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BY COURIER

June 11, 2013

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
Suite 2700, 2300 Yonge Street
P.O. Box 2319
Toronto, ON, M4P 1E4

Dear Ms. Walli:

EB-2013-0421 – Hydro One Networks' Section 92 – Supply to Essex County Transmission Reinforcement Project – Final System Impact and Final Customer Impact Assessments

I am attaching two (2) paper copies of the final version of the System Impact Assessment and Customer Impact Assessment with respect to Hydro One Networks' Application and Pre-filed Evidence that was filed with the Board on January 22, 2014. These assessments were originally filed in draft form as Exhibit B, Tab 6, Schedules 3 and 4 on May 23, 2014.

These documents have been filed electronically using the Board's Regulatory Electronic Submission System and the confirmation of successful submission is provided with this letter.

Sincerely,

ORIGINAL SIGNED BY SUSAN FRANK

Susan Frank

Attach.

c. Intervenors (electronic)

IESO'S SYSTEM IMPACT ASSESSMENT

REPORT

Power to Ontario.
On Demand.

System Impact Assessment Report

CONNECTION ASSESSMENT & APPROVAL PROCESS

Final Report

CAA ID: **2013-507**

Project: **Leamington TS - Supply to Essex County Transmission Reinforcement Project**

Applicant: **Hydro One Networks Inc.**

Market Facilitation Department
Independent Electricity System Operator

Date: June 9, 2014

Document Name	System Impact Assessment Report
Issue	Final Report
Reason for Issue	First Issue
Effective Date	June 9, 2014

System Impact Assessment Report

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

Conditional approval of the proposed connection is based on information provided to the IESO by the connection applicant and Hydro One at the time the assessment was carried out. The IESO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by Hydro One at the request of the IESO. Furthermore, the conditional approval is subject to further consideration due to changes to this information, or to additional information that may become available after the conditional approval has been granted.

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

Conditional approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed project to the IESO-controlled grid. However, the conditional approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter(s) during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with physical or equipment limitations, or with the Transmission System Code, before connection can be made.

This 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, the connection applicant must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to the connection applicant. Although the IESO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that the most recent version of this report is being used.

Hydro One

The results reported in this report are based on the information available to Hydro One, at the time of the study, suitable for a System Impact Assessment of this 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 facilities on load and generation customers.

In this report, short circuit adequacy is assessed only for Hydro One circuit breakers. The short circuit results are only for the purpose of assessing the capabilities of existing Hydro One circuit breakers and identifying upgrades required to incorporate the proposed facilities. These results should not be used in the design and engineering of any new or existing facilities. The necessary data will be provided by Hydro One and discussed with any connection applicant 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 project loading, and may be higher or lower than those stated in this study.

The additional facilities or upgrades which are required to incorporate the proposed facilities have been identified to the extent permitted by a System Impact Assessment under the current IESO Connection Assessment and Approval process. Additional project 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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Executive Summary

Conditional Approval for Connection

Hydro One Networks Inc. (the "connection applicant") has proposed to develop Leamington TS – Supply to Essex County Transmission Reinforcement Project (the "project"), in Leamington, Ontario. The project will consist of two 75/100/125 MVA, 215.5/27.6/27.6 kV transformers connecting to 230 kV circuits C21J and C22J via a 13 km 230 kV double circuit overhead tap line. Some of the load at Kingsville TS, which is connected to 115 kV circuits K2Z and K6Z, will be transferred to the project. Hydro One is considering the following two load transfer options:

A. Retain four transformers with 124 MW of load at Kingsville TS and transfer the remaining Kingsville load to the project.
B. Retain two transformers with 54 MW of load at Kingsville TS and transfer the remaining Kingsville load to the project.

The planned in-service date of the project is May 2016.

This assessment concludes that the proposed project, subject to the requirements specified in this report, is expected to have no material adverse impact on the reliability of the integrated power system. Therefore, the IESO recommends that a Notification of Conditional Approval for Connection be issued for Leamington TS – Supply to Essex County Transmission Reinforcement Project subject to the implementation of the requirements outlined in this report.

Findings and Recommendations

Findings

The Project:

1. The project improves the supply capacity needs of the Windsor area.
2. The proposed connection arrangement and equipment for the project are acceptable to the IESO. The proposed 230 kV connection equipment meet the requirements and standards in the Market Rules and Transmission System Code (TSC).
3. Under certain outage conditions, there is a potential for reverse power flow on the project's transformers. This is not a concern for the IESO. See recommendation 2 for Hydro One.

Kingsville Load Transfer Options:

The two load transfer options, A & B, from Kingsville TS to the project were compared for their impact on the Windsor 230 kV and 115 kV systems under 2026 summer peak load conditions. The following findings were identified based on the study results:

4. With option B for loss of K2Z, post-contingency loading on circuit K6Z and 115 kV voltages at Kingsville TS are within the *Ontario Resource and Transmission Assessment Criteria (ORTAC)* without the need of any control action.

With option A for loss of K2Z, post-contingency loading above the short term emergency rating (STE) on circuit K6Z and low 115 kV voltages at Kingsville TS will occur. Arming the Lauzon load rejection (L/R) scheme as part of the Windsor Area Special Protection Scheme (SPS) to reject load at Kingsville will mitigate these issues. However, this control action is a violation of the *ORTAC* criteria. Hence, option B is better than option A.

With two transformers retained at Kingsville in option B, for loss of one transformer, post-contingency loading above the 10-day long term rating (LTR) will occur on the remaining transformer with the more limiting rating. Should option B be retained, Hydro One has indicated that they have plans to replace this transformer with a new transformer that has a higher 10-day LTR.

5. With option A or B and high flows east or west between Keith TS and Chatham SS, which represent past historical maximum transfers, post-contingency thermal loadings and voltages in the Windsor 230 and 115 kV systems remain within applicable *ORTAC* criteria with the utilization of appropriate control actions. With option B, the post-contingency loadings are lower and less control actions are required. Hence, option B is better than option A.
6. With option A or B and high flows east or west between Keith TS and Chatham SS, the incorporation of the project is not expected to have adverse impact on import/export capability via circuit J5D.
7. With option A or B, the load restoration capability of the Windsor 115 kV system is improved following the simultaneous loss of double circuits C23Z and C24Z. Option B is better, as it allows all forecasted load that is lost following this contingency to be restored.
8. With option B, the simultaneous loss of double circuits C21J and C22J will interrupt load at Malden TS and the project of up to 237 MW for the 2016-2026 period which is within the *ORTAC* criteria.

Findings 9 and 10 below were observed when respecting the North American Electric Reliability Corporation (NERC) TPL-001-04 Bulk Electric System (BES) Planning Performance Events based on NERC's new definition of the BES effective in Ontario July 1, 2014. These findings pose operating challenges but are not a violation of the *ORTAC* criteria.

9. With options A or B, high flows east from Keith TS to Chatham SS and all elements in-service, for a Lauzon T1L7 breaker failure, multiple control actions are needed to mitigate post-contingency thermal loadings in the Windsor 115 kV system. This event could be better managed if the Lauzon L/R scheme which is part of the Windsor Area SPS was expanded to include this contingency.
10. With options A or B, high flows east or west between Keith TS and Chatham SS and all elements in-service, for the loss of double circuit Z1E and Z7E, control actions are necessary to mitigate post-contingency over-voltages on the Lauzon 115 kV system. Option A requires arming the Lauzon L/R scheme as part of the Windsor Area SPS to switch out the Kingsville capacitors. Option B requires the Lauzon capacitor to be switched out pre-contingency as there were no control actions available post-contingency. Both options could be better managed if the Lauzon L/R scheme was expanded to trip the Lauzon capacitor for this contingency.

Recommendations

1. It is recommended that Hydro One choose Kingsville load transfer option B rather than option A. Option A is however, an improvement compared to keeping all of the load at Kingsville.
2. It is recommended that Hydro One assess the reverse power flow on the project's transformers and confirm that there is no unacceptable tripping or loading concern on the transformers.

Recommendations 3 and 4 below are not required for the project, but are options for consideration to more effectively manage double-element contingencies at Lauzon.

3. It is recommended that Hydro One consider expanding the Lauzon L/R scheme as part of the Windsor Area SPS to include the selection of load rejection (L/R) for the Lauzon T1L7 breaker failure contingency. This would provide greater operating flexibility.
4. It is recommended that Hydro One consider adding the selection of the Lauzon capacitor to be tripped for the Z1E+Z7E contingency which is a contingency that is already included in the Lauzon L/R scheme as part of the Windsor Area SPS. This would provide greater operating flexibility.

IESO's Requirements for Connection

Connection Applicant Requirements

Project Specific Requirements: The following *specific* requirements are applicable for the incorporation of the project. Specific requirements pertain to the level of reactive compensation needed, operation restrictions, special protection system, upgrading of equipment and any project specific items not covered in the *general* requirements.

(1) Hydro One is required to review the relay settings of the 230 kV circuits C21J and C22J. Any modifications made to protections after this SIA is finalized must be submitted to the IESO at least six (6) months before any modifications are to be implemented on the existing protection systems.

(2) The simultaneous loss of double circuits C21J and C22J will interrupt load at Malden TS and the project of up to 237 MW for the 2016 to 2026 period which is within the *ORTAC* criteria. Hydro One and the affected Local Distribution Companies (LDCs) are expected to work together to ensure that up to 87 MW of load can be restored within approximately 4 hours and up to 237 MW of load can be restored within approximately 8 hours as per the *ORTAC* criteria.

General Requirements: The connection applicant shall satisfy all applicable requirements and standards specified in the Market Rules and the TSC. The following requirements summarize some of the general requirements that are applicable to the project, and are presented in detail in section 2 of this report.

1. As currently assessed the project does not fall within the Northeast Power Coordinating Council's (NPCC) definition of Bulk Power System (BPS). As such, the project will not have any elements classified as BPS and will not have to meet any NPCC reliability obligations.
2. NERC's new definition of the BES will be effective in Ontario July 1, 2014. As currently assessed, based on this new definition, the project will not have any elements classified as BES and will not have to meet any NERC reliability obligations.
3. The project is required to meet obligations and requirements of the Market Rules.
4. The connection applicant shall ensure that the project's 230 kV connection equipment is capable of continuously operating between 220 kV and 250 kV, as specified in Appendix 4.1 of the Market Rules. Any protective relay settings must be set to ensure that equipment remains in-service for voltages up to 5% above the maximum continuous value.
5. The connection applicant shall ensure that the project's 230 kV connection equipment is designed to be fully operational in all reasonably foreseeable ambient temperature conditions. The connection equipment must also be designed so that the adverse effects of its failure on the IESO-controlled grid are mitigated.

6. The connection applicant shall ensure that the project's 230 kV connection equipment is designed to withstand the fault levels in the local area. If any future system changes result in an increased fault level higher than the equipment's capability, the connection applicant is required to replace the equipment with higher rated equipment capable of withstanding the increased fault level, up to maximum fault level specified in Appendix 2 of the TSC.
7. The connection applicant shall install and maintain facilities and equipment at the project to provide 3% and 5% voltage reduction within five minutes of receipt of direction from the IESO.
8. The connection applicant shall have the capability to maintain the power factor at the defined meter point of the project within the range of 0.9 lagging and 0.9 leading.
9. The connection applicant is required to install under frequency load shedding (UFLS) facilities at the project to allow for the detection of under-frequency conditions and the selection and tripping of load via circuit breakers.

   The connection applicant is required to ensure that the UFLS targets specified in Section 10.4.6 of Chapter 5 of the Market Rules and Section 4.5 of Market Manual 7.4 are met after the addition of the proposed project. During the IESO Market Entry/Facility Registration process, the connection applicant is required to submit a revised schedule of under-frequency tripping selections and their related load amounts for each applicable shedding stage that will satisfy the UFLS targets.
10. The connection applicant shall ensure that the telemetry requirements for the project are satisfied as per the applicable Market Rules requirements. The determination of telemetry quantities and telemetry testing will be conducted during the IESO Market Entry/Facility Registration process.
11. If revenue metering equipment is being installed as part of this project, the connection applicant should be aware that revenue metering installations must comply with Chapter 6 of the IESO Market Rules. For more details the connection applicant is encouraged to seek advice from their Metering Service Provider (MSP) or from the IESO metering group.
12. The connection applicant shall ensure that the project's protection systems are designed to satisfy all the requirements of the TSC.

    As currently assessed by the IESO, the project is not considered essential to the power system and therefore does not require redundant protection systems in accordance with section 8.2.1a of the TSC.

    The project's protection systems must also only trip the appropriate equipment required to isolate the fault. The project shall have the capability to ride through routine switching events and design criteria contingencies in the grid that do not disconnect the project by configuration.

    The connection applicant shall have adequate provision in the project's design of protections and controls to allow for future installation of Special Protection Scheme (SPS) equipment. Should a new SPS be installed or an existing SPS be expanded to improve the transfer capability into the area or to accommodate transmission reinforcement projects, the facility may be required to participate in the SPS system and to install the necessary protection and control facilities to affect the required actions. These SPS facilities must comply with the NPCC Reliability Reference Directory #7 for Type 1 SPS.
13. The connection applicant is currently a restoration participant. The connection applicant is required to update its restoration participant attachment to include details regarding the project. For more details please refer to the Market Manual 7.8. Details regarding restoration participant requirements will be finalized in the IESO Market Entry/Facility Registration process.
14. The connection applicant must initiate and complete the IESO Market Entry/Facility Registration process for this project in a timely manner before IESO final approval for connection is granted.

    Equipment data must be provided to the IESO at least seven months before energization to the IESO-controlled grid. The IESO will confirm that the data for the equipment installed meets the Market Rules requirements and matches or exceeds the performance predicted in this assessment.

If the submitted data differs materially from the ones used in this assessment, then further analysis of the project will need to be done by the IESO.

At the sole discretion of the IESO, performance tests may be required at transmission facilities. The objectives of these tests are to demonstrate that equipment performance meets the IESO requirements, and to confirm models and data are suitable for IESO purposes.

– End of Section –

1. Project Description

Hydro One Networks Inc. (the "connection applicant") has proposed to develop Leamington TS – Supply to Essex County Transmission Reinforcement Project (the "project"), in Leamington, Ontario. This new transformer station will connect to 230 kV circuits C21J and C22J at about 49.1 km from Chatham SS via a 13 km double circuit 230 kV overhead tap line. Some of the load at Kingsville TS, connected to 115 kV circuits K2Z and K6Z, will be transferred to the project. Hydro One is considering the following two load transfer options:

A. Retain four transformers with 124 MW of load at Kingsville TS and transfer the remaining Kingsville load to the project.
B. Retain two transformers with 54 MW of load at Kingsville TS and transfer the remaining Kingsville load to the project.

Figure 1 shows the single-line diagram of the proposed project. The station will consist of two 75/100/125 MVA, 215.5/27.6/27.6 kV transformers each with a 230 kV disconnect switch on the high voltage side of the transformer. The 27.6 kV buses will be separated by a normally open bus-tie breaker and a shunt capacitor bank rated at 21.6 Mvar@28.8 kV will be installed on one of the 27.6 kV buses. The load will be fed from a total of six feeders. The planned in-service date is May 31, 2016.

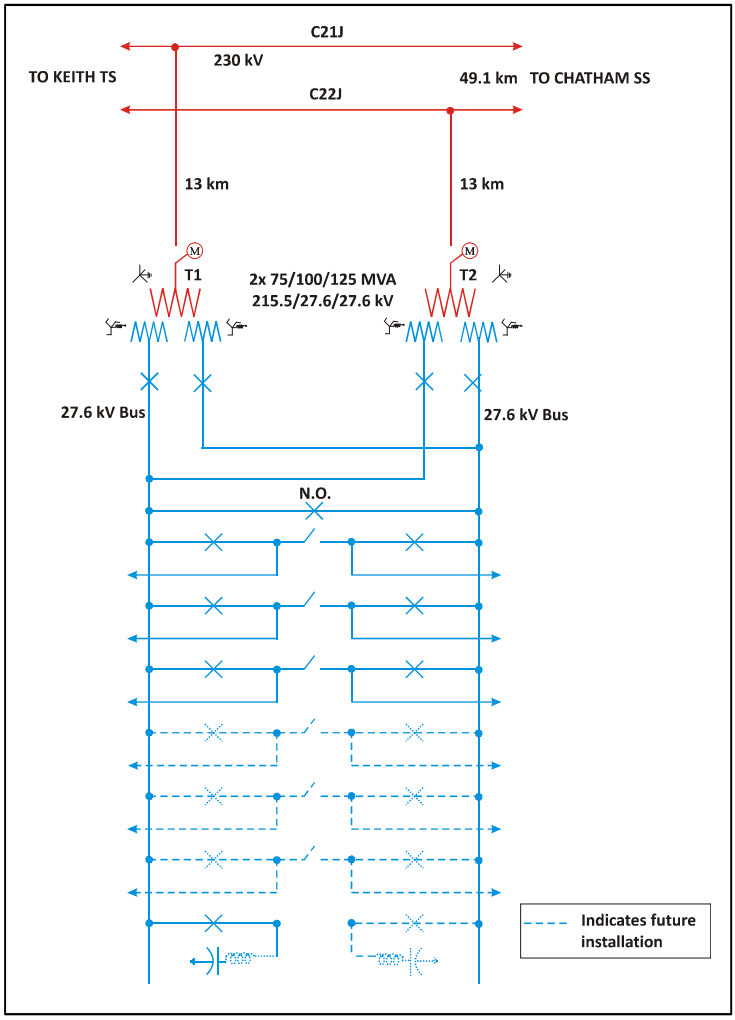

Figure 1: Single Line Diagram of Leamington TS

– End of Section –

2. General Requirements

The connection applicant shall satisfy all applicable requirements and standards specified in the Market Rules and the TSC. The following sections highlight some of the general requirements that are applicable to the project.

2.1 Reliability Standards

As currently assessed the project does not fall within the NPCC definition of BPS. As such, the project will not have any elements classified as BPS and will not have to meet any NPCC reliability obligations.

NERC's new definition of the BES will be effective in Ontario July 1, 2014. As currently assessed, based on this new definition, the project will not have any elements classified as BES and will not have to meet any NERC reliability obligations.

The project is required to meet obligations and requirements of the Market Rules. The project's BPS and BES classifications will be re-evaluated by the IESO as the electrical system evolves.

2.2 Voltage Requirements

Appendix 4.1 of the Market Rules states that under normal operating conditions, the voltages in the 230 kV system in IESO-controlled grid are maintained within the range of 220 kV to 250 kV. Thus, the project's 230 kV connection equipment must have a maximum continuous voltage rating of at least 250 kV.

Any protective relay settings must be set to ensure that connection equipment remains in-service for voltages up to 5% above the maximum continuous value specified in Appendix 4.1 of the Market Rules, to allow the power system to recover from transient disturbances.

2.3 Connection Equipment Design

The connection applicant shall ensure that the project's 230 kV connection equipment is designed to be fully operational in all reasonably foreseeable ambient temperature conditions. The connection equipment must also be designed so that the adverse effects of its failure on the IESO-controlled grid are mitigated.

2.4 Fault Levels

The TSC requires connection equipment connecting to the transmission system be designed to withstand the fault levels in the area where the equipment is installed. Thus, the connection applicant shall ensure that the project's connection equipment is designed to withstand the fault levels in the area. If any future system changes result in an increased fault level higher than the equipment's capability, the connection applicant is required to replace the equipment with higher rated equipment capable of withstanding the increased fault level, up to maximum fault level specified in the TSC. Appendix 2 of the TSC establishes the maximum fault levels for the transmission system.

For the 230 kV system, the maximum 3 phase symmetrical fault level is 63 kA and the maximum single line to ground symmetrical fault level is 80 kA (usually limited to 63 kA).

2.5 Voltage Reduction Facilities

Appendix 4.3 of the Market Rules requires that distributors connected to the IESO-controlled grid with directly connected load facilities of aggregated rating of 20 MVA or more and with the capability to regulate distribution voltage under load, shall install and maintain facilities and equipment to provide voltage reduction capability. Voltage reduction capability represents the capability of reducing demand by lowering the customer voltage by 3% and 5% within five minutes of receipt of direction from the IESO. This is required to achieve load reduction during periods when supply resources are limited. The voltage reduction capability can be achieved by installing under-load tap changers (ULTC) at the project.

2.6 Power Factor

Appendix 4.3 of the Market Rules requires connected wholesale customers and distributors connected to the IESO-controlled grid to have the capability to maintain the power factor within the range of 0.9 lagging and 0.9 leading as measured at the defined meter point of the project.

