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June 15, 2011

BY COURIER, RESS AND EMAIL

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street
27th Floor, Box 2329
Toronto, ON M4P 1E4

Dear Ms. Walli:

Re: Haldimand County Hydro Inc.
Response to Interrogatories
EB-2011-0027

We are counsel to Haldimand County Hydro Inc. ("HCHI").

Attached is HCHI's response to the interrogatories of Board Staff, Hydro One Networks Inc., and Summerhaven Wind L.P. The letter and response are being filed with the Board on the RESS today and two (2) hard copies will follow by courier.

If there are any questions please contact the undersigned.

Yours truly,

AIRD & BERLIS LLP

Scott A. Stoll

SAS/hm
Encl.

cc: All Intervenors
Kristyn Annis, McCarthy Tetrault LLP
Ben Greenhouse, Summerhaven Wind, LP
Helen Newland, Fraser Milner Casgrain LLP
Lloyd Payne, Haldimand County Hydro Inc.
N. Mikhail, Ontario Energy Board
Kristi Sebalj, Ontario Energy Board

SUMMERHAVEN WIND LP
LEAVE TO CONSTRUCT TRANSMISSION FACILITIES
EB-2011-0027

RESPONSES OF
HALDIMAND COUNTY HYDRO INC.
("HCHI")
TO THE INTERROGATORIES OF
BOARD STAFF

June 15, 2011

Board Staff Interrogatory #1:

Basis for Recommended 10 metre (or more) Distance Separation between Transmission and Distribution poles

Reference: Kinectrics Report/CONCLUSIONS/p. 5/first paragraph

Preamble:

The report at the Reference states that:

> *Due to its proximity, the transmission line will provide lightning protection against direct lightning strikes. It is recommended to maintain a minimum distance of 10 m or more between the transmission and distribution poles to limit the GPR (Ground Potential Rise) transfer during lightning strikes to the transmission line and 60 Hz faults.*

Question:

(i) Please indicate the basis for concluding that 10 metres or more is required between the poles of the transmission line and the distribution line to limit the Ground Potential Rise (GPR) transfer during lightning strikes to the transmission line and 60Hz faults.

(ii) Did the Kinectrics study simulate lightning strikes and its effect on the GPR transfer rise? If so, what was the GPR transfer in the event of a lightning strike? If not, please provide the results of such a study.

(iii) Did the Kinectrics study simulate 60 Hz faults on the transmission system and its effect on the GPR transfer? If so, please provide details of assumptions and results. If not please undertake a simulation and provide the results based on:

a. Fault assumptions such as: single-phase to ground, two phases to ground, or three-phases to ground faults

b. The fault current for each case; and

Please tabulate the results on the GPR transfer rise calculated in the event of each of the assumed cases.

(iv) For comparison purposes, please provide results by repeating the simulation and calculating the GPR transfer assuming an offset of 4.7 metres [14 metres – 9.3 metres] between the transmission line structures and the HCHI distribution line (assumptions – Tech.Conference, Exhibit TCJ1.5) – essentially repeating the requested simulations outlined in Questions/Requests (ii) and (iii) above.

Response:

i) The recommended 10 m separation is a diagonal distance, including the direction along the line. This distance is mentioned in CSA StandardCSA-C22.3 No. 6 "Principles and Practices of Electrical Coordination between Pipelines and Electric Supply Lines" as a recommended offset between high voltage lines and gas pipelines in order to prevent sustained underground arcing between these utilities. As part of this review, we need to ensure that a lightning strike to the 230-kV line leading to a 60-Hz fault, will not cause sustained arcing below grade to ground rods associated with HCHI distribution poles. Such arcing could cause the failure of the equipment of HCHI and HCHI's ratepayers.

ii) No recent studies have been conducted by Kinectrics. Power Tech Labs in Surrey, BC, tested the 60-Hz potential required to sustain a high current arc following initiation of a conducting path by lightning [Craig Webster, "Powerline Ground Fault Effects on Pipelines", CEA Report 239 T 917, October 1994]. The measurements showed that about 10 kV per metre of arcing distance was required to sustain an arc in soil. Thus the 230-kV structure would have to rise to 100 kV in order to sustain an arc in soil over a 10 metre distance to the distribution pole. There is some uncertainty as to whether such extrapolations are valid and whether the tests themselves properly simulated transient recovery potentials.

   The potential rise of the Applicant's 230-kV structures would depend upon the fault current, shield wire type, span between structures and footing resistances. This is likely to be much less than 100 kV, reducing the concern regarding the uncertainty and transient recovery voltages.

iii) Such a study has not be performed and would take approximately 2 weeks to complete. It would require knowledge of the fault current, shield wire type, span between structures and footing resistances.

iv) The study would include various distances between the 230-kV structures and distribution poles.

Board Staff Interrogatory #2:

Establishing a Base Line for Existing Neutral Potential on HCHI Distribution Lines

Reference: Kinectrics Report/Section 1. CONCLUSIONS/p. 5/second paragraph

Preamble:

The report at the Reference states in part that:

> *The calculated neutral potential to remote earth remained below 7 V in both cases. The Ontario Electrical Safety Code limits the neutral potential to 10 V, which could be still exceeded depending upon the existing potentials that may be present. [emphasis added].*

Question:

(i) Please undertake a simulation to establish the existing neutral potentials referenced above on HCHI's circuits under two scenarios – one scenario assuming HCHI's existing distribution system voltage level (is it 8.32/4.8 kV or is it 4.16/2.4 kV) and the second scenario with the future distribution system voltage level of 27.6/16 kV.

Response:

i) A modelling study would require a site inspection noting the kVA rating of customer transformers, their location and number of pole grounds in the vicinity of the parallel exposure. This study and the simulations could be completed in about 3 weeks (concurrent with the study mentioned above in response to Board Staff IR#1).

