REPORT

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System Impact Assessment Report (Addendum)

Northern Ontario Shunt Capacitors

CONNECTION ASSESSMENT & APPROVAL PROCESS

CAA ID 2008-352

Final Report

Applicant: Hydro One Networks Inc.

Market Facilitation Department

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System Impact Assessment Report

Northern Ontario Shunt Capacitors

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 System Impact 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 OPG) 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 System Impact 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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NORTHERN ONTARIO SHUNT CAPACITORS
IESO SYSTEM IMPACT ASSESSMENT (ADDENDUM)

Description

This addendum updates the System Impact Assessment (CAA ID 2008-352) originally issued in May 1, 2009 for the connection of capacitors at 8 locations in northern Ontario. These locations include: Dryden TS, Mississagi TS, Kapuskasing TS, Essa TS, Algoma TS, Pinard TS, Hanmer TS and Porcupine TS. The following table summarizes the respective sizes of these new capacitors:

	Station	Size	Designation(s)
1	Dryden TS	2 x 50 Mvar@ 250 kV	SC11, SC12
2	Mississagi TS	2 x 75 Mvar @ 220 kV	SC11, SC12
3	Kapuskasing TS	1 x 21.6 Mvar @ 28.8 kV	SC1
4	Essa TS	1 x 245 Mvar @ 250 kV	SC22
5	Algoma TS	1 x 90 Mvar @ 250 kV	SC22
6	Pinard TS	2x32.4 Mvar @ 27.6 kV	SC1, SC2
7	Hanmer TS	1 x 149 Mvar@ 220 kV	SC22
8	Porcupine TS	2 x 100 Mvar @ 250 kV	SC21, SC22

Please refer to the original System Impact Assessment report for the assessment details. This addendum addresses two changes to the proposed design of this project since the release of the original SIA:

(1) Repositioning of Hanmer SC22 Capacitor

In the original assessment, Hydro One proposed to install a 149 Mvar @ 220 kV capacitor at Hanmer TS, SC22 to be connected between breaker T6L23 and T6L23 as shown in **Figure 1**. The in service of this capacitor was originally planned for December, 2010.

Due to construction limitations, Hydro One has revised its planning specifications and is proposing to install the capacitor on the H bus as shown in **Figure 2**. The in service of this capacitor has now been rescheduled for December, 2011.

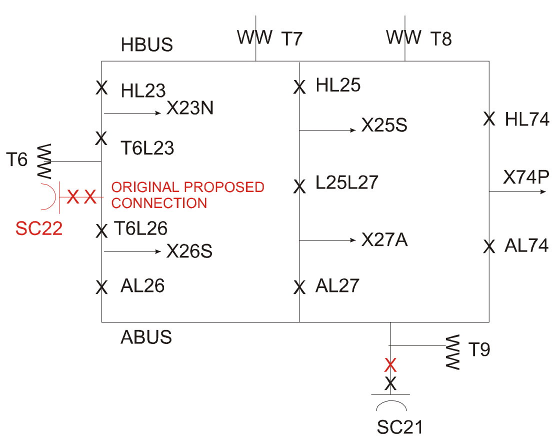

Figure 1: Original Hanmer SC22 connection

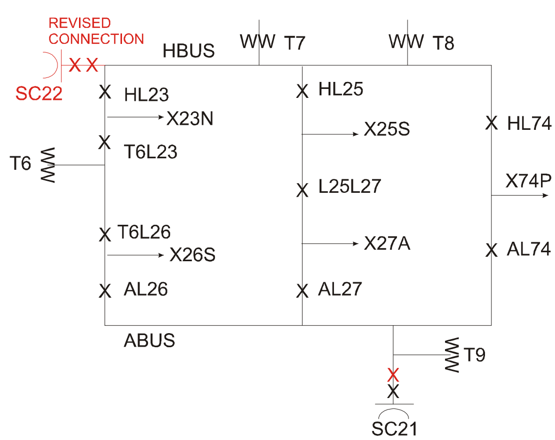

Figure 2: Revised Hanmer SC22 connection

(2) Reactive Switching Schemes at Hanmer (Redesign), Porcupine (New) and Pinard (New)

Previous System Impact Assessment studies have shown that under High Flow South scenarios on the Flow North-Flow South interface, a combination of the capacitors at Hanmer, Porcupine and Pinard will need to be tripped post-contingency in situations in which generation rejection is initiated.

The original Northern Shunt Capacitors System Impact Assessment had recommended that these new capacitors be incorporated as part of the Moose River Basin Generation Rejection Scheme and the North East 115 kV Load and Generation Rejection Scheme.

Hydro One has since decided not to incorporate the switching of the Hanmer and Porcupine capacitors as part of the Moose River Basin Generation Rejection Scheme and North East 115 kV Load and Generation Rejection Scheme. As an alternate solution, Hydro One has proposed the implementation of a new reactive switching scheme at Porcupine TS and a re-design of the existing Hanmer reactive switching scheme. These reactive switching schemes would be considered as Special Protection Systems (SPS).

As for the Pinard capacitors, at the time of this report, Hydro One is considering to implement either a (i) status based switching scheme as part of the Moose River Basin Generation Rejection Scheme, (ii) a status based switching scheme separate from the Moose River Basin Generation Rejection Scheme or (iii) a switching scheme that will switch reactors and capacitors in/out when the local voltage at Pinard exceeds certain thresholds.

At this point, Hydro One has only provided design details of (ii) for IESO review. As such, this assessment assumes a status-based solution that is separate from the Moose River Basin Generation Rejection Scheme.

Should Hydro One decide to proceed with alternative (i) or (iii) instead, Hydro One will need to provide additional information regarding these designs to the IESO.

The re-design of Hanmer reactive switching scheme and the incorporation of the new reactive switching scheme at Porcupine are expected for December 2011 to coincide with the in service of the new capacitors at the stations.

The incorporation of the new reactive switching scheme at Pinard is expected for July 2013 to coincide with the in service of the new capacitors at the station.

This System Impact Assessment examined the impact of the above two changes. The analysis is divided into two parts to evaluate each of these changes separately.

