

March 29, 2011

Nancy McNeil
Regulatory Affairs Officer/Clerk
Nova Scotia Utility and Review Board
1601 Lower Water Street, 3rd Floor
P.O. Box 1692, Unit "M"
Halifax, NS B3J 3S3

**Re: CI 40425 – Kempt Road Transformer - NSPI Information Requests (IRs) -
Second Set P –510/Matter No. 03715**

Dear Ms. McNeil:

Enclosed are the IR responses pertaining to the capital item referenced above.

These IRs were received on February 21, 2011.

The System Operation Diagrams and System Planning Studies filed in response to IR-16(d), (e), IR-17(b), IR-24 and IR-26 are fully confidential due to security concerns. Protection of the power system preserves reliability and reduces the risks associated with external threats. The diagrams are filed with the Board in hard copy only.

The supplier information included in response to IR-25 is partially redacted. NSPI strives to keep the terms and conditions of suppliers' pricing and arrangements confidential from their other customers or potential competitors. This prevents competitors from using their information to gain a competitive advantage. This is equally true for NSPI, which desires to protect its ability to acquire capital services and equipment on the most competitive terms. Those "best" terms may not be available if there is a risk that they will be disclosed to the customers or competitors of the supplier.

Since NSPI customer rates are cost-based, the maintenance of confidentiality for this item is to the direct benefit of customers.

Regards,



Lee Thomson-Lutz MBA, CMA
Manager, Capital

Encl.

CI 40425 - Kempt Road Transformer (NSUARB P-510)
NSPI Responses to UARB Information Requests

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Request IR-15:

On page 4 of 20 of the submission it is stated that the two recent transformer failures occurred on July 5, 2009, and September 4, 2010. According to page 4 of 5 of the CI# 39723 submission, 104-T63 Transformer Refurbishment, this unit suffered damage during a storm in February of 2010. Please clarify.

Response IR-15:

The reference to July 5, 2009 on page 4 of 5 of CI 40425 is incorrect. This was an oversight. The correct date is February 2010.

Please note, page 4 of 5 pertaining to CI 39723 references February 10, 2010.

T-63 failed in February 2010.

T-61 failed in September 2010.

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Request IR-16:

With reference to the response to IR-3 (b), it is stated that a transformer was taken from another location and placed in-service at Kempt Road:

(a) Where was this transformer taken from?

(b) What is the rating of this transformer?

(c) Where will this transformer be transferred to after the second Kempt Road Substation transformer is rewound and returned to service?

(d) Please provide a copy of the Kempt Road Substation single line diagram, with the proposed fourth transformer installed.

(e) Please provide details of all locations where NSPI currently has "energized spares". Include substation configurations, transformer ratings, and installation dates.

(f) Please provide a copy of NSPI's planning criteria justifying the use of energized spares.

Response IR-16:

(a) This transformer was taken from the Dartmouth Crossing Substation. This substation is not yet in service. NSPI anticipates this substation to be in-service by December 2011.

(b) The rating of this transformer is 138 – 26.4 kV, 25/33.3/41.6//46.7 MVA.

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Response IR-16: (cont'd)

(c) The new transformer will be installed at the Dartmouth Crossing Substation. The transformer that was moved from the Dartmouth Crossing Substation to Kempt Road will remain at Kempt Road as an energized spare once 104-T61 is returned to service in Sept. /Oct 2011. The transformers described above are identical to one another.

(d) Please refer to Confidential Attachment 1, in hard copy only. This transformer is identified as T-64 on this diagram.

(e) The details on energized spares is included in Appendix 10 in the response to IR-24. Please refer to Confidential Attachments 2, 3 and 4, in hard copy only, for the substation configurations. The installation dates of these units are as follows:

30N-T1 is now 30N-T61-	Maccan	1978
50N-T8 -	Trenton	1969
50N-T12-	Trenton	1975
88W-T52 –	Pleasant St. Yarmouth	1974

These transformers were not purchased for the purpose of being an “energized spare” that would be moved on a regular basis from substation to substation. NSPI has deemed these units as “energized spares” to be moved only in emergency situations for a short period of time. These units were installed for the purpose of supplying area load. In the report provided in the response to IR-24 these transformers were identified as being able to be removed from that particular location and temporarily installed in another location.

