IESO_REP_0430

REPORT

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System Impact Assessment Report

Vansickle TS- Capacity Increase

CONNECTION ASSESSMENT & APPROVAL PROCESS
Final Draft Report

CAA ID 2007-258

Applicant: Hydro One Networks

Transmission Assessments & Performance Department

2008 March 15

Document ID	IESO_REP_0430
Document Name	System Impact Assessment Report
Issue	Issue 1.0
Reason for Issue	First issue.
Effective Date	March 15, 2008

System Impact Assessment Report

Vansickle TS- Capacity Increase

Acknowledgement

The IESO wishes to acknowledge the assistance of Hydro One in completing this assessment.

Disclaimers

IESO

This report has been prepared solely for the purpose of assessing whether the connection applicant's proposed connection with the IESO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IESO should issue a notice of approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules.

Approval of the proposed connection is based on information provided to the IESO by the connection applicant and the transmitter(s) at the time the assessment was carried out. The IESO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by the transmitter(s) at the request of the IESO. Furthermore, the connection approval is subject to further consideration due to changes to this information, or to additional information that may become available after the approval has been granted. Approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed facility to the IESO-controlled grid. However, connection approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter(s) during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with physical or equipment limitations, or with the Transmission System Code, before connection can be made.

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 and the IESO in accordance with Chapter 4, section 6 of the Market Rules. The IESO assumes no responsibility to any third party for any use, which it makes of this report. Any liability which the IESO 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 IESO provides a draft of this report to the connection applicant, you must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IESO 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.

HYDRO ONE

Special Notes and Limitations of Study Results

The results reported in this study are based on the information available to Hydro One, at the time of the study, suitable for a preliminary assessment of a new generation or load connection proposal.

The short circuit and thermal loading levels have been computed based on the information available at the time of the study. These levels may be higher or lower if the connection information changes as a result of, but not limited to, subsequent design modifications or when more accurate test measurement data is available.

This study does not assess the short circuit or thermal loading impact of the proposed connection on facilities owned by other load and generation (including OPGI) customers.

In this study, short circuit adequacy is assessed only for Hydro One breakers and does not include other Hydro One facilities. The short circuit results are only for the purpose of assessing the capabilities of existing Hydro One breakers and identifying upgrades required to incorporate the proposed connection. These results should not be used in the design and engineering of new facilities for the proposed connection. The necessary data will be provided by Hydro One and discussed with the connection proponent upon request.

The ampacity ratings of Hydro One facilities are established based on assumptions used in Hydro One for power system planning studies. The actual ampacity ratings during operations may be determined in real-time and are based on actual system conditions, including ambient temperature, wind speed and facility loading, and may be higher or lower than those stated in this study.

The additional facilities or upgrades which are required to incorporate the proposed connection have been identified to the extent permitted by a preliminary assessment under the current IESO Connection Assessment and Approval process. Additional facility studies may be necessary to confirm constructability and the time required for construction. Further studies at more advanced stages of the project development may identify additional facilities that need to be provided or that require upgrading.

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IESO SYSTEM IMPACT ASSESSMENT

SIA Findings

Summary

Hydro One is planning to replace the existing 20/27/33 MVA T5 and T6 two-winding transformers at Vansickle TS with higher rated 45/60/75 MVA three-winding transformers. Hydro One is also planning to install a second 13.8 kV metalclad switchgear at Vansickle TS. The scheduled in-service date is May 2010.

This project is under the developmental project classification and is needed to provide reliable power supply within the St. Catharines area. The upgraded Vansickle TS transformer will accommodate new supply growth of the Horizon Utilities Corporation.

This System Impact Assessment examined the impact the Vansickle TS transformer replacement on the IESO-controlled grid with peak loads under two generation scenarios: low Beck 1 and high Decew Falls output (S1) and high Beck 1 and low Decew Falls output (S2). The following conclusions and recommendations were made.

Conclusions and Recommendations

Conclusions:

(1) With the existing transformers, Vansickle TS may exceed its summer station capability from 2008 to 2009. The replacement transformers will be capable of handling peak load forecasted for the study period (2010 – 2014).

(2) Historical Vansickle load data shows the power factor at the defined meter point is often below 0.9.

S1 - The analysis concluded that for Low Beck 1 and High Decew Falls output under 2014 conditions:

(a) All elements are within continuous ratings pre-contingency. Under post-contingency conditions, all elements are within short term emergency ratings (STE). Elements that exceed their long term emergency ratings (LTE) are summarized below. There are sufficient resources available to ensure that equipment loading returns to LTE values consistent with the *Load Security Criteria* as outlined in the Transmission Assessment Criteria.

Monitored Element		Loss of	Loading
	From x To		
D9HS	LOUTH JCT x VANSICKLE TS	D10S	LTE < Loading < STE
D10S	LOUTH JCT x VANSICKLE TS	D9HS	LTE < Loading < STE
T1	ALLANBURG 115 kV x 230 kV	Allanburg T2	LTE < Loading < STE

(b) The post-contingency voltage declines and voltages on the IESO-controlled grid are within criteria.

S2 - The analysis concluded that for High Beck 1 and Low Decew Falls output under 2014 conditions:

(a) All elements are within continuous ratings pre-contingency. Under post-contingency conditions, all elements are within short term emergency ratings (STE). Elements that exceed their long term emergency ratings (LTE) are summarized below. There are sufficient resources available to ensure that equipment loading returns to LTE values consistent with the *Load Security Criteria* as outlined in the Transmission Assessment Criteria.

Monitored Element		Loss of	Loading
	From x To		
Q11S	BECK # 1 SS x WARNER ROAD JCT	Q12S	LTE < Loading < STE
		Q26M+Q28A	LTE < Loading < STE
Q12S	BECK # 1 SS x NOTL YORK MTS #1 JCT	Q11S	LTE < Loading < STE
T1	ALLANBURG 115 kV x 230 kV	Allanburg T2	LTE < Loading < STE

Note: Under extreme conditions in which Beck 1 output is further increased and/or Decew Falls is out of service, Q11S/Q12S may exceed STE post-contingency for the loss of Q12S, Q11S or Q26M+Q28A. Appropriate constrain on or dispatch of Decew Falls generation will prevent the occurrence of this situation.

(b) The post-contingency voltage declines on the IESO-controlled grid are within IESO criteria.

The following are other findings of the analysis unrelated to the Vansickle TS transformer replacement:

(1) Load security criteria as per the Transmission Assessment Criteria along the Decew Falls and Beck 1 60 Hz corridor is met for the load forecast provided by Hydro One for the study period.

(2) It was found that Bunting TS and Niagara-on-the-Lake DS may reach their station capabilities by 2009. It is expected that station owners and area LDCs assess the load growth and capacity periodically and review plans to accommodate increases in load.

IESO's Requirements for Connection

(1) Hydro One is required to provide the impedance and ULTC details of the Vansickle TS transformers before or at the earliest stage of development to ensure the data assumed for the study is valid.

(2) Hydro One is required to have the capability to maintain a power factor within the range of 0.9 lagging and 0.9 leading as measured at defined metering point at Vansickle TS. Historical records from Hydro One indicate a 0.87 load power factor at Vansickle TS during peak load. IESO records show that the load power factor can be as low as 0.79 during on peak hours. It would be necessary to install devices of about 15 MVar to compensate for power factor when the existing transformers are replaced and up to an additional 20 MVar in the future to accommodate the reactive requirements required to meet the station design capacity.