Findings

The analysis concluded that:

(1) The proposed revised Hanmer SC22 capacitor connection will not have a material adverse effect on the IESO-controlled grid.

(2) The proposed new reactive switching schemes at Pinard and Porcupine and redesign of the reactive switching scheme at Hanmer will help mitigate the magnitude of post-contingency voltage changes.

It should be noted, however, that the loss of H22D and loss of L20D are only recognized by the Pinard switching scheme. Under high Flow South conditions for the loss of H22D or loss of L20D, voltages at Porcupine 500 kV, Porcupine 230 kV and Hanmer 500 kV buses still exceed the maximum allowable post-contingency voltages post-Pinard capacitor tripping.

Hydro One has indicated to the IESO that these overvoltages are marginal and are willing to accept the risk to their equipment. As an alternative to including the loss of L20D and H22D into the Porcupine reactive switching scheme, Hydro One expects that these overvoltages will be mitigated through manual control actions.

(3) Hydro One has removed automatic closing of reactors and tripping of capacitors upon the energization of P502X from the existing Hanmer reactive switching scheme. The removal of this action is acceptable to the IESO as P502X is reclosed manually and not automatically. Automatic reclosure on P502X is permanently disabled for better post-contingency control action management. As such, the switching of reactive elements during manual reclosure on P502X can also be achieved manually.

(4) Under flow south conditions, the loss of D501P with no automatic switching of Hanmer and Porcupine capacitors may result in voltages at Porcupine 500 kV and 230 kV buses to be as high as 582.3 kV and 264.3 kV, which are above 105% of the maximum bus voltages. Voltages at Hanmer 500 kV and 230 kV buses may be as high as 567.3 kV and 255 kV.

(5) Based on preliminary study results performed under all elements in service, it is anticipated that the Hanmer reactive switching scheme retains its Type III Special Protection System classification.

(6) Based on preliminary study results performed under all elements in service, it is anticipated that the Pinard and Porcupine reactive switching schemes are given a Type III Special Protection System classification.

Recommendations

(1) If Hydro One decides to implement the contingency based reactive switching scheme at Pinard as outlined in this report, Hydro One is recommended to retain the existing under/over voltage switching scheme that currently exists for the Pinard reactors as back-up in case the contingency based switching scheme fails. Hydro One would need to submit proposed voltage and time response thresholds for IESO review.

IESO's Requirements for Connection

- An adjustable delay of 2 to 5 seconds must be implemented with the switching schemes at Pinard, Pocupine and Hanmer to allow the initial transient response to the contingency to pass before individual switching of reactors/capacitors is initiated. This delay is to ensure acceptable voltage response under the transient period, as per the CAA 2006-223(SVCs at Porcupine TS & Kirkland Lake TS 2nd Addendum)

- If Hydro One decides not to implement the contingency based reactive switching scheme at Pinard as the one outlined in this report and chooses to implement a voltage based reactive switching scheme or a contingency based reactive switching scheme that is part of the Moose River Basin Generation Rejection Scheme, Hydro One will need to submit details of this scheme to the IESO for review at least 8 months prior to its in-service date.

- Facility Description Documents containing the high level design, functional description and timing for each reactive switching scheme must be provided to the IESO during Market Entry process
- Hydro One is required to provide online monitoring of the status of the Special Protection System arming.
- Hydro One has indicated that it will design these schemes to Type III specifications consistent with the existing reactive switching schemes in the area. If NPCC classifies the scheme to be Type I, or if future, changes in system conditions results in any of these SPS to be classified as Type I, Hydro One will need to satisfy NPCC Type 1 SPS criteria with these switching schemes.
- The connection applicant must complete the IESO Facility Registration/Market Entry process in a timely manner before IESO final approval for connection is granted.
- 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.
- The switching schemes currently respect single contingencies only. Should double contingencies be also respected in the future, additional contingencies shall be added into the schemes to include the recognized double contingencies.
- All other requirements specified in the original Northern Shunt Capacitor System Impact Assessment remain valid.

Notification of Conditional Approval

From the information provided, our review concludes that the (i) revised Hanmer SC22 connection and (ii) the proposed redesign of the Hanmer reactive switching scheme and the new Pinard and Porcupine reactive switching schemes, subject to the requirements specified in this report 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 for Connection be issued for the modifications detailed in the System Impact Assessment addendum subject to the implementation of the requirements listed in this report.

Part 1: Repositioning of Hanmer SC22 Capacitor

1. Assessment

1.1 Scenarios and Assumptions

Two scenarios, S1 and S2, representing summer and winter peak load conditions, respectively, were studied. In both scenarios, a Flow South interface flow of about 2050 MW and Mississagi Flow East of 650 MW were assumed.

The following table summarizes the load flow conditions for **Scenarios S1 and S2**.

Scenarios and Assumptions		
	S1 – Summer Case	**S2 – Winter Case**
Interface flows and Demand		
Flow South	2048.3 MW	2065 MW
Mississagi Flow East	658.5 MW	650.1 MW
Northeast Demand	1224 MW	1600 MW
Reactors and Capacitors		
Algoma 230 kV	Capacitor O/S: SC21	Capacitor I/S: SC21
Hanmer 230 kV	Capacitors I/S: SC21, SC22 (new)	Capacitors I/S: SC21, SC22 (new)
Hanmer 500 kV	Reactors O/S: R6, R7, R9, R8; Reactors I/S: R1, R2	Reactors O/S: R6, R7, R9, R8; Reactors I/S: R1, R2
Pinard 27.6 kV	Capacitors I/S: SC1(new), SC2 (new) Reactors O/S: R1, R2	Capacitors I/S: SC1(new), SC2 (new) Reactors O/S: R1, R2
Porcupine 230 kV	Capacitors I/S: SC21(new), SC22 (new)	Capacitors I/S: SC21(new), SC22 (new)
Kapuskasing 24.9 kV	Capacitor I/S: SC1 (new)	Capacitor I/S: SC1 (new)
Essa 230 kV	Capacitor I/S: SC21, SC22(new)	Capacitor I/S: SC21, SC22(new)
• Based on the studied Mississagi Flow East flow of 650 MW, new capacitors at Mississagi 230 kV and Algoma 230 kV were assumed out of service and the SVC at Mississagi 230 kV was assumed not to be in service.		
Other Assumptions		
• Series Capacitors at Nobel in service • Lower Mattagami Expansion in service • SVCs at Porcupine and Kirkland Lake in service		

1.2 Voltage Declines

A voltage decline analysis was performed to ensure that the revised configuration does not result in unacceptable voltage declines for contingencies involving the loss of the Hanmer capacitor, including breaker failure conditions.

