



ADDENDUM

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

Issue 2.0

***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

May 2, 2006

Document ID	IESO_REP_0292
Document Name	System Impact Assessment Addendum - Greenfield & St. Clair Energy Centres
Issue	Issue 2.0
Reason for Issue	Addendum to SIA report dated December 6, 2005
Effective Date	May 2, 2006

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 this addendum 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 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. In the SIA report, St Clair was assessed with a proposed connection via 230 kV taps to the existing Nova Corunna taps on Lambton to Sarnia-Scott circuits L25N and L27N.

Subsequent to the issue of the SIA report, St. Clair has proposed a new site and a resulting new interconnection point to the IESO-controlled grid. The plant is to be located on a new site approximately 3 km northeast of the original site, and is to be connected via 230 kV taps directly to circuits L25N and L27N at towers 16 and 17, respectively.

In addition, subsequent to the issue of the SIA report, it was determined that the existing Lambton G/R Scheme associated with the Lambton thermal generating station (TGS) will no longer function once the Lambton 230 kV bus is reconfigured. As a result, the current functionality provided by this Scheme needs to be built into the new Lambton G/R Scheme.

Finally, the functional specifications provided in the SIA report for the existing Sarnia-Scott G/R Scheme and the new Lambton G/R Scheme have been revised to minimize the work required by Hydro One, to provide maximum operating flexibility for the IESO, and to monitor new contingency conditions.

The SIA report assessment together with this addendum re-assessment finds that network additions and modifications are required in and around Hydro One's Lambton and Sarnia-Scott switchyards to satisfy IESO reliability standards and to allow the simultaneous operation of Greenfield, St. Clair, and four Lambton TGS units. The complete new set of network additions and modifications are:

- 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,

- replace Sarnia-Scott TS 230 kV breakers AL21, AL3, 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, and
- operate the St. Clair bus-tie breaker T3T4 normally open, whenever the Lambton SS 230 kV bus is operated 'split'.

When comparing the above conclusions and requirements to those in the original SIA report, the following changes are identified in this addendum:

- Hydro One must also replace Sarnia-Scott 230 kV breaker AL3. This increases the number of 230 kV breakers to be replaced at Sarnia-Scott from four to five;
- Hydro One does not need to improve the continuous rating and 15-Minute LTR of the existing Nova Corunna L25N and L27N 230 kV taps from tower #2 to Petrosar Junction; and
- Hydro One must build the current functionality provided by the existing Lambton G/R Scheme into the new Lambton G/R Scheme.

Conclusions and IESO Requirements

Notification of Approval

It is recommended that a revised *Notification of Conditional Approval for Connection* be issued for each of Greenfield Energy Centre and St. Clair Energy Centre subject to the IESO receiving from each proponent written acknowledgement that the requirements described below and those described in the SIA report under the heading “IESO Requirements” will be implemented.

The connection of the Greenfield Energy Centre (Greenfield) 1,147 MW combined cycle generation facility, and the St. Clair Energy Centre (St. Clair) 638 MW combined cycle generation facility at its new interconnection point, subject to the requirements stated in the SIA report and this addendum, is expected to have no material adverse effect on the reliability of the IESO-controlled grid.

IESO Requirements

The new interconnection point proposed by St. Clair does not change the specific requirements identified in the SIA report for Greenfield and St. Clair. However, some of the Hydro One specific requirements do change.

The SIA report identified six requirements to be completed by Hydro One to connect Greenfield and St. Clair. In particular, Hydro One requirements 3 to 6 in the SIA report are superseded by the following requirements in this addendum:

1. 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 and L7L22 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 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. 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.

3. 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.
4. 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) dated December 6, 2005 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 addendum analyzes the adequacy of the short circuit capability of the local transmission system due to St. Clair's proposed site change and resulting change in the interconnection point to the IESO-controlled grid. This addendum also provides the Hydro One a list of the changes to the original SIA conclusions and requirements to ensure that the new facilities, when connected, will not have a material adverse effect on the reliability of the IESO-controlled grid.

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. St. Clair Energy Centre Project

The St. Clair Energy Centre (St. Clair) is to be a new 638 MW combined cycle generation in St. Clair Township, consisting of two gas-fired turbine generators GTG3 and GTG4 with a maximum rated capacity of 185 MW each, and two steam turbine generators STG3 and STG4 with a maximum rated capacity of 134 MW each.

In the SIA report, St. Clair was assessed with a connection via new 230 kV taps to tower #2 of the existing Nova Corunna taps associated with circuits L25N and L27N between Lambton SS and Sarnia-Scott Transformer Station (TS).

In January 2006, the IESO was notified by St. Clair Power, LP that the location of the facility had changed. The new site is to be approximately 3 km northeast of the original site. Electrically, the facility is to be connected to the same L25N and L27N circuits at towers 16 and 17, respectively.

Furthermore, St. Clair Power, LP has indicated to the IESO that the connection arrangement of the St. Clair facility itself will remain unchanged from the one assessed in the SIA report.

Diagram 1 is a 230 kV single line diagram of St. Clair showing the new interconnection point.

– End of Section –

3. Re-Assessment of Fault Levels

Based on the new interconnection point for St. Clair, Hydro One completed new fault level studies in February 2006 under various generator dispatches, assuming all transmission elements in service with the Lambton 230 kV bus closed as shown in Diagram 2, and the Lambton 230 kV bus ‘split’ (breakers P1P2 and K1K2 open) and reconfigured as shown in Diagram 3.

Similar to the original study results, the new studies indicate that the 3-phase and line-to-ground (L-G) fault levels at Lambton SS and Sarnia-Scott TS exceed the interrupting capability of some existing circuit breakers at these locations depending on the Greenfield, St. Clair and Lambton TGS generator dispatches and the Lambton 230 kV bus operating mode.

