

**Final Draft Report**
**CAA ID Number: 2007-EX358**
**Navan DS – Replacing T1 & T2 and splitting the secondary bus**
**ASSESSMENT SUMMARY**
**Hydro One Networks Inc.**
**1. GENERAL DESCRIPTION**

Six single-phase transformers comprising T1 and T2 at Navan DS are being replaced with two three-phase transformers. Navan DS is connected to the 115 kV circuit H9A. Currently, the station is stepping down the voltage to 8.32 kV with both T1 and T2. The bus tie switch between the secondary of T1 and the secondary of T2 is normally open. Two 8.32 kV feeders are connected to the secondary bus of T1 and two 8.32 kV feeders are connected to the secondary bus of T2.

The new 110/8.32 kV T1 will continue to step the voltage down to 8.32 kV. Feeders #1, #2, and #3 will connect to the secondary of T1 and will feed the 8.32 kV load. The original #4 feeder is being renamed as the new feeder #3.

The new 115.5/29.32 kV T2 will step the voltage down to supply 27.6 kV load. The original #3 feeder is being renamed as the new feeder #4 and will be reinsulated to the higher voltage class with new bus insulators. Feeder #4 will connect to the secondary of T2 and all feeder #4 load will be converted to 27.6 kV from 8.32 kV.

Feeder #	Load - January 21, 2007		Maximum Projected Load <sup>1</sup>	
	average loading per phase	MVA per phase	average loading per phase	MVA per phase
1	138 A (8.32 kV)	2.0	200 A (8.32 kV)	2.9
2	33 A (8.32 kV)	0.5	200 A (8.32 kV)	2.9
3	36 A (8.32 kV) (This load will be converted to 27.6 kV)	0.5	200 A (8.32 kV)	2.9
4	159 A (8.32 kV)	2.3	314 A (27.6 kV)	4.5

**Note 1.** Hydro One Distribution will ensure that the maximum load does not exceed the summer or winter ratings of their transformers.

Because the secondary voltages of T1 and T2 will be different, the existing bus tie switch will be removed. A Mobile Unit Substation (MUS) rated at 15 MVA for either 27.6 kV or 8.32 kV will be available for support in case of emergencies.

The target in-service date for the proposed work is May 31, 2008.

## 2. PROPOSED MODIFICATION

A comparison of the technical specifications between the new transformers and the original transformers is given below.

<b>Navan DS (8.32 kV secondary)</b>			
	<b>Original T1</b>	<b>Original T2</b>	<b>New T1</b>
<b>Configuration</b>	3 x single-phase units (1 single phase spare)	3 x single-phase units	three phase
<b>Transformation (kV)</b>	115.5 / 8.32	115.5 / 8.32	110 / 8.32
<b>Winding Configuration</b>	Delta / wye	Delta / wye	Delta / wye
<b>Thermal Rating</b>	1 MVA ONAN (per phase) 3 MVA ONAN (total)	1 MVA ONAN (per phase) 3 MVA ONAN (total)	6 MVA ONAN
<b>Notes:</b> Continuous, 15 Minute LTR and 10 Day LTR are not applicable for Distribution transformers. Overloads are accepted by Hydro One Distribution rather than cutting customers off, i.e. no load shedding is done to alleviate short-term overloads.			
<b>Unit Planning Loading Limit (PLL)</b>	<b>Summer:</b> ONAN rating + 15% = 3.45 MVA <b>Winter:</b> ONAN rating + 55% = 4.65 MVA		<b>Summer:</b> ONAN rating + 15% = 6.9 MVA <b>Winter:</b> ONAN rating + 55% = 9.3 MVA
<b>Positive Sequence Impedance (H-X)</b>	R = 0.512 % X = 6.5 % on 6 MVA base	R = 1.5 % X = 14.7 % on 6 MVA base	R = 0.739% X = 9.71% on 6 MVA base
<b>Impedance to Ground</b>	Solidly grounded	Solidly grounded	Solidly grounded
<b>Under-Load Tap-Changer (ULTC)</b>	8.32 +0.832, -0.832 kV 32 steps	8.32 +0.832, -0.832 kV 32 steps	8.32 +0.832, -0.832 kV 17 steps
<b>Off-Circuit Tap-Changer (OCTC)</b>	Tap 1 118.25 kV Tap 2 115.50 kV Tap 3 112.75 kV Tap 4 110.00 kV Tap 5 107.25 kV	Tap 1 118.25 kV Tap 2 115.50 kV Tap 3 112.75 kV Tap 4 110.00 kV Tap 5 107.25 kV	Tap 1 118.25 kV Tap 2 115.50 kV Tap 3 112.75 kV Tap 4 110.00 kV Tap 5 107.25 kV
<b>In service off-circuit tap position</b>	Not known	Not known	Not known
<b>Manufacturer</b>	CGE	EE	Pioneer
<b>Serial #</b>	165413 Red phase 165415 White phase 165414 Blue phase	179150 Blue phase 179151 Red phase 179152 White phase	T-3939-1