Hydro One and area LDC shall work together to formulate and have a plan ready for implementation within the next three years to ensure compliance with the Market Rules.

(3) Transmission equipment must remain in service, and not automatically trip, for the voltages up to 5% above the maximum continuous rating, in this case 133 kV, for up to 30 minutes, to allow system to be re-dispatched to return voltages within their normal range.

(4) Hydro One is required to retain/install Under-Frequency Load Shedding facilities at Vansickle TS to trip selected low voltage feeders in accordance with Chapter 5 of Section 10.4 of Market Rules, which requires at least 30% of customer's peak demand to be available for automatic rejection.

(5) Hydro One shall install and maintain facilities at Vansickle TS to provide 3% and 5% voltage reduction within five minutes of receipt of the direction from the IESO.

(6) As specified in Appendix 4.16 of the Market Rules, Hydro One is required to install all the equipment needed to monitor information required by IESO on a continuous basis. The IESO requires that the status of all isolating disconnect switches and breakers as well as voltages and active and reactive power flows over the new transformers be monitored at Vansickle TS.

(7) Protection systems must be designed to meet all the requirements of the *Transmission System Code* (*TSC)*. Existing lines protections and DESN protection settings must be revised and coordinated, as required.

(8) Under-Load Tap Changer facilities (ULTC) must be available at the station.

(9) The registration of the new facilities will need to be completed through the IESO facility registration process before any part of the facility can be placed in-service. It is required that the applicant initiates the facility registration process with the IESO at least six months prior to connection. It must be noted that if the data supplied for the registration of the facilities materially differ from those that were used for the assessment, the some of the analysis might need to be repeated to ensure that the IESO-controlled grid is not adversely affected.

Notification of Conditional Approval

From the information provided, our review concludes that the proposed changes will not result in a material adverse effect on the reliability of the IESO-controlled grid. It is recommended that a Notification of Conditional Approval be issued for the new Vansickle TS subject to the IESO receiving written acknowledgement that the requirements listed in this report will be implemented.

1. Project Description

Hydro One is planning to replace the existing 20/27/33 MVA T5 and T6 transformers at Vansickle TS with higher rated 45/60/75 MVA transformers. With this upgrade, Hydro One is also planning to install a second 13.8 kV metalclad switchgear at Vansickle TS. These upgrades will accommodate the growing load within the Horizon Utilities Corporation.

The scheduled completion dates for the Vansickle TS upgrade is May 2010.

2. General Requirements

Models & Data

1. The Connection Applicant must complete the IESO Facility Registration process in a timely manner before IESO final approval for connection is granted. Finalized models and data must be provided to the IESO. This information should be submitted to the IESO before first energization of any equipment to allow the IESO to perform any additional reliability studies.

Connection Equipment (Breakers, Disconnects, Transformers, Buses)

High voltage 115 kV equipment connected to terminal stations must be capable of continuously operating in the range between 113 kV and 127 kV.

Some recognized contingencies such as load shedding, open line end can cause a temporary voltage increase above the maximum continuous limit of 127 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.

The IESO requires that the 115 kV connection equipment have the following requirements:

- equipment must be able to interrupt rated fault current for voltages up to the maximum continuous rating
- equipment must remain in service and not automatically trip for voltages up to 5% above the maximum continuous rating for up to 30 minutes to allow the system to be re-dispatched to return voltages within their normal range.

Protection Systems

1. Hydro One is required to meet the transmitters' requirements with respect to protection systems for tapped transformer stations supplying load, as outlined in the Transmission System Code.

Underfrequency Load Shedding Requirements

1. The Market Rules 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.

Voltage Reduction Facilities

1. The Connection Applicant is required to confirm that voltage control will be available from a local or remote location to provide 3% or 5% reduction within five minutes of receipt of the direction from the IESO, to support operating obligations.

Power Factor

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

IESO Monitoring and Telemetry Data

1. The Market Rules list the requirements with respect to the telemetry data that must be provided to the IESO and to the performance standards that must be adhered to.

Hydro One Networks is required to provide on-line monitor of the status of all isolating disconnect switches and breakers at the new Vansickle TS and active and reactive power flows over the new transformers to be monitored on a continuous basis.

In accordance with the requirements for a *transmitter*, Connection Applicant must ensure that all the equipment needed to provide the telemetry data and meet the performance standards will be installed.

2. The IESO will finalize items to be telemetered during the IESO Market Entry Process.

3. Review of Connection Proposal

3.1 Proposed Connection Arrangement

The connection arrangement is shown in **Figure 1**.

The existing 20/27/33 MVA 110/14.2 kV transformers at Vansickle TS will be replaced with 45/60/75 MVA 115/14.2/14.2 kV transformers. The transformers have a 10 day LTR of 102 MVA. These transformers will be connected to the same line taps from D9HS and D10S as the existing transformers. Six additional 13.8 kV feeders are to be installed at Vansickle TS. Each new feeder is equipped with a 1200 A breaker. The 13.8 kV bus can be split via a 2500 A tie-breaker and is isolated from the transformer by two 2500 A breakers.