2.7 Under Frequency Load Shedding Facilities

The connection applicant has an aggregate peak load at all its owned facilities, including the proposed project that is greater than 25 MW. Thus, the connection applicant is required to participate in the UFLS program according to Section 4.5 of the Market Manual Part 7.4.

The connection applicant is required to install UFLS facilities at the proposed project to allow for the detection of under-frequency conditions and the selection and tripping of load via circuit breakers.

The connection applicant must select 35% of aggregate peak load among its owned facilities for under-frequency tripping, based on a date and time specified by the IESO that approximates system peak, according to section 10.4 of Chapter 5 of the Market Rules.

As the connection applicant has a peak load of 100 MW or greater at all its owned facilities, the UFLS relay connected loads shall be set to achieve the amounts to be shed stated in the following table:

UFLS Stage	Frequency Threshold (Hz)	Total Nominal Operating Time (s)	Load Shed at stage as % of Connection Applicant's Load	Cumulative Load Shed at stage as % of Connection Applicant's Load
1	59.5	0.3	7 – 9	7 – 9
2	59.3	0.3	7 – 9	15 – 17
3	59.1	0.3	7 – 9	23 – 25
4	58.9	0.3	7 - 9	32 - 34
Anti-Stall	59.5	10.0	3 – 4	35 - 37

The requirements in the table above are currently under review. The IESO will notify the connection applicant of any impending changes to which the connection applicant will have to comply.

Capacitor banks connected to the same facility as the load should be shed by UFLS relay at 59.5 Hz with a time delay of 3 seconds.

The maximum load that can be connected to any single UFLS relay is 150 MW to ensure that the inadvertent operation of a single under-frequency relay during the transient period following a system disturbance does not lead to further system instability.

2.8 IESO Telemetry Data

In accordance with Section 7.5 of Chapter 4 of the Market Rules, the connection applicant shall provide to the IESO the applicable telemetry data for the project as listed in Appendix 4.17 of the Market Rules on a continual basis. The data shall be provided in accordance with the performance standards set forth in Appendix 4.22, subject to Section 7.6A of Chapter 4 of the Market Rules. The whole telemetry list will be finalized during the IESO Market Entry/Facility Registration process.

The connection applicant must install monitoring equipment that meets the requirements set forth in Appendix 2.2 of Chapter 2 of the Market rules. As part of the IESO Market Entry/Facility Registration process, the connection applicant must also complete end to end testing of all necessary telemetry points with the IESO to ensure that standards are met and that sign conventions are understood. All found anomalies must be corrected before IESO final approval to connect any phase of the project is granted.

2.9 Revenue Metering

If revenue metering equipment is being installed as part of the project, the connection applicant should be aware that revenue metering installations must comply with Chapter 6 of the IESO Market Rules. For more details the connection applicant is encouraged to seek advice from their Metering Service Provider (MSP) or from the IESO metering group.

2.10 Protection Systems

The connection applicant shall ensure that the project's protection systems are designed to satisfy all the requirements of the TSC. New protection systems must be coordinated with the existing protection systems.

As currently assessed by the IESO, the project is not considered essential to the power system and therefore does not require redundant protection systems in accordance with section 8.2.1a of the TSC. In the future, as the electrical system evolves, the project may be designated as essential by the IESO. In that case these redundant protections systems would have to satisfy all requirements of the TSC, and in particular, they could not use common components, common battery banks or common secondary CT or PT windings.

The project's protection systems must only trip the appropriate equipment required to isolate the fault. After the facility begins commercial operation, if an improper trip of the 230 kV circuit(s) C21J and C22J occurs due to events within the facility, the facility may be required to be disconnected from the IESO-controlled grid until the problem is resolved.

The project shall have the capability to ride through routine switching events and design criteria contingencies in the grid that do not disconnect the project by configuration. Standard fault detection, auxiliary relaying, communication, and rated breaker interrupting times are to be assumed.

As currently assessed by the IESO, the project is not required to be part of an SPS. However, the connection applicant is required to have adequate provision in the design of protections and controls at the facility to allow for future installation of Special Protection Scheme (SPS) equipment. Should a future SPS be installed or an existing SPS be expanded to improve the transfer capability in the area or to accommodate transmission reinforcement projects, the facility may be required to participate in the SPS system and to install the necessary protection and control facilities to affect the required actions. These SPS facilities must comply with the NPCC Reliability Reference Directory #7 for Type 1 SPS. In particular, if the SPS is designed to have 'A' and 'B' protection at a single location for redundancy, they must be on different non-adjacent vertical mounting assemblies or enclosures. Two independent trip coils are required on the breakers selected for L/R.

2.11 Restoration Requirements

The connection applicant is currently a restoration participant. The connection applicant is required to update its restoration participant attachment to include details regarding the project. For more details please refer to the Market Manual 7.8. Details regarding restoration participant requirements will be finalized in the IESO Market Entry/Facility Registration process.

As currently assessed by the IESO, this facility is not classified as a Key Facility that is required to establish a Basic Minimum Power System following a system blackout. Key Facility and Basic Minimum Power System are terms defined in the NPCC Glossary of Terms.

2.12 IESO Market Entry/Facility Registration

The connection applicant must initiate and complete the IESO Market Entry/Facility Registration process for the project in a timely manner before IESO final approval for connection is granted.

Equipment data must be provided to the IESO at least seven months before energization to the IESO-controlled grid, to allow the IESO to incorporate this project into IESO work systems and to perform any additional reliability studies. The data may be shared with other reliability entities in North America as needed to fulfill the IESO's obligations under the Market Rules, NPCC and NERC rules.

The IESO will confirm that the data for the equipment installed meets the Market Rules requirements and matches or exceeds the performance predicted in this assessment. If the submitted data differs materially from the ones used in this assessment, then further analysis of the project will need to be done by the IESO.

At the sole discretion of the IESO, performance tests may be required at transmission facilities. The objectives of these tests are to demonstrate that equipment performance meets the IESO requirements, and to confirm models and data are suitable for IESO purposes

– End of Section –

3. Data Verification

3.1 Connection Arrangement

The connection arrangement of the project, as shown in Figure 1, will not reduce the level of reliability of the integrated power system and is, therefore, acceptable to the IESO.

3.2 Equipment Data

The connection equipment specifications were assessed based on the information provided by the connection applicant.

3.2.1 Tap Line

Table 1: 230 kV Overhead Tap Line

Length (km)	Maximum Operating (kV)	Summer Ratings (A) 35ºC 4 km/h			Positive Sequence Impedance (pu, S_B= 100 MVA, V_B=220 kV)		
		Cont	LTE	STE	R	X	B
13	250	1060	1400	1900	0.002168	0.01332	0.021006

3.2.2 230 kV Disconnect Switch

Table 2: Specifications of the 230 kV Disconnect Switch

Number to be installed	Maximum Continuous Voltage Rating (kV)	Continuous Current Rating (A)	Short Circuit Symmetrical Rating (kA)
2	250	To be provided by Hydro One	63

The 230 kV disconnect switch has a maximum continuous voltage rating of 250 kV and a short circuit symmetrical rating of 63 kA which meet the requirements and standards in the Market Rules and TSC.

3.2.3 230 kV Transformer

Table 3: Specifications of the 230 kV Transformer

Unit	Transformation (kV)	Rating (MVA) (ONAN/ONAF/OFAF)	Positive Sequence Impedance (pu) S_B= 62.5 MVA	Configuration			High Voltage ULTC Tap Changer
				H	L	T	
T1/T2	215.5/27.6-27.6	75/100/125	HT: 0.00487+j0.17867 HL: 0.00489+j0.17750 LT: 0.0199+j0.32559	Yg	Zig-zag Grounded through 1.5 ohm reactor	Zig-zag Grounded through 1.5 ohm reactor	215.5 ± 40 kV in ± 16 steps

3.2.4 Shunt Capacitor

Table 4: Specifications of the 27.6 kV Shunt Capacitor

Rated Capacitance at Rated Voltage (Mvar)	Rated Voltage (kV)	Nominal System Voltage (kV)
21.6	28.8	27.6

– End of Section –

4. Fault Level Assessment

As the LV winding of the transformers is configured Zigzag and there is no major synchronous motor load to be supplied, the project will not change the fault levels in its surrounding area for both 3-phase and L-G faults. Thus, short circuits studies were not conducted.

– End of Section –

5. Protection Impact Assessment

A Protection Impact Assessment (PIA) was completed by Hydro One to examine the impact of the project on existing transmission system protections. A copy of the Protection Impact Assessment can be found in Appendix C of this report.

No changes to the existing protection settings at Keith TS and Chatham SS are required due to the incorporation of the project as the increase in apparent impedance is negligible. The existing zone 1 protection settings at Keith TS will cover the whole 13 km overhead line tap that connects the facility to the IESO-controlled grid. The existing zone 2 protection settings at Chatham SS and Keith TS will reach into a portion of the transformers at the facility.

The incorporation of the project will require installation of new communication links and modifications to the existing C21J and C22J protection systems at Keith TS and Chatham SS. Dual communication links between the project and one of Keith TS or Chatham SS are required to send transfer trip signals

The proposed protection changes will have no material adverse impact on reliability of the IESO-controlled grid.

Hydro One must submit any protection modifications that are different from those considered in this SIA at least six (6) months before any modifications are to be implemented on the existing protection systems. If those modifications result in adverse reliability impacts, mitigation solutions must be developed.

– End of Section –

6. Impact on System Reliability

The technical studies focused on identifying the impact of the project on the reliability of the IESO-controlled grid. They include a thermal loading assessment of local transmission lines and transformers and a voltage assessment of local buses under specific flow conditions.

6.1 Existing System

The Windsor area is bounded by 230 kV circuits C23Z and C24Z from Chatham to Lauzon, C21J and C22J from Chatham to Keith and J5D from Keith to Michigan. There are three wind generating stations Comber West and East connected to C23Z and C24Z respectively, Port Alma I and II connected to C24Z and Dillon connected to C23Z. The Windsor 115 kV area load is supplied from Lauzon 230/115 kV autotransformers T1 and T2, Keith 230/115 kV autotransformers T11 and T12, West Windsor CGS G1 and G2, East Windsor CGS G1 and G2, Windsor TransAlta CGS G1 and G2, Brighton Beach CGS G1A, Pointe Aux Roches WGS and Goshen WGS.

The Windsor area is summer peaking and is susceptible to a variety of operational problems including pre-contingency voltage instability, post-contingency voltage decline and thermal overload. As a result, a number of special protection schemes are employed to facilitate operation of the area which are all included as part of the Windsor Area Special Protection Scheme (SPS). This SPS includes contingency based generation rejection and cross-tripping scheme at Keith TS, a contingency based load rejection scheme at Lauzon TS, under-voltage load rejection scheme at Kingsville TS and high voltage switching scheme at Kingsville TS.

Past completed SIAs relating to new or modified connections in the Windsor area have identified thermal overload and under-voltage concerns. Thermal overloads on circuits K2Z or K6Z and under-voltages at Kingsville have been previously identified in SIA 2008-332. Thermal overloads or congestion on circuits J3E, J4E and Keith T12 have been highlighted in previous SIAs (2005-203, 2007-268, 2008-343, 2010-381, 2010-382, 2010-383, 2010-405).

Figure 2 provides an overview of the transmission system in the vicinity of the proposed project.

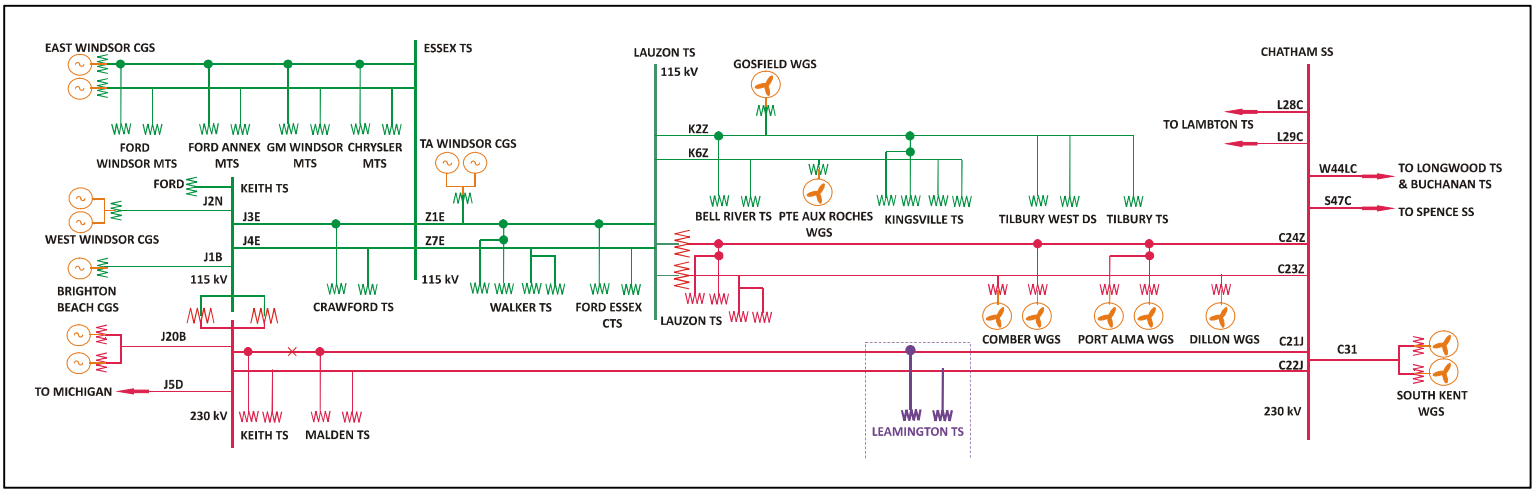

Figure 2: Transmission System in the vicinity of Leamington TS

6.2 Assumptions

In this assessment, the 2014 summer base case was used with the following assumptions:

(1) **Transmission facilities**: All existing transmission facilities and future proposed transmission system upgrades with 2016 in-service dates or earlier were assumed in-service.

Of the proposed transmission system upgrades, the following were not assumed in-service:

- Transformer Replacement at Keith TS (2007-265)
- Tilbury West DS Second 115 kV Connection (2008-332)

(2) **Generation facilities:** All existing and committed major generation facilities with 2016 in-service dates or earlier were assumed in-service unless otherwise specified.

(3) **Load Facilities:** All major load facilities with 2016 in-service dates or earlier were assumed in-service.

(4) **Load Forecast:** Hydro One provided the extreme weather coincident peak load forecast after conservation from 2016 to 2026 for the project and the stations in its vicinity in the Windsor 230 / 115 kV area. For the purposes of the study any embedded generation at these stations was assumed out of service. The load forecast for the Windsor 230/115 kV area is displayed in Table 5.

Table 5: Load Forecast for Windsor 230/115 kV area stations

Station	Load Forecast (MW)										
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Belle River TS	45.4	46.0	46.5	47.0	47.5	48.0	48.6	49.1	49.6	50.1	50.6
Chrysler MTS	32.7	32.7	32.8	32.8	32.9	32.9	33.0	33.1	33.1	33.2	33.2
Crawford TS	66.1	66.3	66.5	66.8	67.0	67.3	67.5	67.7	68.0	68.2	68.5
Essex TS	54.3	54.6	54.8	55.0	55.2	55.4	55.6	55.9	56.1	56.3	56.5
Ford Annex MTS	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Ford Essex CTS	8.0	8.0	8.1	8.1	8.1	8.1	8.1	8.2	8.2	8.2	8.2
* Ford Windsor MTS	17.6	17.6	17.6	17.7	17.7	17.8	17.8	17.8	17.9	17.9	17.9
G.M.Windsor MTS	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Keith TS T1	5.6	5.7	5.7	5.8	5.8	5.9	6.0	6.0	6.1	6.2	6.2
Tilbury TS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tilbury West DS	17.5	17.6	17.6	17.7	17.8	17.9	18.0	18.1	18.1	18.2	18.3
Walker TS #1	74.1	74.3	74.6	74.8	75.0	75.3	75.5	75.7	75.9	76.2	76.4
Walker MTS #2	86.5	86.7	87.0	87.2	87.5	87.8	88.0	88.3	88.5	88.8	89.1
Kingsville TS – Option A	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0
Kingsville TS – Option B	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0
Leamington TS – Option A	22.5	26.9	28.4	29.9	31.5	33.0	34.6	36.2	37.8	39.4	41.0
Leamington TS – Option B	92.5	96.9	98.4	99.9	101.5	103.0	104.6	106.2	107.8	109.4	111.0
Keith TS T22/T23	44.0	44.3	44.6	45.0	45.5	46.0	46.5	47.0	47.5	48.0	48.5
Malden TS	119.0	119.7	120.5	121.2	121.9	122.6	123.3	124.1	124.8	125.5	126.2
Lauzon TS	185.3	186.2	187.1	188.0	188.9	189.8	190.7	191.6	192.4	193.3	194.2
TOTAL	911.7	919.7	924.9	930.1	935.4	940.9	946.3	951.9	957.1	962.6	967.9

* The Windsor area motor plants were assumed in full production at the time of the summer peak. Hence, the forecast at Ford Windsor MTS was assumed to be close to the 2013 historical peak load at this station as opposed to the load at the coincident peak

As seen from the load forecast, Hydro One is considering the following two load transfer options:

A. Retain four transformers with 124 MW of load at Kingsville TS and transfer the remaining Kingsville load to the project.
B. Retain two transformers with 54 MW of load at Kingsville TS and transfer the remaining Kingsville load to the project.

(5) **Load power factor:** The power factor was assumed to be 0.9 at the high-voltage buses of the project

(6) **Base cases:** Four base cases with 2026 summer peak load, under various generation dispatches and load transfer options A & B were used. The generation dispatch was chosen to stress the 230 kV circuits C21J and C22J under high flow east and west conditions. The base cases employed the following assumptions:

- The Ontario demand was assumed 27,820 MW, and the demand in the Western zone was assumed 3,001 MW based on the extreme weather summer peak load forecast available to the IESO for the year 2026;
- Load level at individual stations in the vicinity of the project were set to the forecasted load level for 2026 as shown in Table 5;
- The Windsor 115 kV area was assumed closed in this study which means that there is a continuous 115 kV transmission path between Lauzon TS and Keith TS;
- The Windsor area SPS was assumed in-service;
- Under high flow east conditions, the import from Michigan on J5D and the Brighton Beach output was maximized to achieve a high flow east on the C21J and C22J circuits while not violating the continuous rating of circuits J3E and J4E pre-contingency. In addition, the rest of the generation in the Windsor 230 and 115 kV area was dispatched at full output to stress the C21J and C22J circuits flowing east.
- Under high flow west conditions, the export to Michigan on J5D was assumed to be 400 MW based on historical data. In addition, low wind was assumed with all wind generation out of service and all gas generation dispatched at full output in the Windsor 230 and 115 kV area with the exception of Brighton Beach. At Brighton Beach, one unit was assumed out of service and the other two units were dispatched in order to stress the C21J, C22J, C23Z and C24Z circuits flowing west to the maximum historical levels.
- With load transfer option B (54 MW of load at Kingsville), the Lauzon capacitor was required to be switched out of service and the Keith capacitor was switched in-service pre-contingency in order to maintain acceptable voltages pre- and post-contingency. This was done to avoid post-contingency over-voltages on the Lauzon 115 kV system for the double circuit loss of Z1E and Z7E which is a NERC TPL-001-4 Bulk Electric System Planning Performance Event as there were no control actions available post-contingency. This will be discussed further in Section 6.6.

Table 6 lists the generation dispatch, load assumption at Kingsville, 115 kV capacitor statuses and the flow on J5D, C21J and C22J for the four scenarios, S1, S2, S3 and S4 that were studied:

Table 6: Base case scenarios

Scenario	S1	S2	S3	S4
Condition	High flow east Option A	High flow east Option B	High flow west Option A	High flow west Option B
Flow on J5D (+ out of Ontario)	- 137 MW	- 137 MW	388 MW	388 MW
Flow on C21J and C22J at Chatham	-222 MW	-186 MW	494 MW	527 MW
Brighton Beach	530 MW	530 MW	186 MW	186 MW
West Windsor	116 MW	116 MW	116 MW	116 MW
TA Windsor	69 MW	69 MW	69 MW	69 MW
East Windsor	90 MW	90 MW	90 MW	90 MW
Gosfield	50 MW	50 MW	0 MW	0 MW
Pointe Aux Roches	49 MW	49 MW	0 MW	0 MW
Comber East and West	166 MW	166 MW	0 MW	0 MW
Port Alma I & II	202 MW	202 MW	0 MW	0 MW
Dillon	78 MW	78 MW	0 MW	0 MW
South Kent	269 MW	269 MW	0 MW	0 MW
Kingsville TS load in 2026	124 MW	54 MW	124 MW	54 MW
115 kV Capacitor Status	Keith Cap O/S Lauzon Cap I/S	Keith Cap I/S Lauzon Cap O/S	Keith Cap O/S Lauzon Cap I/S	Keith Cap I/S Lauzon Cap O/S

6.3 Contingencies

Contingencies were performed based on the NERC TPL-001-4 BES Planning Performance Events. All four scenarios were subjected to the same contingencies for voltage and thermal analysis.

