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CONNECTION ASSESSMENT & APPROVAL PROCESS

PRELIMINARY ASSESSMENT REPORT

For the Proposed 850MW Development by Calpine Canada Power Holdings Ltd. near the Nova Corunna Complex in the Township of St. Clair

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Long Term Forecasts & Assessments Department

FINAL Version

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Preliminary Assessment Report

For the Proposed Development by Calpine Canada Power Holdings Ltd. near the Nova Corunna Complex in the Township of St. Clair

Acknowledgement

The IMO wishes to acknowledge the assistance of Hydro One in completing some of the studies for this assessment.

Disclaimers

IMO

This report has been prepared solely for the purpose of assessing, on a preliminary basis, whether the connection applicant's proposed connection with the IMO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether a System Impact Assessment of the proposed connection should be conducted under Chapter 4, section 6 of the Market Rules. 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, Hydro One and the IMO in accordance with Chapter 4, Section 6 of the Market Rules. The IMO assumes no responsibility to any third party for any use which it makes of this report. Any liability which the IMO 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 IMO provides a draft of this report to the connection applicant, you must be aware that the IMO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IMO 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. The IMO expects the connection applicant and affected transmitter to discuss the connection project with any persons located in the vicinity of the project and to advise the IMO of any concerns they might express about the impact of the project on system reliability.

Hydro One

Special Notes and Limitations of Study Results

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

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

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

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

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

Preliminary Assessment Report for the Calpine Project in the Township of St. Clair, near the Nova Corunna Complex

1. Introduction

Calpine Canada Power Holdings Ltd. is proposing to develop an 850MW generating facility near the Nova Corunna Chemical Complex in the Township of St. Clair in South-western Ontario. The facility is to comprise three 200MW gas-turbine generating units and a single 250MW steam-turbine unit.

The proposed in-service dates for the new facility are as follows:

Initial in-service date:	June 2003
Final in-service date: (start of full commercial operation)	December 2003

2. Connection Arrangement

The System Impact Assessment for the four generating projects in the Sarnia-Windsor area concluded that the increased fault levels on the 230kV busbar at Lambton TGS that would result from their incorporation could best be addressed by operating with the busbar permanently 'split'. This would involve reconfiguring some the existing 230kV circuits and one of the Ontario-Michigan Interconnections in order to achieve an optimum balance between the two halves of the busbar.

Diagram 3 shows the current proposal for reconfiguring the terminations on the 230kV busbar at Lambton TGS to allow it to be operated permanently 'split'. This revised arrangement incorporates changes that have resulted from recent preliminary engineering work that has been completed by Hydro One, and is therefore different from the arrangement that was shown in the System Impact Assessment Report for the original Sarnia-Windsor cluster of Projects.

For this Assessment it has been assumed that this work will have been completed before the Calpine Project is placed in-service.

The incorporation arrangement proposed by Calpine Canada takes account of the intended 'split' of the Lambton busbar by operating with the 230kV busbar at its new generation facility site similarly 'split'. Diagrams 1 and 2 show the proposed arrangement.

One of the gas-turbine units, together with the single steam-turbine unit, are to be connected to the 1.5km tapped connections from circuits L25N and L27N, that supply the Nova Corunna Complex. A new 1.5km tapped connection on to circuit L23N is to be established between the Nova Corunna Complex and Petrosar Junction for the incorporation of the remaining two gas-turbine generating units. This arrangement, which is intended to minimise the impact on the fault levels at Lambton TGS of the Calpine-Corunna Project, will result in the two gas-turbine units being connected to the northern half of the 'split' busbar at Lambton TGS, while the gas-turbine and steam-turbine combination will be connected to the southern half.

It would have been preferred to have the larger half of the Calpine-Corunna Project incorporated into the northern half of the Lambton busbar, to counteract the impact that the proposed ENRON Project would have on the fault levels on the southern half. However, this would have resulted in higher transfers on the single 230kV circuit between Scott TS and Lambton TGS. The arrangement that has been proposed therefore has the gas-turbine/steam-turbine portion of the Project connected to circuits L25N & L27N, which are better able to accommodate the additional output.

The proposed busbar arrangement for the Calpine-Corunna Project, as shown in Diagram 2, incorporates the flexibility required to allow different generating units to be associated with different circuits by changing the location of the normally-open points. This flexibility could also be used to allow more of the generating units at the Calpine-Corunna facility to be operated under outage conditions involving one of the Lambton TGS to Scott TS circuits, if the thermal ratings/loadings on the remaining circuits are not restrictive.

Ratings of the Incorporation Circuits

The Table below shows the thermal ratings for the existing three 230kV circuits between Lambton TGS and Scott TS.

Since the circuits have adequate line-to-ground clearances for operation at temperatures higher than 93°C, thermal ratings have been provided for continuous operation at the 'normal' conductor temperature of 93°C as well as at the maximum operating temperature to which each individual circuit has been 'sagged'.

The 15-minute limited-time-ratings correspond to the maximum conductor operating temperature for the respective circuits.

It should be noted that since the main sections of the three circuits are equipped with high-aluminum-content conductors (1843.2kcmil: 72/7 stranding) they are restricted to 50 hours of operation in a year at conductor temperatures above 93°C. The cells in the following table with ratings that correspond to this restriction are shown shaded.

Thermal Ratings								
Section	*Lambton TGS to Scott TS*				*Petrosar Junction to Nova Corunna*			
Circuit ID	*L23N, L25N & L27N*				*L25N & L27N*			
Conductor	*1843.2kcmil*				*795kcmil*			
	Continuous rating							
Ambient temperature	*Summer 30°C*		*Winter 10°C*		*Summer 30°C*		*Winter 10°C*	
Conductor temperature	93°C	127°C	93°C	127°C	93°C	150°C	93°C	150°C
Ratings at 240kV	1420amp 590MVA	1840amp 765MVA	1660amp 690MVA	2010amp 836MVA	870amp 362MVA	1250amp 520MVA	1020amp 424MVA	1340amp 557MVA
	15-minute Limited-time-rating							
Ambient temperature	*Summer 30°C*		*Winter 10°C*		*Summer 30°C*		*Winter 10°C*	
Conductor temperature	127°C		127°C		150°C		150°C	
Ratings at 240kV	2473 amp 1028MVA		2800 amp 1164MVA		1498 amp 623MVA		1648 amp 685MVA	
Pre-load	Nominal 1000 amp: 416MVA				650 amp: 270MVA ≈ ½ output from GT + ST			

Operation at this rating is limited to 50 hours/year

The gas-turbine and steam-turbine combination, with a combined output of 525MVA is to be incorporated via the existing tapped connections on to circuits L25N & L27N. Under normal conditions, with both circuits in-service, the tapped connections would only be loaded to approximately 263MVA, which is well within their 93°C thermal rating. However, under outage conditions involving either circuit L25N or circuit L27N, the loading on the companion, tapped connection would be approximately 525MVA.

This post-contingency loading would exceed the *continuous* rating for conductor temperatures of both 93°C and 150°C, when ambient temperatures are at 30°C, or higher. However, it would be within the 15-minute limited-time-rating of the remaining tapped connection.

The following options would therefore be available to Calpine Canada for addressing the situation:

i. In the event of a contingency involving circuit L25N or L27N, initiate generation rejection to reduce the output from the gas-turbine/steam-turbine combination to within the continuous rating corresponding to a conductor temperature of 93°C.

ii. Subject to agreement from the transmitter, restrict the output from the gas-turbine/steam-turbine combination under contingency/outage conditions so as to respect the continuous rating corresponding to a conductor temperature of 150°C. Since outage conditions are expected to occur infrequently, operating the circuit to a temperature of 150°C for short periods may be acceptable to the transmitter.

iii. Reconductor the two tapped circuits to provide a continuous summertime rating for each 1.5km connection of 525MVA.

Implementation of any one of these options would be acceptable to the IMO for the incorporation of the gas-turbine/steam-turbine portion of the new generating facility into the IMO-controlled grid.

For the incorporation of the two gas-turbine generating units, with a combined output of 450MVA, a new 1.5km single-circuit line is to be installed to provide a connection on to circuit L23N. To ensure that the thermal rating of this connection is not limiting it would need to be equipped with conductors having a cross-section of at least 1192.5kcmil. 1192.5kcmil conductors would provide a continuous rating of 1110 amps (460MVA) for a maximum conductor operating temperature of 93°C with an ambient temperature of 30°C. Alternatively twin 477kcmil conductors would provide a continuous summertime rating of 515MVA (1240 amp) at a maximum conductor operating temperature of 93°C.

[Calpine Canada has subsequently indicated that they plan to adopt the twin 477kcmil alternative.]

3. Transfers on the circuits between Lambton TGS & Scott TS

The impact of contingencies was examined for the following operational condition:

- all four generation Projects from the original Sarnia-Windsor cluster assumed to be in-service
- the new Calpine-Corunna Project assumed to be in-service
- all of the existing generating facilities in the Sarnia-Windsor area assumed to be in-service
- high transfers being made eastwards across the Sarnia-London Interface

Diagram 4 shows the incremental impact on the flow distribution within the local area of the Calpine-Corunna Project.

This shows that approximately $^2/_3$ of the output from the Calpine Project will flow towards Lambton TGS with only $^1/_3$ flowing toward Sarnia-Scott TS. Since, under Import Conditions, the normal flow direction on circuits L23N, L25N & L27N is from Lambton TGS to Sarnia-Scott TS, the Calpine Project would therefore have the effect of reducing the flows on the section of circuits L23N, L25N & L27N between Lambton TGS & Petrosar Junction, while increasing them between Petrosar Junction and Scott TS. This will result in the flows on the sections north of Petrosar Junction becoming the more critical.

Overloading would be expected to occur, particular during periods of high ambient temperatures and low wind speeds, for the following contingency conditions. The degree of overloading would also be affected by the loading condition for the local area:

i. A single-circuit contingency involving circuit L25N or L27N
ii. A double-circuit contingency involving circuits N21W & N22W
iii. A double-circuit contingency involving circuits L24L & L26L
iv. A double-circuit contingency involving circuits L28C & L29C

v. A double-circuit contingency involving circuits L23N & L25N
vi. A double-circuit contingency involving circuits L25N & L27N (on the tapped connection)
vii. An L51L29 breaker failure condition at Lambton TGS, resulting in the loss of circuits L25N & L28C
viii. An L27L28 breaker failure condition at Lambton TGS, resulting in the loss of circuits L27N & L26L
ix. An L23L24 breaker failure condition at Lambton TGS, resulting in the loss of circuits L23N & L24L

***OR** (if the proposal discussed in Section 6.1.3 is implemented.)*

An L25L26 breaker failure condition at Lambton TGS, resulting in the loss of circuits L23N & L29C

Since circuits L23N, L25N & L27N are 'sagged' for operation at 127°C, but are restricted to 50 hours of operation per year at this temperature, the remedial action that would need to be implemented to address the overloads will depend on the extent of the overload.

- If the overload is within the *continuous rating* of the circuit for a conductor temperature of 127°C, then it is expected that no immediate action will be necessary. However, if the outage persists, then it would be necessary to reduce the output to restore the loading on the circuits to within their continuous rating at 93°C within a 'reasonable' period.
- If the overload exceeds the *continuous rating* at 127°C, but is within the *15-minute limited-time-rating* of the circuits, then generation run-back, rather than generation rejection, could be initiated to reduce the output and restore the loading on the circuits to within their *continuous* rating corresponding to a conductor temperature of 127°C, within a maximum of 15 minutes. As before, should the outage persist, then a further reduction in output would be required to restore the loading on the circuits to within their continuous rating at 93°C.
- If the overload exceeds the *15-minute limited-time-rating* of the circuits, then generation rejection would need to be initiated immediately to reduce the loading on the circuits to within the *continuous rating* at 127°C.

  Further reductions in output could be achieved using generation run-back.

A generation rejection/generation run-back scheme will need to be installed to allow appropriate amounts of generation capacity to be armed for generation rejection and/or generation run-back in response to the contingency conditions detailed above.

In addition, further detailed analysis will need to be performed for different operating and/or generation dispatch scenarios to determine whether any contingency conditions, other than those that have been identified above, could require an automatic reduction in generating capacity to respect post-contingency thermal limits.

4. Comments on the Proposed Connection Arrangement

The connection arrangement proposed by Calpine Canada for the incorporation of their new Project employs a 'breaker-and-a-third' switching station that will limit the possible impact on the local system of any contingencies within the new generating facility. Furthermore, since two of the three tapped connections that are required for the incorporation of the new generating facility already exist (the connections from circuits L25N & L27N to the Nova Corunna Complex) the only increase in exposure will be from the new 1.5km tapped connection on to circuit L23N. This increase in exposure is expected to have minimal impact on the reliability of supply of those loads (Nova St. Clair & Shell Canada) that are supplied from circuit L23N, particularly since they involve DESN connections with an alternative supply from circuit L27N.

The station service supply for the Calpine-Corunna Project is to be obtained from the LV terminals of two of the generator step-up transformers. Consequently the two units associated with these particular generator step-up transformers are to be equipped with LV synchronising breakers, as shown in Diagram 2. Synchronising of the two remaining generating units is to be performed via the 230kV circuit breakers at the new switching station. Because of the various synchronising arrangements that can be employed, it is recommended that all of the circuit breakers that are to be installed at the switching station should be capable of withstanding a 2 pu voltage across their open terminals.