Board Staff Interrogatory #3:

Contribution to Animal Contact Potential at Existing Customer Premises

Reference: (a) Kinectrics Report/Section 1. CONCLUSIONS/p. 5/second Paragraph

(b) Kinectrics Report/Figure 3 & Exhibit TCJ1.4, Technical Conference (May 17, 2011)

Preamble:

The report at Reference (a) states in part that:

> *In addition, utilities must maintain their contribution to animal contact potentials at customer premises under 0.5 V which could be exacerbated by the new line.*

Question/Request:

(i) Please provide a list of the customers who have animals that can be affected due to the proposed construction of the 230 kV transmission line where it runs parallel to a HCHI's distribution line for approximately 2 kilometres on the same side of the road as shown in Reference (b).

ii) Please indicate if any of the customers listed in (i) above complained in the past about problems with their animals that were traced to animal contact neutral potentials? Also indicate as to whether such complaints resulted in HCHI taking mitigating steps to address that issue. If so what mitigation did HCHI implement?

iii) Did your consultant, Kinectrics, simulate the impact of the proposed transmission line, as outlined in Reference (b), on the animal contact potential and calculate the magnitude of the increase at those customers identified in (ii) above? If yes, what are those impacts? If not, please conduct such simulations and provide the results.

Response:

i) Reference (b) Kinectrics Report/Figure 3 has been modified and attached to identify all existing electric customers in the general vicinity of the proposed transmission line route. Haldimand County Hydro does not have a record of customers who have animals. We also do not know what livestock plans current or future owners of these lands may have. However, Haldimand County is an active farming community as evidenced from the following table copied from http://www.haldimandcounty.on.ca/Business.aspx?id=978 on June 9, 2011

Historical classification of farms reporting gross receipts greater than $2,499 by farm type

Type of Farm	Number
Total number of farms reporting	891
Dairy farms reporting	114
Cattle (beef)	161
Hog	34
Poultry and egg	60
Wheat	14
Grain and oilseed (except wheat)	249
Field crop (except grain and oil seed)	51
Fruit	13
Miscellaneous (specialty)	131
Live stock combination	23
Vegetable	9
Other/combination	32

Source: Statistics Canada, OMAF2002-2003 Ontario Statistics and 2001 Ag and Agri-Food Canada Census of Agriculture

It also appears from Haldimand County Hydro aerial maps and/or observations driving by (fencing, equipment, hay storage, animals) that the following addresses from the modified Kinectrics Report/Figure 3 have animals:

1	1065	Cheapside Road	Possible livestock present (barns)
2	1064	Cheapside Road	Livestock present (chicken barn)
3	997	Cheapside Road	Possible livestock present (barns)
4	972	Cheapside Road	Livestock present (cows)
5	889	Cheapside Road	Possible livestock present (barns)
6	1254	Concession 5 Road	Livestock present (cows)
7	1163	Concession 5 Road	Possible livestock present (barns)
8	1154	Concession 5 Road	Possible livestock present (barns)
9	1114	Concession 5 Road	Livestock present (cows)
10	1111	Concession 5 Road	Possible livestock present (barns)
11	941	Sandusk Road	Livestock present (chicken barns)
12	934	Sandusk Road	Livestock present (cows)
13	1226	Concession 4 Road	Possible livestock present (barns)
14	1131	Concession 4 Road	Possible livestock present (barns)
15	1070	Concession 4 Road	Possible livestock present (barns)
16	1018	Concession 4 Road	Possible livestock present (barns)
17	929	Concession 4 Road	Livestock present (chicken barns)
18	835	Concession 4 Road	Livestock present (chicken barns)
19	757	Concession 4 Road	Livestock present (cows)
20	744	Concession 4 Road	Livestock present (horses)
21	636	Concession 4 Road	Livestock present (pigs)

(ii) Haldimand County Hydro has no records which indicate that any of the customers whose addresses are identified on the modified Reference (b) Kinectrics Report/Figure 3 have complained in the past about problems with their animals that were traced to animal contact neutral potentials.

(iii) Animal contact potentials are normally measured as in Appendix H of the Distribution System Code. Simulations may not be reliable given the complexity and unknown parameters present on customer premises.

NextEra - Summerhaven Proposed Transmission Line

N

SANDUSK RD

CONC 5 W-1

1019 Con 5
986 Con 5
1111 Con 5
1145 Con 5
1163 Con 5
1185 Con 5
1205 Con 5
1265 Con 5
1088 Con 5
1114 Con 5
1154 Con 5
1194 Con 5
1254 Con 5
1345 Con 5

2.0 KM

1115 CHEAPSIDE RD (x2)
1112 CHEAPSIDE RD (x2)
1107 CHEAPSIDE RD
1065 CHEAPSIDE RD
1064 CHEAPSIDE RD
1001 CHEAPSIDE RD
984 CHEAPSIDE RD
997 CHEAPSIDE RD
972 CHEAPSIDE RD
889 CHEAPSIDE RD
850 CHEAPSIDE RD

941 SANDUSK RD
934 SANDUSK RD
915 SANDUSK RD
909 SANDUSK RD

757 CON 4
727 CON 4
744 CON 4
636 CON 4
70 M
835 CON 4
929 CON 4
834 CON 4
866 CON 4
956 CON 4
954 CON 4
952 CON 4 (x2)
948 CON 4
806 SANDUSK RD
1018 CON 4
1044 CON 4
1051 CON 4
1070 CON 4
1131 CON 4
1160 CON 4
1226 CON 4
1234 CON 4
1309 CON 4
1314 CON 4
1373 CON 4

LEGEND

EXISTING DISTRIBUTION TRANSFORMER

EXISTING 4.8kV OVERHEAD LINE

PROPOSED TRANSMISSION LINE

PROPOSED WIND TURBINE

Revised to show addresses June 13, 2011

Board Staff Interrogatory #4:

Effort Level and Time Required to Conduct a thorough Assessment on the Impact of the 230 kV line on HCHI's Distribution Line

Reference: Kinectrics Report/Section 1. CONCLUSIONS/p. 5/fifth paragraph

Preamble:

The report at the noted Reference states that:

> *This study was based on the draft design information available to date and do [sic] not provide a thorough assessment on the impact of the 230 kV line on the HCHI distribution line. A more comprehensive study is recommended when final construction plans will become available.*

Question/Request:

(i) Please provide an estimate of the amount of time needed to complete the study, once the final design of the 230 kV transmission line is filed in this proceeding.

