general public from adverse health effects associated with thermal exposures of the whole body to radiofrequency fields. Although the whole body exposure limits given in Safety Code 6 appear protective against thermal effects, the panel noted that protracted worker exposures at the local limits established for the head, neck and trunk and for the limbs could lead to thermal effects. The panel therefore recommends that these local exposure limits for workers be reviewed, both in terms of the level and duration of exposure.*

*Biological effects can occur at non-thermal exposure levels. However, since there is insufficient evidence to conclude that such biological effects are associated with adverse health effects, the potential significance of biological effects observed at non-thermal exposure levels requires clarification before non-thermal effects are considered for inclusion in Safety Code 6. (p. 4)*

10. Does FortisBC agree that “Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz – Safety Code 6 (2009)” (SC6) is only addressing thermal biological effects and not the non– thermal effects due to persistent radio wave/microwave radiation, such as from cell phones, cell phone transmitter stations, and wireless smart meters?

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 5                                |

1 **Response:**

2 From 3 to 100 kHz the standard is designed to protect against electrical stimulation and to  
3 protect against tissue heating from exposures at frequencies between 100 kHz to 300 GHz.  
4 Regarding non-thermal effects, Safety Code 6 states:

5 *At present, there is no scientific basis for the premise of chronic and/or cumulative health risks*  
6 *from RF energy at levels below the limits outlined in Safety Code 6. Proposed*  
7 *effects from RF energy exposures in the frequency range between 100 kHz and*  
8 *300 GHz, at levels below the threshold to produce thermal effects, have been*  
9 *reviewed. At present, these effects have not been scientifically established, nor*  
10 *are their implications for human health sufficiently well understood. Additionally, a*  
11 *lack of evidence of causality, biological plausibility and reproducibility greatly*  
12 *weaken the support for the hypothesis for such effects. Thus, these proposed*  
13 *outcomes do not provide a credible foundation for making science-based*  
14 *recommendations for limiting human exposures to low-intensity RF energy.*

15 *....Other proposed non-thermal effects have not been conclusively documented*  
16 *to occur at levels below the threshold where thermal effects arise. (p. 9)*

17  
18

19 11.1 Please state, whether SC6 or any other guidelines or safety standards for pulsed  
20 radio wave/microwave radiation (please name these) are in place in Canada that  
21 do protect the electro-sensitive population (as per medical  
22 diagnosis/prescription), or are addressing the risk for many chronic diseases like  
23 cancer, autoimmune diseases, semen quality, birth defects, miscarriages, etc.

24

25 **Response:**

26 Health Canada's Safety Code 6 provides for limits on pulsed fields. These limits were not  
27 designed to address public concerns about potential effects listed, although studies involving or  
28 relevant to these conditions would have been reviewed. Please also refer to the response to  
29 WKCC IR No. 2 Q10.

30  
31

32 11.2. Please state whether in Canada and In the US the guidelines or safety standards  
33 are enforced by law or governmental regulation, if yes, please state which ones  
34 and by whom enforced.

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 6                                |

1

2 **Response:**

3 Canada's federal government applies Health Canada's Safety Code 6 in Part X of the Schedule  
4 to the Canada Occupational Health and Safety Regulations; Part 5 of the Aviation Occupational  
5 Health and Safety Regulations; Part XI of the Oil and Gas Occupational Safety and Health  
6 Regulations; and Part VII of the On Board Trains Occupational Health and Safety Regulations.  
7 Each of those Regulations is enforced by Canada's Minister of Labour.

8 The federal government also applies Safety Code 6 in the context of its Radio Standards  
9 Specification RSS-102 – Radio Frequency (RF) Exposure Compliance of Radiocommunication  
10 Apparatus (All Frequency Bands); GL-02 – Guidelines for the Protection of the General Public in  
11 Compliance with Safety Code 6; and GL-08 – Guidelines for the Preparation of Radio  
12 Frequency (RF) Exposure Compliance Reports for Radiocommunication and Broadcasting  
13 Antenna Systems. These standards, specifications and guidelines are enforced by Canada's  
14 Minister of Industry.

15 In British Columbia the Workers Compensation Act Occupational Health and Safety Regulation,  
16 Part 7, applies Safety Code 6. That Regulation is enforced by the Workers' Compensation  
17 Board.

18 Certain other jurisdictions in Canada also apply Safety Code 6. The Company notes s. 37 of  
19 New Brunswick's General Regulation – Occupational Health and Safety Act, Reg. 91-191 and s.  
20 9.81 of Nunavut's Mine Health and Safety Regulations.

21

22

23 12. Is FortisBC aware of any scientific data addressing safe radio wave/microwave  
24 exposure levels with regards to their non-thermal effects? If so, please state.

25

26 **Response:**

27 FortisBC understands that the research on radiofrequency fields reviewed by national and  
28 international health and scientific agencies, including Health Canada, addresses scientific data  
29 regarding potential adverse effects of non-thermal exposures.

30

31

|  |                                       |
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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 7                                |

13. Please state whether Health Canada SC6 is a safety guideline or a safety standard, and please explain the difference of both in terms of mandatory and/or recommended practices.

**Response:**

Health Canada describes its Safety Code 6 as “human exposure guidelines to radiofrequency electromagnetic energy”. The Preface to Safety Code 6 indicates that the safety limits in the code apply to all individuals working at, or visiting, federally regulated sites. It goes on to note that the guidelines may also be adopted by the provinces, industry or other interested parties.

Health Canada describes guidelines as follows ([http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio\\_guide-lignes\\_direct-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct-eng.php)):

*Guidelines (sometimes called guidance documents or directives) are important administrative documents that support laws and regulations. Unlike laws and regulations, guidelines do not have the force of law. However, they set out how a department, regulatory authority or other body applies laws and regulations under their jurisdiction.*

Compliance with guidelines may become mandatory if they are adopted in legislation or regulation, for example. See the response to WKCC IR No. 2 Q11.2 for instances of the mandatory application of Safety Code 6.

