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# REPORT

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# System Impact Assessment Report

## CONNECTION ASSESSMENT & APPROVAL PROCESS

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Issue 1.0

### **FINAL Draft REPORT**

**Project:** Hurontario SS to Jim Yarrow MTS 230 kV  
Transmission

**Applicant:** Hydro One Networks Inc.

*CAA ID 2006-248*

Transmission Assessments & Performance Department  
February 14, 2007

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## **System Impact Assessment Report**

### ***Hurontario SS to Jim Yarrow MTS 230 kV Transmission***

#### **Acknowledgement**

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

#### **Disclaimers**

##### **IESO**

This report has been prepared solely for the purpose of assessing whether the connection applicant's proposed connection with the IESO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IESO should issue a notice of approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules.

Approval of the proposed connection is based on information provided to the IESO by the connection applicant and the transmitter(s) at the time the assessment was carried out. The IESO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by the transmitter(s) at the request of the IESO. Furthermore, the connection approval is subject to further consideration due to changes to this information, or to additional information that may become available after the approval has been granted. Approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed facility to the IESO-controlled grid. However, connection approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter(s) during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with physical or equipment limitations, or with the Transmission System Code, before connection can be made.

This report has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. This report has been prepared solely for use by the connection applicant and the IESO in accordance with Chapter 4, section 6 of the Market Rules. The IESO assumes no responsibility to any third party for any use, which it makes of this report. Any liability which the IESO may have to the connection applicant in respect of this report is governed by Chapter 1, section 13 of the Market Rules. In the event that the IESO provides a draft of this report to the connection applicant, you must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IESO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that it is using the most recent version of this report.

##### **HYDRO ONE**

#### **Special Notes and Limitations of Study Results**

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

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

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

In this study, short circuit adequacy is assessed only for Hydro One breakers and does not include other Hydro One facilities. The short circuit results are only for the purpose of assessing the capabilities of existing Hydro One breakers and identifying upgrades required to incorporate the proposed connection. These results should not be used in the design and engineering of new facilities for the proposed connection. The necessary data will be provided by Hydro One and discussed with the connection proponent upon request.

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

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

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## **PROJECT IESO SYSTEM IMPACT ASSESSMENT**

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### **SIA Findings**

This System Impact Assessment has examined the benefits and impact of the new Hurontario SS to Jim Yarrow MTS 230 kV cables on the reliability of the IESO-Controlled grid. The installation of the circuits is a development project that will relieve current transmission overloads and provide the adequate level of supply to the area loads. The need for this development was originally identified by Hydro One and also highlighted by the IESO in the Pleasant TS SIA (CAA ID 2006-231).

### **Conclusions**

*The assessment concluded that new transmission development:*

1. will not materially affect the reliability of the IESO-controlled grid
2. will eliminate the post-contingency overloads and improve voltage performance in the area
3. will mitigate the severity of load disruptions following the double circuit contingency and improve the level of reliability of supply to the area loads
4. will have an insignificant effect on the system short circuit fault levels

*The study results concluded the following:*

1. Pleasant TS and Jim Yarrow MTS total summer 2006 peak demand exceeded the thermal capability of Hurontario SS to Jim Yarrow Jct. section of R19T/R21T line. Once in service, new circuits will off-load Jim Yarrow MTS from Pleasant tap providing the relief to the thermally congested section.
2. Thermal capability of Hurontario SS to Pleasant TS section will be sufficient to supply Pleasant TS load of about 412 MW. Based on the available load forecast data, this load level is expected to be exceeded by the summer of 2012.
3. About 64 MVar of reactive power will be provided locally by the new underground circuits thus improving the voltage performance in the area.
4. Pre and post-contingency voltage declines are well within the IESO's assessment criteria.

Although, not the result of the Hurontario SS to Jim Yarrow MTS 230 kV circuits, it was observed that under the heavy FETT conditions post-contingency loading on R x T circuits might exceed their long-term emergency ratings causing thermal congestion on these circuits. However, the circuits' loading will remain well below their LTRs. Based on the available load forecast data, it is anticipated that thermal congestion could occur in 2010.

## **IESO's Requirements for Connection**

For the proposed two new 230 kV transmission circuits that will be constructed between Hurontario SS and Jim Yarrow MTS, the following requirements were identified in this assessment:

- Hydro One is required to implement a plan to prevent post-contingency overloading of Hurontario SS to Pleasant TS section of R19T/R21T line, before the Pleasant TS load exceeds 412 MW.
- Hydro One is required to install all the equipment needed to monitor the information required by the IESO on a continuous basis as described in Appendix 4.16 of the Market Rules. The IESO requires that the status of all isolating disconnect switches and breakers as well as voltages and active and reactive power flows be monitored at Hurontario SS and Jim Yarrow MTS.
- Hydro One must follow the Transmission System Code technical requirements for transmission lines. The existing protection systems are to be revised as required.
- As per Appendix 4.1 of Market Rules, all 230 kV equipment must be capable of continuously operating in the range between 220 kV and 250 kV.
- IESO also requires that 230 kV equipment must remain in service, and not automatically trip, for the voltages up to 5% above the maximum continuous rating, for up to 30 minutes, to allow the system to be re-dispatched to return voltages within their normal range.

## **Notification of Approval for Connection Proposal**

It is recommended that a Notification of Conditional Approval for connection of the two new 230 kV transmission circuits between Hurontario SS and Jim Yarrow MTS be issued to Hydro One, subject to IESO's Requirements for Connection listed above, and any further requirements that may be identified by Hydro One Networks Inc. in the Customer Impact Assessment.

# 1. Project Description

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Jim Yarrow MTS and Pleasant TS are two transformer stations that serve the electricity to west Brampton area. The stations are currently supply by a double circuit line tapped from R19T/R21T line that connects Trafalgar TS and Richview TS. This line tap is called R19T/R21T Pleasant tap. Increasing load in the area has caused thermal congestion on the tap.

Hydro One has previously applied for and received approval for a new transmission project in this area known as the Hurontario Station and Line Project. Hydro One proposes to extend the existing V72R/V73R 230 kV line 4.2 km from Cardiff TS along the Parkway Belt to the Pleasant tap and join this line to the Pleasant tap. Where the two lines cross, Hydro One proposes to construct a new switching station, Hurontario SS, that will have 4 in-line circuit breakers. These new facilities which are planned to be in-service by May 2009 will deal the thermal congestion on both the main part of R19T/R21T and along part of the Pleasant tap. However, thermal congestion will remain on the Pleasant tap from Hurontario SS to Jim Yarrow MTS.

To address the additional transmission capacity requirements, Hydro One Network Inc. is proposing to construct two new 230 kV circuits between Hurontario SS and Jim Yarrow MTS. The new circuits will off-load Jim Yarrow MTS from R19T /R21T Pleasant tap hence relieving thermal congestion of this section.

The proposed ready for service date for the new circuits is June 1, 2009.

The purpose of the System Impact Assessment is to evaluate the results of the studies and to identify the benefit of the new facilities and their effect on system reliability.

– End of Section –

## 2. Review of Connection Proposal

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### 2.1 Proposed Connection Arrangement

New circuits will be 3 km long underground cables. They will be tapped south of the R19T/R21T in-line breakers at Hurontario SS and routed along the existing Pleasant tap right-of-way from Hurontario SS to Jim Yarrow Jct.

The existing Trafalgar TS to Claireville TS 230 kV transmission corridor, along with the step-down transformer stations connected to this system are shown in Diagram 1.

System studied in this assessment is shown in Diagram 2. This system assumed committed project such as Sithe Goreway, new generating facility, and Hurontario SS to be in-service.

The ratings of the proposed equipment are described in section 3 of this report.

### 2.2 On-line Monitoring

The Market Rules (Chapter 4 section 7.5) require that each transmitter shall provide the IESO on a continual basis with on-line monitored quantities as specified in Appendix 4.17. It is required that Hydro One install all the equipment needed to monitor the information required by the IESO on a continuous basis. The IESO requires that the status of all isolating disconnect switches and breakers as well as voltages and active/reactive power flows at Hurontario SS and Jim Yarrow MTS be monitored on a continual basis.

### 2.3 Protection Systems

With respect to the protection and telecommunication requirements, the connection applicant will have to follow the Transmission System Code technical requirements for transmission lines.

The existing protection systems are to be revised as required.

<p>The Transmission System Code requires duplicate battery protection for Protection Groups A and B unless otherwise agreed upon by the Transmitter. The applicant is required to confirm this with the Transmitter.</p>
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– End of Section –

### 3. Data Verification

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Hydro One has provided the following equipment specifications for the new facilities proposed for installation:

*Hurontario SS to Jim Yarrow MTS 230 kV Underground Circuits:*

R	0.000167 p.u.
X	0.000791 p.u.
B	0.2696 p.u.
Length	3 km
Normal continuous voltage (inter phase)	240 kV
Maximum continuous voltage (inter phase)	250 kV
Maximum temporary overvoltage (phase to ground)	250 kV
Duration	0.5 sec
Basic lightning impulse level (LIL)	950 kV
Continuous rating	1500 A
Long-term emergency rating	1500 A

– End of Section –

## 4. Fault Level Assessment

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The purpose of this assessment is to evaluate the effect that the proposed transmission facility will have on short circuit level in the area as well as to identify any violations of the existing equipment short circuit rating.

Since the new line is the radial line which will supply local area loads, it was concluded that the transmission enhancement will have an insignificant effect on the system short circuit fault levels. However, the incorporation of the new transmission facilities will affect the short circuit level at Jim Yarrow MTS. Hydro One has to ensure that short circuit level do not exceed the capability of the low voltage breakers at this station.

– End of Section –

## 5. System Description

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### 5.1 Existing Transmission

The load in GTA West is effectively supplied by two main 500/230 kV transformer stations, Trafalgar TS and Claireville TS, and one 230 kV electrical system hub, Richview TS. The 230 kV transmission system that extends between Trafalgar TS and Richview TS is comprised of four circuits, R14T, R17T, R19T & R21T. This corridor supply electricity to Erindale TS, Tomken TS, Jim Yarrow MTS and Pleasant TS as well as carry power to Richview TS and transformation facilities further east. Erindale TS and Tomken TS are tapped off these four circuits while two radial extensions from R19T and R21T circuits at Hanlan Jct. supply Pleasant TS and Jim Yarrow MTS.