Although it is the intention that the 230kV busbar at Lambton TGS will be operated permanently 'split' once some of the 230kV circuits and one of the Interconnections have been reterminated, there may be occasions when conditions would allow the Lambton busbar to be operated 'closed'. (This situation is more likely to arise under line outage conditions when less generation capacity is being dispatched and the projected fault levels are lower.)

For this reason it is strongly recommended that the new breakers should have a fault interrupting capability of at least 70kA, to match those that are currently in-service at Lambton TGS.

5. Fault Level Analysis

Fault level studies were performed to determine the impact of the proposed Calpine Development near the Nova Corunna Complex in St. Clair Township on the existing transmission facilities.

The following system conditions were assumed when conducting the studies:

- All existing transmission facilities, together with those facilities that have been 'committed' are assumed to be in-service.
- The three Interconnections with Michigan reflect their final arrangement following the installation of the new phase-shifters.
- The generators at the Bruce 'A' station are out-of-service
- The generators at the Pickering 'A' station are in-service
- The two 500/230kV auto-transformers at Lennox TS, together with units G1 to G4 at Lennox GS are in-service.
- The 230kV busbars at Richview TS are operated 'split', while Cherrywood TS is operated with a separate North & South switchyard.
- All of the generators that were specified for each Project in the original Sarnia-Windsor cluster were assumed to be in-service and incorporated into the system in accordance with the arrangements detailed in the System Impact Assessment Report for this cluster.
- The circuits terminating at the Lambton 230kV busbar have been reconfigured in accordance with the requirements detailed in the System Impact Assessment for the original Sarnia-Windsor cluster, and the 230kV busbar is operated permanently 'split'.
- All of the 20kA circuit breakers on the 115kV busbar at Sarnia-Scott TS have been replaced with higher rated units.
- The two 115kV series-connected reactors on the two 230/115kV auto-transformers at Sarnia-Scott TS have been removed.
- *The original (1995) representation for the Detroit Edison Company in the year-2000 was used to model that system*.

The full, quoted fault interrupting capability of the circuit breakers on the 230kV and 115kV systems was used when assessing the adequacy of the equipment for the projected fault interrupting duty that is likely to be imposed on it.

5.1 Detroit Edison Company

In discussions with the Detroit Edison Company (DECO) we were made aware of a major new development in the Belle River/St. Clair area of the Detroit Edison Transmission System. This Project, which is to have a capacity of 950MW, is scheduled to be in-service in the Spring-2003.

A Facilities Study, to establish a detailed specification for the incorporation equipment, has recently been completed, and since Detroit Edison is still of the opinion that this Project will proceed, it was therefore decided to include it in the system model for the fault level analysis for this assessment.

5.2 Representation of the Detroit Edison System

The expected model for the year-2000, which was provided by Detroit Edison in 1995, has been used in all of the fault level studies that were performed for this Assessment. The IMO has concerns regarding the accuracy of this representation as it could affect the study results, and the conclusions that have been drawn from them.

Prior to commencing the System Impact Assessment for those Projects in the next cluster, which is to include the Calpine-Corunna Project, the IMO will confirm the validity of the model that is to be used for the Detroit Edison System and the Ontario-Michigan Interconnections.

5.3 Fault Level Results

The results for the three most-critical locations are shown on the following Diagrams:

At Lambton TGS
- Diagram 5 For a 3-phase Fault on the 230kV busbar
- Diagram 6 For a Line-to-Ground Fault on the 230kV busbar

At Sarnia-Scott TS
- Diagram 7 For a 3-phase Fault on the 230kV & 115kV busbar
- Diagram 8 For a Line-to-Ground Fault on the 230kV & 115kV busbar

At Keith TS
- Diagram 9 For a 3-phase Fault on the 230kV & 115kV busbar
- Diagram 10 For a Line-to-Ground Fault on the 230kV & 115kV busbar

5.3.1 Fault levels at Lambton TGS

The maximum fault levels with all four generating units at the Calpine development in-service, are also summarised in the Table below:

Fault levels on the 230kV busbars at Lambton TGS for a Pre-fault Voltage of 250kV

		Symmetrical		***Asymmetrical***		***Breaker Ratings***			
		3-phase	***L-G***	***3-phase***	***L-G***	***Symmetrical***		***Asymmetrical***	
With the four Sarnia-Windsor Projects in-service	*North*	35.69kA	40.20kA	46.33kA	53.47kA	*B*	70.0kA	*B*	92.0kA
	South	41.98kA	46.55kA	54.49kA	61.91kA	*A* *B*	65.0kA 70.0kA	*A* *B*	78.0kA 92.0kA
With the four Sarnia-Windsor Projects & all four units at the Calpine Project in-service	*North*	37.69kA	42.21kA	48.99kA	55.76kA	*B*	70.0kA	*B*	92.0kA
		+2.0kA	*+2.01kA*	*+2.66kA*	*+2.29kA*				
	South	45.04kA	49.60kA	58.59kA	65.53kA	*A* *B*	65.0kA 70.0kA	*A* *B*	78.0kA 92.0kA
		+3.06kA	*+3.05kA*	*+4.1kA*	*+3.62kA*				

Note: The 'A' ratings are for breakers PL4 & KL4, while the 'B' ratings are for the remaining breakers at Lambton TGS

The results in the above table indicate that with the Lambton 230kV busbar operated 'split' all of the existing circuit breakers will be adequate for the expected fault interrupting duty that could be imposed on them with the four generating units at the Calpine facility in-service.

The incremental change in the fault levels as a result of incorporating the Calpine facility into the system has also been provided.

5.3.2 Fault levels at Sarnia-Scott TS

The maximum fault levels are also summarised in the Table below:

Fault levels on the 230kV busbar at Scott TS for a Pre-fault Voltage of 250kV						
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
	3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
With all four Sarnia-Windsor Projects In-service	36.75kA	33.57kA	45.16kA	38.67kA	38.4kA	46.2kA
With all four Sarnia-Windsor Projects plus the four units at Calpine-Corunna in-service	***40.60kA***	37.58kA	***50.50kA***	43.29kA		
	+3.85kA	*+4.01kA*	*+5.34kA*	*+4.62kA*		

Fault levels on the 115kV busbar at Scott TS for a Pre-fault Voltage of 127kV								
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability			
	3-phase	L-G	3-phase	L-G	Symmetrical		Asymmetrical	
With all four Sarnia-Windsor Projects In-service	16.22kA	18.74kA	21.41kA	25.43kA	*A*	31.4kA	*A*	34.1kA
With all four Sarnia-Windsor Projects plus the four units at Calpine-Corunna in-service	19.96kA	23.84kA	25.93kA	31.63kA	*B*	38.8kA	*B*	45.5kA
	+3.74kA	*+5.10kA*	*+4.52kA*	*+6.20kA*				

Note: The 'A' rating applies to breaker KL1; & the 'B' rating to breakers KL7, L1L6, L5L7, & PL5.

The incremental increases in the fault levels on the 230kV & 115kV busbars at Scott TS, that are expected to be contributed by the four generating units of the Calpine Project have also been included in the above Table

230kV Facilities

The Table above indicates that with the four new generating units in the Calpine Development in-service, the *total* symmetrical and asymmetrical fault levels for three-phase faults on the Scott 230kV busbar will exceed the rating of the existing breakers. The Table below shows the fault interrupting duty that could be imposed on specific breakers after making allowance for the fault contributions that individual breakers are not required to interrupt.

Breaker ID	Fault Duty		Breaker Rating		Breaker ID	Fault Duty		Breaker Rating	
	Sym	Asym	Sym	Asym		Sym	Asym	Sym	Asym
AL21	***38.4kA***	***47.8kA***	***38.4kA***	***46.2kA***	**HL22**	***38.4kA***	***47.8kA***	***38.4kA***	***46.2kA***
L21L27	***38.4kA***	***47.8kA***			AL3	36.4kA	45.2kA		
HL27	32.3kA	40.2kA			NEW	38.0kA	47.3kA	70.0kA	92.0kA
AL25	32.4kA	40.3kA			**L3L23**	38.0kA	***47.3kA***	38.4kA	***46.2kA***
NEW	38.1kA	47.4kA	70.0kA	92.0kA	HL23	30.7kA	37.6kA		
L22L25	***38.4kA***	***47.8kA***	***38.4kA***	***46.2kA***					

The figures in bold-italic indicate breakers whose fault interrupting capability is exceeded.

The Table above indicates that the incorporation of the four generating units in the Calpine development, together with all four Projects in the original Sarnia-Windsor cluster, would result in the fault interrupting capability of ***five*** of the existing 230kV breakers at Sarnia-Scott being exceeded.

115kV Facilities

On the assumption that all of the 20kA 115kV breakers at Scott TS will be replaced with higher-rated units for the incorporation of the TransAlta Project, breaker KL1, with a rating of 31.4kA symmetrical and 34.1kA asymmetrical, would become the next critical unit.

Since none of the 115kV circuits at Scott TS contribute to the fault levels on the 115kV busbar at that station, the fault interrupting duty that would be imposed on each individual breaker would be the same as the fault level on the busbar. However, since the maximum symmetrical (23.8kA) & asymmetrical (31.6kA) fault currents for a line-to-ground fault would be within the rating of the critical KL1 breaker, the incorporation of the Calpine Project would not require any additional 115kV breakers at Scott TS to be replaced.

5.3.3 Fault levels at Keith TS

Fault levels on the 230kV busbar at Keith TS for a Pre-fault Voltage of 250kV						
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
	3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
With all four Sarnia-Windsor Projects In-service	20.25kA	20.94kA	25.37kA	25.27kA	38.4kA	46.2kA
With all four Sarnia-Windsor Projects plus all four units of the Calpine Project in-service	20.26kA	20.95kA	25.39kA	25.29kA		

Fault levels on the 115kV busbar at Scott TS for a Pre-fault Voltage of 127kV								
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability			
	3-phase	L-G	3-phase	L-G	Symmetrical		Asymmetrical	
With all four Sarnia-Windsor Projects In-service	25.14kA	29.31kA	31.65kA	36.73kA	*A*	31.4kA	*A*	34.1kA
With all four Sarnia-Windsor Projects plus all four units of the Calpine Project in-service	25.15kA	29.32kA	31.66kA	36.74kA	*B*	38.8kA	*B*	45.5kA

The results summarised in the Table above show that the new generating facilities at the Calpine facility will have only a negligible impact on the fault levels on either the 230kV or the 115kV busbars at Keith TS.

5.3.4 Fault Levels at the other Principal Busbars in the Sarnia-Windsor Area

The Table below provides a summary of the fault levels at the principal busbars in the Sarnia-Windsor area, with all four generating units at the proposed Calpine development in-service.

Busbar			Symmetrical		Asymmetrical		Breaker Ratings	
			3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
Buchanan TS	230kV	*A*	29.71kA	25.22	32.59kA	28.15kA	39.0kA to 74.0kA	
		B	29.93kA	25.33kA	32.83kA	28.27kA		
Chatham TS	230kV	*A*	23.28kA	14.65kA	25.54kA	14.76kA	36.4kA & 48.6kA	
		B	23.44kA	14.71kA	25.27kA	14.81kA		
Lauzon TS	C23Z 230kV	*A*	9.23kA	8.90kA	10.81kA	10.27kA	No 230kV breakers	
		B	9.23kA	8.90kA	10.82kA	10.27kA		
	C24Z 230kV	*A*	9.17kA	8.87kA	10.88kA	10.23kA		
		B	9.18kA	8.87kA	10.89kA	10.24kA		
	115kV	*A*	20.69kA	23.16kA	23.48kA	25.84kA	39.3kA	45.5kA
		B	20.70kA	23.17kA	23.49kA	25.85kA		
Essex TS	115kV	*A*	22.31kA	22.90kA	25.75kA	26.43kA	39.3kA	45.5kA
		B	22.32kA	22.91kA	25.76kA	26.44kA		

Note: The 'A' values correspond to the fault levels without the Calpine development, while the 'B' values correspond to those with the four new generating units at the Calpine Project in-service.

The values in the Table above show that the additional generators at the Calpine development would be expected to have very little impact on the fault levels at those busbars that are not within the immediate vicinity of Sarnia.

5.3.5 Summary of the Impact of the New Generators on Fault Level

With the 230kV busbar at Lambton TGS assumed to have been reconfigured to allow it to be operated 'split', the increased fault level on the two halves of the 'split' busbar due to the new Calpine development, will remain within the interrupting capability of all the existing circuit breakers at that location.

Similarly with all of the 20kA circuit breakers on the 115kV busbar at Sarnia-Scott TS assumed to be replaced with higher rated units for the incorporation of the TransAlta Project, the increased fault level on the 115kV busbar resulting from the incorporation of the Calpine Project will not exceed the interrupting capability of any of the remaining circuit breakers at that location.

However, the analysis has shown that with all four Projects from the original Sarnia-Windsor cluster assumed to be in-service, the incorporation of the Calpine Project, in isolation, would result in an increase in the fault level that would trigger the need to replace five of the existing circuit breakers on the 230kV busbar.

For all the remaining 115kV and 230kV busbars in the area, the impact that the Calpine Project has on the fault levels was found to be negligible.