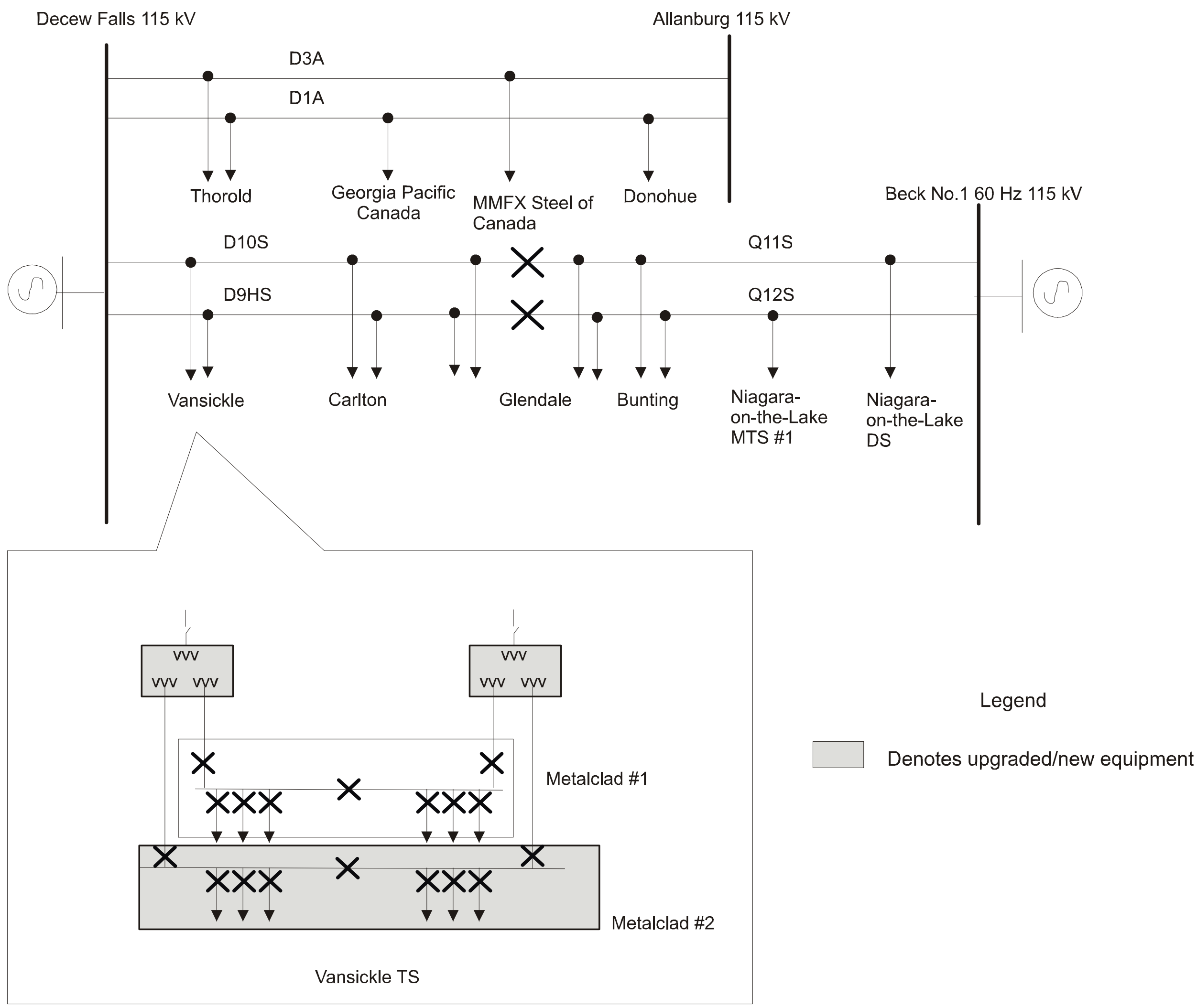

FIGURE 1: PROPOSED CONNECTION

3.2 Existing System

Figures 2A and **2B** show the MW flow on D9HS and D10S at Decew Falls in 1 Hr average samples during the period of Jan 1- Dec 31, 2006. The positive flow is leaving the bus. It can be seen that the direction of active power on these lines is almost always towards Beck 1 (60 Hz).

Figures 2C and **2E** show the MW output at Beck 1 (60 Hz) and Decew Falls G1 and G2 in 1 Hr average samples during the period of Jan 1 – Dec 31, 2006. **Figures 2D** and **2F** show the corresponding generation duration curves. The generation duration curves show the percentage of time at which the generation was greater than a certain value. From these duration curves, it can be seen that Beck 1 (60 Hz) generation at least 150 MW (approximately equal to 3 units at full output), 50% of the time. Decew Falls G1 and G2 generation is at least 70 MW (approximately equal to 1 unit at full output), 50% of the time.