The area transmission is also equipped with 230 kV, 2 x 412 MVar shunt capacitors installed at Richview TS, and 300 MVar shunt capacitor installed at Trafalgar TS.

The existing 230 kV transmission system between Claireville TS and Trafalgar TS with transformer stations connected to it is shown in Diagram 1.

### 5.2 Area Loads and Load Forecast

During the summer of 2006 an all time new system peak of over 27,000 MW was recorded. The corresponding coincident peak loading of the existing R19T/R21T Pleasant tap was 473 MW, see Figure 1. At the same time, loading of the R19T/R21T line reached level of 778 MW as shown in Figure 2. Since emergency rating of Pleasant tap is 444 MW at 235 kV, this leads to the conclusion that post-contingency loading of the remaining single supply would have exceeded its thermal limit.

The load forecast provided by local distribution companies (LDC) in the GTA West indicate that load growth is expected to continue at a summer average rate of 2.6% per annum for the next ten years at the 27.6 kV level and at 1.5% at the 44 kV level. Table 1 below lists the expected summer coincident peak load growth at the stations in GTA West in MW as well as the station or DESN 10-day LTRs in MVA.

Figure 1: Pleasant TS & Jim Yarrow MTS Load (MW)

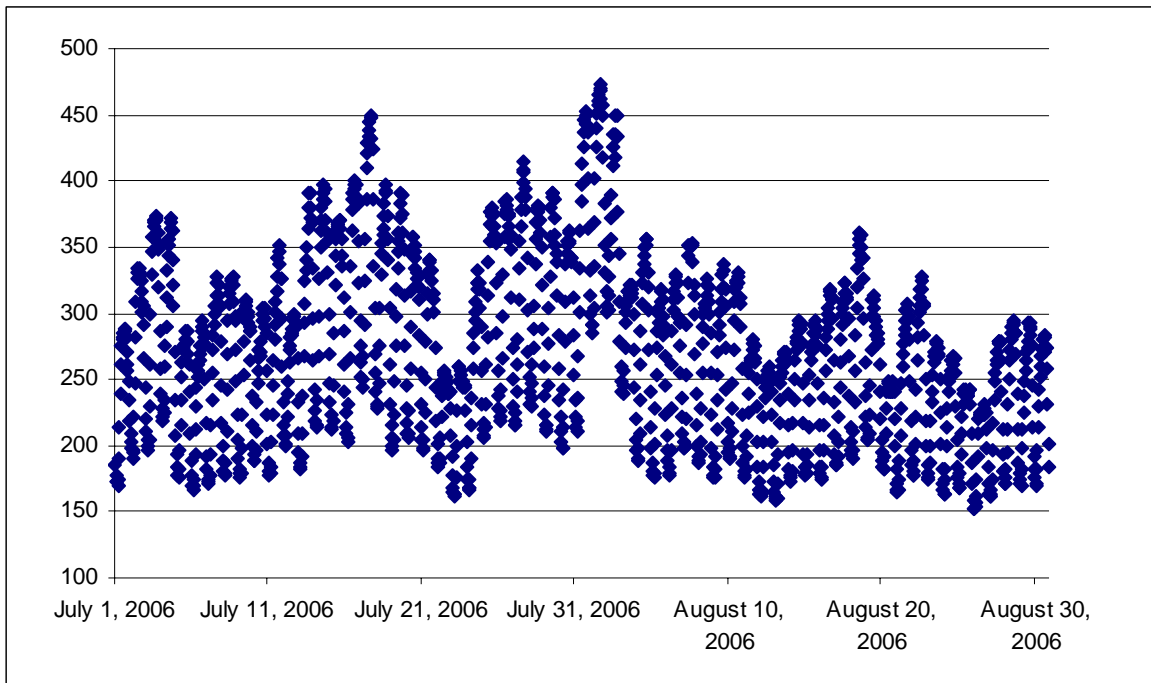


Figure 2: R19T + R21T Circuits Load (MW)

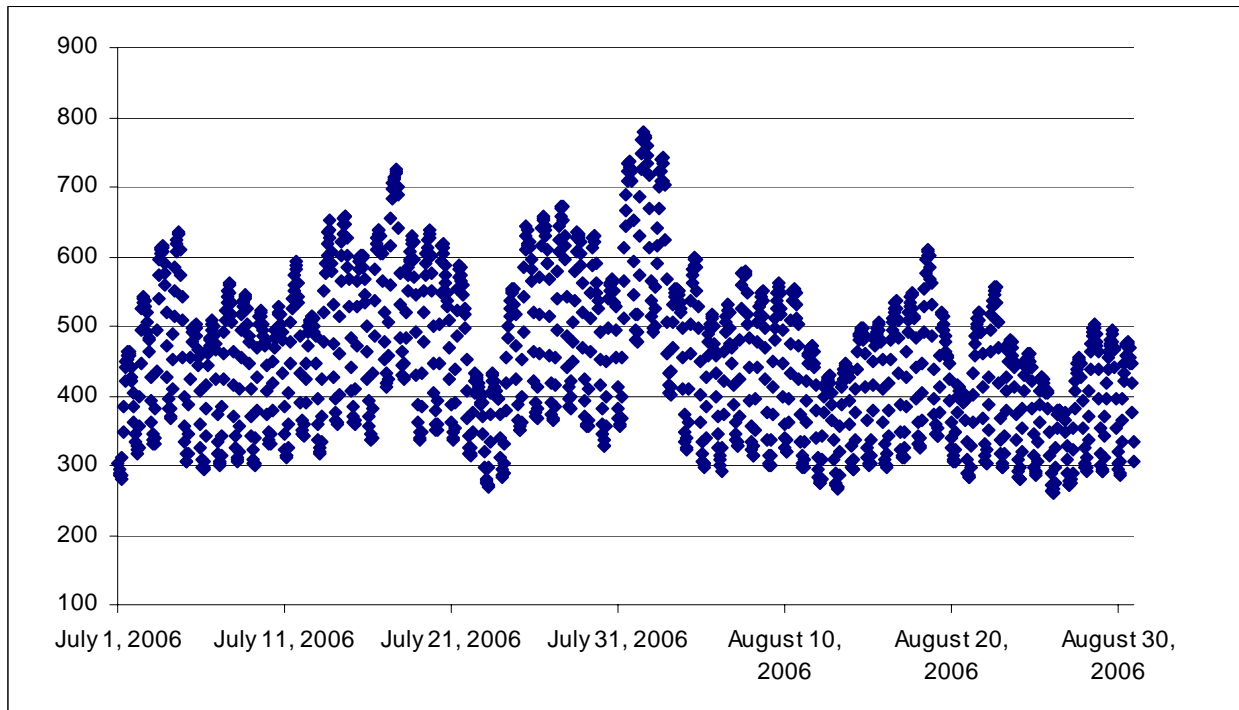


Table 1: Summer Coincident Peak Load Forecast to 2015

<b>230/27.6 KV STATIONS (MW)</b>											
	<b>LTR (MVA)</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Pleasant T5/T6 <sup>2</sup>	198.6	198	198	198	198	198	198	198	198	198	198
Jim Yarrow MTS <sup>2</sup>	167	141	150	150	150	150	150	150	150	150	150
Pleasant T3/T4 NEW <sup>5</sup>	170	0	0	12	26	42	58	72	86	100	115
Bramalea T1/T2 <sup>1,2,3</sup>	172.6	174	175	177	179	181	183	183	184	184	184
Cardiff TS <sup>1</sup>	126.1	101	103	105	107	110	112	112	112	113	113
Erindale T1/T2 <sup>1,4</sup>	190.8	167	170	174	177	181	185	185	186	187	187
Goreway T5/T6 <sup>3</sup>	191.8	155	163	170	177	184	192	200	208	216	224
Halton TS	206.6	114	131	149	162	166	170	175	179	183	188
Richview TS	459.1	362	364	368	371	374	377	380	385	388	392
<b>230/44 kV STATIONS (MW)</b>											
	<b>LTR (MVA)</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Pleasant T1/T2 <sup>2</sup>	164.5	136	140	144	148	152	156	161	164	170	174
Bramalea T3/T4 <sup>1</sup> , T5/T6	117.4 176.8	184	188	192	196	201	205	210	215	220	224
Goreway TS <sup>3</sup>	95.4	29	30	31	32	34	35	36	37	39	40
Erindale T3/T4 <sup>2</sup> , T5/T6	209.1 171.9	374	384	394	405	415	425	427	429	431	433
Tomken T1/T2, T3/T4	183 202.9	314	316	317	319	321	322	323	324	325	326
Meadowvale TS	200.7	181	181	181	181	181	181	181	181	181	181

<sup>1</sup> Net load; includes load transfers from Bramalea TS and Erindale TS to Cardiff TS as per Hydro One.

<sup>2</sup> Net load; includes load transfers from Pleasant TS and Bramalea TS as per Hydro One.

<sup>3</sup> Net load; Includes load transfers from Bramalea TS as per Hydro One.

<sup>4</sup> Net load; Includes load transfers from Meadowvale TS to Erindale TS as per Hydro One.

<sup>5</sup> Net load; Includes load transfer from Pleasant TS and Jim Yarrow MTS as per Hydro One Brampton.