1.21 Scenario S1: Summer Case

As shown in the table below, all voltage declines are within IESO criteria.

Scenario S1: Voltage Declines (%)									
Bus Name	Pre-Cont Voltage (kV)	Loss of Hanmer T7+T8+SC22		Loss of Hanmer T7+T8+X23N+SC22		Loss of Hanmer T7+T8+X25S +SC22		Loss of Hanmer T7+T8+X74P +SC22	
		Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc
Hanmer TS 500 kV	541.4	1.68	1.74	1.70	1.70	1.70	1.77	2.51	3.13
Algoma TS 230 kV	241.3	1.43	1.62	1.47	1.46	1.48	1.68	4.63	7.51
Hanmer TS 230 kV	244.5	2.70	2.80	2.72	2.70	2.73	2.83	4.13	5.13
Martindale 230 kV	243.8	2.61	2.70	2.66	2.65	2.86	2.96	4.11	5.14
Mississagi 230 kV	245.0	0.98	1.18	1.00	0.99	1.02	1.23	2.30	5.23

1.22 Scenario S2: Winter Case

As shown in the table below, all voltage declines are within IESO criteria.

Scenario S2: Voltage Declines (%)									
Bus Name	Pre-Cont Voltage (kV)	Loss of Hanmer T7+T8+SC22		Loss of Hanmer T7+T8+X23N+SC22		Loss of Hanmer T7+T8+X25S +SC22		Loss of Hanmer T7+T8+X74P +SC22	
		Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc
Hanmer TS 500 kV	527.4	1.84	1.91	1.86	1.86	1.81	1.90	2.80	3.44
Algoma TS 230 kV	243.4	1.58	1.78	1.63	1.63	1.66	1.88	4.97	7.63
Hanmer TS 230 kV	241.1	2.75	2.86	2.76	2.77	2.71	2.84	4.36	5.36
Martindale 230 kV	239.8	2.68	2.79	2.73	2.74	3.12	3.25	4.36	5.40
Mississagi 230 kV	243.8	1.16	1.37	1.18	1.18	1.21	1.43	2.83	5.49

2. Conclusions

The proposed modifications to the connection arrangement will not have a material adverse effect on the IESO-controlled grid.

Part 2: Reactive Switching Schemes at Hanmer, Pinard, Porcupine

3. Switching Matrix

(1) Porcupine Reactive Switching Scheme

The following table shows the switching matrix for the scheme proposed at Porcupine:

Switching Matrix for Porcupine Reactive Switching Scheme		
Initiating Action	Location of Detection	Trip Cap SC21, SC22
Trip E511V	At Essa; Trip signal sent to Porcupine	X
Trip E510V	At Essa; Trip signal sent to Porcupine	X
Trip X504E	At Hanmer; Trip signal sent to Porcupine	X
Trip X503E	At Hanmer; Trip signal sent to Porcupine	X
Trip D501P	At Porcupine	X
Trip P502X	At Porcupine	X

The tripping of Porcupine capacitors for the loss of D501P and P502X are expected actions for all elements in service scenario under Flow South conditions. All other trip selections are expected to cater to outage scenarios.

(2) Pinard Reactive Switching Scheme

In addition to the new capacitors being incorporated at Pinard, there currently exists 2x50 Mvar reactors connected to the 27.6 kV tertiary winding of the Pinard transformers. A contingency based switching scheme that incorporates both the existing reactors and new Pinard capacitors has been proposed. The following is the tripping matrix for the Special Protection System proposed at Pinard TS.

Switching Matrix for Pinard Reactive Switching Scheme			
Initiating Action	Location of Detection	Close R1, R2	Trip SC1, Trip SC2
Trip H22D	At Pinard	X	X
Trip L20D	At Pinard	X	X
Trip R21D	At Pinard	X	X
Trip E511V	At Essa; Trip signal sent	X	X
Trip E510V	At Essa; Trip signal sent	X	X
Trip X503E	At Hanmer; Trip signal sent	X	X
Trip X504E	At Hanmer; Trip signal sent	X	X
Trip P502X	At Porcupine; Trip signal sent	X	X

Note, at the time of this report, Hydro One has not finalized its plans regarding the Pinard reactive switching scheme and is still considering several other alternatives. One alternative is a contingency based switching scheme, similar to the one describe above, but part of the Moose River Basin Generation Rejection Scheme, while another alternative is a switching scheme that will switch reactors and capacitors in/out when the local voltage at Pinard exceeds certain thresholds. At this point, Hydro One has not provided design details of these alternative solutions for IESO review, and would be required to do so should Hydro One decide to use either of these options instead. As such, this assessment is limited to the status-based solution that is independent of the Moose River Basin Generation Rejection Scheme.

Currently there exists functionality at Pinard to switch Pinard reactors based on local voltages exceeding certain threshold values. In the event that the contingency based switching scheme solution is chosen, it is recommended that this functionality be retained to act as a back-up to trip/close Pinard reactors should the contingency based solution fails to operate. Settings of the existing switching scheme would need to be reviewed by the IESO.

The tripping of capacitors/ closing of reactors are expected actions for the loss of H22D and L20D for all elements under Flow South conditions on the Flow-North Flow South interface. All other switching actions are expected to cater to outage scenarios.

(3) Hanmer Reactive Switching Scheme

There currently exists a reactor/capacitor switching scheme at Hanmer TS which is used to minimize the possibility of sustained voltage variations in the Hanmer area. It is currently classified as Type III SPS. With the new SC22 capacitor installation, Hydro One is proposing to update this scheme to match the existing SC21 capacitor selections and introduce new contingencies that it will recognize. Furthermore, Hydro One has also taken the opportunity to expand this scheme such that a wider range of recognized contingencies are available for existing reactive devices and remove unnecessary actions. Hydro One has removed from the existing scheme the automatic closing of reactors and tripping of capacitors upon the energization of P502X. The removal of this action is acceptable to the IESO as P502X is reclosed manually and not automatically. Automatic reclosure is on P502X is permanently disabled for better post-contingency control action management. As such, the switching of reactive elements during manual reclosure on P502X can also be achieved manually.