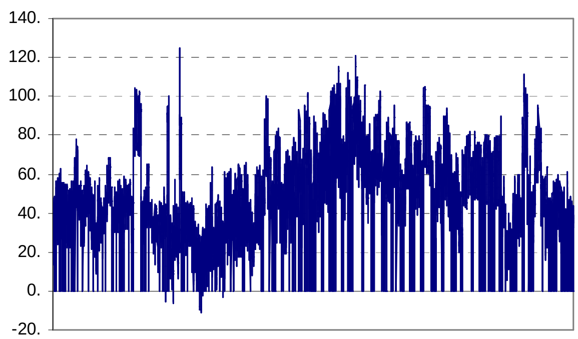

FIGURE 2A – MW FLOW IN D9HS @ DECEW FALLS

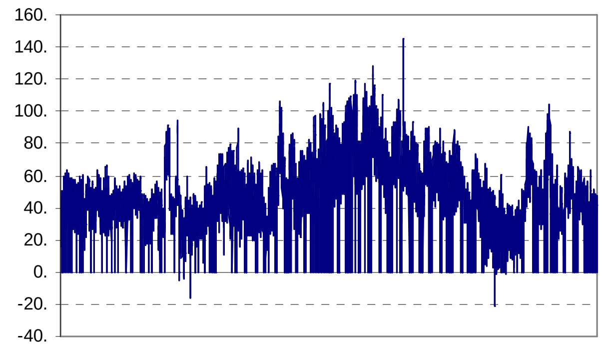

FIGURE 2B – MW FLOW IN D10S @ DECEW FALLS

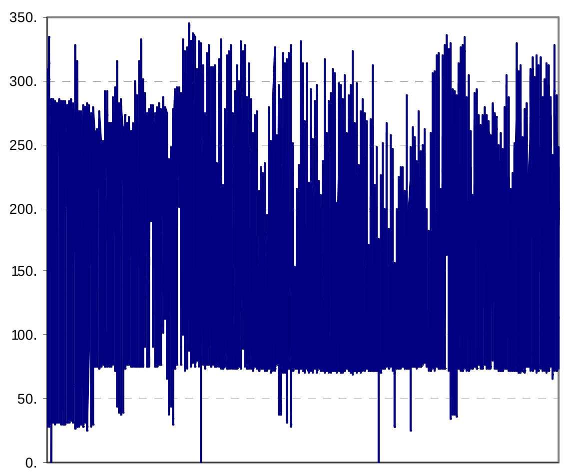

FIGURE 2C – BECK 1 (60 HZ) BUS MW OUTPUT

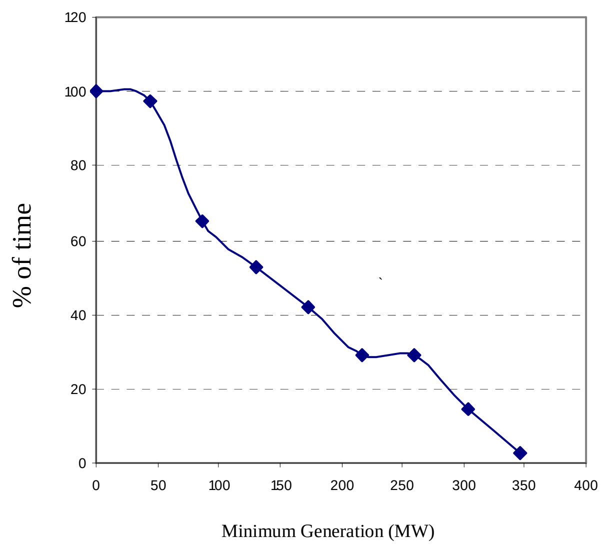

FIGURE 2D – BECK 1 (60 HZ) BUS GENERATION DURATION CURVE

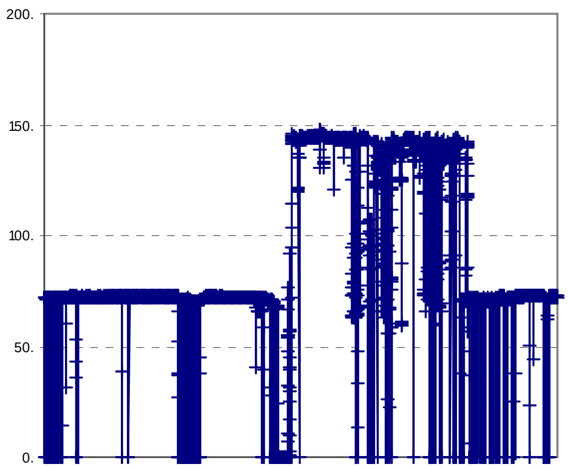

FIGURE 2E – DECEW FALLS G1+G2 MW OUTPUT

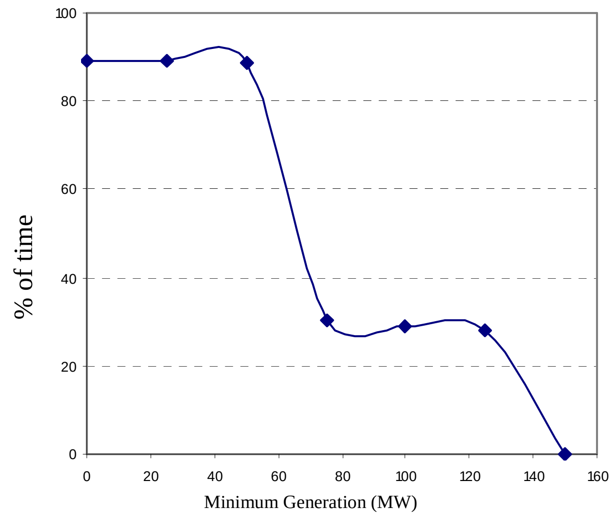

FIGURE 2F – DECEW FALLS G1+G2 GENERATION DURATION CURVE

Figure 2G shows the Allanburg 115 kV Area demand in 1 Hr average samples during the period of Jan 1-Dec 31, 2006. Allanburg 115 kV Area Demand is defined by the following equation:

Allanburg 115 kV Area Demand = $(\text{Allanburg T1+T2+T3+T4})_{\text{MW in at Allanburg}}$
$+ (\text{Beck No.1 60 Hz + DeCew Falls GS and ND1})_{\text{generation}}$
$- (\text{Frequency Changer for 25Hz system})_{\text{MW out at Beck}}$

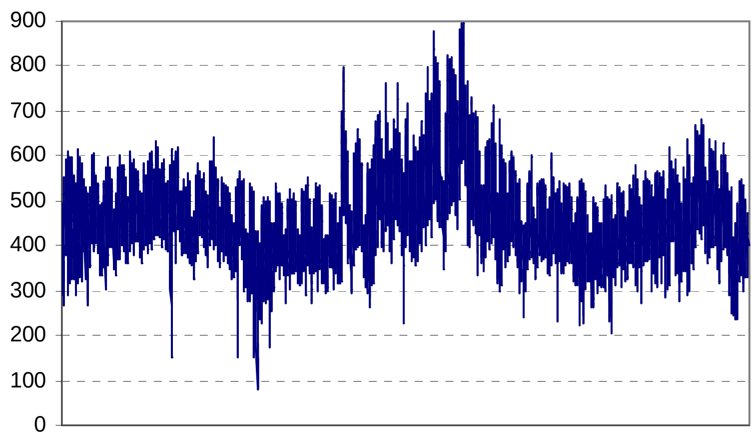

FIGURE 2G – ALLANBURG 115 KV DEMAND

4. Data Verification

4.1 Transformers

Hydro One did not provided impedance and ULTC specifications for the Vansickle transformers. The following are specifications of a similar 110/14.2/14.2 kV 45/60/75 MVA transformer obtained from the Hydro One Secure Operations website. These values were assumed for Vansickle T5 and T6 for the analysis. **The proponent should notify the IESO if these values are different.**

Rating (MVA)	45/60/75 MVA
Voltage (kV)	110/14.2/14.2
Impedance (pu on 22.5 MVA base)	9.279% (HX); 9.938% (HY); 17.716% (XY)
Continuous Rating (MVA)	75 MVA
10 Day Limited Time Rating (MVA)	102 MVA
ULTC	± 2.84 kV in 32 steps

4.2 Circuit Breakers

Specifications of the connection applicant are listed below.

	Transformer & Bus Tie Breakers	Feeder Breakers
Nominal Voltage (kV)	13.8	13.8
SC Circuit Interrupting Capability (kA)	21	21
Continuous Rating (A)	2500	1200
Normal Operation	Closed	Closed

5. Fault Level Assessment

A fault level study is not required for this assessment.

– End of Section –

6. System Impact Studies

This connection assessment study focused on identifying the effect of the proposed transformer replacement at Vansickle TS would have on thermal loading and the system voltages under pre- and post-contingency situations. The effect of the load growth in the St. Catharines area on the Allanburg 115/230 kV transformers was also examined.

6.1 Study Assumptions and Background

Following sub-sections summaries the assumptions and background information used in the assessment.

6.1.1 Pre-contingency conditions

- The study was performed for a system with all transmission elements in service.
- The Niagara zonal load was scaled to 2014 summer peak conditions. Loads on D9HS+D10S and Q12S+Q11S were further scaled to the 2014 summer forecast provided by Hydro One **(Section 6.1.2)**. The rest of the loads in Ontario remained at 2009 summer peak conditions.
- The Allanburg 115 kV Area Demand is approximately 1048 MW.
- For voltage decline studies, before tap changer action, the active power loads were converted into constant current and constant admittance loads equally. The reactive loads were converted only into constant admittance loads. A constant power load model was used under post tap changer action conditions.
- The following assumptions were made:

  Vineland and Beamsville loads are supplied from Allanburg TS via circuit Q2AH

  a) MMFX Steel load connected to D3A is assumed to be 0 MW
  b) Beck 1 25 Hz equipment, G1, G2, FC1, G7 are deregistered.
  c) D10S and D11S line sections from Decew Falls to Vansickle have been upgraded to a 1443.7 ACSR 56/19 conductor.

6.1.2 Load Growth

- The following is a load forecast for the local area for 2007 to 2014 summer weather under a coincident peak. This forecast was provided by Hydro One. Note, summer station peak load projections are provided in MVA while the total load projection on D9HS+D10S and Q12S+Q11S are provided in MW.

  This forecast accounts for an additional 20 MW of load at Glendale to be add in 2007. The power factor, provided by Hydro One, represents the historical power factor which occurred at peak loads.

Summer Station Peak Load Projections (MVA)									
Monitored Facility	pf	2007	2008	2009	2010	2011	2012	2013	2014
Vansickle TS	0.87	42.9	52.1	55.5	59.1	62.8	66.7	70.8	75.0
Carlton TS (T1+T4)	0.91	18.8	19.1	19.3	19.6	19.9	20.2	20.5	20.8
Carlton TS (T2+T3)	0.91	111.6	111.6	111.6	111.6	111.6	111.6	111.6	111.6
Glendale TS (T3+T4)	0.87	18.5	18.8	19.0	19.3	19.6	19.9	20.2	20.5
Glendale TS (T1+T2)	0.87	82.6	83.8	85.1	86.4	87.7	89.0	90.3	91.7
Bunting TS	0.83	81.8	83.0	83.2	83.2	83.2	83.2	83.2	83.2
Niagara-on-the-Lake MTS#1	0.94	19.9	20.1	20.5	21.0	21.5	22.1	22.6	23.1
Niagara-on-the-Lake DS	0.92	31.4	31.7	31.8	31.8	31.8	31.8	31.8	31.8
Total Load on Decew Falls and Beck 1 Corridor (MW)									
D9HS+D10S		172.1	180.6	183.9	187.6	191.4	195.3	199.4	203.6
Q12S+Q11S		187.4	189.9	191.6	193.2	194.8	196.5	198.1	199.8
Total		359.4	370.5	375.6	380.8	386.2	391.8	397.5	403.4

The following table shows the IESO forecast of the loads on D9HS+D10S and Q12S+Q11S in MW. The forecast was obtained by scaling the loads recorded on August 1 2006 for the hour ending 16, which represents the highest recorded historical coincident peak at the time of this report. The loads were then scaled to growth rates provided by Hydro One. It can be seen from the totals that both forecasts are closely matched.