### 5.3 Load Supply Deliverability

The load security and restoration criteria for IESO-controlled grid are defined in the Ontario Resource and Transmission Assessment Criteria document as follows:

*“With any one element out of service, equipment loading must be within applicable long-term emergency ratings, voltages must be within applicable emergency ranges, and transfers must be within applicable normal condition stability limits. Not more than 150MW of load may be interrupted by configuration. Planned load curtailment or load rejection, excluding voluntary demand management, is not permissible.*

*With any two elements out of service voltages must be within applicable emergency ranges. Equipment may be loaded up to applicable short-term emergency ratings immediately following a contingency, but must be reduced to the long-term emergency ratings in the time afforded by the short-term ratings. Not more than 600MW of load may be interrupted as a result of the contingency, and this may include up to 150MW of planned load curtailment or load rejection, excluding voluntary demand management.*

*The transmission system must be planned such that, following design criteria contingencies on the transmission system, affected loads can be restored within the restoration times listed below:*

- a. All load must be restored within approximately 8 hours.*
- b. When the amount of load interrupted is greater than 150MW, the amount of load in excess of 150MW must be restored within approximately 4 hours.*
- c. When the amount of load interrupted is greater than 250MW, the amount of load in excess of 250MW must be restored within 30 minutes.”*

Any permanent fault that involves one of the R19T or R21T circuits would result in the overloading of the Hanlan Jct. to Jim Yarrow Jct. section of the remaining circuit. Furthermore, these circuits supply electricity to more than 600 MW of load (~ 778 MW) and are thus operating beyond the adequate system reliability and secure guidelines as outlined in the IESO’s Ontario Resources and Transmission Assessment Criteria.

The problem of inadequate supply to the loads connected to the R19T/R21T line has been addressed in Hydro One’s plan to build new switching station, Hurontario SS. This will effectively provide a second point of supply for the Pleasant tap, off-loading R19T/R21T circuits from Erindale Jct. to Hanlan Jct. and from Hanlan Jct. to Hurontario SS. The new switching station will also create an isolation point on R19T/R21T line hence allowing the load connected to the line to meet the IESO’s guidelines. This proposal was assessed and approved by the IESO under CAA ID 2006-224.

However, it should be noted that incorporation of Hurontario SS will not improve the thermal loading conditions on the Hurontario SS to Jim Yarrow Jct. section of R19T/R21T line.

To relieve thermal congestion of Hurontario SS to Jim Yarrow Jct. section, Hydro One is proposing to build two new 230 kV transmission circuits between Hurontario SS and Jim Yarrow MTS. These will radially supply Jim Yarrow MTS therefore off-loading the congested section. Since the possible overloading could have occurred in 2006, it is recommended that Hydro One implement this plan as soon as practicable.

## 6. System Impact Studies

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The system impact assessment studies focused on identifying the effect of the proposed transmission addition on the 230 kV transmission system bordered by two 500/230 kV transformer station, Trafalgar TS and Claireville TS, and 230 kV electrical system hub, Richview TS. This included the evaluation of the system voltages and thermal loadings, and a comparison between the performance of the existing system and the performance of the reinforced system.

Studies were performed under the summer 2009 loading condition for the following two different generating scenarios:

1. Sithe Goreway generating at maximum output of 900 MW (all 4 units in service)
2. Sithe Goreway GS loaded to 600 MW (3 units in service)

Comparison analysis of enhanced transmission system performance under the two generating scenarios is also included in subsequent sections.

### 6.1 Study Assumptions

Jul06 base case was used as a starting load flow with the following modifications made to it:

- Double circuit line V72R/V73R extended from Cardiff TS joining the R19T/R21T Pleasant tap through four in line breakers at Hurontario SS.
- Sithe Goreway GS connected to V72R/V73R line.
- New Pleasant TS DESN #3 is assumed in service.
- Natural load power factor of 0.9 was assumed at Pleasant TS.
- Natural load power factor of 0.91 was assumed at Jim Yarrow MTS.
- Both existing Pleasant TS and Jim Yarrow MTS were loaded to their LTRs i.e. 198 MW and 150 MW respectively.
- GTAA generation connected to 44 kV buses at Bramalea TS and Woodbridge TS = 117 MW.
- TA Douglas generation connected to Bramalea TS 44 kV bus = 114 MW
- GTA load was scaled to the 2009 extreme weather monthly peak forecast of 10,544 MW.
- GTA West transformer station loads were scaled up according to the load forecast data given in Table 1.
- Flow over FETT (Flow East Toward Toronto) interface during the system peak of summer 2006 was about 4,500 MW. Since R x T circuits are part of this interface, in order to stress the studied system FETT transfer was increased to approximately 4,650 MW under scenario 1. Scenario 2 assumed that generation output at Sithe Goreway was decreased to 600 MW with the corresponding generation increase in the western and Niagara zone. This resulted in FETT power transfer being gradually increased from the initial transfer level of 4,650 MW to approximately 4,955 MW.

Scenario 1: All four Sithe Goreway units were in service with a total generation of 900 MW, FETT at 4,650MW

Scenario 2: Three units at Sithe Goreway in service generating 600 MW of power, FETT at 4,955 MW

For the purpose of the studies, the initial system was defined as the year 2009 system with Hurontario SS, Sithe Goreway GS and new Pleasant TS facilities assumed in-service. The initial and proposed transmission configurations are shown in Diagram 2 and Diagram 3 respectively.

## 6.2 Transmission Thermal Loading Assessment

The study examines the pre and post-contingency loading capabilities of the 230 kV transmission system. For the purpose of this study, active and reactive power loads were represented by *constant MVA* load model.

Since the new circuits are radial circuits providing supply to the local area load, only the following single contingencies were simulated:

Loss of R14T	Loss of R21T
Loss of R17T	Loss of R21T North
Loss of R19T	Loss of V72R
Loss of R19T North	Loss of V73R

The monitored transmission path consisted of the above listed circuits.

In view of the fact that the ratings of the individual circuits in a double circuit line are the same, it is assumed that the loss of the other circuit in the double circuit line would warrant the same technical results. Hence, only results for the loss of one circuit of double circuit line were shown in the Tables 2-5.

The ratings used to evaluate the thermal capability of the system were design ratings provided by connection applicant. The ratings were calculated for the summer peak conditions, i.e. temperature of 35°C, wind speed of 4 km/h and for the day time. Pre-load dependant LTRs were calculated assuming circuit pre-contingency loading of 75%.

The criteria applied in assessing the thermal loading capability of the 230 kV system is the following:

- With all elements in-service, all line loads shall be within their continuous rating.
- With any one element out of service, post-contingency line loads shall be within their long-term emergency ratings.
- Lines may be loaded up to their short-term emergency ratings immediately following contingencies to effect re-dispatch, perform switching, or implement control actions to reduce the loading to the long-term emergency ratings.

### 6.2.1 Study Results - Scenario 1

Scenario 1 assumed all four Sithe Goreway units in service with power flow over the FETT interface of approximately 4650 MW.

Study results for the initial transmission configuration and proposed transmission reinforcement are summarized in Tables 2 and 3 respectively in Appendix A. The results indicate the following:

With all elements in service, loading of the lines are well below their continuous ratings.

Pre-contingency power flows on monitored circuits will slightly decrease in proposed system in comparison to the initial system flows. This is due to fact that about 64 MVar of needed reactive power support will be provided locally from the new lightly loaded cables; only about 12% of the thermal capability of the new circuits will be used to supply Jim Yarrow MTS load of 150 MW. Initial and proposed system reactive power flows and voltage profiles are shown in Diagram 4 and Diagram 5 respectively. The diagrams indicate that with the new cables in service the voltage profile in the area is much improved.

Under the initial system configuration, the loss of either R19T North or R21T North was identified as the most critical single contingency. This contingency would result in overloading of Hurontario SS to Jim Yarrow Jct. section of the remaining circuit (130.4%). The construction of the new circuits would alleviate this problem since the new circuits will provide radial supply to Jim Yarrow MTS thus off-loading Jim Yarrow load from the existing R19T/R21T North circuits.

In the proposed system, the loss of R14T would cause the remaining circuit being loaded to 93.1% of its long-term emergency rating. This becomes the most critical contingency in the proposed system. However, it should be noted that this critical contingency is inherent to Trafalgar to Richview system configuration and it is not the result of the proposed cables.

Study results also indicated that post-contingency loading of the remaining Pleasant tap circuit is approaching its thermal limit. This problem was initially identified in the assessment of the new Pleasant DESN station (CAA ID 2006-231). As per this assessment, thermal capability of the line will be sufficient to supply about 408 MW of the load. The incorporation of the two new circuits will improve the line voltage conditions in the area, thus resulting in improving the post-contingency thermal capability of the circuits. As a result, the circuits will be capable of supplying projected summer 2011 peak load of 412 MW without exceeding its thermal capacity limit.

The results of the summer 2011 study are given in Table 4.

Any permanent fault involving any one of R19T/R21T circuits under the proposed system conditions will also disconnect the associated new circuit. This, as a consequence, will have slightly different distribution of the post-contingency power flows in comparison to post-contingency flows in the initial system.

## **6.2.2 Study Results - Scenario 2**

The studies were performed for a 3 Sithe Goreway units in-service with a total output of 600 MW and FETT transfer of about 4, 955 MW. Decreasing the generation output at Sithe Goreway GS with the corresponding generation increase in the western and Niagara zone maximizes the power flowing from Trafalgar TS into the load center and increases the loading of Claireville autotransformers. The assessment was carried out for the proposed system configuration only. The results are summarized in Table 5.

Comparison analysis of proposed system performance under the scenario 1 versus scenario 2 indicates that, under scenario 2 conditions, there was an increase in loading of the following lines: R19T/R21T and R14T/R17T circuits emanating from Trafalgar TS will carry about 12 % and 8% more power respectively while 17% increase in loading of V72R/V73R line sections coming from Claireville TS was also recorded. Claireville autotransformers carried out an additional load of 123 MVA resulting in one of the autotransformers being loaded to 95.6% of its continuous rating.

Post-contingency loadings of R x T circuits will also increase and will be approaching their long-term emergency ratings. The loss of one of the R14T/R17T circuits would result in the remaining circuit being loaded to 98.1% of its emergency rating while contingency associated with R19T/R21T would load the

remaining circuit to 93.1%. However, the circuits' loadings will remain well below the LTRs. Since these lines are part of the bulk power system, it is assumed that loading conditions and control actions are available to reduce the loading to the continuous rating or less. Based on the available load forecast data, it is anticipated that thermal congestion on these circuits could occur in 2010.

### **6.3 System Voltage Assessment**

The IESO's Ontario Resource and Transmission Assessment Criteria require the post-contingency voltage decline on 230 kV system be limited to 10% while immediate post-contingency voltage decline and voltage decline following the tap-changer response on the low voltage side must be limited to 12% and 6% respectively. Also, the IESO-controlled grid should be capable of achieving acceptable system voltages, i.e. minimum continuous voltage of 220 kV and maximum continuous voltage of 250 kV under steady state conditions.

