



ADDENDUM #2

System Impact Assessment Addendum #2 Greenfield & St. Clair Energy Centres Connection Assessment & Approval Process

Issue 3.0

***Greenfield Energy Centre CAA ID 2004-167
Applicant: Greenfield Energy Centre LP.***

***St. Clair Energy Centre CAA ID 2004-187
Applicant: St. Clair Power LP.***

Transmission Assessments & Performance
Department

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Greenfield & St. Clair Energy Centres

Acknowledgement

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

Disclaimers

IESO

This addendum 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 conditional approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules.

Conditional approval of the proposed connection is based on information provided to the IESO by the connection applicant and Hydro One 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 Hydro One at the request of the IESO. Furthermore, the conditional approval is subject to further consideration due to changes to this information, or to additional information that may become available after the conditional approval has been granted.

If the connection applicant has engaged a consultant to perform connection assessment studies, the connection applicant acknowledges that the IESO will be relying on such studies in conducting its assessment and that the IESO assumes no responsibility for the accuracy or completeness of such studies including, without limitation, any changes to IESO base case models made by the consultant. The IESO reserves the right to repeat any or all connection studies performed by the consultant if necessary to meet IESO requirements.

Conditional 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, the conditional 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 addendum has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. This addendum 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 addendum. Any liability which the IESO may have to the connection applicant in respect of this addendum is governed by Chapter 1, section 13 of the Market Rules. In the event that the IESO provides a draft of this addendum to the connection applicant, the connection applicant must be aware that the IESO may revise drafts of this addendum at any time in its sole discretion without notice to the connection applicant. 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 the most recent version of this addendum is being used.

Hydro One

The results reported in this addendum are based on the information available to Hydro One, at the time of the study, suitable for a preliminary assessment of this transmission system reinforcement 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 facilities on load and generation customers.

In this addendum, short circuit adequacy is assessed only for Hydro One breakers. 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 facilities. These results should not be used in the design and engineering of any new or existing facilities. The necessary data will be provided by Hydro One and discussed with any 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 facilities 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.

Summary

The connection of the Greenfield Energy Centre (Greenfield) and the St. Clair Energy Centre (St. Clair) in the vicinity of Lambton switching station (SS) and Sarnia-Scott transformer station (TS), subject to the requirements stated in the addendum dated May 2, 2006 and in the SIA report dated December 6, 2005, is expected to have no material adverse effect on the reliability of the IESO-controlled grid.

Greenfield is proposing a new 1,147 MW combined cycle generation facility in St. Clair Township. The plant, consisting of three natural gas-fired units of 210 MW each, and one steam turbine generator of 517 MW, is to be connected via a new 3.5 km 230 kV double circuit line to the Lambton SS.

St. Clair is proposing a new 638 MW combined cycle generation facility in St. Clair Township, consisting of two gas-fired units of 185 MW each and two steam turbine generators of 134 MW each. The facility is to connect via new 230 kV taps to circuits V41N and V43N at towers 16 and 17, respectively.

Subsequent to the issue of the SIA addendum, the IESO has discovered that an error was made in the fault level assessment for the Sarnia-Scott 230 kV bus. As a result, this additional addendum re-assesses the fault levels at the Sarnia-Scott 230 kV bus and their impact on 230 kV breakers AL21, AL3, HL23, L21L27, L6L23 and L7L22, and concludes that the Sarnia-Scott 230 kV breaker HL23 will also need to be replaced by Hydro One.

The replacement of breaker HL23 along with the other breaker replacements identified in the SIA addendum dated May 2, 2006 will result in the following network modifications for Hydro One's Sarnia-Scott switchyard:

- replace 230 kV breakers AL21, AL3, HL23, L21L27, L6L23 and L7L22 with breakers having a higher fault interrupting capability, to allow the operation of more than one Lambton unit simultaneously with Greenfield and St. Clair.