(f) The planning criterion is included in the response to IR-24.

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Request IR-17:

With reference to the response to IR-4:

(a) As it relates to the hypothetical loss of all three transformers at the Kempt Road Substation, how much of the stated 54 MVA could not be transferred to the Armdale and Water Street substations? Please specify separately amounts that are limited due to feeder capacity and amounts that are limited due to the substation transformers themselves.

(b) Please provide copies of the Armdale and Water Street substation single line diagrams.

(c) What is the maximum capacity of the mobile transformer used in this example?

(d) What spares are generally available, other than the 28/37/47 MVA unit located at Onslow?

Response IR-17:

(a) All of the 54 MVA of load cannot be transferred due to the fact that the existing feeders are loaded to capacity as of a result of load transfers that have taken place from the Kempt Road Substation due to the contingency issues at this station.

(b) Please refer to Confidential Attachments 1 and 2, in hard copy only.

(c) The maximum capacity of the mobile transformer is 30 MVA if the ambient temperature is 0 degrees Celsius or lower. The maximum capacity is 25 MVA if the ambient temperature is higher than 0 degrees Celsius.

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1 Response IR-17: (cont'd)

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3 (d) The unit located at Onslow is the only system spare capable of being connected to 138-25
4 kV.

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Request IR-18:

With reference to the response to IR-5:

- (a) When were the investigations noted in IR-5 (a) completed?**
- (b) When did NSPI start to use the procedure described in IR-5 (b)?**
- (c) Please describe any measures taken to limit the magnitude of fault current.**
- (d) Describe any possible options that have not been implemented and explain the reasons.**

Response IR-18:

- (a) NSPI performed an internal investigation on Units T-61 and T-63 shortly after the units failed. T-61 failed in September 2010. T-63 failed in 2001 and in February 2010.
- (b) NSPI started to use this procedure after 104H-T61 failed in September 2010.
- (c) There is a design limitation on the magnitude of fault current which at 25 kV is 8000 amps.
- (d) A possible option would be a design change in the transformer impedance. However this would introduce challenges regarding voltage control that would result in additional feeder regulators. The impedance of transformers on the NSPI system is similar to units used across the industry.

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Request IR-19:

With reference to the response to IR-6:

- (a) Describe any test results regarding the integrity of this third transformer.**
- (b) On page 4 of 20 of the submission NSPI states: "The remaining unit has been exposed to similar conditions and is therefore at risk for failure." Please elaborate on the levels of risk for failure of this unit, before and after the implementation of the procedure described in the response to IR-5 (b).**
- (c) Based on investigations of the two faulted transformers, what steps can be taken to reinforce the integrity of the third transformer to enhance its ability to withstand these through faults?**
- (d) Please estimate the cost of such enhancements and compare that with the cost of a new transformer.**

Response IR-19:

- (a) Standard tests will not detect mechanical movement of the windings in a transformer. There are new tests such as the Sweep Frequency Response Analysis (SFRA) and the leakage reactance test that can give an "indication" of mechanical movement inside a unit. These tests can indicate that there has been mechanical movement of the windings in a transformer. However, these tests cannot give a quantitative answer as to when a transformer may fail. It is necessary to have a signature fingerprint of the unit when the transformer was built to compare the original snapshot against the unit that has experienced damage to its windings. These tests were not available at the time of the construction of these transformers. NSPI does not have a signature fingerprint of these units.**

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1 Response IR-19: (cont'd)

2
3 NSPI monitors the transformer oil in each unit for dissolved gasses. This may give an
4 indication that something is wrong with the transformer. A mechanical failure tends to
5 be very sudden, usually during a through fault.
6

7 (b) 104H-T62 is a sister unit to 104H-T63 and 101H-T61. These units are similar in design
8 and have the same mechanical bracing of the coil assemblies. NSPI believes 104H- T62
9 may already have had some mechanical movement due to the similar coil bracing of the
10 other two units. Additional high magnitude through faults could cause damage to the
11 unit. Internal inspection results would be very limited and would not show the condition
12 of low voltage windings due to the physical construction of the units. The low voltage
13 winding is wound inside the high voltage winding. The unit has to be dismantled at an
14 external transformer factory in order to inspect the low voltage windings.
15