The following is the tripping matrix for the Special Protection System proposed at Hanmer TS. Highlighted elements represent options available under the existing scheme.

Proposed Hanmer Reactive Switching Matrix									
Initiating Action	Location of Detection	Trip R6, R9[1]	Close R6, R9[1]	Trip SC21[2]	Trip SC22	Close SC21[2]	Close SC22	Trip R1[3]	Close R1[3]
Trip X503E	At Hanmer	X	X	X	X	X	X	X	X
Energize X503E	At Hanmer	N/A	X	X	X	N/A	N/A	N/A	X
Trip X504E	At Hanmer	X	X	X	X	X	X	X	X
Energize X504E	At Hanmer	N/A	X	X	X	N/A	N/A	N/A	X
Trip P502X	At Hanmer	X	X	X	X	X	X	N/A	N/A
~~Energize P502X~~	~~At Hanmer~~	~~N/A~~	~~X~~	~~X~~	~~X~~	~~N/A~~	~~N/A~~	~~N/A~~	~~X~~
Trip D501P	At Porcupine, trip signal sent	X	X	X	X	X	X	X	X
Trip E510V	At Essa, trip signal sent	X	X	X	X	X	X	X	X
Trip E511V	At Essa, trip signal sent	X	X	X	X	X	X	X	X

Notes: (1) Hanmer R6, R9 are existing150 Mvar reactors connected to the Hanmer T9 and T6 tertiary windings
(2) Hanmer SC21 represents existing 192 Mvar capacitor connected to the Hanmer 230 kV bus
(3) Hanmer R1 represents existing 120 Mvar reactor connected to the 500 kV line P502X.

The tripping of capacitors /closing of reactors at Hanmer are expected actions for the loss of D501P and P502X under high Flow South conditions and P502X under high Flow North conditions with all elements in service pre-contingency. All other switching actions are expected to cater to outage scenarios.

4. Assessment

4.1 Scenarios and Assumptions

The analysis of the operation of the reactive switching schemes was observed under high Flow South and high Flow North conditions on the Flow North-Flow South interface. The following table lists the conditions assumptions for both scenarios:

(1) Flow South Conditions

The following table summarizes the various flows, Northeast demand values and reactive elements in service:

Flow into Hanmer on P502X	Flow into Porcupine on D501P
1303 MW	1208.6 MW

Flow South (MW)	Mississagi Flow East (MW)	P502X+A8K+A9K Flow South (MW)	Northeast Demand (MW)	Reactive Elements in Service			
				Hanmer[1,2]	Porcupine	Pinard	Essa
2059	598.6	1334	1200	SC21, SC22, R1, R2	SC21, SC22	SC1, SC2	SC21, SC22

Notes:

(1) Hanmer Reactor R2 does not have under-load switching capability and therefore was assumed to be in service pre-contingency.

(2) Hanmer Reactor R1 can be switched under-load, but the preference is not to do so frequently, therefore was assumed to be in service pre-contingency.

(2) Flow North Conditions

The following table summarizes the various flows, Northeast demand values and reactive elements in service:

Flow North (MW)	Mississagi Flow West (MW)	P502X+A8K+A9K Flow North (MW)	Northeast Demand (MW)	Reactive Elements in Service			
				Hanmer[1,2]	Porcupine	Pinard	Essa
1897.1	620.6	568.3	1740.39	SC21,SC22, R1, R2	None	R1,R2	SC21

Notes:

(1) Hanmer Reactor R2 does not have under-load switching capability and therefore was assumed to be in service pre-contingency.

(2) Hanmer Reactor R1 can be switched under-load, but the preference is not to do so frequently, therefore was assumed to be in service pre-contingency.

(3) Other Assumptions:

- Porcupine SVC in service (+300/-100 Mvar reactive capability)
- Kirkland Lake SVC in service (+30/-14 Mvar continuous reactive capability)
- Nobel Series Capacitors I/S
- For Flow South case Lower Mattagami expansion I/S (CAA 2006-239)
- For Flow North case Detour Gold I/S connected to Pinard 230 kV connection (CAA 2009-359)
- Loads were represented by constant MVA loads.
- Allowable pre-contingency bus voltage range as per the Ontario Resource and Transmission Assessment for northern Ontario:

Allowable Pre-Contingency Bus Voltage Range (Northern Ontario)			
Nominal Bus Voltage	500 kV	230 kV	115 kV
Maximum	550 kV	250 kV	132 kV
Minimum	490 kV	220 kV	113 kV

- Allowable post-contingency bus voltage range as per the Ontario Resource and Transmission Assessment Criteria for northern Ontario:

Allowable Post-Contingency Bus Voltage Range (Northern Ontario)			
Nominal Bus Voltage	500 kV	230 kV	115 kV
Maximum	550 kV	250 kV	132 kV
Minimum	470 kV	207 kV	108 kV

4.2 Voltage Declines

4.21 Flow South Conditions

(1) Loss of L20D

The following table shows the pre and post contingency bus voltages and declines (i) without any use of automatic reactive switching, (ii) with Pinard capacitor tripping, and (iii) with Pinard and Porcupine capacitor tripping. Highlighted values indicate voltages that are above maximum voltages values as per the Ontario Resource and Transmission Assessment Criteria. Based on Hydro One's proposal, the automatic reactive switching for the loss of L20D is only addressed by the Pinard switching scheme. As shown in the table below, tripping Pinard capacitors will not be sufficient in eliminating all instances of over voltages – the voltages at Hanmer 500 kV, Porcupine 500 kV and 230 kV buses marginally exceed IESO criteria. Further simulations indicated that tripping a Porcupine capacitor could help ensure that all voltages are within allowable post-contingency voltage ranges.