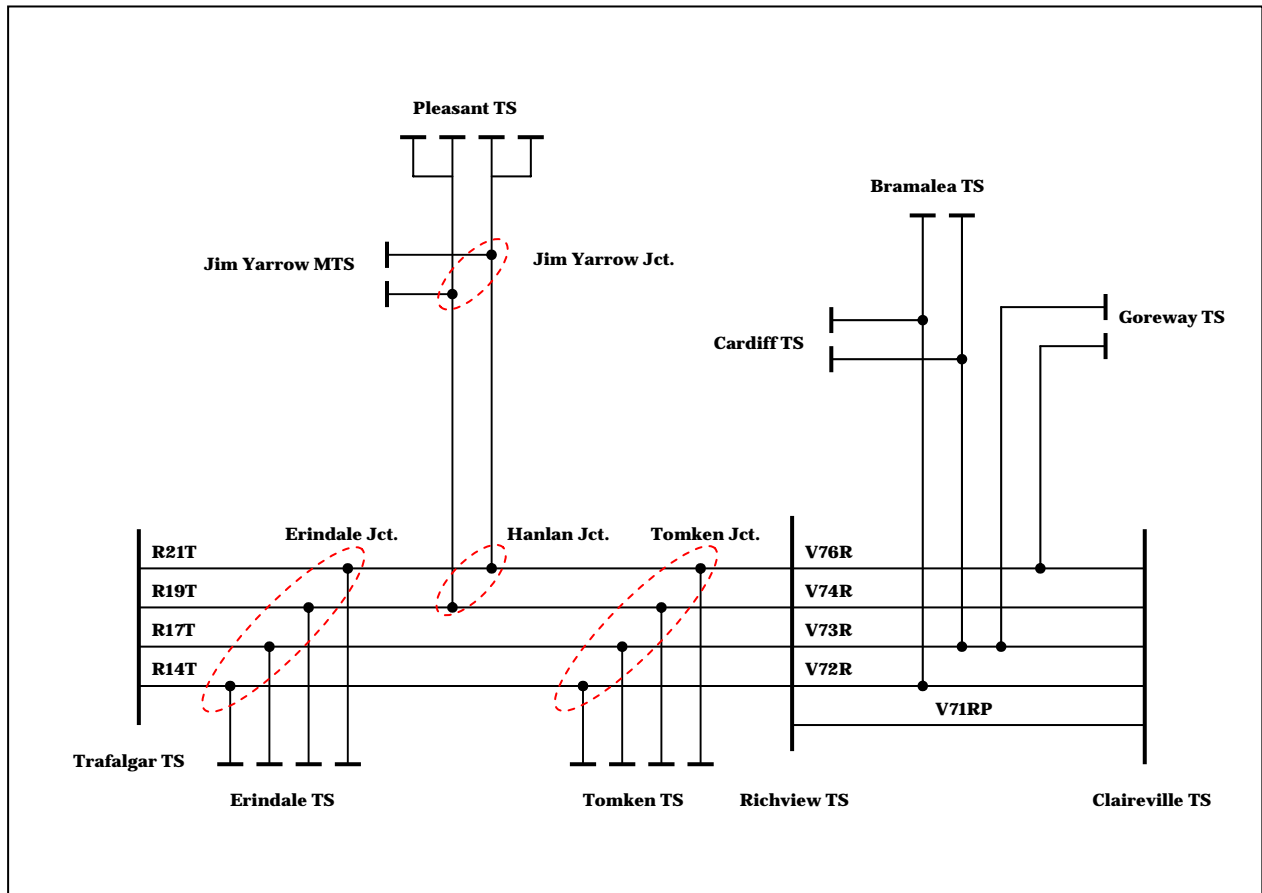
The voltage decline study was carried out with loads modeled as voltage-varying loads in the immediate post-contingency state: P modeled as 50% constant current and 50% constant impedance; Q modeled as 100% constant impedance. Following the tap changers response, load was represented as constant MVA.

The study results for the initial and proposed system configurations are given in Table 6 and 7. The results indicate that construction of the new circuits will improve the voltage situation in the area by means of off-loading the existing Pleasant tap, and also by new circuits providing reactive power support locally. As a result, contingency simulated in the reinforced system resulted in smaller voltage declines; 1.8% on high voltage side and 6.4% on low voltage side for the loss of R19T/R21T as comparing to 2.4% and 7.5% voltage declines under the initial system configuration following the loss of R19T/R21T North.

It can be concluded that the transmission enhancement will not only improve the thermal capability of the system and increase the reliability of supply to the area loads system, but will also improve the voltage performance in the area.