For Lambton TGS, the following generator dispatches were assumed in the studies:

- All four units G1, G2, G3 & G4
- Three units G1, G3 & G4
- Two units G3 & G4
- One unit G3

3.1 230 kV Fault Levels at Lambton SS

Lambton SS - 230 kV bus closed

Table 1: Fault Levels on the Lambton 230 kV bus for a pre-fault voltage of 250 kV (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	56.87	62.76	74.51	83.56	A	65.0	A	78.0
					B	70.0	B	92.0
Existing with Greenfield, St. Clair & 4 Lambton units	71.92	80.63	94.59	107.87	A	65.0	A	78.0
					B	70.0	B	92.0
Existing with Greenfield, St. Clair & Lambton G1, G3 & G4 units	68.01	75.06	89.57	99.25	A	65.0	A	78.0
					B	70.0	B	92.0
Existing with Greenfield, St. Clair & Lambton G3 & G4 units	64.10	69.36	84.10	90.47	A	65.0	A	78.0
					B	70.0	B	92.0
Existing with Greenfield, St. Clair & Lambton G3 unit	60.19	63.48	79.10	80.82	A	65.0	A	78.0
					B	70.0	B	92.0

Note: The 'A' rating applies to breakers PL4 & KL4; the 'B' rating to remaining 230 kV breakers at Lambton SS.

The new results continue to indicate that the Lambton 230 kV breakers are inadequate for interrupting the fault duty that would be imposed on them with Greenfield, St. Clair and three or more Lambton units in service. Hence, the original IESO requirement to operate the Lambton 230 kV bus 'split' remains, to reduce fault levels and to provide margin for future developments, whenever there are two or more Lambton units in service with Greenfield and St. Clair in service.

Lambton SS - 230 kV bus open

Table 2: Fault Levels on the Lambton 230 kV NORTH bus for a pre-fault voltage of 250 kV (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	46.43	50.23	60.34	65.88	A B	65.0 70.0	A B	78.0 92.0
Existing with Greenfield, St. Clair & Lambton G1, G3 & G4 units	42.53	44.30	55.02	56.30	A B	65.0 70.0	A B	78.0 92.0
Existing with Greenfield, St. Clair & Lambton G3 & G4 units	38.62	37.93	49.35	45.13	A B	65.0 70.0	A B	78.0 92.0

Note: The ‘A’ rating applies to breakers PL4 & KL4; the ‘B’ rating to remaining 230 kV breakers at Lambton SS.

Table 3: Fault Levels on the Lambton 230 kV SOUTH bus for a pre-fault voltage of 250 kV (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	42.87	47.06	55.90	62.16	A B	65.0 70.0	A B	78.0 92.0
Existing with Greenfield, St. Clair & Lambton G1, G3 & G4 units	42.64	46.84	55.59	61.87	A B	65.0 70.0	A B	78.0 92.0
Existing with Greenfield, St. Clair & Lambton G3 & G4 units	42.37	46.56	55.23	61.50	A B	65.0 70.0	A B	78.0 92.0

Note: The ‘A’ rating applies to breakers PL4 & KL4; the ‘B’ rating to remaining 230 kV breakers at Lambton SS.

With the Lambton 230 kV ‘split’ and reconfigured, Tables 2 and 3 show a significant reduction in fault levels at the Lambton north and south buses. Furthermore, the fault levels do not exceed the interrupting capabilities of the breakers.

Since the Lambton will be operated ‘split’ whenever there are two or more Lambton units in service with Greenfield and St. Clair in service, the worst case fault levels at the Lambton 230 kV bus will occur when the bus is operated closed with Greenfield, St. Clair and one Lambton TGS unit in service, as shown in row 5 of Table 1.

3.2 230 kV Fault Levels at Sarnia-Scott

Diagram 4 is a single line diagram of the Sarnia-Scott 230 kV switchyard.

Sarnia-Scott TS – 230 kV bus (Lambton 230 kV bus closed)

Table 4: 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.

With the new interconnection point of St. Clair, the new fault study results indicate 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.

Since the Lambton will be operated 'split' whenever there are two or more Lambton units in service with Greenfield and St. Clair in service, the results in row 5 of Table 4 represent the worst case levels at the Sarnia-Scott 230 kV bus when the Lambton 230 kV bus is operated closed.

Sarnia-Scott TS – 230 kV bus (Lambton 230 kV bus ‘split’)

Table 5: Fault Levels on the Sarnia-Scott 230 kV bus for a pre-fault voltage of 250 kV (Lambton 230 kV bus ‘split’, 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.

As shown in Table 5, the 3-phase and L-G symmetrical and asymmetrical fault levels also exceed the interrupting capability of the ‘A’ rated breakers when the Lambton 230 kV bus is ‘split’.

In comparing similar generator dispatches in Table 5 to Table 4, there is only a small beneficial effect on the fault levels at the Sarnia-Scott 230 kV bus when the Lambton 230 kV bus is ‘split’.

At the Sarnia-Scott 230 kV bus, the worst case fault levels are expected to occur when the Lambton 230 kV bus is operated ‘split’ with Greenfield, St. Clair and four Lambton TGS units in service, as shown in Table 5, row 1.

Actual Fault Duty Imposed on the ‘A’ Rated Breakers

In the SIA report, the IESO identified the need for Hydro One to replace ‘A’ rated breakers AL21, L21L27, L6L23 and L7L22 after analyzing the worst case fault duties imposed on the individual breakers.