The other network additions and modifications identified in the SIA addendum dated May 2, 2006 and required in and around Hydro One's Lambton and Sarnia-Scott switchyards remain unchanged. They include:

- add a new 230 kV diameter with three new breakers installed in the Lambton SS north switchyard to connect Greenfield,
- replace Lambton SS 230 kV breakers KL29, L51L29 and PL51 with higher thermally rated breakers,
- operate the Lambton SS 230 kV bus 'split', to mitigate fault levels in excess of the breaker interrupting capability, whenever there are two or more Lambton units operating simultaneously with Greenfield and St. Clair,
- re-terminate certain existing circuits in the Lambton SS, and install new Generation Rejection (G/R) tripping system at Lambton SS and modify existing G/R tripping system at Sarnia-Scott TS to include Greenfield, St. Clair and Lambton TGS in these G/R systems so as to preserve the existing transfer capability into and out of Lambton SS, and
- operate the St. Clair bus-tie breaker T3T4 normally open, whenever the Lambton SS 230 kV bus is operated 'split'.

Conclusions and IESO Requirements

Notification of Approval

The revised Notifications of Conditional Approval for Connection issued to Greenfield Energy Centre LP and St. Clair Power LP on May 2, 2006, subject to the implementation of the IESO requirements, remain valid.

IESO Requirements

This addendum does not identify any new requirements for Greenfield and St. Clair. They are identified in the SIA report dated December 6, 2005.

However, this addendum does identify a new requirement for Hydro One. The existing Sarnia-Scott 230 kV breaker HL23 must be replaced with a higher rated unit.

The SIA report dated December 6, 2005 and the SIA addendum dated May 2, 2006 identified six requirements to be completed by Hydro One to connect Greenfield and St. Clair. With the new requirement to replace breaker HL23, the six requirements for Hydro One are:

1. To connect Greenfield at Lambton SS, Hydro One must install a new 230 kV diameter with three new breakers P1, K1P1 and K1 rated at least 3,000 A in the north switchyard as shown in Diagram 4 of the SIA report . The three new breakers also must have auto-reclosure facilities including under-voltage plus time and synchrocheck capabilities.

Hydro One also must replace Lambton SS 230 kV breakers KL29, L51L29 and PL51 with higher rated units of least 3,000 A.

The new breakers must also be capable of continuously operating in the range of 59.5 Hz to 60.5 Hz (Reference 1 of Appendix 4.1 of the Market Rules) and in the range of 220 kV to 250 kV (Reference 2 of Appendix 4.1 of the Market Rules).

Additionally, the breakers must:

- have a maximum continuous voltage rating of at least 250 kV in southern Ontario,
 - be able to interrupt fault current for voltages up to the maximum continuous rating, and
 - 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.
2. To allow a 'split' operation of the Lambton SS 230 kV bus (breakers K1K2 and P1P2 open), Hydro One must connect the new Greenfield circuits and re-terminate some existing circuits at Lambton SS according to the diameter arrangements shown in Diagram 7 of this Report. Specifically, the following work is required:
 - connect Greenfield (G1 & G4) to the new diameter in the position by the K1 bus,
 - re-terminate circuit L24L to the new diameter in the position by the P2 bus,
 - re-terminate circuit L51D to the vacated L24L position,

- connect Greenfield (G2 & G3) to the vacated L51D position, and
 - interchange circuits L26L and L29C positions.
3. To allow for the possible dispatch of more than two Lambton TGS units with Greenfield and St. Clair in service, Hydro One must replace the existing Sarnia-Scott TS 230 kV breakers AL21, AL3, L21L27, L6L23, L7L22 and HL23 with new breakers having rated fault interrupting capabilities of 63 kA and rated interrupting times of three cycles (50 ms) or less.

The new breakers at Sarnia-Scott must also comply with the Market Rules requirements and additional items identified for the new Lambton 230 kV breakers. See Requirement 1 above.

4. Hydro One must modify the existing Sarnia-Scott generation rejection (G/R) Scheme and install a new connectivity-based G/R Scheme at Lambton SS to allow the G/R tripping of Greenfield, St. Clair and Lambton TGS according to the functional specifications shown in Diagrams 5 and 6 of this addendum.

The new Lambton G/R Scheme must also comply with the Northeast Power Coordinating Council (NPCC) Special Protection System Criteria (Document A-11) for type 1 special protection systems.

5. Hydro One must provide a Functional Description Document (FDD) to the IESO that describes the new Lambton G/R Scheme and the modified Sarnia Scott G/R Scheme in sufficient detail for the IESO to demonstrate to Northeast Power Coordinating Council (NPCC) that the Schemes will not have a material adverse effect on reliability. The FDD must be available six months before the Greenfield and St. Clair in-service dates.
6. Hydro One must examine the effect that the increased fault levels may have on the remaining station equipment (buswork, disconnect switches, etc.) at Lambton SS and Sarnia-Scott TS, and make any required enhancements to the equipment. This examination should be based on the expected worst cases for fault levels.