Part 7 of British Columbia’s Workers Compensation Act Occupational Health and Safety Regulation, among other regulations in Canada, applies Safety Code 6. Safety Code 6 is also the basis for mandatory limits on radiofrequency fields produced by devices authorized for use in Canada under Industry Canada’s RSS-Gen – General Requirements and Information for the Certification of Radio Apparatus and RSS-102 – Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands).

Industry Canada describes standards in these terms (<http://www.ic.gc.ca/eic/site/oca-bc.nsf/eng/ca01579.html>):

*Standards are technical specifications or other criteria that a product, process or service must meet...*

...

*Standards are developed through a set process. Companies and individuals use and adhere to standards voluntarily, or because they are required to by law. When compliance with a standard is not mandated by law, companies and individuals follow the terms of the standards simply because it is in their interest*

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 8                                |

*to do so — standards improve the quality of products, processes or services, reassure customers and open up markets. Approximately two thirds of standards are voluntary.*

The terms of standards may also be incorporated into government statutes and regulations, in which case companies and individuals must follow them as a matter of law. In some cases, governments initiate and participate in standards development so the standard can be included in legislation. In other cases, governments find that an existing standard can be used to deal with a public policy problem and include it in new legislation. For example, the federal law for the protection of personal information in the private sector is based on a national standard.

14. Please state whether the May, 2011, World Health Organization/International Agency for Research on Cancer's Class 2B possible carcinogen classification of radio frequency radiation is considered in SC6, or is a review of SC6 to be expected in near future because of this recent classification? If not, please inquire whether Provincial Health Officer, Dr. Perry Kendall [PHO], plans to apply for an SC6 review with regard to the Class 2B classification of radio frequency radiation by Health Canada as soon as possible and inform about.

**Response:**

Health Canada is well aware of the IARC report as discussed in information Safety of Cell Phones and Cell Phone Towers (<http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/prod/cell-eng.php>)

It has been known throughout that Health Canada Safety Code 6 (the Code) is subject to review. The establishment of a further panel or target reporting date does not change that underlying premise. The Preface to the existing Code notes that the safety limits "are based on an ongoing review of published scientific studies" and that the Code is "periodically revised" (Exhibit B-1, Appendix B-6 p. 5 of 30). The Royal Society itself has previously been involved in this exercise.

There is no basis to assume that any revisions to the Code would be either recommended or, if recommended, significant. It is apparent from the context that an expert panel has been struck because of public comment on the issue rather than because of an underlying, objective concern. Notably the concern expressed by prominent Quebec scientists in their recent "Open Letter to the Public" ("Wireless Technologies: For an Informed and Responsible Debate Guided by Sound Science") has been not with the technology (indeed, to the contrary), but with the nature and content of the public discussion.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 9                                |

Given that advanced meters operate on average at a level 10,000 times less than the current Code limit and that the proposed advanced meters meet the strictest exposure limits in the world (which are approximately 100 times lower than Canada), it is highly unlikely that any change would have any impact on the AMI Project.

The Commission is accustomed to proceeding in circumstances where further research is being done into an issue. For example, in its Vancouver Island Transmission Reinforcement Project decision, the Commission directed British Columbia Transmission Corporation to file updates on EMF risk assessments and any changes in guidelines developed by the World Health Organization, International Commission on Non-Ionizing Radiation Protection, Health Canada and others where relevant (Decision dated July 7, 2006 at p. 72).

FortisBC's application is made in a context where many customers in Canada and the United States already have wireless advanced meters. Radio frequency (RF)-mesh based solutions have captured approximately 90 percent of the Canadian smart meter communications market (refer to response to BCUC IR No. 1 Q113.1.4). More generally, by the time of FortisBC's Request for Proposals (RFP), the North American AMI market had generally shifted to RF technologies (refer to response to Shadrack IR No. 2 Q2.12).

In the highly unlikely event that the Code limit is lowered enough to make the proposed AMI meters non-compliant, there would be time to halt the deployment of the meters as this is not scheduled until 2014.

FortisBC does not have any information as to the plans of the Provincial Health Officer.

15. What is FortisBC position regarding the radio wave/microwave Class 2B possible carcinogen classification in the Work Safe B.C., Workers Compensation Act Occupational Health and Safety Regulation 5.57(1) which says: *"If a substance identified as any of the following is present in the workplace, the employer must replace it, if practicable, with material which reduces the risk to workers: (a)...2B carcinogens."* How does the Class 2B carcinogen classification of radio wave/microwaves differ from the classification given to DDT, lead, diesel fumes, Etc.? If FortisBC and/or PHO determines that it is safe that workers can be exposed to this kind of class 2B carcinogen (radio wave/microwave radiation,) on what grounds can FortisBC and/or PHO Kendall make this determination based on FortisBC's PHO's experience or training to dispute the judgment of 31 IARC experts?

**Response:**

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 10                               |

Radiofrequency fields, a non-ionizing form of electromagnetic radiation, are regulated under Part 7 of the Occupational Health and Safety Regulation “Noise, Vibration, Radiation and Temperature.” The Regulation does not specify that procedures to address hazardous substances and biological agents quoted from “Part 5 Chemical Agents and Biological Agents” at 5.57(1) apply to physical agents, including radiofrequency fields. Moreover, Health Canada’s Safety Code 6 applies to occupational exposures to radiofrequency fields in Canadian workplaces.

The 2011 IARC report classified radiofrequency fields in the 2B category that also includes DDT, lead, coffee, and pickled vegetables. Diesel exhaust has been classified by IARC as a human carcinogen (Group 1), not in category 2B.

FortisBC follows the mandated guidance in Safety Code 6 and relies upon Health Canada to determine safe levels of radiofrequency fields from devices to which workers and the general public may be exposed. The IARC report and classification has been considered by Health Canada.

Neither FortisBC nor the Provincial Health Officer have the authority to determine compliance with the Workers’ Compensation Act.

16. Does FortisBC agree that there is a certain percentage of our population which is/might be electro-sensitive? If so, please state the percentage as far as it is generally known to be and provide information sources. If FortisBC does not agree, please state why not?