Using the new fault study results, 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	41.64	51.11	39.7	46.2
AL3	39.47	48.47		
HL23	36.32	44.60		
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	40.60	49.86	39.7	46.2
AL3	38.45	47.21		
HL23	35.77	43.92		
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	39.45	48.41	39.7	46.2
AL3	37.29	45.77		
HL23	35.15	43.14		
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	39.87	49.50	39.7	46.2
AL3	37.72	46.83		
HL23	34.51	42.85		
L21L27	39.87	49.50		
L6L23	38.74	48.09		
L7L22	39.87	49.50		

In all cases, the interrupting capabilities of breakers AL21, L21L27, L6L23 and L7L22 are still exceeded after determining the actual fault duty imposed on the breakers for different fault locations at the bus. However, in three of four cases, the interrupting capability of breaker AL3 is also exceeded.

Therefore, to allow for the possible dispatch of more than one Lambton units with Greenfield and St. Clair, Hydro One must also replace Sarnia-Scott 230 kV breaker AL3 with a higher rated unit, in addition to the AL21, L21L27, L6L23 and L7L22 breakers already specified in the SIA report.

3.3 115 kV Fault Levels at Sarnia-Scott

Sarnia-Scott TS – 115 kV bus (Lambton 230 kV bus closed)

Diagram 4 shows the Sarnia-Scott 115 kV switchyard.

Table 10: Fault Levels on the Sarnia-Scott 115 kV bus for a pre-fault voltage of 127 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) @ 127 kV			
	3-phase	L-G	3-phase	L-G	Symmetrical		Asymmetrical	
Existing with 4 Lambton units	20.36	24.04	26.16	31.36	A	38.8	A	45.5
					B	42	B	45.5
					C	52	C	61
					D	63	D	74
Existing with Greenfield, St. Clair & 4 Lambton units	21.32	25.26	27.70	33.78	A	38.8	A	45.5
					B	42	B	45.5
					C	52	C	61
					D	63	D	74
Existing with Greenfield, St. Clair & Lambton G1, G3 & G4 units	21.23	25.17	27.45	33.66	A	38.8	A	45.5
					B	42	B	45.5
					C	52	C	61
					D	63	D	74
Existing with Greenfield, St. Clair & Lambton G3 & G4 units	21.13	25.07	27.32	33.52	A	38.8	A	45.5
					B	42	B	45.5
					C	52	C	61
					D	63	D	74
Existing with Greenfield, St. Clair & Lambton G3 unit	21.01	24.95	27.17	33.37	A	38.8	A	45.5
					B	42	B	45.5
					C	52	C	61
					D	63	D	74

Note: The 'A' rating applies to breaker KL7, L5L7 & PL5, the 'B' rating to breaker L1L6, the 'C' rating to breaker KL2, the 'D' rating to breakers KL1, L2L4, PL4 & PL6.

As shown in Table 10, all 3-phase and L-G symmetrical and asymmetrical fault levels at the Sarnia-Scott 115 kV bus are below the interrupting capabilities of breakers.

Sarnia-Scott TS – 115 kV bus (Lambton 230 kV bus ‘split’)

Table 11: Fault Levels on the Sarnia-Scott 115 kV bus for a pre-fault voltage of 127 kV (Lambton 230 kV bus ‘split’, Greenfield 230 kV bus open & St. Clair 230 kV bus open)

	Symmetrical Fault (kA)		Asymmetrical Fault (kA)		Breaker Capabilities (kA) @ 127 kV			
	3-phase	L-G	3-phase	L-G	Symmetrical		Asymmetrical	
Existing with Greenfield, St. Clair & 4 Lambton units	21.24	25.22	27.46	33.72	A	38.8	A	45.5
					B	42	B	45.5
					C	52	C	61
					D	63	D	74
Existing with Greenfield, St. Clair & Lambton G1, G3 & G4 units	21.11	25.09	27.30	33.55	A	38.8	A	45.5
					B	42	B	45.5
					C	52	C	61
					D	63	D	74
Existing with Greenfield, St. Clair & Lambton G3 & G4 units	20.96	24.94	27.10	33.35	A	38.8	A	45.5
					B	42	B	45.5
					C	52	C	61
					D	63	D	74

Note: The ‘A’ rating applies to breaker KL7, L5L7 & PL5, the ‘B’ rating to breaker L1L6, the ‘C’ rating to breaker KL2, the ‘D’ rating to breakers KL1, L2L4, PL4 & PL6.

Table 11 also shows that all fault levels at the Sarnia-Scott 115 kV bus are below the interrupting capabilities of breakers when the Lambton 230 kV bus is ‘split’.

Operating the Lambton 230 kV bus ‘split’ has no beneficial effect on the 115 kV fault levels at Sarnia-Scott TS.

At the Sarnia-Scott 115 kV bus, the worst case fault levels are expected to occur when the Lambton 230 kV bus is operated ‘split’ with Greenfield, St. Clair and four Lambton TGS units in service, as shown in Table 11, row 1.

3.4 Fault Level Restrictions on Other Station Equipment

The previous three fault level assessments in sub-sections 3.1, 3.2 and 3.3 were based only on the breaker fault interrupting capabilities.

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.

– End of Section –

4. Special Protection Systems

In the SIA report, functional descriptions of the existing Lambton Generation Rejection (G/R) Scheme and the existing Sarnia-Scott G/R Scheme were provided. In addition, details regarding the need for Greenfield and St. Clair G/R were provided.

The SIA report concluded that Hydro One must build a new Lambton G/R Scheme and modify the existing Sarnia-Scott G/R to incorporate the Greenfield and St. Clair Energy Centres. The SIA report also provided functional specifications for the new Lambton G/R Scheme and for the existing Sarnia-Scott G/R Scheme.

Subsequent to the issue of the SIA report, the IESO in consultation with Hydro One determined that the existing Lambton G/R Scheme associated with Lambton TGS will no longer function once the Lambton 230 kV bus is reconfigured. To maintain this capability, the IESO requires the current functionality provided by this Scheme to be built into the new Lambton G/R Scheme. This additional requirement will allow the IESO to pre-arm and reject one Lambton TGS unit via the new Scheme.

