CONNECTION ASSESSMENT & APPROVAL PROCESS

PRELIMINARY ASSESSMENT REPORT

For the Proposed 580MVA Development at Dow Chemical by TransAlta Energy Corp.

Final Version

Long Term Forecasts & Assessments Department

Date: 26th September 2000

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Preliminary Assessment Report

For the proposed 580MVA Development at the Dow Chemical Plant - Sarnia
by TransAlta Energy Corp.

Acknowledgement

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

Disclaimers

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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 Proposed 580MVA Development at the Dow Chemical Plant in Sarnia by TransAlta Energy Corp.

Executive Summary

This Preliminary Assessment has examined the impact on the local system of the proposed **TransAlta** development, in isolation of any other proposed developments.

Incorporation into Sarnia-Scott TS

TransAlta is proposing to construct a new 580MVA generating facility at the Dow Chemical Plant and to incorporate it into the 230kV busbar at Sarnia-Scott TS, via a new 3.5km double-circuit 230kV line that is to be connected to the two, existing 230kV circuits N6S & L23N. Since circuits N6S & L23N are presently three-ended, TransAlta is proposing to reterminate the radial sections of these circuits, to which the new Project is to be connected, into new positions at Scott TS.

To accommodate the new generating capacity, the following additional work will also be required to upgrade the existing 230kV circuits:

- Uprate the section of circuits N6S & L23N, between Imperial Oil Ltd. and Bayer Junction to an operating temperature of 93^{o}C.
- Reconductor the section of circuits N6S & L23N between Bayer Junction and Scott TS to provide an enhanced continuous rating ***OR*** accept restrictions on the maximum output from their facility during periods of high ambient temperatures with reduced loads at Imperial Oil Ltd. and Bayer.
- Installation of a generation rejection scheme to ensure sufficient capacity is automatically rejected at the TransAlta facility in response to a contingency involving either circuit N6S or circuit L23N.

With the proposed reconfiguration of circuits N6S & L23N at Sarnia-Scott TS there is expected to be no net degradation in system reliability as result of incorporating the new generating facility.

Impact on Fault Levels

While the TransAlta Project contributes to an increase in the fault level at Lambton TGS, the increased fault level remains within the fault interrupting capability of all the existing 230kV breakers at that station.

However, at Sarnia-Scott TS, the TransAlta Project will increase the fault levels on the 115kV busbar beyond the capability of all the existing breakers. Remedial measures will therefore be required, involving either the replacement of all the 115kV breakers with higher-rated units, or the installation of higher-rated 115kV series-connected reactors (or supplementary reactors) on the two 230/115kV auto-transformers at Scott TS.

Since it was deemed to be outside the scope of this Preliminary Assessment, Hydro One was not asked to undertake a study to determine whether it would be feasible to replace the existing series-connected reactors with higher rated ones. Furthermore, no analysis was undertaken to assess the potential impact of higher-rated reactors on the performance of the 115kV voltage at Scott TS.

Impact on the Transfer Capability of the Ontario-Michigan Interface

The TransAlta Project has been determined to have the following impact on the maximum transfers that can be maintained across the Ontario-Michigan Interconnections:

- Under IMPORT conditions, the transfer capability would be reduced by approximately 365MW to 1140MW
- Under EXPORT conditions, the transfer capability would be reduced by approximately 140MW to 2270MW

While the Report identifies measures that (theoretically) would need to be undertaken to restore the transfer capability of the Interface to its present levels, no attempt has been made to assess the feasibility or practicality of these measures.

TransAlta Development Proposal at the Dow Chemical Complex, Sarnia

1. Introduction

TransAlta Energy Corp. is proposing to construct a 580MVA generating facility at the Dow Chemical plant in Sarnia. The new generating facility is to be connected to the two 230kV circuits, N6S & L23N, between the Imperial Oil Complex and Sarnia-Scott TS.

The proposed in-service date for the development is late-2002.

Diagram 1 shows the proposed incorporation arrangement into Sarnia-Scott TS via the 230kV circuits N6S & L23N.

TransAlta is also proposing to modify the termination arrangement for circuits N6S & L23N at Sarnia-Scott TS, to achieve the following:

- to relocate the termination of circuit N6S from the main 'A' busbar on to one of the existing diameters.
- to separate the termination of the section of L23N between Lambton TGS and Sarnia-Scott TS from the section between Imperial Oil Ltd. and Sarnia-Scott TS, on to different diameters.

The proposed incorporation arrangement will render idle the section of circuit N6S that is currently used to supply the Dow Chemical Complex.

Diagram 2 shows the revised arrangement at Scott TS.

2. Comments on the Proposed Incorporation Arrangement

Load flow studies were performed with the TransAlta facility in-service, together with 72.8MW of generating capacity at Dow Chemical Ltd., and a further 49MW at Bayer.

The results of these studies are summarised in the table below. For an outage condition involving either circuit, the flows will effectively double.

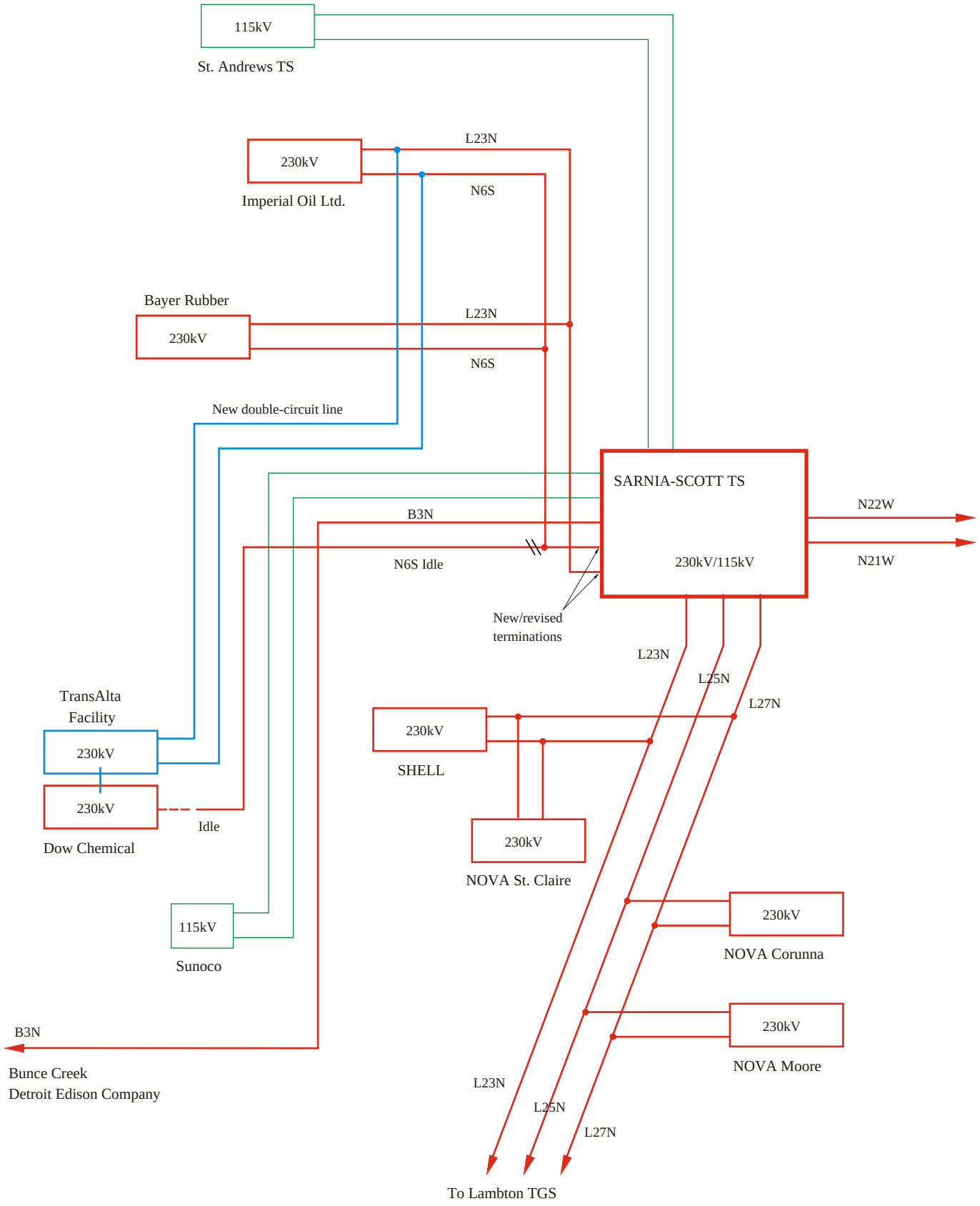
Ratings & Pre-contingency Flows on Circuits N6S & L23N: Between Scott TS and Imperial Oil Limited
With all elements in-service

Section	Maximum Operating Temperature	Rating (at 30°C, 4km/hr wind & 240kV)	Projected Flows (at 240kV)	
			Assumed loads at Bayer & Imperial Oil Ltd.	
			Summer base-case Loads (2002)	No loads
Imperial Oil Ltd. to Bayer Jct.	60°C	228MVA	***320MVA***	***357MVA***
Bayer Jct. to Scott TS	93°C	365MVA	338MVA	***383MVA***
TransAlta Tap	-	-	357MVA	357MVA

These results show that the line section between Imperial Oil Ltd. and the Junction for the tap to Bayer Rubber is limiting for both the normal summertime loading condition, and for the condition with no load at either Imperial Oil Ltd. or at Bayer Rubber.

This line section is restricted to a maximum operating temperature of only 60°C due to clearance limitations between the line and the structures for the line tap that supplies Bayer TS.

For the 'extreme' condition, with no load at either Imperial Oil Ltd. or at Bayer, the flows on the section of circuits N6S & L23N between Bayer Junction and Scott TS will exceed the continuous rating of the circuits.