**Response:**

FortisBC understands that a certain percentage of the population in some countries have reported being “electro-sensitive”. FortisBC is not aware of any scientific or medical surveys that have assessed the prevalence of such persons in Canada . Based on research studies, the World Health Organization has determined that there is no scientific basis to link such reported symptoms to EMF (ELF or RF) exposure. Consequently, no diagnostic criteria have been developed for ‘electro-sensitivity.’ As stated in the World Health Organization backgrounder dated December 2005 and found at: <http://www.who.int/peh-emf/publications/facts/fs296/en/>:

*“EHS [Electromagnetic hypersensitivity] is characterized by a variety of non-specific symptoms that differ from individual to individual. The symptoms are certainly real and can vary widely in their severity. Whatever its cause, EHS can be a disabling problem for*



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 11                               |

*the affected individual. EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure. Further, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem."*

17. Is FortisBC aware that in Sweden electro-hyper-sensitivity (EHS) is an officially recognized functional impairment; that in the U.S., EHS afflicted people are protected under the U.S. Disability Act, and that in Canada EHS afflicted people are recognized by the Canadian Human Rights Commission? If FortisBC are aware, how will FortisBC and/or PHO make sure that those recognized EHS people in British Columbia will be given an option not to be involuntarily and chronically cumulatively exposed to persistent wireless smart meter radio microwave radiation?

**Response:**

FortisBC is aware of the claims asserted in the question but has not assessed their accuracy or legal status. However, the Company notes the following report issued by the Ireland Department of Communications, Energy, and Natural Resources, available at:

<http://www.dcenr.gov.ie/NR/rdonlyres/9E29937F-1A27-4A16-A8C3-F403A623300C/0/ElectromagneticReport.pdf>

The report states:

"The focus in Sweden is on the symptoms presented by the afflicted person and the right to sick leave, sickness benefits, disability pension etc is based on the degree of ill health and functional handicap of the person regardless of a known or unknown cause for the condition."

"The Swedish Board of Health and Welfare is the Swedish authority to grant financial support through the national budget to disability organisations. A disability organisation is according to the authorities understood to be an organisation which members (at least a majority of) meet substantial difficulties in everyday life due to some kind of disability. The National Board of Health and Welfare thus make their decisions based on the consequences for the afflicted individuals and not based on any known underlying cause of the disability/problems. The Swedish Association for the Electrosensitive was granted financial support as a disability organisation. Most disability organisations that have received this type of financial support join the Swedish Disability Federation, as has The Swedish Association for the Electrosensitive. This fact has sometimes been



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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 12                               |

1 misinterpreted as if electromagnetic hypersensitivity is a recognised medical diagnosis in  
2 Sweden."

3 FortisBC believes that its AMI Project will be compliant with the applicable legal framework.

4  
5

6 18. Qualified medical doctors and scientists around the globe are calling for stricter  
7 regulations and/or a moratorium on wireless technology. Please state FortisBC  
8 position, as to which ones, and why, FortisBC would not recognise/consider/support  
9 any of the resolutions/appeals/reports below:

- 10 Vienna Resolution 1998
- 11 Salzburg Resolution 2000
- 12 Declaration of Alcalá 2002
- 13 Catania Resolution 2002
- 14 Freiburger Appeal 2002 & 2012
- 15 Bamberger Appeal 2004
- 16 Maintaler Appeal 2004
- 17 Coburger Appeal 2005
- 18 Stockacher Appeal 2005
- 19 Oberammergauer Appeal 2005
- 20 Haibacher Appeal 2005
- 21 Pfarrkirchener Appeal 2005
- 22 Freienbacher Appeal 2005
- 23 Lichtenfelser Appeal 2005
- 24 Hofer Appeal 2005
- 25 Helsinki Appeal 2005
- 26 Parish Kirchner Appeal 2005
- 27 Saarlander Appeal 2005
- 28 Benevento Resolution 2006
- 29 Allgaeuer Appeal 2006
- 30 WiMax Appeal 2006

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 13                               |

- 1 Brussels Appeal 2007
- 2 Bioinitiative Report, 2007
- 3 Schlüchterner appeal
- 4 Venice Resolution 2008
- 5 Berlin Appeal 2008
- 6 Paris Appeal 2009
- 7 London Resolution 2009
- 8 Porto Alegre Resolution 2009
- 9 European Parliament EMF Resolution 2009
- 10 Dutch Appeal 2009
- 11 Behind Interphone, August 7, 2009
- 12 Int'l Appeal of Würzburg 2010
- 13 Cellphones and Brain Tumors: 15 Reasons for Concern, Science, Spin and the Truth
- 14 An examination of the potential Health Impacts of Radiofrequency Electromagnetic
- 15 Radiation, 2010 (House of Commons: Report of the Standing Committee on Health)
- 16 Council of Europe: "Remove wireless from schools" 2011
- 17 Sage Report 2011
- 18 Report of The Standing Committee on Health, County of Santa Cruz 2011
- 19 Board of American Academy of Environmental Medicine's Resolution against
- 20 wireless smart meters, American Academy of Environmental Medicine, January 19,
- 21 2012

22

23 **Response:**

24 FortisBC is generally aware of such "resolutions/appeals/reports", and understands that they do  
 25 not provide the kind of scientific evidence that are relied upon by health agencies in making  
 26 decisions about health and safety. FortisBC relies upon the scientists and physicians at Health  
 27 Canada and other qualified health agencies to assess the relevance and validity of the scientific  
 28 evidence concerning the safety of radiofrequency exposures.

29

30

31 19. Please state (with references) radio/microwave exposure limits/guidelines for:

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 14                               |

- 1 – Canada
- 2 – USA
- 3 – any other country and their exposure limits that FortisBC are aware of and provide
- 4 links. If these countries have different exposure limits which are lower than
- 5 Canada's, please explain why Canada should not also adopt much stricter
- 6 guidelines.