**– End of Section –**

# Diagrams



**Diagram 1: Existing Area Transmission and Step-down Facilities**

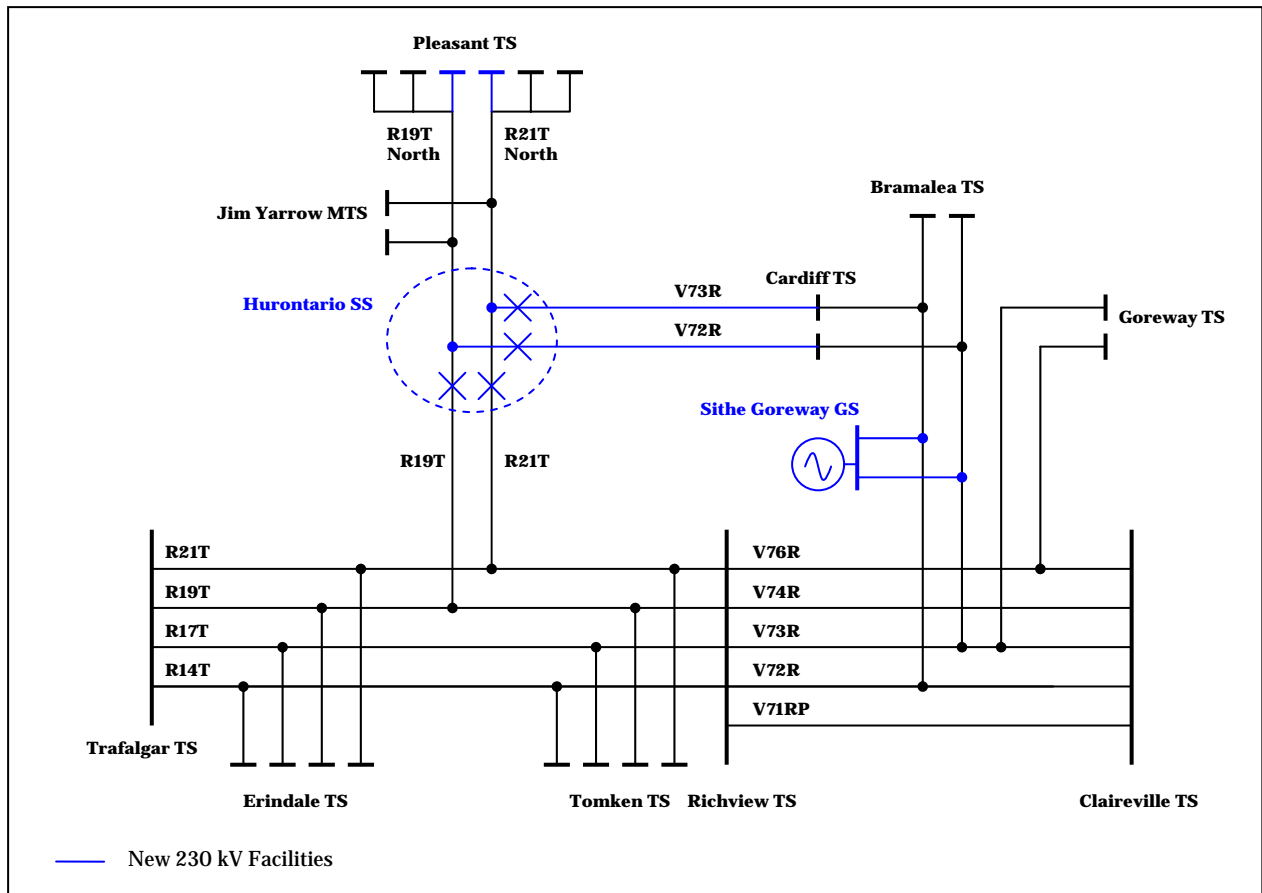


Diagram 2: Year 2009, Initial System Configuration

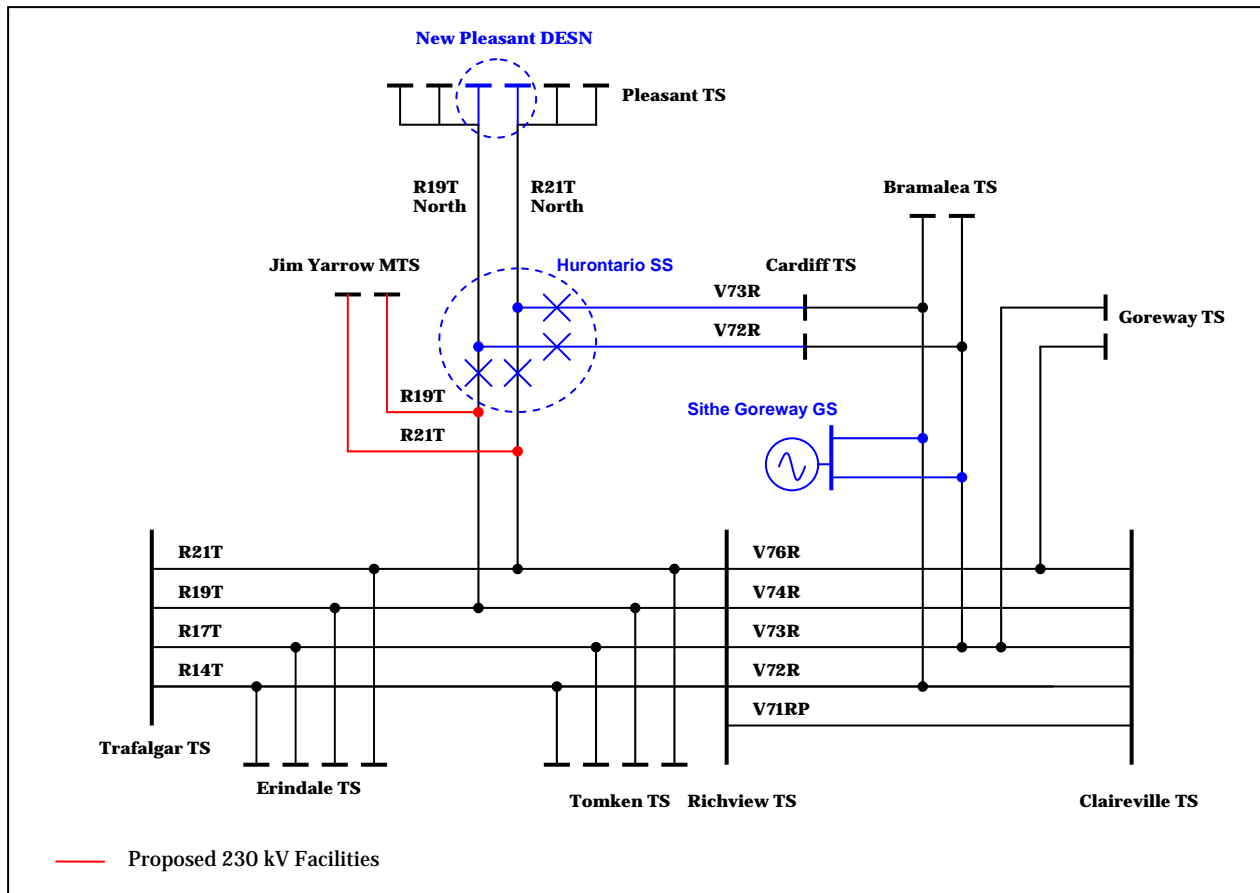


Diagram 3: Year 2009, Proposed System Configuration

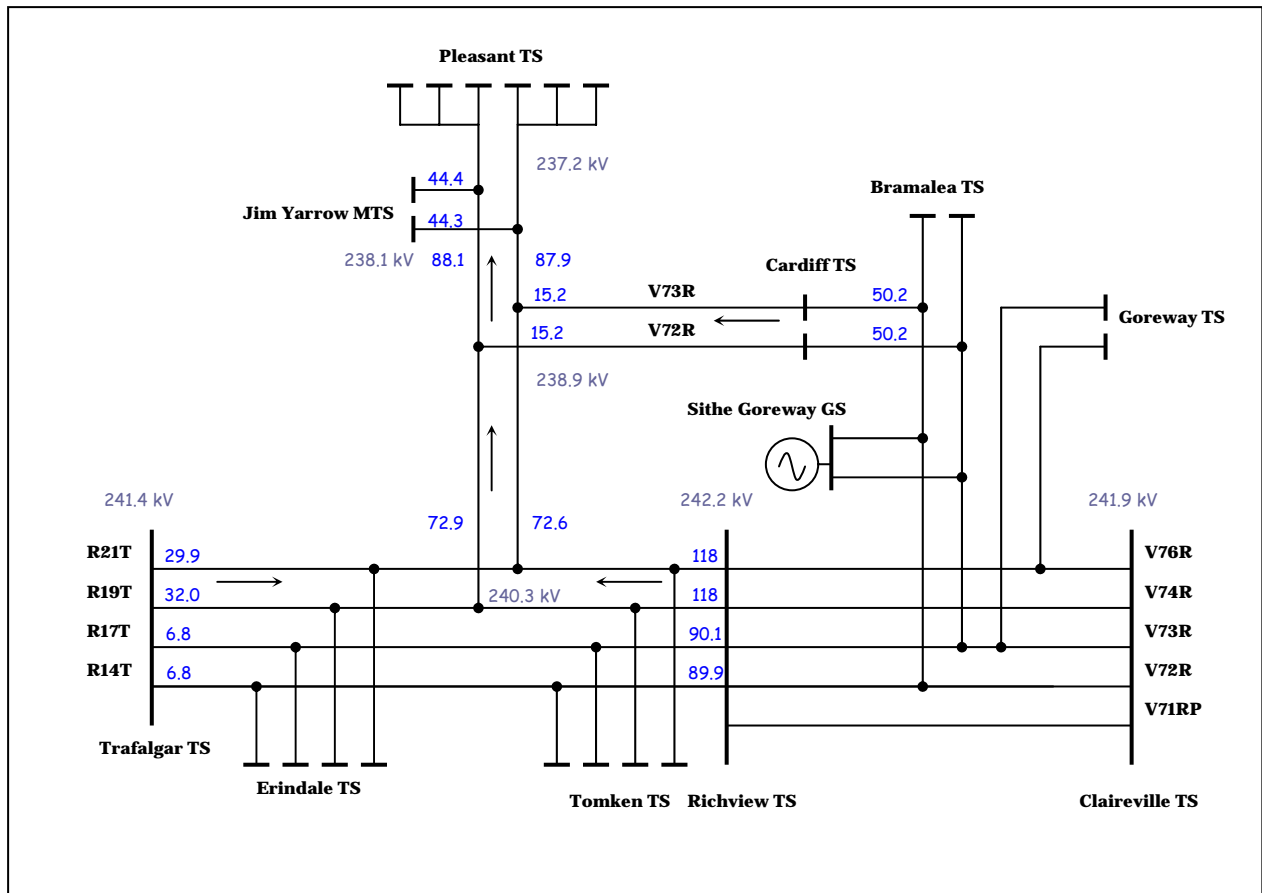
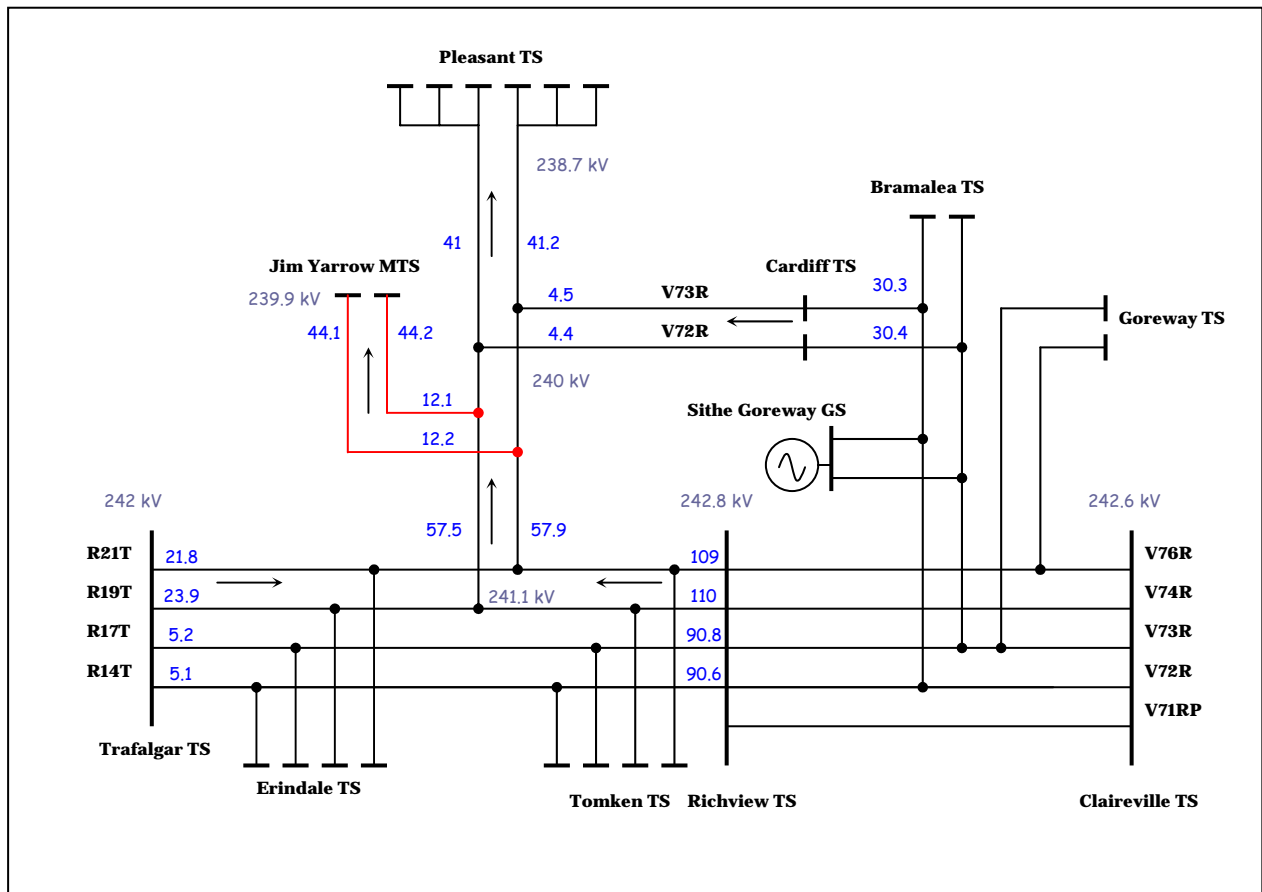