<b>Navan DS (27.6 kV secondary)</b>	
<b>New T2</b>	
<b>Configuration</b>	three phase
<b>Transformation (kV)</b>	115.5 / 29.32
<b>Winding Configuration</b>	delta / wye
<b>Thermal Rating</b>	15 MVA ONAN
<b>Notes:</b> Continuous, 15 Minute LTR and 10 Day LTR are not applicable for Distribution transformers. Overloads are accepted by Hydro One Distribution rather than cutting customers off, i.e. no load shedding is done to alleviate short-term overloads.	
<b>Unit Planning Loading Limit (PLL)</b>	<b>Summer:</b> ONAN rating + 15% = 17.25 MVA <b>Winter:</b> ONAN rating + 55% = 23.25 MVA
<b>Positive Sequence Impedance (H-X)</b>	R = 0.5% X = 8.5% on 15 MVA base
<b>Impedance to Ground</b>	Solidly grounded
<b>Under-Load Tap-Changer (ULTC)</b>	29.32 +4.605, -2.77 kV 32 steps
<b>Off-Circuit Tap-Changer (OCTC)</b>	Not Available
<b>In service off-circuit tap position</b>	Not Applicable
<b>Manufacturer</b>	Pioneer
<b>Serial #</b>	61-02-67919

### 3. ASSESSMENT

Replacing the existing 115.5/8.32 kV transformers T1 and T2 with one new T1 transformer at 110.0/8.32 kV and one new T2 transformer at 115.5/29.32 kV will effectively result in the creation of two Distribution Stations in the place of the original DS. This is a standard procedure with Hydro One Distribution, who have several Distribution Stations with 2 different operating voltages.

#### 3.1 8.32 kV Navan DS

With the exception of thermal ratings, the technical characteristics of the new transformer T1 are similar to those of the original T1 and T2. The new T1's positive sequence impedance is slightly higher than that of the original T1 and lower than that of the original T2. The new T1 will have similar ULTC arrangements and identical OCTC settings as the original T1 and T2. The new T1's thermal ratings are equal to those of the original T1 and T2 combined.

The new 8.32 kV station will be winter peaking and have a winter PLL of 9.3 MVA. According to Hydro One, the new T1 has enough capacity to deliver 8.32 kV load until 2013 without exceeding its PLL. If necessary, Hydro One will convert load from 8.32 kV to 27.6 kV to ensure that the new T1 does not exceed its PLL.

### 3.2 27.6 kV Navan DS

The new T2's positive sequence impedance is within normal bounds when compared to similar transformers. The new T2's thermal ratings are five times as high as those of the original T2. The new T2 does not have an OCTC at the primary, but it has a 32 step ULTC on the secondary.

The new 27.6 kV station will be summer peaking and have a summer PLL of 17.25 MVA. In an emergency, Bilberry Creek TS and Wilhaven DS can be used to cover some of the Navan DS 27.6 kV load. According to Hydro One, T2 has enough capacity to deliver its load until 2014 without exceeding its PLL.

## 4. CONCLUSIONS

It can be concluded that the new transformers will not result in a material adverse effect on the reliability of the IESO-controlled grid because:

- The new 110/8.32 kV T1 has identical ULTC and OCTC voltage ranges as the original T1 and T2.
- The impedance of the new T1 is within normal upper bounds when compared to similar transformers.
- Thermal ratings for the new T1 are equal to the original combined T1 and T2 ratings but the 8.32 kV load will be reduced.
- The new T1 is rated sufficiently high to accommodate the load in this area until 2013.
- The impedance of the new T2 is within normal upper bounds when compared to similar transformers.
- Thermal ratings for the new 27.6 kV transformer T2 are higher than the projected new 27.6 kV load.
- The new T2 is rated sufficiently high to accommodate the winter load in this area until 2014 based on Hydro One's forecast.

## 5. *REQUIREMENTS*

Hydro One Distribution Inc. must notify the IESO as soon as it becomes aware of any changes to the assumptions made in the connection assessment. The IESO will determine whether these changes require a re-assessment.

Some recognized contingencies (e.g. load shedding, open line end) can cause a temporary voltage increase above the maximum continuous voltage of 115 kV. For these conditions, connection equipment may be exposed to voltages slightly above its maximum continuous rating for the short period of time that it takes the IESO to direct operations to restore a normal voltage profile, and to prepare for the next contingency. This re-preparation period will be as short as possible, but it will not take longer than 30 minutes. Therefore, the IESO requires that the 115 kV connection equipment have the following requirements:

- connection equipment must have a maximum continuous voltage rating of at least 127 kV in southern Ontario; and
- equipment must remain in service, and not automatically trip, for voltages up to 5% above the maximum continuous rating or 133.4 kV, for up to 30 minutes, to allow the system to be re-dispatched to return voltages within their normal range.