(ii) Please ensure that the scope of the detailed study cover the other aspects as outlined in the Board staff Questions/Requests listed in this interrogatory document?

Response:

i) Such a study should also include testing of existing neutral potentials. This and the other studies mentioned previously in response to Board Staff IRs would require about 4 weeks in total.

ii) Kinectrics can accept this scope.

Board Staff Interrogatory #5:

Offset Between the proposed 230 kV Transmission Line and the HCHI Distribution Line

Reference: (a) Kinectrics Report/Section 2. INTRODUCTION/p. 5/first paragraph under INTRODUCTION
(b) Kinectrics Report/Figure 4 & Exhibit TCJ1.5, Technical Conference (May 17, 2011)

Preamble:

At Reference (a), the Report states in part that:

> *The latest 230-kV draft design provided by NextEra shows the offset between the transmission line structures and the HCHI distribution line as 3.4 m (see Figure 4).*

At Reference (b), it is noted that the offset is 4.7 metres being the difference between:

- **14 metres** (distance between the 230 KV line and the centerline of County Road 5); and
- **9.3 metres** (distance between HCHI's distribution line and the centerline of County Road 5)

Question/Request:

(i) Was a mistake made? If so, please provide updates to the study, where applicable, to reflect the offset being 4.7 metres instead of assuming it to be 3.4 metres. Please also ensure use of that 4.7 metre offset in calculating the various additional requests made by Board staff in this interrogatory document. If not, please explain the discrepancy.

Response:

(i) The 3.4 m is a typo. The Kinectrics study assumed 4.7 m between the centre lines of the two circuits.

Board Staff Interrogatory #6:

Potential Negative Consequences on HCHI's Distribution System

Reference: Kinectrics Report/Section 2. INTRODUCTION/pp. 5-6/last paragraph in page 5 and page 6

Preamble:

The Kinectrics report at the noted Reference, states in part that:
Even with the 230-kV currents well balanced, the result is a longitudinal potential induced in all distribution line conductors that may negatively impact the distribution line operation. The following negative consequences can be experienced on the distribution side due to this coupling:

- *Difficulty in maintaining voltage levels on the distribution line or keeping unbalanced phase voltages below 1% (causing damage to customer motors).*
- *Failure of distribution line arresters by induced voltages during transmission line faults.*
- *Maintenance issues such as induced voltages and currents on the de-energized distribution line when the transmission line remains energized.*
- *Excessive voltages between the distribution phase conductors and the neutral may appear during transmission-line faults as well as the associated ground potential rise on customer service conductors.*
- *Stray voltage problems. The Ontario Energy Board since 2009 requires utilities to maintain the cow contact potentials in farm country below 0.5 V (which can be related back to induction to the neutral).*

Question/Request:

(i) Did Kinectrics quantitatively calculate any of the noted 5 aspects? If not, please indicate the reasons for not carrying out such analysis.

(ii) Is the Applicant intending to have Kinectrics perform the more detailed study upon receipt of the final 230 kV design including quantitative evaluation of the 5 items identified in the noted Reference and repeated in the Preamble above?

Response:

i) Aspect 1 and part of Aspect 5 (neutral potentials, but not cow contact potentials) were modelled with preliminary results given in the Kinectrics report. Cow contact potentials are difficult to model. However Appendix H of the Ontario Distribution System Code describes a test protocol. Kinectrics can provide more specialized studies for Aspects 2, 3 and 4.

ii) Kinectrics is the consultant to the Intervenor HCHI and not the Applicant. HCHI has not yet made any decision with respect to having Kinectrics perform a more detailed study. Such a decision will be made following receipt of the detailed or final 230 kV design.

Board Staff Interrogatory #7:

Modelling Methodology and Results

Reference: Kinectrics Report/Section 4. MODELLING METHODOLOGY AND RESULTS/p. 6/first paragraph under Section 4

Preamble:

The Report states in part at the Reference that:

> *Distribution neutrals usually contribute significantly to station grounding because they fan out in several directions and are multi-grounded. The models are based on the driving point impedance seen looking into a system of cascaded π circuits. Carson earth return impedances [4] account for the longitudinal branches. Pole, transformer and customer grounds describe the shunt connections to earth. The models also account for inductive coupling between phase conductors and the neutral. This coupling tends to increase the split of current flowing back to the substation on the neutral.*

It is important to establish a base case that reflects HCHI's system as it exists today, and the effect of the unbalanced loads on its distribution feeders may affect the distribution neutral voltages, under the current situation.

Question/Request:

(i) Please explain the number of distribution circuits that Kinectrics modelled in this study, and for each distribution line, its location and voltage level (8.32/4.8 kV or 4.16/2.4 kV, etc);

(ii) Please provide the results of the distribution neutral voltages of the existing HCHI's system without modelling the proposed 230 kV transmission system, and another set with modelling the transmission system.

(iii) Please repeat step (ii) above, assuming HCHI system to have converted to 27.6/16 kV system without modelling the transmission system. Please confirm that the calculation with modelling of the transmission system is shown in Figure 1, page 7 of the Kinectrics Report.

Response:

i) The preliminary results given in the Kinectrics report were based on a single line extending 4 km in each direction beyond the parallel exposure. Kinectrics is prepared to conduct a more detailed study, which would require a site visit to note the kVA rating of transformers, their phasing, their location and the density of pole /

customer service grounds. Measurements of existing neutral potentials would be helpful in corroborating these results.

ii) Such an analysis has not been completed. Kinectrics is capable of completing such a study.

iii) Conversion to a 27.6/16 kV system should reduce neutral potentials related to existing unbalanced customer load. The conversion may have a much smaller effect on the component of neutral potential caused by the 230-kV line if the number of pole and customer service grounds remains about the same. .

Board Staff Interrogatory #8:

Voltage Unbalance – Detailed Calculations

Reference: (a) Kinectrics Report/Section 4. MODELLING METHODOLOGY AND RESULTS/p. 6/second paragraph under Section 4
(b) Kinectrics Report/Appendix C

Question/Request:

(i) At Reference (a), the report indicated that the spread sheet software used by Kinectrics was validated against simulation software such as EMTP. Please provide a short description of the EMTP simulation.