7

8 **Response:**

9 The limits on occupational and public exposure to radiofrequency fields in Canada are  
 10 contained in Tables 5 and 6 in Health Canada's Safety Code 6 and similar limits in the USA are  
 11 published by the Federal Communications Commission, Parts 1 and 2 of the FCC's Rules and  
 12 Regulations [47 C.F.R. 1.1307(b), 1.1310, 2.1091, 2.1093  
 13 (<http://transition.fcc.gov/Bureaus/EngineeringTechnology/Documents/fedreg/61/41006.pdf>).

14 A world database of standards for ELF and RF electromagnetic field exposures has been  
 15 assembled by the World Health Organization ([http://www.who.int/docstore/peh-](http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm)  
 16 [emf/EMFStandards/who-0102/Worldmap5.htm](http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm)). FortisBC has no control over the  
 17 radiofrequency guidelines developed by Health Canada but notes that the exposures from  
 18 FortisBC smart meters calculated in Table 1 of Exponent's report are below what appears to be  
 19 the lowest standard in that database from Russia.

20

21

22 20.1. Please confirm :

23 *"...The **precautionary principle** or precautionary approach states if an action or*  
 24 *policy has a suspected risk of causing harm to the **public** or to the **environment**,*  
 25 *in the absence of **scientific consensus** that the action or policy is harmful, the*  
 26 ***burden of proof** that it is not harmful falls on those taking the action. This principle*  
 27 *allows policy makers to make discretionary decisions in situations where there is*  
 28 *the possibility of harm from taking a particular course or making a certain*  
 29 *decision when extensive scientific knowledge on the matter is lacking. The*  
 30 *principle implies that there is a social responsibility to protect the public from*  
 31 *exposure to harm, when scientific investigation has found a plausible risk. These*  
 32 *protections can be relaxed only if further scientific findings emerge that provide*  
 33 *sound evidence that no harm will result. In some legal systems, as in the **law of***  
 34 ***the European Union**, the application of the precautionary principle has been*  
 35 *made a **statutory** requirement..."*

36 [ source: [http://en.wikipedia.org/wiki/Precautionary\\_principle](http://en.wikipedia.org/wiki/Precautionary_principle) ]

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 15                               |

1

2 **Response:**

3 Numerous other definitions of the precautionary principle are available. For example, the  
 4 Canadian Environmental Protection Act (1999) states that "... the government of Canada is  
 5 committed to implementing the precautionary principle that, where there are threats of serious  
 6 or irreversible damage, lack of full scientific certainty shall not be used as a reason for  
 7 postponing cost-effective measures to prevent environmental degradation". See also Health  
 8 Canada Decision-Making Framework for Identifying, Assessing, and Managing Health Risks  
 9 ([http://www.hc-sc.gc.ca/ahc-asc/pubs/hpfb-dgpsa/risk-risques\\_tc-tm-eng.php](http://www.hc-sc.gc.ca/ahc-asc/pubs/hpfb-dgpsa/risk-risques_tc-tm-eng.php))

10

11

12

13 20.2. Please state whether in Canada and/or British Columbia the Precautionary  
 14 Principle with regard to the smart meter project has been considered. If so,  
 15 please state how; if not, why not.

16

17 **Response:**

18 FortisBC assumes that "the smart meter project" referenced in the question is the FortisBC  
 19 Advanced Metering Infrastructure project. That project has not yet been the subject of a  
 20 Commission determination, or indeed legal argument as to whether such matters as the  
 21 "precautionary principle" can or should be considered in relation to it.

22

23

24 21. Please confirm that there possibly will be naturally many cases where children and/or  
 25 frail older people would be sleeping with their head 2 - 3 feet away from the planned  
 26 installed wireless smart meters on the other side of the bedroom's wall.

27

28 **Response:**

29 While the exposure scenario may occur, FortisBC has no way to determine how frequently it  
 30 would occur. In any event, there is no good scientific basis to assume that those individuals  
 31 would suffer adverse effects to their health based on exposures that would be a small fraction of  
 32 the public exposure limit given in Safety Code 6. In fact, the exposure on the other side of the  
 33 wall would be greatly reduced by the absorption of the RF signal by house walls (approximately

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 16                               |

a factor of 10) and reflection of the signal from panel on which the meters are mounted (another factor of 10).

22. FortisBC as well BC Hydro depend upon PHO for confirmation of the adequacy of Health Canada's Safety Code 6, and the WHO/IARC EMR safety guidelines. If, on medical advice and prescription, somebody who is electro-sensitive/electro-hypersensitive (ES/EHS) and who must avoid electro-magnetic radiation (EMR) as much as possible, and who lives, so far, in a prior, chosen EMR-harmless environment, and if this ES/ EHS afflicted person were to be no longer free from radio wave/microwave radiation once a wireless smart meter was installed, please advise as to how this ES/EHS afflicted person might be legally able to avoid having the microwave emitting smart meter installed and be allowed to retain his/her present analog meter and whether FortisBC will cooperate to mitigate the wireless radiation.

**Response:**

FortisBC will always consider individual customer circumstances if it is made aware of them. Exceptions to FortisBC policies may be made in extenuating circumstances provided such exceptions are consistent with the FortisBC Electric Tariff.

23. Please inquire by the PHO, whether he is willing to assure an ES/EHS afflicted person and his/her medical doctor in writing that the wireless smart meters, that PHO is instrumental in approving to be affixed to homes, are biologically harmless for ES/EHS and any other persons beyond a reasonable doubt? As FortisBC and PHO must be aware, "Beyond a reasonable doubt" is an accepted scientific measure in bio-safety. Does FortisBC /PHO agree that no less a determination should apply in this instance?

**Response:**

FortisBC has not asked the PHO to express an opinion about wireless smart meters and persons reporting ES/EHS symptoms or to formulate health policies to address their concerns, however, please refer to the response to BC Hydro IR No. 2 Q2.1 for a statement from the Chief Medical Health Officer of British Columbia, dated June 2011, regarding health concerns about cellular phone transmission antennae and base stations. As well, please also refer to the

|  |                                       |
|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 17                               |

response to BC Hydro IR No. 2 Q2.2 which provides test results from the BC Centre for Disease Control titled "Measurement of Radiofrequency (RF) Emissions from BC Hydro's Itron Smart Meters". The ultimate determination of the safety of the proposed AMI system (related to reasonable doubt mentioned) is the responsibility of the BCUC.