The IESO also revised the functional specifications for the existing Sarnia-Scott Scheme G/R and the new Lambton G/R Scheme to minimize the work required by Hydro One, to provide maximum operating flexibility for the IESO, and to monitor new contingency conditions. Specifically, these revisions include:

- The Buchanan L22L44 breaker-fail condition is to be monitored only in the Sarnia-Scott G/R Scheme. Rejection of Greenfield and St. Clair for this contingency will also be only provided by this Scheme.
- The capability to reject Greenfield and St. Clair for contingencies involving either 230 kV circuit N6S or N7S in the Sarnia-Scott G/R Scheme.
- The capability in the new Lambton G/R Scheme to monitor contingency conditions ‘L27N + L28C’ and ‘L24L + L29C’, which will become recognized 230 kV double circuit contingencies as a result of the Lambton circuit re-termination work to be completed by Hydro One.

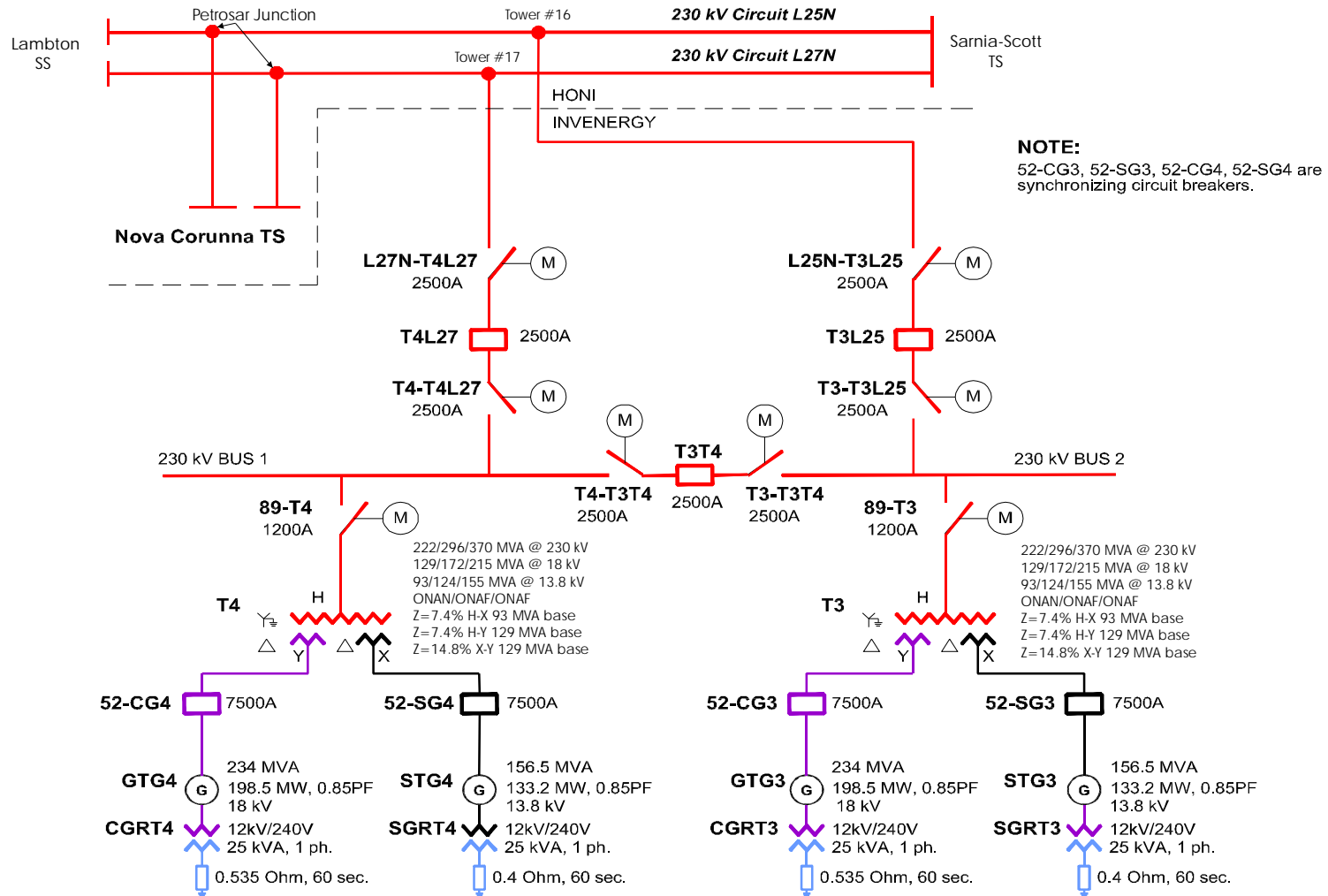
Diagrams 5 and 6 provide the new, overall functional specifications required for the existing Sarnia-Scott G/R Scheme and the new Lambton G/R Scheme, respectively, to incorporate the Greenfield and St. Clair Energy Centres and to maintain the existing Lambton TGS G/R capability.

Hydro One must modify the existing Sarnia-Scott G/R Scheme and install a new connectivity-based G/R Scheme at Lambton SS according to the functional specifications shown in Diagrams 5 and 6.

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.