Response:

A description of the EMTP (ElectroMagnetic Transients Program) software can be found at http://www.emtp.com/ and includes the following summary *"The package is a sophisticated computer program for the simulation of electromagnetic, electromechanical and control systems transients in multiphase electric power systems."*

The following distribution line configuration was simulated using both the Kinectrics spreadsheet model and the EMTP as part of a previous study:

- system voltage 12.5 kV phase to phase
- soil resistivity 100 Ωm
- conductor framing distances (phase a to n: 4.54 m, b to n: 3.06 m, c to n: 1.62 m, vertical armless)
- 20 grounding spans, each 100 m long
- substation grounding resistance 0.5Ω at span 0, other spans 50 Ω, unless noted

The following variations were modelled:

- 125 kVA load on phase a at span 20
- 125 kVA load on phase c at span 20
- 125 kVA load on phase c at spans 5, 10, 15 and 20
- 125 kVA load on phase a at spans 5 and 10, phase b at 15 and phase c at 20
- as above with 50 Ω replaced by 5 Ω on spans 1 to 20
- as above with 5 Ω replaced by 1 Ω on spans 10 and 20

The following table shows that very good agreement was observed. The results for the last variation are also plotted in the following figure.

Table 7.2

Comparison of EMTP and Spreadsheet Simulated Neutral Potentials (V)

Span	NEV Sheet	EMTP
0	2.1879	2.187891
1	1.1459	1.145873
2	0.1151	0.115047
3	0.9181	0.918105
4	1.9565	1.95648
5	3.011	3.011006
6	2.9884	2.988383
7	3.0171	3.017119
8	3.087	3.086988
9	3.1903	3.190321
10	3.3226	3.322573
11	2.6815	2.681481
12	2.1652	2.165191
13	1.8289	1.828892
14	1.7374	1.737401
15	1.8989	1.898911
16	1.1527	1.152753
17	1.0114	1.011392
18	1.6138	1.61375
19	2.4602	2.46022
20	3.3785	3.378483

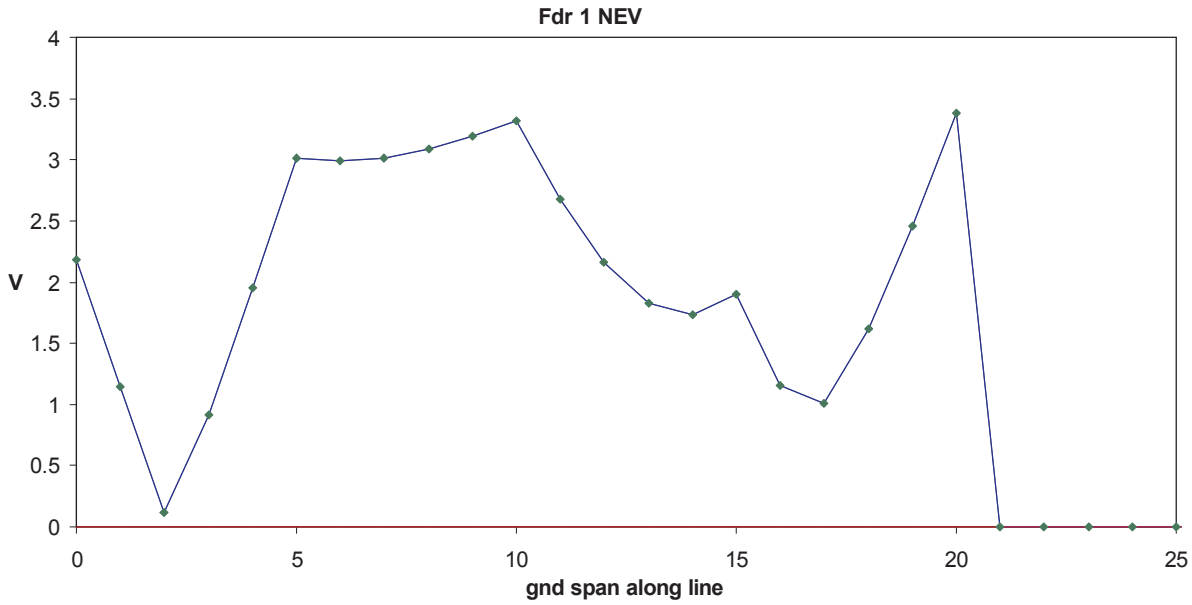


Figure 7.1

Neutral to Earth Voltage Plotted by Span (line is EMTP, points are Spreadsheet)

Preamble:

At Reference (b), Appendix (c) shows the results of the potential along the feeder and reflects the effect of inductive coupling for three cases:

- one scenario between the proposed 230 kV transmission line and the existing 8.32/4.8 kV; and
- two more scenarios for the coupling between the 230 kV transmission system and the future 27.6/16 kV distribution system – one at “closer 27.6 kV line”, and one at “more distant 27.6 kV line”.

Question/Request:

(ii) In regard to Appendix C, for each of the three scenarios please provide a description / narrative for each of the sub-tables containing assumptions, and results.

(iii) Indicate whether the “Closer Scenario for 27.6 kV” reflects an offset of 3.4 metres. If so, please recalculate that scenario to reflect an offset of 4.7 metres as outlined in Interrogatory No. 5 above.

(iv) Please indicate what is the offset distance assumed for the “More distant 27.6 kV Line” scenario.

(v) Please provide a calculation to reflect offsets between the 4.7 metres provided by the applicant on May 17, and the 10 metres proposed in your Report. Perhaps one run at 6 metre offset and one at 8 metre offset.