INCORPORATION ARRANGEMENT FOR THE TRANSALTA PROJECT

DIAGRAM 1

26th September 2000

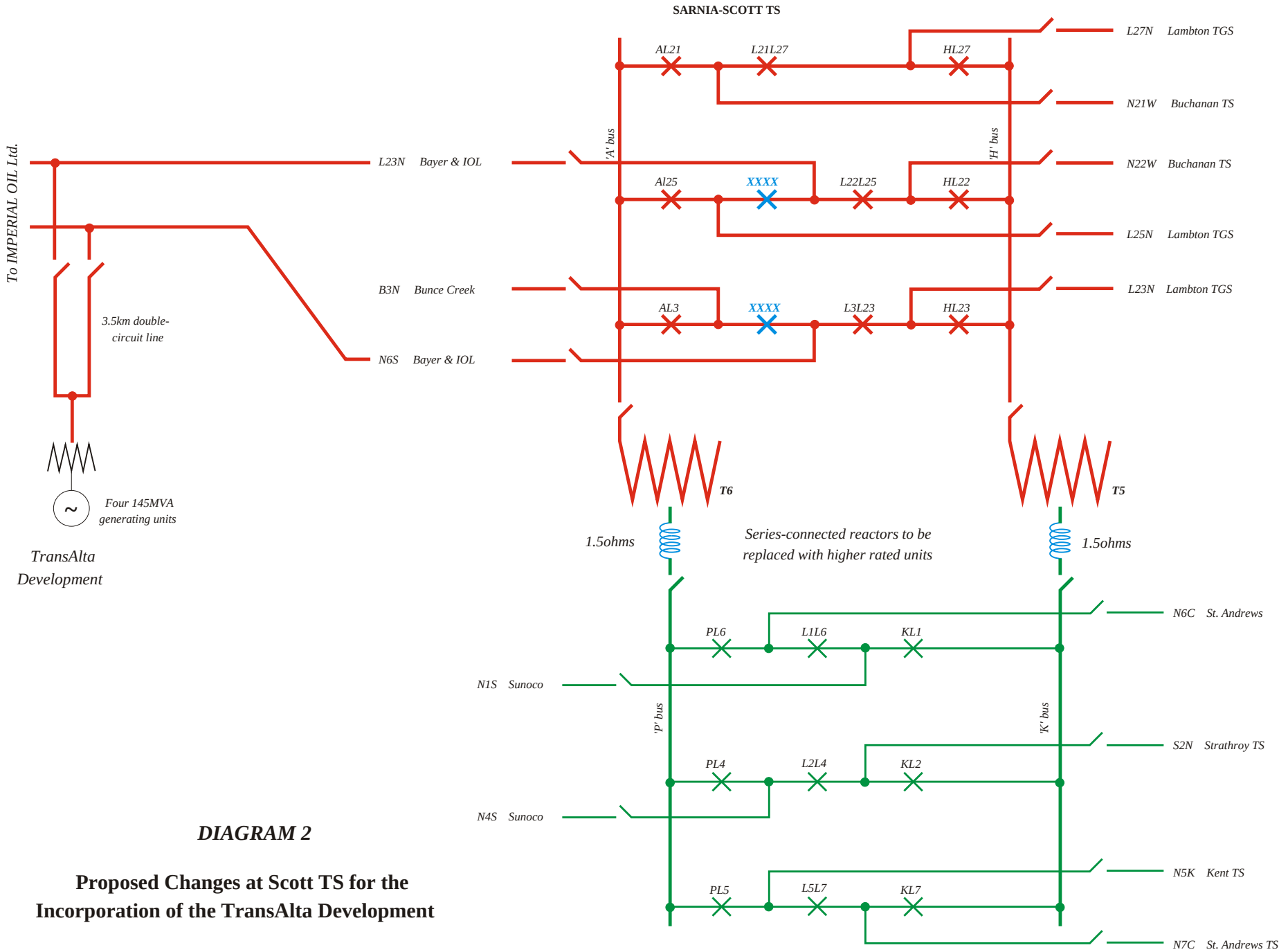


DIAGRAM 2

Proposed Changes at Scott TS for the Incorporation of the TransAlta Development

10th August 2000

A contingency involving either circuit will substantially overload the companion circuit. Since the resulting flows would be well beyond the 15-minute limited-time-rating of the individual circuits, generation rejection would be necessary to ensure that the post-contingency flow remains within the continuous rating of the remaining circuit.

2.1 Requirements for Incorporation

For TransAlta to connect their proposed generating facility to the system it would be necessary for the following work to be completed:

- Uprate the section of circuits N6S & L23N, between Imperial Oil Ltd. and Bayer Junction to an operating temperature of 93^{o}C.
- Reconductor the section of circuits N6S & L23N between Bayer Junction and Scott TS to provide an enhanced continuous rating ***OR*** accept restrictions on the maximum output from their facility during periods of high ambient temperatures with reduced loads at Imperial Oil Ltd. and Bayer.
- Installation of a generation rejection scheme to ensure sufficient capacity is automatically rejected at the TransAlta facility in response to a contingency involving either circuit N6S or circuit L23N.

2.2 Other Observations

Impact on Reliability

The connection of the new 3.5km double-circuit line for incorporating the TransAlta Project into the system, to the two circuits (N6S & L23N) that supply Imperial Oil Ltd. and Bayer would increase the exposure, and hence adversely impact on the supply reliability to these customers. However, the retermination of the section of circuit L23N that supplies these two customers, so that it is separated from the 20km section between Scott TS and Lambton TGS would effectively reduce the exposure and therefore have a positive impact on the supply reliability. These two impacts are expected to effectively cancel one another.

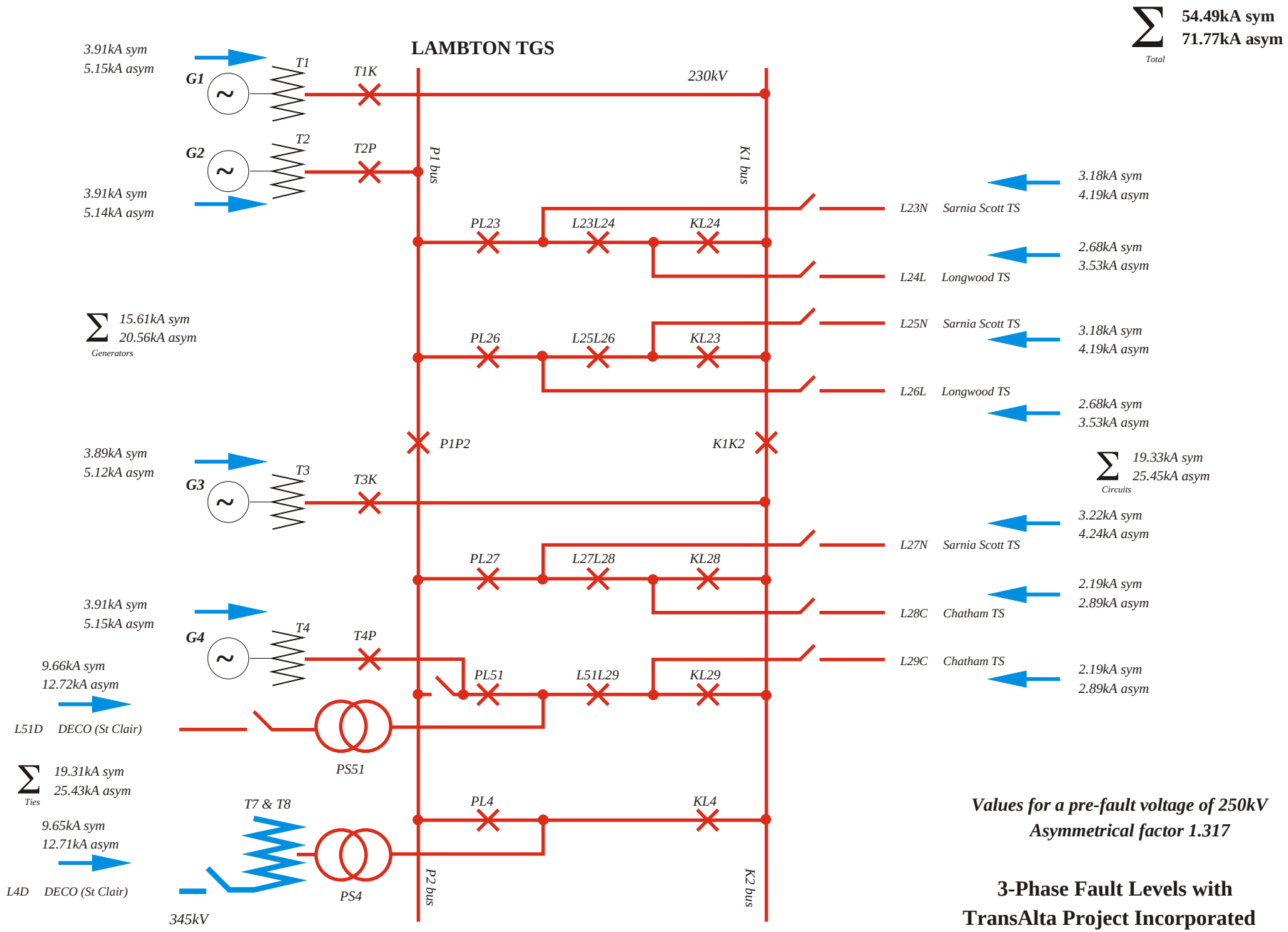
Furthermore, by separating the section of circuit L23N between Scott TS and Lambton TGS from the section supplying Imperial Oil Ltd. and Bayer, there should also be a reduction in the number of times that the generation rejection scheme would need to be activated due to the loss of one of the 'incorporation' circuits into Scott TS.