24. Please inquire by PHO, whether he would order FortisBC and/or B.C. Hydro that, upon a customer's request with a medical doctor's advice and prescription, that the customer be allowed to retain the present analog meter or, in the case of a smart meter, to be connected via a hard-wired (non-radio wave frequency/non-microwave frequency emitting) smart meter or leave the existing previous non-wireless analog or digital meter? This would probably involve only 1-3 % (+/-) of BC households? If PHO would not make this recommendation, please inquire with him why not?

**Response:**

Please refer to the response to WKCC IR No. 2 Q23.

25. Obviously, for PHO's role as a consultant to FortisBC and B.C. Hydro with respect to the safety of wireless smart meters, PHO must have accredited expertise in the EMR subject. Please provide any peer-reviewed studies or papers on this subject that PHO has reviewed or published on this technology.

**Response:**

The PHO does not work for FortisBC and FortisBC does not have the PHO's resume, publications, or the peer-reviewed studies that the PHO has reviewed.

26. "...epigenetics [is] the study of how changes in the expression of genes can occur without changes in the underlying DNA). Richard Stein, a post doctorate in molecular biology at Princeton... [i]n a just published essay in the Journal of Epidemiology and Community Health, Stein writes: "For a long time, it was assumed that chemicals are

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 18                               |

able to cause cancer only by mutating the DNA. However, a growing body of scientific evidence reveals that this 'carcinogenesis equals mutagenesis' paradigm is not accurate." (This applies equally to radiation as well as chemicals.)..." [Cited from Microwave News, Short Takes, <http://www.microwavenews.com/>

<http://jech.bmj.com/content/early/2011/10/31/jech.2010.130690.abstract> ]

Please provide FortisBC's and/or PHO's position on the possibility for epigenetics being a mechanism for cancer with regards to the ever-increasing wireless radiation, including smart meters.

**Response:**

FortisBC does not evaluate or take position on the details of proposed disease mechanisms or their potential relevance to the evaluation of radiofrequency fields but leaves that to Health Canada and other health agencies.

27. On what basis is FortisBC or B.C. Hydro allowed to put something that is emitting a Class 2B possible carcinogen on/in homes and buildings? This is the first time it has been known that governments are forcing their citizens to use something that is dangerous. Is it FortisBC's and PHO's position that this is acceptable?

**Response:**

FortisBC does not believe that the radio frequency transmission associated with the wireless advanced meters that it has proposed are dangerous.

FortisBC does not yet have approval to proceed with its AMI Project. It is seeking approval of a CPCN for the AMI Project pursuant to the *Utilities Commission Act*. It does believe that its AMI Project should be accepted.

FortisBC does not speak for the Provincial Health Officer or BC Hydro. However, the Company notes the following statements on BC Hydro's website<sup>1</sup>:

If the World Health Organization (WHO) says cell phones are "possibly carcinogenic", are smart meters still safe?

<sup>1</sup> [http://www.bchydro.com/energy\\_in\\_bc/projects/smart\\_metering\\_infrastructure\\_program/fags.html](http://www.bchydro.com/energy_in_bc/projects/smart_metering_infrastructure_program/fags.html)

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 19                               |

The WHO has not drawn any definitive conclusions about cell phones, but has called for further investigation.

The WHO stated: "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."

While smart meters and cell phones both communicate wirelessly, they have different parameters. Smart meters are located outside of the home and transmit less than one minute a day at one hundredth the power of a cell phone. The exposure to radio frequency from a smart meter – over its entire 20-year lifespan – is the equivalent to a 30-minute cell phone conversation.

For more information on the WHO's recent announcement, please refer to Provincial Health Officer [Perry Kendall's statement](#).

More generally, BC Hydro says the following on its website:

#### **Are smart meters safe?**

Smart meters are safe, as confirmed by health and science authorities including B.C.'s Provincial Health Officer, Health Canada and the World Health Organization.

Smart meters communicate for a total average of less than one minute a day. In fact, exposure to radio frequency during a 20-year life span of a smart meter is equivalent to the exposure during a single 30-minute cell phone call.

BC Hydro's smart meters are well below Health Canada's exposure limits and the precautionary limits set by Switzerland, the country with the most rigorous standards in the world.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 20                               |

For more information, please see [Radio Frequency and BC Hydro's Smart Meters](#) and the factsheet on radio frequency in Related Resources.

28.1 Please state all frequencies of electromagnetic radiation that will be emitted by wireless smart meters.

**Response:**

The FortisBC proposed AMI meters have 2 wireless interfaces, one that is used for meter to meter to collector communication (902-928 MHz) and one that can be used for home area network communications (2.4-2.4835 GHz) if desired by the customer.

28.2 Please state how often the transmitters in the smart meters are transmitting, not just data but to also keep in touch with the smart meter network, as well how often - at the possible maximum - a neighborhood "collector" smart meter (actual smart meter installed at a residential home) is transmitting (not only for the purpose of data/detection).

**Response:**

The minimum, maximum and average transmission duty cycles are detailed in the response to CSTS IR No. 2 Q43.7, and the table compiled in response to BCSEA IR No. 1 Q55.4 relates those duty cycles to a number of minutes per day. These numbers include relaying of consumption data as well as all command and control messages. The transmission time for the referenced meter in the question would correspond to the maximum value of approximately 8 minutes per day. The average meter transmits for about one minute per day.