16 (c) The integrity of 104H-T62 could only be improved at an external transformer repair
17 facility. The entire core and coil assembly would have to be dismantled and rebraced. A
18 design review would be required along with a new bracing system designed to today's
19 standards. NSPI is currently reviewing this option.
20

21 (d) Currently, the rewind activities described above are forecast to cost approximately
22 \$950,000. CI 40425, to purchase a new 138-25 kV transformer, is budgeted at
23 \$1,093,699.

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Request IR-20:

With reference to the response to IR-7:

- (a) What is the remaining life expectancy of the two transformers that were or will be rewound and refurbished?
- (b) It is noted that 104H-T61 was rewound in 2010. Please elaborate on this project and provide the date when the Board approved this capital item.
- (c) Please provide the history of 104H-T63 which appears to have been rewound in 2001 and in 2010. Include in your response its ratings, locations, and also explain the 2001 rewind.

Response IR-20:

- (a) The life expectancy of the two transformers that were or will be rewound would be equivalent to that of a new unit (approximately 45 years). If these units are subjected to through fault activity at this substation, their life expectancy could be reduced.
- (b) Transformer 104H-T61 was to be rewound in 2010. This project was delayed and it will now be rewound in 2011. This project was filed with the Board on 2011-03-29.
- (c) The transformer rating is 138 – 26.4 kV, 28/37.3/46.7 MVA. The unit has always been in the same bay as it is now. The exception would be when this unit was shipped away for repair in 2011. The transformer had one leg (high voltage, low voltage and regulating windings) replaced in 2001.

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Request IR-21:

With reference to the response to IR-8:

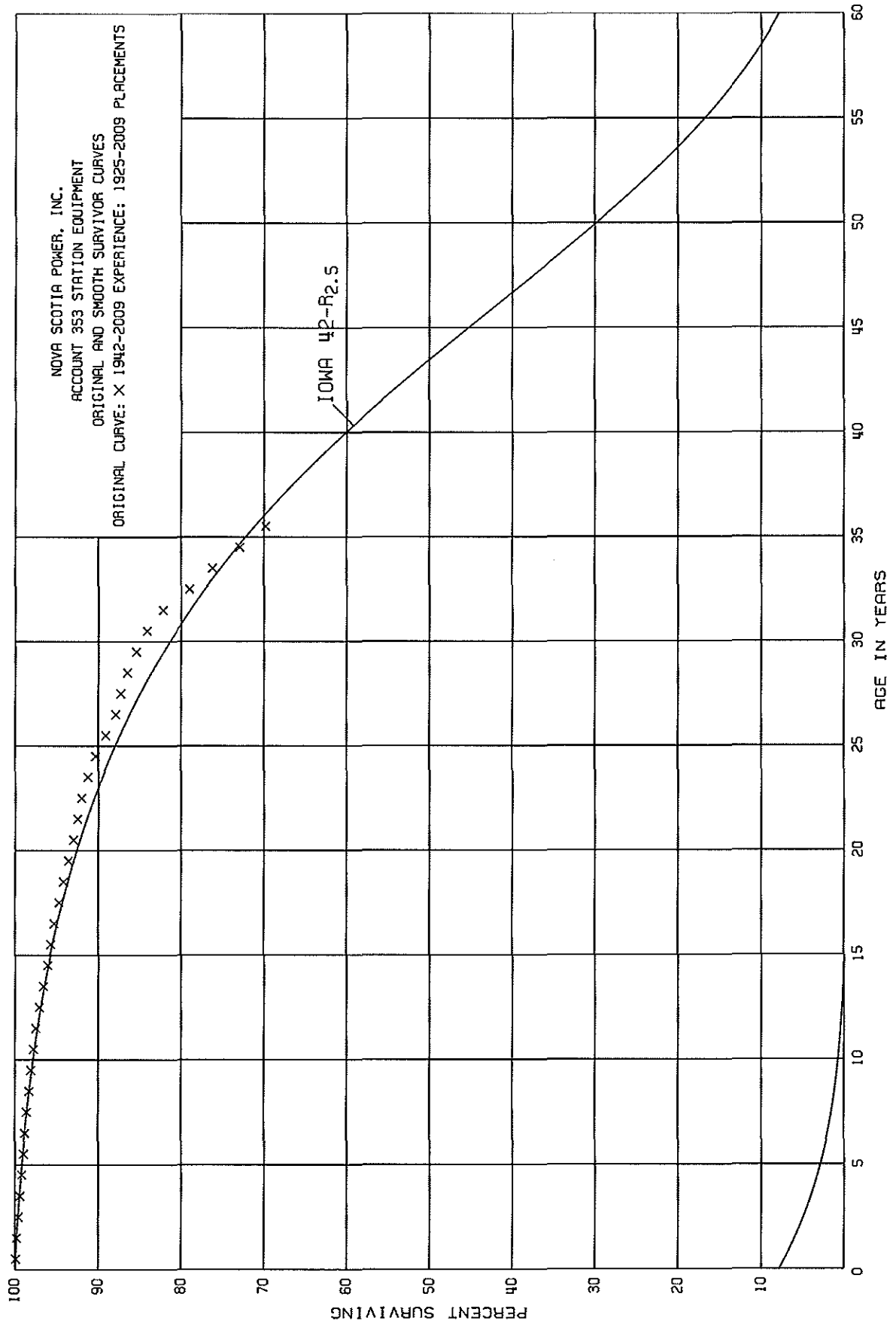
(a) It is noted that the life expectancy of transformers being used at the Kempt Road Substation is "less than 45 years". Please quantify the quoted phrase.