Loss of L20D														
Bus	Pre-cont. (kV)	No Automatic Switching				Trip Pinard Capacitors SC1, SC2				Trip Pinard Capacitors SC1, SC2 and Porcupine SC21				
		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc		
		kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	
HANMER_TS 500	529.7	551	-4.0	553.2	-4.4	549	-3.6	551.2	-4.1	544.9	-2.9	546.9	-3.2	
PINARD_TS 500	514.2	549.8	-6.9	551.5	-7.2	543	-5.6	544.5	-5.9	536.2	-4.3	537.1	-4.5	
PORCUPINE_TS500	517.3	555.3	-7.4	557.7	-7.8	550.4	-6.4	552.7	-6.9	540	-4.4	541.4	-4.7	
ALGOMA_TS 230	237.1	237.7	-0.2	240.9	-1.6	237.1	0.0	240.4	-1.4	235.9	0.5	239.3	-0.9	
ANSONVILLE 230	241.4	251.5	-4.2	245.7	-1.8	249.7	-3.4	245.4	-1.6	242.1	-0.3	241.9	-0.2	
HANMER_TS 230	239.4	247.5	-3.4	248.9	-4.0	246.7	-3.1	248.1	-3.7	244.9	-2.3	246.2	-2.9	
MARTINDALE 230	238.7	246.5	-3.3	247.9	-3.9	245.7	-3.0	247.1	-3.5	244	-2.2	245.3	-2.8	
PINARD_TS 230	232.9	246	-5.6	246.6	-5.9	242.5	-4.1	242.9	-4.3	240.2	-3.1	240.5	-3.3	
PORCUPINE_TS230	242.9	254.3	-4.7	247.3	-1.8	252.1	-3.8	247	-1.7	242.9	0.0	242.9	0.0	
HUNTA_SS 115	125.7	130.5	-3.8	129.2	-2.8	130	-3.4	128.8	-2.5	128.5	-2.3	127.8	-1.7	
PORCUPINE_TS115	123.5	132.2	-7.0	129.9	-5.2	131.1	-6.2	128.8	-4.4	128.7	-4.2	126.5	-2.4	
ESSA_TS 500	525.7	537.2	-2.2	538.1	-2.4	536.3	-2.0	537.2	-2.2	534.4	-1.7	535.2	-1.8	
ESSA_TS 230	245.2	249.8	-1.9	250	-2.0	249.4	-1.7	249.7	-1.8	248.6	-1.4	248.9	-1.5	
CLAIREVILLE 500	522.3	526.9	-0.9	527.2	-1.0	526.5	-0.8	526.9	-0.9	525.7	-0.7	526	-0.7	

Hydro One has indicated to the IESO that these overvoltages are marginal and are willing to accept the risk to their equipment. As an alternative to including the loss of L20D into the Porcupine reactive switching scheme, Hydro One expects that these overvoltages will be mitigated through manual control actions.

(2) Loss of H22D

The following table shows the pre and post contingency bus voltages and declines (i) without any use of automatic reactive switching, (ii) with Pinard capacitor tripping, and (iii) with Pinard and Porcupine capacitor tripping. Highlighted values indicate voltages that are above maximum voltages values as per the Ontario Resource and Transmission Assessment Criteria. Based on Hydro One's proposal, the automatic reactive switching for the loss of H22D is only addressed by the Pinard switching scheme. As shown in the table below, tripping Pinard capacitors will not be sufficient in eliminating all instances of over voltages – the voltages at Hanmer 500 kV, Porcupine 500 kV and 230 kV buses marginally exceed IESO criteria. Further simulations indicated that tripping a Porcupine capacitor could help ensure that all voltages are within allowable post-contingency voltage ranges.

Loss of H22D														
Bus	Pre-cont. (kV)	No Automatic Switching				Trip Pinard Capacitors SC1, SC2				Trip Pinard Capacitors SC1, SC2 and Porcupine SC21				
		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc		
		kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	
HANMER_TS 500	529.7	551.7	-4.2	553.9	-4.6	549.6	-3.8	551.8	-4.2	545.2	-2.9	547.2	-3.3	
PINARD_TS 500	514.2	553	-7.5	554.7	-7.9	545.6	-6.1	547.2	-6.4	538.6	-4.7	539.5	-4.9	
PORCUPINE_TS500	517.3	557.2	-7.7	559.7	-8.2	551.9	-6.7	554.3	-7.2	540.9	-4.6	542.4	-4.9	
ALGOMA_TS 230	237.1	237.9	-0.3	241.1	-1.7	237.3	-0.1	240.6	-1.4	236	0.5	239.4	-0.9	
ANSONVILLE 230	241.4	252	-4.4	245.5	-1.7	249.9	-3.5	245.7	-1.8	241.9	-0.2	241.7	-0.1	
HANMER_TS 230	239.4	247.8	-3.6	249.2	-4.1	246.9	-3.2	248.3	-3.8	245.1	-2.4	246.4	-2.9	
MARTINDALE 230	238.7	246.9	-3.4	248.2	-4.0	246	-3.1	247.4	-3.7	244.1	-2.3	245.5	-2.8	
PINARD_TS 230	232.9	247.6	-6.3	248.3	-6.6	243.9	-4.7	244.4	-4.9	241.6	-3.7	241.9	-3.8	
PORCUPINE_TS230	242.9	255.1	-5.0	247.1	-1.7	252.7	-4.0	247.6	-2.0	242.9	0.0	242.9	0.0	
HUNTA_SS 115	125.7	130.1	-3.5	128.8	-2.5	129.5	-3.0	128.5	-2.2	128	-1.8	127.3	-1.2	
PORCUPINE_TS115	123.5	132.5	-7.3	130.2	-5.4	131.3	-6.3	129.1	-4.5	128.8	-4.3	126.5	-2.5	
ESSA_TS 500	525.7	537.5	-2.3	538.4	-2.4	536.5	-2.1	537.5	-2.2	534.5	-1.7	535.4	-1.8	
ESSA_TS 230	245.2	249.9	-1.9	250.2	-2.0	249.5	-1.8	249.8	-1.9	248.7	-1.4	248.9	-1.5	
CLAIREVILLE 500	522.3	527.1	-0.9	527.3	-1.0	526.7	-0.8	527	-0.9	525.8	-0.7	526.1	-0.7	

Hydro One has indicated to the IESO that these overvoltages are marginal and are willing to accept the risk to their equipment. As an alternative to including the loss of H22D into the Porcupine reactive switching scheme, Hydro One expects that these overvoltages will be mitigated through manual control actions.