The following is the list of all contingencies simulated for thermal and voltage analysis.

Table 7: List of Simulated Contingencies

N-1 Contingencies (All elements I/S – Single Contingencies)			
C21J /C22J	C23Z / C24Z	J5D	J20B
C31	J3E/J4E	Z1E / Z7E	J1B
J2N	Keith A Bus	K2Z	K6Z
N-2: Tower Contingencies (All elements I/S – Double Contingencies)			
C21J+C23Z	C21J+C22J	C22J+C24Z	C23Z+C24Z
J3E+J4E	Z1E+Z7E		
N-2: Breaker Failure (BF) Contingencies (All elements I/S – Double Contingencies)			
J20B + C22J- Keith 230 HL20 BF	J5D + C22J – Keith 230 HL5 BF	J20B + Keith A Bus – Keith 230 AL20 BF	J5D + Keith A Bus – Keith 230 AL5 BF
C21J + Keith A Bus - Keith 230 C21J BF	C21J + Chatham D Bus – Chatham 230 DL21 BF	C23Z + Chatham D Bus – Chatham 230 DL23 BF	C31 + Chatham D Bus – Chatham 230 DL31 BF
C22J+J2N – Keith T12P BF	J1B+J2N – Keith L1P BF	J3E+J2N – Keith L3P BF	Keith A Bus +J2N – Keith T11P BF
J4E+J1B – Keith L1L4 BF	Z7E+C23Z – Lauzon T1L7 BF	C24Z+Lauzon cap – Lauzon T2K BF	

N-1-1: Contingencies (Outage condition + contingency)			
J20B+C21J	Keith A Bus + C23Z/C24Z	Keith A Bus + C22J	Keith A Bus +J1B
Chatham K Bus + loss of Chatham D Bus	C22J open ended at Chatham + Keith C21J IBO	C21J open ended at Chatham + Keith C21J IBO	Z7E + C21J
Z7E + C24Z	J3E+C21J	J3E + C23Z/C24Z	J3E+Z7E

6.4 Permissible Control Actions

In the Windsor area, permissible control actions can be used to manage thermal or voltage concerns following the contingencies listed in Table 7. These include generation re-dispatch or curtailment of imports or exports on circuit J5D within 15 minutes following contingencies and arming of the Windsor Area SPS. Listed below are some of the control actions available with the Windsor Area SPS:-

- Kingsville transformer switching – This is part of the Kingsville high voltage switching scheme which switches back in a third transformer at Kingsville TS following the loss of two of the four transformers at Kingsville TS.
- Mode A Essex Bus Split- This is part of the Keith generation rejection and cross-tripping scheme which splits the Essex bus by opening Essex breakers L1L9, L7L8 and T6Z for contingencies included in the scheme. This split results in circuits J3E, J4E, E8F and E9F being supplied from Keith TS and circuits Z1E, Z7E and load at Essex TS being supplied from Lauzon TS.
- Brighton Beach generation rejection (BB G/R) –This is part of the Keith generation rejection and cross-tripping scheme which rejects Brighton Beach units that are armed for contingencies included in the scheme.
- Kingsville load rejection (L/R) – This is part of the Lauzon load rejection scheme which provides selection of load to be rejected at Kingsville TS in two stages for contingencies included in the scheme with each stage consisting of half the Kingsville load.
- Bell River load rejection (L/R) – This is part of the Lauzon load rejection scheme for which all the load at Bell River TS can be rejected for contingencies included in the scheme.
- Kingsville capacitor switching – This is part of the Lauzon load rejection scheme which provides selection of capacitors at Kingsville TS to be switched out in two stages for contingencies included in the scheme with each stage consisting of two Kingsville capacitors.

6.5 Thermal Assessment and Load Security

The *Ontario Resources and Transmission Assessment Criteria* (*ORTAC*) specify the following criteria for load security on thermal loading of transmission facilities:

Criterion I: With all the transmission facilities in service, equipment loading must be within continuous ratings.

Criterion II: With one element out of service, equipment loading must be within applicable long-term ratings and not more than 150 MW of load may be interrupted by configuration. Planned load curtailment or load rejection, excluding voluntary demand management, is permissible only to account for local generation outages.

Criterion III: With two elements out of service, equipment loading must be within applicable short-term emergency ratings. The equipment loading must be reduced to the applicable long-term emergency ratings in the time afforded by the short-time ratings. Planned load curtailment or load rejection exceeding 150 MW is permissible only to account for local generation outages. Not more than 600 MW of load may be interrupted by configuration and by planned load curtailment.

Table 8 lists the thermal ratings of the monitored circuits in Amperes and transformers in MVA that were provided by Hydro One. The circuit's conductor ratings were calculated for summer weather conditions with ambient temperature of 35°C and wind speed of 4 km/h. The continuous ratings for the conductors were calculated at the lower of the sag temperature or 93°C operating temperature. The LTE ratings for the conductors were calculated at the lower of the sag temperature or 127°C operating temperature. The STE ratings were calculated at the sag temperature with 100% continuous pre-load.

Table 8: Circuit Section and Transformer Summer Thermal Ratings

Circuit/ Transformer	Circuit Section		Continuous	LTE	STE
	From	To	A/MVA	A/MVA	A/MVA
C21J	Keith TS	Malden TS	840	1020	1100
C21J	Malden TS	Sandwich JCT	840	1020	1100
C21J	Sandwich JCT	Leamington TS	1060	1370	1570
C21J	Leamington TS	Chatham SS	1060	1370	1570
C22J	Keith TS	Malden TS	840	1020	1100
C22J	Malden TS	Sandwich JCT	840	1050	1150
C22J	Sandwich JCT	Leamington TS	840	1020	1100
C22J	Leamington TS	Chatham SS	840	1020	1100
C23Z	Lauzon TS	Sandwich JCT	1060	1400	1900
C23Z	Sandwich JCT	Comber WF JCT	1060	1400	1840
C23Z	Comber WF JCT	KEPA WF JCT	1060	1400	1840
C23Z	KEPA WF JCT	Dillon RWEC JCT	1060	1400	1690
C23Z	Dillon RWEC JCT	Chatham SS	1060	1400	1690
C24Z	Lauzon TS	Sandwich JCT	1060	1400	1900
C24Z	Sandwich JCT	Comber WF JCT	840	1040	1130
C24Z	Comber WF JCT	KEPA WF JCT	840	1040	1130
C24Z	KEPA WF JCT	Chatham SS	840	1020	1100
J3E	Keith TS	Crawford JCT	810	1070	1390
J3E	Crawford JCT	Essex TS	810	1070	1390
J4E	Keith TS	Crawford JCT	810	1000	1090
J4E	Crawford JCT	Essex TS	810	1000	1090
Z1E	Essex TS	Windsor Transalta JCT	970	1260	1430
Z1E	Windsor Transalta JCT	Walker JCT	970	1260	1430
Z1E	Walker JCT	Jefferson JCT	870	1140	1390
Z1E	Jefferson JCT	Lauzon TS	910	1190	1370
Z7E	Essex TS	Walker JCT	970	1260	1430
Z7E	Walker JCT	Jefferson JCT	870	1140	1390
Z7E	Jefferson JCT	Lauzon TS	910	1190	1370
Lauzon T1			250	296.8	364.2
Lauzon T2			250	296.8	364.2
Keith T11			115	180.3	224.5
Keith T12			115	160.3	187.5

6.5.1 Kingsville Local Supply

Kingsville TS is connected to 115 kV radial circuits K2Z and K6Z through four transformers with two transformers on each circuit. For loss of one of the circuits, the Kingsville load is supplied by the remaining two transformers connected to the companion circuit.

Thermal analysis was performed to compare the two load transfer options from Kingsville. The loading on K6Z for loss of K2Z is presented below as K6Z has lower thermal ratings than K2Z. Under option A, with four transformers and 124 MW of load at Kingsville, for the loss of K2Z the two remaining transformers are above their combined summer 10-day LTR of 112 MVA. This overload can be mitigated by using the Kingsville transformer switching control action in option A. Under option B, with two transformers and 54 MW of load at Kingsville, for the loss of K2Z the remaining transformer with the more limiting rating is above its summer 10-day LTR of 54.5 MVA. Hydro One has indicated that for option B they have plans to replace this transformer with a new transformer that has a higher 10-day LTR.

Table 9 shows a comparison of the two load transfer options from Kingsville TS to the project with the Kingsville transformer switching control action used in option A.

Table 9: Thermal Loading on K6Z for the two load transfer options

Circuit	Circuit Section		LTE	STE	Option A: 124 MW with 4 transformers at Kingsville				Option B: 54 MW with 2 transformers at Kingsville	
					K2Z		K2Z – 62 MW Kingsville L/R		K2Z	
	From	To	A	A	A	% LTE	A	% LTE	A	% LTE
K6Z	Lauzon TS	Lauzon JCT	1070	1200	728.9	68.1	316.2	29.5	427.1	39.9
K6Z	Lauzon JCT	Rourke Line JCT	1070	1200	728.9	68.1	316.2	29.5	427.2	39.9
K6Z	Rourke Line JCT	Belle River TS	620	640	260.1	42	243.3	39.2	259.7	41.9
K6Z	Belle River JCT	Rourke Line JCT	1070	1200	479.4	44.8	104.8	9.8	252.4	23.6
K6Z	Pte-Aux-Roches WF JCT	Belle River JCT	620	730	479.7	77.4	104.4	16.8	253	40.8
K6Z	Kingsville TS	Pte-Aux-Roches WF JCT	580	590	665.7	**114.8**	322.8	55.7	331.4	57.1

From Table 9 it is noticed that under option A for loss of K2Z, there are post-contingency overloads above the short-term emergency rating on a section of circuit K6Z that supplies Kingsville TS. The Lauzon load rejection (L/R) scheme which is part of the Windsor Area SPS can be used in this scenario to reject half the load at Kingsville (62 MW) and reduce the loading within the LTE rating of K6Z. However, this is a violation of the *ORTAC* criteria as with one element out of service, equipment loading must be within applicable long-term ratings, and any load rejection is permissible only to account for local generation outages. Since there are no generation outages in this scenario, load rejection is not permitted. Under option B for this scenario, there is no overload condition on K6Z. Hence, option B is the recommended option.

6.5.2 High Flow East Conditions

<u>All elements in-service: Pre-contingency</u>

The pre-contingency thermal loading for the two load transfer options from Kingsville under high flow east (HFE) conditions, which represent past historical maximum transfers, in scenarios S1 and S2 are presented in Table 10. The pre-contingency flows on all monitored elements are within their continuous ratings for both load transfer options under HFE conditions. The flows are in Ampere for circuits and MVA for transformers.

Table 10: Pre-contingency thermal loading under HFE conditions - All Elements I/S

Circuit/ Transformer	Circuit Section		Continuous	S1 – 124 MW at Kingsville		S2- 54 MW at Kingsville	
	From	To	A/MVA	A/MVA	% Cont	A/MVA	% Cont
C21J	Keith TS	Malden TS	840	499.2	59.4	538	64
C21J	Malden TS	Sandwich JCT	840	358.5	42.7	391.6	46.6
C21J	Sandwich JCT	Leamington TS	1060	355.5	33.5	389.4	36.7
C21J	Leamington TS	Chatham SS	1060	314.2	29.6	290.1	27.4
C22J	Keith TS	Malden TS	840	493.5	58.7	531.6	63.3
C22J	Malden TS	Sandwich JCT	840	353.7	42.1	385.6	45.9
C22J	Sandwich JCT	Leamington TS	840	350.5	41.7	383.2	45.6
C22J	Leamington TS	Chatham SS	840	310.1	36.9	286.9	34.2
C23Z	Lauzon TS	Sandwich JCT	1060	223.9	21.1	216.4	20.4
C23Z	Sandwich JCT	Comber WF JCT	1060	216.4	20.4	207.2	19.5
C23Z	Comber WF JCT	KEPA WF JCT	1060	155.2	14.6	188.5	17.8
C23Z	KEPA WF JCT	Dillon RWEC JCT	1060	146.1	13.8	180.1	17
C23Z	Dillon RWEC JCT	Chatham SS	1060	286.5	27	332.8	31.4
C24Z	Lauzon TS	Sandwich JCT	1060	284.1	26.8	263.8	24.9
C24Z	Sandwich JCT	Comber WF JCT	840	279	33.2	257.2	30.6
C24Z	Comber WF JCT	KEPA WF JCT	840	145.6	17.3	157.4	18.7
C24Z	KEPA WF JCT	Chatham SS	840	476.4	56.7	523.3	62.3
J3E	Keith TS	Crawford JCT	810	803.2	99.2	755.9	93.3
J3E	Crawford JCT	Essex TS	810	609.9	75.3	547.5	67.6
J4E	Keith TS	Crawford JCT	810	778.8	96.2	726.2	89.7
J4E	Crawford JCT	Essex TS	810	630.6	77.8	575	71
Z1E	Essex TS	Windsor Transalta JCT	970	410.1	42.3	313.4	32.3
Z1E	Windsor Transalta JCT	Walker JCT	970	727	74.9	643.6	66.3
Z1E	Walker JCT	Jefferson JCT	870	399.2	45.9	267.5	30.7
Z1E	Jefferson JCT	Lauzon TS	910	387.3	42.6	251.7	27.7
Z7E	Essex TS	Walker JCT	970	719.3	74.2	652.8	67.3
Z7E	Walker JCT	Jefferson JCT	870	396.9	45.6	263.3	30.3
Z7E	Jefferson JCT	Lauzon TS	910	385.5	42.4	248.2	27.3
Lauzon T1			250	50.3	20.1	70.1	28
Lauzon T2			250	34.4	13.7	49.5	19.8
Keith T11			115	50.3	43.7	34.9	30.4
Keith T12			115	56.7	49.3	39.4	34.3

Post-contingency

Table 14 to Table 19 in Appendix A show the post-contingency flows for the monitored circuits for scenarios S1 and S2 under HFE conditions following contingencies listed in Table 7. The simulation results show that the post-contingency thermal loadings in the Windsor 230 and 115 kV systems remain within applicable *ORTAC* criteria with the utilization of appropriate control actions. For scenario S2 with Kingsville load transfer option B, the post-contingency loadings are lower and less control actions are required. Hence, option B is better than option A.

Under scenarios S1 and S2 for the Lauzon T1L7 breaker failure which results in the loss of circuits Z7E and C23Z shown in Table 16 and Table 17 respectively, multiple control actions are needed to mitigate post-contingency thermal loadings in the Windsor 115 kV system. Arming load rejection as part of the Lauzon L/R scheme in the Windsor Area SPS for loss of Z7E or C23Z with all elements in-service and all local generation in-service was not considered. This is not allowed based on the *ORTAC* criteria, where load rejection is permissible only to account for local generation outages when one element is out of service.

This event could be better managed if the Lauzon L/R scheme which is part of the Windsor Area SPS was expanded to include this contingency. It is recommended that Hydro One consider expanding the Lauzon L/R scheme as part of the Windsor Area SPS to include the selection of load rejection (L/R) for the Lauzon T1L7 breaker failure which is a NERC TPL-001-04 BES Planning Performance Event. This would provide greater operating flexibility

Load Restoration

For the loss of double circuits C23Z and C24Z, the load at Lauzon is tripped and can be restored by opening the 230 kV disconnect switches at Lauzon on the C23Z and C24Z circuits and closing the 115 kV and 27.6 kV transformer breakers at Lauzon. This was studied as it shows a comparison in the capability to restore load on the Windsor 115 kV system with the two load transfer options.

Under HFE conditions with 194.2 MW of load at Lauzon for the year 2026, it was found that 102 MW of load at Lauzon can be restored in scenario S1 and 160 MW of load at Lauzon can be restored in scenario S2 without additional load transfers out of the Windsor 115 kV system. However, there is capability to transfer 68 MW of load supplied by the Windsor 115 kV system to the 230 kV system and 20 MW of load supplied by the Windsor 115 kV system to the Scott 115 kV system depending on the loading within that system. Transferring 68 MW of load from the Windsor 115 kV to the 230 kV system will enable all the load to be restored in scenario S2. Hence option B is better than option A as it allows all the load at Lauzon to be restored.

Sensitivity Studies: With no TA Windsor and West Windsor Generation Facilities

Sensitivity studies were performed under HFE conditions without the TA Windsor and West Windsor generation facilities in-service given that their contracts are expiring in 2016. These results are not presented in this report but summarized below.

Without these facilities in-service, the Brighton Beach output can be maximized and imports can be kept similar to that in scenarios S1 and S2. Studies show that under these conditions the post-contingency thermal loadings in the Windsor 230 and 115 kV systems remain within applicable *ORTAC* criteria with the utilization of appropriate control actions. When compared to scenarios S1 and S2, the post-contingency thermal loading on the Keith transformers are higher and the post-contingency thermal loading on the J4E/J3E and Z1E/Z7E circuits are lower. For these conditions with Kingsville load transfer option A, a lot more control actions would need to be taken under outage conditions which include pre-contingency control actions followed by automatic and manual actions post-contingency. Hence, option B is better than option A.

6.5.3 High Flow West Conditions

All elements in-service: Pre-contingency

The pre-contingency thermal loading for the two load transfer options from Kingsville under high flow west (HFW) conditions, which represent past historical maximum transfers, in scenarios S3 and S4 are presented in Table 11. The pre-contingency flows on all monitored elements are within their continuous ratings for both load transfer options under HFW conditions. The flows are in Ampere for circuits and MVA for transformers.

Table 11: Pre-contingency thermal loading under HFW conditions - All Elements I/S

Circuit/ Transformer	Circuit Section		Continuous	S3 – 124 MW at Kingsville		S4- 54 MW at Kingsville	
	From	To	A/MVA	A/MVA	% Cont	A/MVA	% Cont
C21J	Keith TS	Malden TS	840	394.2	46.9	349.1	41.6
C21J	Malden TS	Sandwich JCT	840	551.8	65.7	506.5	60.3
C21J	Sandwich JCT	Leamington TS	1060	550.9	52	506	47.7
C21J	Leamington TS	Chatham SS	1060	599	56.5	644.4	60.8
C22J	Keith TS	Malden TS	840	385.9	45.9	342	40.7
C22J	Malden TS	Sandwich JCT	840	543.5	64.7	498.9	59.4
C22J	Sandwich JCT	Leamington TS	840	542.8	64.6	498.7	59.4
C22J	Leamington TS	Chatham SS	840	591.2	70.4	636	75.7
C23Z	Lauzon TS	Sandwich JCT	1060	544.1	51.3	504.1	47.6
C23Z	Sandwich JCT	Comber WF JCT	1060	541.7	51.1	501.1	47.3
C23Z	Comber WF JCT	KEPA WF JCT	1060	538.9	50.8	497.8	47
C23Z	KEPA WF JCT	Dillon RWEC JCT	1060	537.5	50.7	496.1	46.8
C23Z	Dillon RWEC JCT	Chatham SS	1060	535.9	50.6	494.2	46.6
C24Z	Lauzon TS	Sandwich JCT	1060	538	50.8	499	47.1
C24Z	Sandwich JCT	Comber WF JCT	840	535.9	63.8	496.2	59.1
C24Z	Comber WF JCT	KEPA WF JCT	840	533.3	63.5	493.1	58.7
C24Z	KEPA WF JCT	Chatham SS	840	526.9	62.7	484.8	57.7
J3E	Keith TS	Crawford JCT	810	449.8	55.5	442.8	54.7
J3E	Crawford JCT	Essex TS	810	235.6	29.1	221.2	27.3
J4E	Keith TS	Crawford JCT	810	413.7	51.1	395.8	48.9
J4E	Crawford JCT	Essex TS	810	268.7	33.2	271.3	33.5
Z1E	Essex TS	Windsor Transalta JCT	970	159	16.4	81.5	8.4
Z1E	Windsor Transalta JCT	Walker JCT	970	341	35.2	270.3	27.9
Z1E	Walker JCT	Jefferson JCT	870	141.7	16.3	132.6	15.2
Z1E	Jefferson JCT	Lauzon TS	910	156.1	17.2	152.8	16.8
Z7E	Essex TS	Walker JCT	970	346	35.7	332.4	34.3
Z7E	Walker JCT	Jefferson JCT	870	159.2	18.3	142.7	16.4
Z7E	Jefferson JCT	Lauzon TS	910	173.6	19.1	163.2	17.9
Lauzon T1			250	118	47.2	100.5	40.2
Lauzon T2			250	115.5	46.2	98.2	39.3
Keith T11			115	17	14.8	31.5	27.4
Keith T12			115	19.1	16.6	35.5	30.9

Post-contingency

Table 20 to Table 25 in Appendix A show the post-contingency flows for the monitored circuits for scenarios S3 and S4 under HFW conditions following contingencies listed in Table 7. The simulation results show that the post-contingency thermal loadings in the Windsor 230 and 115 kV systems remain within applicable *ORTAC* criteria with the utilization of appropriate control actions. For scenario S2 with Kingsville load transfer option B, the post-contingency loadings are lower and less control actions are required. Hence, option B is better than option A.

