ieso
Power to Ontario.
On Demand.
Station A, Box 4474
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M5W 4E5

IESO Expedited System Impact Assessment

Replacement of T22 at Keith TS

2013-EX674

Final Report

1 Executive Summary

Conditional Approval for Connection

Hydro One Networks Inc. (the "connection applicant") is proposing to replace T22 at Keith TS with a new unit due to failure.

This assessment concluded that the proposed changes are expected to have no material adverse impact on the reliability of the IESO-controlled grid. Therefore, the IESO recommends that a *Notification of Conditional Approval for Connection* be issued for the proposed project, subject to implementation of the requirements outlined in this report.

The connection applicant shall satisfy all applicable requirements and standards specified in the Market Rules and the Transmission System Code. The following requirements summarize some of the general requirements that are applicable to the proposed project.

Requirements

1. The connection applicant shall ensure that the 230 kV equipment is capable of continuously operating between 220 kV and 250 kV, as specified in Appendix 4.1 of the Market Rules. Protective relaying must be set to ensure that transmission equipment remains in-service for voltages up to 5% above the maximum continuous value.
2. The connection applicant shall have the capability to maintain the power factor at the defined meter point of the proposed facility within the range of 0.9 lagging and 0.9 leading.
3. In accordance with Section 7.4 of Chapter 4 of the Market Rules, the connection applicant shall provide to the IESO the applicable telemetry data listed in Appendix 4.16 of the Market Rules on a continual basis. The data shall be provided in accordance with the performance standards set forth in Appendix 4.20 and Appendix 4.21, subject to Section 7.6A of Chapter 4 of the Market Rules. The whole telemetry list will be finalized during the IESO Facility Registration/Market Entry process.

   The connection applicant must install monitoring equipment that meets the requirements set forth in Appendix 2.2 of Chapter 2 of the Market rules. As part of the IESO Facility Registration/Market Entry process, the connection applicant must also complete end to end testing of all necessary telemetry points with the IESO to ensure that standards are met and that sign conventions are understood. All found anomalies must be corrected before IESO final approval to connect any phase of the project is granted.

4. If revenue metering equipment is being installed as part of this project, the connection applicant should be aware that revenue metering installations must comply with Chapter 6 of the IESO Market Rules. For more details the connection applicant is encouraged to seek advice from their Metering Service Provider (MSP) or from the IESO metering group
5. The connection applicant must complete the IESO Facility Registration/Market Entry process for the project in a timely manner before the IESO final approval for connection is granted.

   Models and data, including any controls that would be operational, must be provided to the IESO at least seven months before energization to the IESO-controlled grid. This includes both PSS/E and DSA software compatible mathematical models.

   The connection applicant must also provide evidence to the IESO confirming that the equipment installed meets the Market Rules requirements and matches or exceeds the performance predicted in this assessment. This evidence shall be either type tests done in a controlled environment or commissioning tests done on-site. The evidence must be supplied to the IESO within 30 days after completion of commissioning tests. If the submitted models and data differ materially from the ones used in this assessment, then further analysis of the project will need to be done by the IESO.

   At the sole discretion of the IESO, performance tests may be required at generation and transmission facilities. The objectives of these tests are to demonstrate that equipment performance meets the IESO requirements, and to confirm models and data are suitable for IESO purposes. The transmitter may also have its own testing requirements. The IESO and the transmitter will coordinate their tests, share measurements and cooperate on analysis to the extent possible.

2 Project Description

The applicant is proposing to replace T22 at Keith TS with a new unit due to failure. Keith TS is a 215.5/28 kV DESN connected to Chatham TS via the 230 kV circuits C21J and C22J, via J20B to Brighton Beach GS and via J5D to Michigan.

The expected in-service date for the replacement transformer is November 2013.

The technical specifications of the existing and replacement transformers are given in Table 1.