(b) Please provide any scientific or statistical analysis which can support "45 years" and "less than 45 years".

Response IR-21:

(a) The life expectancy of transformers being used at Kempt Road Substation is expected to be less than 45 years due to the fact that these units supply distribution loads and as such would be subjected to through faults on the distribution system. Generating unit transformers would not be subjected to this type of duty.

(b) Please refer to Attachment 1. This attachment is Appendix A, page 69 from the Iowa State Survivor Curve 2010 Depreciation Report. This information indicates the life of station equipment to be 42 years. In this case, station equipment is defined to include electrical control equipment, station service, transformers, circuit breakers and other items used in the construction and operation of a substation. The statement "less than 45 years", which is explained in part (a) is based more on an engineering judgment and the history of the units at Kempt Road than a scientific or statistical analysis.



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Request IR-22:

With reference to the response to IR-10:

- (a) NSPI states that the winding configuration of the spare transformer located in Onslow is such that it cannot be paralleled with the existing units without taking an outage. Please further explain the above statement, including the required outage duration.
- (b) In addition to the two mobile transformers referenced in the response, does NSPI plan to acquire an additional mobile transformer? If so, when is the new mobile expected to be available, and what is its rating?

Response IR-22:

- (a) The spare transformer is a wye-wye winding configuration. NSPI substation transformers use a standard delta-wye configuration. Since there is a 30 electrical degree phase shift between the output of the two transformers, it is not possible to match the phasing. Since this unit is a wye-wye configuration, the protection settings on the 138 kV transmission system supplying Kempt Road would have to be changed to make the protection system in this area less sensitive. As a result of this change, the protection system would be degraded and this could cause other issues such as false tripping of other equipment. The length of an outage to transfer load is as long as it would take to open and close circuit breakers and switches. Providing the switching procedures go as planned, the outage duration required could be in the range of five to fifteen minutes.

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1 Response IR-22: (cont'd)

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3 (b) NSPI plans on acquiring an additional mobile transformer. This item is identified in
4 ACE 2011 on page 13 under CI 40311. This project was not fully scoped at the time
5 ACE 2011 was filed with the Board in December 2010. NSPI plans to file this capital
6 application for Board approval in July 2011. The new mobile transformer is expected to
7 be available in 2012 or 2013.

8
9 The rating of the proposed new mobile is a maximum of 50 MVA. NSPI is currently
10 reviewing the voltage configurations of the new mobile.