Load Restoration

Load restoration at Lauzon was analyzed following the loss of double circuits C23Z and C24Z similar to the description provided earlier in section 6.5.2 under HFE conditions.

Under HFW conditions with 194.2 MW of load at Lauzon for the year 2026, it was found that 10 MW of load at Lauzon can be restored in scenario S3 and 86 MW of load at Lauzon can be restored in scenario S4 without additional load transfers out of the Windsor 115 kV system. Taking into account the load transfer capability discussed in section 6.5.2, with 68 MW of load transferred from the Windsor 115 kV system to the 230 kV system and with the generation at Pte Aux Roches and Gosfield in-service at full output, all the load can be restored in scenario S4. Hence option B is better than option A as it allows all the load at Lauzon to be restored.

Reverse Power Flow

Reverse power flow through the project's transformers was observed in all four scenarios S1 to S4 with the maximum reverse power flow in scenario S3 for the outage combinations with C21J or C22J open at Chatham and the inadvertent breaker open (IBO) of C21J at Keith. There were no post-contingency thermal or voltage violations observed for these outage combinations in all four scenarios.

In scenario S3 for the outage combination with C22J open at Chatham and IBO of C21J at Keith, the maximum reverse power flow of 44 MW through the project's transformers was observed. Under these conditions, the reverse power flow through the Malden transformer is 7 MW and would increase to 14 MW without the incorporation of the project.

In addition in scenario S3, for the outage combination with C21J open at Chatham and IBO of C21J at Keith, the reverse power flow through the project's transformer is 33 MW. Under these conditions, without the incorporation of the project there is no reverse power flow at Malden TS.

It is recommended that Hydro One assess the reverse power flow on the project's transformers and confirm that there is no unacceptable tripping or loading concern on the transformers.

Sensitivity Studies: With no TA Windsor and West Windsor Generation Facilities

Sensitivity studies were performed under high flow west conditions without the TA Windsor and West Windsor generation facilities in-service given that their contracts are expiring in 2016. These results are not presented in this report but summarized below

Without these facilities in-service, the Brighton Beach output can be increased to make up for this generation while keeping the total flow out of Chatham on circuits C21J,C22J, C23Z and C24Z similar to that in scenarios S3 and S4. Studies show that under these conditions the post-contingency thermal loadings in the Windsor 230 and 115 kV systems remain within applicable *ORTAC* criteria with the utilization of appropriate control actions. When compared to scenarios S3 and S4, the post-contingency thermal loading on the Keith transformers and J4E/J3E circuits are higher and the post-contingency thermal loading on the C22J and Z1E circuits are lower. For these conditions with Kingsville load transfer option A, a lot more control actions would need to be taken under outage conditions which include pre-contingency control actions followed by automatic and manual actions post-contingency. Hence, option B is better than option A.

6.5.4 Load Tripped by Configuration

To assess that *ORTAC* load security criteria will be met after the incorporation of the project, the total amount of load tripped by configuration for loss of either one or two elements that involve the project was examined.

Single contingencies involving the loss of C21J or C22J result in no load interruption at Malden TS and the project.

The simultaneous loss of double circuits C21J and C22J will interrupt load at Malden TS and the project of up to 237 MW for the 2016 to 2026 period based on the Hydro One load forecast under option B. The interrupted load does not exceed 600 MW and is within the *ORTAC* criteria.

The *ORTAC* load restoration criteria states that all load must be restored within approximately 8 hours and the amount of load in excess of 150 MW must be restored within approximately 4 hours. This means that of the load that is interrupted for loss of C21J and C22J as mentioned above, up to 87 MW of load will need to be restored within approximately 4 hours and up to 237 MW of load will need to be restored within approximately 8 hours. Hydro One and the affected Local Distribution Companies (LDCs) are expected to work together to ensure that these load restoration targets can be achieved.

6.6 Voltage Assessment

The *ORTAC* states that with all facilities in service pre-contingency, or with a critical element out of service after permissible control actions, the following criteria shall be satisfied:

- The pre-contingency voltages on 230 kV buses must not be less than 220 kV and no greater than 250 kV and 115kV buses must not be less than 113 kV and no greater than 127 kV;
- The post-contingency voltages on 230 kV buses must not be less than 207 kV and no greater than 250 kV and 115 kV buses must not be less than 108 kV and no greater than 127 kV; and
- The voltage change following a contingency must not exceed 10% pre-ULTC and 10% post-ULTC on both 115 kV and 230 kV buses.

All the loads were modeled as constant MVA unless otherwise specified.

6.6.1 Kingsville Local Supply

Voltage Analysis was performed to compare the two load transfer options from Kingsville. The loss of K2Z is presented in Table 12 below as the voltage declines are greater for the loss of K2Z than K6Z. Under option A, the Kingsville transformer switching control action was used so that the loading on the remaining Kingsville transformers do not exceed their summer 10-day LTR as discussed earlier in Section 6.5.1.

Table 12: Voltage Results for loss of K2Z with the two load transfer options

Bus Name	Option A: 124 MW with 4 transformers at Kingsville									Option B: 54 MW with 2 transformers at Kingsville				
	Pre-cont.	* K2Z				K2Z – 62 MW Kingsville L/R				Pre-cont.	K2Z			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC			Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%		kV	%	kV	%
Lauzon 115 kV	122.7	122.1	-0.53	121.8	-0.78	124.4	1.37	124.2	1.18	121.1	120.4	-0.52	120.5	-0.44
Bell River K6Z 115 kV	120.9	117.1	-3.11	116.3	-3.84	124.3	2.82	123.6	2.26	119.4	115.8	-3.00	116.1	-2.74
Pointe Aux Roches 115	120.5	116.2	-3.56	115.2	-4.44	124.6	3.34	123.8	2.70	119.1	115.1	-3.42	115.4	-3.16
Kingsville K6Z 115 kV	117.3	109.1	-6.97	**106.8**	-8.92	125.5	7.02	124.1	5.81	116.9	109.2	-6.64	109.5	-6.37

* Kingsville load was converted for this contingency both Pre and Post ULTC

From Table 12 it is noticed that with option A, the post-contingency voltage at Kingsville is below 108 kV for loss of K2Z with the load at Kingsville converted both pre and post ULTC. Note that in this scenario without the Kingsville transformer switching control action, the voltage at Kingsville would be even lower. The Lauzon L/R scheme which is part of the Windsor Area SPS can be used in this scenario to reject half the load at Kingsville (62 MW) to bring the voltage above 108 kV.

However, this is a violation of the *ORTAC* criteria as with one element out of service, equipment loading must be within applicable long-term ratings, and any load rejection is permissible only to account for local generation outages. Since there are no generation outages in this scenario, load rejection is not permitted.

Under option B the post-contingency voltages are above 108 kV which is within the *ORTAC* criteria. Hence option B is the recommended option. Note that under option B, with 54 MW of load at Kingsville, the Lauzon capacitor was switched out of service pre-contingency to avoid high voltages at Lauzon post-contingency for the loss of Z1E+Z7E with all elements in-service.

6.6.1 High Flow East or West Conditions

The pre- and post-contingency voltage results for scenarios S1 and S2 under HFE conditions following contingencies listed in Table 7 are presented in Table 26 to Table 31 in Appendix B. The pre- and post-contingency voltage results for scenarios S3 and S4 under HFW conditions following contingencies listed in Table 7 are presented in Table 32 to Table 37 in Appendix B.

Study results show that for all four scenarios S1, S2, S3 and S4 the pre and post-contingency voltages in the Windsor 230 and 115 kV systems remain within applicable *ORTAC* criteria with the utilization of appropriate control actions.

In all four scenarios for the loss of double circuit Z1E and Z7E, control actions are necessary to mitigate post-contingency over-voltages on the Lauzon 115 kV system. For scenarios S1 and S3 with Kingsville load transfer option A, the Lauzon L/R scheme as part of the Windsor Area SPS was armed to switch out the Kingsville capacitors.. For scenarios S2 and S4 with Kingsville load transfer option B, the Lauzon capacitor was switched out-service pre-contingency and the Keith capacitor was switched in-service pre-contingency to maintain acceptable voltages pre- and post –contingency as there were no control actions available post-contingency. This resulted in lower voltages on the Lauzon 230 kV and 115 kV systems compared to scenarios S1 and S3 even though more load was transferred out of Kingsville in scenarios S2 and S4. In all four scenarios, this event could be better managed if the Lauzon L/R scheme which is part of the Windsor Area SPS was expanded to trip the Lauzon capacitor for this contingency.

Therefore under both load transfer options A or B, it is recommended that Hydro One consider adding the selection of the Lauzon capacitor to be tripped for the Z1E+Z7E contingency which is a contingency that is already included in the Lauzon L/R scheme as part of the Windsor Area SPS. This would provide greater operating flexibility.

Sensitivity Studies: With no TA Windsor and West Windsor Generation Facilities

Sensitivity studies were performed under high flow east or west conditions without the TA Windsor and West Windsor generation facilities in-service given that their contracts are expiring in 2016. These results are not presented in this report but summarized below.

Without these facilities in-service, the pre- and post-contingency voltage in the Windsor 230 and 115 kV systems remain within applicable *ORTAC* criteria with the utilization of appropriate control actions. However when compared to scenarios S1, S2, S3 and S4, the pre and post-contingency voltages are lower and voltage changes are higher without these facilities in-service.

6.7 Switching Studies

The *ORTAC* states that reactive devices should be sized to ensure that voltage declines or rises at delivery point buses on switching operations will not exceed 4% of steady-state rms voltage before tap changer action using a voltage dependent load model.

The switching of the proposed capacitor bank of 21.6 Mvar @ 28.8 kV was tested under various outage conditions for the two different load transfer options A and B at 2026 load levels. Table 13 shows the capacitor switching results for the project's 230 kV buses. In all studied scenarios, the voltage change following the capacitor switching is within the prescribed 4% permissible voltage change limit.

Table 13: Capacitor Switching Study for Leamington TS

	Load transfer option A						Load transfer option B					
230 kV Bus	Leamington C21J			Leamington C22J			Leamington C21J			Leamington C22J		
Outage Condition	Cap O/S	Cap I/S	Change	Cap O/S	Cap I/S	Change	Cap O/S	Cap I/S	Change	Cap O/S	Cap I/S	Change
	kV	kV	%	kV	kV	%	kV	kV	%	kV	kV	%
None	236.7	238.2	0.66%	236.6	238.1	0.66%	229.9	231.4	0.67%	229.7	231.3	0.67%
C22J Chatham end open	232.2	233.9	0.72%	230.2	232.4	0.96%	224.8	226.5	0.73%	221.2	223.3	0.98%
C22J Keith end open	235.2	236.7	0.66%	235.1	237.0	0.82%	229.8	231.4	0.67%	229.0	230.9	0.82%
J5D	235.5	237.7	0.92%	235.4	237.6	0.93%	229.0	231.2	0.94%	228.8	231.0	0.94%
C21J				227.3	229.7	1.06%				217.1	219.3	1.04%
C22J	227.6	230.0	1.06%				216.5	218.8	1.07%			

– End of Section –

Appendix A Thermal Loading

Table 14: Thermal loading with all elements in-service for single contingencies – Scenario S1

Circuit/ Xformer	Circuit Section		LTE	STE	C22J		C23Z		** J3E (Mode A Essex Bus Split)*		** Z7E (BB G/R)*		Keith A Bus	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE
C21J	Keith TS	Malden TS	1020	1100	819.5	80.3	521	51.1	718.8	70.5	423.6	41.5	0	0
C21J	Malden TS	Sandwich JCT	1020	1100	525.7	51.5	382.1	37.5	570	55.9	289.7	28.4	48	4.7
C21J	Sandwich JCT	Leamington TS	1370	1570	523.3	38.2	379	27.7	568.3	41.5	285.8	20.9	41.5	3
C21J	Leamington	Chatham SS	1370	1570	445.9	32.6	338.6	24.7	522.9	38.2	248.9	18.2	40.3	2.9
C22J	Keith TS	Malden TS	1020	1100	0	0	514.8	50.5	710.6	69.7	418.5	41	799.7	78.4
C22J	Malden TS	Sandwich JCT	1050	1150	0	0	377	35.9	562.5	53.6	285.7	27.2	534.4	50.9
C22J	Sandwich JCT	Leamington TS	1020	1100	0	0	373.6	36.6	560.5	55	281.7	27.6	532	52.2
C22J	Leamington	Chatham SS	1020	1100	0	0	334.1	32.8	515.7	50.6	245.7	24.1	432.9	42.4
C23Z	Lauzon TS	Sandwich JCT	1400	1900	226.8	16.2	0	0	566.2	40.4	293	20.9	219	15.6
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	218.7	15.6	0	0	562.8	40.2	287.1	20.5	210.7	15
C23Z	Comber WF	KEPA WF JCT	1400	1840	170.4	12.2	0	0	368.8	26.3	153.1	10.9	171.3	12.2
C23Z	KEPA WF JCT	Dillon RWEC	1400	1690	161.3	11.5	0	0	366.3	26.2	147.7	10.6	162.4	11.6
C23Z	Dillon RWEC	Chatham SS	1400	1690	302.8	21.6	0	0	250.9	17.9	233.8	16.7	308.6	22
C24Z	Lauzon TS	Sandwich JCT	1400	1900	282.6	20.2	426.6	30.5	640.4	45.7	360.7	25.8	273.7	19.5
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	277	26.6	421	40.5	637.8	61.3	356.6	34.3	267.9	25.8
C24Z	Comber WF	KEPA WF JCT	1040	1130	154.8	14.9	269.3	25.9	443.4	42.6	193.3	18.6	150.8	14.5
C24Z	KEPA WF JCT	Chatham SS	1020	1100	491.3	48.2	437.9	42.9	239.9	23.5	407.9	40	498.5	48.9
J3E	Keith TS	Crawford JCT	1070	1390	820	76.6	886.2	82.8	0	0	661.7	61.8	838.5	78.4
J3E	Crawford JCT	Essex TS	1070	1390	630.6	58.9	685.8	64.1	0	0	458.3	42.8	648.6	60.6
J4E	Keith TS	Crawford JCT	1000	1090	797.2	79.7	863.1	86.3	531.3	53.1	634.1	63.4	815.5	81.6
J4E	Crawford JCT	Essex TS	1000	1090	649.4	64.9	707.2	70.7	163.8	16.4	482.3	48.2	667.7	66.8
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	438.7	34.8	454.5	36.1	347.3	27.6	800.6	63.5	454.5	36.1
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	751.4	59.6	787.1	62.5	87.6	6.9	1129.7	89.7	768.7	61
Z1E	Walker JCT	Jefferson JCT	1140	1390	427.9	37.5	402.7	35.3	412.5	36.2	559.9	49.1	441.5	38.7
Z1E	Jefferson JCT	Lauzon TS	1190	1370	416.2	35	385.1	32.4	433.7	36.4	550.5	46.3	429.3	36.1
Z7E	Essex TS	Walker JCT	1260	1430	741.8	58.9	793.8	63	43	3.4	0	0	759.6	60.3
Z7E	Walker JCT	Jefferson JCT	1140	1390	425.8	37.4	396.4	34.8	426	37.4	0	0	439	38.5
Z7E	Jefferson JCT	Lauzon TS	1190	1370	414.6	34.8	379.2	31.9	447	37.6	0	0	427.3	35.9
Lauzon T1			296.8	364.2	56.7	19.1	0	0	126.2	42.5	41.8	14.1	58.6	19.8
Lauzon T2			296.8	364.2	39.7	13.4	56.6	19.1	146.4	49.3	46.6	15.7	39.9	13.4
Keith T11			180.3	224.5	104.8	58.1	64.5	35.8	77.6	43	80.5	44.7	0	0
Keith T12			160.3	187.5	0	0	72.7	45.3	87.5	54.6	90.8	56.6	114.5	71.4

* Control Actions shown in brackets

Table 15: Thermal loading with all elements in-service for single contingencies – Scenario S2

Circuit/ Xformer	Circuit Section		LTE	STE	C22J		C23Z		*J3E-(Mode A Essex Bus Split)		* Z7E-(BB G/R)		Keith A Bus	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE
C21J	Keith TS	Malden TS	1020	1100	897.9	88	568.7	55.8	729	71.5	456.9	44.8	0	0
C21J	Malden TS	Sandwich JCT	1020	1100	588.6	57.7	423.8	41.6	577.5	56.6	314.3	30.8	40.3	4
C21J	Sandwich JCT	Leamington TS	1370	1570	587.3	42.9	421.4	30.8	576.2	42.1	311.4	22.7	33.5	2.4
C21J	Leamington	Chatham SS	1370	1570	401.6	29.3	324.6	23.7	461	33.7	226.9	16.6	116.6	8.5
C22J	Keith TS	Malden TS	1020	1100	0	0	561.6	55.1	720.5	70.6	451.3	44.2	853.6	83.7
C22J	Malden TS	Sandwich JCT	1050	1150	0	0	417.3	39.7	569.3	54.2	309.1	29.4	575	54.8
C22J	Sandwich JCT	Leamington TS	1020	1100	0	0	414.7	40.7	567.8	55.7	306.1	30	573.1	56.2
C22J	Leamington	Chatham SS	1020	1100	0	0	320.9	31.5	455.1	44.6	224.8	22	408.8	40.1
C23Z	Lauzon TS	Sandwich JCT	1400	1900	218.6	15.6	0	0	515.8	36.8	268.5	19.2	211.6	15.1
C23Z	Sandwich JCT	Comber WF	1400	1840	208.9	14.9	0	0	510.6	36.5	261.1	18.7	201.7	14.4
C23Z	Comber WF	KEPA WF JCT	1400	1840	207.6	14.8	0	0	327.8	23.4	171.2	12.2	211.4	15.1
C23Z	KEPA WF JCT	Dillon RWEC	1400	1690	199.5	14.2	0	0	324	23.1	161.8	11.6	203.5	14.5
C23Z	Dillon RWEC	Chatham SS	1400	1690	354.5	25.3	0	0	232.4	16.6	276.1	19.7	362.3	25.9
C24Z	Lauzon TS	Sandwich JCT	1400	1900	259.1	18.5	394.7	28.2	585	41.8	328.8	23.5	249.5	17.8
C24Z	Sandwich JCT	Comber WF	1040	1130	251.7	24.2	387.7	37.3	580.9	55.9	323.5	31.1	241.9	23.3
C24Z	Comber WF	KEPA WF JCT	1040	1130	179	17.2	259.3	24.9	390.4	37.5	179.1	17.2	177.9	17.1
C24Z	KEPA WF JCT	Chatham SS	1020	1100	544.6	53.4	497.3	48.8	309.4	30.3	456.1	44.7	553.6	54.3
J3E	Keith TS	Crawford JCT	1070	1390	782.4	73.1	828.5	77.4	0	0	639.2	59.7	805.5	75.3
J3E	Crawford JCT	Essex TS	1070	1390	577.2	53.9	613.6	57.3	0	0	422	39.4	600.4	56.1
J4E	Keith TS	Crawford JCT	1000	1090	754.4	75.4	797.4	79.7	533.9	53.4	604.9	60.5	777.5	77.8
J4E	Crawford JCT	Essex TS	1000	1090	602.4	60.2	643.5	64.4	172.4	17.2	455.5	45.6	625.8	62.6
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	352.2	28	361	28.7	364.9	29	683.6	54.3	374	29.7
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	680.6	54	704.3	55.9	70.9	5.6	1015.3	80.6	703.1	55.8
Z1E	Walker JCT	Jefferson JCT	1140	1390	308.7	27.1	291.3	25.5	419.4	36.8	263.6	23.1	328.5	28.8
Z1E	Jefferson JCT	Lauzon TS	1190	1370	293.2	24.6	270.3	22.7	441.4	37.1	249.6	21	312.5	26.3
Z7E	Essex TS	Walker JCT	1260	1430	686.4	54.5	731.9	58.1	54.8	4.3	0	0	709.1	56.3
Z7E	Walker JCT	Jefferson JCT	1140	1390	304.8	26.7	281	24.6	433.1	38	0	0	324.1	28.4
Z7E	Jefferson JCT	Lauzon TS	1190	1370	290	24.4	260.2	21.9	454.9	38.2	0	0	308.7	25.9
Lauzon T1			296.8	364.2	78.6	26.5	0	0	108.7	36.6	53	17.8	81.5	27.5
Lauzon T2			296.8	364.2	57.1	19.2	86.8	29.2	123.8	41.7	45.4	15.3	59	19.9
Keith T11			180.3	224.5	76.1	42.2	45.4	25.2	74.5	41.3	62.8	34.8	0	0
Keith T12			160.3	187.5	0	0	51.2	32	84	52.4	70.8	44.2	88.1	54.9