3. Fault Level Analysis

Fault level studies were performed to determine the impact of the TransAlta development (in isolation) 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' have been 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 Bruce 'A' and Pickering 'A' stations are out-of-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 separate North & South switchyards.
- The four 145MVA generators at the TransAlta development are incorporated via a 3.5km double-circuit 230kV line, connected to circuit N6S and L23N at the Imperial Oil TS.
- The four existing units, G1, G2, G4 & G5, at the Dow Complex are in-service.
- The existing supply to the Dow Complex, via circuit N6S, is disconnected.
- The 230kV busbars at the TransAlta Development and the Dow Complex are interconnected via a single, short 230kV connection.
- The LV busbar at the Dow Complex is interconnected via a single step-up transformer to the 230kV busbar at the TransAlta Development.

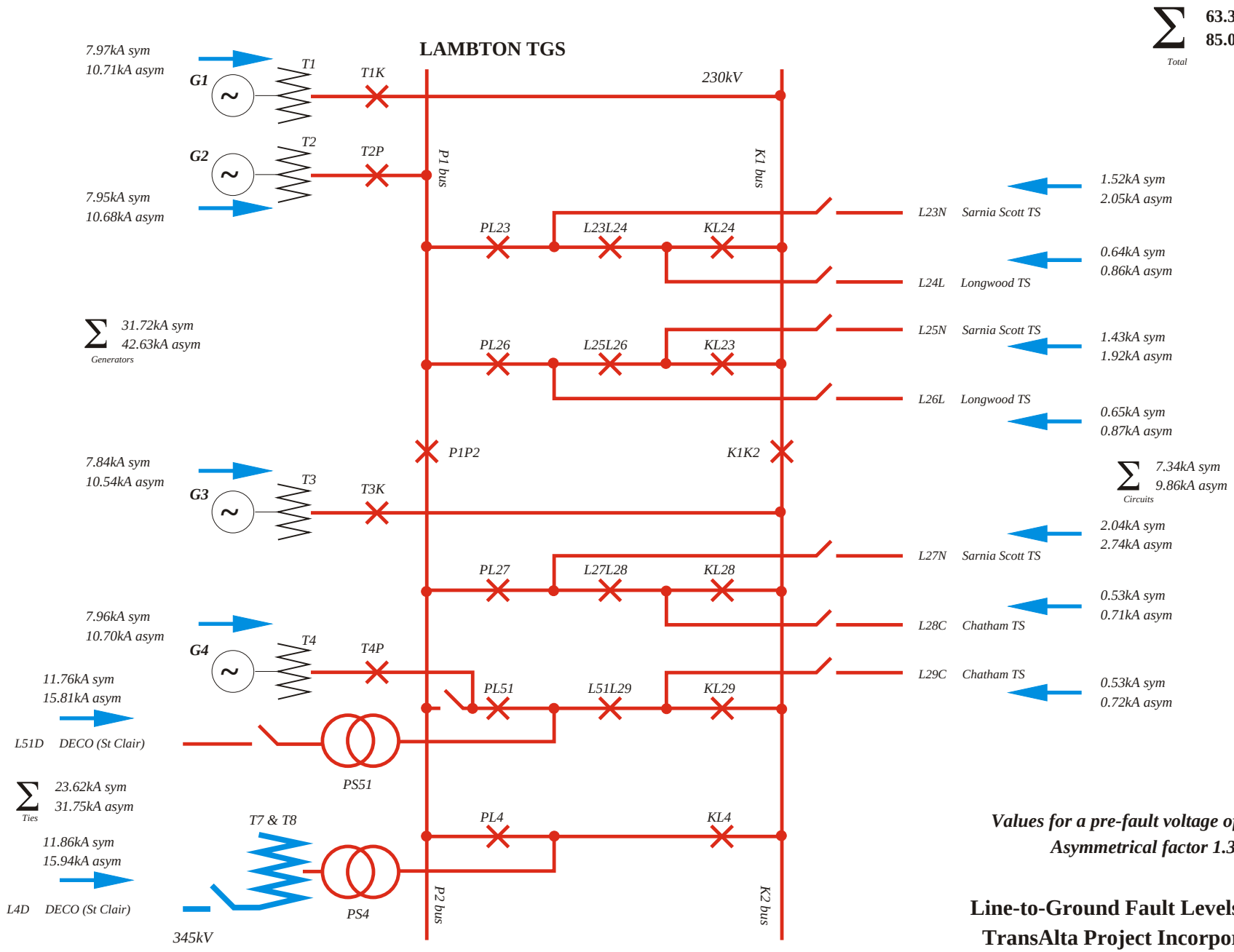


Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.317

3-Phase Fault Levels with
TransAlta Project Incorporated

DIAGRAM 3

1st August 2000

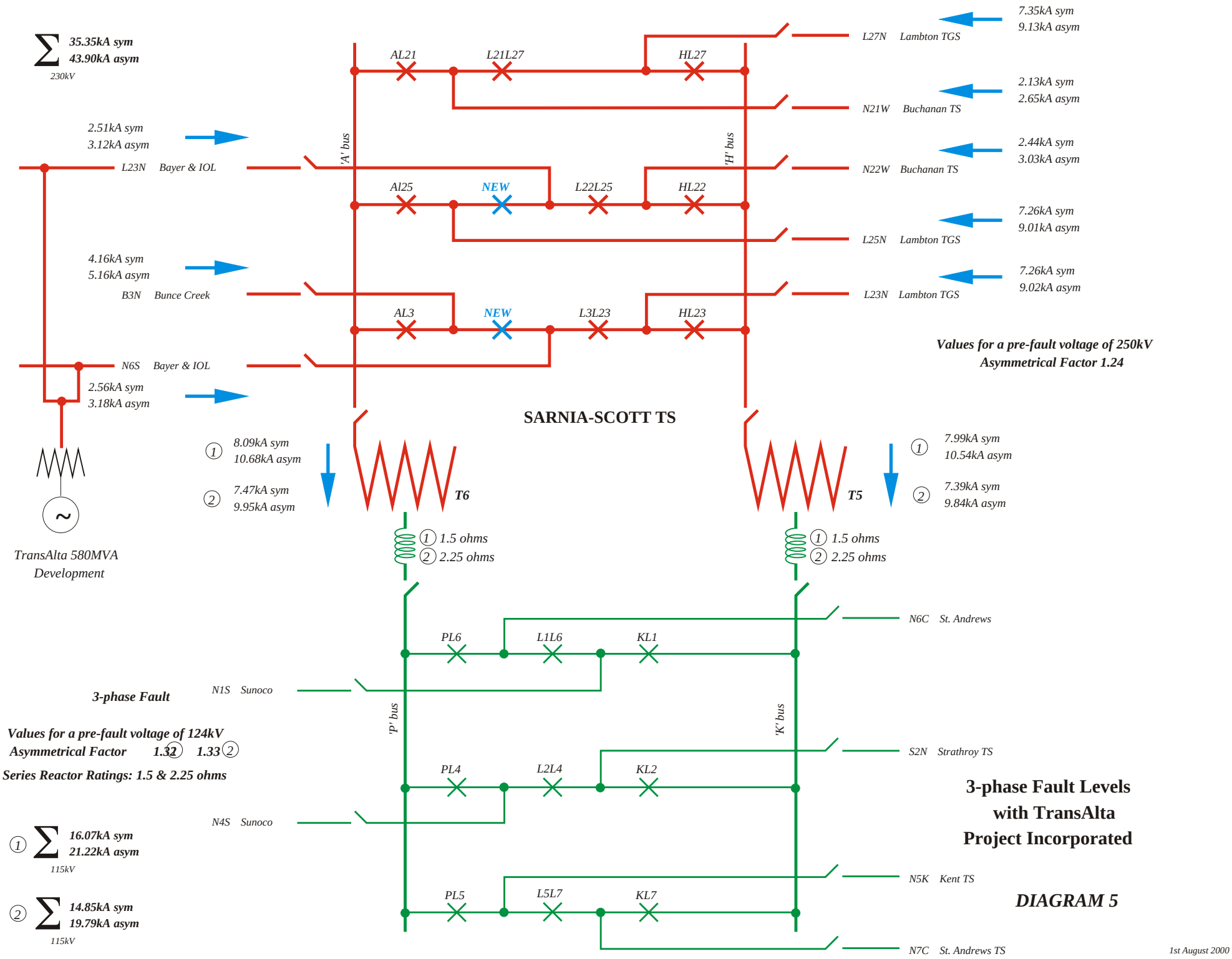


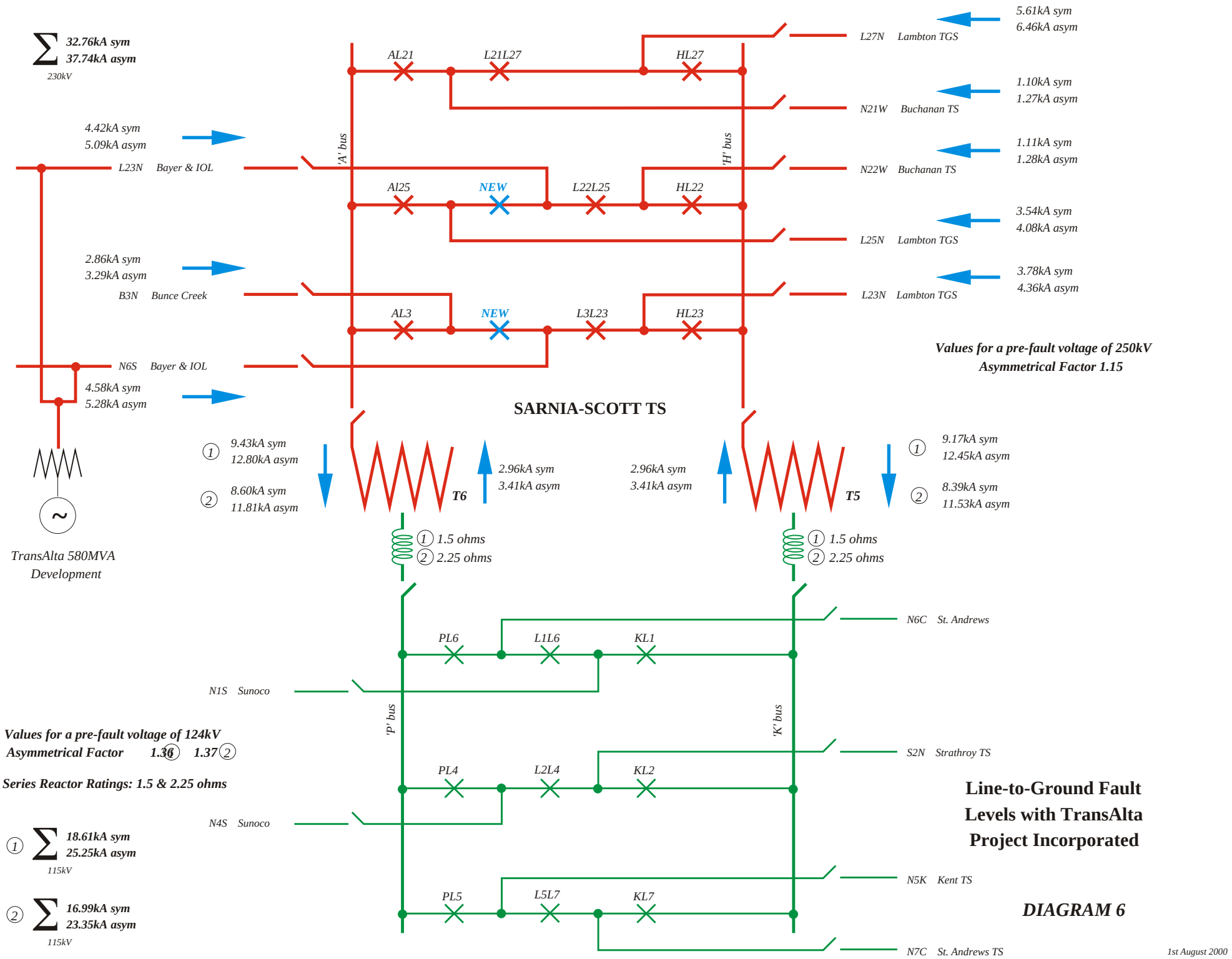
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.344

Line-to-Ground Fault Levels with TransAlta Project Incorporated

DIAGRAM 4

1st August 2000


35.35kA sym
43.90kA asym
230kV
AL21
L21L27
HL27
L27N Lambton TGS
7.35kA sym
9.13kA asym
N21W Buchanan TS
2.13kA sym
2.65kA asym
2.51kA sym
3.12kA asym
L23N Bayer & IOL
'A' bus
'H' bus
Al25
NEW
L22L25
HL22
N22W Buchanan TS
2.44kA sym
3.03kA asym
L25N Lambton TGS
7.26kA sym
9.01kA asym
4.16kA sym
5.16kA asym
B3N Bunce Creek
AL3
NEW
L3L23
HL23
L23N Lambton TGS
7.26kA sym
9.02kA asym
N6S Bayer & IOL
2.56kA sym
3.18kA asym
Values for a pre-fault voltage of 250kV
Asymmetrical Factor 1.24
SARNIA-SCOTT TS
1 8.09kA sym
10.68kA asym
2 7.47kA sym
9.95kA asym
T6
T5
1 7.99kA sym
10.54kA asym
2 7.39kA sym
9.84kA asym
1 1.5 ohms
2 2.25 ohms
1 1.5 ohms
2 2.25 ohms
TransAlta 580MVA
Development
N6C St. Andrews
PL6
L1L6
KL1
3-phase Fault
N1S Sunoco
'P' bus
'K' bus
S2N Strathroy TS
PL4
L2L4
KL2
Values for a pre-fault voltage of 124kV
Asymmetrical Factor 1.32 1 1.33 2
Series Reactor Ratings: 1.5 & 2.25 ohms
N4S Sunoco
3-phase Fault Levels
with TransAlta
Project Incorporated
1 16.07kA sym
21.22kA asym
115kV
N5K Kent TS
PL5
L5L7
KL7
DIAGRAM 5
2 14.85kA sym
19.79kA asym
115kV
N7C St. Andrews TS
1st August 2000


Σ 32.76kA sym
37.74kA asym
230kV
AL21
L21L27
HL27
L27N Lambton TGS
5.61kA sym
6.46kA asym
N21W Buchanan TS
1.10kA sym
1.27kA asym
4.42kA sym
5.09kA asym
L23N Bayer & IOL
'A' bus
'H' bus
Al25
NEW
L22L25
HL22
N22W Buchanan TS
1.11kA sym
1.28kA asym
L25N Lambton TGS
3.54kA sym
4.08kA asym
2.86kA sym
3.29kA asym
B3N Bunce Creek
AL3
NEW
L3L23
HL23
L23N Lambton TGS
3.78kA sym
4.36kA asym
N6S Bayer & IOL
4.58kA sym
5.28kA asym
Values for a pre-fault voltage of 250kV
Asymmetrical Factor 1.15
SARNIA-SCOTT TS
1 9.43kA sym
12.80kA asym
2 8.60kA sym