Response:

ii) Appendix C reviews the unbalance on 4 feeder circuits:

1. A new 27.6 kV circuit with armless (vertical) phasing on the pole facing the 230-kV line with phase a to the top. The unbalance is 0.0104 % (using the NEMA definition of the maximum difference from average phase to phase voltage divided the average).
2. A new 27.6 kV circuit with armless (vertical) phasing on the pole away from the 230-kV line with phase a to the top. The unbalance is 0.0110 %.
3. The existing line assuming this to be three phase 8.32/4.8 kV on a crossarm, with phase c closest to the new line. The unbalance is 0.0170 %.
4. A new 27.6 kV circuit with armless (vertical) phasing on the pole facing the 230-kV line with phase c to the top. The unbalance is 0.0113 %.

iii) The closer 27.6 kV scenario took the offset between pole centres as 4.7 m (the distribution conductors were 0.8 m from their own pole centre or 3.9 m from the 230-kV pole centre).

iv) The most distant 27.6 kV scenario took the offset between pole centres as 4.7 m (the distribution conductors were 0.8 m from their own pole centre or 5.5 m from the 230-kV pole centre).

v) The Kinectrics study assumed 4.7 m between the centre lines of the two circuits. The 10m refers to the recommended closest distance between the poles, which could be staggered (not adjacent to each other).

SUMMERHAVEN WIND LP
LEAVE TO CONSTRUCT TRANSMISSION FACILITIES
EB-2011-0027

RESPONSES OF HALDIMAND COUNTY HYDRO INC. ("HCHI") TO THE INTERROGATORIES OF SUMMERHAVEN WIND LP

June 15, 2011

Summerhaven Interrogatory #1:

Reference:

On page 4 of the Kinectrics Induction Study for Haldimand County Hydro Inc. (May 31, 2011), in regard to the statement:

> Kinectrics performed induction calculations considering the geometry given in the 230-kV transmission line draft design provided by NextEra and the HCHI construction standard design for 27.6/16kV lines. This line will connect their new 125MW wind power generation farm to the Hydro One Networks Inc. grid.
>
> Kinectrics studied the voltage unbalance on the distribution phases downstream of 2 kmof exposure. The calculated values are very small, about 0.01 % of average line to linevoltage for any of the configurations studied. This analysis neglects the effect of theneutral and the overhead ground wire, which should be negligible. The result is wellbelow the 1% limit to voltage unbalance normally accepted by utilities.

Question:

(a) Please confirm the current voltage on HCHI's existing line running along Concession Road 5.

Response:

The existing single phase lines along Concession 5 Road, and along Concession 4 Road, both between Sandusk Road and Cheapside Road are built for and operating at 4.8 kV supplied from overhead step down transformer # SD-82, 167 kVA, 16 kV/4.8 kV.

This step down transformer was installed in 2008 when Nanticoke Distribution Station was taken out of service as part of an ongoing program to gradually convert Haldimand County Hydro's whole service territory to 27.6/16 kV. Such step down transformers, also commonly known as "rabbits", are typically installed as part of a larger project to convert an area from a lower voltage to a higher voltage. These "rabbits" enable bypassing immediate conversion of certain line sections in favour of future conversion for various reasons, including cost constraints.

Any additional load on this rabbit, such as the requirements for electrical service from HCHI for the Summerhaven transformer station will trigger an immediate need to eliminate SD-82 and complete the conversion of this vicinity to 16 kV single phase based upon the following comment from the Technical Conference:

> "MR. ARKERSON: Our normal practice is single-phase station service backup, so I don't know any details on this project that would indicate that we would be looking for three-phase distribution into our collector sub."
>
> Consequently all analysis and discussion about measurements relating to 8/4.8 kV become academic and the 27.6/16 kV system should form the basis for all considerations.

Summerhaven Interrogatory #2:

Reference:

On page 4 of the Kinectrics Induction Study for Haldimand County Hydro Inc. (May 31, 2011), in regard to the statement:

> Calculations of the induced voltage into distribution phases during a transmission line fault were also performed. The maximum calculated longitudinal voltage induced in the distribution phases was 46 kV when a 63 kA fault on the lowest transmission line phase was considered. To limit these fault induced overvoltages, the protection of distribution equipment may require the installation of surge arresters properly rated for the expected duty on distribution phases at each end of the parallel exposure.

Preamble:

> Please refer to Summerhaven Wind, LP.'s Leave to Construct Application submitted on January 26, 2011. Please refer to Exhibit B, Tab 8, Schedule 2, the System Impact Assessment (SIA), dated November 4, 2010, and Schedule 3, the Customer Impact Assessment (CIA), dated November 9, 2010. In the SIA, at page 24, grid calculated post-Summerhaven symmetrical line to-ground fault current at the closest transmission interconnected facilities includes the Nanticoke bus at 42.4 kA and the Middleport bus at 44.2 kA. In the CIA, on the final page, the post-Summerhaven symmetrical line-to-ground fault current at the Imperial Oil facility is shown to be 25.012 kA.

Questions:

(a) Given that system fault levels identified in the SIA range from 44.2 kA at Middleport to 42.4 kA at Nanticoke, and given that the fault level at the Imperial Oil facility is identified in the CIA to be 25.012 kA, please explain the decision to use 63 kA as the fault level in your analysis.

(b) Please describe how the conclusions in 4.2 would change if a 44.2 kA fault (the highest anticipated at closest buses) was used instead of 63 kA.

(c) Please confirm that if the effects of a 63kA fault on the lowest transmission phase can be mitigated by the installation of surge arresters, a similar mitigation would suffice, if needed, with a lower fault level.

(d) Please confirm that fault contribution decreases as you go further away from the source.

Response:

(a) Currents of 44.2 and 42.4 kA apply soon after completion of project, 63 kA is the future ultimate value.

(b) Longitudinally induced potential is reduced in proportion to fault current. The result is 32 kV for 44.2 kA fault level.

(c) Mitigation of longitudinal induced potentials at 63 or 44.2 kA may be practical using arresters, but more detailed studies are needed to confirm this.

(d) While fault current generally falls with distance from a given source, multiple sources complicate the analysis. Also fault current tends to increase in proximity to transformers with grounded high voltage neutrals.

Summerhaven Interrogatory #3:

Reference:

On Page 5 of the Kinectrics Induction Study for Haldimand County Hydro Inc. (May 31, 2011), in regard to the statement:

> Due to its proximity, the transmission line will provide lightning protection against direct lightning strikes. It is recommended to maintain a minimum distance of 10 m or more between the transmission and distribution poles to limit the GPR (Ground Potential Rise) transfer during lightning strikes to the transmission line and 60 Hz faults.