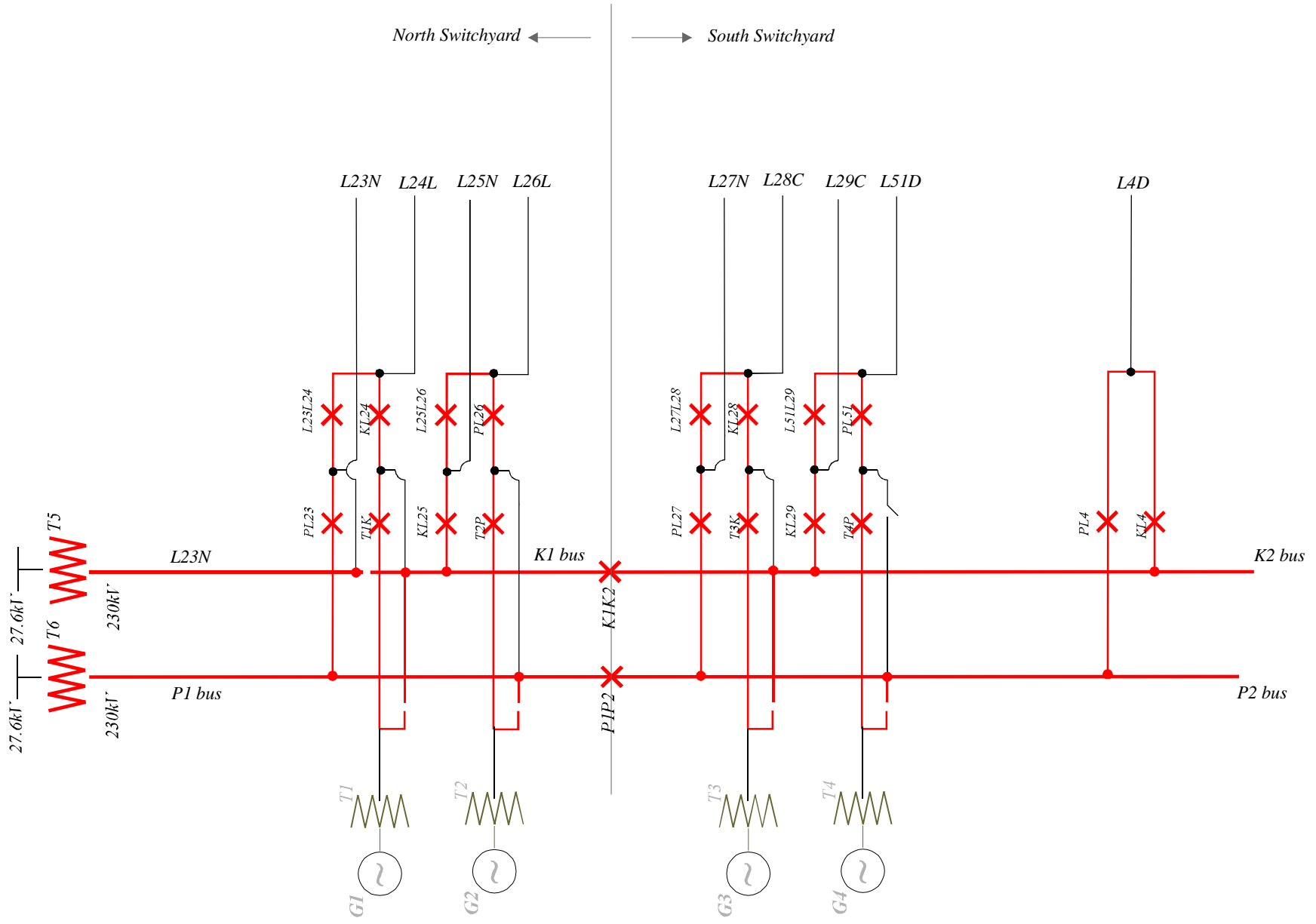
Please note that Diagram 5 also shows additions required due to Hydro One's plan to install in-line breakers on 230 kV circuits L25N and L27N at Petrosar Junction in a new switching station called Nova Chemical. Further details on this project (CAA ID 2005-EX261) and the associated G/R requirements shown in Diagram 5 can be found in the IESO SIA report at http://www.ieso.ca/imoweb/connAssess/caa_SmallPrj_StatusSummary.asp.