* Control Actions shown in brackets

Table 16: Thermal loading with all elements in-service for double contingencies – Scenario S1

Circuit/ Xformer	Circuit Section		LTE	STE	C21J+C23Z		* C21J+C22J (Lower BB to 417 MW post)		C22J+C24Z		C23Z+C24Z		* Keith T11P BF: Keith A Bus + J2N – (Lower imports to 80 MW post)		* Lauzon T1L7 BF: Z7E+C23Z – (BB G/R and manually shed 62 MW at Kingsville post)	
	From	To	A/ MVA	A/ MVA	A/ MVA	% LTE	A/ MVA	% LTE	A/ MVA	% LTE	A/ MVA	% LTE	A/ MVA	% LTE	A/ MVA	% LTE
C21J	Keith TS	Malden TS	1020	1100	0	0	0	0	873.5	85.6	593.1	58.2	0	0	446.1	43.7
C21J	Malden TS	Sandwich	1020	1100	0	0	0	0	582.2	57.1	455.8	44.7	59.9	5.9	314.3	30.8
C21J	Sandwich	Leamington	1370	1570	0	0	0	0	579.8	42.3	452.5	33	54.9	4	310.2	22.6
C21J	Leamington	Chatham SS	1370	1570	0	0	0	0	503.8	36.8	412.6	30.1	57.2	4.2	274	20
C22J	Keith TS	Malden TS	1020	1100	821.5	80.5	0	0	0	0	585.8	57.4	694.9	68.1	440.6	43.2
C22J	Malden TS	Sandwich	1050	1150	534.4	50.9	0	0	0	0	449.6	42.8	449.5	42.8	309.9	29.5
C22J	Sandwich	Leamington	1020	1100	531.6	52.1	0	0	0	0	446.2	43.7	446.6	43.8	305.7	30
C22J	Leamington	Chatham SS	1020	1100	459.7	45.1	0	0	0	0	407.1	39.9	357.4	35	270.5	26.5
C23Z	Lauzon TS	Sandwich	1400	1900	0	0	202	14.4	403.1	28.8	0	0	282.2	20.2	0	0
C23Z	Sandwich	Comber WF	1400	1840	0	0	191.5	13.7	396	28.3	0	0	275.8	19.7	0	0
C23Z	Comber WF	KEPA WF	1400	1840	0	0	234.7	16.8	263.1	18.8	0	0	155.6	11.1	0	0
C23Z	KEPA WF	Dillon	1400	1690	0	0	227	16.2	257.9	18.4	0	0	150	10.7	0	0
C23Z	Dillon	Chatham SS	1400	1690	0	0	390.6	27.9	303.6	21.7	0	0	249.7	17.8	0	0
C24Z	Lauzon TS	Sandwich	1400	1900	385.1	27.5	229.3	16.4	0	0	0	0	347.5	24.8	462.5	33
C24Z	Sandwich	Comber WF	1040	1130	378.3	36.4	221.2	21.3	0	0	0	0	343.1	33	457.8	44
C24Z	Comber WF	KEPA WF	1040	1130	253.9	24.4	190.4	18.3	0	0	0	0	187.2	18	292.3	28.1
C24Z	KEPA WF	Chatham SS	1020	1100	497.8	48.8	583.3	57.2	0	0	0	0	426.1	41.8	391.2	38.4
J3E	Keith TS	Crawford	1070	1390	946	88.4	991.1	92.6	935.4	87.4	778.9	72.8	674.5	63	683.7	63.9
J3E	Crawford	Essex TS	1070	1390	745.8	69.7	807.1	75.4	737	68.9	567.5	53	482.2	45.1	478.1	44.7
J4E	Keith TS	Crawford	1000	1090	921.4	92.1	970.3	97	911.6	91.2	748.4	74.8	650.4	65	656.6	65.7
J4E	Crawford	Essex TS	1000	1090	767.7	76.8	824.1	82.4	757.7	75.8	596	59.6	501.6	50.2	502.3	50.2
Z1E	Essex TS	Windsor Transalta	1260	1430	519.4	41.2	616.8	49	516.2	41	327	26	299.3	23.8	828	65.7
Z1E	Windsor Transalta	Walker JCT	1260	1430	851.5	67.6	930.3	73.8	845.6	67.1	663	52.6	603.6	47.9	1163.1	92.3
Z1E	Walker JCT	Jefferson	1140	1390	467.7	41	596.8	52.4	464.6	40.8	269.1	23.6	309.5	27.2	506.5	44.4
Z1E	Jefferson	Lauzon TS	1190	1370	450.1	37.8	583.2	49	447.4	37.6	251	21.1	302.6	25.4	491.1	41.3
Z7E	Essex TS	Walker JCT	1260	1430	856.5	68	919.3	73	849.2	67.4	676.1	53.7	593.1	47.1	0	0
Z7E	Walker JCT	Jefferson	1140	1390	461.4	40.5	593.4	52.1	459.3	40.3	262.4	23	310.5	27.2	0	0
Z7E	Jefferson	Lauzon TS	1190	1370	444.1	37.3	580.1	48.7	442.5	37.2	244.8	20.6	304.2	25.6	0	0
LauzonT1			296.8	364.2	0	0	89.6	30.2	83.2	28	0	0	44.1	14.8	0	0
LauzonT2			296.8	364.2	83.6	28.2	64.6	21.8	0	0	0	0	44.4	14.9	32.8	11.1
Keith T11			180.3	224.5	72.8	40.4	179.6	99.6	146.3	81.1	47.6	26.4	0	0	84.7	47
Keith T12			160.3	187.5	82.1	51.2	0	0	0	0	53.6	33.5	159.1	99.3	95.5	59.6

* Control Actions shown in brackets

Table 17: Thermal loading with all elements in-service for double contingencies – Scenario S2

Circuit/ Xformer	Circuit Section		LTE	STE	C21J+C23Z		*C21J+C22J (Lower BB to 505 MW post)*		C22J+C24Z		C23Z+C24Z		Keith T11P BF: Keith A Bus + J2N		*Lauzon T1L7 BF: Z7E+C23Z – (BB G/R and lower TA Windsor to 58 MW post)*	
	From	To	A/ MVA	A/ MVA	A/ MVA	% LTE	A/ MVA	% LTE	A/ MVA	% LTE	A/ MVA	% LTE	A/ MVA	% LTE	A/ MVA	% LTE
C21J	Keith TS	Malden TS	1020	1100	0	0	0	0	963.5	94.5	662.9	65	0	0	470	46.1
C21J	Malden TS	Sandwich	1020	1100	0	0	0	0	656.6	64.4	519.4	50.9	44.1	4.3	330.5	32.4
C21J	Sandwich	Leamington	1370	1570	0	0	0	0	655.1	47.8	516.9	37.7	37.9	2.8	327.3	23.9
C21J	Leamington	Chatham SS	1370	1570	0	0	0	0	471.5	34.4	420	30.7	123.5	9	249	18.2
C22J	Keith TS	Malden TS	1020	1100	919.1	90.1	0	0	0	0	654.3	64.1	817.9	80.2	463.8	45.5
C22J	Malden TS	Sandwich	1050	1150	614.2	58.5	0	0	0	0	511.5	48.7	545.9	52	325	31
C22J	Sandwich	Leamington	1020	1100	612.6	60.1	0	0	0	0	508.8	49.9	543.9	53.3	321.6	31.5
C22J	Leamington	Chatham SS	1020	1100	440.6	43.2	0	0	0	0	414.9	40.7	385	37.7	246.6	24.2
C23Z	Lauzon TS	Sandwich	1400	1900	0	0	233.8	16.7	370	26.4	0	0	242.2	17.3	0	0
C23Z	Sandwich	Comber WF	1400	1840	0	0	228.4	16.3	361.3	25.8	0	0	233.9	16.7	0	0
C23Z	Comber WF	KEPA WF	1400	1840	0	0	310.8	22.2	266	19	0	0	178.8	12.8	0	0
C23Z	KEPA WF	Dillon	1400	1690	0	0	304.2	21.7	260.3	18.6	0	0	169.7	12.1	0	0
C23Z	Dillon	Chatham SS	1400	1690	0	0	475.5	34	352.4	25.2	0	0	305.7	21.8	0	0
C24Z	Lauzon TS	Sandwich	1400	1900	362.4	25.9	220.2	15.7	0	0	0	0	296.5	21.2	504.5	36
C24Z	Sandwich	Comber WF	1040	1130	354.2	34.1	209.9	20.2	0	0	0	0	290.5	27.9	498.9	48
C24Z	Comber WF	KEPA WF	1040	1130	261.7	25.2	250.4	24.1	0	0	0	0	166.7	16	334	32.1
C24Z	KEPA WF	Chatham SS	1020	1100	559.9	54.9	668.8	65.6	0	0	0	0	491.3	48.2	414.9	40.7
J3E	Keith TS	Crawford	1070	1390	882.3	82.5	1007.	94.2	884.9	82.7	692.7	64.7	681.1	63.7	757.6	70.8
J3E	Crawford	Essex TS	1070	1390	669.1	62.5	810.7	75.8	672.9	62.9	473.2	44.2	471	44	545.7	51
J4E	Keith TS	Crawford	1000	1090	852.7	85.3	983	98.3	856.2	85.6	656.5	65.6	650.8	65.1	731.2	73.1
J4E	Crawford	Essex TS	1000	1090	697.1	69.7	832.3	83.2	699.7	70	509.8	51	499.2	49.9	571.6	57.2
Z1E	Essex TS	Windsor Transalta	1260	1430	420.3	33.4	595.6	47.3	427.6	33.9	216.4	17.2	237.4	18.8	950.6	75.4
Z1E	Windsor Transalta	Walker JCT	1260	1430	766	60.8	921.7	73.1	773.8	61.4	543.9	43.2	566.9	45	1246.9	99
Z1E	Walker JCT	Jefferson	1140	1390	354.4	31.1	549	48.2	362.8	31.8	156.9	13.8	198.9	17.5	326.5	28.6
Z1E	Jefferson	Lauzon TS	1190	1370	333.7	28	532.2	44.7	342.3	28.8	139.8	11.8	185.6	15.6	283.7	23.8
Z7E	Essex TS	Walker JCT	1260	1430	793.6	63	921.4	73.1	798.8	63.4	599.2	47.6	576.7	45.8	0	0
Z7E	Walker JCT	Jefferson	1140	1390	344.7	30.2	543.9	47.7	353.6	31	141.5	12.4	196.9	17.3	0	0
Z7E	Jefferson	Lauzon TS	1190	1370	324.2	27.2	527.5	44.3	333.4	28	124.6	10.5	184.7	15.5	0	0
LauzonT1			296.8	364.2	0	0	125.5	42.3	120.4	40.6	0	0	60.9	20.5	0	0
LauzonT2			296.8	364.2	114.2	38.5	99	33.4	0	0	0	0	45.7	15.4	45.7	15.4
Keith T11			180.3	224.5	51.8	28.7	178	98.7	107.9	59.9	36.8	20.4	0	0	84.1	46.6
Keith T12			160.3	187.5	58.4	36.4	0	0	0	0	41.5	25.9	145	90.4	94.8	59.2

* Control Actions shown in brackets

Table 18: Thermal loading under outage contingencies – Scenario S1

Circuit/ Xformer	Circuit Section		LTE	STE	** Keith A bus + J1B – (Lower imports to 155 MW post)*		Keith A bus + C24Z		** Z7E+C21J- (After 1st outage lower imports to 0 MW and BB to 460 MW)*		** Z7E+C24Z – (After 1st outage lower imports to 0 MW, BB to 478 MW and TA Windsor to 44 MW + Arm 62 MW Kingsville L/R for next contingency)*	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE /MVA
C21J	Keith TS	Malden TS	1020	1100	0	0	0	0	0	0	367.7	36.1
C21J	Malden TS	Sandwich JCT	1020	1100	65.8	6.5	47.3	4.6	0	0	243.6	23.9
C21J	Sandwich JCT	Leamington TS	1370	1570	61.3	4.5	39.4	2.9	0	0	238.8	17.4
C21J	Leamington	Chatham SS	1370	1570	66.2	4.8	42	3.1	0	0	208	15.2
C22J	Keith TS	Malden TS	1020	1100	649.2	63.6	861.8	84.5	541.9	53.1	363	35.6
C22J	Malden TS	Sandwich JCT	1050	1150	412.9	39.3	588.6	56.1	273.4	26	240.1	22.9
C22J	Sandwich JCT	Leamington TS	1020	1100	409.6	40.2	586	57.5	269	26.4	235.1	23
C22J	Leamington	Chatham SS	1020	1100	325.2	31.9	483.1	47.4	224.9	22	205.5	20.1
C23Z	Lauzon TS	Sandwich JCT	1400	1900	300.7	21.5	388.4	27.7	276.5	19.8	425.5	30.4
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	294.6	21	381.1	27.2	270.3	19.3	420	30
C23Z	Comber WF	KEPA WF JCT	1400	1840	164.4	11.7	253.8	18.1	152.3	10.9	261	18.6
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	159	11.4	248.5	17.8	146.7	10.5	256.7	18.3
C23Z	Dillon RWEC	Chatham SS	1400	1690	242.5	17.3	304.6	21.8	249.5	17.8	253.6	18.1
C24Z	Lauzon TS	Sandwich JCT	1400	1900	366.8	26.2	0	0	342.2	24.4	0	0
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	362.5	34.9	0	0	338	32.5	0	0
C24Z	Comber WF	KEPA WF JCT	1040	1130	202.5	19.5	0	0	182.9	17.6	0	0
C24Z	KEPA WF JCT	Chatham SS	1020	1100	413	40.5	0	0	427.4	41.9	0	0
J3E	Keith TS	Crawford JCT	1070	1390	638.2	59.6	951.6	88.9	695.5	65	781	73
J3E	Crawford JCT	Essex TS	1070	1390	447.2	41.8	753.1	70.4	493	46.1	576.2	53.9
J4E	Keith TS	Crawford JCT	1000	1090	614.5	61.4	927.8	92.8	668.1	66.8	752.9	75.3
J4E	Crawford JCT	Essex TS	1000	1090	465.6	46.6	774.1	77.4	517.2	51.7	601.7	60.2
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	273.8	21.7	531.4	42.2	869.3	69	1025.8	81.4
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	570.1	45.2	861.1	68.3	1197.4	95	1237.4	98.2
Z1E	Walker JCT	Jefferson JCT	1140	1390	291.2	25.5	479.5	42.1	611.1	53.6	570.2	50
Z1E	Jefferson JCT	Lauzon TS	1190	1370	286.3	24.1	462.2	38.8	598.2	50.3	551.1	46.3
Z7E	Essex TS	Walker JCT	1260	1430	558.4	44.3	864.8	68.6	0	0	0	0
Z7E	Walker JCT	Jefferson JCT	1140	1390	293.4	25.7	474	41.6	0	0	0	0
Z7E	Jefferson JCT	Lauzon TS	1190	1370	289.4	24.3	457.1	38.4	0	0	0	0
Lauzon T1			296.8	364.2	45.8	15.4	89.2	30.1	42.3	14.3	50.3	17
Lauzon T2			296.8	364.2	50	16.8	0	0	42.3	14.3	0	0
Keith T11			180.3	224.5	0	0	0	0	43.4	24.1	58.4	32.4
Keith T12			160.3	187.5	159.2	99.3	155.4	97	48.9	30.5	65.8	41.1

* Control Actions shown in brackets

Table 18: Thermal loading under outage contingencies – Scenario S1 (continued)

Circuit/ Xformer	Circuit Section		LTE	STE	* J3E+Z7E-(After 1st outage lower Imports to 0 MW and BB to 305 MW)		* J3E+C21J- (After 1st outage lower Imports to 0 MW and BB to 305 MW)		* J3E+C24Z – (After 1st outage lower imports to 0 MW and BB to 260 MW + Arm 62 MW Kingsville & 50 MW Bell River L/R for next contingency)	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE /MVA
C21J	Keith TS	Malden TS	1020	1100	235.6	23.1	0	0	227.2	22.3
C21J	Malden TS	Sandwich JCT	1020	1100	138.3	13.6	0	0	144.9	14.2
C21J	Sandwich JCT	Leamington TS	1370	1570	131.2	9.6	0	0	137.4	10
C21J	Leamington	Chatham SS	1370	1570	125.8	9.2	0	0	115.2	8.4
C22J	Keith TS	Malden TS	1020	1100	232.1	22.8	403.5	39.6	223.3	21.9
C22J	Malden TS	Sandwich JCT	1050	1150	135.7	12.9	165.5	15.8	142.1	13.5
C22J	Sandwich JCT	Leamington TS	1020	1100	128.6	12.6	158.9	15.6	134.5	13.2
C22J	Leamington	Chatham SS	1020	1100	124.5	12.2	147	14.4	114.2	11.2
C23Z	Lauzon TS	Sandwich JCT	1400	1900	376.6	26.9	373.4	26.7	503.4	36
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	371.8	26.6	368.4	26.3	498.7	35.6
C23Z	Comber WF	KEPA WF JCT	1400	1840	207.1	14.8	208.2	14.9	325.1	23.2
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	202.9	14.5	203.8	14.6	321.5	23
C23Z	Dillon RWEC	Chatham SS	1400	1690	207.8	14.8	216.5	15.5	265	18.9
C24Z	Lauzon TS	Sandwich JCT	1400	1900	447.4	32	443	31.6	0	0
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	444	42.7	439.5	42.3	0	0
C24Z	Comber WF	KEPA WF JCT	1040	1130	267.2	25.7	265.5	25.5	0	0
C24Z	KEPA WF JCT	Chatham SS	1020	1100	345	33.8	355.1	34.8	0	0
J3E	Keith TS	Crawford JCT	1070	1390	0	0	0	0	0	0
J3E	Crawford JCT	Essex TS	1070	1390	0	0	0	0	0	0
J4E	Keith TS	Crawford JCT	1000	1090	967.4	96.7	955.1	95.5	994.8	99.5
J4E	Crawford JCT	Essex TS	1000	1090	595.7	59.6	600.5	60.1	631.5	63.2
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	460.8	36.6	174.1	13.8	155.8	12.4
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	789.1	62.6	419.7	33.3	425.6	33.8
Z1E	Walker JCT	Jefferson JCT	1140	1390	448.1	39.3	228.9	20.1	200.1	17.6
Z1E	Jefferson JCT	Lauzon TS	1190	1370	466.4	39.2	235.3	19.8	205.6	17.3
Z7E	Essex TS	Walker JCT	1260	1430	0	0	401.7	31.9	415	32.9
Z7E	Walker JCT	Jefferson JCT	1140	1390	0	0	239	21	209.6	18.4
Z7E	Jefferson JCT	Lauzon TS	1190	1370	0	0	246	20.7	215.4	18.1
Lauzon T1			296.8	364.2	60.3	20.3	60	20.2	19.9	6.7
Lauzon T2			296.8	364.2	76.2	25.7	74.9	25.3	0	0
Keith T11			180.3	224.5	50.5	28	46.7	25.9	53.4	29.6
Keith T12			160.3	187.5	57	35.5	52.6	32.8	60.2	37.6