Keith TS			
All values for replacement equipment are specified at the time of order. Actual values to be provided prior to in-service dates.			
Transformer	**Existing T22**	**Existing T23**	**Replacement T22**
Configuration	Three phase	Three phase	Three phase
Transformation (kV)	215.5/28.0	215.5/28.0	215.5/28.0
Winding Configuration	Wye/Zed	Wye/Zed	Wye/Zed
Thermal Rating	50.0 MVA ONAN 66.6 MVA ONAF 83.3 MVA OFAF	50.0 MVA ONAN 66.6 MVA ONAF 83.3 MVA OFAF	50.0 MVA ONAN 66.6 MVA ONAF 83.3 MVA OFAF
Continuous Thermal Rating (summer 35°C)	83.3 MVA	83.3 MVA	83.3 MVA
10-DAY Thermal Rating (summer 35°C)	109.6 MVA	130.0 MVA	116.4 MVA
15-MIN Thermal Rating (summer 35°C)	160.3 MVA	171.4 MVA	166.1
Positive Sequence Impedance (H-L)	R = 0.33% X = 12.5% on 50 MVA base	R = 0.251% X = 12.02% on 50 MVA base	R = 0.273% X = 12.398% on 50 MVA base
Impedance to Ground	**HV** – solidly grounded **LV** – grounded via 1.5 Ω reactor	**HV** – solidly grounded **LV** – grounded via 1.5 Ω reactor	**HV** – solidly grounded **LV** – grounded via 1.5 Ω grounding
Under-load tap-changer	215.5 ± 40 kV, 32 Steps	215.5 ± 43.1 kV, 32 Steps	215.5 ± 40 kV, 32 Steps
Off-load tap-changer	Not applicable	Not applicable	Not applicable

Table 1 – Comparison of Transformer Parameters at Keith TS

3 Assessments

3.1 10-Day Summer Load Supply Capability

The 10-DAY summer load supply capability for a DESN is determined by removing the transformer with the highest 10-DAY thermal rating from service. The 10-DAY summer ratings of the 215.5/28 kV transformers at Keith TS as well as the overall 28 kV load supply capability at Keith TS, before and after the replacement of T22, are listed in Table 2.

10-DAY Summer Thermal Ratings (35°C) for 215.5/28 kV Transformers at Keith TS		
Transformer	**Existing T22 & T23**	**New T22 & Existing T23**
T22	109.6 MVA	116.4 MVA
T23	**O/S** (130.0 MVA)	**O/S** (130.0 MVA)
10-DAY Summer Load Supply Capability (with highest rated transformer out of service)	**109.6 MVA**	**116.4 MVA**

Table 2 – 10-DAY Summer Load Supply Capability at Keith TS

It is shown that the existing 28 kV 10-DAY summer load supply capability at Keith TS is 109.6 MVA and it will increase to 116.4 MVA when the new T22 is put into service.

3.2 Peak Loads and Projections

Operational meter information from February 12, 2012 through September 20, 2013 was used to obtain the 28 kV load data at Keith TS, as shown in Figure 1. The peak 28 kV load of 85.06 MVA at Keith TS occurred on August 26, 2013 at 20:00. The figure below shows the T22 and T23 load at Keith TS.