– End of Section –



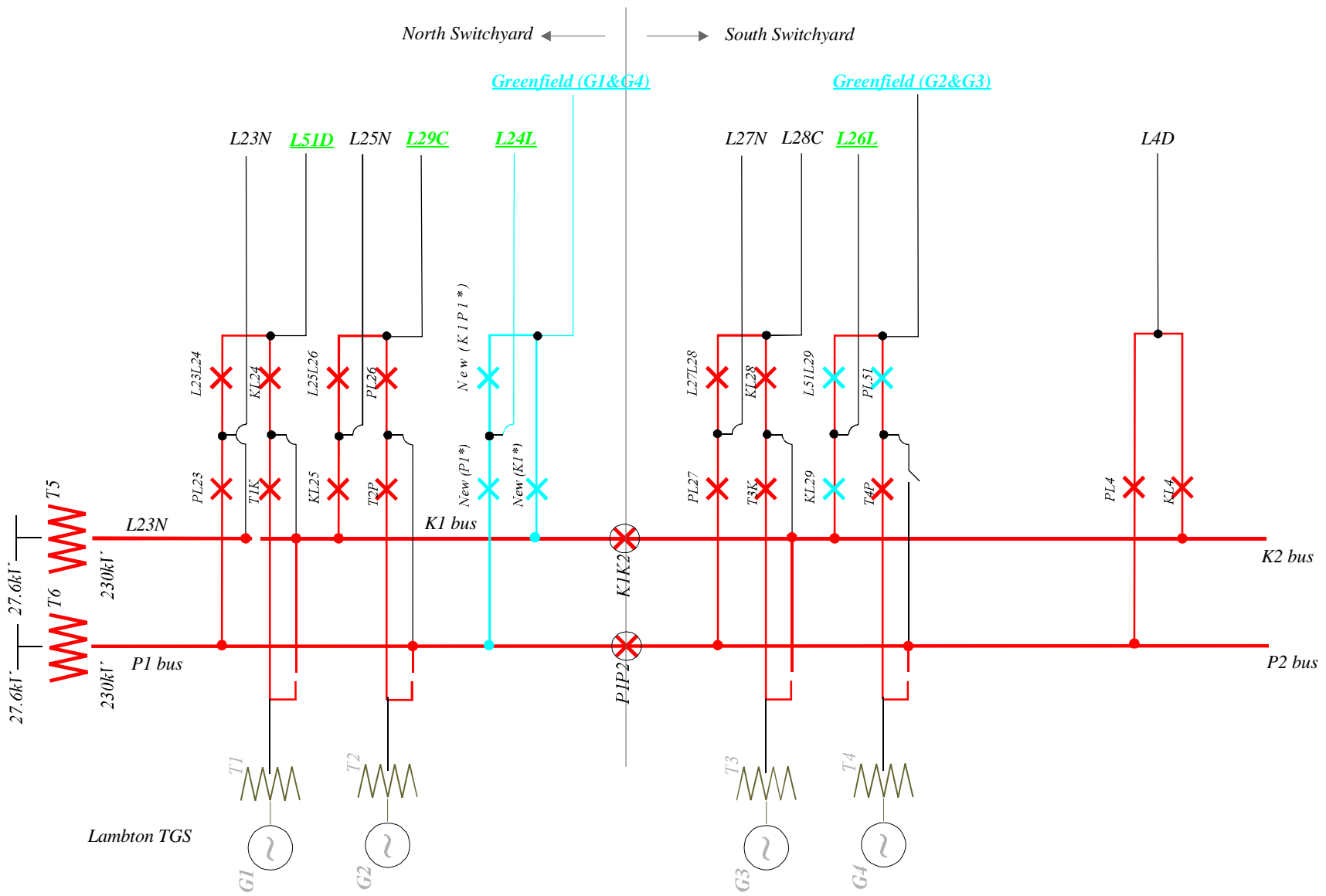
St. Clair Energy Centre
230 kV Single Line Diagram
638 MW

DIAGRAM 1



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

DIAGRAM 2

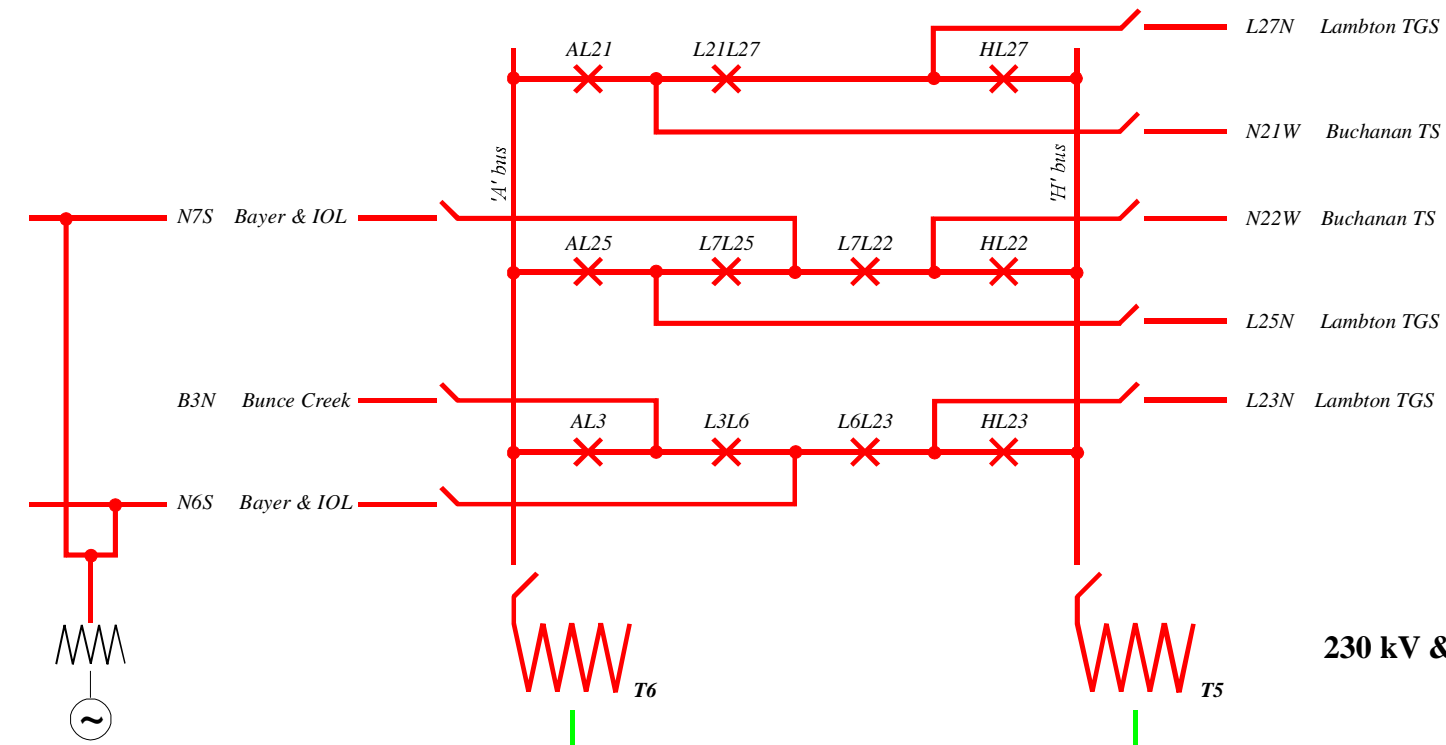


Lambton SS - 'Split' (Breakers K1K1 & P1P2 Open) and Reconfigured 230kV Single Line Diagram