1. Introduction

The System Impact Assessment (SIA) report dated December 6, 2005 and the SIA addendum dated May 2, 2006 had been conducted to examine the effect of the Greenfield Energy Centre (Greenfield) 1,147 MW generation facility and the St. Clair Energy Centre (St. Clair) 638 MW generation facility on the reliability of the IESO-controlled grid.

This additional addendum re-analyzes the adequacy of the short circuit capability of the 230 kV breakers at the Sarnia-Scott transformer station.

Both Greenfield and St. Clair were selected by the Ontario Government as part of the 2,500 MW new clean generation and demand-side RFP. The contract capacity for Greenfield is 1,005 MW and the contract capacity for St. Clair is 570 MW.

Commissioning of Greenfield is scheduled to commence in the second quarter of 2007, while commissioning St. Clair is scheduled to commence in the third quarter of 2007. Commercial operation of Greenfield and St. Clair is to commence in either the fourth quarter of 2007 or the first quarter of 2008.

– End of Section –

2. Assessment of 230 kV Fault Levels at Sarnia-Scott TS

For the SIA addendum dated May 2, 2006, Hydro One had completed fault level studies in February 2006 for various generator dispatches, assuming all transmission elements in service with the Lambton 230 kV bus closed as shown in Figure 1, and the Lambton 230 kV bus open (breakers P1P2 and K1K2 open) and reconfigured as shown in Figure 2.

The SIA addendum had concluded that the 3-phase and line-to-ground (L-G) fault levels at Sarnia-Scott TS exceed the interrupting capability of some of the existing circuit breakers depending on the Greenfield, St. Clair and Lambton TGS generator dispatches and the Lambton 230 kV bus operating mode.

Subsequent to the issue of the SIA addendum, the IESO has discovered that an error was made in the fault level assessment for the Sarnia-Scott 230 kV bus. As a result, this addendum re-assesses the fault levels at the Sarnia-Scott 230 kV bus and their impact on 230 kV breakers AL21, AL3, HL23, L21L27, L6L23 and L7L22, which are referred to as the 'A' rated breakers in the following sections.

Figure 3 is a single line diagram of the Sarnia-Scott 230 kV switchyard.

2.1 Fault Levels with the Lambton 230 kV bus operated closed

Table 1 summarizes the 230 kV fault levels at Sarnia-Scott TS with the Lambton 230 kV bus operated closed.

**Table 1: Fault Levels on the Sarnia-Scott 230 kV bus for a pre-fault voltage of 250 kV
(Lambton 230 kV bus closed, Greenfield 230 kV bus open & St. Clair 230 kV bus closed)**

	Symmetrical Fault (kA)		Asymmetrical Fault (kA)		Breaker Capabilities (kA) @ 250 kV			
	3-phase	L-G	3-phase	L-G	Symmetrical		Asymmetrical	
Existing with 4 Lambton units	37.36	33.96	45.81	39.11	A	39.7	A	46.2
					B	63	B	73.9
					C	63	C	77.3
					D	63	D	77.6
Existing with Greenfield, St. Clair & 4 Lambton units	44.55	41.69	54.71	48.04	A	39.7	A	46.2
					B	63	B	73.9
					C	63	C	77.3
					D	63	D	77.6
Existing with Greenfield, St. Clair & Lambton G1, G3 & G4 units	43.78	41.19	53.76	48.19	A	39.7	A	46.2
					B	63	B	73.9
					C	63	C	77.3
					D	63	D	77.6
Existing with Greenfield, St. Clair & Lambton G3 & G4 units	42.94	40.63	52.72	47.53	A	39.7	A	46.2
					B	63	B	73.9
					C	63	C	77.3
					D	63	D	77.6
Existing with Greenfield, St. Clair & Lambton G3 unit	42.03	40.00	52.18	46.80	A	39.7	A	46.2
					B	63	B	73.9
					C	63	C	77.3
					D	63	D	77.6

Note: The 'A' rating applies to breakers AL21, AL3, HL23, L21L27, L6L23 & L7L22; the 'B' rating to breaker AL25, the 'C' rating to breakers HL22 & HL27, and the 'D' rating to breakers L3L6 & L7L25.