The forecast provided by Hydro One was adopted for the remaining analysis of this report.

IESO Load Forecast for Decew Falls and Beck 1 Corridor Loads (MW)								
	2007	2008	2009	2010	2011	2012	2013	2014
D9HS+D10S	174.0	183.7	188.5	193.5	197.9	203.9	209.4	215.1
Q12S+Q11S	171.2	173.9	176.4	179.2	182.0	184.7	187.6	190.3
Total	345.2	357.6	364.9	372.7	379.9	388.6	397	405.4

The following table lists each station and their capabilities with the highest rated transformer out of service under summer conditions. A comparison was made with the loads in the table above. It can be seen that Vansickle TS power transfer capability may be exceeded for the summer 2008 to 2009 period. Bunting TS and Niagara-on-the-Lake DS may reach station capability by 2009.

Load	10 Day LTR of Remaining Transformer(s) (MVA)	Year load Capability Reached/Exceeded
Vansickle TS	43.5[a]/102[b]	2008[a]/Not before 2014 [b]
Carlton TS	225	Not before 2014
Glendale TS	143.2	Not before 2014
Bunting TS	83.2	2009
Niagara-on-the-Lake MTS #1	53	Not before 2014
Niagara-on-the-Lake DS	31.8	2009

Notes:
(a) Value valid for 2007 to 2009
(b) Value valid for 2010 to 2014

- The load security criteria as per the Transmission Assessment Criteria requires that with any one element out of service, not more than 150 MW of load can be interrupted by configuration. With any two elements out of service, not more than 600 MW of load can be interrupted by configuration. This criteria is met for the loads along the Decew Falls and Beck 1 (60 Hz) corridor for the study period.

  The load security criteria for local generation outages is evaluated in **Section 6.2** of the report.

6.1.3 Study Scenarios

Two scenarios S1 and S2 were examined.

The following table outlines the number of in-service equipment for each scenario.

Scenario		Decew Falls	Beck 1	# Allanburg Capacitors in-service (3)
S1	# of units in-service	2	3	2
	MW	143.4 (1)	150.8	
S2	# of units in-service	1	7	1
	MW	71.7 (2)	347 (4)	

Notes:
(1) Decew ND1 output = 34 MW
(2) Decew ND1 output = 27 MW
(3) Each Allanburg Capacitor = 117 MVAr
(4) Historical hourly average flow data for years 2005-2006 indicate Beck 1 bus output ≤ 350 MW.

6.1.4 Contingencies

The following are the contingencies that were performed for the thermal and voltage analysis.

Contingency		Control Actions
C1	Loss of D10S	N/A
C2	Loss of D9HS	N/A
C3	Loss of Q11S	N/A
C4	Loss of Q12S	N/A
C5	Loss of Allanburg T2	N/A
C6	Loss of Q26M+Q28A+ Allanburg T1+T2	Initiate Allanburg 230/115 kV autotransformer overload protection scheme (Trip Allanburg breakers L7L36 and L1L6)

Included in the list of contingencies is C6, a double contingency. Only single contingencies are recognized in the Allanburg area. Contingency C6 was included in the analysis as there exists an autotransformer overload protection scheme within the Allanburg area to detect the loss of Allanburg T1 and T2. Its purpose is to provide protection against severe voltage declines following the contingency.

6.2 Thermal Analysis

6.2.1 Monitored Equipment

The following ratings were provided by Hydro One for 35 ºC, 4 km/h wind speed, daytime conditions.

	From	To	Continuous [1]	Long Term Emergency [2]	Short-Term Emergency [3]
D9HS	DECEWFLS	HOOPERSJ	1130 A	1500 A	1810 A
	VANSICKL	HOOPERSJ	1130 A	1500 A	1810 A
	LOUTHJ	VANSICKL	680 A	890 A	1090 A
	LOUTHJ	GLENDALE	680 A	890 A	970 A
	CARLTON	LOUTHJ	710 A	710 A	790 A
D10S	DECEWFLS	HOOPERSJ	1130 A	1500 A	1810 A
	VANSICKL	HOOPERSJ	1130 A	1500 A	1810 A
	LOUTHJ	VANSICKL	680 A	890 A	1090 A
	LOUTHJ	GLENDALE	680 A	890 A	970 A
	CARLTON	LOUTHJ	710 A	710 A	790 A
Q12S	BECK1	NIAOTL1J	680 A	890 A	970 A
	GLENDALJ	GLENDALE	680 A	890 A	1090 A
	BUNTING	GLENDALJ	680 A	890 A	1090 A
	NIAOTL1J	GLENDALJ	680 A	890 A	1090 A
	NIAOTL1J	NIAOTL1	680 A	890 A	970 A
Q11S	BECK1	WARNERJ	680 A	890 A	970 A
	MCKINNOJ	WARNERJ	680 A	890 A	1090 A
	GLENDALJ	MCKINNOJ	680 A	890 A	1090 A
	GLENDALJ	GLENDALE	680 A	890 A	1090 A
	NIAGLAKE	WARNERJ	480 A	560 A	580 A
	BUNTING	GLENDALJ	680 A	890 A	1090 A

Notes:
(1) Rating obtained at a conductor temperature of 93 ºC or at sag temperature, whichever is more limiting.
(2) Rating obtained at a conductor temperature of 127 ºC or at sag temperature, whichever is more limiting.
(3) Rating obtained at the sag temperature with a pre-contingency loading of 75% of the long term emergency rating.

	From	To	Continuous	Long Term Emergency [1]	Short Term Emergency [2]
T1	ALLANBURG 115kV	ALLANBURG 230kV	225 MVA	229 MVA	303 MVA
T2	ALLANBURG 115kV	ALLANBURG 230kV	250 MVA	407 MVA	453 MVA
T3	ALLANBURG 115kV	ALLANBURG 230kV	250 MVA	308 MVA	396 MVA
T4	ALLANBURG 115kV	ALLANBURG 230kV	250 MVA	407 MVA	453 MVA

Notes:
(1) The values presented are equivalent to the 10 day Limited Time Rating.
(2) The values presented are equivalent to the 15 minute Limited Time Rating.

6.2.2 Pre-contingency Analysis

The following are the pre-contingency flows represented as a percentage of its continuous rating for scenarios S1 and S2.