* Control Actions shown in brackets

Table 19: Thermal loading under outage contingencies – Scenario S2

Circuit/ Xformer	Circuit Section		LTE	STE	Keith A bus + J1B		Keith A bus + C24Z		** Z7E+C21J- (After 1st outage lower Imports to 0 MW and BB to 513 MW)*		** Z7E+C24Z – (After 1st outage lower imports to 0 MW, BB to 478 MW and TA Windsor to 44 MW + Arm 27 MW Kingsville L/R for next contingency)*	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE /MVA
C21J	Keith TS	Malden TS	1020	1100	0	0	0	0	0	0	401.4	39.4
C21J	Malden TS	Sandwich JCT	1020	1100	52.6	5.2	40.3	4	0	0	265.9	26.1
C21J	Sandwich JCT	Leamington TS	1370	1570	47.7	3.5	31.7	2.3	0	0	262.1	19.1
C21J	Leamington	Chatham SS	1370	1570	138.3	10.1	109.1	8	0	0	200.6	14.6
C22J	Keith TS	Malden TS	1020	1100	736.9	72.2	930.5	91.2	681.8	66.8	396	38.8
C22J	Malden TS	Sandwich JCT	1050	1150	479.1	45.6	641.7	61.1	378.2	36	261	24.9
C22J	Sandwich JCT	Leamington TS	1020	1100	476.8	46.7	639.7	62.7	376.2	36.9	257.1	25.2
C22J	Leamington	Chatham SS	1020	1100	329.6	32.3	471.7	46.2	263.4	25.8	199.1	19.5
C23Z	Lauzon TS	Sandwich JCT	1400	1900	259.2	18.5	356.7	25.5	245.9	17.6	436.4	31.2
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	251.5	18	347.8	24.8	237.3	17	429.6	30.7
C23Z	Comber WF	KEPA WF JCT	1400	1840	174.8	12.5	270.9	19.4	188.2	13.4	280.2	20
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	165.4	11.8	261.6	18.7	179.1	12.8	275.2	19.7
C23Z	Dillon RWEC	Chatham SS	1400	1690	288	20.6	357.5	25.5	315.2	22.5	296.3	21.2
C24Z	Lauzon TS	Sandwich JCT	1400	1900	317.2	22.7	0	0	297.5	21.3	0	0
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	311.6	30	0	0	291.3	28	0	0
C24Z	Comber WF	KEPA WF JCT	1040	1130	175.1	16.8	0	0	173.4	16.7	0	0
C24Z	KEPA WF JCT	Chatham SS	1020	1100	469.9	46.1	0	0	499.8	49	0	0
J3E	Keith TS	Crawford JCT	1070	1390	635.3	59.4	904.1	84.5	707.8	66.2	791.4	74
J3E	Crawford JCT	Essex TS	1070	1390	423.3	39.6	692.2	64.7	494	46.2	574.8	53.7
J4E	Keith TS	Crawford JCT	1000	1090	604	60.4	875.3	87.5	676.1	67.6	759.1	75.9
J4E	Crawford JCT	Essex TS	1000	1090	452.7	45.3	719.1	71.9	524	52.4	606.3	60.6
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	187	14.8	446.3	35.4	843.8	67	1005.1	79.8
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	516.6	41	792	62.9	1180.1	93.7	1235.9	98.1
Z1E	Walker JCT	Jefferson JCT	1140	1390	155.1	13.6	381.2	33.4	428.4	37.6	342.5	30
Z1E	Jefferson JCT	Lauzon TS	1190	1370	144.5	12.1	360.7	30.3	404.9	34	302.5	25.4
Z7E	Essex TS	Walker JCT	1260	1430	527.8	41.9	817	64.8	0	0	0	0
Z7E	Walker JCT	Jefferson JCT	1140	1390	155.1	13.6	371.9	32.6	0	0	0	0
Z7E	Jefferson JCT	Lauzon TS	1190	1370	146	12.3	351.6	29.6	0	0	0	0
Lauzon T1			296.8	364.2	55.7	18.8	127	42.8	64.8	21.8	72.7	24.5
Lauzon T2			296.8	364.2	45.1	15.2	0	0	49.1	16.6	0	0
Keith T11			180.3	224.5	0	0	0	0	25.9	14.4	50.2	27.8
Keith T12			160.3	187.5	138.1	86.2	118.5	74	29.2	18.2	56.6	35.3

* Control Actions shown in brackets

Table 19: Thermal loading under outage contingencies – Scenario S2 (continued)

Circuit/ Xformer	Circuit Section		LTE	STE	** J3E+Z7E- (After 1st outage lower Imports to 0 MW and BB to 335 MW)*		** J3E+C21J- (After 1st outage lower Imports to 0 MW and BB to 335 MW)*		** J3E+C24Z – (After 1st outage lower imports to 0 MW and BB to 260 MW + Arm 27 MW Kingsville & 50 MW Bell River L/R for next contingency)*	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE /MVA
C21J	Keith TS	Malden TS	1020	1100	286.5	28.1	0	0	198.5	19.5
C21J	Malden TS	Sandwich JCT	1020	1100	156.3	15.3	0	0	109.1	10.7
C21J	Sandwich JCT	Leamington TS	1370	1570	151.5	11.1	0	0	101.6	7.4
C21J	Leamington	Chatham SS	1370	1570	118.7	8.7	0	0	164.6	12
C22J	Keith TS	Malden TS	1020	1100	282.9	27.7	519.8	51	194.8	19.1
C22J	Malden TS	Sandwich JCT	1050	1150	152.6	14.5	218.4	20.8	104.6	10
C22J	Sandwich JCT	Leamington TS	1020	1100	147.7	14.5	215.8	21.2	97	9.5
C22J	Leamington	Chatham SS	1020	1100	118.6	11.6	207.5	20.3	163.8	16.1
C23Z	Lauzon TS	Sandwich JCT	1400	1900	338.1	24.2	331.4	23.7	516.7	36.9
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	331.9	23.7	325.1	23.2	511.2	36.5
C23Z	Comber WF	KEPA WF JCT	1400	1840	189.3	13.5	187.2	13.4	338.8	24.2
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	184.1	13.2	182	13	334.7	23.9
C23Z	Dillon RWEC	Chatham SS	1400	1690	243.1	17.4	247.2	17.7	291.5	20.8
C24Z	Lauzon TS	Sandwich JCT	1400	1900	403.4	28.8	396.1	28.3	0	0
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	398.8	38.4	391.5	37.6	0	0
C24Z	Comber WF	KEPA WF JCT	1040	1130	233.8	22.5	229.2	22	0	0
C24Z	KEPA WF JCT	Chatham SS	1020	1100	399.9	39.2	406.4	39.8	0	0
J3E	Keith TS	Crawford JCT	1070	1390	0	0	0	0	0	0
J3E	Crawford JCT	Essex TS	1070	1390	0	0	0	0	0	0
J4E	Keith TS	Crawford JCT	1000	1090	962.5	96.2	932.8	93.3	994.7	99.5
J4E	Crawford JCT	Essex TS	1000	1090	573.3	57.3	548	54.8	607.9	60.8
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	387.9	30.8	60.2	4.8	28.7	2.3
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	725.4	57.6	354.4	28.1	367.2	29.1
Z1E	Walker JCT	Jefferson JCT	1140	1390	247.5	21.7	110.1	9.7	47.1	4.1
Z1E	Jefferson JCT	Lauzon TS	1190	1370	281.3	23.6	125.3	10.5	67.5	5.7
Z7E	Essex TS	Walker JCT	1260	1430	0	0	370.2	29.4	412	32.7
Z7E	Walker JCT	Jefferson JCT	1140	1390	0	0	124.8	10.9	57	5
Z7E	Jefferson JCT	Lauzon TS	1190	1370	0	0	140	11.8	78.2	6.6
Lauzon T1			296.8	364.2	57	19.2	56.1	18.9	39.2	13.2
Lauzon T2			296.8	364.2	63.4	21.4	61.5	20.7	0	0
Keith T11			180.3	224.5	34.6	19.2	32.5	18	37.4	20.7
Keith T12			160.3	187.5	39	24.3	36.6	22.8	42.2	26.3

* Control Actions shown in brackets

Table 20: Thermal loading with all elements in-service for single contingencies – Scenario S3

Circuit/ Xformer	Circuit Section		LTE	STE	C21J		C23Z		J3E		Z7E		Keith A bus	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE
C21J	Keith TS	Malden TS	1020	1100	0	0	479.7	47	382.3	37.5	394.8	38.7	0	0
C21J	Malden TS	Sandwich JCT	1020	1100	0	0	637.8	62.5	539.9	52.9	552.7	54.2	256.8	25.2
C21J	Sandwich JCT	Leamington TS	1370	1570	0	0	637	46.5	539	39.3	551.7	40.3	255.2	18.6
C21J	Leamington	Chatham SS	1370	1570	0	0	685.4	50	587.4	42.9	599.9	43.8	349.7	25.5
C22J	Keith TS	Malden TS	1020	1100	422.8	41.4	470.4	46.1	374.2	36.7	386.5	37.9	616.2	60.4
C22J	Malden TS	Sandwich JCT	1050	1150	726.1	69.1	628.2	59.8	531.8	50.6	544.3	51.8	672.5	64
C22J	Sandwich JCT	Leamington TS	1020	1100	725.9	71.2	627.8	61.5	531.2	52.1	543.6	53.3	672.1	65.9
C22J	Leamington	Chatham SS	1020	1100	826.6	81	676.3	66.3	579.7	56.8	592	58	673.4	66
C23Z	Lauzon TS	Sandwich JCT	1400	1900	619	44.2	0	0	568.1	40.6	545	38.9	567.5	40.5
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	616.7	44.1	0	0	565.5	40.4	542.6	38.8	565.1	40.4
C23Z	Comber WF	KEPA WF JCT	1400	1840	614	43.9	0	0	562.6	40.2	539.8	38.6	562.3	40.2
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	612.6	43.8	0	0	561	40.1	538.3	38.5	560.8	40.1
C23Z	Dillon RWEC	Chatham SS	1400	1690	610.9	43.6	0	0	559.3	39.9	536.6	38.3	559.1	39.9
C24Z	Lauzon TS	Sandwich JCT	1400	1900	611.9	43.7	842.7	60.2	561.9	40.1	539	38.5	561.2	40.1
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	609.8	58.6	840.5	80.8	559.5	53.8	536.8	51.6	559	53.7
C24Z	Comber WF	KEPA WF JCT	1040	1130	607.3	58.4	837.5	80.5	556.8	53.5	534.2	51.4	556.4	53.5
C24Z	KEPA WF JCT	Chatham SS	1020	1100	600.7	58.9	828.2	81.2	549.5	53.9	527.6	51.7	549.7	53.9
J3E	Keith TS	Crawford JCT	1070	1390	334.5	31.3	733.3	68.5	0	0	473.4	44.2	407.8	38.1
J3E	Crawford JCT	Essex TS	1070	1390	111	10.4	516.8	48.3	0	0	252.5	23.6	191.5	17.9
J4E	Keith TS	Crawford JCT	1000	1090	291.3	29.1	699.2	69.9	802.1	80.2	434	43.4	370.5	37
J4E	Crawford JCT	Essex TS	1000	1090	157.9	15.8	548.8	54.9	426.1	42.6	291.1	29.1	226.6	22.7
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	196.6	15.6	271.5	21.6	173.3	13.8	354.1	28.1	167.2	13.3
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	202.1	16	614	48.7	312.4	24.8	696.6	55.3	298.2	23.7
Z1E	Walker JCT	Jefferson JCT	1140	1390	223.5	19.6	208.1	18.3	162.7	14.3	303.5	26.6	167.3	14.7
Z1E	Jefferson JCT	Lauzon TS	1190	1370	243.9	20.5	187.9	15.8	179.6	15.1	333.3	28	184.6	15.5
Z7E	Essex TS	Walker JCT	1260	1430	220.8	17.5	646.8	51.3	316.4	25.1	0	0	301.7	23.9
Z7E	Walker JCT	Jefferson JCT	1140	1390	239	21	199.4	17.5	180.5	15.8	0	0	184.8	16.2
Z7E	Jefferson JCT	Lauzon TS	1190	1370	259.1	21.8	179.9	15.1	197	16.6	0	0	201.8	17
Lauzon T1			296.8	364.2	147.4	49.7	0	0	125.6	42.3	117.9	39.7	127.7	43
Lauzon T2			296.8	364.2	144.4	48.7	124.2	41.8	122.9	41.4	115.4	38.9	125	42.1
Keith T11			180.3	224.5	43.1	23.9	38.7	21.4	22.5	12.5	18	10	0	0
Keith T12			160.3	187.5	48.6	30.3	43.6	27.2	25.4	15.8	20.3	12.7	52.6	32.8

Table 21: Thermal loading with all elements in-service for single contingencies – Scenario S4

Circuit/ Xformer	Circuit Section		LTE	STE	C21J		C23Z		J3E		Z7E		Keith A bus	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE
C21J	Keith TS	Malden TS	1020	1100	0	0	425.7	41.7	340.9	33.4	351.4	34.4	0	0
C21J	Malden TS	Sandwich JCT	1020	1100	0	0	583.4	57.2	498	48.8	509	49.9	247.8	24.3
C21J	Sandwich JCT	Leamington TS	1370	1570	0	0	583	42.6	497.6	36.3	508.5	37.1	246.4	18
C21J	Leamington	Chatham SS	1370	1570	0	0	721.6	52.7	635.9	46.4	647.1	47.2	428.1	31.2
C22J	Keith TS	Malden TS	1020	1100	356.4	34.9	417.7	40.9	334.1	32.8	344.3	33.8	553.4	54.3
C22J	Malden TS	Sandwich JCT	1050	1150	636.8	60.7	574.7	54.7	490.5	46.7	501.3	47.7	620.5	59.1
C22J	Sandwich JCT	Leamington TS	1020	1100	637.6	62.5	574.6	56.3	490.5	48.1	501.1	49.1	620.5	60.8
C22J	Leamington	Chatham SS	1020	1100	917.6	90	712.1	69.8	627.6	61.5	638.6	62.6	714.6	70.1
C23Z	Lauzon TS	Sandwich JCT	1400	1900	579.4	41.4	0	0	525.1	37.5	504.5	36	517.1	36.9
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	576.6	41.2	0	0	521.9	37.3	501.4	35.8	514.1	36.7
C23Z	Comber WF	KEPA WF JCT	1400	1840	573.4	41	0	0	518.2	37	497.8	35.6	510.7	36.5
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	571.8	40.8	0	0	516.4	36.9	496.1	35.4	509	36.4
C23Z	Dillon RWEC	Chatham SS	1400	1690	569.9	40.7	0	0	514.3	36.7	494.1	35.3	507.1	36.2
C24Z	Lauzon TS	Sandwich JCT	1400	1900	573.1	40.9	780.2	55.7	519.9	37.1	499.6	35.7	511.8	36.6
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	570.6	54.9	777.6	74.8	516.9	49.7	496.6	47.8	509	48.9
C24Z	Comber WF	KEPA WF JCT	1040	1130	567.6	54.6	774.3	74.4	513.5	49.4	493.3	47.4	505.9	48.6
C24Z	KEPA WF JCT	Chatham SS	1020	1100	559.4	54.8	763.7	74.9	503.8	49.4	484.2	47.5	497.3	48.8
J3E	Keith TS	Crawford JCT	1070	1390	359.7	33.6	689.4	64.4	0	0	476	44.5	421.4	39.4
J3E	Crawford JCT	Essex TS	1070	1390	170.8	16	463.6	43.3	0	0	254.8	23.8	201.5	18.8
J4E	Keith TS	Crawford JCT	1000	1090	306.5	30.6	647.4	64.7	773.7	77.4	427.7	42.8	373.6	37.4
J4E	Crawford JCT	Essex TS	1000	1090	223.2	22.3	506.2	50.6	391.1	39.1	306	30.6	252.9	25.3
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	212.6	16.9	196.2	15.6	111.8	8.9	326.9	25.9	106.2	8.4
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	151.5	12	548.5	43.5	246.6	19.6	653.9	51.9	244.7	19.4
Z1E	Walker JCT	Jefferson JCT	1140	1390	273.3	24	162.4	14.2	159.9	14	266.2	23.3	157.7	13.8
Z1E	Jefferson JCT	Lauzon TS	1190	1370	293	24.6	145.3	12.2	180.9	15.2	308.1	25.9	177.9	15
Z7E	Essex TS	Walker JCT	1260	1430	254.1	20.2	603.6	47.9	304.1	24.1	0	0	309.5	24.6
Z7E	Walker JCT	Jefferson JCT	1140	1390	281.8	24.7	146.3	12.8	171.7	15.1	0	0	168	14.7
Z7E	Jefferson JCT	Lauzon TS	1190	1370	301.7	25.4	129.3	10.9	192.8	16.2	0	0	188.5	15.8
Lauzon T1			296.8	364.2	129.3	43.6	0	0	106.7	36	99.9	33.7	106	35.7
Lauzon T2			296.8	364.2	126.6	42.7	95.5	32.2	104.4	35.2	97.7	32.9	103.6	34.9
Keith T11			180.3	224.5	58.9	32.7	17.5	9.7	35.5	19.7	30.2	16.8	0	0
Keith T12			160.3	187.5	66.4	41.4	19.8	12.3	40	25	34.1	21.3	77.4	48.3

Table 22: Thermal loading with all elements in-service for double contingencies – Scenario S3

Circuit/ Xformer	Circuit Section		LTE	STE	C21J+C23Z		C21J+C22J		C22J+C24Z		C23Z+C24Z		** Lauzon T1L7 BF: Z7E+C23Z – (Lower TA Windsor to 44 MW post)*	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE
C21J	Keith TS	Malden TS	1020	1100	0	0	0	0	561.8	55.1	641.3	62.9	483.9	47.4
C21J	Malden TS	Sandwich JCT	1020	1100	0	0	0	0	865.2	84.8	799.5	78.4	642.2	63
C21J	Sandwich JCT	Leamington TS	1370	1570	0	0	0	0	865.1	63.1	798.5	58.3	641.5	46.8
C21J	Leamington	Chatham SS	1370	1570	0	0	0	0	966	70.5	846.1	61.8	690.1	50.4
C22J	Keith TS	Malden TS	1020	1100	564	55.3	0	0	0	0	629.7	61.7	474.6	46.5
C22J	Malden TS	Sandwich JCT	1050	1150	864.9	82.4	0	0	0	0	787.7	75	632.6	60.2
C22J	Sandwich JCT	Leamington TS	1020	1100	864.9	84.8	0	0	0	0	787	77.2	632.2	62
C22J	Leamington	Chatham SS	1020	1100	965.8	94.7	0	0	0	0	834.7	81.8	680.9	66.8
C23Z	Lauzon TS	Sandwich JCT	1400	1900	0	0	692.1	49.4	982	70.1	0	0	0	0
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	0	0	689.6	49.3	979.9	70	0	0	0	0
C23Z	Comber WF	KEPA WF JCT	1400	1840	0	0	686.6	49	976.9	69.8	0	0	0	0
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	0	0	685	48.9	975.2	69.7	0	0	0	0
C23Z	Dillon RWEC	Chatham SS	1400	1690	0	0	683.1	48.8	973.1	69.5	0	0	0	0
C24Z	Lauzon TS	Sandwich JCT	1400	1900	968.8	69.2	684.1	48.9	0	0	0	0	880.1	62.9
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	966.8	93	681.8	65.6	0	0	0	0	877.9	84.4
C24Z	Comber WF	KEPA WF JCT	1040	1130	964	92.7	679.1	65.3	0	0	0	0	874.9	84.1
C24Z	KEPA WF JCT	Chatham SS	1020	1100	954.7	93.6	671.2	65.8	0	0	0	0	865.2	84.8
J3E	Keith TS	Crawford JCT	1070	1390	637.1	59.5	227.2	21.2	624.1	58.3	1003.6	93.8	786.9	73.5
J3E	Crawford JCT	Essex TS	1070	1390	414.8	38.8	80	7.5	401.5	37.5	800.8	74.8	566.8	53
J4E	Keith TS	Crawford JCT	1000	1090	599.6	60	174.5	17.5	586.6	58.7	978.4	97.8	751.7	75.2
J4E	Crawford JCT	Essex TS	1000	1090	451.2	45.1	116.3	11.6	438	43.8	823.6	82.4	600.5	60
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	157.3	12.5	316.8	25.1	144.9	11.5	573.3	45.5	1003.3	79.6
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	509.7	40.5	81.7	6.5	495.1	39.3	907.2	72	1253.9	99.5
Z1E	Walker JCT	Jefferson JCT	1140	1390	98.6	8.6	361.8	31.7	85.7	7.5	507.9	44.6	356.8	31.3
Z1E	Jefferson JCT	Lauzon TS	1190	1370	77.3	6.5	382.3	32.1	64.5	5.4	488.6	41.1	316.7	26.6
Z7E	Essex TS	Walker JCT	1260	1430	548.4	43.5	90.2	7.2	539.4	42.8	922.7	73.2	0	0
Z7E	Walker JCT	Jefferson JCT	1140	1390	86.8	7.6	375.6	32.9	73.8	6.5	500.8	43.9	0	0
Z7E	Jefferson JCT	Lauzon TS	1190	1370	65.9	5.5	396	33.3	53.1	4.5	481.9	40.5	0	0
Lauzon T1			296.8	364.2	0	0	179.1	60.3	176.3	59.4	0	0	0	0
Lauzon T2			296.8	364.2	171.5	57.8	175.6	59.2	0	0	0	0	134.9	45.4
Keith T11			180.3	224.5	16	8.9	154.2	85.5	26.9	14.9	96.5	53.5	46.5	25.8
Keith T12			160.3	187.5	18	11.2	0	0	0	0	108.8	67.9	52.4	32.7