Questions:

(a) Please confirm that the distance between the proposed transmission line and the HCH distribution line is less than 10m for only approximately 550 meters where HCHI's line runs on the south side of Concession Road 5, west of Cheapside Road.

(b) Please identify the calculation for the recommendation of the 10m minimum separation distance.

(c) Please provide a definition of "GPR (Ground Potential Rise) transfer".

(d) Please identify HCHI's current design specifications for mitigation of transient overvoltage on its distribution line.

Response:

(a) According to the sketch provided by Summerhaven Wind LP, which is reproduced as Figure 4 in the Kinectrics report, the distance from the outside edge of an existing HCHI pole location and the centre of a Summerhaven pole location is 4.7 metres.

Assuming the question is referring to the distance along Concession Road 5 for which the existing HCHI distribution line and the proposed Summerhaven transmission line, as depicted on Figure 3 of the Kinectrics report, it appears the parallel distance between the two would be 4.7 metres for a distance of approximately 550 metres where HCHI's existing line runs on the south side of Concession Road 5 west of Cheapside.

However, HCHI would continue to emphasize:

- its existing and future need for distribution lines everywhere along municipal roadways, including in this instance an understood need for a line extension to the proposed Summerhaven transformer station location which would add an additional approximately 700 metres of parallel line along Concession 5 Road east of Cheapside Road (see also response to Summerhaven interrogatory #1 (a)).

- adherence to the principle and intent to avoid lines on both sides of a roadway, which suggests that the distribution line should be on the same side of the roadway as the transmission line if the transmission line is as close to the roadway as proposed in Figure 4. If the distribution line is rebuilt for 27.6/16 kV along Concession 5 Road on the south side of the road it will make these lines parallel for the full 2 km of transmission line along Concession 5 Road.

(b) The recommended 10 m separation is a diagonal line distance and refers to the closest recommended distance between the poles. The Kinectrics study assumed 4.7m between the centrelines at the two circuits. This distance is mentioned in CSA StandardCSA-C22.3 No. 6 "Principles and Practices of Electrical Coordination between Pipelines and Electric Supply Lines" as a recommended offset between high voltage lines and gas pipelines in order to prevent sustained underground arcing between these utilities. As part of this review, there is a need to ensure that a lightning strike to the 230-kV line leading to a 60-Hz fault, will not cause sustained arcing below grade to ground rods associated with HCHI distribution poles. Such arcing could cause failure of equipment of HCHI and HCHI's ratepayers.

(c) Please understand the phrase "limit the GPR (Ground Potential Rise) transfer during lightning strikes to the transmission line and 60 Hz faults" to mean "preventing damage to HCHI or customer equipment associated with a sustained arc underground between the 230-kV and HCHI poles. This damage could result from a lightning strike to the 230-kV line which also causes a local 230-kV fault."

(d) HCHI, along with 45 other municipal utilities in Ontario, uses the Utilities Standards Forum Inc. distribution design standards including its grounding and lightning arrester installation design standards.

Additionally HCHI's equipment approval process developed in accordance with Electrical Distribution Safety, O. Reg. 22/04 includes equipment approval sheets with purchasing specification as follows for lightning arresters:

- Product number 704047 – "Arrester, surge, distribution class, 21 kV heavy duty cycle, 17 kV MCOV, 8/20 max. discharge voltage of 64 kV @ 10 kA, 26-in. leakage distance, grey silicone rubber insulated gapless metal oxide varistor, with nut, wire clamp and protective cap at top, an 18-in. #6 AWG Cu wire having one ring terminal, an insulated base bracket with 1/2-in. mounting hole, and isolator, washer and nut at bottom, per IEEE C62.11-2005"

- Product number 704022 – "Arrester, surge, distribution class, 6 kV normal duty cycle, 5.1 kV MCOV, 8/20 max. discharge voltage of 23 kV @ 10 kA, 15-in. leakage distance, grey silicone rubber insulated gapless metal oxide varistor, with nut, wire clamp and protective cap at top, an 18-in. #6 AWG Cu wire having one ring terminal, an insulated base bracket with 1/2-in. mounting hole, and isolator, washer and nut at bottom, per IEEE C62.11-2005"

Summerhaven Interrogatory #4:

Reference:

On Page 5 of the Kinectrics Induction Study for Haldimand County Hydro Inc. (May 31, 2011), in regard to the statement:

> Kinectrics modelled the neutral to earth voltages considering 2 km length of parallel exposure. Calculations were performed for two ground rod resistances (transformer and customer service ground), 37 ohm and 75 ohm, on the neutral at 100 m spacing. The calculated neutral potential to remote earth remained below 7 V in both cases. The Ontario Electrical Safety Code limits the neutral potential to 10 V, which could be still exceeded depending upon the existing potentials that may be present. In addition, utilities

must maintain their contribution to animal contact potentials at customer premises under 0.5 V which could be exacerbated by the new line.

Questions:

(a) NextEra's practice is typically to achieve less than 25 ohm resistances. In light of that, please identify the reason for the selection of the 37 and 75 ohm resistances.

(b) Please provide calculations of the voltages using 10 to 15 ohm resistances.

(c) Please provide a spreadsheet of HCHI's current contributions to animal contact potentials at customer premises in the vicinity of HCHI's distribution line.

(d) Regarding the calculated induced neutral to ground potential stated as 7V, please describe how that relates to animal contact potentials at customer premises.

(e) Please identify whether HCHI has ever had a complaint where HCHI's contribution to animal contact potentials at customer premises was over 0.5.

(f) Please describe mitigation HCHI has conducted for all complaints HCHI received where HCHI's contributions to animal contact potentials at customer premises were over 0.5.

(g) For all mitigation described in question 4.f., please provide the cost of mitigation.

(h) Please provide a list of all dairy farms along Concession Road 5.

(i) Please provide the evidence supporting the statement that the 10V limit could be exceeded.