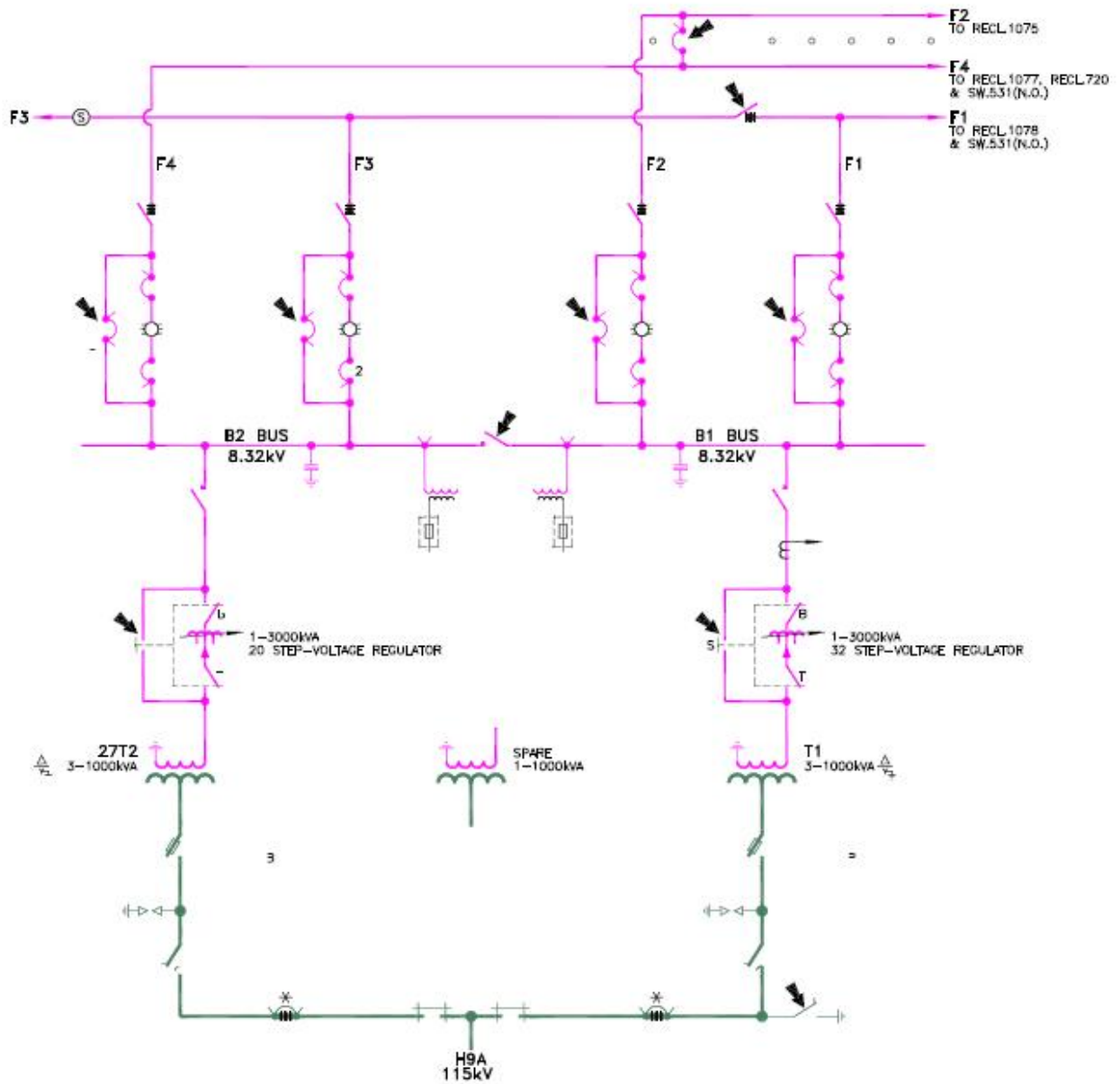
The Market Rules (chapter 4, section 7.5) require that each distributor shall provide the IESO on a continual basis with on-line monitored quantities as specified in Appendix 4.17. Additional PTs and CTs beyond those required for revenue metering are usually necessary to provide these quantities. Currently, Navan DS does not have additional PTs or CTs on either the high or low voltage side of the transformer and therefore, is not required by the Market Rules to provide monitored quantities to the IESO.