* Control Actions shown in brackets

Table 23: Thermal loading with all elements in-service for double contingencies – Scenario S4

Circuit/ Xformer	Circuit Section		LTE	STE	*C21J+C23Z – (Lower exports to 208 MW post)*		C21J+C22J		C22J+C24Z		C23Z+C24Z		Lauzon T1L7 BF: Z7E+C23Z	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE
C21J	Keith TS	Malden TS	1020	1100	0	0	0	0	481.3	47.2	563.9	55.3	424.7	41.6
C21J	Malden TS	Sandwich JCT	1020	1100	0	0	0	0	771	75.6	722	70.8	582.7	57.1
C21J	Sandwich JCT	Leamington TS	1370	1570	0	0	0	0	771.7	56.3	721.2	52.6	582.2	42.5
C21J	Leamington	Chatham SS	1370	1570	0	0	0	0	1053.2	76.9	859.3	62.7	721.1	52.6
C22J	Keith TS	Malden TS	1020	1100	436.7	42.8	0	0	0	0	553.6	54.3	416.7	40.9
C22J	Malden TS	Sandwich JCT	1050	1150	720.8	68.7	0	0	0	0	711.2	67.7	574	54.7
C22J	Sandwich JCT	Leamington TS	1020	1100	721.6	70.7	0	0	0	0	710.8	69.7	573.9	56.3
C22J	Leamington	Chatham SS	1020	1100	1002	98.2	0	0	0	0	847.9	83.1	711.6	69.8
C23Z	Lauzon TS	Sandwich JCT	1400	1900	0	0	640.3	45.7	900.1	64.3	0	0	0	0
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	0	0	637.2	45.5	897.6	64.1	0	0	0	0
C23Z	Comber WF	KEPA WF JCT	1400	1840	0	0	633.6	45.3	894.3	63.9	0	0	0	0
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	0	0	631.8	45.1	892.5	63.7	0	0	0	0
C23Z	Dillon RWEC	Chatham SS	1400	1690	0	0	629.6	45	890.2	63.6	0	0	0	0
C24Z	Lauzon TS	Sandwich JCT	1400	1900	886	63.3	633.3	45.2	0	0	0	0	793.5	56.7
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	883.5	85	630.5	60.6	0	0	0	0	790.7	76
C24Z	Comber WF	KEPA WF JCT	1040	1130	880.3	84.6	627.2	60.3	0	0	0	0	787.1	75.7
C24Z	KEPA WF JCT	Chatham SS	1020	1100	869.6	85.3	617.4	60.5	0	0	0	0	775.6	76
J3E	Keith TS	Crawford JCT	1070	1390	623.1	58.2	290.5	27.2	609.5	57	883.1	82.5	715.7	66.9
J3E	Crawford JCT	Essex TS	1070	1390	396.9	37.1	188.4	17.6	383.4	35.8	662.4	61.9	488.2	45.6
J4E	Keith TS	Crawford JCT	1000	1090	577.8	57.8	235.7	23.6	564	56.4	847.1	84.7	672.1	67.2
J4E	Crawford JCT	Essex TS	1000	1090	443.8	44.4	223.8	22.4	430.6	43.1	697	69.7	532.6	53.3
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	140.7	11.2	338.3	26.8	131	10.4	403.5	32	859.5	68.2
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	471.1	37.4	46.8	3.7	457.2	36.3	760.3	60.3	1202.8	95.5
Z1E	Walker JCT	Jefferson JCT	1140	1390	149.8	13.1	395	34.7	147	12.9	348.8	30.6	284.5	25
Z1E	Jefferson JCT	Lauzon TS	1190	1370	144.4	12.1	415.2	34.9	142.8	12	327.4	27.5	247.1	20.8
Z7E	Essex TS	Walker JCT	1260	1430	547.8	43.5	180.1	14.3	534.9	42.4	803.5	63.8	0	0
Z7E	Walker JCT	Jefferson JCT	1140	1390	135.4	11.9	405	35.5	132.8	11.6	335.9	29.5	0	0
Z7E	Jefferson JCT	Lauzon TS	1190	1370	130.9	11	425.3	35.7	130.5	11	314.6	26.4	0	0
Lauzon T1			296.8	364.2	0	0	157.6	53.1	140.5	47.4	0	0	0	0
Lauzon T2			296.8	364.2	134.9	45.5	154.4	52	0	0	0	0	96.5	32.5
Keith T11			180.3	224.5	7.5	4.2	178.5	99	17.2	9.5	61	33.8	19.3	10.7
Keith T12			160.3	187.5	8.5	5.3	0	0	0	0	68.8	42.9	21.7	13.5

* Control Actions shown in brackets

Table 24: Thermal loading under outage conditions – Scenario S3

Circuit/ Xformer	Circuit Section		LTE	STE	J20B+C21J		J3E+Z7E		Keith A bus + C23Z		** J3E+C23Z –(After 1st outage, Arm 62 MW Kingsville & 50 MW Bell River L/R for next contingency)*	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE
C21J	Keith TS	Malden TS	1020	1100	0	0	383.4	37.6	0	0	442.6	43.4
C21J	Malden TS	Sandwich JCT	1020	1100	0	0	541.2	53.1	277.7	27.2	600.2	58.8
C21J	Sandwich JCT	Leamington TS	1370	1570	0	0	540.3	39.4	276	20.1	599.2	43.7
C21J	Leamington	Chatham SS	1370	1570	0	0	588.7	43	379.9	27.7	647	47.2
C22J	Keith TS	Malden TS	1020	1100	472.2	46.3	375.3	36.8	738.6	72.4	433.6	42.5
C22J	Malden TS	Sandwich JCT	1050	1150	781.4	74.4	533	50.8	775.7	73.9	591.1	56.3
C22J	Sandwich JCT	Leamington TS	1020	1100	781.1	76.6	532.4	52.2	775.5	76	590.4	57.9
C22J	Leamington	Chatham SS	1020	1100	883.2	86.6	581	57	767.8	75.3	638.5	62.6
C23Z	Lauzon TS	Sandwich JCT	1400	1900	641.4	45.8	569.2	40.7	0	0	0	0
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	639.1	45.7	566.5	40.5	0	0	0	0
C23Z	Comber WF	KEPA WF JCT	1400	1840	636.4	45.5	563.4	40.2	0	0	0	0
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	635	45.4	561.8	40.1	0	0	0	0
C23Z	Dillon RWEC	Chatham SS	1400	1690	633.3	45.2	560	40	0	0	0	0
C24Z	Lauzon TS	Sandwich JCT	1400	1900	633.9	45.3	563	40.2	922.5	65.9	753.6	53.8
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	631.9	60.8	560.6	53.9	920.5	88.5	751.3	72.2
C24Z	Comber WF	KEPA WF JCT	1040	1130	629.5	60.5	557.7	53.6	917.6	88.2	748.5	72
C24Z	KEPA WF JCT	Chatham SS	1020	1100	622.8	61.1	550	53.9	908.3	89.1	739.8	72.5
J3E	Keith TS	Crawford JCT	1070	1390	313	29.3	0	0	669.9	62.6	0	0
J3E	Crawford JCT	Essex TS	1070	1390	88.9	8.3	0	0	449.9	42.1	0	0
J4E	Keith TS	Crawford JCT	1000	1090	267.4	26.7	844.2	84.4	633.9	63.4	943	94.3
J4E	Crawford JCT	Essex TS	1000	1090	140.2	14	461.2	46.1	484.4	48.4	576.6	57.7
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	209.1	16.6	295.2	23.4	197.7	15.7	192.3	15.3
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	168.2	13.3	640.2	50.8	546.5	43.4	392.3	31.1
Z1E	Walker JCT	Jefferson JCT	1140	1390	245.1	21.5	355.2	31.2	136.3	12	151.3	13.3
Z1E	Jefferson JCT	Lauzon TS	1190	1370	266	22.4	389	32.7	115.5	9.7	160.4	13.5
Z7E	Essex TS	Walker JCT	1260	1430	204.6	16.2	0	0	580.6	46.1	391.2	31.1
Z7E	Walker JCT	Jefferson JCT	1140	1390	259.3	22.7	0	0	126.4	11.1	167.4	14.7
Z7E	Jefferson JCT	Lauzon TS	1190	1370	280	23.5	0	0	106.3	8.9	177.1	14.9
Lauzon T1			296.8	364.2	154.2	51.9	125.3	42.2	0	0	0	0
Lauzon T2			296.8	364.2	151.1	50.9	122.7	41.3	154.4	52	96.4	32.5
Keith T11			180.3	224.5	49.8	27.6	22.5	12.5	0	0	8.4	4.7
Keith T12			160.3	187.5	56.2	35	25.3	15.8	50.8	31.7	9.5	5.9

* Control Actions shown in brackets

Table 25: Thermal loading under outage conditions – Scenario S4

Circuit/ Xformer	Circuit Section		LTE	STE	J20B+C21J		J3E+Z7E		Keith A bus + C23Z		** J3E+C23Z – (After 1st outage place Lauzon cap I/S +arm 54 MW Kingsville L/R for next contingency)*	
	From	To	A/MVA	A/MVA	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE	A/MVA	%LTE
C21J	Keith TS	Malden TS	1020	1100	0	0	343.4	33.7	0	0	402.5	39.5
C21J	Malden TS	Sandwich JCT	1020	1100	0	0	500.7	49.1	266	26.1	559.5	54.8
C21J	Sandwich JCT	Leamington TS	1370	1570	0	0	500.3	36.5	264.5	19.3	559	40.8
C21J	Leamington	Chatham SS	1370	1570	0	0	638.7	46.6	454.8	33.2	696.8	50.9
C22J	Keith TS	Malden TS	1020	1100	397.2	38.9	336.5	33	661.2	64.8	394.7	38.7
C22J	Malden TS	Sandwich JCT	1050	1150	689.9	65.7	493.1	47	711.2	67.7	551.1	52.5
C22J	Sandwich JCT	Leamington TS	1020	1100	690.5	67.7	493.1	48.3	711.3	69.7	550.9	54
C22J	Leamington	Chatham SS	1020	1100	976.4	95.7	630.4	61.8	797.3	78.2	687.6	67.4
C23Z	Lauzon TS	Sandwich JCT	1400	1900	600.6	42.9	525.6	37.5	0	0	0	0
C23Z	Sandwich JCT	Comber WF JCT	1400	1840	597.9	42.7	522.1	37.3	0	0	0	0
C23Z	Comber WF	KEPA WF JCT	1400	1840	594.8	42.5	518.3	37	0	0	0	0
C23Z	KEPA WF JCT	Dillon RWEC JCT	1400	1690	593.2	42.4	516.4	36.9	0	0	0	0
C23Z	Dillon RWEC	Chatham SS	1400	1690	591.3	42.2	514.2	36.7	0	0	0	0
C24Z	Lauzon TS	Sandwich JCT	1400	1900	594	42.4	520.5	37.2	838.8	59.9	745.8	53.3
C24Z	Sandwich JCT	Comber WF JCT	1040	1130	591.5	56.9	517.3	49.7	836.2	80.4	743.5	71.5
C24Z	Comber WF	KEPA WF JCT	1040	1130	588.7	56.6	513.7	49.4	833	80.1	740.5	71.2
C24Z	KEPA WF JCT	Chatham SS	1020	1100	580.6	56.9	503.3	49.3	822.5	80.6	731.6	71.7
J3E	Keith TS	Crawford JCT	1070	1390	341.4	31.9	0	0	649.3	60.7	0	0
J3E	Crawford JCT	Essex TS	1070	1390	169	15.8	0	0	423	39.5	0	0
J4E	Keith TS	Crawford JCT	1000	1090	287.3	28.7	830	83	605.5	60.6	951.3	95.1
J4E	Crawford JCT	Essex TS	1000	1090	218.4	21.8	452.4	45.2	467.9	46.8	570.9	57.1
Z1E	Essex TS	Windsor Transalta JCT	1260	1430	246	19.5	268	21.3	161.2	12.8	124.2	9.9
Z1E	Windsor Transalta JCT	Walker JCT	1260	1430	143.2	11.4	599.8	47.6	504.2	40	370.7	29.4
Z1E	Walker JCT	Jefferson JCT	1140	1390	308.8	27.1	329	28.9	144.5	12.7	88.6	7.8
Z1E	Jefferson JCT	Lauzon TS	1190	1370	328.3	27.6	372	31.3	133	11.2	102.3	8.6
Z7E	Essex TS	Walker JCT	1260	1430	242.8	19.3	0	0	565.2	44.9	392.1	31.1
Z7E	Walker JCT	Jefferson JCT	1140	1390	316.8	27.8	0	0	128.9	11.3	105.9	9.3
Z7E	Jefferson JCT	Lauzon TS	1190	1370	336.7	28.3	0	0	118.3	9.9	119.8	10.1
Lauzon T1			296.8	364.2	135.9	45.8	106.6	35.9	0	0	0	0
Lauzon T2			296.8	364.2	133.1	44.8	104.3	35.1	117.9	39.7	91	30.7
Keith T11			180.3	224.5	66.2	36.7	33.8	18.7	0	0	9.2	5.1
Keith T12			160.3	187.5	74.7	46.6	38.1	23.8	18.8	11.8	10.4	6.5

* Control Actions shown in brackets

Appendix B Voltage Assessment

Table 26: Voltage assessment results with all elements in-service for single contingencies – Scenario S1

Bus Name	Pre-Cont.	C21J				C23Z				J3E				Z7E				Keith A Bus			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	235.2	233.3	-0.82	233.4	-0.77	234.7	-0.23	234.9	-0.14	235.2	-0.03	235.3	0.01	235.0	-0.11	235.0	-0.10	234.6	-0.26	234.6	-0.25
Malden C21J 230 kV	235.3					234.8	-0.21	235.1	-0.12	235.2	-0.04	235.3	-0.01	235.1	-0.11	235.1	-0.10	240.1	2.04	240.1	2.04
Malden C22J 230 kV	235.4	233.1	-0.98	233.2	-0.92	234.9	-0.21	235.1	-0.12	235.3	-0.04	235.4	0.00	235.1	-0.11	235.1	-0.10	234.6	-0.30	234.7	-0.30
Leamington C21J 230 kV	237.9					237.9	0.01	238.1	0.11	237.6	-0.11	237.7	-0.08	237.7	-0.09	237.7	-0.08	241.0	1.33	241.0	1.33
Leamington C22J 230 kV	237.9	235.6	-1.01	235.7	-0.96	238.0	0.01	238.2	0.11	237.7	-0.11	237.8	-0.08	237.7	-0.09	237.8	-0.08	237.4	-0.24	237.4	-0.24
Lauzon C23Z 230 kV	232.1	232.0	-0.05	232.0	-0.03					230.4	-0.75	230.6	-0.65	231.8	-0.13	231.9	-0.10	231.9	-0.10	231.9	-0.10
Lauzon C24Z 230 kV	231.6	231.5	-0.03	231.5	-0.02	223.3	-3.56	225.7	-2.55	229.8	-0.76	230.1	-0.66	231.3	-0.14	231.3	-0.10	231.4	-0.09	231.4	-0.09
Chatham 230 kV	242.9	243.4	0.18	243.4	0.19	243.7	0.32	244.0	0.44	242.6	-0.15	242.6	-0.12	242.8	-0.05	242.8	-0.04	243.3	0.17	243.3	0.17
Keith 115 kV	124.1	123.7	-0.31	123.7	-0.29	122.9	-0.97	123.2	-0.74	124.0	-0.04	124.2	0.08	123.6	-0.38	123.6	-0.35	123.5	-0.44	123.5	-0.44
Crawford J3E 115 kV	122.6	122.3	-0.30	122.3	-0.28	120.8	-1.47	121.3	-1.11					122.0	-0.56	122.0	-0.51	122.2	-0.38	122.2	-0.38
Crawford J4E 115 kV	122.8	122.5	-0.29	122.5	-0.28	121.0	-1.47	121.4	-1.16	121.5	-1.11	121.8	-0.89	122.2	-0.56	122.2	-0.51	122.4	-0.38	122.4	-0.38
Essex 115 kV	122.0	121.7	-0.25	121.7	-0.24	119.6	-1.96	120.1	-1.52	120.6	-1.11	120.8	-0.96	121.1	-0.73	121.2	-0.67	121.6	-0.31	121.6	-0.31
Windsor Transalta 115 kV	122.0	121.7	-0.25	121.7	-0.24	119.6	-1.96	120.2	-1.52	120.7	-1.10	120.9	-0.95	121.1	-0.74	121.2	-0.69	121.7	-0.30	121.7	-0.30
Walker Z1E 115 kV	122.0	121.7	-0.25	121.7	-0.24	119.5	-2.01	120.1	-1.56	120.6	-1.10	120.8	-0.95	121.0	-0.83	121.0	-0.77	121.6	-0.30	121.6	-0.30
Walker Z7E 115 kV	121.9	121.6	-0.25	121.6	-0.24	119.5	-2.02	120.0	-1.56	120.6	-1.11	120.8	-0.96					121.6	-0.30	121.6	-0.30
Ford Essex Z1E 115 kV	122.5	122.2	-0.23	122.2	-0.21	119.5	-2.40	120.2	-1.87	121.2	-1.02	121.4	-0.88	122.0	-0.37	122.1	-0.32	122.1	-0.27	122.1	-0.27
Ford Essex Z7E 115 kV	122.5	122.2	-0.23	122.2	-0.21	119.5	-2.41	120.2	-1.87	121.2	-1.02	121.4	-0.88					122.1	-0.27	122.1	-0.27
Lauzon 115 kV	122.7	122.4	-0.22	122.5	-0.20	119.5	-2.58	120.2	-2.01	121.5	-0.98	121.7	-0.85	122.5	-0.16	122.6	-0.11	122.4	-0.26	122.4	-0.26
Bell River K2Z 115 kV	122.1	121.8	-0.22	121.8	-0.21	118.9	-2.65	119.6	-2.05	120.9	-1.01	121.0	-0.87	121.9	-0.16	122.0	-0.11	121.8	-0.26	121.8	-0.26
Bell River K6Z 115 kV	120.9	120.6	-0.24	120.6	-0.22	117.5	-2.81	118.3	-2.13	119.6	-1.07	119.8	-0.92	120.7	-0.17	120.8	-0.12	120.6	-0.28	120.6	-0.28
Kingsville K2Z 115 kV	118.9	118.6	-0.21	118.6	-0.20	115.9	-2.52	116.7	-1.84	117.7	-0.96	117.9	-0.83	118.7	-0.16	118.7	-0.11	118.6	-0.25	118.6	-0.25
Kingsville K6Z 115 kV	117.3	117.0	-0.26	117.0	-0.25	113.6	-3.15	114.6	-2.29	115.9	-1.19	116.1	-1.03	117.1	-0.19	117.1	-0.13	116.9	-0.31	116.9	-0.31
Tilbury West 115 kV	119.8	119.5	-0.21	119.5	-0.20	116.7	-2.54	117.5	-1.93	118.6	-0.97	118.8	-0.83	119.6	-0.16	119.6	-0.11	119.5	-0.25	119.5	-0.25
Kent 115 kV	119.9	119.7	-0.21	119.7	-0.20	116.9	-2.54	117.6	-1.93	118.8	-0.97	118.9	-0.83	119.7	-0.16	119.8	-0.11	119.6	-0.25	119.6	-0.25

Table 27: Voltage assessment results with all elements in-service for single contingencies – Scenario S2