The above Table shows that the 3-phase and L-G symmetrical and asymmetrical fault levels at the Sarnia-Scott 230 kV bus exceed the interrupting capability of the 'A' rated breakers with Greenfield, St. Clair and Lambton in service.

2.2 Fault Levels with the Lambton 230 kV bus operated open

Table 2 summarizes the 230 kV fault levels at Sarnia-Scott TS with the Lambton 230 kV bus operated open.

Table 5: Fault Levels on the Sarnia-Scott 230 kV bus for a pre-fault voltage of 250 kV (Lambton 230 kV bus open, Greenfield 230 kV bus open & St. Clair 230 kV bus open)

	Symmetrical Fault (kA)		Asymmetrical Fault (kA)		Breaker Capabilities (kA) @ 250 kV			
	3-phase	L-G	3-phase	L-G	Symmetrical		Asymmetrical	
Existing with Greenfield, St. Clair & 4 Lambton units	43.82	41.80	53.81	48.16	A	39.7	A	46.2
					B	63	B	73.9
					C	63	C	77.3
					D	63	D	77.6
Existing with Greenfield, St. Clair & Lambton G1, G3 & G4 units	42.79	41.08	52.54	47.34	A	39.7	A	46.2
					B	63	B	73.9
					C	63	C	77.3
					D	63	D	77.6
Existing with Greenfield, St. Clair & Lambton G3 & G4 units	41.62	40.22	51.08	47.06	A	39.7	A	46.2
					B	63	B	73.9
					C	63	C	77.3
					D	63	D	77.6

Note: The 'A' rating applies to breakers AL21, AL3, HL23, L21L27, L6L23 & L7L22; the 'B' rating to breaker AL25, the 'C' rating to breakers HL22 & HL27, and the 'D' rating to breakers L3L6 & L7L25.

The 3-phase and L-G symmetrical and asymmetrical fault levels at Sarnia-Scott TS also exceed the interrupting capability of the 'A' rated breakers when the Lambton 230 kV bus is operated open.

2.3 Actual Fault Duty Imposed on the 'A' Rated Breakers

Tables 6, 7, 8 and 9 summarizes the worst case fault interrupting duty imposed on each 'A' rated breakers for various generation dispatches of Greenfield, St. Clair and Lambton TGS and the expected operation of the Lambton 230 kV bus.

Table 6: Fault Duty on Sarnia-Scott ‘A’ rated 230 kV breakers with Greenfield, St. Clair & four Lambton units in service & Lambton 230 kV bus ‘split’

Breaker Operating Designation	Fault Duty – worst case (kA)		Breaker Rating (kA)	
	3-phase Sym	3-phase Asym	Sym	Asym
AL21	43.82	53.81	39.7	46.2
AL3	43.82	53.81		
HL23	43.82	53.81		
L21L27	41.64	51.11		
L6L23	40.53	49.76		
L7L22	41.62	51.11		

Table 7: Fault Duty on Sarnia-Scott ‘A’ rated 230 kV breakers with Greenfield, St. Clair & Lambton units G1, G3 & G4 in service & Lambton 230 kV bus ‘split’

Breaker Operating Designation	Fault Duty – worst case (kA)		Breaker Rating (kA)	
	3-phase Sym	3-phase Asym	Sym	Asym
AL21	42.79	52.54	39.7	46.2
AL3	42.79	52.54		
HL23	42.79	52.54		
L21L27	40.60	49.86		
L6L23	39.50	48.50		
L7L22	40.60	49.86		

Table 8: Fault Duty on Sarnia-Scott ‘A’ rated 230 kV breakers with Greenfield, St. Clair & Lambton units G3 & G4 in service & Lambton 230 kV bus ‘split’

Breaker Operating Designation	Fault Duty – worst case (kA)		Breaker Rating (kA)	
	3-phase Sym	3-phase Asym	Sym	Asym
AL21	41.62	51.08	39.7	46.2
AL3	41.62	51.08		
HL23	41.62	51.08		
L21L27	39.45	48.41		
L6L23	38.33	47.04		
L7L22	39.45	48.41		