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1 **Request IR-23:**

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3 **With reference to the response to IR-11, please explain why a spare transformer available**
4 **for the Kempt Road Substation, as noted in the response to IR-10, is not a lower cost option**
5 **than purchasing a new transformer?**

6
7 Response IR-23:

8
9 The system spare transformer is a unit that is intended for use at several substations on a
10 temporary basis. This system spare is rated at 138kV/69kV/25kV. The main purpose of this
11 spare is to serve load at 138kV/69kV. If this unit was installed at the Kempt Road Substation for
12 an extended period of time, NSPI would not have a system spare available to serve load in an
13 emergency situation at 138kV/69kV.

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1 **Request IR-24:**

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3 **With reference to the response to IR-12, please provide a copy of the analysis (review)**
4 **mentioned in the response, as well as copies of any updated studies.**

5
6 Response IR-24:

7
8 Please refer to Confidential Attachment 1. Please note, transformers that have been removed
9 from NSPI's system are scratched out with an "X".

10
11 NSPI is currently in the process of updating this report.

12
13 NSPI anticipates filing this revised report with the Board in April 2011.

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Request IR-25:

With reference to the response to IR-13, please identify this external company and explain any affiliation with NSPI.

Response IR-25:

The external company is [REDACTED]. There is no affiliation with NSPI.

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Request IR-26:

With reference to the response to IR-14:

(a) Please explain why 5 additional circuits are needed to provide sufficient transfer capability for the Kempt Road Substation load.

(b) Provide a copy of NSPI's long range planning study for the Halifax Peninsula and clearly identify the next step required to supply increased load growth.

Response IR-26:

(a) For the loss of all three transformers at Kempt Road, after load transfers and the use of the mobile transformer, there would be 54 MVA of unsupplied load. Due to distribution circuit loadings, additional 25 kV circuits would be required. The loading limitation on a single 25 kV circuit is approximately 12 MVA. Therefore, 5 additional circuits would be required to provide sufficient transfer capability.

(b) Please refer to Confidential Attachment 1. This report recommended a new substation be constructed at Armdale. This substation has since been constructed. As properties are developed near Water St. the new load would be served via a new 25 kV cable circuit from Water St. NSPI is currently not aware of potentially significant future loads on the Halifax peninsula but if such loads materialize then additional distribution feeds and possibly additional transformer capacity will be required.

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Request IR-27:

Please explain, using transformer 104H-T62 as an example, how NSPI determines an optimum replacement age for a substation transformer.

Response IR-27:

NSPI does not have an optimum replacement age for a substation transformer. NSPI performs regular maintenance on substation transformers to determine their integrity. If issues are identified with any transformer, then the unit will be reviewed to determine if it is still useful on the system. If the unit is still required then it is repaired and /or replaced depending on the cost comparison and the configuration of the transformer.

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Request IR-28:

Please provide and discuss assumed transformers' failure rates, and probabilistic risk assessments of the reliability of power supply to customers in the downtown Halifax area, for the following transformer configurations at the Kempt Road Substation:

- (a) Before the noted transformer failure on July 5, 2009 occurred;**
- (b) Between July 5, 2009, and the noted transformer failure on September 4, 2010;**
- (c) Between September 4, 2010, and the return in service of 104H-T63 in November of 2010;**
- (d) Between the return in service of 104H-T63 in November of 2010, and the return in service of 104H-T61;**
- (e) With both transformers, 104H-T63 and 104H-T61 returned to service, and 104H-T62 in operation;**
- (f) As configuration in e), but with the proposed spare transformer 104H-T64 in place.**

Please take into consideration information provided in the response to IR-5 (b).

Response IR-28:

The reference to July 5, 2009 was incorrect. The correct date is February 2010 as stated in response to IR-15.

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Response IR-28: (cont'd)

NSPI has based this analysis starting with the February 2010 date.

With regards to assumed transformer failure rates an annual transformer failure rate of approximately 0.5% of the population is assumed. NSPI has a population of 350 units which yields a statistical failure rate of 1 to 1.75 failures per year.

