



# **CONNECTION ASSESSMENT & APPROVAL PROCESS**

## **Connection Assessment Report for**

*Norfolk TS Transformer Replacement  
CAA ID 2002-EX058*

*Installation of the Second 115 kV Circuit from Vanessa Jct. to  
Norfolk TS  
CAA ID 2002-EX070*

Connection Applicant: Hydro One Networks Inc.

## **Final Report**

Prepared by  
Long Term Forecasts & Assessments Department &  
Consistent Information Set Department

November 12, 2002



Norfolk TS Transformer Replacements  
115 kV Circuit from Vanessa jct. to Norfolk TS

**Disclaimers**

**IMO**

This report has been prepared solely for the purpose of assessing, on a preliminary basis, whether the connection applicant's proposed connection with the IMO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether a System Impact Assessment of the proposed connection should be conducted under Chapter 4, section 6 of the *Market Rules*. This report has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. This report has been prepared solely for use by the connection applicant, Hydro One and the IMO in accordance with Chapter 4, section 6 of the *Market Rules*. The IMO assumes no responsibility to any third party for any use which it makes of this report. Any liability which the IMO may have to the connection applicant in respect of this report is governed by Chapter 1, section 13 of the *Market Rules*. In the event that the IMO provides a draft of this report to the connection applicant, you must be aware that the IMO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IMO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that it is using the most recent version of this report.



## 1.0 Project Description

Presently Norfolk TS is equipped with two 110-28.4 kV transformers rated 33.6/56 MVA and is supplied via a single 115 kV circuit line, A1N, emanating from Vanessa jct..

Hydro One Network Inc. has submitted two separate connection assessment applications for installation of:

- (A) Two 110-28.4 kV, 50/66.6/83.3 MVA transformers at Norfolk TS which will replace the existing lower rated transformers (CAA ID 20020-EX058), and
- (B) One second 115 kV circuit between Vanessa jct. to Norfolk TS, which will provide for a dual supply to Norfolk TS (CAA ID 2002-EX070) by completing the 115 kV double circuit line A8N/A11N.

Since the two connection applications involve the replacement and addition of adjacent transmission facilities, the IMO has decided to cluster the projects and performed a single assessment.

However, because these are separate plans individual Notifications of Approval will be issued for each project, as requested by the applicant.

### ***CAA ID 2002-EX058***

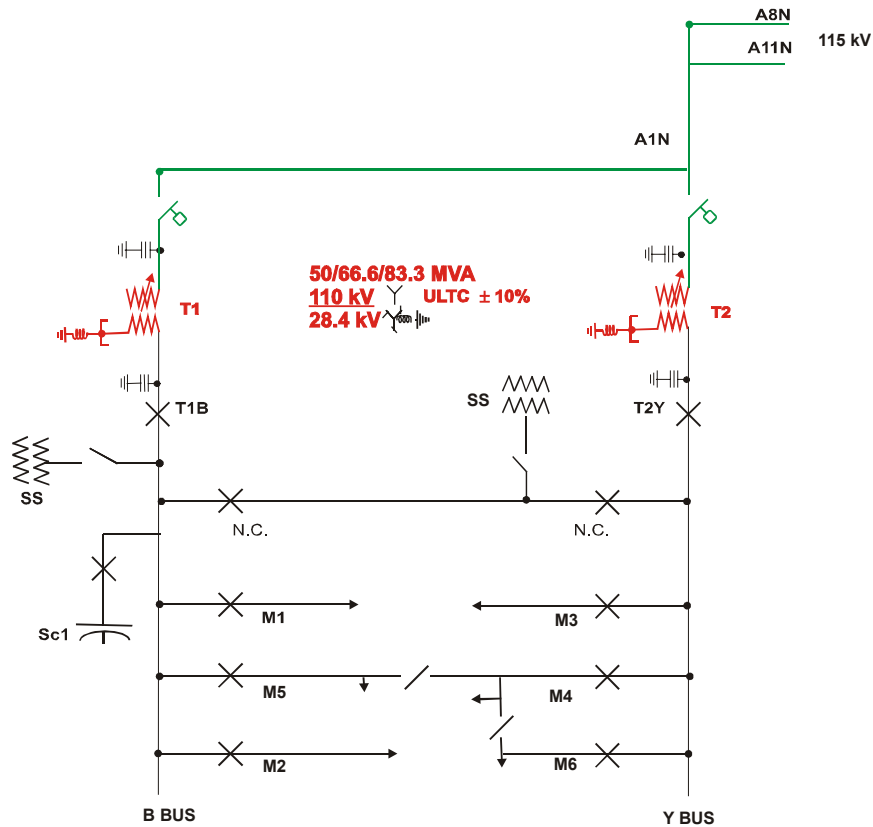
The new transformers are identical and each has the following specifications:

- Transformation from 110kV to 28.4 kV,
- Capability 50/66.6/83.3 MVA,
- The 10 day summer LTR will be about 105 MVA,
- High voltage winding configuration will be wye,
- Low voltage winding configuration will be zigzag with 1.5 ohms neutral grounding reactor,
- Transformer impedance, 12.5% on 50 MVA
- Under-load tap changers will be place on the high voltage side with a range to be determined,
- Surge arresters will be installed on each side of both transformers.