6. Linear Load Flow Analysis

For this analysis the following conditions were assumed:

For Export Conditions:

- A maximum Lake Erie Circulation of 800MW counter-clockwise
- A maximum transfer of *350MW* on the J5D Interconnection from Keith TS (Windsor) to the Waterman station in Detroit, Michigan

For Import Conditions:

- A maximum Lake Erie Circulation of 200MW counter-clockwise
- A maximum transfer of ***0MW*** on the J5D Interconnection into Keith TS from the Waterman station in Detroit, Michigan.

For both Import & Export Conditions:

- The tap-changers on the phase-shifters on the L4D, L51D & B3N Interconnections were set on the neutral tap position.
- The phase shifter on the J5D Interconnection was set to regulate the maximum transfers on that Interconnection to the values detailed above.
- No attempt was made to optimise the relative tap positions in order to reduce any import or export restrictions.
- The ratings for the Ontario-Michigan Interconnections were based on an ambient temperature of 35^{o}C and a wind speed of 4km/hr.
- The ratings for all the other circuits were based on an ambient temperature of 30^{o}C and a wind speed of 4km/hr.
- The 15-minute limited-time-ratings were based on a pre-loading of 75% of the continuous rating.
- Flows in Amps were converted to MVA at voltages of 250kV and 127kV.

In all of the analysis, Lambton TGS was assumed to be operating at full output, with all four 500 MW units in-service. In addition, the existing generating units at West Windsor Power, TransAlta, and the Dow Chemical Complex were assumed to be operating at their maximum contracted power output.

The four generation Projects from the initial Sarnia-Windsor Cluster, together with the Calpine Project were also assumed to be in-service, and operating at full output.

In order to be able to accommodate the output from all four generating Projects from the initial Sarnia-Windsor Cluster, together with that from the Calpine Project, it was necessary to have transfers westwards across the Ontario-Michigan Interface for the IMPORT condition. Since the purpose of studying this condition was primarily to examine the performance of the internal Interfaces on the IMO-controlled grid, this was accepted as an unavoidable consequence of the potentially high level of congestion on the transmission system within south-western Ontario.

6.1 Transfer Interfaces & Transfer Capabilities

Diagram 11 shows the principal interfaces that were examined in this analysis.

*6.1.1 Existing 'Reference' Conditions - with the 230kV busbar at Lambton TGS '**closed**'*

Following the reinforcement of the Interconnections between Ontario and Michigan, the transfer capability of the Ontario-Michigan Interface will increase to approximately ***1505MW and 2410MW***, for import and export conditions, respectively. These transfer limits, as summarised in the Table below, are the direct result of thermal limitations on the companion Interconnections under contingency conditions involving either an Interconnection or the related facilities at the terminal stations of the Interconnection.

Limiting Transfers Across the Principal Interfaces, for the Existing System with the Lambton busbar 'closed'				
Interfaces	*Ontario-Michigan Interface*	*Sarnia-London Interface*	*London Import Interface*	*Limiting Condition*
IMPORT Condition	***1505MW***	2684MW	1875MW	*Lambton PL51 Breaker Failure* Interface transfers are restricted by the 15-minute limited-time-rating of the L4DInterconnection (1170MVA)
	1593MW	***2773MW***	1964MW	*Contingency involving circuit L29C: Lambton to Chatham* Interface transfers are restricted by the 15-minute limited-time-rating of the companion circuit L28C (652MVA).
EXPORT Condition	***2409MW***	-641MW	-2136MW	*Lambton L51L29 Breaker Failure* (with rejection of one Lambton unit) Interface transfers are restricted by the 15-minute limited-time-rating of the B3N Interconnection (482MVA)

The contingency condition that determines the limit of 1505MW for transfers eastwards across the Ontario-Michigan Interface does not have any impact on the flows on those circuits that comprise either of the two internal Interfaces that have been identified for this Assessment. Consequently, neither of these Interfaces becomes limiting when the Ontario-Michigan Interface is at its transfer limit of 1505MW.

However, if the 15-minute limited-time-rating of the L4D Interconnection were to be higher, allowing an increase in the transfer limit for the Ontario-Michigan Interface, and/or the loads in the Sarnia area were lower than those that have been assumed in this analysis, this would result in higher transfers across the Sarnia-London Interface. As shown in the table above, these transfers would become limiting at a value of 2773MW. At this transfer level, a contingency involving circuit L29C would result in a post-contingency flow on the companion circuit L28C, which is one of the circuits that comprise the Sarnia-London Interface, reaching its 15-minute limited-time-rating.

6.1.2 Conditions with the four Projects from the initial Sarnia-Windsor Cluster in-service

With the four Projects from the initial Sarnia-Windsor Cluster in-service and with those circuits at the 230kV busbar at Lambton TGS reconfigured so as to allow the busbar to be operated permanently 'split', the transfer limits were determined to be as shown below, for the Import and Export conditions, respectively.

IMPORT CONDITION ***with all four Sarnia-Windsor Projects in-service, and with the 230kV busbar at Lambton TGS 'Split'***						
Limiting Contingency		*Limiting Circuit*	*Rating of Circuit*	*Corresponding Interface Flows*		
				Ontario-Michigan Interface	*Sarnia-London Interface*	*London Import Interface*
1	Pre-contingency	L26L	579MVA (continuous)	*374MW*	***2607MW***	***2815MW***
2	Double-circuit contingency N21W + N22W	L26L	795MVA (15-min LTR)	376MW	2608MW	2817MW
3	Pre-contingency	L24L	579MVA (continuous)	480MW	2695MW	2921MW

EXPORT CONDITION ***with all four Sarnia-Windsor Projects in-service, and with the 230kV busbar at Lambton TGS 'Split'***						
Limiting Contingency		*Limiting Circuit*	*Rating of Circuit*	*Corresponding Interface Flows*		
				Ontario-Michigan Interface	*Sarnia-London Interface*	*London Import Interface*
1	Lambton PL51 Stuck-breaker condition ~ Loss of L51D + G4	Interconnection B3N	482MVA (15-min LTR)	***2267MW***	449MW	108MW
2	Pre-contingency	Interconnection L51D	845MVA (Continuous)	2319MW	397MW	56MW
3	Interconnection L4D + G/R of one Lambton unit	Interconnection B3N	482MVA (15-min LTR)	2427MW	289MW	-52MW
4	Single-circuit contingency L27N	Interconnection L51D	1170MVA (15-min LTR)	2923MW	-207MW	-548MW

It should be noted that a revised value for the transfer capability of the Ontario-Michigan Interface, for transfers into Ontario with the Lambton busbar 'split' and with none of the Sarnia-Windsor Projects in-service, was not determined as part of the earlier System Impact Assessment for the initial Sarnia-Windsor Cluster. In that SIA, the transfer limit of 1505MW for the existing facilities with a 'closed' busbar at Lambton TGS was assumed to be still valid.

*6.1.3 Revised Transfer Limits for the Ontario-Michigan Interface with the 230kV busbar at Lambton TGS '**split**'*

Studies were performed to determine revised 'reference' transfer limits for the Ontario-Michigan Interface with the Lambton 230kV busbar 'split' for the existing facilities, with none of the Projects in the original Sarnia-Windsor Cluster assumed to be in-service.

The results are summarised in the Tables below. It should also be noted that as a result of these studies a revised arrangement for the reconfiguration of the northern half of the Lambton busbar was considered, and this was found to result in an improved transfer capability under Import Conditions. This revised arrangement is shown in Diagram 12.

IMPORT CONDITION ***Limiting Transfers Across the Principal Interfaces*** ***~ With no new generating facilities and with the 230kV busbar at Lambton TGS 'split' ~ Diagram 3***			
Interfaces			*Limiting Condition*
Ontario-Michigan Interface	*Sarnia-London Interface*	*London Import Interface*	
1332MW	***2511MW***	1703MW	*Lambton L23L24 Breaker Failure* *(Results in the loss of circuits L23N & L24L)* Interface transfers are restricted by the 15-min LTR of 713MVA for circuit L29C.
1723MW	2901MW	2094MW	*Contingency involving the L51D Interconnection* *(with the loss of unit G1 or G2 at Lambton TGS due to breaker failure)* Interface transfers are restricted by the 15-min LTR of 1170MVA for the L4D Interconnection
~ With the revised termination arrangement as shown in Diagram 12			
1716MW	***2895MW***	2087MW	*Lambton L23L26 Breaker Failure* *(Results in the loss of circuits L23N & L29C)* Interface transfers are restricted by the 15-min LTR of 795MVA for circuit L24L

As a result of the revised termination arrangement that has been proposed, the two Interconnections L4D and L51D, would be connected to separate halves of the Lambton 230kV busbar. This would result in less of the pre-contingency transfer on Interconnection L51D appearing on the companion Interconnection L4D (and vice versa) for a contingency involving this Interconnection.

Consequently, the breaker failure condition involving circuit breaker PL51 at Lambton TGS, which would result in the simultaneous loss of the L51D Interconnection and one of the generating units at that station, only becomes limiting at a transfer level of 1723MW. Previously, with the Lambton 230kV busbar operated 'closed' this contingency condition was limiting at a transfer of 1505MW.

However, the critical contingency with the 230kV busbar 'split' would become one involving a breaker failure condition on circuit breaker L23L24 at Lambton TGS. This condition would result in the simultaneous loss of circuits L23N and L24L, and as shown in the Table above, would limit the transfer capability of the Ontario-Michigan Interface to 1332MW.

Although a similar situation could arise on the southern half of the Lambton 230kV busbar for a breaker failure condition involving circuit breaker L27L28 which would result in the simultaneous loss of circuits L27N and L26L, this would be less impactive on the Ontario-Michigan Interface limit because two circuits from Scott TS are connected the southern busbar.

The response of the revised termination arrangement for the 230kV circuits at Lambton TGS, as shown in Diagram 12, was examined to determine whether the simultaneous loss of circuits L23N and L29C, for a breaker failure condition on circuit breaker L23L26, would be as limiting as the simultaneous loss of circuits L23N and L24L.

The results shown in the Table above indicate an improvement of almost 400MW in the transfer capability of the Ontario-Michigan Interface between the two breaker-failure conditions, and an improvement of approximately 200MW from the existing limit for a 'closed' 230kV busbar at Lambton TGS.

It is therefore proposed to adopt this revised termination arrangement as the preferred option for reconfiguring the 230kV circuits at Lambton TGS and all future analysis will be based on this arrangement.

EXPORT CONDITION
Limiting Transfers Across the Principal Interfaces
~ With no new generating facilities and with the 230kV busbar at Lambton TGS 'split'

Interfaces			*Limiting Condition*
Ontario-Michigan Interface	*Sarnia-London Interface*	*London Import Interface*	
2205MW	438MW	1932MW	*Contingency involving the L4D Interconnection (with rejection of unit G1 or G2 at Lambton TGS)* Interface transfers are restricted by the 15-min LTR of 482MVA for the B3N Interconnection
2327MW	560MW	2054MW	*Contingency involving the L51D Interconnection (with rejection of unit G3 or G4 at Lambton TGS)* Interface transfers are restricted by the 15-min LTR of 482MVA for the B3N Interconnection
2378MW	611MW	2106MW	*Contingency involving the L4D Interconnection (with rejection of unit G3 or G4 at Lambton TGS)* Interface transfers are restricted by the 15-min LTR of 482MVA for the B3N Interconnection
2401MW	634MW	2130MW	*Contingency involving the L51D Interconnection (with rejection of unit G1 or G2 at Lambton TGS)* Interface transfers are restricted by the 15-min LTR of 482MVA for the B3N Interconnection
2440MW	673MW	2168MW	*Pre-contingency* Interface transfers are restricted by the continuous rating of 845MVA for the L51D Interconnection
2491MW	723MW	2219MW	*Pre-contingency* Interface transfers are restricted by the continuous rating of 845MVA for the L4D Interconnection
2847MW	1080MW	2575MW	*Contingency involving the L4D Interconnection (with rejection of G4* ***and*** *loss of G3 at Lambton TGS due to KL4 breaker failure)* Interface transfers are restricted by the 15-min LTR of 1170MVA for the L51D Interconnection

In the Table above, for the Export Condition, the effect on the transfer capability of the Ontario-Michigan Interface of selecting the 'wrong' Lambton generating units for rejection in response to a contingency involving either of the Interconnections is apparent. It is particularly noticeable for contingencies involving the L4D Interconnection, which is to remain connected to the southern half of the Lambton busbar once it has been 'split'. If either of the units that are connected to the northern half of the Lambton busbar, G1 or G2, selected for rejection in response to an L4D contingency, then the transfer capability of the Interface would decrease by approximately 200MW. However, by selecting either unit G3 or unit G4 for this particular contingency it would be possible to maintain the transfer capability of the Interface at its present value of approximately 2400MW.

This means that when the Lambton busbar is reconfigured to allow it to be operated 'split', the Lambton Generation Rejection Scheme will also need to be modified to permit the appropriate generating units to be selected for rejection for contingencies involving either of the two Ontario-Michigan Interconnections that are terminated at Lambton TGS.

Since the Calpine Project will have a similar impact on the post-contingency transfers on the companion Interconnections as the existing units at Lambton TGS, it will be a requirement for the connection of this Project to the IMO-controlled grid that it be incorporated into the revised Lambton Generation Rejection Scheme.