11.81kA asym
T6
2.96kA sym
3.41kA asym
2.96kA sym
3.41kA asym
T5
1 9.17kA sym
12.45kA asym
2 8.39kA sym
11.53kA asym
TransAlta 580MVA
Development
1 1.5 ohms
2 2.25 ohms
1 1.5 ohms
2 2.25 ohms
N6C St. Andrews
PL6
L1L6
KL1
N1S Sunoco
'P' bus
'K' bus
S2N Strathroy TS
PL4
L2L4
KL2
N4S Sunoco
N5K Kent TS
PL5
L5L7
KL7
N7C St. Andrews TS
Values for a pre-fault voltage of 124kV
Asymmetrical Factor 1.36 (1) 1.37 (2)
Series Reactor Ratings: 1.5 & 2.25 ohms
1 Σ 18.61kA sym
25.25kA asym
115kV
2 Σ 16.99kA sym
23.35kA asym
115kV
Line-to-Ground Fault
Levels with TransAlta
Project Incorporated
DIAGRAM 6
1st August 2000

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. The 5% margin that has traditionally been applied to the ratings of the 230kV (and 500kV) breakers has been eliminated

3.1 Fault Level Results

The results have been summarised on the following Diagrams:

Diagram 3 For a 3-phase Fault on the 230kV busbar at Lambton TGS
Diagram 4 For a Line-to-Ground Fault on the 230kV busbar at Lambton TGS
Diagram 5 For a 3-phase Fault on the 230kV & 115kV busbar at Sarnia-Scott TS
Diagram 6 For a Line-to-Ground Fault on the 230kV & 115kV busbar at Sarnia-Scott TS

Fault level studies were also performed for faults on the 230kV busbar at the TransAlta facility.

3.2 Maximum Voltage on the Scott 115kV Busbar & Existing Fault Levels

Currently, the maximum voltage that can be achieved on the 115kV busbar at Scott TS is limited to approximately 124kV. Under peak transfer conditions, when the circuits are heavily loaded, the voltage is normally in the 122kV to 123kV range. This is confirmed by the trace of the voltages recorded on the 115kV busbar at Scott TS for all of last year (1999), shown in the accompanying Figures 1A and 1B.

Consequently, it has been normal practice to calculate the maximum fault level on the 115kV busbar at Scott TS for a pre-fault voltage of 124kV, and the table below provides a summary of the fault levels for the existing system configuration.

Fault levels on the 115kV busbar at Scott TS for the Current System Conditions					*For a Pre-fault Voltage of 124kV*	
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
	3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
Pre-fault Voltage: 124kV	15.3kA	17.5kA	20.0kA	***23.26kA***	19.4kA	***23.28kA***

Note: The highlighted values indicate fault conditions that would result in the fault level exceeding the breaker ratings.

This shows that the existing 115kV breakers at Scott TS, with a 1.5 ohm series-connected reactor on each of the 230/115kV auto-transformers, *are marginally adequate* for the expected fault-interrupting duty.

Incorporating the TransAlta Development will have the effect of increasing the voltage profile in the Sarnia area, resulting in a requirement to apply a normal pre-fault voltage of 127kV when assessing the fault levels on the 115kV busbar at Scott TS.

Load flow analysis has confirmed that with the TransAlta Project in-service, the voltage at the 115kV busbar at Scott TS could be operated at 127kV.