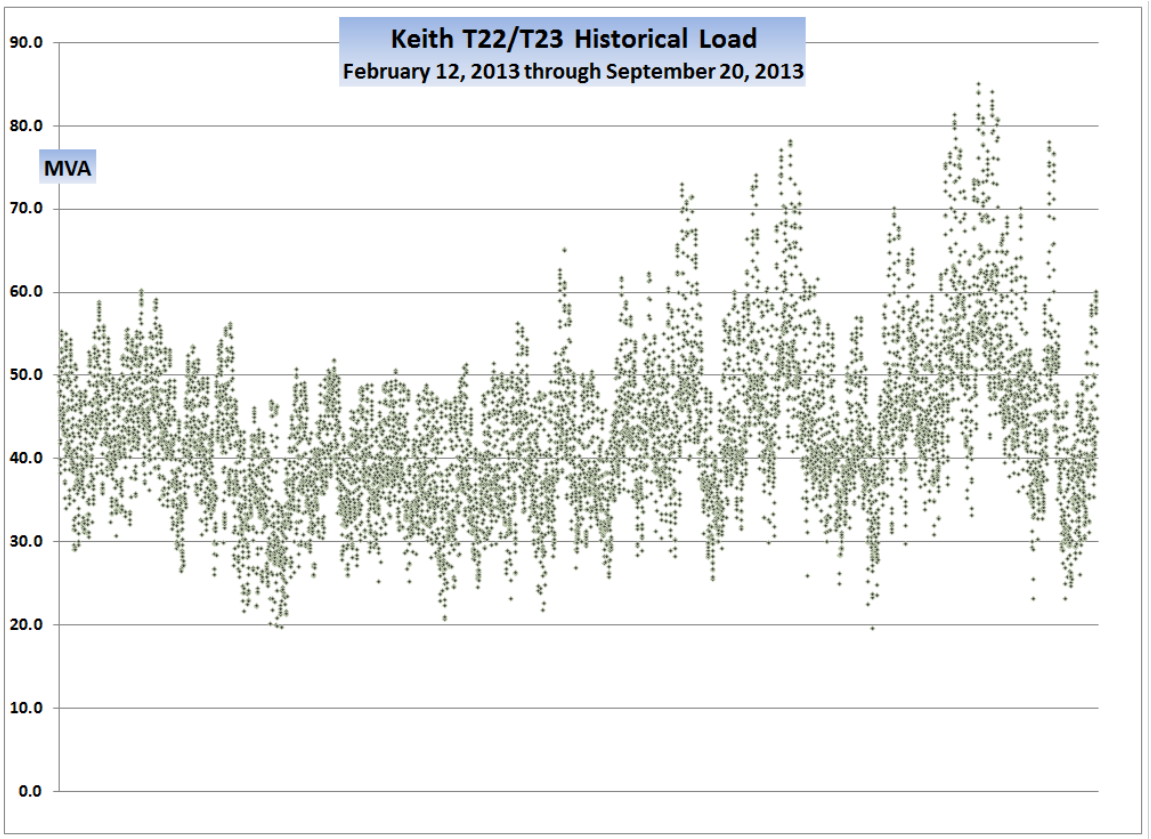

Figure 1 – Historical Load at Keith TS

The peak 28 kV load at Keith TS is projected to increase by 1% annually as shown in Table 3.

Projected Peak 28 kV Load Growth at Keith TS		
Year	**Projected Peak Load (MVA)**	**10-DAY Summer Capability (MVA)**
2013	85.1	109.6
2014	85.9	
2015	86.8	116.4
2016	87.6	
2017	88.5	
2025	95.8	

Table 3 – Projected 28 kV Load Growth at Keith TS

Table 3 shows the projected peak 28 kV load will not exceed the 28 kV 10-DAY summer capability at Keith TS by 2025 assuming the 28 kV load at Keith TS is annually increased by 1%.

3.3 Load Angle & Power Factor

The Market Rules require that Hydro One have the capability to maintain a power factor within the range of 0.9 lagging and 0.9 leading as measured at the defined metering points at Keith TS. This power factor range is translated into a load angle range of ± 0.45 radians. A load angle above 0.45 radians indicates a lagging power factor below 0.9 and one below -0.45 radians indicates a leading power factor below 0.9.

Revenue meter information from February 12, 2012 through September 20, 2013 was used to evaluate the load angle on the T22/T23 DESN at Keith TS. The historical load angles are shown in Figure 2.

There are two low voltage shunt capacitors at Keith TS, SC1 and SC2 providing 57.6 MX at 28.8 kV.