The existing station switching facilities on the high voltage and low voltage sides and the high voltage connection facilities to the *IMO-controlled grid* are to be retained. The existing LV breakers have an interrupting capability of 20.9 kA.

The scheduled in service date for this project is Q4 2003.

A schematic diagram of the existing transformer station together with the proposed facilities is shown in Figure 1.



**FIGURE 1. Norfolk TS - Proposed New Transformer Facilities**

**CAA ID 2002-EX070**

The new 12 km, 115 kV circuit will be installed on the existing double circuit wood pole structures which presently carry the 115 kV circuit A1N from Vanessa jct. to Norfolk TS,

The existing 115 kV circuit, A1N, was upgraded in 1999. During the upgrade work, a fourth conductor was installed to ensure the continued power supply to Norfolk TS. This conductor is now idle and it will be used as one phase in the new circuit.

Hydro One indicated that presently, the maximum summer continuous current rating of A1N is 475 A (93 MVA). Under the proposed project the new circuit will be built to a summer continuous rating of 575 A (112 MVA) and the existing line will also be re-tensioned to achieve the same summer continuous rating.

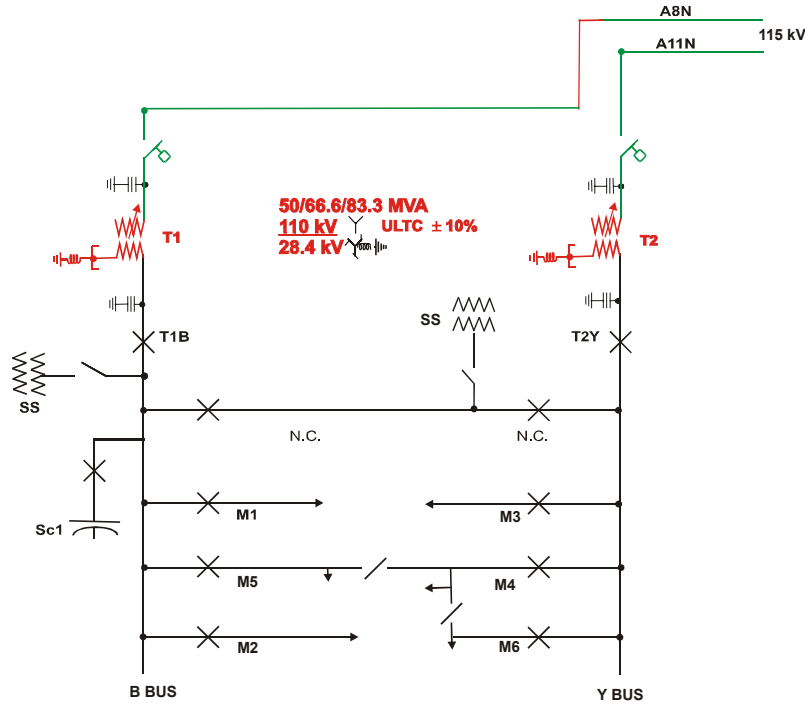
The existing 115 kV tap into Norfolk TS will be modified to provide for the dual connection of the transformer station.

The scheduled in service date for this project is Q4 2003.

If possible, the connection of the new circuit will be coordinated with the commissioning of the new 115/230 kV Caledonia autotransformers (CAA ID 2002-056).

Hydro One has indicated that protective relaying, supervisory control and teleprotection are to be provided as required by the Transmission System Code.

Figure 2 represents a schematic diagram of the proposed modification to transformer connections.



**FIGURE 2. Norfolk TS - With New 115 kV Circuit**

## 2.0 Connection Assessment

### 2.1 Underfrequency Load Shedding Requirements

The *Market Rules* (Chapter 5 section 10.4) require that each distributor and connected wholesale customer, in conjunction with the relevant transmitter, make arrangements to enable the automatic disconnection of up to 35% of its peak demand for conditions of system under-frequency. To meet this requirement an underfrequency load shedding (UFLS) scheme must be available at the station. The single line diagram does not show the presence of the UFLS scheme.

### 2.2 Voltage Reduction Facilities Requirements

The *Market Rules* (Chapter 4 Appendix 4.3) requires that distributors connected to the *IMO controlled grid* with directly connected load facilities of aggregated rating of 20 MVA or more

and the capability to regulate distribution voltage under load, shall install and maintain facilities to provide *voltage reduction capability* to achieve load reduction during periods when supply resources are limited. *Voltage reduction capability* represents the capability of reducing demand by lowering the customer voltage by 3% and 5% and having the controlling authority to be able to effect the voltage reduction within five minutes of receipt of the direction from the IMO.

### **2.3 On-line Monitoring**

The *Market Rules* (Chapter 4 section 7.4) require that each transmitter shall provide the IMO on a continual basis with on-line monitored quantities as specified in Appendix 4.16. It is required that Hydro One Networks Inc. install all the equipment needed to monitor the information required by the IMO on a continuous basis.

The existing on-line monitoring facilities at Norfolk TS meet the requirements of the IMO and are to be retained after the installation of the new transformers.