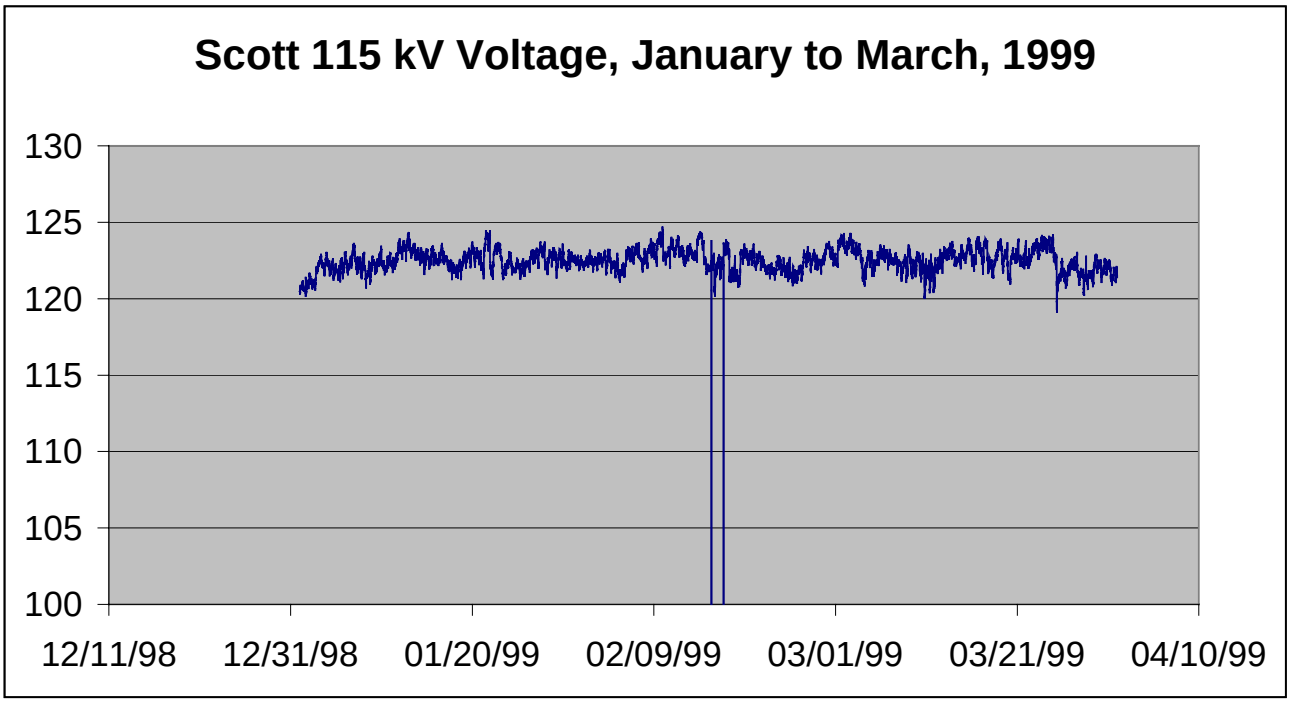
The computed fault levels on the 230kV and 115kV busbars at Scott TS with the TransAlta Development incorporated into the system are shown in Diagrams 5 & 6, for a 3-phase and a Line-to-Ground Fault, respectively.

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

[No reduction has been made to these values to account for the specific infeeds that the individual breakers would not be required to interrupt.

(It should also be noted that since none the 115kV feeders at Scott TS contribute to the asymmetrical fault level on the 115kV busbar, the maximum fault interrupting duty that would be imposed on each individual breaker, is the actual fault level at the 115kV busbar.]

RECORDED VOLTAGES ON THE 115kV BUSBAR AT SCOTT TS FOR 1999



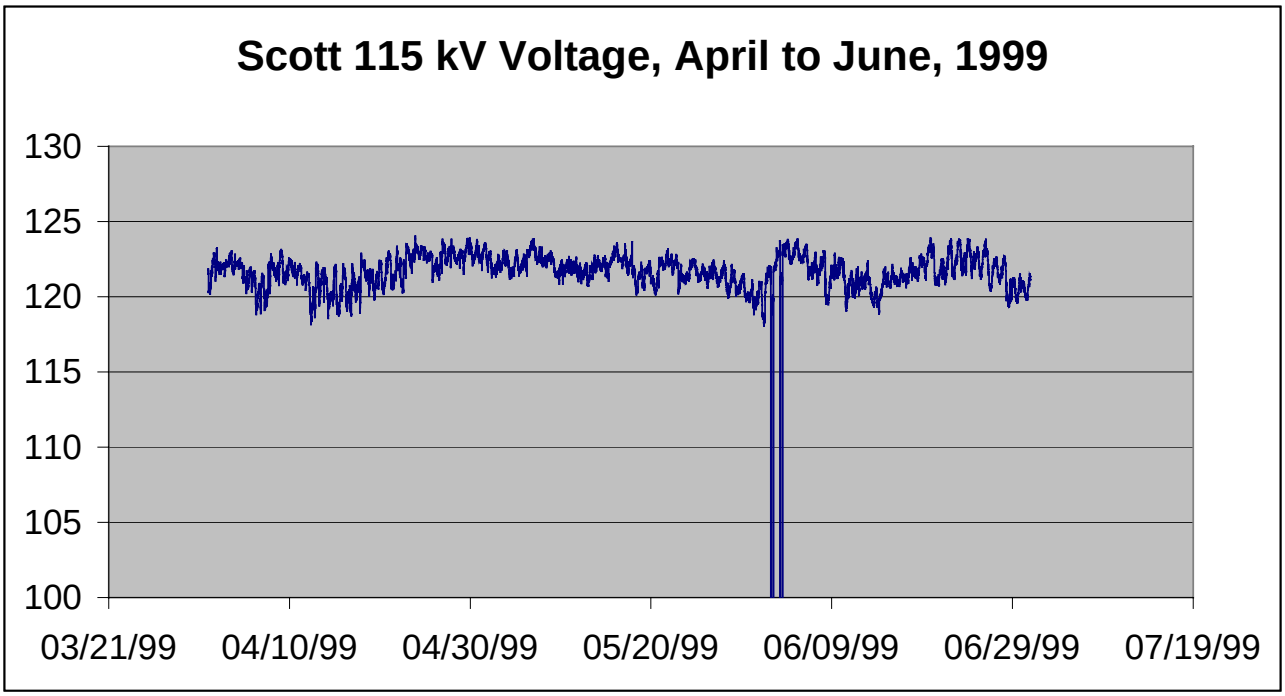
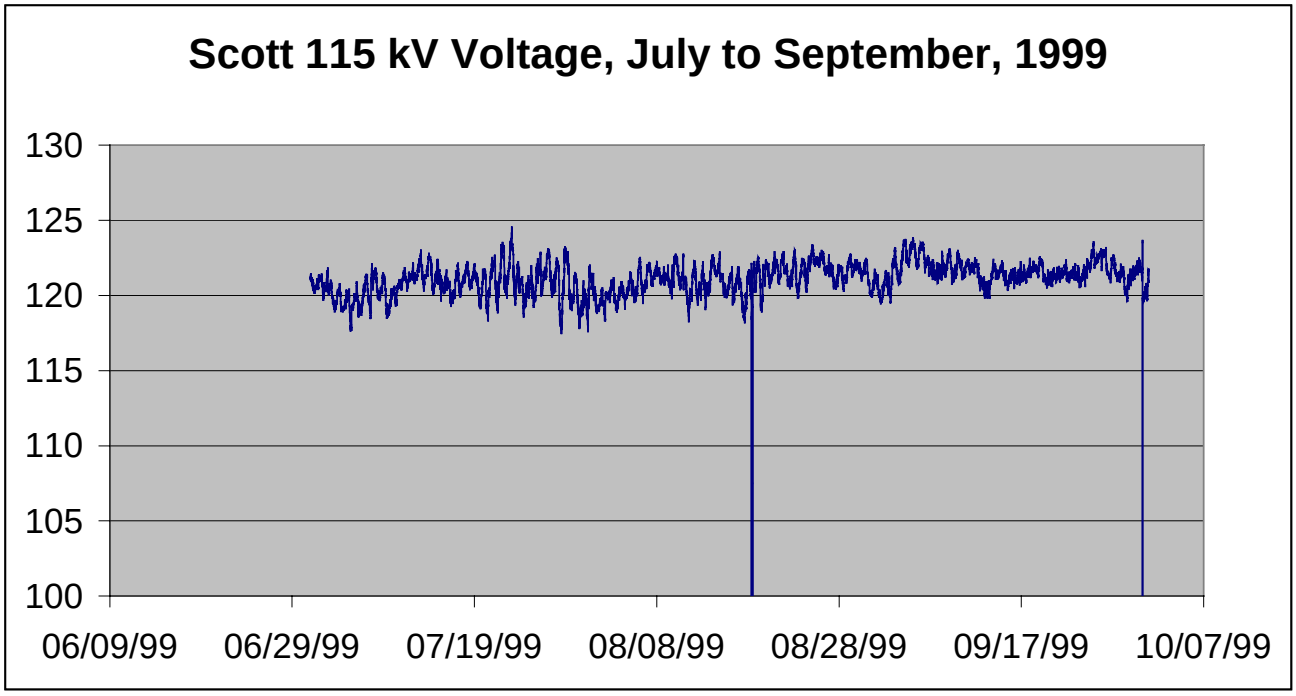