The maximum peak load of the substation transformers on the peninsula of Halifax at 104H Kempt Rd, 1H Water St and 2H Armdale is as follows:

Kempt Road Substation

104H-T61 = 38 MVA

104H-T62 = 35 MVA

104H-T63 = 44 MVA

Water Street Substation

1H-T61 = 41 MVA

1H-T62 = 29 MVA

Armdale Substation

2H-T61 = 28 MVA

(a) Before the 104H-T63 transformer failure in February 2010, if NSPI were to lose the most heavily loaded transformer at 104H, NSPI would have had to do the following as a contingency:

- transfer 20 MVA on a short-term basis onto the mobile transformer

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Response IR-28: (cont'd)

- transfer 7 MVA from 104H-T62 onto 104H-T61
- transfer 10 MVA from 104H-T63 onto 1H Water St (T61 and T62)
- pick up the remaining 14 MVA on 104H-T62.

Kempt Road Substation

104H-T61 = 45 MVA

104H-T62 = 42 MVA

104H-T63 = 0 MVA

Mobile = 20 MVA

Water Street Substation

1H-T61 = 46 MVA

1H-T62 = 34 MVA

(b) Between the transformer failure in February 2010 and the second transformer failure on Sept. 4, 2010, if NSPI were to lose the next most heavily loaded transformer then the following transfers would have to be carried out as a contingency:

- transfer 22 MVA from 104H-T61 on a short-term basis onto the mobile transformer
- transfer another 10 MVA from T61 onto 1H – T61 Water St
- transfer 6 MVA from T61 onto T62.
- transfer of 8 MVA from T63 onto 2H Armdale
- transfer 23 MVA from T63 onto 1H-T62 Water St
- transfer 13 MVA from T63 onto T62:

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Response IR-28: (cont'd)

Kempt Road Substation

104H-T61 = 0 MVA

104H-T62 = 54 MVA

104H-T63 = 0 MVA

Mobile = 22 MVA

Armdale Substation

2H-T61 = 36 MVA

Water Street Substation

1H-T61 = 51 MVA

1H-T62 = 52 MVA

(c) When the second transformer failed at 104H on September 4, 2010 NSPI was able to install a Dartmouth Crossing transformer in the place of 104H-T61. For the period from Sept. 4 to Nov. 2010 when 104H-T63 was returned to service, NSPI would have had the same contingency plan as noted above in (b).

If NSPI did not have the Dartmouth Crossing transformer available to install at 104H and if the third transformer was to fail then there would be the same contingency plan as for (a) and (b) but NSPI would have to offload an additional 54 MVA from T62 onto both Armdale 2H and Water 1H substations. Due to the limitation of the feeder connections there would not have been enough capacity for this remaining load.

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1 Response IR-28: (cont'd)

2
3 (d) When the 104H-T63 transformer was returned in November, 2010 NSPI still had the
4 Dartmouth Crossing transformer in place of 104H-T61. For the period from Nov. 2010
5 to the return to service of 104H-T61, NSPI would have had the same contingency plan as
6 noted above in (a).

7
8 (e) With all 3 transformers back in service at 104H and the Dartmouth Crossing transformer
9 not available, NSPI would have the same contingency plan as noted above in (a).

10
11 (f) With all 3 transformers back in service at 104H and the spare 104H-T64 transformer in
12 place NSPI would not have to transfer load over to 1H Water Street as was the case noted
13 above in (a).

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Request IR-29:

Please provide risk assessments and an economic analysis of two alternatives, to purchase the proposed transformer now, and to delay the purchase for a number of years, based on an acceptable level of risk. If a delay in the purchase of the proposed transformer is not an acceptable option, please summarize NSPI's justification for the urgent purchase of this transformer.

Response IR-29:

There should not be a delay in the purchase of the proposed transformer.

The magnitude of area load supplied from the Kempt Road substation (117 MVA at peak) and the risk of transformer failures that could result in significant unsupplied load (54 MVA at peak) combined with the failures experienced in 2010 left the station at an unacceptable level of exposure for the loss of the 3rd transformer at Kempt Road.

NSPI moved a transformer from the Dartmouth Crossing Substation to mitigate this risk. This leaves the substation at Dartmouth Crossing without a transformer and as such there is a risk to supply reliability in that area. It is for this reason, NSPI believes there is an urgent requirement to purchase this transformer.