Pre-Contingency Thermal Analysis				
Monitored Elements			% of Continuous	
	From	To	S1	S2
D9HS	DECEWFLS	HOOPERSJ	67.5	48.6
	VANSICKL	HOOPERSJ	67.5	48.6
	LOUTHJ	VANSICKL	84.6	53.5
	LOUTHJ	GLENDALE	38.2	7.6
	CARLTON	LOUTHJ	44.9	44.6
D10S	DECEWFLS	HOOPERSJ	67.4	48.5
	VANSICKL	HOOPERSJ	67.4	48.5
	LOUTHJ	VANSICKL	84.6	53.5
	LOUTHJ	GLENDALE	38.9	7.9
	CARLTON	LOUTHJ	43.8	43.6
Q12S	BECK1	NIAOTL1J	53.5	83.1
	GLENDALJ	GLENDALE	8.8	37.2
	BUNTING	GLENDALJ	29.0	28.7
	NIAOTL1J	GLENDALJ	36.8	65.8
	NIAOTL1J	NIAOTL1	17.1	16.8
Q11S	BECK1	WARNERJ	57.6	87.2
	MCKINNOJ	WARNERJ	34.5	64.3
	GLENDALJ	MCKINNOJ	34.6	64.4
	GLENDALJ	GLENDALE	1.8	31.0
	NIAGLAKE	WARNERJ	33.5	32.9
	BUNTING	GLENDALJ	33.9	33.6
T1	ALLANBURG 115kV	ALLANBURG 230kV	91.1	79.3
T2	ALLANBURG 115kV	ALLANBURG 230kV	80.4	69.8
T3	ALLANBURG 115kV	ALLANBURG 230kV	63.6	52.4
T4	ALLANBURG 115kV	ALLANBURG 230kV	82.5	71.9

Comments:

- All elements are within continuous ratings.

6.2.3 Post-contingency Analysis

The following four tables show the post-contingency flow percentages. The first value represents the post-contingency flow with respect to the long-term emergency rating and the second value represents the post-contingency flow with respect to the short term emergency rating.

(1) Scenario S1 – High Decew Falls Output

Scenario S1 Post-Contingency Analysis			Projected Current Flow/LTE (%) and Projected Current Flow/STE (%)					
Element	From	To	C1	C2	C3	C4	C5	C6
D9HS	DECEWFLS	HOOPERSJ	94.2/78.1	0.0/0.0	66.2/54.9	39.1/32.4	51.2/42.4	33.2/27.5
	VANSICKL	HOOPERSJ	94.2/78.1	0.0/0.0	66.2/54.9	39.1/32.4	51.2/42.5	33.2/27.5
	LOUTHJ	VANSICKL	114.9/93.8	0.0/0.0	91.1/74.3	44.2/36.1	65.1/53.2	36.1/29.5
	LOUTHJ	GLENDALE	40.0/36.7	0.0/0.0	57.5/52.8	7.0/6.4	29.2/26.8	26.5/24.3
	CARLTON	LOUTHJ	93.8/84.3	0.0/0.0	43.5/39.1	46.9/42.1	45.4/40.8	45.4/40.8
D10S	DECEWFLS	HOOPERSJ	0.0/0.0	94.4/78.2	38.7/32.1	66.6/55.2	51.2/42.4	33.4/27.7
	VANSICKL	HOOPERSJ	0.0/0.0	94.4/78.2	38.7/32.1	66.7/55.2	51.2/42.4	33.4/27.7
	LOUTHJ	VANSICKL	0.0/0.0	115.3/94.1	43.4/35.5	91.8/75.0	65.1/53.1	36.5/29.8
	LOUTHJ	GLENDALE	0.0/0.0	40.2/36.9	7.0/6.4	58.8/53.9	29.8/27.3	23.5/21.6
	CARLTON	LOUTHJ	0.0/0.0	94.1/84.6	45.8/41.2	42.5/38.2	44.3/39.8	45.1/40.5
Q12S	BECK1	NIAOTL1J	42.6/39.1	61.1/56.1	70.1/64.3	0.0/0.0	41.7/38.3	78.5/72.0
	GLENDALJ	GLENDALE	9.1/7.4	27.6/22.5	4.4/3.6	0.0/0.0	7.3/6.0	45.4/37.1
	BUNTING	GLENDALJ	24.9/20.3	20.8/17.0	53.3/43.5	0.0/0.0	22.7/18.6	22.9/18.7
	NIAOTL1J	GLENDALJ	30.6/25.0	48.3/39.5	57.6/47.0	0.0/0.0	29.2/23.8	65.5/53.5
	NIAOTL1J	NIAOTL1	13.2/12.1	13.3/12.2	13.2/12.1	0.0/0.0	13.2/12.1	13.3/12.2
Q11S	BECK1	WARNERJ	64.4/59.1	45.6/41.9	0.0/0.0	73.2/67.2	44.8/41.1	82.1/75.4
	MCKINNOJ	WARNERJ	46.3/37.8	28.2/23.0	0.0/0.0	55.6/45.4	27.0/22.0	64.3/52.5
	GLENDALJ	MCKINNOJ	46.4/37.9	28.3/23.1	0.0/0.0	55.6/45.4	27.1/22.1	64.3/52.5
	GLENDALJ	GLENDALE	22.3/18.2	4.4/3.6	0.0/0.0	3.5/2.9	1.6/1.3	42.4/34.6
	NIAGLAKE	WARNERJ	29.2/28.2	29.0/28.0	0.0/0.0	29.1/28.1	29.0/28.0	29.2/28.2
	BUNTING	GLENDALJ	24.3/19.8	28.4/23.2	0.0/0.0	52.2/42.6	26.2/21.4	26.4/21.5
T1	ALLANBURG 115kV	ALLANBURG 230kV	90.0/68.0	90.0/68.1	87.2/65.9	87.9/66.5	116.1/87.8	0.0/0.0
T2	ALLANBURG 115kV	ALLANBURG 230kV	49.7/44.7	49.7/44.7	48.1/43.2	48.6/43.6	0.0/0.0	0.0/0.0
T3	ALLANBURG 115kV	ALLANBURG 230kV	52.3/40.7	52.3/40.7	49.8/38.8	50.5/39.3	71.9/55.9	76.1/59.2
T4	ALLANBURG 115kV	ALLANBURG 230kV	51.0/45.8	51.0/45.8	49.4/44.4	49.8/44.8	65.7/59.1	71.4/64.2