Response:

(a) HCHI 's distribution standards includes:

"9.1 System requirements

The system neutral on primary distribution lines must be multi-grounded. Minimum four grounds per km is the standard number of 25 ohm grounds per km of circuit or the equivalent of 6 ohms per km for 2.4/4.16 kV to 14.4/25 kV systems, and 6 grounds per km or the equivalent of 4 ohms for 16/27.6 kV

systems. The neutral potential must not exceed 10 volts under steady-state conditions."

The resistance of a given ground rod or customer service ground will depend upon the soil resistivity and in this part of Ontario typically ranges from 20 to 40 ohms. In order to comply with the 10 V limit for neutral potential in the Ontario Electrical Safety Code, utilities commonly apply sufficient pole ground rods so these are equivalent to two, four or six 25 Ω ground rods per kilometre. The Kinectrics study used ten 37 and 75 Ω rods per kilometre which is equivalent to 6.8 and 3.4 25 Ω ground rods per kilometre. This is consistent with utility practice in Ontario.

(b) The span between the 10 to 15 ohm resistances needs to be indicated in order to do a study.

(c) The procedures for testing animal contact potentials is described by Appendix H of the Ontario Distribution Code. It is generally difficult to model these potentials due to the complexity of conductor types and locations as well as soil resistivity at customer premises.

Location	Instantaneous Neutral – Earth Voltage	Time	Date
1345 Concession 5 Road	0.8 V	10:00 am	June 13, 2011
1245 Concession 5 Road	0.6 V	10:15 am	June 13, 2011
941 Sandusk Road	0.7 V	10:30 am	June 13, 2011
1226 Concession 4 Road	0.7 V	10:50 am	June 13, 2011
997 Cheapside Road	0.6 V	11:10 am	June 13, 2011

The Neutral to Earth voltages were instantaneous Vrms measurements taken at a light loading time of the day. The Distribution System Code Appendix H requires that this Voltage from the primary neutral at the transformer to the reference ground rod, Vp be recorded with a digital recording device over a period of forty-eight consecutive hours. More time is needed to appropriately conduct these recorded tests.

Weather conditions for June 13, 2011 according to the www.theweathernetwork.com for Hagersville was as follows:

Observations Updated: Monday June 13 2011, 17:00EDT

	Sky	Temp (°C)	Dewpoint	Feels Like	Wind (km/h)	Relative Humidity (%)	Pressure (kPa)	Visibility (km)	Ceiling (ft)
MON 12:00		18	11	-	NW 19	64	101.43	24	5100
MON 11:00		18	11	-	NW 15	64	101.46	24	unlimited
MON 10:00		16	11	-	W 7	72	101.49	24	unlimited
MON 09:00		14	10	-	W 13	77	101.53	24	unlimited

Loading during these times of day and weather conditions would be at a minimum for the normal load profile.

(d) Animal contact potentials can range from 0 to almost 100 % of the neutral potentials, depending upon factors mentioned in (c) above.

(e) HCHI has records of four instances where customers have complained of animal contact potential as follows:

(1) The first involves a dairy farm and includes a lawsuit commenced January 17, 2001 for damages in the amount of $2M plus interest and costs against HCHI and its predecessor utilities. The lawsuit actively continues to date in 2011 against HCHI alone. According to the Statement of Claim the problems began in November 1995 when the farm was part of Ontario Hydro's service territory before it was transferred ultimately to HCHI. HCHI's insurer engaged two consultants who prepared recent reports dated October 25, 2010 and November 16, 2010 which *"...demonstrated that the animal contact voltage limit was less than 50 mV during the 68 hours of continuous testing ..."*

(2) The second involves a beef farm where problems were reported in October, 2004.Animal contact voltage measurements were taken and found to be 0 V.

(3) The third involves a dairy farm where problems were reported in August, 2006. Animal contact voltage up to 0.5 V was measured.

(4) The fourth involves a chicken farm and dates to a complaint received November 23, 2010 about deformed eggs.Testing and investigation are ongoing to date in 2011. Animal contact voltages were measured up to 2.98 V.

(f) The response for each is below:

(1) In the case of the dairy farm noted in question (e) item 1. above, direct active involvement and investigation by HCHI stopped when the lawsuit began and HCHI's insurers became involved. Early in the investigation HCHI's mitigation activities included installation of grounds at additional poles, replacement of insulators, and relocation of the transformer serving the customer.

(2) In the case of the beef farm noted in question (e) above, action included the installation of a new ground rod, and replacement of lightning arresters.

(3) In the case of the dairy farm noted in question (e) item 3. above, no mitigation action was undertaken.

(4) In the case of the chicken farm noted in question (e) above, mitigation action to date includes the installation of a new ground rod, new down ground wire, and new connectors. A ground resistance measurement of 55 ohms was the reason for this early mitigation work. The new ground resistance was 9.2 ohms. Further mitigation work may be required pending the outcome of DSC Appendix H section H.5.2 Phase 2 testing. This testing will be completed upon receipt of a load box which was ordered March 22, 2011.

(g) HCHI has not tracked the costs specific to these occurrences.

(h) See OEB staff interrogatory # 3. (i).

(i) The neutral potential caused by HCHI and by the new 230-kV line generally add as vectors. The resulting magnitude of neutral potential considering both sources would reach their arithmetic sum if the phase angles are similar. Utility neutral potentials commonly range from 1 to 3 V, with higher levels common.

Summerhaven Interrogatory #5:

Reference:

On page 5 of the Kinectrics Induction Study for Haldimand County Hydro Inc. (May 31, 2011), in regard to the statement:

> The latest 230-kV draft design provided by NextEra shows the offset between the transmission line structures and the HCHI distribution line as 3.4 m (see Figure 4).

Questions:

(a) Figure 4 in HCHI's submission indicates that HCHI's infrastructure is 9.3 m from the county road center line, and that Summerhaven's proposed infrastructure is 14m from the county road center line. Please confirm that the resulting difference is 4.7m between HCHI's infrastructure and Summerhaven's proposed transmission line.

Response:

(a) See OEB staff interrogatory # 5.(i).

Kinectrics used a difference of 4.7 m between the centres of each pole line in their studies.