FIGURE 1A

RECORDED VOLTAGES ON THE 115kV BUSBAR AT SCOTT TS FOR 1999



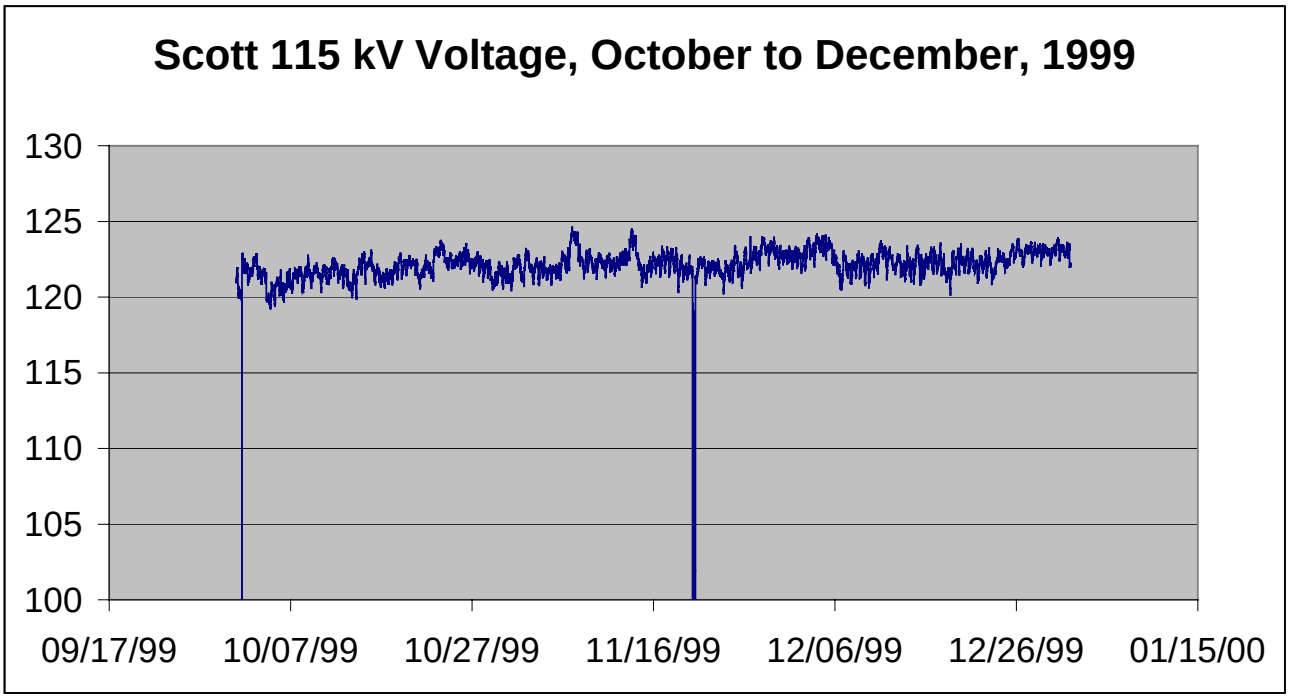


FIGURE 1B

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
Existing	31.9kA	27.1kA	38.9kA	30.66kA	38.4kA	46.2kA
With the TransAlta Project Incorporated						
	35.35kA	32.76kA	43.90kA	37.74kA		

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
Existing		15.7kA	17.9kA	20.5kA	***23.82kA***	19.4kA	***23.28kA***
With the TransAlta Project Incorporated							
Reactor rating	1.5 ohms	16.07kA	18.61kA	21.22kA	***25.25kA***		
	2.25 ohms	14.85kA	16.99kA	19.79kA	***23.35kA***		

For the 230kV busbar the symmetrical and asymmetrical fault levels are within the ratings of the existing equipment, even before making allowance for any infeeds in order to reflect the actual interrupting duty imposed on individual breakers.

For the 115kV busbar, while the symmetrical fault levels are within the breaker ratings, the asymmetrical fault levels for a line-to-ground fault condition exceed the 23.28kA rating of the existing breakers. This occurs with both the existing series reactors (with a rating of 1.5 ohms) and with the replacement series reactors (with a nominal rating of 2.25 ohms).

Consequently, in order to maintain the asymmetrical fault levels within the equipment ratings, replacement series reactors of 2.3 ohms are expected to be required. (It should be noted that since none the 115kV feeders contribute to the asymmetrical fault level on the 115kV busbar at Scott TS, the maximum fault interrupting duty that would be imposed on each individual breaker, is the actual fault level at the 115kV busbar.)

Since it was deemed to be outside the scope of this Preliminary Assessment, Hydro One was not asked to undertake a study to determine whether it would be feasible to replace the existing series-connected reactors with higher rated ones. Furthermore, no analysis was undertaken to assess the potential impact of increasing the rating of these reactors, on the voltage of the 115kV busbar at Scott TS. For these reasons, no attempt was made to try and determine an appropriate rating should it be both possible, and desirable, to replace the existing units.

3.3 Fault Levels at Lambton TGS

Because of the close electrical proximity of Scott TS to Lambton TGS, the TransAlta Development will also have an impact on the fault levels at the latter site. Diagrams 3 & 4 show the computed fault levels on the 230kV busbar at Lambton TGS with the TransAlta Development incorporated into the system, for a 3-phase and a Line-to-Ground Fault, respectively.

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

(No reduction has been made to these values to account for the specific infeeds that the individual breakers would not be required to interrupt)

Fault levels on the 230kV busbar at Lambton TGS *For a Pre-fault Voltage of 250kV*								
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability			
	3-phase	L-G	3-phase	L-G	Symmetrical		Asymmetrical	
Existing System	52.1kA	60.9kA	68.5kA	***82.48kA***	*A*	65.0kA	*A*	***78.0kA***
With the TransAlta Project Incorporated					*B*	70.0kA	*B*	92.0kA
	54.49kA	63.31kA	71.77kA	***85.09kA***				

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

From the table above, it is apparent that it is only the **total** fault level for an asymmetrical fault condition that exceeds the rating of the two, lower-rated breakers at Lambton TGS. The ratings for all the other breakers are adequate for the **total** fault levels, even before making allowance for specific fault infeeds in order to reflect the actual interrupting duty imposed on individual breakers.

The table below shows the situation once allowance has been made for the respective fault infeeds that breakers KL4 and PL4 are not required to interrupt.

Asymmetrical fault duties imposed on breakers KL4 & PL4 for a line-to-ground fault			
	Critical breaker	Asymmetrical Fault Line-to-Ground	Breaker Capability Asymmetrical
Existing System	KL4 (less the G3 contribution)	71.96kA	78.0kA
	PL4 (less the G4 contribution)	71.80kA	
With the TransAlta Development Incorporated			
	KL4 (less the G3 contribution)	74.55kA	
	PL4 (less the G4 contribution)	74.39kA	

Existing Facilities

For the existing system configuration, after making allowance for specific infeeds in order to reflect the actual interrupting duty imposed on individual breakers, the projected fault levels are within the rating of the existing equipment.

With the TransAlta Project Incorporated

Similarly, with the TransAlta Project incorporated, after allowing for the non-contributing fault infeeds, the actual fault interrupting duty imposed on each critical breaker would also remain within its rating.

None of the breakers at Lambton TGS would therefore need to be replaced in order to cater for the enhanced fault level on the 230kV busbar resulting from the incorporation of the TransAlta project.

3.4 Projected Fault levels at the TransAlta Facility

The following Table provides details of the expected fault levels at the TransAlta site:

Fault levels at the TransAlta Site *For a Pre-fault Voltage of 250kV*				
	Symmetrical Fault		Asymmetrical Fault	
	3-phase	L-G	3-phase	L-G
Fault Levels	27.11kA	24.98kA	32.42kA	30.22kA

3.5 230kV Generator Breakers at Lambton TGS

Discussions are currently underway with Ontario Power Generation regarding the fault interrupting capability of their 230kV breakers T1K, T2P, T3K & T4P at Lambton TGS. In the absence of any LV breakers, these HV breakers are used for both fault isolation duty and for synchronising of the individual generators to the system.

We have been informed that breakers T2P & T3K have already been replaced with higher-rated units, while breakers T1K & T4P are scheduled for replacement.

From the information that is currently available, it appears that the rating of the remaining two original breakers is not adequate for the projected fault levels for the existing system configuration. However, we have been informed that in order to address this situation, modifications have been made to the relay protection to ensure that, in the event of a fault, operation of these breakers is delayed until after the main busbar has been isolated.

We propose to pursue this issue in more detail within the System Impact Assessment.

3.6 Summary of Fault Level Analysis

The fault level analysis that has been performed has shown that, in order to incorporate the proposed TransAlta Development at the Dow Chemical Complex in Sarnia *(in isolation of any other developments in the Sarnia-Windsor area)*, the following change would need to be made to the existing system facilities at Sarnia-Scott TS:

- Replace all of the existing 115kV breakers at the Sarnia-Scott TS with higher rated units,

OR

- If it technically feasible, increase the effective rating of the existing 1.5 ohm 115kV series-connected reactors on each of the 230/115kV auto-transformers either by replacing them with higher-rated units, or by installing supplementary reactors.

It should also be stressed that no account has been taken in any of the analysis of possible plans by the Detroit Edison Company to incorporate additional generating capacity into their system. Depending on the proximity of these developments to the Interconnections, they could have a significant impact on the fault levels at Lambton TGS, Scott TS and Keith TS.