(2) Scenario S2 – High Beck 1 Output

Scenario S2 Post-Contingency Analysis			Projected Current Flow/LTE (%) and Projected Current Flow/STE (%)					
Element	From	To	C1	C2	C3	C4	C5	C6
D9HS	DECEWFLS	HOOPERSJ	72.9/60.5	0.0/0.0	48.2/39.9	37.9/31.4	36.6/30.3	21.2/17.6
	VANSICKL	HOOPERSJ	73.0/60.5	0.0/0.0	48.2/39.9	37.9/31.4	36.6/30.3	21.2/17.6
	LOUTHJ	VANSICKL	79.2/64.7	0.0/0.0	60.2/49.2	42.6/34.8	40.7/33.2	21.3/17.4
	LOUTHJ	GLENDALE	4.8/4.4	0.0/0.0	27.4/25.1	6.2/5.7	5.1/4.6	37.0/33.9
	CARLTON	LOUTHJ	93.3/83.9	0.0/0.0	44.6/40.1	45.8/41.1	45.1/40.5	45.1/40.5
D10S	DECEWFLS	HOOPERSJ	0.0/0.0	73.3/60.7	37.4/31.0	48.6/40.2	36.6/30.3	20.0/16.6
	VANSICKL	HOOPERSJ	0.0/0.0	73.3/60.7	37.4/31.0	48.6/40.2	36.6/30.3	20.0/16.6
	LOUTHJ	VANSICKL	0.0/0.0	79.8/65.2	41.7/34.1	60.9/49.7	40.7/33.2	18.7/15.3
	LOUTHJ	GLENDALE	0.0/0.0	5.3/4.9	6.2/5.7	28.2/25.9	5.7/5.2	34.9/32.1
	CARLTON	LOUTHJ	0.0/0.0	93.9/84.4	44.7/40.2	43.5/39.1	44.0/39.6	43.2/38.8
Q12S	BECK1	NIAOTL1J	70.3/64.5	65.1/59.7	101.1/92.8	0.0/0.0	64.7/59.3	98.0/89.9
	GLENDALJ	GLENDALE	36.1/29.5	29.8/24.3	36.6/29.9	0.0/0.0	29.8/24.3	64.8/52.9
	BUNTING	GLENDALJ	21.9/17.9	23.0/18.7	52.9/43.2	0.0/0.0	22.4/18.3	22.2/18.1
	NIAOTL1J	GLENDALJ	57.9/47.3	52.7/43.0	88.5/72.3	0.0/0.0	52.2/42.6	85.4/69.7
	NIAOTL1J	NIAOTL1	12.9/11.9	12.9/11.8	13.0/11.9	0.0/0.0	12.9/11.9	12.8/11.7
Q11S	BECK1	WARNERJ	68.2/62.6	73.7/67.6	0.0/0.0	104.2/95.6	67.8/62.2	101.4/93.0
	MCKINNOJ	WARNERJ	50.6/41.3	56.1/45.8	0.0/0.0	86.6/70.7	50.2/41.0	84.0/68.6
	GLENDALJ	MCKINNOJ	50.7/41.4	56.2/45.9	0.0/0.0	86.7/70.8	50.2/41.0	84.1/68.6
	GLENDALJ	GLENDALE	24.6/20.1	31.0/25.3	0.0/0.0	35.5/29.0	24.5/20.0	61.0/49.8
	NIAGLAKE	WARNERJ	28.3/27.3	28.4/27.4	0.0/0.0	28.6/27.6	28.4/27.4	28.0/27.1
	BUNTING	GLENDALJ	26.3/21.5	25.3/20.6	0.0/0.0	51.8/42.3	25.8/21.1	25.6/20.9
T1	ALLANBURG 115kV	ALLANBURG 230kV	78.4/59.2	78.4/59.3	76.0/57.4	76.7/58.0	100.4/75.9	0.0/0.0
T2	ALLANBURG 115kV	ALLANBURG 230kV	43.1/38.7	43.1/38.8	41.8/37.5	42.2/37.9	0.0/0.0	0.0/0.0
T3	ALLANBURG 115kV	ALLANBURG 230kV	43.1/33.5	43.1/33.5	41.2/32.0	41.8/32.5	59.3/46.1	54.0/42.0
T4	ALLANBURG 115kV	ALLANBURG 230kV	44.4/39.9	44.4/39.9	43.1/38.7	43.5/39.1	56.9/51.1	56.7/50.9

(5) Summary

- All elements are within STE ratings.
- The following table summarizes the elements which exceed its LTE rating for contingencies C1 to C6. Shown is the amount exceeded in amperes and MVA. MVA values calculated assuming a voltage of 127 kV.

Elements Exceeding LTE Ratings						
Monitored Element			Loss of	Scenario (s)	Loading	
	From	To			A	MVA
Q11S	BECK1	WARNERJ	Q12S	S2	37.7	8.29
			Q26M+Q28A	S2	12.4	2.73
Q12S	BECK1	NIAOTL1J	Q11S	S2	10.20	2.24
D9HS	LOUTHJ	VANSICKL	D10S	S1	132.2	29.08
D10S	LOUTHJ	VANSICKL	D9HS	S1	135.9	29.89
T1	ALLANBURG 115 kV	ALLANBURG 230 kV	Allanburg T2	S1	N/A	36.9
				S2	N/A	0.9

- The following table shows the remaining load allowable for planned load curtailment net load lost by configuration.

Loss of	Load Lost by Configuration (MW)	Generation Out of Service (MW)		Remaining Load Available for Curtailment (MW)	
		S1	S2	S1	S2
Q12S	23.1	196.2	71.7	126.9	71.7
Q11S	31.8	196.2	71.7	118.2	71.7
D9HS	0	196.2	71.7	150	71.7
D10S	0	196.2	71.7	150	71.7
Allanburg T1	0	196.2	71.7	150	71.7
Q26M+Q28A	23.0	196.2	71.7	346.2	221.7

As per the load security criteria with any one element out of service, planned load curtailment is permissible to account for local generation outages. Not more than 150 MW of load may be interrupted by configuration and by planned load curtailment. With any two elements out of service, planned load curtailment exceeding 150 MW is permissible only to account for local generation outages. Not more than 600 MW of load may be interrupted by configuration and by planned load curtailment.

As shown from the above table, there is sufficient available load to be curtailed that would allow elements to be within LTE ratings. All load curtailed must restored within restoration times outlined in the "Load Restoration Criteria" as per the Transmission Assessment Criteria.

- In the extreme "High Beck 1 and Low Decew Falls output" S2 scenario in which there is no output from Decew Falls and or Beck 1 output is further increased, the flows on the Q11S section from Beck 1 to Warner JCT or the Q12S section from Beck 1 to Niagara-on-the-Lake MTS #1 will exceed STE ratings for the loss of Q11S, Q12S or Q26M+Q28A. This situation will be avoided through the appropriate dispatch or constrain on of Decew Falls generation.

6.3 Voltage Analysis

6.3.1 Pre-contingency Analysis

The following are the pre-contingency voltages at selected busses in the local area.

Scenario	Decew Falls 115kV	Beck 1 115 kV	Allanburg 115 kV	Vansickle 115 kV	Vansickle 13.8 kV	Carlton R1 13.8 kV	Carlton EQ 13.8 kV	Glendale 115 kV
S1	120	121	124	120	14.5	14.4	14.4	118
S2	120	124	124	120	14.5	14.5	14.5	120

All voltages were found to be within the maximum and minimum continuous voltages as observed by the IESO Transmission Assessment Criteria.

6.3.2 Post-contingency Analysis

The following tables summarize the computer results obtained from voltage decline analysis for the two scenarios under pre and post ULTC action.

(1) Scenario S1 – 2 Decew Falls I/S, 3 Beck 1 I/S, 1 Allanburg Cap I/S

	Decew Falls 115kV		Beck 1 115 kV		Allanburg 115 kV		Vansickle 115 kV		Vansickle 13.8 kV		Carlton R1 13.8 kV		Carlton EQ 13.8 kV		Glendale 13.8 kV	
	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
C1	-0.18	0.22	0.50	0.80	0.11	0.33	0.22	0.69	4.19	-0.25	3.27	4.14	3.48	4.36	1.46	1.86
C2	-0.21	0.20	0.53	0.84	0.11	0.34	0.20	0.67	4.15	-0.27	2.16	0.51	2.05	0.40	1.60	2.02
C3	0.02	0.46	-0.53	-0.19	-0.16	0.10	0.17	0.67	0.04	-0.81	0.06	0.58	0.04	0.56	0.98	1.75
C4	0.05	0.52	-0.46	-0.08	-0.12	0.15	0.22	0.75	0.07	-0.74	0.08	0.63	0.10	0.66	1.11	1.92
C5	0.92	1.09	0.89	1.03	1.19	1.31	0.92	1.10	0.92	-0.17	0.92	1.15	0.92	1.15	0.91	1.11
C6	1.43	1.93	0.72	1.07	-0.72	-0.46	1.43	1.95	1.43	-0.59	1.41	1.43	1.41	1.38	1.21	1.72