Diagram 4: Year 2009, Initial System Reactive Power Flows



**Diagram 5: Year 2009 Proposed System Reactive Power Flows**

# Appendix A: Thermal Assessment Study Results

Table 2: Thermal Assessment, Scenario 1

Scenario 1: Year 2009, Jim Yarrow Circuits NOT In-service, FETT = 4650 MW														
Monitored Element			Cont rating	Emergency	Pre-contingency		Loss of R19T		Loss of R19T North		Loss of V72R		Loss of R14T	
Cct	From	To	Amp	Amp	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %
<b>R19T</b>	TRAFALGA	ERINJR19	1110	1460	74.5	56.6	0	0	64.6	49.2	90.3	68.6	85.4	65.0
	ERINJR19	HANLNJ19	840	1090	67.4	51.9	0	0	54.5	42.0	88.0	67.8	82.1	63.3
	HANLNJ19	TOMKJR19	840	1090	56.8	43.8	0	0	72.5	55.8	38.2	29.4	68.1	52.5
	TOMKJR19	RICH AH2	840	1090	44.7	34.4	0	0	56.1	43.2	37.0	28.5	54.5	42.0
	HANLNJ19	HURONTAR	840	1090	27.1	20.9	0	0	19.2	14.8	72.3	55.7	27.5	21.3
<b>R21T</b>	TRAFALGA	ERINJR21	1110	1460	75.3	57.3	<b>109.4</b>	83.1	86.5	65.8	73.4	55.8	86.1	65.5
	ERINJR21	HANLNJ21	840	1090	66.8	51.5	79.1	61.0	80.8	62.3	62.4	48.1	81.6	62.9
	HANLNJ21	TOMKJR21	840	1090	56.7	43.7	68.8	53.1	49.1	37.7	66.6	51.4	67.9	52.3
	TOMKJR21	RICH AH2	840	1090	44.5	34.2	52.4	40.5	45.1	34.8	54.9	42.3	54.3	41.8
	HANLNJ21	HURONTAR	840	1090	26.9	20.8	25.5	19.6	65.5	50.5	37.0	28.5	27.4	21.1
<b>R19T North</b>	HURONTAR	J YARJ19	840	1090	79.8	61.5	78.3	60.3	0	0	72.5	55.8	80.1	61.6
	J YARJ19	PLEASR19	840	1090	55.5	42.7	54.5	42.0	0	0	50.1	38.5	55.6	42.8
<b>R21T North</b>	HURONTAR	J YARJ21	840	1090	79.7	61.4	82.4	63.4	<b>169.1</b>	<b>130.4</b>	88.9	68.5	79.8	61.5
	J YARJ21	PLEASR21	840	1090	55.4	42.7	57.1	44.1	<b>116.4</b>	89.8	61.9	47.7	55.5	42.8
<b>V72R</b>	CLAIRVIL	CLAIRV72	1340	1780	46.3	35.0	53.5	40.2	46.0	34.5	0	0	47.2	35.4
	CLAIRV72	RICH J72	1340	1780	63.0	47.3	63.7	47.8	63.1	47.5	0	0	65.5	49.4
	RICH J72	RICH AH2	1340	1780	54.2	40.9	55.0	41.3	54.4	40.9	0	0	56.8	42.8
	CLAIRV72	CLV PJ72	1370	1690	28.5	23.1	29.8	24.0	29.9	24.3	0	0	29.0	23.4
	CLV PJ72	SITHJV72	1370	1690	29.0	23.5	30.2	24.5	30.2	24.5	0	0	29.4	23.9
	SITHJV72	BRAMAV72	1370	1690	62.6	50.8	75.8	61.5	37.9	30.7	0	0	61.3	49.7
	BRAMAV72	CARDFV72	1290	1700	48.6	36.9	62.5	47.3	21.0	15.9	0	0	47.3	35.8
	CARDFV72	HURONTAR	1290	1700	37.8	28.7	51.0	38.7	12.8	9.8	0	0	36.2	27.5
<b>V73R</b>	CLAIRVIL	CLAIRV73	1340	1780	60.3	45.4	66.8	50.4	62.4	46.9	46.3	35.0	61.2	46.0
	CLAIRV73	RICH AH2	1340	1780	61.8	46.5	62.4	47.0	61.9	46.6	78.5	59.2	64.3	48.4
	CLAIRV73	CLV PJ73	1370	1690	28.5	23.1	29.5	24.0	29.6	24.0	72.4	58.5	29.0	23.4
	CLV PJ73	SITHJV73	1370	1690	29.0	23.5	30.0	24.4	30.1	24.4	72.7	58.9	29.4	23.9
	SITHJV73	BRAMAV73	1370	1690	62.6	50.8	65.0	52.7	90.4	73.2	<b>103.9</b>	84.4	61.3	49.7
	BRAMAV73	CARDFV73	1290	1700	48.6	36.9	50.6	38.4	79.6	60.4	71.3	54.1	47.3	35.9
	CARDFV73	HURONTAR	1290	1700	37.8	28.7	39.3	29.8	68.9	52.3	50.6	38.4	36.2	27.5
<b>R14T</b>	TRAFALGA	ERINJR14	1110	1460	79.6	60.4	90.8	69.0	79.9	60.7	79.9	60.7	0.0	0.0
	ERINJR14	TOMKJR14	840	1090	55.8	42.9	70.6	54.4	55.8	43.1	55.9	43.1	0.0	0.0
	TOMKJR14	RICH AH1	840	1090	37.8	29.2	50.8	39.0	37.6	29.1	38.1	29.4	0.0	0.0
<b>R17T</b>	TRAFALGA	ERINJR17	1110	1460	79.4	60.4	90.8	69.0	79.7	60.7	79.7	60.7	<b>122.7</b>	93.3
	ERINJR17	TOMKJR17	840	1090	55.6	42.9	70.4	54.2	55.8	42.9	55.9	43.1	60.5	46.6
	TOMKJR17	RICH AH1	840	1090	37.9	29.2	50.8	39.2	37.8	29.1	38.2	29.4	51.3	39.4

Table 3: Thermal Assessment, Scenario 1

Scenario 1, Year 2009: Jim Yarrow Circuits IN-service, FETT = 4650 MW														
			Cont. Rating	Emergency	Pre-contingency		Loss of R19T		Loss of R19T North		Loss of V72R		Loss of R14T	
Cct	Monitored Element		Amp	Amp	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %
	From	To												
<b>R19T</b>	TRAFALGA	ERINJR19	1110	1460	74.2	56.5	0	0	67.6	51.3	89.8	68.3	85.1	64.7
	ERINJR19	HANLNJ19	840	1090	67.4	51.9	0	0	58.6	45.1	88.0	67.8	82.3	63.4
	HANLNJ19	TOMKJR19	840	1090	55.8	43.1	0	0	66.9	51.6	34.1	26.3	67.2	51.8
	TOMKJR19	RICH AH2	840	1090	42.9	33.1	0	0	51.4	39.7	32.1	24.8	53.2	41.0
	HANLNJ19	HURONTAR	840	1090	23.7	18.3	0	0	13.5	10.4	69.0	53.2	24.7	19.1
<b>NEW19</b>	HURONTAR	J YARJ19	1500	1500	12.3	12.3	0	0	13.5	13.5	10.9	10.9	12.3	12.3
<b>R21T</b>	TRAFALGA	ERINJR21	1110	1460	75.0	57.1	<b>111.2</b>	82.6	82.5	62.7	72.9	55.4	85.8	65.2
	ERINJR21	HANLNJ21	840	1090	66.9	51.5	81.2	61.1	76.1	58.6	62.2	48.0	81.7	63.0
	HANLNJ21	TOMKJR21	840	1090	55.6	42.8	65.7	52.0	48.3	37.2	65.0	50.1	67.1	51.6
	TOMKJR21	RICH AH2	840	1090	42.8	33.0	52.3	38.4	40.7	31.4	52.9	40.7	52.9	40.7
	HANLNJ21	HURONTAR	840	1090	23.6	18.2	31.9	16.7	49.1	37.7	32.1	24.8	24.5	18.8
<b>NEW21</b>	HURONTAR	J YARJ19	1500	1500	12.2	12.2	27.4	12.6	11.1	11.1	13.8	13.8	12.3	12.3
<b>R19T N</b>	HURONTAR	PLEASR19	840	1090	55.1	42.4	56.9	43.9	0	0	49.6	38.3	55.2	42.5
<b>R21T N</b>	HURONTAR	PLEASR19	840	1090	54.8	42.3	54.1	41.7	<b>115.8</b>	89.3	61.5	47.3	55.1	42.4
<b>V72R</b>	CLAIRVIL	CLAIRV72	1340	1780	45.8	34.5	51.2	38.5	45.6	34.3	0	0	46.7	35.2
	CLAIRV72	RICH J72	1340	1780	62.9	47.3	64.2	48.3	63.0	47.3	0	0	65.4	49.2
	RICH J72	RICH AH2	1340	1780	54.1	40.8	55.5	41.8	54.2	40.9	0	0	56.8	42.7
	CLAIRV72	CLV PJ72	1370	1690	27.7	22.6	29.6	24	28.5	23.1	0	0	28.1	22.8
	CLV PJ72	SITHJV72	1370	1690	28.1	22.8	30.1	24.4	29.0	23.5	0	0	28.5	23.1
	SITHJV72	BRAMAV72	1370	1690	61.7	50.1	63.5	51.5	45.3	36.7	0	0	60.6	49.1
	BRAMAV72	CARDFV72	1290	1700	48.0	36.4	48.6	36.8	29.3	22.2	0	0	46.5	35.3
	CARDFV72	HURONTAR	1290	1700	37.7	28.5	37	28.1	19.5	14.8	0	0	36.0	27.3
<b>V73R</b>	CLAIRVIL	CLAIRV73	1340	1780	60.0	45.2	65.5	49.3	61.2	46.0	45.1	33.9	60.8	45.8
	CLAIRV73	RICH AH2	1340	1780	61.7	46.4	63	47.4	61.8	46.5	78.4	59.1	64.2	48.3
	CLAIRV73	CLV PJ73	1370	1690	27.7	22.6	29.5	23.9	28.2	22.8	71.5	58.0	28.1	22.8
	CLV PJ73	SITHJV73	1370	1690	28.1	22.8	30	24.3	28.8	23.2	71.8	58.2	28.5	23.1
	SITHJV73	BRAMAV73	1370	1690	61.7	50.0	72	58.3	80.0	64.8	<b>102.1</b>	82.8	60.5	49.1
	BRAMAV73	CARDFV73	1290	1700	48.0	36.4	58.5	44.4	68.4	51.9	70.8	53.7	46.5	35.3
		CARDFV73	HURONTAR	1290	1700	37.7	28.5	47.4	36	57.7	43.9	51.1	38.8	36.0
<b>R14T</b>	TRAFALGA	ERINJR14	1110	1460	79.4	60.3	90.4	68.8	79.6	60.4	79.6	60.6	0	0
	ERINJR14	TOMKJR14	840	1090	55.6	42.9	70.1	54	55.8	42.9	55.9	43.1	0	0
	TOMKJR14	RICH AH1	840	1090	37.8	29.2	50.5	38.9	37.8	29.2	38.2	29.4	0	0
<b>R17T</b>	TRAFALGA	ERINJR17	1110	1460	79.3	60.3	90.4	68.7	79.6	60.4	79.6	60.4	<b>122.4</b>	93.1
	ERINJR17	TOMKJR17	840	1090	55.6	42.8	70	54	55.6	42.9	55.8	42.9	60.5	46.7
	TOMKJR17	RICH AH1	840	1090	37.9	29.2	50.6	39	37.9	29.2	38.2	29.4	51.7	39.8