4. Assessment of the Impact on Transfer Capabilities

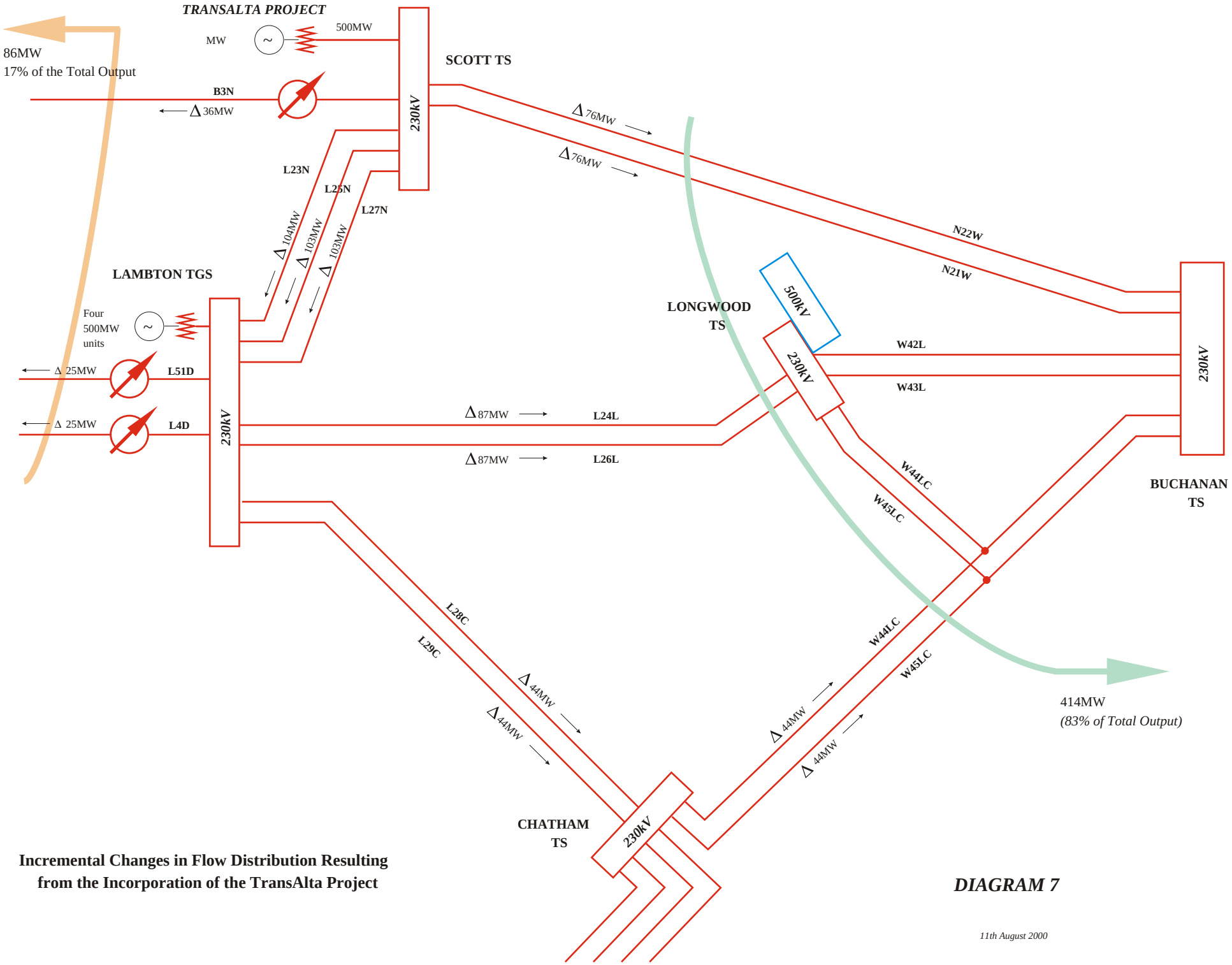
Following the reinforcement of the Interconnections between Ontario and Michigan, the transfer capability of the Ontario-Michigan Interface has increased to approximately 1500MW and 2400 MW, for import and export conditions, respectively. These transfer limits are the direct result of thermal limitations on the interconnections under contingency conditions involving either the companion interconnections or facilities at the terminal stations.

Diagram 7 shows the incremental changes in the flow distribution in the Sarnia – London area that would result from the incorporation of the TransAlta Project into Scott TS.

It should be noted that approximately 17% of the output from the TransAlta Development, with the phase-shifters maintained at a fixed tap position, would be expected to appear on the Ontario – Michigan Interconnections. This would effectively increase the loop flow around Lake Erie in a counter-clockwise direction.

4.1 Linear (TLTG) Analysis

In order to assess the potential impact of the TransAlta Development on the existing transfer capability, the PTI Linear Analysis Program, TLTG was used to rank the limiting conditions for both the reference condition, based on the existing system configuration, and for the situation with the TransAlta Project incorporated. The respective results have then been compared.



Incremental Changes in Flow Distribution Resulting from the Incorporation of the TransAlta Project

DIAGRAM 7

11th August 2000

The following conditions were assumed as a basis for the analysis:

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 220MW 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 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 235kV & 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.

A select number of Load Flow Studies were performed to confirm the results from the Linear (TLTG) Analysis.

4.2 Results of the Linear (TLTG) Analysis

Diagram 8 shows the principal interfaces that were used in this analysis, and Tables 1 & 2 summarise the results.

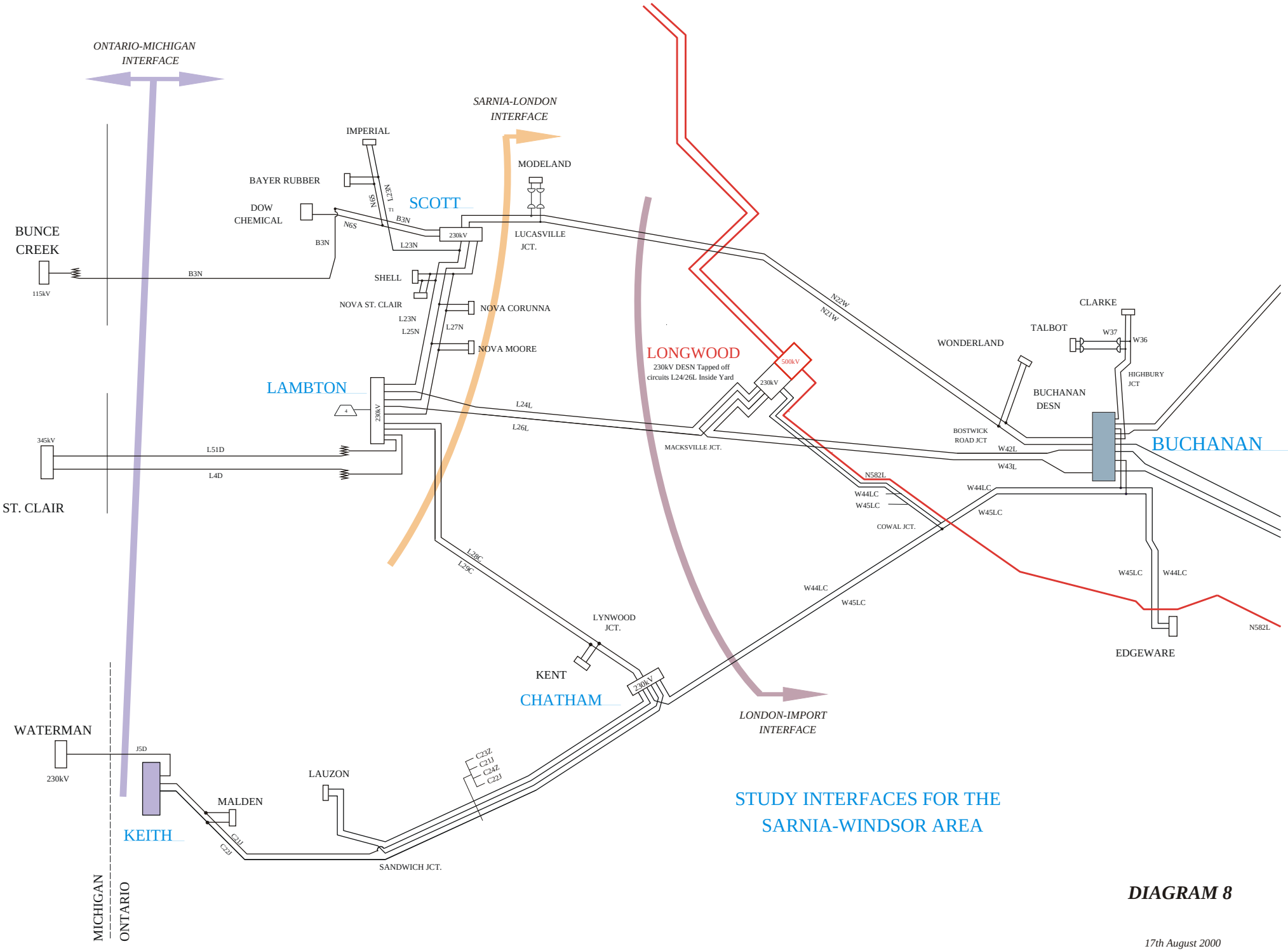
4.3 Discussion of the Results.

The analysis only addressed limitations on the Interconnections between Michigan and Ontario, and on that portion of the system between the International Border and London, as shown in Diagram 10. It did not address limitations imposed on the level of imports and exports that could be maintained between Ontario and Michigan as a result of transfers on the other Interconnections with Ontario.

4.3.1 For the IMPORT Condition

Reference Condition I1, for the existing system configuration.

The transfer capability of the Ontario-Michigan Interface is currently limited to approximately 1500 MW.



STUDY INTERFACES FOR THE SARNIA-WINDSOR AREA

DIAGRAM 8

17th August 2000

Since a PL51 breaker-failure condition will result in the simultaneous loss of the L51D Interconnection and the G4 generating unit at Lambton TGS, it will result in an increased level of transfers on the remaining Interconnections. In order that the elevated, post-contingency flow appearing on the companion L4D Interconnection does not exceed its 15-minute limited-time-rating of 1170MW, transfers on the Ontario-Michigan Interface have to be restricted to approximately 1500MW.

Condition I2

If it were possible to increase the 15-minute limited-time-rating of the L4D Interconnection by about 100MVA, then the next limiting condition would correspond to an Interface flow of approximately 1600MW. At transfers above this level, the post-contingency flow on circuit L28C, for a contingency involving the companion circuit L29C, would exceed its 15-minute limited-time-rating of 652MVA.

[It is worth noting that while circuits L28C & L29C are equipped with identical conductors, the maximum operating temperature for the conductors of circuit L28C is 119^{o}C, while for L29C it is 135^{o}C. Consequently a contingency involving circuit L29C is the more critical one.]

Conditions with the TransAlta Development Incorporated

Condition I3

In order to respect a contingency involving the loss of the 230kV circuit L29C from Lambton to Chatham, transfers on the Ontario-Michigan Interface need to be limited to approximately 1140MW.

With transfers limited to this value, the post-contingency flow that appears on the companion circuit L28C, as a result of a contingency involving circuit L29C, will remain within its 15-minute limited-time-rating of 652MVA. Having to limit transfers across the Ontario-Michigan Interface to 1140MW would correspond to an effective reduction of approximately 365MW in the transfer capability of this Interface.

Uprating circuit L28C to an operating temperature of 127^{o}C (the maximum value used for computing the 15-minute limited-time-rating of a circuit) would alleviate this particular limiting condition.

Condition I4

At a transfer level of 1240MW on the Ontario-Michigan Interface, the pre-contingency flows on the sections of circuits N21W & N22W between Scott TS and Lucasville Junction would exceed the continuous rating of 464MW for these circuits.