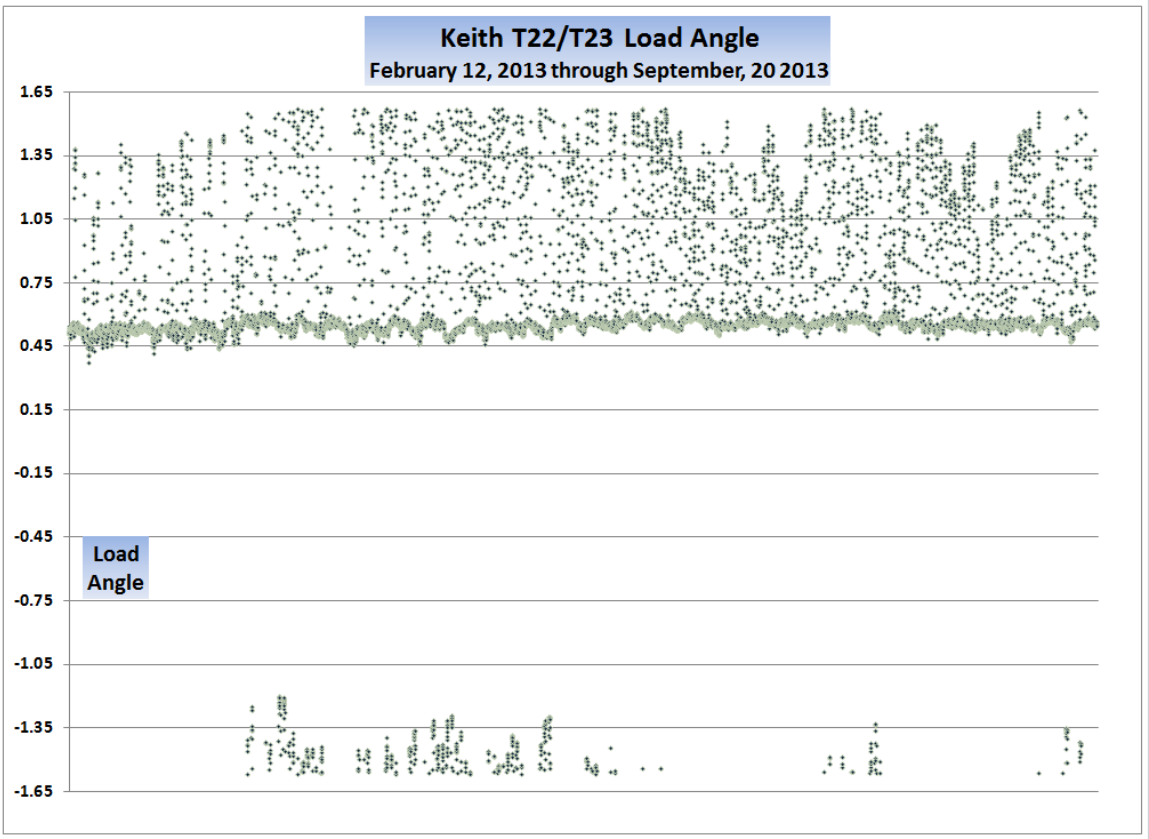

Figure 2 – Historical Load Angles at Keith TS

Between February 12, 2012 and September 20, 2013, the highest load angle of 1.57 on T22 and T23 at Keith TS occurred on April 16, 2013 at 14:30 when the load was 39.72 MVA. However, when the load is greater than 80% of the peak load, the highest load angle of 0.596 occurred on June 26, 2013 at 19:30 when the load was 71.45 MVA as shown in Figure 3.

Figure 3 – Historical Load Angles for Load ≥ 80% Peak Load at Keith TS

Both shunt capacitors were in service at this time providing the maximum amount of reactive support.

The lowest observed power factor on the low voltage side and the corresponding power factor as calculated on the high voltage side are shown in the table below.

Date	Time	P Total (MW)	Q Total (MX)	LV Power Factor (observed)	HV Power Factor (calculated)
June 26, 2013	19:30	59.11	40.13	0.8274	0.787

To maintain the power factor in the range of 0.9 lagging to 0.9 leading at the defined meter point, 17 MX of reactive compensation would be required at Keith TS.

The IESO requires that Hydro One implements correction measures as soon as practical, either in cooperation with the load, or by installing power factor correction devices at this station.

3.4 Conclusions

It can be concluded that the replacement of T22 at Keith TS with a new transformer will not result in a material adverse impact on the reliability of the IESO-controlled grid provided that all requirements in this report are met.

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