Table 5: Thermal Assessment, Scenario 1

Scenario 1, Year 2011: Jim Yarrow Circuits IN-service, FETT=4650 MW														
			Cont rating	Emergency	Pre-contingency		Loss of R19T		Loss of R19T North		Loss of V72R		Loss of R14T	
Cct	Monitored Element		Amp	Amp	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %
	From	To												
<b>R19T</b>	TRAFALGA	ERINJR19	1110	1460	76.2	57.9	0	0	68.7	52.2	92.4	70.3	87	66.1
	ERINJR19	HANLNJ19	840	1090	68.2	52.6	0	0	58.4	45	89.5	69	83	63.9
	HANLNJ19	TOMKJR19	840	1090	54	41.6	0	0	65.8	50.7	34.2	26.4	65.2	50.3
	TOMKJR19	RICH AH2	840	1090	42.1	32.5	0	0	50.6	39	35.1	27	51.7	39.9
	HANLNJ19	HURONTAR	840	1090	27.2	21	0	0	12.8	9.8	75.7	58.4	28.7	22.1
<b>NEW19</b>	HURONTAR	J YARJ19	1500	1500	12.3	12.3	0	0	13.7	13.7	11	11	12.4	12.4
<b>R21T</b>	TRAFALGA	ERINJR21	1110	1460	77	58.5	<b>114.7</b>	87.2	85.4	64.9	75.3	57.2	87.8	66.7
	ERINJR21	HANLNJ21	840	1090	67.7	52.1	81.9	63.1	77.9	60.1	63.3	48.8	82.4	63.5
	HANLNJ21	TOMKJR21	840	1090	53.8	41.5	64.3	49.5	46.7	36	63.3	48.8	65	50.1
	TOMKJR21	RICH AH2	840	1090	42	32.4	54.7	42.2	41.4	31.9	52.2	40.2	51.5	39.7
	HANLNJ21	HURONTAR	840	1090	26.9	20.8	36.2	27.9	55.6	42.8	36	27.7	28.4	21.9
<b>NEW21</b>	HURONTAR	J YARJ21	1500	1500	12.3	12.3	27.6	27.6	11.1	11.1	14	14	12.3	12.3
<b>R19T N</b>	HURONTAR	PLEASR19	840	1090	61.8	47.6	63.4	48.8	0	0	56.3	43.4	62	47.8
<b>R21T N</b>	HURONTAR	PLEASR21	840	1090	61.6	47.5	61.1	47.1	<b>129.5</b>	<b>99.8</b>	68.6	52.8	61.8	47.7
<b>V72R</b>	CLAIRVIL	CLAIRV72	1340	1780	49.1	37	55.4	41.7	48.8	36.7	0	0	50	37.7
	CLAIRV72	RICH J72	1340	1780	63.1	47.5	64.2	48.3	63.3	47.6	0	0	65.8	49.5
	RICH J72	RICH AH2	1340	1780	54.3	40.9	55.3	41.6	54.4	40.9	0	0	56.9	42.8
	CLAIRV72	CLV PJ72	1370	1690	25.8	20.9	29.0	23.5	26.8	21.8	0	0	26.4	21.4
	CLV PJ72	SITHJV72	1370	1690	26.3	21.3	29.6	24.0	27.3	22.1	0	0	26.8	21.8
	SITHJV72	BRAMAV72	1370	1690	65.3	53	69.4	56.3	46.9	38.1	0	0	64.3	52.1
	BRAMAV72	CARDFV72	1290	1700	50.4	38.2	53.4	40.5	29.4	22.3	0	0	48.9	37.1
	CARDFV72	HURONTAR	1290	1700	39.2	29.7	41.2	31.3	18.9	14.3	0	0	37.6	28.5
<b>V73R</b>	CLAIRVIL	CLAIRV73	1340	1780	64.4	48.5	70.8	53.3	65.9	49.6	50.5	38	65.4	49.2
	CLAIRV73	RICH AH2	1340	1780	61.9	46.6	63.0	47.4	62.1	46.7	79.1	59.6	64.5	48.6
	CLAIRV73	CLV PJ73	1370	1690	25.8	20.9	29.0	23.5	26.7	21.6	68.7	55.7	26.4	21.4
	CLV PJ73	SITHJV73	1370	1690	26.3	21.3	29.5	23.9	27.2	22	68.8	55.8	26.9	21.8
	SITHJV73	BRAMAV73	1370	1690	65.2	52.9	75.8	61.4	85.8	69.5	<b>108.2</b>	87.7	64.2	52.1
	BRAMAV73	CARDFV73	1290	1700	50.4	38.2	61.0	46.3	73.2	55.5	73.2	55.5	49	37.2
	CARDFV73	HURONTAR	1290	1700	39.2	29.8	49.2	37.3	61.9	47	52.1	39.5	37.6	28.5
<b>R14T</b>	TRAFALGA	ERINJR14	1110	1460	80.5	61.2	91.6	69.6	80.7	61.4	80.7	61.4	0	0
	ERINJR14	TOMKJR14	840	1090	54.8	42.3	69.3	53.4	54.9	42.3	54.9	42.3	0	0
	TOMKJR14	RICH AH1	840	1090	37.7	29	50.2	38.7	37.6	29	37.8	29.2	0	0
<b>R17T</b>	TRAFALGA	ERINJR17	1110	1460	80.4	61.1	91.5	69.6	80.7	61.3	80.6	61.3	<b>125.3</b>	95.2
	ERINJR17	TOMKJR17	840	1090	54.7	42.2	69.2	53.4	54.8	42.2	54.8	42.2	59	45.5
	TOMKJR17	RICH AH1	840	1090	37.7	29.1	50.3	38.7	37.7	29.1	37.9	29.2	54.2	41.7

Table 4: Thermal Assessment, Scenario 2

Scenario 2, Year 2009: Jim Yarrow Circuits IN-service, FETT = 4955 MW														
			Cont rating	Emergency	Pre-contingency		Loss of R19T		Loss of R19T North		Loss of V72R		Loss of R14T	
Cct	Monitored Element From	To	Amp	Amp	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %	Cont %	Emer %
<b>R19T</b>	TRAFALGA	ERINJR19	1110	1460	83.2	63.3	0	0	76.5	58.2	96.3	73.2	95.4	72.5
	ERINJR19	HANLJ19	840	1090	79.4	61.2	0	0	70.5	54.3	96.5	74.4	95.9	73.9
	HANLJ19	TOMKJR19	840	1090	56.9	43.8	0	0	68	52.4	39.3	30.3	69.6	53.7
	TOMKJR19	RICH AH2	840	1090	44	33.9	0	0	52.4	40.4	34.6	26.7	55.3	42.6
	HANLJ19	HURONTAR	840	1090	31.3	24.1	0	0	11.3	8.7	71.5	55.1	33.5	25.8
<b>NEW19</b>	HURONTAR	J YARJ19	1500	1500	12.3	12.3	0	0	13.6	13.6	11.4	11.4	12.4	12.4
<b>R21T</b>	TRAFALGA	ERINJR21	1110	1460	83.9	63.8	<b>122.4</b>	93.1	91.4	69.5	83.7	63.6	96.1	73.1
	ERINJR21	HANLJ21	840	1090	78.9	60.8	96.4	74.3	88.1	67.9	76.9	59.3	95.4	73.5
	HANLJ21	TOMKJR21	840	1090	56.7	43.7	67.8	52.3	49	37.7	62.9	48.5	69.4	53.5
	TOMKJR21	RICH AH2	840	1090	43.8	33.8	54.5	42	41.1	31.7	51.2	39.5	55.1	42.5
	HANLJ21	HURONTAR	840	1090	31	23.9	42.1	32.4	56.8	43.8	37.7	29	33.2	25.6
<b>NEW21</b>	HURONTAR	J YARJ21	1500	1500	12.3	12.3	27.7	27.7	11.2	11.2	13.5	13.5	12.3	12.3
<b>R19T N</b>	HURONTAR	PLEASR19	840	1090	55.3	42.6	56.4	43.5	0	0	51.3	39.5	55.5	42.8
<b>R21TN</b>	HURONTAR	PLEASR19	840	1090	55.2	42.5	55.3	42.6	<b>115.6</b>	89.1	60.3	46.5	55.3	42.6
<b>V72R</b>	CLAIRVIL	CLAIRV72	1340	1780	62.2	46.8	69.6	52.4	61.7	46.5	0	0	63.2	47.6
	CLAIRV72	RICH J72	1340	1780	60.3	45.4	61.1	46	60.4	45.4	0	0	63.2	47.5
	RICH J72	RICH AH2	1340	1780	51.5	38.8	52.3	39.4	51.6	38.9	0	0	54.4	41
	CLAIRV72	CLV PJ72	1370	1690	17.3	14	24	19.5	17.9	14.5	0	0	16.8	13.6
	CLV PJ72	SITHJV72	1370	1690	17.9	14.5	24.5	19.9	18.4	15	0	0	17.4	14.1
	SITHJV72	BRAMAV72	1370	1690	56	45.4	63.1	51.1	39.3	31.9	0	0	54.5	44.2
	BRAMAV72	CARDV72	1290	1700	41.7	31.6	48.2	36.6	22.7	17.2	0	0	40	30.4
	CARDV72	HURONTAR	1290	1700	30.9	23.5	36.7	27.8	12.5	9.5	0	0	29.1	22.1
<b>V73R</b>	CLAIRVIL	CLAIRV73	1340	1780	76.9	57.9	84.3	63.5	78	58.7	75.4	56.8	77.9	58.6
	CLAIRV73	RICH AH2	1340	1780	59.1	44.5	59.9	45.1	59.2	44.6	75.2	56.6	61.9	46.6
	CLAIRV73	CLV PJ73	1370	1690	17.3	14	24.1	19.6	18.8	15.2	38.5	31.2	16.8	13.6
	CLV PJ73	SITHJV73	1370	1690	17.9	14.5	24.7	20	19.4	15.7	39	31.6	17.4	14.1
	SITHJV73	BRAMAV73	1370	1690	56	45.4	66.2	53.7	74.2	60.1	92.1	74.7	54.5	44.2
	BRAMAV73	CARDV73	1290	1700	41.7	31.6	51.9	39.4	62.2	47.2	58.8	44.6	40.1	30.4
	CARDV73	HURONTAR	1290	1700	31	23.5	40.3	30.6	51.4	39	38.7	29.4	29.1	22.1
<b>R14T</b>	TRAFALGA	ERINJR14	1110	1460	85	64.6	97.7	74.3	85.2	64.8	85.3	64.9	0	0
	ERINJR14	TOMKJR14	840	1090	63.1	48.6	79.6	61.4	63.1	48.6	63.2	48.7	0	0
	TOMKJR14	RICH AH1	840	1090	44.5	34.3	59.5	45.8	44.3	34.2	44.6	34.4	0	0
<b>R17T</b>	TRAFALGA	ERINJR17	1110	1460	85	64.6	97.7	74.3	85.2	64.7	85.2	64.8	<b>129.1</b>	98.1
	ERINJR17	TOMKJR17	840	1090	63	48.5	79.5	61.3	63	48.6	63.1	48.6	69.1	53.2
	TOMKJR17	RICH AH1	840	1090	44.6	34.3	59.6	45.9	44.4	34.2	44.7	34.5	55	42.4