BC Hydro has commissioned reports to further quantify the duty cycle and number of transmissions for the same Itron meters that FortisBC has selected for use in the proposed AMI project. The real-world measured data collected during these studies suggests that the total duty cycle and the number of transmissions for the max, min and average meter will be reduced from the numbers FortisBC has provided in the Application and in response to CEC IR No. 2 Q34.1. Please refer to Appendix CEC IR No. 2 Q34.1 for these studies and their conclusions.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 21                               |

29.1 Please confirm, if not explain why not: Radiofrequency (RF) and microwave (MW) radiation are electromagnetic radiation in the frequency ranges 3 kilohertz (kHz) – 300 Megahertz (MHz), and 300 MHz - 300 gigahertz (GHz), respectively. Research continues on possible biological effects of exposure to RF/MW radiation from wireless smart meters, radios, cellular phones, baby monitors, the processing and cooking of foods, heat sealers, vinyl welders, high frequency welders, induction heaters, flow solder machines, communications transmitters, radar transmitters, ion implant equipment, microwave drying equipment, ...etc.

**Response:**

The statement above appears to be adapted from text that appears on the U.S. Department of Labor webpage under Radiofrequency and Microwave Radiation (<http://www.osha.gov/SLTC/radiofrequencyradiation/>). Additions and ~~deletions~~ to the original text are shown below:

Radiofrequency (RF) and microwave (MW) radiation are electromagnetic radiation in the frequency ranges 3 kilohertz (kHz) - 300 Megahertz (MHz), and 300 MHz - 300 gigahertz (GHz), respectively. Research continues on possible biological effects of exposure to RF/MW radiation from smart meters, radios, cellular phones, baby monitors, the processing and cooking of foods, heat welders, high frequency welders, induction heaters, flow solder machines, communications transmitters, radar transmitters, ion implant equipment, microwave drying equipment, ~~sputtering equipment and glue curing~~.

29.2. Please confirm, if not, explain why not: the effects of electro-pollution and the wireless smart meters radiating emissions are similar in many respects to X-ray radiation. Both physical forces are invisible, odorless, tasteless and silent. The forces are transmitted by radiating energies that travel varying frequencies, strength and distances and are capable of passing through the bodies of humans, animals and plants and recent research confirms these effects are associated with biological positive and negative biological effects, meaning they also can be harmful. These forces can pass through objects as well and induce electrical currents on conductive objects, including human bodies.

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 22                               |

1 **Response:**

2 Electromagnetic fields are not forces. Electromagnetic fields in different frequency ranges  
3 interact with objects in the environment in different ways. Assessing the similarity or risks of  
4 exposure across wide ranges of frequency based on our ability to perceive or not perceive them  
5 based on sensory qualities of vision, smell, taste, and hearing is not appropriate. The potential  
6 effects of exposure to electromagnetic fields in appropriate frequency ranges need to be  
7 assessed by valid assessments of the relevant research, not by arguments based on false  
8 analogies.

9

10

11 29.3. Please confirm, if not, explain why not: Wireless gadgets' (including smart  
12 meters') electro-magnetic radiation contain energy, and the strength of that  
13 energy is measured i.e. watt/m<sup>2</sup>, dBm, etc. However the actual energy causing  
14 mechanism are **photons**, see also below wiki definition:  
15 [http://en.wikipedia.org/wiki/Electromagnetic\\_radiation](http://en.wikipedia.org/wiki/Electromagnetic_radiation) cited here:

16 *.../ EMR carries energy—sometimes called radiant energy—through space*  
17 *continuously away from the source (this is not true of the near-field part of the*  
18 *EM field). EMR also carries both momentum and angular momentum. These*  
19 *properties may all be imparted to matter with which it interacts. EMR is produced*  
20 *from other types of energy when created, and it is converted to other types of*  
21 *energy when it is destroyed. The photon is the quantum of the electromagnetic*  
22 *interaction, and is the basic "unit" or constituent of all forms of EMR. The*  
23 *quantum nature of light becomes more apparent at high frequencies (or high*  
24 *photon energy). Such photons behave more like particles than lower-frequency*  
25 *photons do..../*

26

27 **Response:**

28 Electromagnetic energy carried by electromagnetic signal can be represented as a motion of  
29 particles called photons. Each photon carries a fixed amount of energy that is a function of the  
30 frequency of the electromagnetic wave. Each photon emitted by a 900 MHz source is  
31 associated with the energy of  $6 \times 10^{-25}$  Joules. A 0.6-watt RF transmitter will emit approximately  
32  $1 \times 10^{24}$  such photons per second (and under a typical duty cycle of 0.06% would produce  $10^{21}$   
33 photons per second). For comparison, the human body naturally emits  $2 \times 10^{22}$  photons per  
34 second each carrying  $2 \times 10^{-20}$  J.

35

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 23                               |

29.4 Please take notice and confirm, if not, explain why the points below do not refer to wireless smart meter radiation:

Source Dr. Robert Kane "Cellular Telephone Russian Roulette, A Historical And Scientific Perspective", page 215 - 217  
[http://www.icems.eu/docs/Robert\\_C\\_Kane.pdf](http://www.icems.eu/docs/Robert_C_Kane.pdf)

*"...Some reporters and magazine feature writers, confused on the physics of radiofrequency radiation, have erroneously reported that we need not be concerned about energy radiated from cellular telephones because it is low-energy radiation. Such statements, clearly, reflect the reporters' reliance on industry scientists to provide them with explanations, and those explanations are wrong. Certainly X rays, photon for photon, are more energetic than RF photons. But the issue here is not that of the energy of single photons. The industry representatives are confident in their belief that few non-scientific persons will understand the distinction in what they falsely represent. The fact of the matter does not lie with the energy of a single photon but, rather, with the total numbers of photons.*

*To put it more clearly, the energy radiated from the antenna of a portable cellular telephone typically is comprised of  $1.7 \times 10^{23}$  photons each second. Written in standard form this becomes 170,000,000,000,000,000,000 photons each second. Now it can be seen how differently the argument shapes up when we look at the real radiation from a cellular telephone antenna instead of the misrepresentations to which the comparison of photon energies lends.*