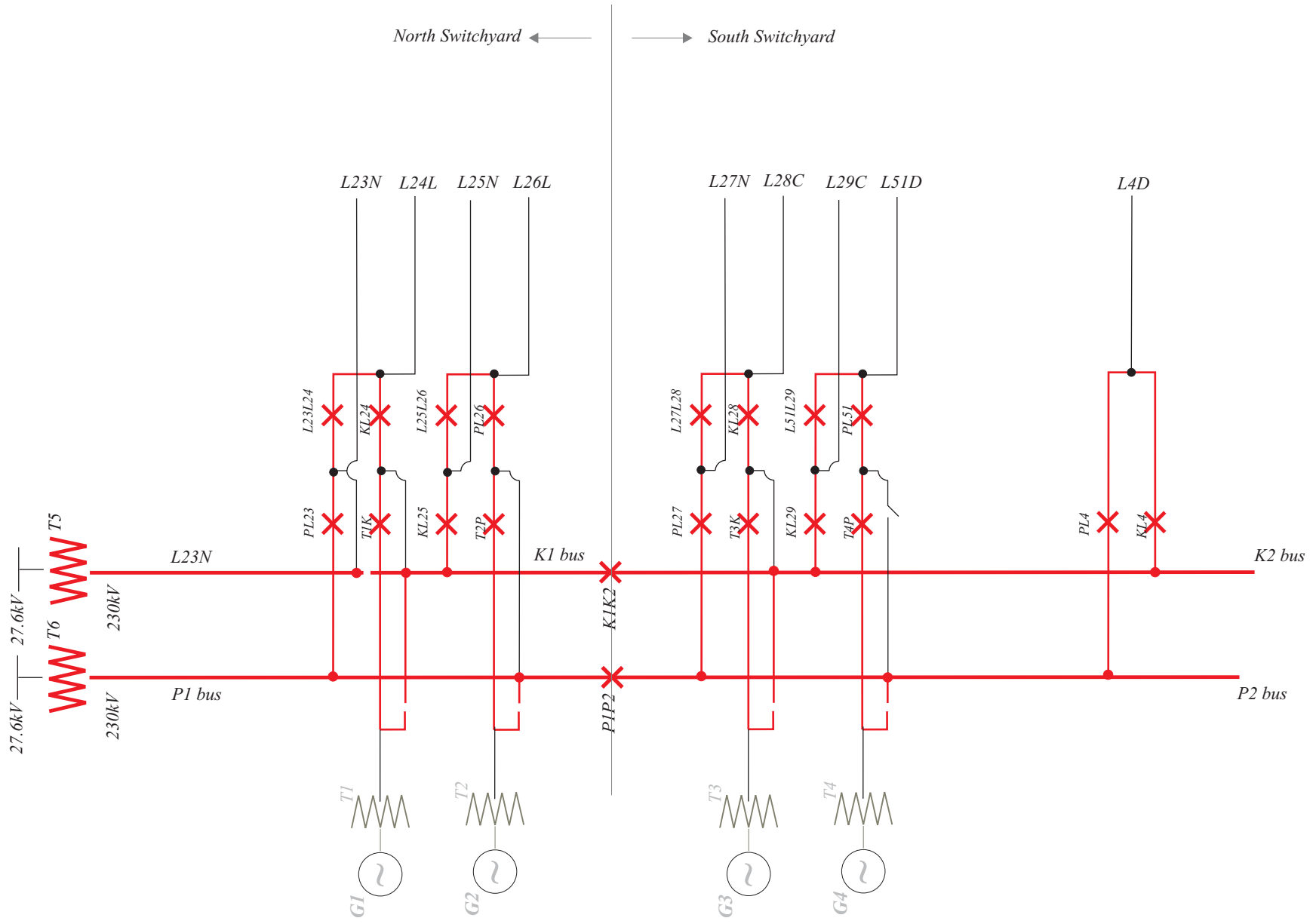
Table 9: Fault Duty on Sarnia-Scott ‘A’ rated 230 kV breakers with Greenfield, St. Clair & Lambton units G3 in service & Lambton 230 kV bus closed

Breaker Operating Designation	Fault Duty – worst case (kA)		Breaker Rating (kA)	
	3-phase Sym	3-phase Asym	Sym	Asym
AL21	42.03	52.18	39.7	46.2
AL3	42.03	52.18		
HL23	42.03	52.18		
L21L27	39.87	49.50		
L6L23	38.74	48.09		
L7L22	39.87	49.50		

In all cases, the actual fault duty imposed on the breakers AL21, L21L27, L6L23 and L7L22 exceeds their interrupting capabilities.