- New
- Existing
- Reterminated

* Actual operating designation is to be determined by Hydro One

DIAGRAM 3



TransAlta 580MVA
Development

Sarnia-Scott TS
230 kV & 115 kV Single Line Diagram

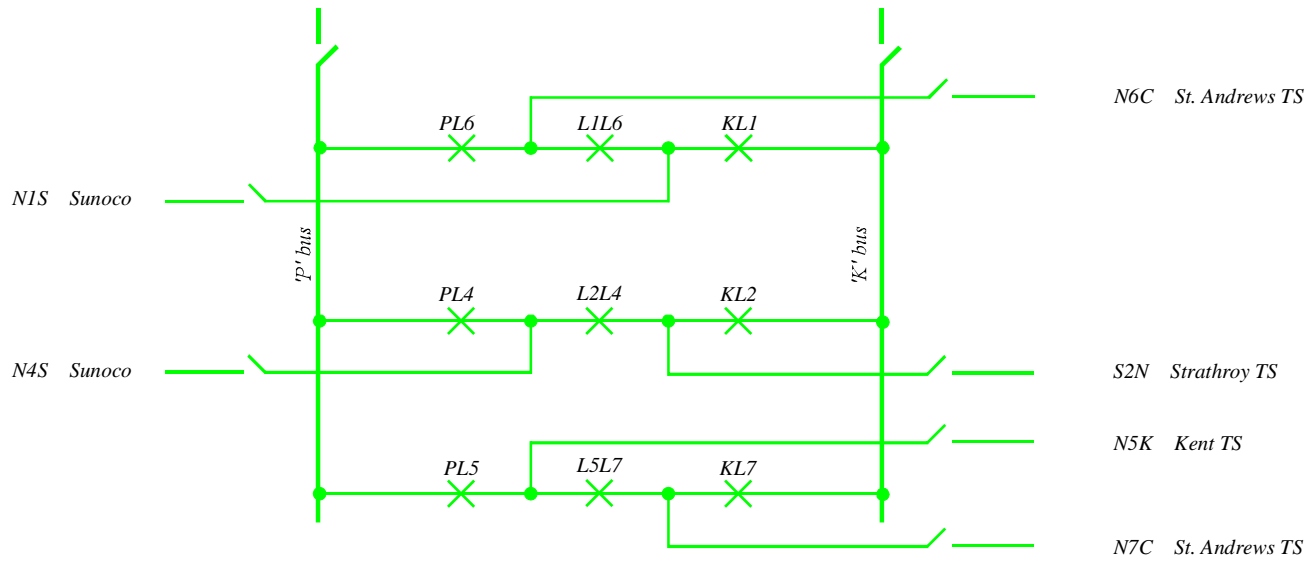


DIAGRAM 4

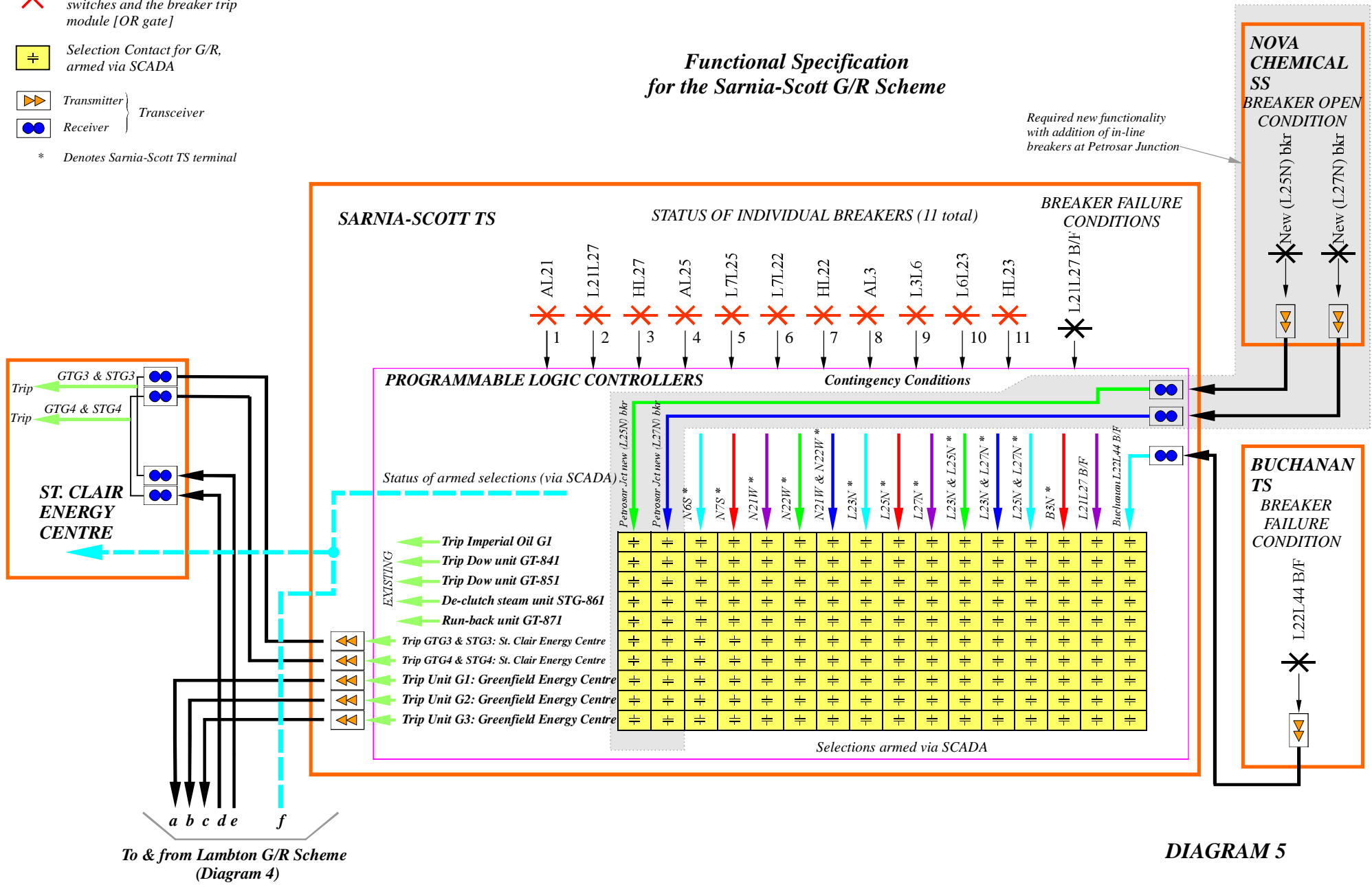
XYZ Status of individual breakers, derived from breaker pallet switches and the breaker trip module [OR gate]