*Let's take it another step further. We know that X rays penetrate tissue and can cause tissue damage through cell destruction and damage. We need about 1 million microwave photons at cellular telephone frequencies to provide the same energy as an X-ray photon. So, we see that the typical radiation from a portable cellular telephone antenna is equivalent in magnitude to about  $1.7 \times 10^{17}$  (170,000,000,000,000,000) X-ray photons per second. Since the radiofrequency and microwave photons each carry a smaller packet of energy than do X-ray photons, the absorption results in a different mechanism leading to cell damage. Nevertheless, the results are the same. The end result is that the absorbed energy, whether from X-ray or radiofrequency radiation, will lead to tissue damage if the energy density is high enough. In the past the industry's often—stated "belief" was that radiofrequency radiation was not energetic enough to cause DNA or chromosomal damage. Now, faced with contradictory research findings coming from all points of the earth—the industry has changed its defense by claiming that no research is available at exactly the cellular transmit frequencies. Well, if that's true then there is also an absence of safety-related research.*

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 24                               |

During 1998 J. L. Phillips<sup>189</sup> reported research that was conducted at the cellular telephone transmit frequencies. His research did employ human cells. His research was conducted at very low power levels—low enough to rule out any heating effects. Phillips essentially replicated the DNA damage studies of Lai/Singh. His results are the same. Exposure to low levels of radiofrequency radiation causes DNA damage...”

**Response:**

Dr. Robert Kane’s analysis is faulty and his description of the phenomenon is misleading. The energy of the individual photon has a dramatic effect on whether that photon can damage DNA. If the energy (frequency) of the individual photon drops below a certain value, the photon becomes non-ionizing and cannot cause DNA damage. In fact, Dr. Kane’s analysis, taken to its logical conclusion, would predict that a human body would be one the strongest sources of electromagnetic energy producing 50 times more photons per second than a typical smart meter and each photon carrying 30,000 times more energy than a photon from a smart meter.

29.5 Please confirm, if not, explain why not: Conductive materials (including human / animal bodies and plants) absorb electromagnetic radiation and the absorbed energy is in some degree amplified in those materials. The whole electrical wiring in homes and any buildings do receive any kind of outside electromagnetic radiation, thus in turn do radiate amplified into the home, in addition to the homes inside and outside transmitting gadgets.

**Response:**

Radiofrequency energy may be reflected, absorbed, or transmitted by materials, but the energy cannot be amplified by materials (with exception of specifically prepared materials such as those used in lasers); in fact, the absorbed RF energy is attenuated by conversion to heat. Any wire may ‘receive’ a radiofrequency signal but it will not amplify the signal. To do so, without the absorbing medium supplying the energy itself, would violate fundamental laws of physics.

29.6 With what is stated in section 29.5. does FortisBC agree that house wiring in walls near and around sleeping persons are exposed to some degree to radiation that originate from outside radiation pollution?

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 25                               |

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2 **Response:**

3 House wiring is exposed to both natural and man-made sources of electromagnetic fields. The  
4 absorption of RF signal by the household wires, if anything, reduces the exposure to RF signal  
5 inside the house.

6

7

8 30. Smart metres' legal issues: Please take note and confirm, if not, explain why not:

9 In consideration of the statements in sections 29.1. -29.4 and of the constitutional,  
10 common/civil law rights of affected persons and parties, the energy carrying photons  
11 of the wireless smart meter radiation into the environment do encroach on private  
12 property, thereby damaging property.

13 This encroachment constitutes a taking of property by way of trespass, nuisance and  
14 assault and affects all property owners living adjacent to electric power lines. The  
15 intent of the word "damage" in the Constitution was to grant relief to property owners  
16 who have been substantially damaged by the creation of public improvements  
17 abutting their lands, but whose land has not been physically taken by government.  
18 Our Constitution states that private property shall not be taken or damaged for  
19 public or private use without just compensation.

20 Even if the transmission carried out by wireless smart meters was for the purpose of  
21 providing remote/ convenient meter reading and trouble detection, physical forces  
22 (photon energetic radiation) from wireless gadgets, including smart meters, are by  
23 law, restricted to the right-of-way and cannot invade/assault private property in the  
24 form of nuisance and trespass without a property owner's permission. In order to  
25 obtain permission from a property owner who may or may not be aware of and/or  
26 may or may not agree to endure such assault/trespass/nuisance, the power  
27 company would have to obtain the property owner's signature on an Informed  
28 Consent Agreement prior to such a trespass. Without such Informed Consent, the  
29 property owner's right to live in peace and enjoy his/her home are violated. This  
30 property owner then becomes a victim of assault, trespass and nuisance due to the  
31 noise, the EMR consisting photons entering upon and through the land, and the  
32 home. Furthermore, these energetic radiating forces invade the human tissue of the  
33 property owner, his/her family, and anyone setting foot on such property, thereby  
34 causing bodily harm.

35 EMR are tangible intrusions that can be measured. In fact, power companies  
36 themselves know the levels of the fields at any distance, and power companies also



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 26                               |

1 know well that all EMR from any transmitters (smart meters, telecommunication  
2 transmitters, wireless laptops, routers, baby monitors , cordless phones etc.) that  
3 each and every transmission is adding up thus increasing the pollution in the  
4 environment. The action these high frequency (including ELF modulated) energy  
5 radiation constitutes an "intentional invasion" of the rights of all property owners  
6 living in close proximities of any transmitters (incl. smart meters) and unreasonably  
7 interferes with humans rights to use and enjoy their properties, thereby "damaging  
8 personal property." The personal rights of these affected people are violated, some  
9 additional legal terms that do apply with the EMR issue are: civil assault, civil battery,  
10 negligence, assault, bodily harm, intimidation, mischief, common nuisance, criminal  
11 negligence, causing bodily harm by criminal negligence.

12 Comparatively, under criminal law, if someone intentionally/knowingly hits a person,  
13 that is an assault and does bodily harm to that person. Either one of the mentioned  
14 electric forces can be a force, a component of simple assault, and are most likely a  
15 weapon, an element of some more serious assault charges, such as causing bodily  
16 harm. The impact of encroachment of smart meter radiation on the environment past  
17 a utilities' right-of- way, is synonymous with a physical attack. In other words,  
18 encroachment upon private property by smart meter radiation constitutes assault,  
19 which causes bodily injury. Smart meter's radiation induce currents in conductive  
20 materials, including human bodies, animals and plants that is, in effect, "a physical  
21 attack".