6.1.4 'Reference' transfer capabilities used in this Assessment

For this review, it has been assumed that the reconfiguration of the 230kV circuits at Lambton TGS will conform with the arrangement shown in Diagram 12, and that the following values, which have been extracted from the Tables above, should therefore be used as the basis on which to compare the impact of incorporating the Calpine-Corunna Project into the IMO-controlled grid.

It has also been assumed that the required uprating of the section of circuits N21W & N22W, between Sarnia-Scott TS and Lucasville Junction, will have been completed.

Interface	*Direction of Transfer*	*Transfer Capability*	*Conditions: Lambton busbar 'split'*
Ontario-Michigan Interface	Transfer eastwards (import)	1716MW	With ***none*** of the Projects from the initial Sarnia-Windsor Cluster in-service
	Transfer westwards (export)	2378MW	
Sarnia-London Interface	Transfers eastwards	2895MW	
London Import Interface		2087MW	
Ontario-Michigan Interface	Transfer eastwards (import)	Not Applicable	With ***all four*** Projects from the initial Sarnia-Windsor Cluster in-service
	Transfer westwards (export)	2267MW	
Sarnia-London Interface	Transfers eastwards	2607MW	
London Import Interface		2815MW	

It is worth noting that the significant change in the limiting value for the London Import Interface is due primarily to the location of the new generation Projects.

Currently, the Sarnia area has an excess of generation capacity of approximately 1500MW over the local load, while the Windsor area has a deficit of approximately 400MW. Under Import Conditions with the transfers on the J5D Interconnection maintained at 0MW (refer to the conditions that were assumed for this analysis), the Windsor area deficit is supplied mainly via circuits L28C & L29C from Lambton TGS. Since the Chatham area load is also supplied primarily via these circuits, the net result is that the transfers on circuits W44LC & W45LC are very low. This means that the flow contributions to the London Import Interface are mainly confined to those on circuits N21W & N22W and L24L & L26L. This results in a low transfer capability for the London Import Interface even though the Sarnia-London Interface has reached its limiting transfer.

With the four generation Projects from the initial Sarnia-Windsor Cluster in-service, the transfers over circuits W44LC & W45LC increase significantly, while those on circuits L28C & L29C decrease. This results in a corresponding higher transfer limit for the London Import Interface coincident with the Sarnia-London Interface reaching its limiting transfer. This effectively means that the two Interfaces are being utilised to approximately the same degree.

6.2 Impact of the Calpine Project on the Principal Transfer Interfaces in South-western Ontario

The Tables below shows the results of the linear load-flow analysis

IMPORT (Transfer Eastwards) CONDITION

With all four projects from the original Sarnia-Windsor cluster, together with the Calpine Generation Project in service

With the 230kV circuits reconfigured and the 230kV busbar at Lambton TGS operated 'Split'

Limiting Contingency		*Limiting Circuit*	*Rating of Circuit*	*Corresponding Interface Flows*		
				Ontario-Michigan Interface	*Sarnia-London Interface*	*London Import Interface*
1	Double-circuit contingency N21W + N22W	L26L	795 MVA (15-min LTR)	-748MW	***2665MW***	2707MW
2	Pre-contingency	L26L	579 MVA (Continuous)	-723MW	2690MW	2732MW
3	Pre-contingency	N22W	465 MVA (Continuous)	-665MW	2747MW	2790MW
		N21W		-663MW	2750MW	2792MW
4	Pre-contingency	L24L	579 MVA (Continuous	-548MW	2865MW	2708MW
5	Double-circuit contingency N21W + N22W	L24L	795 MVA (15-min LTR)	-509MW	2904MW	2947MW
6	Double-circuit contingency L24L + L26L	N22W	685 MVA (15-min LTR)	-541MW	2872MW	2914MW
		N21W		-539MW	2874MW	2916MW
7	Buchanan L22L44 Stuck-breaker condition ~ Loss of N22W + W44LC	L26L	795 MVA (15-min LTR)	-454MW	2959MW	3001MW
8		N21W	685 MVA (15-min LTR)	-494MW	2920MW	2962MW

Transfers eastwards are positive

In order to accommodate the output from the Calpine Project when all four Projects from the initial Sarnia-Windsor Cluster are in-service, it has been necessary to allow transfers *westwards* across the Ontario-Michigan Interface. Since the transfers on the J5D Interconnection are maintained at 0MW, these transfers are therefore confined to the three Interconnections B3N, L4D & L51D. Furthermore, since the incremental changes in flow distribution due to the Calpine Project (as shown in Diagram 4) are primarily confined to circuits N21W & N22W and L24L & L26L, the net result is to increase the utilisation of those circuits that comprise the Sarnia-London Interface. Since the corresponding transfers on circuits W44LC & W45LC are once again relatively small, the limiting transfer for the London Import Interface is similarly reduced.

The values in the Table above for the limiting transfers across the Sarnia-London Interface and the London Import Interface are 2665MW and 2707MW, respectively. These values compare favourably with the respective limiting transfers of 2607MW and 2815MW quoted above for the situation with just those Projects from the initial Sarnia-Windsor Cluster in-service.

EXPORT (Transfer Westwards) CONDITION

With all four projects from the original Sarnia-Windsor cluster, together with the Calpine Generation Project in service

With the 230kV circuits reconfigured and the 230kV busbar at Lambton TGS operated 'Split'

Limiting Contingency		*Limiting Circuit*	*Rating of Circuit*	*Corresponding Interface Flows*		
				Ontario-Michigan Interface	*Sarnia-London Interface*	*London Import Interface*
1	Interconnection L4D + G/R of Lambton unit G3 or G4	Interconnection B3N	795 MVA (15-min LTR)	***2262MW***	-1277MW	936MW
2	Interconnection L51D + G/R of Lambton unit G1 or G2	Interconnection B3N	579 MVA (Continuous)	2309MW	-1230MW	-889MW
3	Pre-contingency	Interconnection L51D	579 MVA (Continuous	2464MW	-1076MW	-735MW
4	Pre-contingency	Interconnection L4D	795 MVA (15-min LTR)	2468MW	-1071MW	-731MW
5	Interconnection L4D + G/R of of Lambton unit G4 + breaker failure of KL4, resulting in loss of Lambton unit G3	Interconnection L51D	685 MVA (15-min LTR)	2831MW	-707MW	-367MW

Transfers westwards are positive

The limiting value of 2262MW for transfers westwards across the Ontario-Michigan Interface with the Calpine Project in-service is virtually identical to that of 2267MW with just the four Projects in the initial Sarnia-Windsor cluster in-service.

The Table above also includes the impact of a stuck breaker condition. Specifically, for a contingency involving Interconnection L4D, for which unit G4 has been selected for rejection, but which could result in the simultaneous loss of unit G3 should breaker KL4 mal-function. Similar scenarios could be postulated for breaker PL4 and for the two new breakers that would need to be installed for the retermination of the L51D Interconnection on to the northern half of the 'split' busbar. The results show that this contingency condition would not have an adverse impact on the transfer limit.

6.3 Conclusion

Apart from adding to the severe congestion that has already been identified on the transmission system in south-western Ontario, the results from the linear load-flow analysis show that the Calpine Project, in isolation, is not expected to materially impact on the transfer capabilities of the Ontario-Michigan Interface; the Sarnia-London Interface; or the London Import Interface.

7. Impact on System Transfers

The System Impact Assessment Report for the four generation projects in the initial Sarnia-Windsor cluster addressed the potential for congestion on the 500kV and 230kV systems in the south-west, assuming all four projects proceed to completion.

Diagram 16 from that Report, which showed the approximate generation-load balance for the three principal centres in the Sarnia-Windsor study area, with all four of the new Projects in-service, has been reproduced as Diagram 13.

This Diagram shows the net transfers from the three principal load and/or generation areas with the expected peak loads for the summer-2004. This Diagram has been amended from its original version to show the impact that an additional 870MW of generating capacity at the Calpine development would have. In particular, with no transfers being made into Ontario across the Ontario-Michigan Interface, the net transfer across the London-Import Interface would increase to approximately 2690MW. Since the eastward transfer limit for the London-Import Interface is approximately 2815MW, the maximum transfer that could occur across the Ontario-Michigan Interface, with all the generating facilities in the area fully dispatched, would be limited to approximately 125MW. Conversely, with maximum transfers of 1715MW across the Ontario-Michigan Interface, approximately 1590MW of the generating capacity in the area would be constrained. During periods with reduced loads in the area, there would be further restrictions on the amount of generating capacity that could be dispatched and on the level of transfers that could be made into Ontario across the Ontario-Michigan Interface.

For the situation when transfers are being made to Michigan across the Ontario-Michigan Interface, then as long as there was a minimum transfer eastwards across the London-Import Interface of at least 290MW, it would be possible to dispatch all of the generating capacity in the Sarnia and Windsor area and respect the transfer limit of approximately 2400MW. Again, during periods with reduced loads, there would have to be a comparable increase in the transfer eastwards across the London-Import Interface, to allow all of the generating capacity to be dispatched.

For the Sarnia-Windsor study area the dispatch of generating capacity could also be restricted by a requirement to respect the Negative BLIP (Bruce-Longwood Input) Interface limit of 1500MW. As shown in Diagram 13, with all the generating facilities in the area fully dispatched and with no transfers into Ontario across the Ontario-Michigan Interface, the net transfer across the Negative BLIP Interface would be approximately 1490MW. Since this is essentially the same value as the Negative BLIP limit, there would be no opportunity for simultaneous transfers into Ontario across the Ontario-Michigan Interface when all the generation capacity within the area is dispatched.

As before the restrictions would be more severe during those periods when the loads are lighter, requiring a 1MW increase in the westward transfer across the Ontario-Michigan Interface, or a reduction of 1MW in the amount of generating capacity that could be dispatched, for every 1MW reduction in the load that has been assumed.

8. Conclusions

The Preliminary Assessment has examined the effect of incorporating the additional generating capacity that Calpine Canada Power Holdings Ltd. is proposing to install at their new generating facility near the Nova Corunna Complex in the Township of St. Clair into the IMO-controlled grid, and the following conclusions have been reached:

- The proposed connection of the steam-turbine/gas-turbine component of the new facility on to circuits L25N & L27N via the existing 230kV circuits, and the connection of the remaining two gas-turbine units on to circuit L23N via a new single-circuit will have no adverse impact on reliability, as long as the following requirements are met:
  i. agreement is reached with the transmitter to allow *limited* operation of the tapped connections on to circuits L25N & L27N to the 'sag' temperature of 150^{o}C,

     OR

     these connections are reconductored to allow for continuous operation of each connection at a loading of 450MVA,

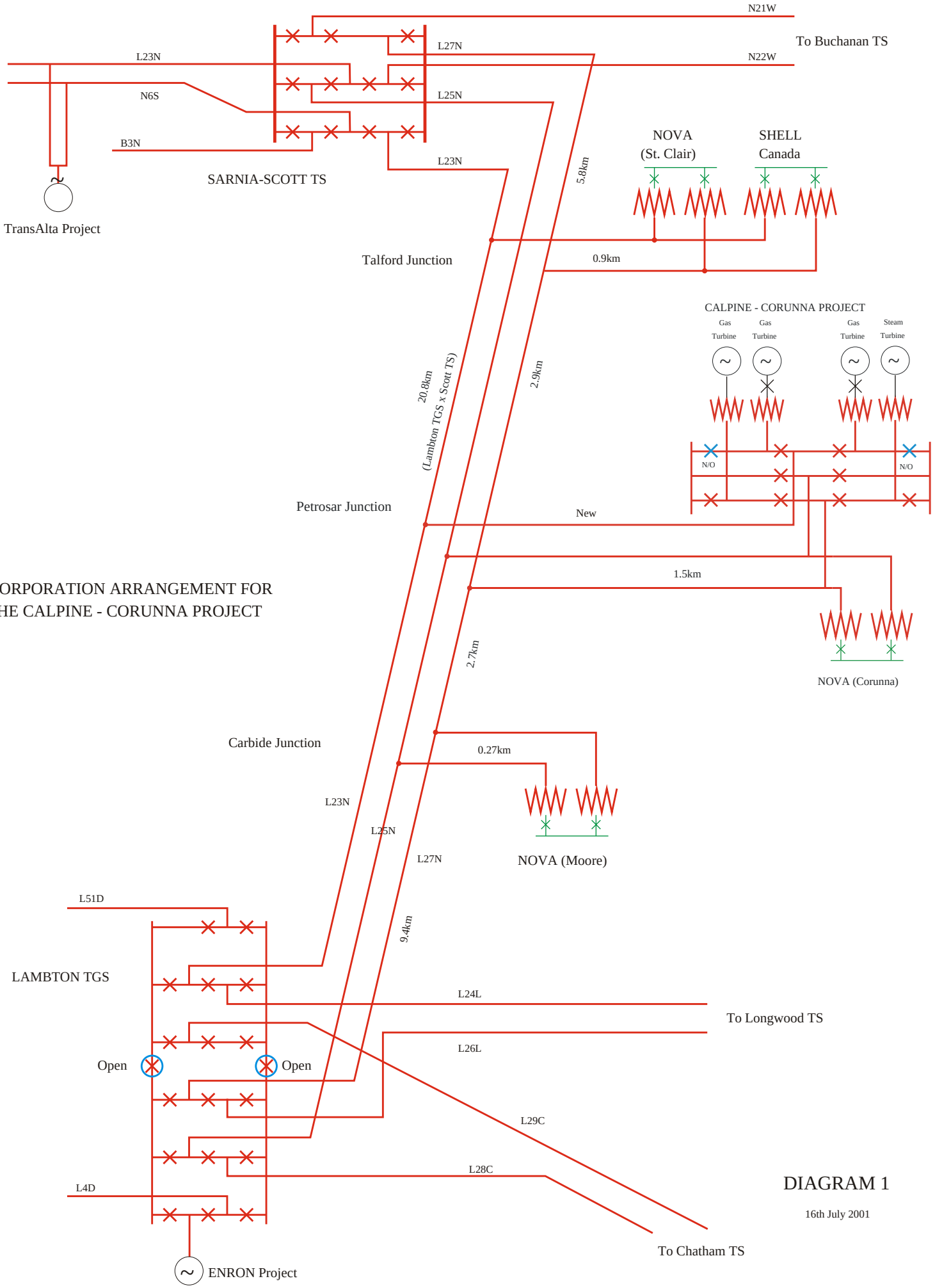
     OR

     a generation rejection scheme is installed to reduce the output from the gas-turbine/steam-turbine combination to within the continuous rating of a single tapped connection under contingency conditions involving the companion connection.