(3) Loss of D501P

The following table shows the pre and post contingency bus voltages and declines (i) without any use of automatic reactive switching, and (ii) with Hanmer and Porcupine capacitor tripping. Highlighted values indicate post-contingency voltages that are above maximum voltages values as per the Ontario Resource and Transmission Assessment Criteria.

Loss of D501P[1]									
Bus	Pre-cont. (kV)	No Automatic Switching				Trip Hanmer SC21, Porcupine SC21, SC22			
		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc	
		kV	%	kV	%	kV	%	kV	%
HANMER_TS 500	529.7	562.6	-6.2	567.3	-7.1	541.9	-2.3	546.7	-3.2
PINARD_TS 500	514.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PORCUPINE_TS500	517.3	577.7	-11.7	582.3	-12.6	544	-5.2	547.1	-5.8
ALGOMA_TS 230	237.1	236.1	0.5	244.6	-3.1	227.8	4.0	237.3	-0.1
ANSONVILLE 230	241.4	260	-7.7	249.9	-3.5	242	-0.2	241.8	-0.2
HANMER_TS 230	239.4	251.7	-5.2	254.9	-6.5	240.2	-0.4	243.6	-1.8
MARTINDALE 230	238.7	250.6	-5.0	253.7	-6.3	239.4	-0.3	242.8	-1.7
PINARD_TS 230	232.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PORCUPINE_TS230	242.9	264.3	-8.8	251.9	-3.7	242.9	0.0	242.9	0.0
HUNTA_SS 115	125.7	134	-6.6	132	-5.0	129.3	-2.9	128.7	-2.4
PORCUPINE_TS115	123.5	137.4	-11.3	135.2	-9.5	129.7	-5.1	127.8	-3.5
ESSA_TS 500	525.7	543.9	-3.5	545.6	-3.8	534.5	-1.7	536.6	-2.1
ESSA_TS 230	245.2	252	-2.8	252.5	-3.0	248.1	-1.2	248.9	-1.5
CLAIREVILLE 500	522.3	528.7	-1.2	529.1	-1.3	524.5	-0.4	525.3	-0.6

Notes:

(1) Cross tripping of L21S and K38S required as G/R or L/R not adequate to respect post contingency flow requirement on Spruce Falls T7 of 50 MW north and 75 MW south. Post-contingency flow on H9K@ Hunta = -42 MW.

As shown, the loss of D501P with no automatic switching of Hanmer and Porcupine capacitors will result in the voltages at Porcupine 500 kV and 230 kV to be as high as 582.3 kV and 264.3 kV, which are above 105% of the maximum bus voltages.

(4) Loss of P502X

The following table shows the pre and post contingency bus voltages and declines (i) without any use of automatic reactive switching, and (ii) with Hanmer and Porcupine capacitor tripping. Highlighted values indicate voltages that are above maximum voltages values as per the Ontario Resource and Transmission Assessment Criteria.

Loss of P502X[1]									
Bus	Pre-cont. (kV)	No Automatic Switching				Trip Hanmer SC21, SC22, Porcupine SC21			
		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc	
		kV	%	kV	%	kV	%	kV	%
HANMER_TS 500	529.7	549	-3.64	555.1	-4.79	524.5	0.99	531.2	-0.27
PINARD_TS 500	514.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PORCUPINE_TS500	517.3	560.2	-8.3	567.4	-9.69	529.7	-2.4	530.8	-2.63
ALGOMA_TS 230	237.1	230.8	2.68	240.9	-1.57	218.8	7.72	230	3.01
ANSONVILLE 230	241.4	255.5	-5.84	247	-2.3	243.3	-0.77	243	-0.67
HANMER_TS 230	239.4	245.1	-2.4	249	-4.03	229.7	4.05	233.8	2.3
MARTINDALE 230	238.7	243.9	-2.18	247.8	-3.83	228.8	4.12	233.1	2.34
PINARD_TS 230	232.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PORCUPINE_TS230	242.9	257.7	-6.08	246.9	-1.66	242.9	0	242.9	0
HUNTA_SS 115	125.7	132.4	-5.34	131	-4.22	128.7	-2.41	127.9	-1.77
PORCUPINE_TS115	123.5	134.4	-8.82	132.9	-7.67	127.6	-3.31	125.3	-1.47
ESSA_TS 500	525.7	537.8	-2.29	540.5	-2.81	526.6	-0.18	529.8	-0.77
ESSA_TS 230	245.2	249.3	-1.69	250.4	-2.13	244.7	0.19	246.1	-0.36
CLAIREVILLE 500	522.3	525.8	-0.68	526.9	-0.89	520.9	0.27	522.3	0

Note (1): Cross tripping of circuits D501P, L21S and K38S required. Total net G/R = 1320.7 MW. Post-contingency flow on A8K+A9K=36.8 MW

(5) Loss of X503E/X504E/E510V/E511V/R21D

The following table shows the pre and post contingency bus voltages and declines without any use of automatic reactive switching for the loss of X504E, X503E, E510V or E511V, and R21D. As shown, there are no voltage violations which would necessitate the use of automatic reactive switching schemes under all elements in service. However, it is expected that the automatic reactive switching schemes for these contingencies would be employed under other system conditions such as during outages.