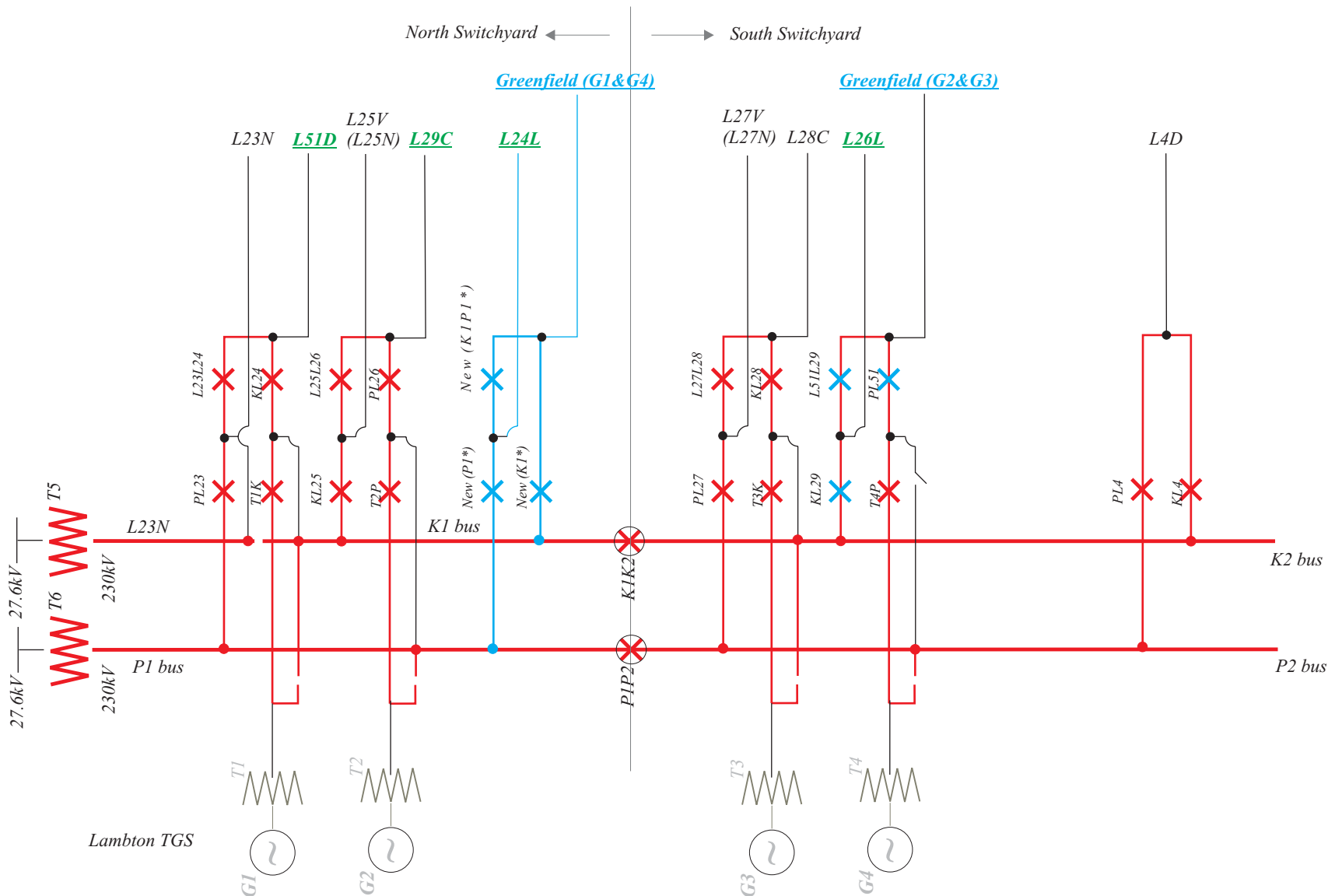
To allow for the possible dispatch of more than one Lambton units with the incorporation of Greenfield and St. Clair, Hydro One must replace Sarnia-Scott 230 kV breakers AL21, AL3, HL23, L21L27, L6L23 and L7L22 with higher rated units.