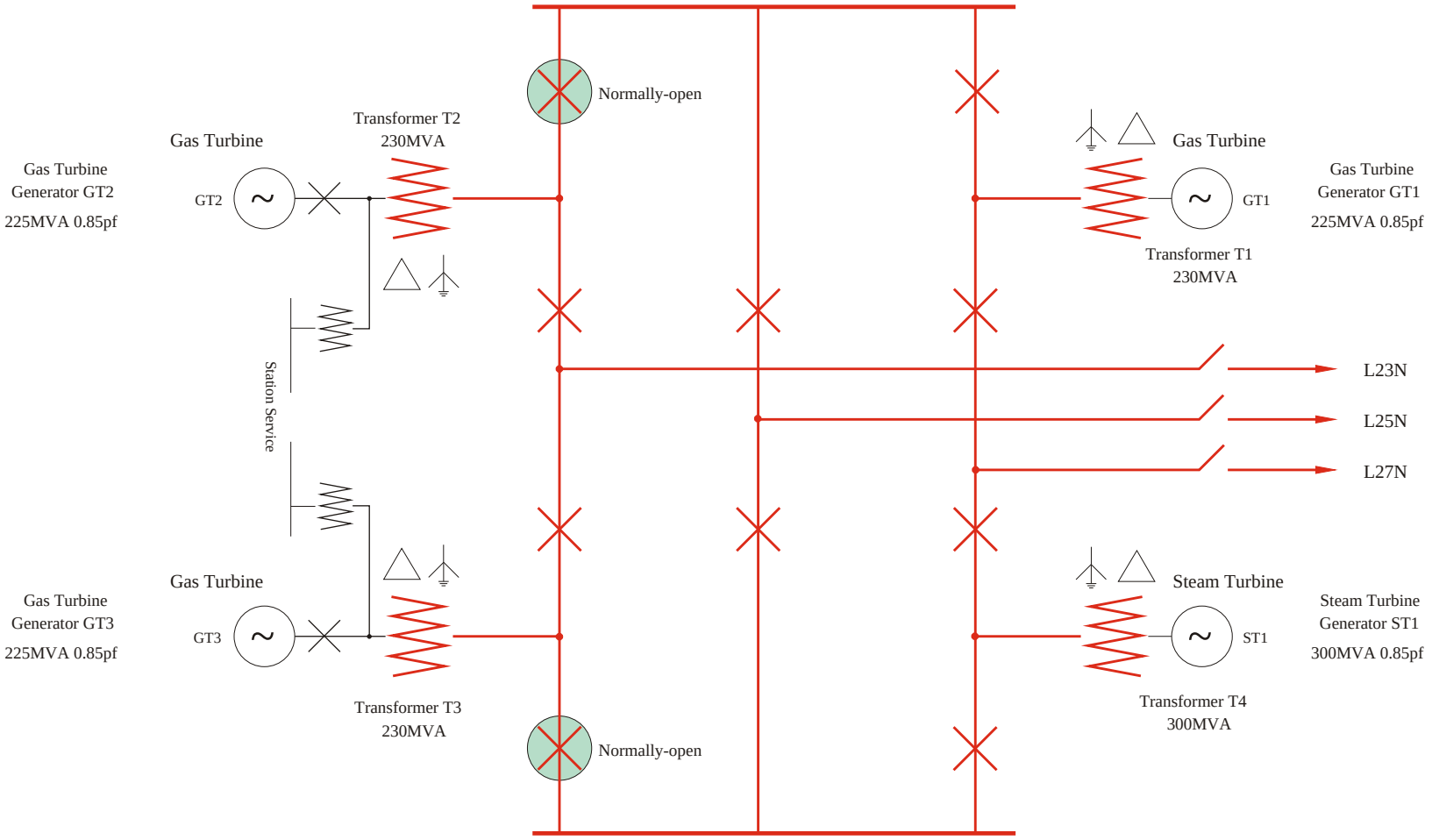
  ii. a generation rejection scheme is installed to address possible post-contingency overloading of the 230kV circuits between Lambton TGS and Scott TS for the following contingency conditions:

Contingency condition		*Circuits Involved*
Single-circuit		L23N or L27N
Double-circuit		N21W & N22W
		L23N & L25N
		L24L & L26L
		L28C & L29C
Breaker Failure:	Lambton L51L29	L25N & L28C
	Lambton L27L28	L26L & L27N
	Lambton L25L26	L23N & L29C

- With the four Projects from the original Sarnia-Windsor Cluster in-service, *and with the 230kV busbar at Lambton TGS reconfigured and operated permanently 'split'*, the Calpine Project would 'trigger' the requirement to replace ***five*** of the existing 230kV circuit breakers at Sarnia-Scott TS with higher rated units.
- It has also been assumed that the existing 20kA circuit breakers on the 115kV busbar at Sarnia-Scott TS will also have been replaced prior to the incorporation of the Calpine Project into the IMO-controlled grid. While the Calpine Project would increase the fault levels on that busbar they would remain within the rating of the next critical breaker (KL1, with a rating of ≈ 31kA)
- Also, on the assumption that the section of the 230kV circuits N21W & N22W between Scott TS and Lucasville Junction will have been uprated prior to the Calpine Project being placed in-service, the Calpine Project is not expected to materially impact on the transfer capabilities of the Ontario-Michigan Interface; the Sarnia-London Interface; or the London Import Interface.
- Once the Lambton 230kV busbar is reconfigured and operated 'split', the Lambton Generation Rejection Scheme will need to be revised to allow units G1 & G2 to be selected specifically for a contingency involving the L51D Interconnection and units G3 & G4 to be selected for a contingency involving the L4D Interconnection.
- It will also be a requirement for the connection of the Calpine Project to the IMO-controlled grid that it be incorporated into the revised Lambton Generation Rejection Scheme.
- The new generating facilities will also increase the congestion within the area, both for the Import and the Export Condition as a result of the limited transmission capacity in south-western Ontario, as well as the capacity of the Ontario-Michigan Interconnections.


N21W
To Buchanan TS
L23N
N22W
L27N
N6S
L25N
B3N
L23N
SARNIA-SCOTT TS
TransAlta Project
NOVA
(St. Clair)
SHELL
Canada
5.8km
Talford Junction
0.9km
CALPINE - CORUNNA PROJECT
Gas Turbine
Gas Turbine
Gas Turbine
Steam Turbine
N/O
N/O
20.8km
(Lambton TGS x Scott TS)
2.9km
Petrosar Junction
New
1.5km
INCORPORATION ARRANGEMENT FOR
THE CALPINE - CORUNNA PROJECT
2.7km
NOVA (Corunna)
Carbide Junction
0.27km
L23N
L25N
L27N
NOVA (Moore)
L51D
9.4km
LAMBTON TGS
L24L
To Longwood TS
L26L
Open
Open
L29C
L28C
L4D
To Chatham TS
ENRON Project
DIAGRAM 1
16th July 2001

CALPINE PROJECT



New 230kV Switching Station

DIAGRAM 2

16th July 2001

Current Proposal for Reconfiguring the 230kV busbar at Lambton TGS to allow it to be operated 'split'

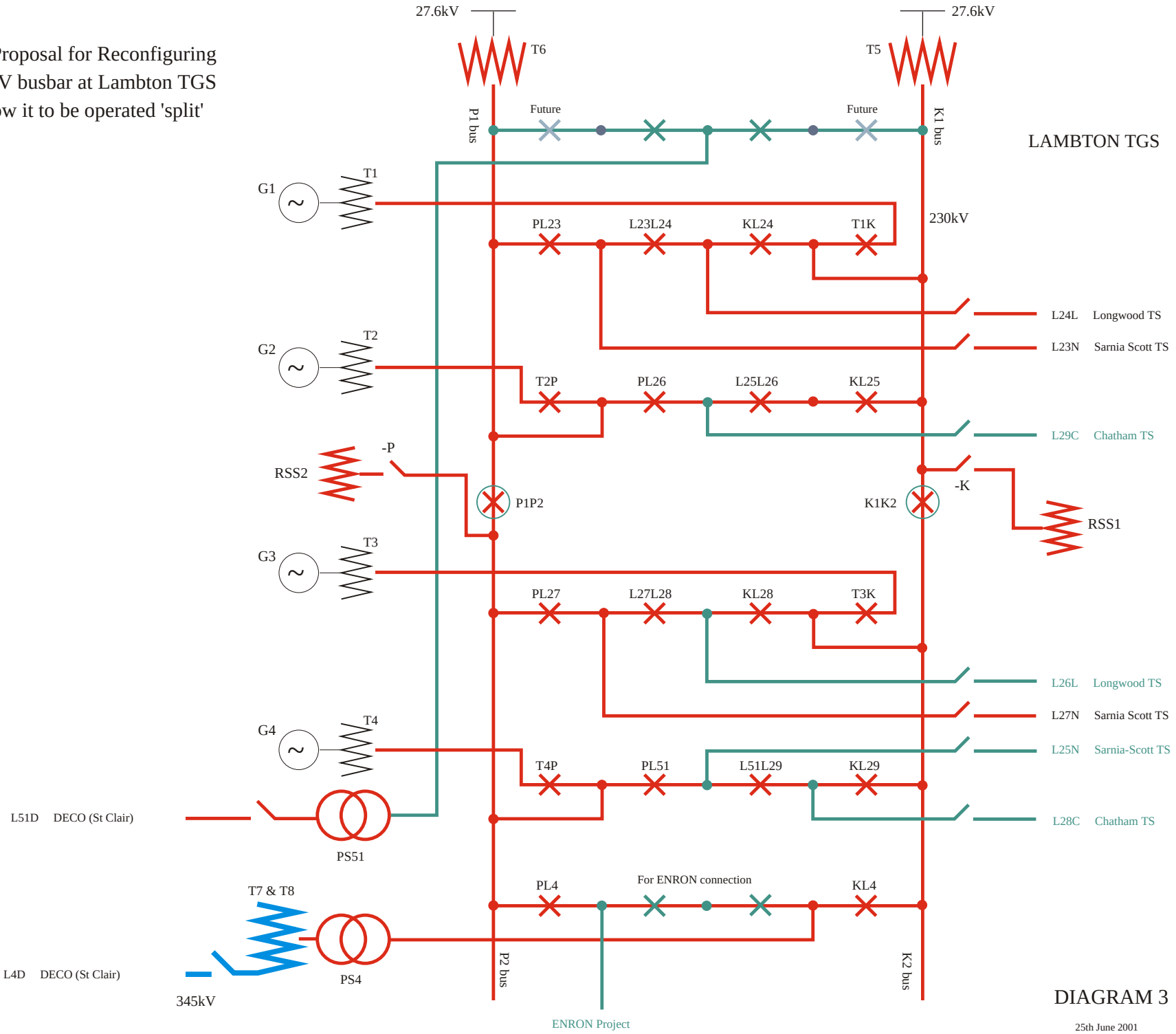
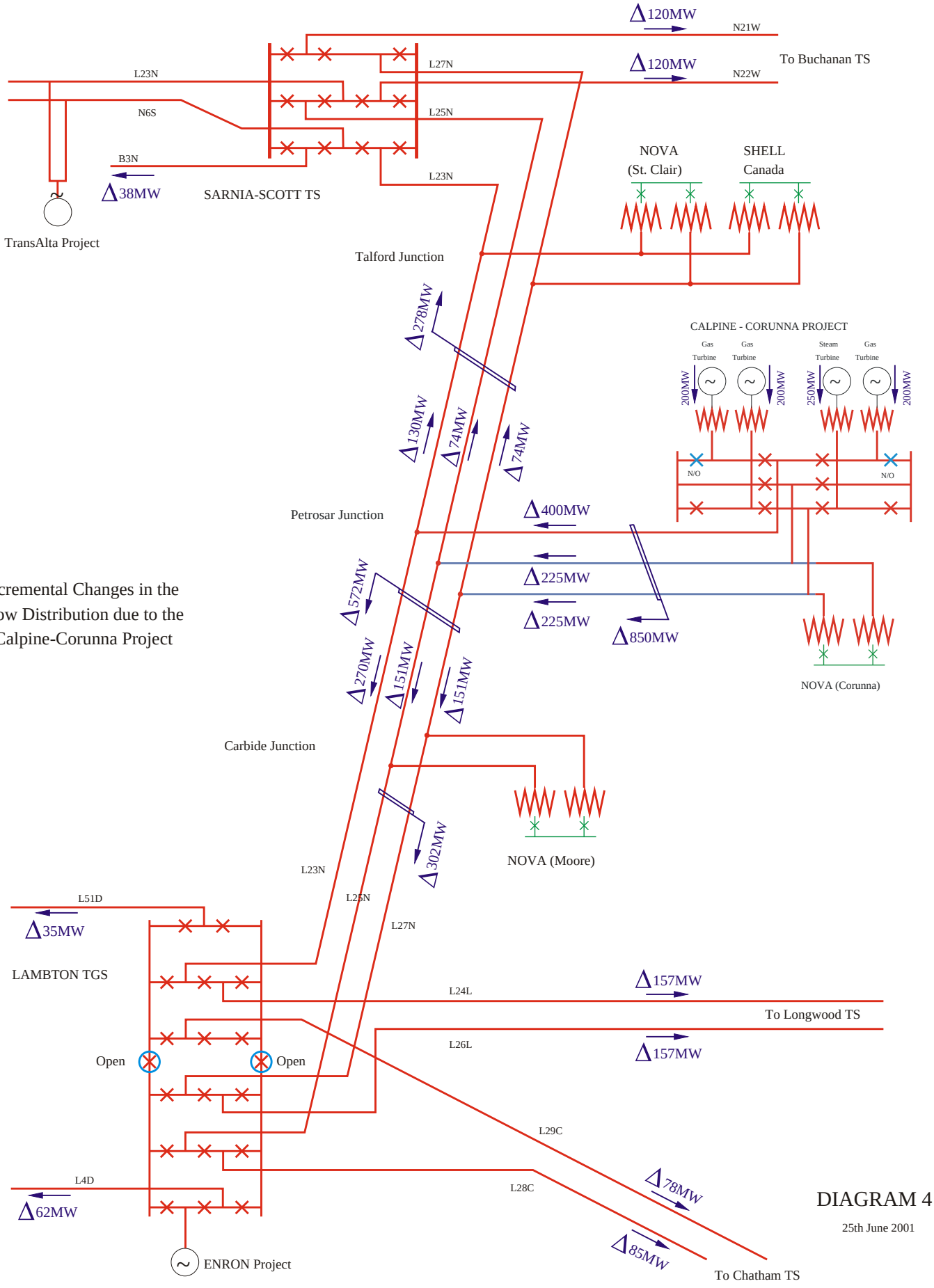