(2) Scenario S2 – 0 Decew Falls I/S, 8 Beck 1 I/S, 1 Allanburg Cap I/S

	Decew Falls 115kV		Beck 1 115 kV		Allanburg 115 kV		Vansickle 115 kV		Vansickle 13.8 kV		Carlton R1 13.8 kV		Carlton EQ 13.8 kV		Glendale 13.8 kV	
	pre	Post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
C1	0.07	0.39	0.15	0.30	0.07	0.22	0.41	0.78	4.34	-0.18	3.39	4.16	3.60	4.38	0.50	0.84
C2	0.04	0.39	0.17	0.35	0.07	0.24	0.38	0.79	4.30	-0.18	2.28	1.79	2.17	1.68	0.50	0.87
C3	0.50	0.94	-0.57	-0.29	-0.01	0.23	0.63	1.13	0.57	-0.22	0.62	1.17	0.62	1.16	1.26	2.02
C4	0.52	0.98	-0.51	-0.23	0.01	0.25	0.67	1.19	0.59	-0.18	0.63	1.20	0.64	1.21	1.37	2.15
C5	0.70	0.81	0.58	0.64	0.99	1.05	0.69	0.80	0.70	0.87	0.69	0.84	0.69	0.84	0.65	0.77
C6	-0.31	-0.07	-1.05	-0.93	-3.33	-3.23	-0.32	-0.07	0.95	-0.09	0.19	0.49	0.24	0.54	-0.57	-0.34

Note:
* Pre-ULTC and post-ULTC voltages were 127.9 kV and 127.8 kV respectively. Values exceeded the maximum of 127 kV.

Summary:

- Under scenario S1 (high Decew Falls output, low Beck 1 output), voltage declines and maximum and minimum voltages are within IESO criteria for the given study period.

- Under scenario S2 (no Decew Falls output, high Beck 1 output), voltage declines are within IESO criteria. Maximum and minimum voltages are within IESO criteria for the given study period with the exception of the Allanburg 115 kV bus. Pre-ULTC and post-ULTC voltages at Allanburg TS 115 kV slightly exceed the maximum 115 kV bus voltage of 127 kV for the loss of Q26M+Q28A with the Allanburg 230/115 kV autotransformer overload protection scheme initiated. Switching SC11 out of service, will return Allanburg voltages within required limits.

6.4 Power Factor Analysis

Figure 3 shows the power factor plotted against time at the LV side of the transformer for 2007. From this plot it can be concluded that the power factor at the defined meter point is often below 0.9.

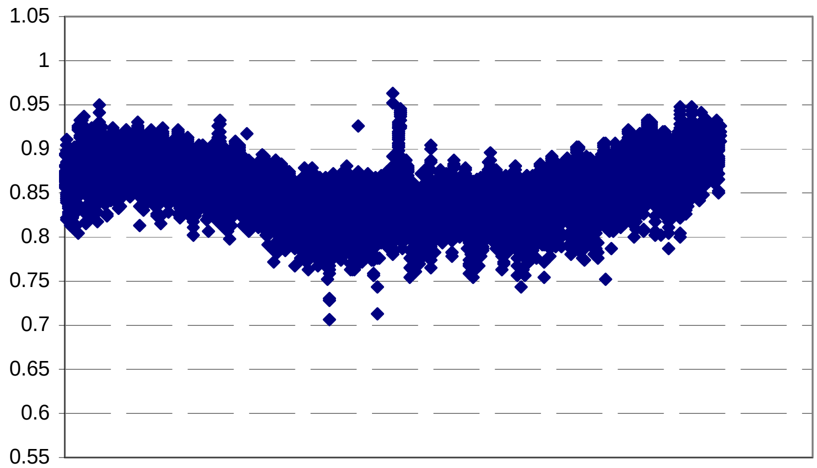

Figure 3: Vansickle TS Power Factor for 2007

Hydro One has indicated the historical power factor that occurred during peak loads at Vansickle TS is 0.87 while IESO records indicate that the power factor can be lower during on peak hours. **Figure 4** shows the hourly power factor for the first day of each month from May to August 2007. During the period from hour 6:00 to hour 22, the power factor can be as low as 0.79. Records also indicate that instances of the power factor being less than 0.79 usually occur between the hours of 0:00 to 5:00.

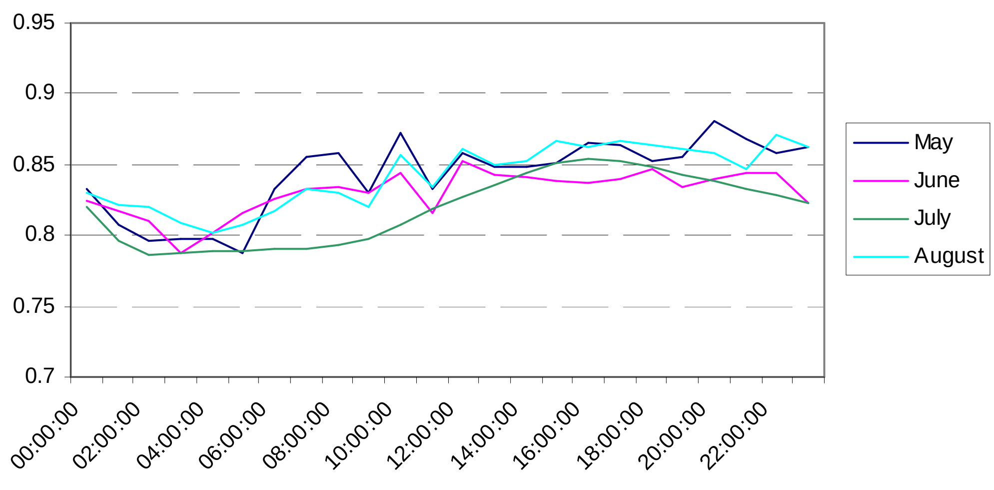

Figure 4: Sample Hourly Power Factor

The following table shows the reactive compensation required for a 0.9 HV power factor based on load flow studies for both 0.87 and 0.79 load power factors.

Load Power Factor =0.87			
Vansickle TS	2010	2014	When Design Capacity Reached *
P_{load} (MW)	51.4	65.2	89
Q_{load} with 0.87 P.F. (MVAr)	29.2	37	49.8
Q_{load}+ $Q_{transformer\_loss}$ (MVAr)	32.7	42.5	60.1
P.F. at HV side	0.84	0.84	0.83
Compensation needed for 0.9 P.F. (MVAr)	7.8	11.0	17.0
Load Power Factor =0.79			
Vansickle TS	2010	2014	When Design Capacity Reached *
P_{load} (MW)	46.7	59.3	80.6
Q_{load} with 0.79 P.F. (MVAr)	36.2	46.0	62.5
Q_{load}+ $Q_{transformer\_loss}$ (MVAr)	39.7	51.6	72.9
P.F. at HV side	0.76	0.75	0.74
Compensation needed for 0.9 P.F. (MVAr)	17.0	22.9	33.9

Note:* Design Capacity is assumed to equal to the proposed 10 day LTR of 102 MVA.

Therefore, it is recommended by the IESO that devices about 15 MVAr be required to compensate for power factor when the existing transformers are upgraded and up to an additional 20 MVAr be required in the future to accommodate the reactive requirements required to meet the station design capacity.

Hydro One and area LDC shall work together and have a plan ready for implementation within the next three years to ensure compliance with the Market Rules.