Some newer revenue meters have the capability to provide the operational data along with revenue meter data and therefore, when the current revenue meter expires, it is likely that the IESO will require the installation of a revenue meter capable of providing the IESO with the required quantities. Hydro One Distribution Inc. is required to notify the IESO 6 months in advance of the revenue meter replacement.

Hydro One Distribution Inc. is required to meet the requirements with respect to protection systems for the new transformers and feeders and coordination with the existing protection systems, as outlined in the Transmission System Code.

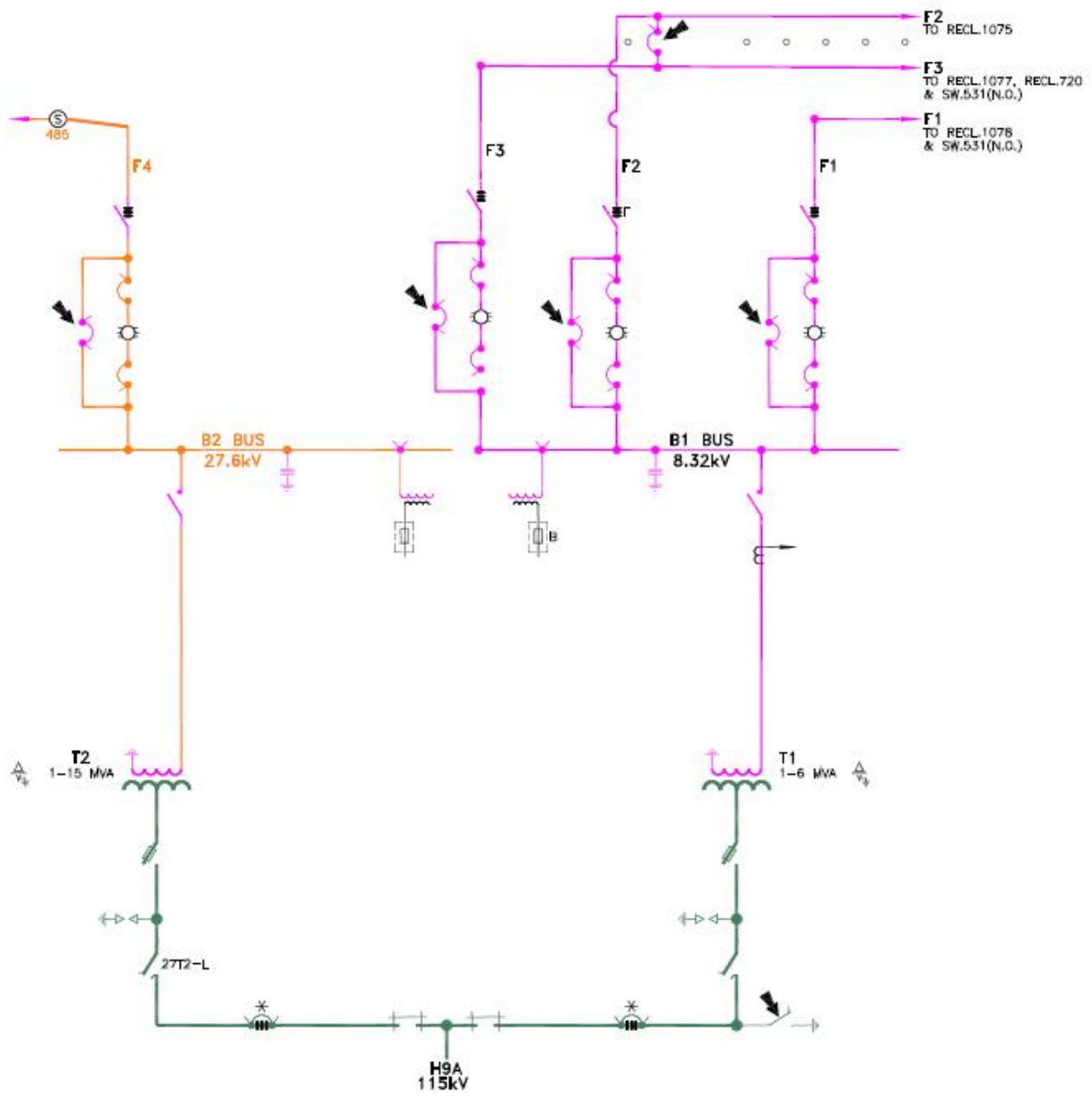
## 6. *NOTIFICATION OF APPROVAL*

It is therefore recommended that a Notification of Approval of the Connection Proposal be issued subject to the implementation of the requirements listed in section 5.0.



Navan DS - original configuration  
115 / 27.6 / 8.32 kV

Figure 1



Navan DS - reconfigured  
115 / 27.6 / 8.32 kV

Figure 2