DIAGRAM 3

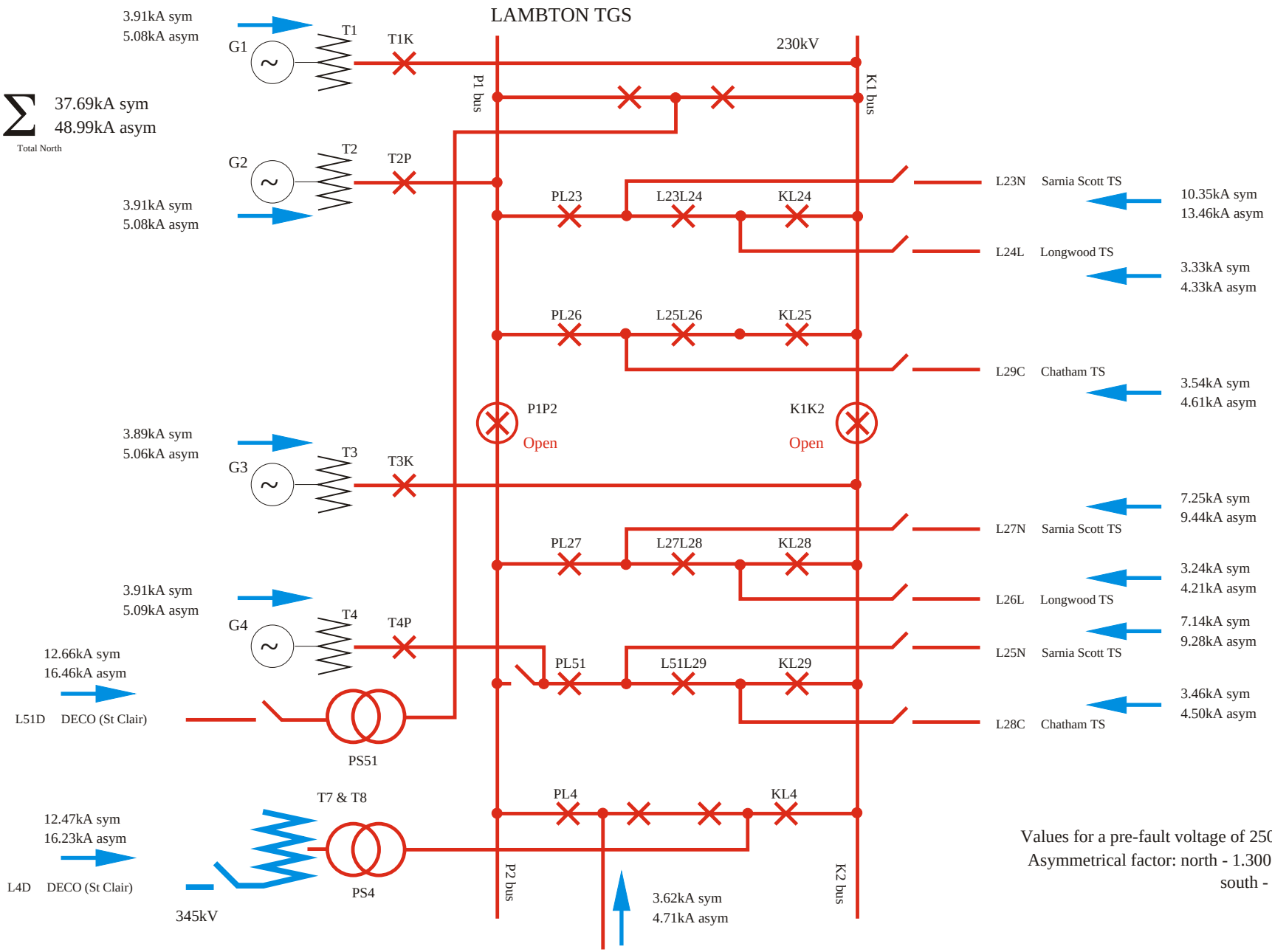
25th June 2001



Incremental Changes in the Flow Distribution due to the Calpine-Corunna Project

DIAGRAM 4

25th June 2001

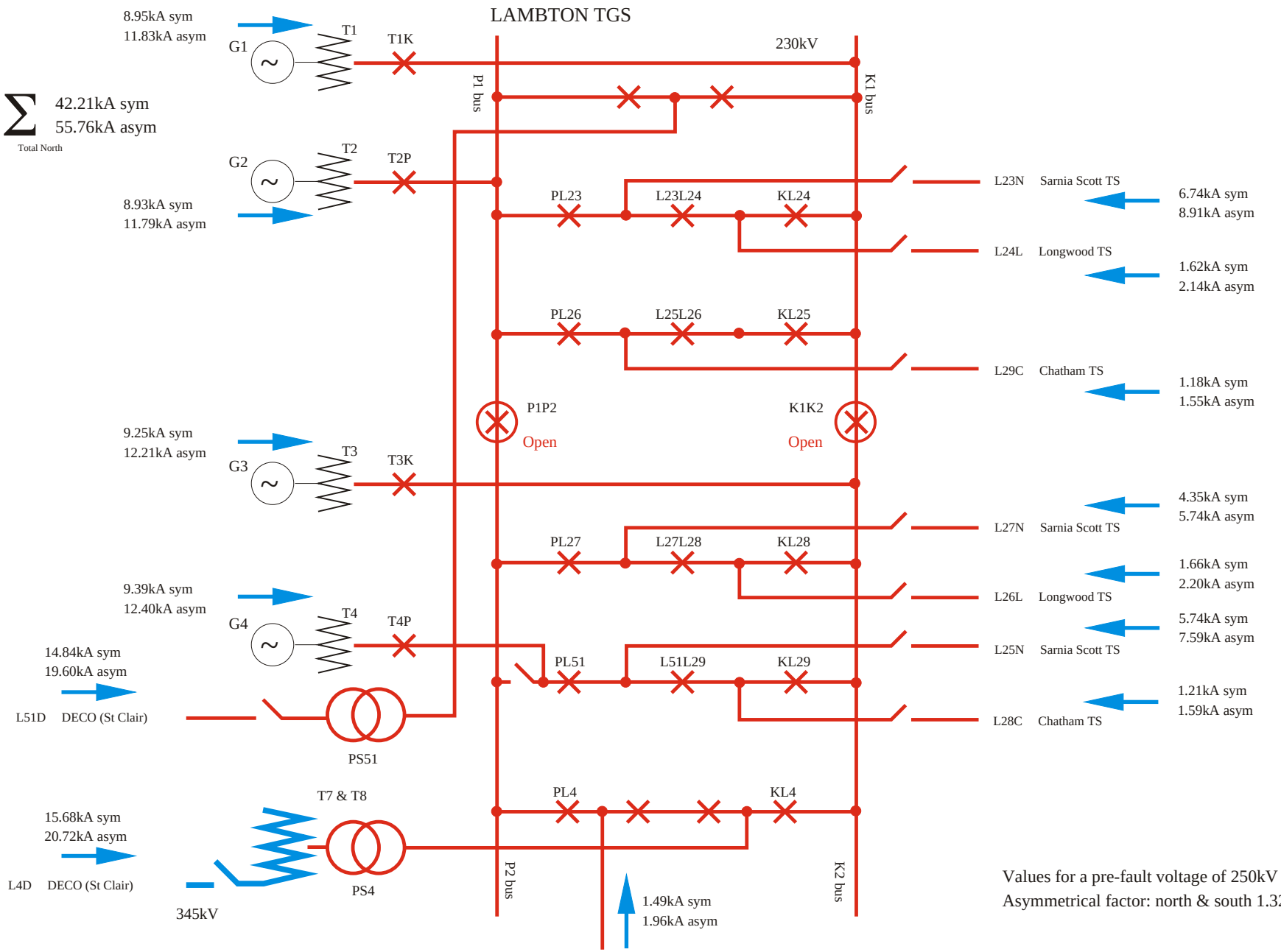


Values for a pre-fault voltage of 250kV
Asymmetrical factor: north - 1.300 &
south - 1.301

3-Phase Fault Levels with the Calpine-Corunna [Sarnia]
Project Incorporated & the Lambton Busbar 'Split'

DIAGRAM 5

30th May 2001

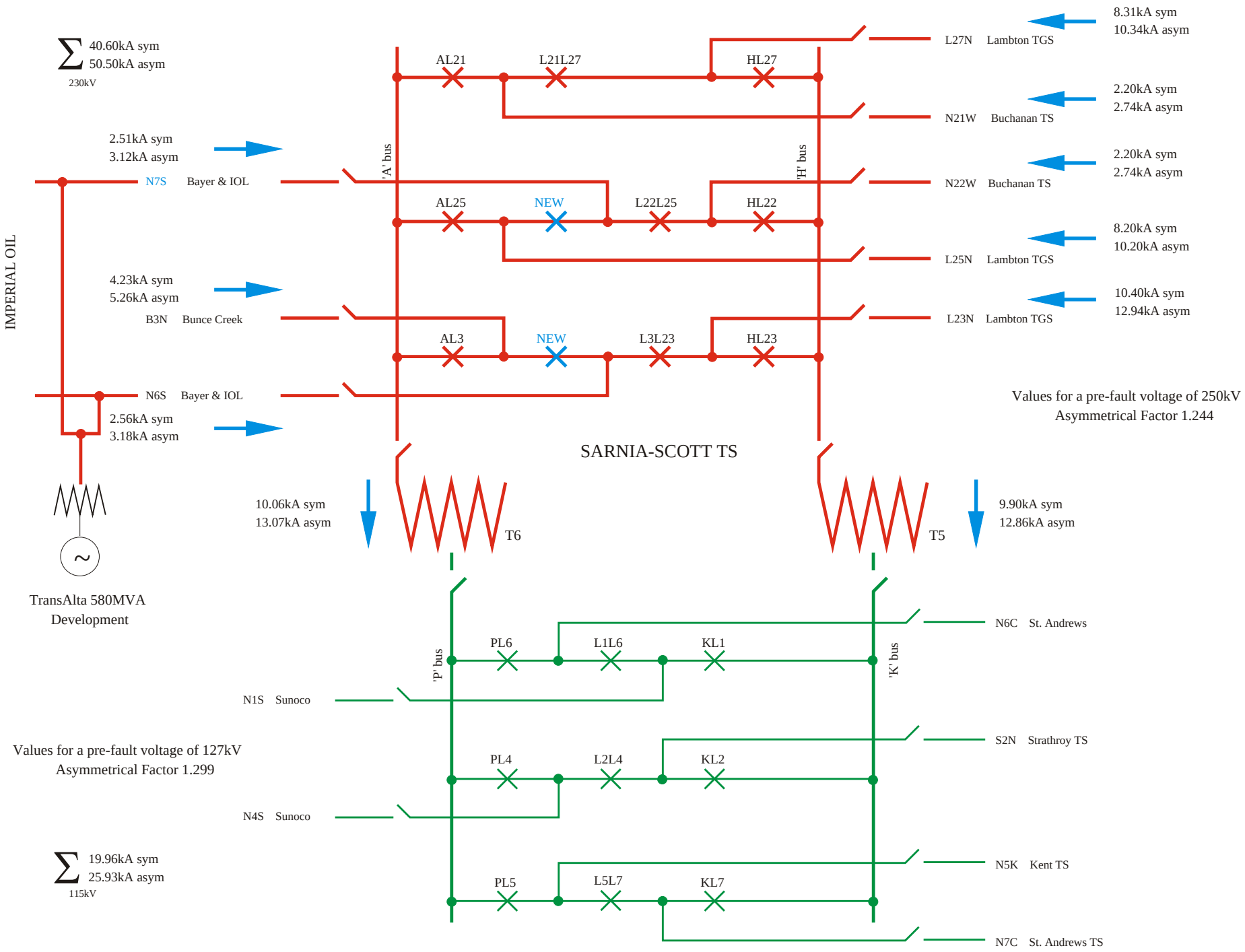


Values for a pre-fault voltage of 250kV
Asymmetrical factor: north & south 1.321

Line-to-Ground Fault Levels with the Calpine Corunna [Sarnia]
Project Incorporated & the Lambton Busbar 'Split'