– End of Section –



**Lambton SS - Existing
230kV Single Line Diagram**

Figure 1



Lambton SS 230 kV Bus Open (Breakers K1K1 & P1P2 Open) and Reconfigured 230kV Single Line Diagram

- New
- Existing
- Reterminated

* Actual operating designation is to be determined by Hydro One

Figure 2

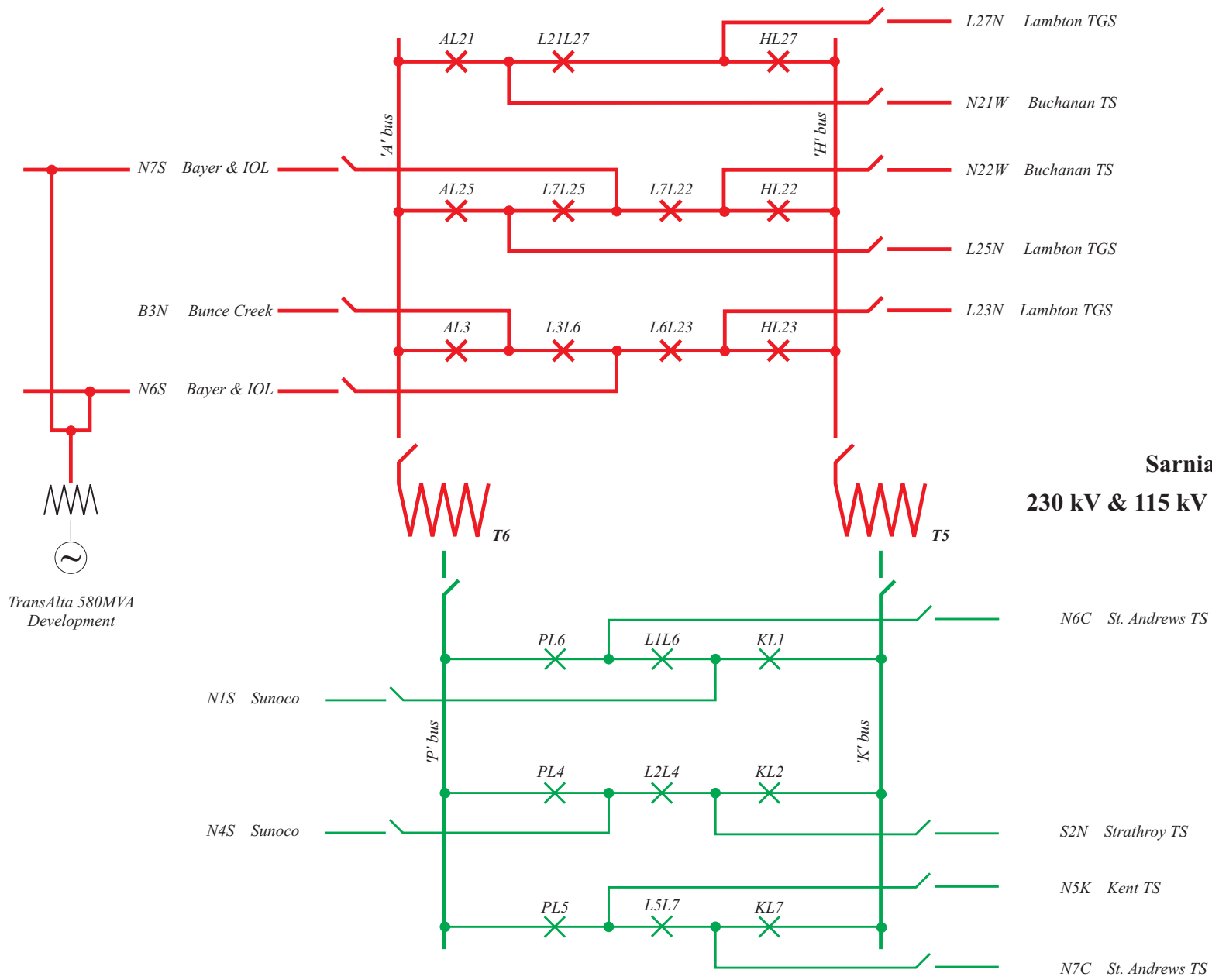


Figure 3

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