Loss of X503E/X504E/E510V/E511V/R21D																	
Bus	Pre-cont. (kV)	Loss of X503E: No Automatic Switching				Loss of X504E: No Automatic Switching				Loss of E510V: No Automatic Switching				Loss of R21D: No Automatic Switching			
		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc		Pre-ultc		Post-ultc	
		kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
HANMER_TS 500	529.7	494.7	6.61	490.9	7.34	507.1	4.28	504.5	4.77	527	0.53	526.5	0.61	542.7	-2.44	544.9	-2.85
PINARD_TS 500	514.2	502.9	2.2	501.2	2.53	507	1.4	505.9	1.61	513.4	0.17	513.2	0.2	532.0	-3.44	534.0	-3.85
PORCUPINE_TS500	517.3	500.9	3.17	498.4	3.65	506.8	2.03	505.2	2.33	516	0.25	515.8	0.29	538.1	-4.03	540.9	-4.56
ALGOMA_TS 230	237.1	226.3	4.58	221.2	6.72	229.7	3.14	226.2	4.63	233.7	1.44	233	1.74	235.9	0.53	238.6	-0.63
ANSONVILLE 230	241.4	241.3	0.08	241.5	-0.01	241.4	0.03	241.5	-0.01	241.4	0	241.4	0	244.7	-1.33	245.3	-1.62
HANMER_TS 230	239.4	224.9	6.05	222.6	7.01	230	3.89	228.5	4.56	237.9	0.6	237.6	0.72	244.1	-1.98	245.4	-2.51
MARTINDALE 230	238.7	224.6	5.88	222.3	6.85	229.7	3.78	228	4.45	237.2	0.6	237	0.72	243.2	-1.90	244.5	-2.43
PINARD_TS 230	232.9	229.2	1.6	228.6	1.84	230.5	1.02	230.2	1.17	232.6	0.12	232.6	0.14	238.3	-2.32	239.1	-2.65
PORCUPINE_TS230	242.9	242.9	0	242.9	0	242.9	0	242.9	0	242.9	0	242.9	0	246.5	-1.48	247.6	-1.94
HUNTA_SS 115	125.7	124.5	0.93	125.2	0.4	125	0.58	125.3	0.33	125.6	0.07	125.6	0.08	127.9	-1.71	127.3	-1.30
PORCUPINE_TS115	123.5	120	2.8	122.1	1.08	121.3	1.78	122.3	0.97	123.2	0.22	123.2	0.25	128.1	-3.78	126.2	-2.21
ESSA_TS 500	525.7	504.6	4.02	504.5	4.04	508.5	3.27	508.7	3.24	523.1	0.49	522.9	0.53	533.0	-1.38	534.0	-1.57
ESSA_TS 230	245.2	236.1	3.73	236.4	3.58	237.7	3.04	238.1	2.88	244.2	0.39	244.2	0.42	248.1	-1.17	248.4	-1.32
CLAIREVILLE 500	522.3	512.7	1.83	513.3	1.71	514.5	1.48	515.2	1.35	519.7	0.48	519.7	0.49	525.2	-0.56	525.6	-0.64

4.22 Flow North Conditions

The following table shows the pre and post contingency voltages (and declines) without the use of reactive switching at Pinard, Porcupine, Hanmer under Flow North conditions. As shown, the use of reactive switching would be required for the loss of P502X under Flow North value of 1900 MW as buses at Hanmer, Essa and Martindale were found to exceed maximum acceptable 230 kV post-contingency voltages. For the other contingencies, it is expected that the automatic reactive switching schemes would be employed under other system conditions such as during outages.