DIAGRAM 6

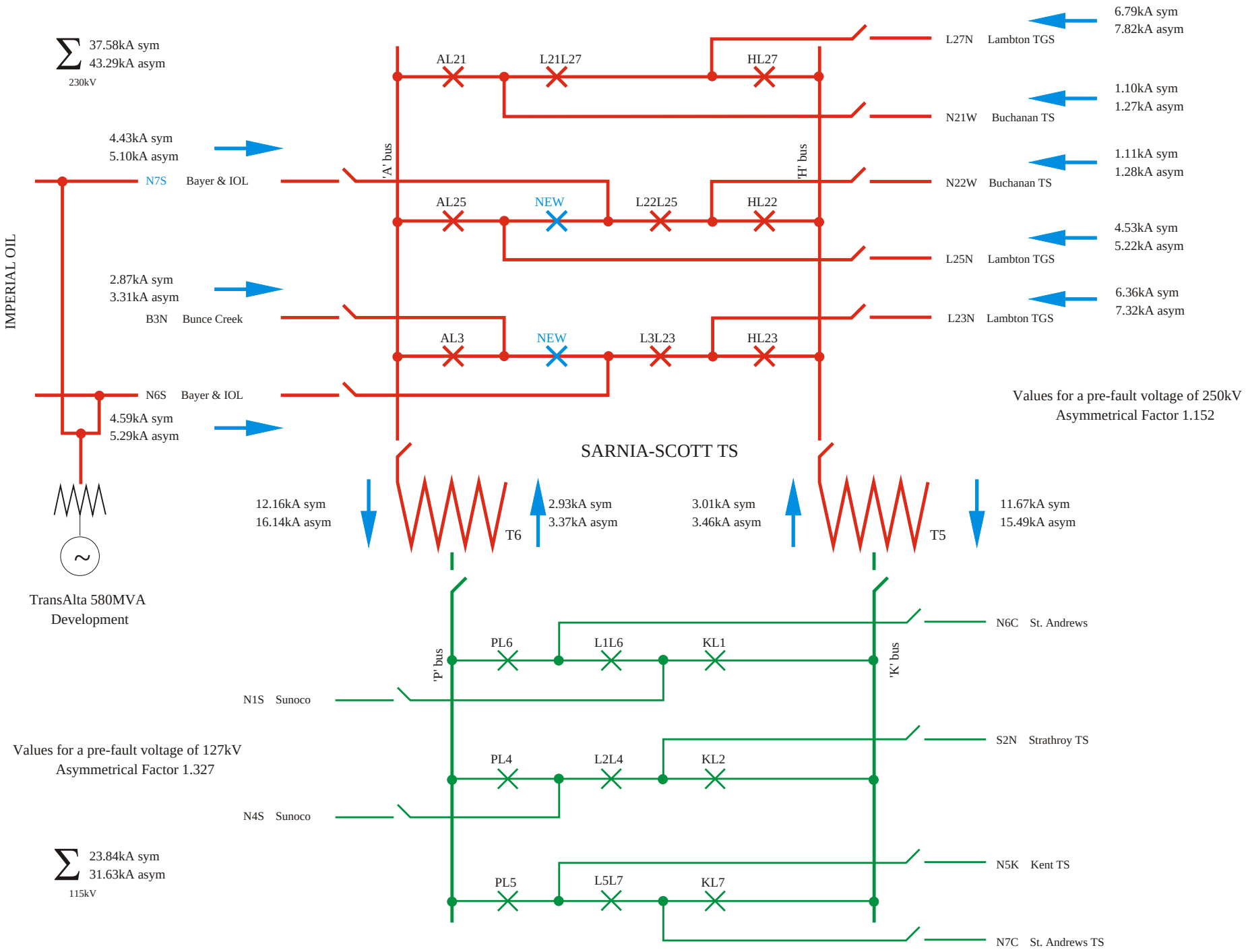
6th June 2001



3-phase Fault Levels with the Calpine Corunna [Sarnia]
Project Incorporated & the Lambton Busbar 'Split'

DIAGRAM 7

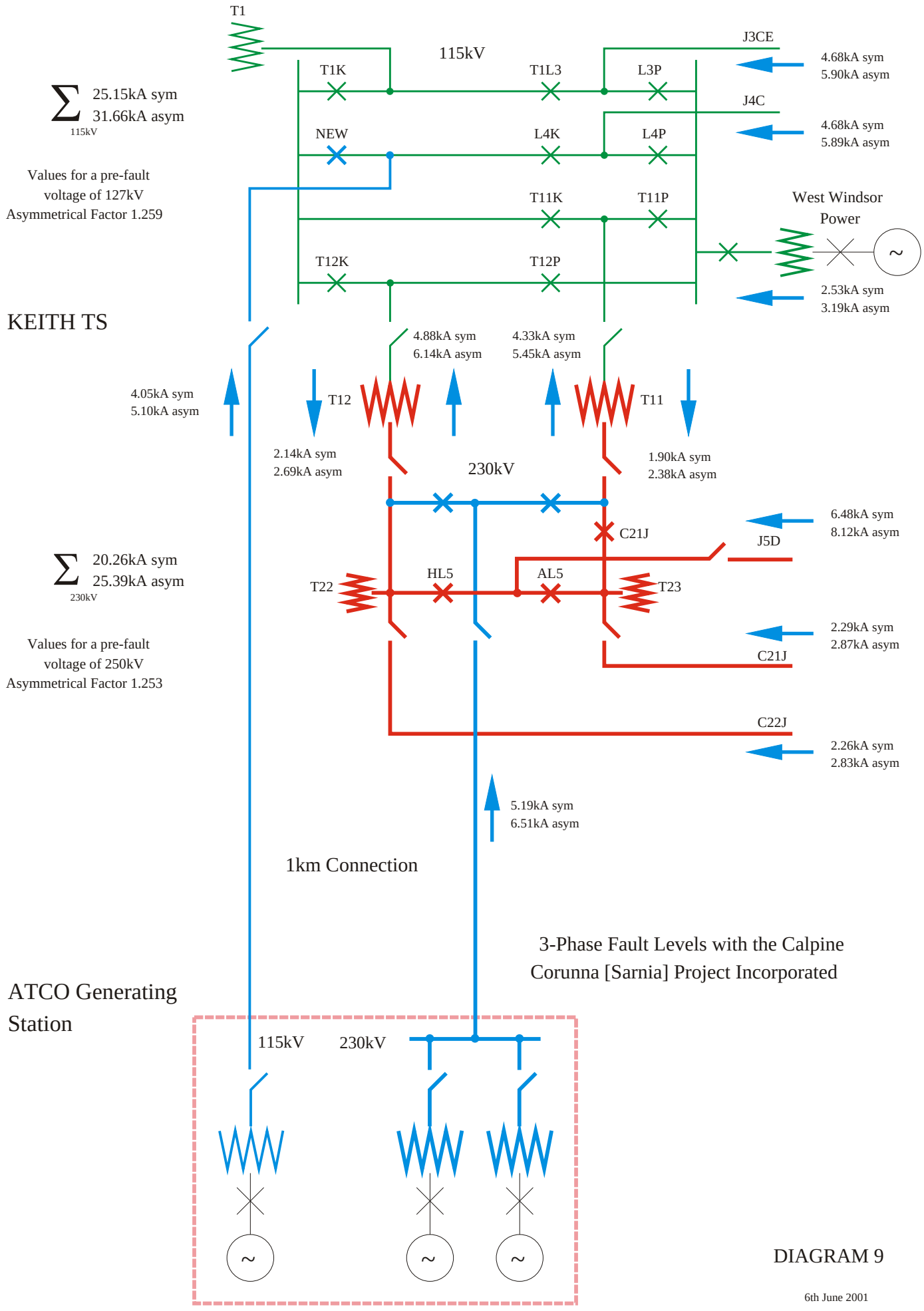
30th May 2001



Line-to-Ground Fault Levels with the Calpine Corunna [Sarnia]
Project Incorporated & the Lambton Busbar 'Split'

DIAGRAM 8

6th June 2001


T1
115kV
T1K
T1L3
L3P
J3CE
4.68kA sym
5.90kA asym
J4C
4.68kA sym
5.89kA asym
NEW
L4K
L4P
T11K
T11P
West Windsor
Power
T12K
T12P
2.53kA sym
3.19kA asym
Σ 25.15kA sym
31.66kA asym
115kV
Values for a pre-fault
voltage of 127kV
Asymmetrical Factor 1.259
KEITH TS
4.88kA sym
6.14kA asym
4.33kA sym
5.45kA asym
4.05kA sym
5.10kA asym
T12
T11
2.14kA sym
2.69kA asym
230kV
1.90kA sym
2.38kA asym
C21J
6.48kA sym
8.12kA asym
J5D
Σ 20.26kA sym
25.39kA asym
230kV
HL5
AL5
T22
T23
2.29kA sym
2.87kA asym
C21J
Values for a pre-fault
voltage of 250kV
Asymmetrical Factor 1.253
C22J
2.26kA sym
2.83kA asym
5.19kA sym
6.51kA asym
1km Connection
3-Phase Fault Levels with the Calpine
Corunna [Sarnia] Project Incorporated
ATCO Generating
Station
115kV
230kV
DIAGRAM 9
6th June 2001