Since this is a pre-contingency limitation, uprating of the two circuits to increase the continuous rating of the critical sections would be necessary to avoid the effective reduction of 265MW in the transfer capability of the Ontario-Michigan Interface.

Condition I5

The next limitation would be at an interface flow of 1313MW. With transfers above this level, a double-circuit contingency involving circuits L24L & L26L would result in the post-contingency flow on circuit L28C exceeding the 15-minute limited-time-rating of 625MVA for this circuit.

As before, uprating circuit L28C to an operating temperature of 127^{o}C would alleviate this particular limiting condition.

Condition I6

An L22L44 breaker-failure condition at Buchanan TS will result in the loss of circuits W44LC and N22W. For Interface flows greater than 1356MW, the 15-minute limited-time-rating of 685MVA for that section of circuit N21W between Scott TS & Lucasville Junction would be exceeded.

Uprating the critical section of circuit N21W to increase its 15-minute limited-time-rating would provide relief from this particular transfer limitation.

Condition I7

The next limiting transfer level is 1542MW, which exceeds the 'reference' transfer level of 1500MW for the existing system configuration, without the TransAlta Development.

At transfer levels in excess of this value, the pre-contingency flows on circuits L24L & L26L would exceed the continuous rating of 579 MVA for these circuits.

4.3.2 For the EXPORT Condition

Under EXPORT Conditions, a Special Protection System is currently available at Lambton TGS, to initiate rejection of a single generating unit at Lambton TGS in response to any of the following conditions:

- Opening of either of the Lambton TGS to St. Clair Interconnections (circuits L4D or L51D)

- Opening of any of the middle breakers in the 230kV switchyard at Lambton TGS (breakers L23L24, L25L26, L27L28 or L51L29)

This action is intended to reduce the post-contingency transfers on the remaining Interconnection.

It should be noted that it might be necessary to include the TransAlta Project in the existing Lambton Generation Rejection Scheme.

Reference Condition E1 for the existing system configuration

Transfers from Ontario across the Ontario-Michigan Interface are currently limited to approximately 2410 MW.

As a result of a breaker-failure condition involving breaker L51L29 at Lambton TGS, the L51D Interconnection will be lost, resulting in increased transfers on the remaining Interconnections. To ensure that the post-contingency flow on the B3N Interconnection does not exceed its 15-minute limited-time-rating of 482MVA, even after automatically rejecting one of the Lambton generating units, the pre-contingency transfer on the Ontario-Michigan Interface will need to be restricted to 2410MW.

Condition E2

If the 15-minute limited-time-rating of the B3N Interconnection were to be increased, then the continuous rating of the L51D Interconnection would impose the next limiting condition, allowing a marginal improvement in the maximum transfer across the Interface to 2414 MW from 2409 MW.

Conditions with the TransAlta Development Incorporated

Condition E3

For the same contingency condition that determined the 'reference level' for transfers on the Ontario-Michigan Interface (an L51L29 breaker-failure), transfers would need to be limited to 2270 MW with the TransAlta Project incorporated, in order to respect the 15-minute limited-time-rating of 482 MVA for the B3N Interconnection.

This represents an effective reduction of approximately 140MW in the transfer capability of the Ontario-Michigan Interface.

Condition E4

The next limiting contingency condition would involve the double-circuit loss of circuits C21J & C22J between Keith TS and Chatham TS. Transfers on the Ontario-Michigan Interface would need to be restricted to approximately 2310MW in order to ensure that the post-contingency flow on the B3N Interconnection does not exceed its 15-minute limited-time-rating of 482MVA. This would represent an effective reduction of approximately 100MW in the transfer capability of the Ontario-Michigan Interface.

Condition E5

Similarly, the 15-minute limited-time-rating of the B3N Interconnection would restrict transfers across the Ontario-Michigan Interface for a contingency involving the L51D Interconnection. In this case, transfers would need to be restricted to approximately 2325 MW to ensure that the post-contingency flow respects the 15-minute limited-time-rating of 482MVA for the B3N Interconnection. This would represent a reduction of approximately 85MW in the transfer capability of the Ontario-Michigan Interface.

Condition E6

The next limiting transfer level for the Ontario-Michigan Interface is 2411MW, which exceeds the 'reference' level of 2410MW for the existing facilities without the TransAlta Project incorporated. This transfer level is restricted by the continuous rating of the L51D Interconnection.

Consequently, if the 15-minute limited-time-rating of the B3N Interconnection were to be increased so that it was no longer restrictive under the contingency conditions detailed for the three preceding entries, it would be possible to maintain the same 'reference' transfer level of 2410MW, with the TransAlta Project incorporated, that can be achieved with the existing facilities.

4.4 Conclusions from the Linear Analysis used to determine the impact of the TransAlta Project on Transfer Capabilities

The following table summarises the results of the Linear Analysis for the IMPORT condition.

For the IMPORT Condition		*'Reference' Transfer Level 1505MW*	
Limiting Condition	Transfer Capability of the O-M Interface	Reduction in Transfer Capability	Measures Required to Restore Transfer Capability
I3	1141MW	365MW	*Increase the 15-minute LTR for circuit L28C* (Raise the maximum operating temperature of its conductors to 127^{o}C from 119^{o}C)
I4	1239MW	265MW	*Increase the continuous rating of circuits N21W & N22W between Scott TS & Lucasville Junction* (Reconductor the line over this section, using conductors > 1277.5kcmil
I5	1313MW	190MW	*Increase the 15-minute LTR for circuit L28C* (Same response as required for condition ***I3***)
I6	1356MW	150MW	*Increase the 15-minute LTR for circuit N21W* (The response for condition ***I3*** would also meet this requirement)

The following table summarises the results of the Linear Analysis for the EXPORT condition.

For the EXPORT Condition	*'Reference' Transfer Level 2410MW*		
Limiting Condition	Transfer Capability of the O-M Interface	Reduction in Transfer Capability	Measures Required to Restore Transfer Capability
E3	2270MW	140MW	*Increase the 15-minute LTR for Interconnection B3N* (Uprate/replace the limiting components of the Ontario-Michigan Interconnection. This response would satisfy all three limiting conditions)
E4	2308MW	100MW	
E5	2326MW	80MW	

Table 1

Imports from Michigan

ID	*Limiting Transfers Across The Principal Interfaces*				
		Ontario-Michigan Interface	Sarnia-London Interface	London Import Interface	Limiting Condition
ID	*Continuous Rating of each Interface*	*2581MW*	*3263MW*	*3466MW*	
I1	For the existing conditions	***1505MW***	2684MW	1875MW	*PL51 Breaker Failure at Lambton TGS.* Interface Transfers are restricted by the 15-minute limited-time-rating of the L4D Interconnection (1170MVA)
I2		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)
	With the TransAlta Project Incorporated				
I3	With the TransAlta Project Incorporated	1141MW	2823MW	2007MW	*Contingency involving circuit L29C: Lambton to Chatham* The Post-contingency flow on the companion circuit L28C exceeds its 15-minute limited-time-rating (652MVA)
I4		1239MW	2921MW	2104	*Base Case – Flows on circuits N21W & N22W: Scott to Lucasville Junction* The Pre-contingency flow exceeds the continuous rating for the circuit (464MVA)
I5		1313MW	2995MW	2179	*Double-circuit contingency involving circuits L24L & L26L: Lambton to Longwood* The Post-contingency flow on circuit L28C exceeds its 15-minute limited-time-rating (652MVA)
I6		1356MW	3039MW	2222	*L22L44 Breaker Failure at Buchanan* The Post-contingency flow on circuit N21W exceeds its 15-minute limited-time-rating (685MVA)
I7		1542MW	3225MW	2408	*Base Case – Flows on circuits L24L & L26L: Lambton to Longwood* The Pre-contingency flows exceed the continuous ratings for these circuits (579MW)

Note: The shaded area denotes that this limiting transfer, with the TransAlta Project Incorporated, would exceed the *existing* 'reference transfer capability' for this Interface.

Table 2

Exports to Michigan

ID	*Limiting Transfers Across The Principal Interfaces*				
		Ontario-Michigan Interface	Sarnia-London Interface	London Import Interface	Limiting Condition
ID	*Continuous Rating of each Interface*	*2581*	*3263*	*3466*	
E1	For the existing conditions	***2409MW***	-641MW	-2136MW	*L51L29 Breaker Failure at Lambton TGS (with rejection of one Lambton unit).* Interface Transfers are restricted by the 15-minute limited-time-rating of the B3N Interconnection (482MVA)
E2		2414MW	-647MW	-2142MW	*Base Case – Flow on the L51D Interconnection* Interface Transfers are restricted by the continuous rating of the L51D Interconnection (845MVA)
	With the TransAlta Project Incorporated				
E3	With the TransAlta Project Incorporated	2270MW	-19MW	-1490MW	*L51L29 Breaker Failure at Lambton TGS (with rejection of one Lambton unit)* Interface Transfers are restricted by the 15-minute limited-time-rating of the B3N Interconnection (482MVA)
E4		2308MW	-57MW	-1528MW	*Double-circuit contingency involving circuits C21J & C22J: Keith to Chatham* Interface Transfers are restricted by the 15-minute limited-time-rating of the B3N Interconnection (482MVA)
E5		2326MW	-75MW	-1546MW	*Contingency involving the L51D Interconnection.* Interface Transfers are restricted by the 15-minute limited-time-rating of the B3N Interconnection (482MVA)
E6		2411MW	-160MW	-1632MW	*Base Case – Flow on the L51D Interconnection* The Pre-contingency flow exceeds the continuous rating of the Interconnection (845MVA)

Note: The shaded area denotes that this limiting transfer, with the TransAlta Project Incorporated, would exceed the *existing* 'reference transfer capability' for this Interface.