22 Smart meter radiation exposure have not yet scientifically conclusive been declared  
23 safe. This extreme exposure constitutes a violation of the personal property rights  
24 and common law rights of the affected persons by way of personal injury, trespass,  
25 civil assault, civil battery and a taking of their property rights whether such exposure  
26 is permitted out of ignorance or inflicted arbitrarily, wantonly and willfully and without  
27 due process of law.

28 Electric utility companies, including FortisBC, do not have the right to assault  
29 affected property owners and residents with their electric forces' emissions. The  
30 elements of civil assault to FortisBC and the effected persons are/will be as follows:

31 a) FortisBC acts with the intent of making contact with the person (with their smart  
32 meter radiation emissions).

33 b) These affected people are placed in apprehension of imminent contact with their  
34 persons by conduct of FortisBC.

35 c) Such contact is or appears to be harmful of offensive.

36 d) Negligence and/or nuisance would apply as well to electric forces' emissions.

37 The movement of electro-magnetic forces (photons) from the lawful utility corridor to  
38 lands outside of that corridor constitutes trespass or nuisance - both are torts. Having

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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 27                               |

the right to transmit power within a given corridor does not carry with it permission or the right to transmit something dangerous or capable of harm beyond the perimeter of that corridor.

The September/October issue 2001 of "Microwave News" indicates that the World Health Organization (WHO) is recommending "prudent avoidance." In the case of persons living in close proximity to smart meters, it is "impossible" to "avoid" exposures to these not harmless radiation. Obviously, persons living in such situations, in fact, have to endure "an unavoidable trespass".

**Response:**

FortisBC does not agree with the statements made in WKCC IR No. 2 Q30. FortisBC believes that the AMI Project will be compliant with the applicable legal framework.

The statements made by WKCC in IR No. 2 Q30 are fundamentally in error, in both fact and law. The "question" consists of a series of offensive and incorrect assertions and implications, including the suggestion that the Company is assaulting its customers (intentionally or otherwise) in some manner. The Company takes fundamental issue with the suggestions advanced in this "question" and believes it to be inappropriate.

Without limiting the generality of the foregoing, FortisBC notes that:

- the RF transmission associated with the advanced meters that FortisBC has proposed:
  - does not involve encroachment on property in any sense recognized by law;
  - does not damage property;
  - does not involve trespass, nuisance, assault, negligence or any other tort, criminal offence or violation of human rights;
  - does not involve the taking of property;
- the Constitution contains no wording or philosophy approximating the content alleged in WKCC IR No. 2 Q30;
- no signatures are required from property owners in order to permit wireless advanced meters to be lawfully installed and operate;

Given the number of misstatements in WKCC IR No. 2 Q30, the list above is not intended to be exhaustive.



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| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 28                               |

31. Please take note and confirm, if not, explain why not:

There is an established and useful definition of safety. It is the WHO IARC's own invention.

If a toxicant or toxic exposure is studied by IARC for potential carcinogenicity, and classified as a 4 - Not A Carcinogen - this is the closest definition to 'studied and safe' that we have Studied. Safe. Decided.

If the IARC listing is anything between 2A or 2B listing, it is by definition, to some degree, 'not-safe' (i.e., a listed probable or possible carcinogen), and

If it is a 1A listing, it is a known carcinogen.

Does FortisBC agree that this obviously an answer to 'proof of safety' argument. And, provides a legitimate answer for those who dismiss the scientific evidence because "you can't prove the null or negative". Of course one can - IARC does it.

**Response:**

Science determines the likelihood and severity of potential risks; it is the responsibility of government to rule on safety, i.e., the acceptability of a risk. The IARC classifications are used to describe the strength of the evidence, not safety. Nowhere in the 2011 IARC report on radiofrequency fields do the words "safe" or "safety" appear.

32. Please confirm that FortisBC has read and taken notice of attached extensive list of studies, which includes those ones with biological effects and please provide FortisBC's position on those studies that do prove harmful biological effects association that go along with electromagnetic radiation, such as those from wireless smart meter as well.

**Response:**

The position of FortisBC is not based upon its own interpretation of individual studies; rather FortisBC relies upon regulations, e.g., those cited in response to WKCC IR No. 2 Q13 above, Safety Code 6, and guidance from Health Canada and the BC government including the Provincial Health Services Authority, the BC Centre for Disease Control, and the BC Cancer Agency that have reviewed and considered published research literature on radiofrequency fields and health. The conclusions of these sources regarding radiofrequency fields and health are similar to those of other national and international health agencies.

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|--|---------------------------------------|
| FortisBC Inc. (FortisBC or the Company)<br>Application for a Certificate of Public Convenience and Necessity<br>for the Advanced Metering Infrastructure Project | Submission Date:<br>December 14, 2012 |
| Response to West Kootenay Concerned Citizens (WKCC)<br>Information Request (IR) No. 2  | Page 29                               |

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3 33. What are the voltages, frequencies and electrical information of biology hit by the  
4 frequencies in the coverage areas.

5

6 **Response:**

7 FortisBC does not understand this question. The Company has provided extensive evidence in  
8 this proceeding with respect to the RF emissions of the AMI system.

9

10

11 34. Are the frequencies in the coverage areas hitting people to any degree in the  
12 coverage areas? Does that stimulate tissue?

13

14 **Response:**

15 FortisBC does not understand the first question. The radiofrequency signals from smart meters  
16 would not be strong enough to 'stimulate' tissue by heating or depolarization of nerve or muscle  
17 cells.

18

19

20 35. What were the voltage changes with frequency interaction with biology within the  
21 coverage areas, please provide references.

22

23 **Response:**

24 FortisBC does not understand which "voltage changes with frequency interaction with biology"  
25 are being referred to, so cannot answer the question.