## Appendix B: Voltage Assessment Study Results

Table 6: Voltage Assessment, Scenario 1

Scenario 1, Year 2009: Jim Yarrow Circuits NOT In-service																	
Monitored Bus	Pre-contingency	Loss of R19T				Loss of R19T North				Loss of V72R				Loss of R14T			
	kV	pre ULTC	dV [%]	post ULTC	dV [%]	pre ULTC	dV [%]	post ULTC	dV [%]	pre ULTC	dV [%]	post ULTC	dV [%]	pre ULTC	dV [%]	post ULTC	dV [%]
Trafalgar	241.4	241.4	0	240.9	-0.2	241.2	-0.1	240.6	-0.3	241	-0.2	240.2	-0.5	240.9	-0.2	240.3	-0.5
Richview	242.2	242.1	0	241.6	-0.2	241.9	-0.1	241.4	-0.3	241.9	-0.1	241	-0.5	241.9	-0.1	241.3	-0.4
Claireville	241.9	241.7	-0.1	241.3	-0.2	241.7	-0.1	241.2	-0.3	241.9	0	241	-0.4	241.7	-0.1	241.2	-0.3
Hurontario R19	238.9	236.8	-0.9	236.3	-1.1	240.1	0.5	239.5	0.3	237.4	-0.6	236.4	-1.0	238.6	-0.1	238.1	-0.3
Hurontario R21	238.9	238.1	-0.3	237.5	-0.6	236.5	-1.0	235.7	-1.3	237.6	-0.5	236.3	-1.1	238.6	-0.1	238.1	-0.3
Pleasant R19T	237.2	235.3	-0.8	234.8	-1.0	0		0		235.9	-0.5	234.8	-1.0	237	-0.1	236.5	-0.3
Pleasant R21T	237.2	236.3	-0.4	235.8	-0.6	232.4	-2.0	231.5	<b>-2.4</b>	235.8	-0.6	234.5	-1.1	237	-0.1	236.5	-0.3
Jim Yarrow R19T	238.1	236.1	-0.8	235.5	-1.1	0		0		236.6	-0.6	235.6	-1.0	237.8	-0.1	237.3	-0.3
Jim Yarrow R21T	238.1	237.2	-0.4	236.7	-0.6	234.6	-1.5	233.6	-1.9	236.7	-0.6	235.4	-1.1	237.8	-0.1	237.3	-0.3
Burlington	240.5	240.6	0.0	240.2	-0.1	240.5	0	240	-0.2	240.3	-0.1	239.6	-0.4	240.3	-0.1	239.8	-0.3
Sithe Goreway	240.8	240.3	-0.2	239.8	-0.4	240.5	-0.1	240	-0.3	240.2	-0.2	239.2	-0.7	240.6	-0.1	240.1	-0.3
Pleasant BY	28.4	28.2	-0.7	28.5	0.4	26.9	-5.3	29.5	3.9	28.2	-0.7	28.4	0	28.3	-0.4	28.3	-0.4
Pleasant EZ	28.1	27.9	-0.7	28.2	0.4	26.3	<b>-6.4</b>	28.8	2.5	27.9	-0.7	28.1	0	28.1	0	28	-0.4
Pleasant3BY	28.1	28	-0.4	28.2	0.4	27.3	-2.8	28.1	0	28	-0.4	28.1	0	28.1	0	28	-0.4
Pleasant3EZ	28.1	28	-0.4	28.2	0.4	27.3	-2.8	28.1	0	28	-0.4	28.1	0	28.1	0	28	-0.4
Jim Yarrow A	28	27.8	-0.7	28	0	25.9	<b>-7.5</b>	28.4	1	27.8	-0.7	28	0	28	0	28.2	0.7
Jim Yarrow B	28	27.8	-0.7	28.1	0.4	25.9	<b>-7.5</b>	28.4	1.4	27.8	-0.7	28	0	28	0	28.2	0.7
Pleasant JQ	45.3	45	-0.7	45.4	0.2	42.8	-5.5	45.9	1.3	45	-0.7	45.3	0	45.2	-0.2	45.7	0.9

Table 7: Voltage Assessment, Scenario 1

Scenario 1, Year 2009: New Circuits <i>IN</i> -service																	
Monitored Bus	Pre-contingency	Loss of R19T				Loss of R19T North				Loss of V72R				Loss of R14T			
	kV	pre ULTC	dV [%]	post ULTC	dV [%]	pre ULTC	dV [%]	post ULTC	dV [%]	pre ULTC	dV [%]	post ULTC	dV [%]	pre ULTC	dV [%]	post ULTC	dV [%]
Trafalgar	242	241.7	-0.1	240.9	-0.5	241.8	-0.1	241.4	-0.2	241.7	-0.1	240.9	-0.5	241.5	-0.2	240.8	-0.5
Richview	242.8	242.6	-0.1	241.7	-0.5	242.6	-0.1	242.2	-0.2	242.6	-0.1	241.8	-0.4	242.6	-0.1	241.9	-0.4
Claireville	242.6	242.2	-0.2	241.4	-0.5	242.4	-0.1	242.0	-0.2	242.5	0.0	241.7	-0.4	242.3	-0.1	241.8	-0.3
Hurontario R19	240	238.4	-0.7	237.5	-1.0	240.5	0.2	240.1	0	239.1	-0.4	238.1	-0.8	239.7	-0.1	239.1	-0.4
Hurontario R21	240	238.4	-0.7	237.3	-1.1	238.5	-0.6	237.9	-0.9	238.7	-0.5	237.5	-1.0	239.7	-0.1	239.1	-0.4
Pleasant R19T	238.7	237.1	-0.7	236.2	-1.0	0		0		237.8	-0.4	236.8	-0.8	238.4	-0.1	237.8	-0.4
Pleasant R21T	238.7	237.1	-0.7	236.0	-1.1	235.2	-1.5	234.4	<b>-1.8</b>	237.4	-0.5	236.2	-1.0	238.4	-0.1	237.8	-0.4
Jim Yarrow R19T	239.9	0		0		240.4	0.2	240.0	0	239.0	-0.4	238.0	-0.8	239.6	-0.1	239	-0.4
Jim Yarrow R21T	239.9	238.2	-0.7	237.1	-1.2	238.4	-0.6	237.8	-0.9	238.6	-0.5	237.4	-1.0	239.6	-0.1	239	-0.4
Burlington	241	240.9	0.0	240.2	-0.3	240.9	0	240.6	-0.2	240.8	-0.1	240.2	-0.3	240.8	-0.1	240.2	-0.3
Sithe Goreway	241.5	240.8	-0.3	240	-0.6	241.2	-0.1	240.8	-0.3	240.8	-0.3	240.0	-0.6	241.2	-0.1	240.7	-0.3
Pleasant BY	28.6	28.4	-0.7	28.6	0	27.3	-4.5	29.0	1.4	28.4	-0.7	28.3	-1.0	28.5	-0.3	28.5	-0.3
Pleasant EZ	28.3	28.1	-0.7	28.3	0	26.7	<b>-5.7</b>	28.2	-0.4	28.2	-0.4	28.0	-1.1	28.3	0	28.2	-0.4
Pleasant3BY	28.3	28.1	-0.7	28.0	-1.1	27.6	-2.5	28.1	-0.7	28.2	-0.4	28.0	-1.1	28.3	0	28.2	-0.4
Pleasant3EZ	28.3	28.1	-0.7	28.0	-1.1	27.6	-2.5	28.1	-0.7	28.2	-0.4	28.0	-1.1	28.3	0	28.2	-0.4
Jim Yarrow A	28.2	26.4	<b>-6.4</b>	28.2	0	28.2	0	28.1	-0.4	28.1	-0.4	28.0	-0.7	28.2	0	28.1	0
Jim Yarrow B	28.2	26.4	<b>-6.4</b>	28.2	0	28.2	0	28.1	-0.4	28.1	-0.4	28.0	-0.7	28.2	0	28.1	0
Pleasant JQ	45.6	45.3	-0.7	45.6	0	43.4	-4.8	45.2	-0.9	45.4	-0.4	45.7	0.2	45.6	0	45.4	-0.4