The on-line monitoring requirements that were established for the reconnection of A8N/A11N to the new Caledonia TS should be sufficient to provide all the information required by the IMO, when the installation of the double circuit line to Norfolk TS is complete.

### **2.4 Power Factor**

The *Market Rules* require that wholesale customers and distributors connected to the IMO-controlled grid shall operate at a power factor within the range 90% lagging to 90% leading as measured at the *defined meter point*.

Norfolk TS is equipped one low voltage shunt capacitor rated at 10.8 Mvar.

Hydro One is required to install sufficient reactive power compensation at the station to ensure that the load meets the power factor requirements of the *Market Rules*.

### **2.5 Effect on System Reliability**

#### ***CAA ID 2002-EX058***

The replacement of the Norfolk 110/28.4 kV transformers with higher rated units was initiated because of concerns related to the maintenance and reliability of the aging transformer units.

A cursory analysis which assumed a load growth rate of 1.0% per year, showed that the new transformers spare capacity, (105 MVA-87MVA=18MVA), could accommodate the station peak load increase for the next twenty years.

The short circuit studies that were performed for Caledonia TS connection assessment indicated that with the Norfolk load connected to the new Caledonia autotransformers, the maximum symmetrical fault level at Norfolk 27.6 kV bus will be about 8.2 kA. This value is well within the fault interrupting capability of the existing LV breakers that are rated at 20.8 kA.

The station equipment that will be retained, including disconnect switches and bus work must be adequately rated to match the continuous and limited time ratings of the new transformers.

**CAA ID 2002-EX070**

With the present arrangement the total Norfolk TS load supply relies on a 12 km single 115 kV circuit from Vanessa jct. to Norfolk TS. Any contingency associated with this circuit would result in a supply interruption to the entire Norfolk TS load. This arrangement would not comply with the proposed IMO load supply guidelines which state that for a single circuit line loss, the supply to a load between 76 and 150 MW should be restorable by switching.

With the addition of the second 115 kV circuits the exposure to load interruptions due to the loss of a single transmission element will be reduced considerably. The level of load supply reliability will improve because for any contingency involving one of the 115 kV circuits the remaining one will be capable to carry the entire Norfolk station peak load.

Table 1. Rating of 115 kV circuits

Circuit, Sections (Conductor)		Max Op. Temp. (°C)	Thermal ratings	
			Continuous (30°C ambient) operating at 93°C Or op. Temp Amps MVA @113 kV	Emergency Continuous at Max Op Temp or 127 C Amps, MVA @113 kV
A8N A11N	Caledonia x Hartford	93°C	<b>550 A</b> <b>108 MVA</b>	<b>550 A</b> <b>108 MVA</b>
	Hartford x Vanessa	127°C	<b>850 A</b> <b>166 MVA</b>	<b>1090 A</b> <b>213 MVA</b>
A1N existing	Vanessa x Norfolk	80°C	<b>475 A</b> <b>93 MVA</b>	N/A
New Double	Vanessa x Norfolk	93°C	<b>575</b> <b>112 MVA</b>	N/A*

\* To be provided when the new facilities are registered.

After the installation of the new Caledonia autotransformers and the second 115 kV circuit between Vanessa jct. and Norfolk TS, this load will be supplied via a 115 kV double circuit line with rated at 575 A for continuous summer operation.

The continuous thermal rating of one of the 115 kV circuits from Caledonia to Norfolk is sufficient to accommodate the continued supply of the Norfolk TS peak load, in the event of permanent loss of the companion circuit.

**3. Conclusions and Requirements**

Hydro One Networks Inc. is required to follow the facility registration process and provide complete equipment rating information for all the new or modified facilities that are to be installed under the two projects.

**CAA ID 2002-EX058**

This assessment concluded that the proposed 110/28.4 kV transformer replacement project:

- will not have an adverse impact on the security and adequacy of the *IMO-controlled grid* and

- will increase the reliability of customer load supply and provide spare station capacity to accommodate the load growth for the next twenty years approximately.

Hydro One Networks Inc. is required to install sufficient reactive power compensation at Norfolk TS to ensure that the load meets the power factor requirements of the *Market Rules*.

Hydro One Networks Inc. is required to ensure that the new transformers' ULTC capability meets the Market Rules voltage reduction requirements of 3% to 5%.

***CAA ID 2002-EX070***

This assessment concluded that the proposed addition of the second 115 kV circuit between Vanessa and Norfolk TS and the upgrading of the existing circuit will result in an improved level of load supply reliability to the Norfolk TS connected customers.

Hydro One Networks Inc. is required to provide protective relaying, supervisory control and teleprotection are as specified by the Transmission System Code.

**4. Notification of Approval**

It is thus recommended that notification of approval be granted, subject to the implementation of the requirements listed in section 3.0, for the installation of the following transmission facilities:

- (A) Two new 110-28.4 kV, 50/66.6/83.3 MVA transformers at Norfolk TS (CAA ID 2002-EX058), and
- (B) A second 115 kV circuit between Vanessa jct. to Norfolk TS (CAA ID 2002-EX070).