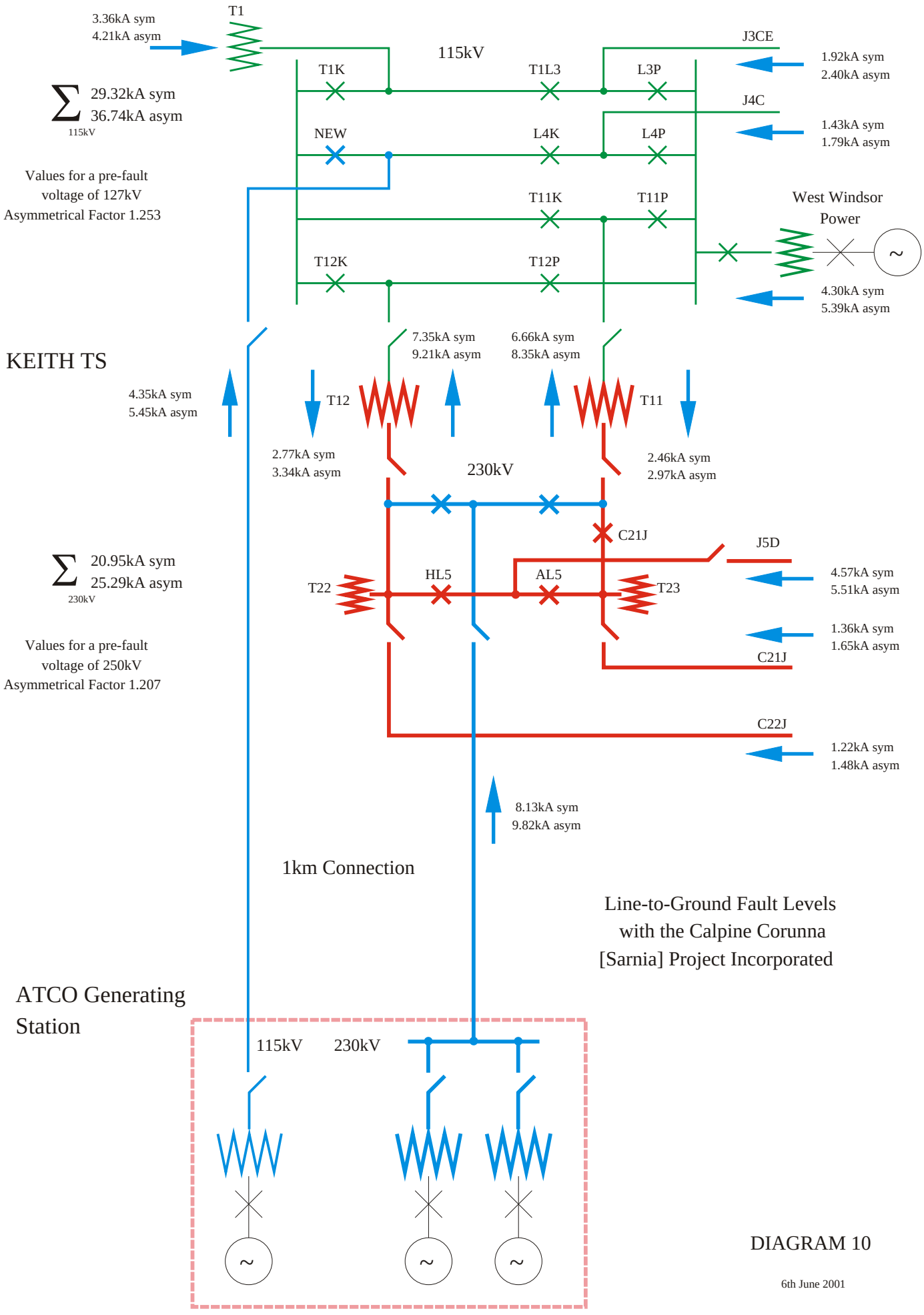
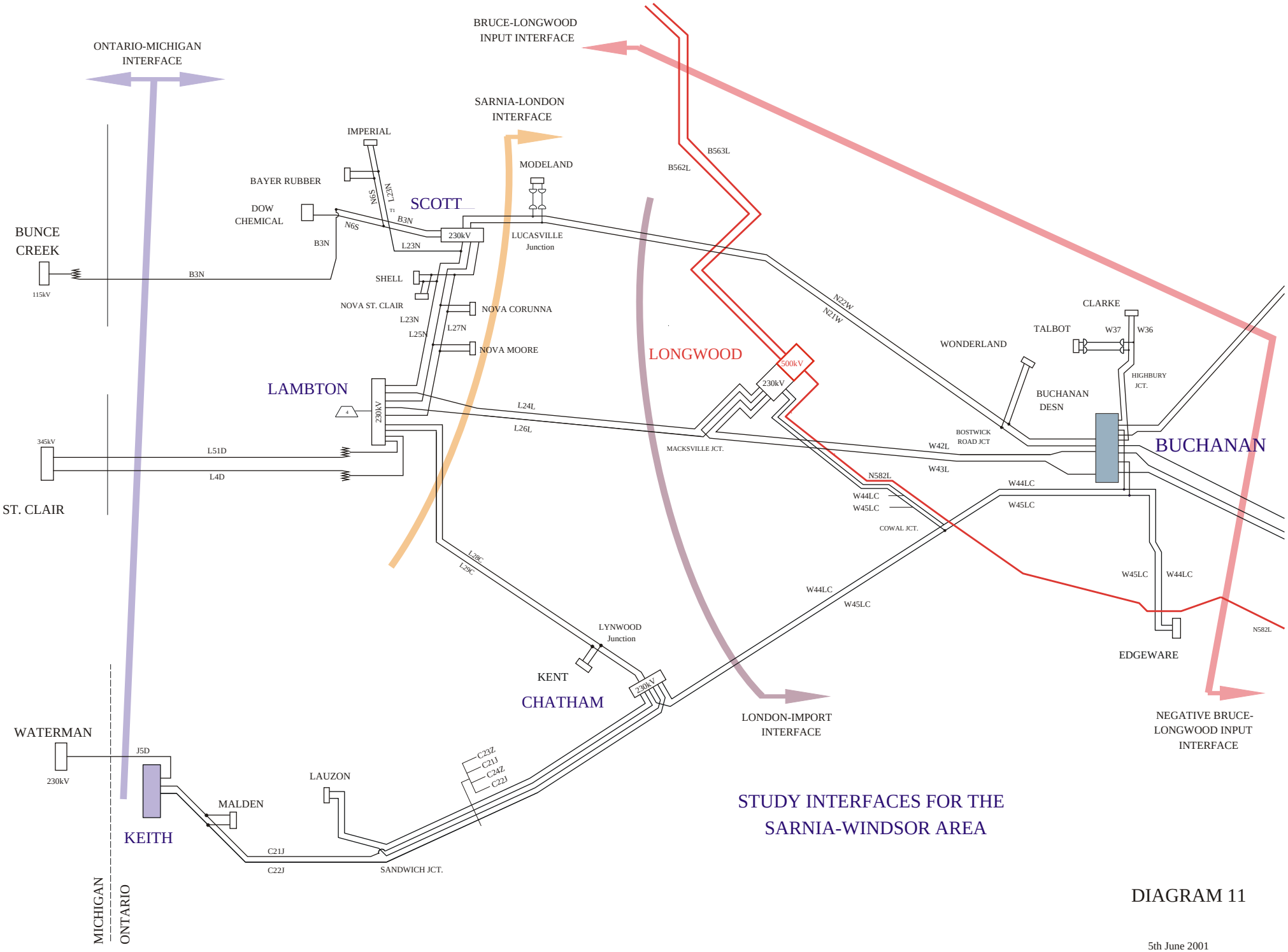


DIAGRAM 10

6th June 2001

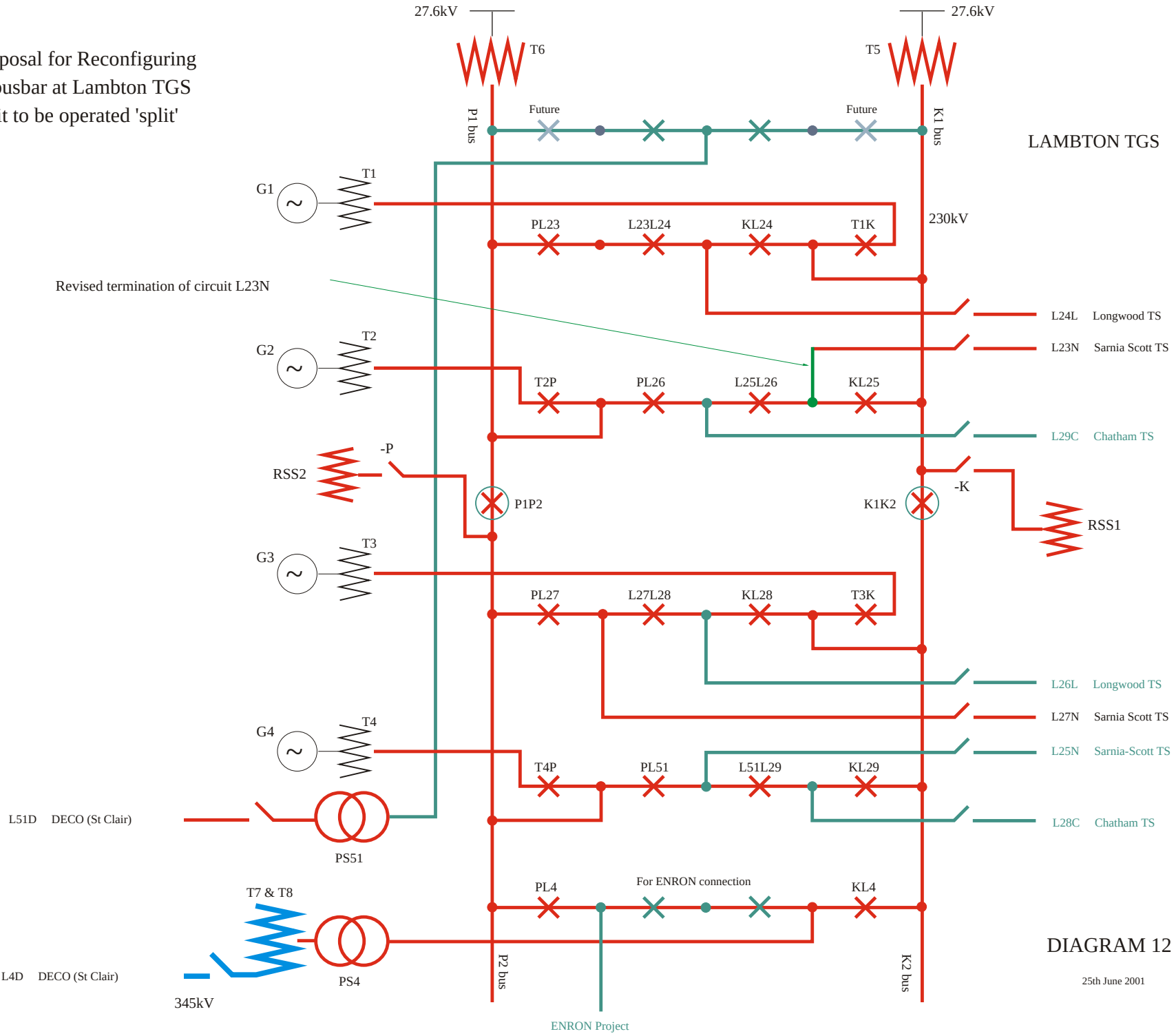


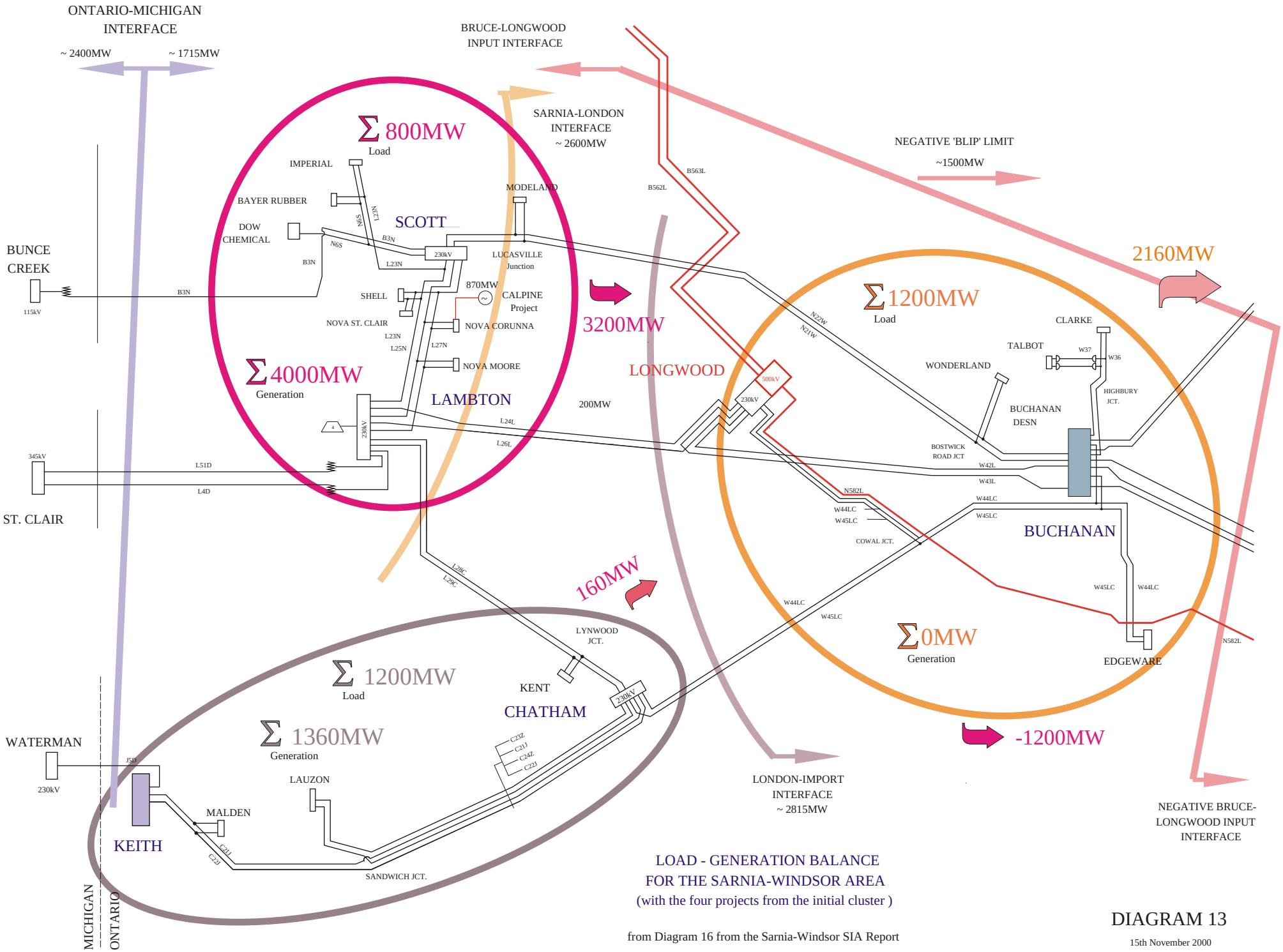
STUDY INTERFACES FOR THE SARNIA-WINDSOR AREA

DIAGRAM 11

5th June 2001

Revised Proposal for Reconfiguring the 230kV busbar at Lambton TGS to allow it to be operated 'split'





LOAD - GENERATION BALANCE
FOR THE SARNIA-WINDSOR AREA
(with the four projects from the initial cluster)

from Diagram 16 from the Sarnia-Windsor SIA Report

DIAGRAM 13

15th November 2000
Revised: 25th June 2001