Selection Contact for G/R, armed via SCADA

Transmitter }
 Receiver } Transceiver

* Denotes Sarnia-Scott TS terminal

Functional Specification for the Sarnia-Scott G/R Scheme






Required new functionality with addition of in-line breakers at Petrosar Junction

To & from Lambton G/R Scheme (Diagram 4)

DIAGRAM 5

XYZ Status of individual breakers, derived from breaker pallet switches and the breaker trip module [OR gate]

 Selection Contact for G/R, armed via SCADA

 Transmitter }
 Receiver } Transceiver

* Denotes Lambton SS terminal

Functional Specification for the Lambton G/R Scheme

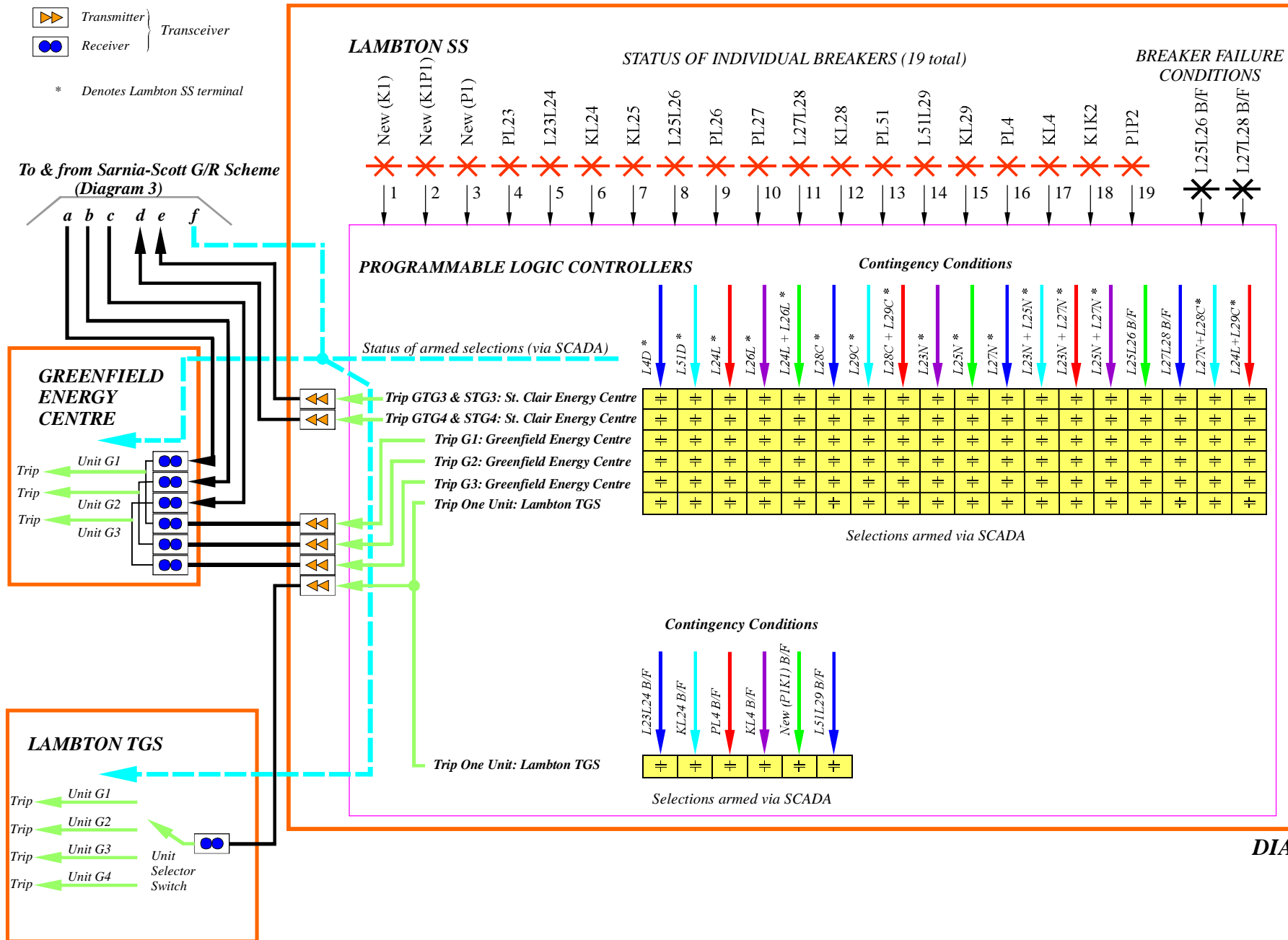


DIAGRAM 6

End of Document –