Bus	Pre-Cont (kV)	L20D		H22D		R21D		D501P[1]		P502X[2]		X504E		X503E		E510V	
		Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc	Pre-ultc	Post-ultc
HANMER_TS 500	528.1	535.6 (-1.4%)	537.2 (-1.7%)	526.6 (0.3%)	526.3 (0.4%)	528.0 (0.0 %)	528.0 (0.0%)	531.7 (-0.7)	533.4 (-1.0%)	538.3 (-1.9%)	542.9 (-2.8%)	507.5 (3.9%)	502 (4.9%)	497 (5.9%)	490.7 (7.1%)	526 (0.4%)	524.4 (0.7%)
PINARD_TS 500	528.7	545.9 (-3.3%)	547.4 (-3.5%)	522.8 (1.1%)	522.6 (1.2%)	527.7 (0.2%)	527.7 (0.2%)	N/A	N/A	N/A	N/A	518.6 (1.9%)	515.7 (2.5%)	513.4 (2.9%)	510.1 (3.5%)	527.7 (0.2%)	526.9 (0.3%)
PORCUPINE_TS500	531.6	544.2 (-2.4%)	545.7 (-2.7%)	528.6 (0.6%)	528.3 (0.6%)	531.2 (0.1%)	531.2 (0.1%)	529.9 (0.3%)	530.8 (0.2%)	N/A	N/A	521.3 (1.9%)	518.2 (2.5%)	516 (2.9%)	512.3 (3.6%)	530.6 (0.2%)	529.8 (0.4%)
ALGOMA_TS 230	244.4	245.7 (-0.6%)	247.2 (-1.2%)	244.2 (0.1%)	243.9 (0.2%)	244.5 (-0.1%)	244.5 (-0.1%)	244.1 (0.1%)	246.3 (-0.8%)	243.8 (0.2%)	249 (-1.9%)	240.5 (1.6%)	236.3 (3.3%)	237.5 (2.8%)	232.6 (4.8%)	245 (-0.3%)	243.3 (0.4%)
ANSONVILLE 230	241.2	244.7 (-1.5%)	245.3 (-1.7%)	241 (0.1%)	241.1 (0.0%)	241.2 (0.0%)	241.2 (0.0%)	241.1 (0.0%)	241.1 (0.0%)	241.2 (0.0%)	241.2 (0.0%)	240.8 (0.2%)	241 (0.1%)	240.6 (0.3%)	241 (0.1%)	241.1 (0.0%)	241.1 (0.0%)
HANMER_TS 230	246.4	249.5 (-1.3%)	250.4 (-1.6%)	245.8 (0.3%)	245.6 (0.3%)	246.4 (0.0%)	246.4 (0.0%)	247.7 (-0.5%)	248.8 (-1.0%)	250.2 (-1.6%)	252.9 (-2.7%)	237.6 (3.6%)	234.6 (4.8%)	233 (5.4%)	229.5 (6.8%)	245.6 (0.3%)	244.7 (0.7%)
MARTINDALE 230	245.4	248.4 (-1.2%)	249.4 (-1.6%)	244.8 (0.2%)	244.6 (0.3%)	245.4 (0.0%)	245.4 (0.0%)	246.7 (-0.5%)	247.8 (-1.0%)	249.1 (-1.5%)	251.8 (-2.6%)	236.8 (3.5%)	233.9 (4.7%)	232.4 (5.3%)	228.9 (6.7%)	244.7 (0.3%)	243.8 (0.7%)
PINARD_TS 230	232.4	240.6 (-3.5%)	241.2 (-3.8%)	229.2 (1.4%)	229.1 (1.4%)	231.8 (0.2%)	231.8 (0.2%)	N/A	N/A	N/A	N/A	228 (1.9%)	226.8 (2.4%)	225.7 (2.9%)	224.4 (3.4%)	231.9 (0.2%)	231.6 (0.3%)
PORCUPINE_TS230	242	246.1 (-1.7%)	246.8 (-2.0%)	242 (0.0%)	242 (0.0%)	242.0 (0.0%)	242.0 (0.0%)	242 (0.0%)	242 (0.0%)	N/A	N/A	242 (0.0%)	242 (0.0%)	242 (0.0%)	242 (0.0%)	242 (0.0%)	242 (0.0%)
HUNTA_SS 115	125.1	126.3 (-1.0%)	126.5 (-1.2%)	124.6 (0.4%)	124.8 (0.2%)	125.0 (0.1%)	125.0 (0.1%)	124.6 (0.4%)	124.7 (0.3%)	N/A	N/A	123.9 (1.0%)	124.6 (0.4%)	123.3 (1.5%)	124.5 (0.5%)	125 (0.1%)	124.9 (0.2%)
PORCUPINE_TS115	125.5	128.2 (-2.1%)	128.6 (-2.4%)	124.8 (0.5%)	125.4 (0.1%)	125.4 (0.1%)	125.4 (0.1%)	125.1 (0.4%)	125.2 (0.2%)	N/A	N/A	123.2 (1.8%)	125.3 (0.2%)	122.1 (2.7%)	125.3 (0.1%)	125.3 (0.2%)	125.1 (0.3%)
ESSA_TS 500	529.9	534 (-0.8%)	534.8 (-0.9%)	529.1 (0.2%)	528.9 (0.2%)	529.8 (0.0%)	529.8 (0.0%)	532.7 (-0.5%)	533.6 (-0.7%)	537.1 (-1.4%)	539.1 (-1.7%)	516.6 (2.5%)	514.8 (2.9%)	513.6 (3.1%)	511.6 (3.5%)	526.4 (0.7%)	525.5 (0.8%)
ESSA_TS 230	246.3	248.1 (-0.7%)	248.5 (-0.9%)	245.9 (0.2%)	245.9 (0.2%)	246.3 (0.0%)	246.3 (0.0%)	247.7 (-0.6%)	248.1 (-0.7%)	249.9 (-1.4%)	250.7 (-1.8%)	240.7 (2.3%)	240 (2.6%)	239.4 (2.8%)	238.8 (3.1%)	243.9 (1.0%)	243.5 (1.1%)
CLAIREVILLE 500	524.7	526.6 (-0.4%)	527 (-0.5%)	524.3 (0.1%)	524.2 (0.1%)	524.6 (0.0%)	524.6 (0.0%)	526.3 (-0.3%)	526.7 (-0.4%)	528.9 (-0.8%)	529.6 (-0.9%)	519.4 (1.0%)	518.6 (1.2%)	518.2 (1.2%)	517.4 (1.4%)	521.1 (0.7%)	520.8 (0.7%)

Notes:
(1) Cross tripping of L21S and K38S required as G/R or L/R not adequate to respect post contingency flow requirement on Spruce Falls T7 of 50 MW north and 75 MW south.
(2) Cross tripping of circuits D501P, L21S, K38S and A8K+A9K required.

The following table shows the effect of tripping the Hanmer capacitor SC21 in conjunction with the loss of P502X. As shown, all voltages are within IESO criteria.

Loss of P502X – Trip Hanmer Capacitor SC21					
Bus	Pre –Cont (kV)	Pre-ULTC		Post-ULTC	
		kV	%	kV	%
HANMER_TS 500	528.1	525.6	0.48	530.0	-0.36
PINARD_TS 500	528.7	N/A	N/A	N/A	N/A
PORCUPINE_TS500	531.6	N/A	N/A	N/A	N/A
ALGOMA_TS 230	244.4	238.2	2.53	243.1	0.52
ANSONVILLE 230	241.2	241.2	0.00	241.2	0.00
HANMER_TS 230	246.4	242.0	1.77	244.6	0.73
MARTINDALE 230	245.4	241.1	1.77	243.7	0.71
PINARD_TS 230	232.4	N/A	N/A	N/A	N/A
PORCUPINE_TS230	242.0	N/A	N/A	N/A	N/A
HUNTA_SS 115	125.1	N/A	N/A	N/A	N/A
PORCUPINE_TS115	125.5	N/A	N/A	N/A	N/A
ESSA_TS 500	529.9	531.5	-0.30	533.6	-0.71
ESSA_TS 230	246.3	247.5	-0.49	248.5	-0.88
CLAIREVILLE 500	524.7	526.6	-0.36	527.5	-0.55

4.3 Special Protection System Classification

Studies were conducted under extreme Flow North and Flow South conditions to examine the failed operation and misoperation of any of the switching schemes at Pinard, Porcupine and Hanmer under all elements in service scenario. It was found that there was no adverse effect to the control areas outside of Ontario. Therefore, based on the results of this study, it is expected that Hanmer reactive switching scheme retains its Type III Special Protection System classification and Pinard and Porcupine reactive switching schemes be given Type III Special Protection System classifications.

5. Conclusions

The proposed new reactive switching schemes at Pinard, Porcupine and proposed redesign of the Hanmer reactive switching scheme will help mitigate post-contingency over-voltage problems.

Slight overvoltages were observed at Porcupine and Hanmer buses for the loss of L20D and H22D. Hydro One has indicated to the IESO that these overvoltages are marginal and are willing to accept the risk to their equipment. Hydro One expects that these overvoltages will be mitigated through manual control actions.