SUMMERHAVEN WIND LP
LEAVE TO CONSTRUCT TRANSMISSION FACILITIES
EB-2011-0027

RESPONSES OF HALDIMAND COUNTY HYDRO INC. ("HCHI") TO THE INTERROGATORIES OF HYDRO ONE NETWORKS INC.

June 15, 2011

Hydro One Networks Inc. Interrogatory #1:

Reference: Kinectrics Inc.'s Induction Study (Report # 015949-RC-0001-R00)

Preamble: The report concludes that the contribution to neutral potential with respect to remote earth (NEV) will remain below 7 V at respective exposure terminals for planned loading levels on the 230-kV circuit and assuming ten (10) ground-rods per kilometre, each exhibiting no more than 75 ohm resistance.

Question:

(a) Is it true that this finding relies on the NEV profile depicted in Figure 1 maintaining a characteristic "V" shape over the exposure?

(b) Please explicitly identify the precise assumptions giving rise to the particular shape in each of Figures 1 and 2.

(c) The LV feeder extends an additional 2 km or so west of the paralleled section (shared use section with the 230 kV circuit) terminating on a dead end, while east of the paralleled section, the feeder continues to an extensive multi-grounded system (substantially more grounding points than west of the paralleling section). Does this affect the assumed V-shape – i.e., the NEV east and west of the paralleled section?

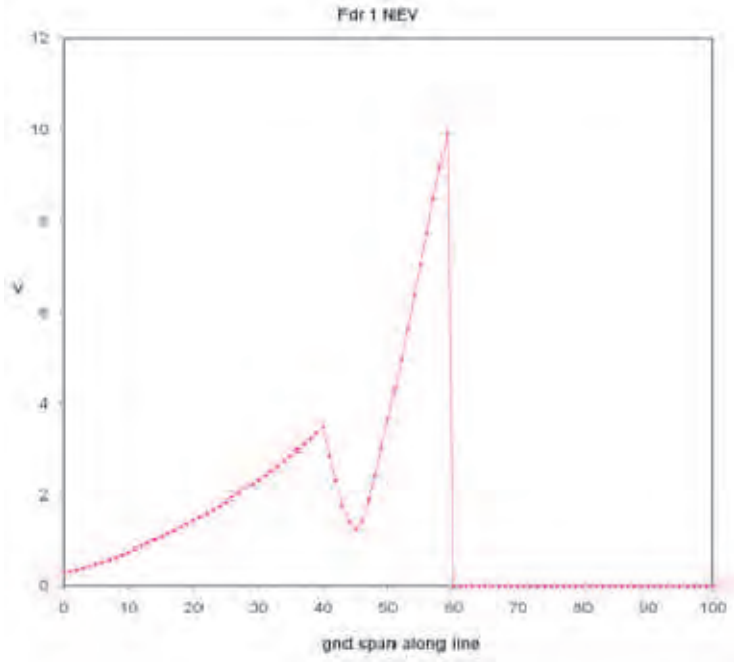
(d) Is it conceivable that these assumptions could be violated in time due to possible changes to the existing feeder configuration, including the possible interconnection of this feeder's neutral to those for adjacent (future) supply circuits? In this context, how might the predicted NEV profile and values change under less favourable circumstances?

Response:

(a) The "V" shape in Figure 1 arises because only the magnitude of potential is plotted (phase angle is ignored) and the exposure is only 2 km long. The two peaks actually have opposite polarities, with the difference equal to the longitudinal induction. Over this short distance, the shunt resistance of all pole and service grounds is high compared to the self impedance of the neutral and they have little effect on the potential.

(b) For the longer 20 km study, the "V" becomes a "U". Over this longer distance, the shunt resistance of all pole and service grounds is comparable to the self impedance of the neutral. This reduces neutral potentials midway along the exposure.

(c) The 2-km study assumed the neutral continued 4 km beyond the exposure section at each end. Removing the 4 km at the far end would increase the neutral potential to 9.9 V at the far end as shown in this plot (for 37.6 ohm pole and service grounds on a 100 m span):



(d) Yes, as a worst case, the entire longitudinal potential of 13 V could appear at one end of the exposure

Hydro One Networks Inc. Interrogatory #2:

Preamble/Question:

The report concludes that neutral potential could exceed the 10 V Ontario Electrical Safety Code limit depending on existing potentials that may be present. Is there an expectation, based on prevailing experience and practices, as to how likely this might be the case? What specific practical mitigation measures are contemplated in the event that it does turn out to be the case?

Response:

Existing neutral potentials are quite sporadic over time due to changing customer loads. The maximum value reached will depend upon factors such as the total load, the phase balancing of loads (long single phase laterals produce higher neutral potentials), the soil resistivity, the number of pole and customer grounds, and the neutral size. Exceeding 3 V for the existing neutral would not be unusual.

Hydro One Networks Inc. Interrogatory #3:

Preamble:

The report identifies a risk of subjecting distribution apparatus to undue temporary overvoltages (TOV) due to induction from line-to-ground fault currents on the 230-kV circuit and suggests installation of "properly rated" surge arresters to limit this duty without offering an opinion on the practicality of this option in terms of available arrester ratings or the likely associated costs.

Question:

Do surge arresters offer a practical means of limiting TOV (power frequency overvoltages caused by phase-to-ground faults) to levels capable of maintaining normal coordination margins for utility and customer apparatus? Would such arresters be expected to be "sacrificial"? If that is the case, would there be a cause for concern for potential wood pole fires?

Response:

Control of longitudinal induction on the phases and neutral of the distribution line due to 230-kV faults requires more detailed study. Since this induction occurs on both phases and neutral, the differential potential seen by utility and customer equipment and the TOV seen by surge arresters (with ground side connected to the neutral) is likely to be relatively modest. Of greater concern may be the potential rise of the primary neutral and the transfer of high potentials to bonded items on customer premises such as exterior water taps (or customers using case grounded tools outside the house). Inside the house, the Electrical Safety Code calls for bonds between the service panel and metallic objects such as drain pipes, cable TV, the gas supply to furnace, etc. This helps to maintain small touch potentials within the house, although such bonds are often missing.