Bus Name	Pre-Cont.	C21J				C23Z				J3E				Z7E				Keith A Bus			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	234.2	232.0	-0.94	232.2	-0.84	233.7	-0.23	233.9	-0.13	234.2	0.01	234.3	0.06	234.0	-0.11	234.0	-0.10	233.7	-0.22	233.7	-0.22
Malden C21J 230 kV	234.2					233.7	-0.21	233.9	-0.11	234.2	0.00	234.3	0.04	233.9	-0.11	234.0	-0.10	237.3	1.32	237.3	1.32
Malden C22J 230 kV	234.2	231.4	-1.20	231.7	-1.07	233.7	-0.21	234.0	-0.11	234.2	0.00	234.3	0.04	234.0	-0.11	234.0	-0.10	233.5	-0.30	233.5	-0.30
Leamington C21J 230 kV	235.2					235.2	0.02	235.5	0.13	235.0	-0.09	235.1	-0.05	235.0	-0.10	235.0	-0.09	237.5	0.96	237.5	0.96
Leamington C22J 230 kV	235.2	229.8	-2.31	230.2	-2.12	235.3	0.02	235.5	0.13	235.0	-0.09	235.1	-0.04	235.0	-0.10	235.0	-0.09	234.3	-0.37	234.3	-0.37
Lauzon C23Z 230 kV	229.9	229.6	-0.11	229.7	-0.08					228.0	-0.84	228.3	-0.68	229.2	-0.31	229.3	-0.26	229.6	-0.13	229.6	-0.13
Lauzon C24Z 230 kV	229.5	229.3	-0.09	229.3	-0.06	221.1	-3.65	223.7	-2.53	227.6	-0.84	227.9	-0.69	228.8	-0.31	228.9	-0.26	229.2	-0.11	229.2	-0.11
Chatham 230 kV	241.9	242.1	0.10	242.2	0.13	242.8	0.36	243.1	0.48	241.5	-0.15	241.6	-0.11	241.7	-0.08	241.7	-0.07	242.1	0.08	242.1	0.08
Keith 115 kV	123.8	123.3	-0.36	123.4	-0.32	122.5	-1.01	122.8	-0.77	123.9	0.14	124.1	0.27	123.4	-0.34	123.4	-0.30	123.3	-0.40	123.3	-0.39
Crawford J3E 115 kV	121.9	121.5	-0.34	121.6	-0.30	120.1	-1.52	120.5	-1.17					121.3	-0.49	121.4	-0.44	121.5	-0.36	121.5	-0.36
Crawford J4E 115 kV	122.1	121.7	-0.34	121.8	-0.30	120.3	-1.52	120.7	-1.17	120.8	-1.11	121.1	-0.85	121.5	-0.49	121.6	-0.43	121.7	-0.36	121.7	-0.36
Essex 115 kV	120.9	120.5	-0.30	120.6	-0.26	118.4	-2.02	119.0	-1.57	119.3	-1.32	119.5	-1.11	120.1	-0.65	120.2	-0.57	120.5	-0.31	120.5	-0.30
Windsor Transalta 115 kV	120.9	120.6	-0.30	120.6	-0.26	118.5	-2.02	119.0	-1.58	119.3	-1.30	119.6	-1.10	120.1	-0.67	120.2	-0.59	120.6	-0.30	120.6	-0.30
Walker Z1E 115 kV	120.8	120.5	-0.30	120.5	-0.26	118.3	-2.08	118.9	-1.62	119.3	-1.30	119.5	-1.10	119.9	-0.78	120.0	-0.70	120.5	-0.30	120.5	-0.30
Walker Z7E 115 kV	120.8	120.4	-0.30	120.5	-0.26	118.3	-2.08	118.8	-1.62	119.2	-1.30	119.5	-1.10					120.4	-0.30	120.4	-0.30
Ford Essex Z1E 115 kV	121.0	120.7	-0.28	120.7	-0.24	118.0	-2.49	118.6	-1.95	119.6	-1.19	119.8	-0.99	120.4	-0.53	120.4	-0.46	120.7	-0.28	120.7	-0.28
Ford Essex Z7E 115 kV	121.0	120.6	-0.28	120.7	-0.24	118.0	-2.49	118.6	-1.95	119.5	-1.19	119.8	-0.99					120.6	-0.28	120.6	-0.28
Lauzon 115 kV	121.1	120.8	-0.27	120.8	-0.24	117.8	-2.68	118.5	-2.10	119.7	-1.14	119.9	-0.95	120.6	-0.42	120.7	-0.36	120.8	-0.27	120.8	-0.27
Bell River K2Z 115 kV	120.5	120.2	-0.28	120.2	-0.24	117.2	-2.74	117.9	-2.12	119.1	-1.17	119.3	-0.96	120.0	-0.43	120.1	-0.36	120.2	-0.28	120.2	-0.28
Bell River K6Z 115 kV	119.4	119.1	-0.28	119.1	-0.25	116.1	-2.81	116.8	-2.17	118.0	-1.20	118.3	-0.98	118.9	-0.44	119.0	-0.37	119.1	-0.28	119.1	-0.28
Kingsville K2Z 115 kV	118.6	118.3	-0.23	118.3	-0.20	115.9	-2.26	116.5	-1.78	117.4	-0.97	117.6	-0.80	118.2	-0.35	118.2	-0.30	118.3	-0.23	118.3	-0.23
Kingsville K6Z 115 kV	116.9	116.6	-0.29	116.7	-0.25	113.6	-2.88	114.3	-2.23	115.5	-1.23	115.8	-1.00	116.4	-0.45	116.5	-0.38	116.6	-0.29	116.6	-0.29
Tilbury West 115 kV	118.7	118.4	-0.25	118.5	-0.22	115.8	-2.49	116.4	-1.95	117.5	-1.06	117.7	-0.88	118.3	-0.39	118.3	-0.33	118.4	-0.25	118.4	-0.25
Kent 115 kV	118.9	118.6	-0.25	118.6	-0.22	115.9	-2.49	116.6	-1.95	117.6	-1.06	117.8	-0.88	118.4	-0.39	118.5	-0.33	118.6	-0.25	118.6	-0.25

Table 28: Voltage assessment results with all elements in-service for double contingencies – Scenario S1

Bus Name	Pre-Cont.	C21J+C23Z				C22J+C24Z				C23Z+C24Z				J3E +J4E				* Z1E+Z7E – (Kingsville capacitor switching with four caps. out)			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	235.2	232.6	-1.12	233.0	-0.95	232.9	-0.98	233.2	-0.85	235.6	0.15	235.6	0.15	235.4	0.05	235.4	0.06	234.9	-0.15	234.9	-0.15
Malden C21J 230 kV	235.3					232.6	-1.14	233.0	-1.00	235.8	0.20	235.8	0.21	235.2	-0.06	235.2	-0.05	234.9	-0.19	234.9	-0.19
Malden C22J 230 kV	235.4	232.4	-1.26	232.8	-1.07					235.8	0.21	235.9	0.21	235.2	-0.05	235.3	-0.04	234.9	-0.18	234.9	-0.18
Leamington C21J 230 kV	237.9					235.6	-0.95	235.9	-0.81	239.7	0.79	239.7	0.78	236.3	-0.66	236.4	-0.64	237.0	-0.38	237.0	-0.38
Leamington C22J 230 kV	237.9	235.5	-1.02	235.9	-0.85					239.8	0.80	239.8	0.79	236.5	-0.62	236.5	-0.59	237.1	-0.35	237.1	-0.36
Lauzon C23Z 230 kV	232.1					223.4	-3.74	225.9	-2.68					226.4	-2.46	226.8	-2.26	230.1	-0.85	229.8	-0.97
Lauzon C24Z 230 kV	231.6	223.3	-3.57	225.7	-2.54									225.6	-2.58	226.1	-2.39	234.2	1.12	234.2	1.14
Chatham 230 kV	242.9	244.4	0.59	244.7	0.73	244.7	0.75	245.1	0.88	247.1	1.71	247.0	1.69	241.2	-0.69	241.3	-0.65	242.5	-0.18	242.5	-0.18
Keith 115 kV	124.1	122.4	-1.34	122.7	-1.07	121.8	-1.82	122.2	-1.53	123.1	-0.78	123.2	-0.74	125.5	1.16	125.5	1.16	123.7	-0.34	123.7	-0.34
Crawford J3E 115 kV	122.6	120.4	-1.83	120.9	-1.45	119.9	-2.21	120.4	-1.82	121.1	-1.23	121.2	-1.16					122.4	-0.20	122.4	-0.19
Crawford J4E 115 kV	122.8	120.6	-1.82	121.1	-1.45	120.1	-2.21	120.6	-1.82	121.3	-1.22	121.4	-1.16					122.6	-0.20	122.6	-0.19
Essex 115 kV	122.0	119.2	-2.27	119.8	-1.80	118.9	-2.56	119.5	-2.07	119.9	-1.68	120.0	-1.59	118.7	-2.68	119.0	-2.48	121.9	-0.11	121.9	-0.10
Windsor Transalta 115 kV	122.0	119.3	-2.27	119.8	-1.81	118.9	-2.56	119.5	-2.06	120.0	-1.69	120.1	-1.60	118.8	-2.66	119.0	-2.46				
Walker Z1E 115 kV	122.0	119.1	-2.33	119.7	-1.85	118.8	-2.61	119.4	-2.10	119.9	-1.74	120.0	-1.65	118.7	-2.66	119.0	-2.46				
Walker Z7E 115 kV	121.9	119.1	-2.33	119.7	-1.85	118.7	-2.61	119.4	-2.11	119.8	-1.74	119.9	-1.65	118.7	-2.67	118.9	-2.47				
Ford Essex Z1E 115 kV	122.5	119.2	-2.70	119.8	-2.15	118.9	-2.95	119.6	-2.36	119.9	-2.12	120.0	-2.01	119.4	-2.54	119.6	-2.33				
Ford Essex Z7E 115 kV	122.5	119.2	-2.71	119.8	-2.15	118.9	-2.95	119.6	-2.36	119.9	-2.12	120.0	-2.01	119.3	-2.54	119.6	-2.34				
Lauzon 115 kV	122.7	119.2	-2.87	119.9	-2.28	118.9	-3.09	119.7	-2.47	119.9	-2.29	120.0	-2.17	119.7	-2.49	119.9	-2.28	125.9	2.64	126.0	2.70
Bell River K2Z 115 kV	122.1	118.5	-2.95	119.3	-2.32	118.2	-3.18	119.0	-2.52	119.2	-2.35	119.4	-2.22	119.0	-2.56	119.3	-2.32	124.8	2.20	124.8	2.23
Bell River K6Z 115 kV	120.9	117.1	-3.13	118.0	-2.42	116.8	-3.38	117.7	-2.64	117.9	-2.49	118.1	-2.31	117.6	-2.72	118.0	-2.42	118.0	-2.37	117.7	-2.68
Kingsville K2Z 115 kV	118.9	115.5	-2.81	116.4	-2.11	115.3	-3.03	116.1	-2.30	116.2	-2.24	116.5	-2.01	116.0	-2.44	116.4	-2.11	115.9	-2.46	116.3	-2.14
Kingsville K6Z 115 kV	117.3	113.2	-3.51	114.2	-2.61	112.9	-3.78	113.9	-2.86	114.0	-2.79	114.4	-2.49	113.7	-3.04	114.2	-2.62	110.8	-5.55	110.1	-6.11
Tilbury West 115 kV	119.8	116.4	-2.84	117.1	-2.20	116.1	-3.06	116.9	-2.39	117.1	-2.26	117.3	-2.10	116.8	-2.46	117.1	-2.20	120.3	0.45	120.5	0.62
Kent 115 kV	119.9	116.5	-2.83	117.3	-2.19	116.3	-3.05	117.1	-2.39	117.2	-2.26	117.4	-2.09	117.0	-2.46	117.3	-2.19	120.5	0.45	120.7	0.62

* Control Actions shown in brackets

Table 28: Voltage assessment results with all elements in-service for double contingencies – Scenario S1 (continued)

Bus Name	Pre-Cont.	Chatham 230 DL23 BF: C23Z + Chatham D Bus				Chatham 230 DL21 BF: C21J + Chatham D Bus				Lauzon T2K BF: C24Z + Lauzon cap				Lauzon T1L7 BF: Z7E+C23Z			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	235.2	233.3	-0.83	233.6	-0.71	232.4	-1.21	232.6	-1.10	234.0	-0.54	234.3	-0.39	234.4	-0.37	234.7	-0.24
Malden C21J 230 kV	235.3	233.3	-0.88	233.5	-0.76					234.1	-0.51	234.5	-0.37	234.5	-0.34	234.8	-0.22
Malden C22J 230 kV	235.4	233.3	-0.88	233.6	-0.76	231.9	-1.46	232.2	-1.33	234.2	-0.51	234.5	-0.37	234.6	-0.34	234.8	-0.22
Leamington C21J 230 kV	237.9	234.8	-1.30	235.1	-1.16					237.3	-0.24	237.7	-0.07	237.6	-0.12	237.9	0.02
Leamington C22J 230 kV	237.9	234.9	-1.30	235.2	-1.16	232.7	-2.19	233.1	-2.04	237.4	-0.24	237.8	-0.07	237.7	-0.12	238.0	0.02
Lauzon C23Z 230 kV	232.1					229.3	-1.19	229.7	-1.02	220.2	-5.12	223.5	-3.69				
Lauzon C24Z 230 kV	231.6	220.7	-4.71	223.7	-3.41	229.0	-1.12	229.3	-0.99					221.7	-4.25	224.8	-2.93
Chatham 230 kV	242.9	238.6	-1.78	239.0	-1.62	238.4	-1.88	238.7	-1.73	243.3	0.16	243.8	0.36	243.5	0.22	243.8	0.38
Keith 115 kV	124.1	122.3	-1.39	122.7	-1.08	123.2	-0.71	123.3	-0.63	121.8	-1.80	122.3	-1.44	122.4	-1.39	122.7	-1.07
Crawford J3E 115 kV	122.6	120.2	-1.97	120.8	-1.52	121.7	-0.80	121.8	-0.72	119.3	-2.69	120.0	-2.18	120.1	-2.08	120.7	-1.62
Crawford J4E 115 kV	122.8	120.4	-1.96	121.0	-1.52	121.9	-0.80	122.0	-0.72	119.5	-2.69	120.2	-2.17	120.3	-2.08	120.9	-1.62
Essex 115 kV	122.0	118.9	-2.52	119.6	-1.94	120.9	-0.87	121.0	-0.78	117.7	-3.55	118.5	-2.88	118.6	-2.76	119.4	-2.16
Windsor Transalta 115 kV	122.0	118.9	-2.52	119.7	-1.94	121.0	-0.87	121.1	-0.78	117.7	-3.55	118.5	-2.89	118.6	-2.79	119.4	-2.18
Walker Z1E 115 kV	122.0	118.8	-2.59	119.6	-1.99	120.9	-0.89	121.0	-0.79	117.5	-3.65	118.4	-2.96	118.4	-2.97	119.1	-2.34
Walker Z7E 115 kV	121.9	118.8	-2.59	119.5	-2.00	120.9	-0.89	121.0	-0.80	117.5	-3.66	118.3	-2.98				
Ford Essex Z1E 115 kV	122.5	118.7	-3.05	119.6	-2.35	121.3	-0.97	121.4	-0.86	117.2	-4.35	118.1	-3.54	118.4	-3.29	119.4	-2.48
Ford Essex Z7E 115 kV	122.5	118.7	-3.05	119.6	-2.35	121.3	-0.97	121.4	-0.86	117.1	-4.35	118.1	-3.54				
Lauzon 115 kV	122.7	118.7	-3.26	119.6	-2.51	121.5	-1.00	121.6	-0.89	117.0	-4.65	118.1	-3.79	118.5	-3.43	119.6	-2.53
Bell River K2Z 115 kV	122.1	118.0	-3.35	119.0	-2.55	120.8	-1.03	121.0	-0.91	116.3	-4.79	117.4	-3.85	117.8	-3.53	119.0	-2.58
Bell River K6Z 115 kV	120.9	116.6	-3.56	117.7	-2.62	119.6	-1.09	119.7	-0.97	114.8	-5.09	116.0	-4.04	116.4	-3.75	117.7	-2.65
Kingsville K2Z 115 kV	118.9	115.1	-3.19	116.2	-2.21	117.7	-0.98	117.8	-0.87	113.4	-4.58	115.0	-3.23	114.9	-3.36	116.2	-2.24
Kingsville K6Z 115 kV	117.3	112.6	-3.98	114.1	-2.74	115.9	-1.22	116.0	-1.08	110.6	-5.72	112.1	-4.44	112.4	-4.20	114.0	-2.77
Tilbury West 115 kV	119.8	115.9	-3.22	116.9	-2.37	118.6	-0.99	118.7	-0.88	114.3	-4.61	115.5	-3.54	115.7	-3.39	116.9	-2.40
Kent 115 kV	119.9	116.1	-3.22	117.1	-2.37	118.7	-0.99	118.9	-0.88	114.4	-4.60	115.7	-3.54	115.9	-3.39	117.1	-2.39

Table 29: Voltage assessment results with all elements in-service for double contingencies – Scenario S2

Bus Name	Pre-Cont.	C21J+C23Z				C22J+C24Z				C23Z+C24Z				J3E +J4E				Z1E+Z7E			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	234.2	231.3	-1.25	231.7	-1.05	231.6	-1.13	232.0	-0.93	234.5	0.11	234.5	0.11	234.8	0.27	234.9	0.29	234.5	0.11	234.5	0.11
Malden C21J 230 kV	234.2					230.9	-1.38	231.5	-1.15	234.6	0.16	234.6	0.16	234.6	0.16	234.6	0.18	234.3	0.07	234.3	0.07
Malden C22J 230 kV	234.2	230.7	-1.48	231.3	-1.26					234.6	0.16	234.6	0.17	234.6	0.17	234.7	0.19	234.4	0.08	234.4	0.08
Leamington C21J 230 kV	235.2					230.0	-2.23	230.7	-1.90	237.0	0.77	237.0	0.76	234.1	-0.47	234.2	-0.44	235.0	-0.07	235.0	-0.07
Leamington C22J 230 kV	235.2	229.7	-2.34	230.5	-2.02					237.1	0.79	237.0	0.78	234.2	-0.43	234.3	-0.40	235.1	-0.05	235.1	-0.04
Lauzon C23Z 230 kV	229.9					220.9	-3.92	223.7	-2.70					223.5	-2.80	224.0	-2.55	232.9	1.29	232.9	1.29
Lauzon C24Z 230 kV	229.5	220.9	-3.76	223.5	-2.59									222.9	-2.89	223.4	-2.65	231.9	1.03	231.9	1.03
Chatham 230 kV	241.9	243.2	0.54	243.6	0.71	243.6	0.70	244.1	0.89	246.2	1.77	246.1	1.75	240.4	-0.63	240.5	-0.58	242.2	0.11	242.2	0.11
Keith 115 kV	123.8	122.0	-1.43	122.4	-1.15	121.5	-1.85	121.9	-1.53	122.6	-0.96	122.6	-0.93	126.2	1.94	126.2	1.95	124.2	0.37	124.2	0.38
Crawford J3E 115 kV	121.9	119.6	-1.92	120.1	-1.53	119.2	-2.28	119.7	-1.85	120.2	-1.45	120.2	-1.40					122.9	0.81	122.9	0.82
Crawford J4E 115 kV	122.1	119.8	-1.92	120.3	-1.53	119.4	-2.27	119.9	-1.85	120.4	-1.45	120.4	-1.40					123.1	0.81	123.1	0.82
Essex 115 kV	120.9	118.0	-2.39	118.6	-1.90	117.7	-2.66	118.3	-2.13	118.5	-1.96	118.6	-1.90	116.4	-3.67	116.7	-3.44	122.4	1.21	122.4	1.22
Windsor Transalta 115 kV	120.9	118.0	-2.39	118.6	-1.90	117.7	-2.66	118.3	-2.13	118.5	-1.96	118.6	-1.91	116.5	-3.64	116.8	-3.40				
Walker Z1E 115 kV	120.8	117.9	-2.45	118.5	-1.95	117.6	-2.72	118.2	-2.17	118.4	-2.02	118.5	-1.96	116.4	-3.64	116.7	-3.40				
Walker Z7E 115 kV	120.8	117.8	-2.45	118.4	-1.96	117.5	-2.72	118.1	-2.18	118.3	-2.03	118.4	-1.97	116.4	-3.65	116.7	-3.41				
Ford Essex Z1E 115 kV	121.0	117.5	-2.85	118.2	-2.27	117.3	-3.09	118.0	-2.46	118.0	-2.46	118.1	-2.40	116.9	-3.38	117.2	-3.13				
Ford Essex Z7E 115 kV	121.0	117.5	-2.85	118.2	-2.28	117.2	-3.09	118.0	-2.47	118.0	-2.46	118.1	-2.40	116.9	-3.38	117.2	-3.14				
Lauzon 115 kV	121.1	117.4	-3.03	118.2	-2.42	117.1	-3.26	117.9	-2.59	117.9	-2.66	117.9	-2.59	117.1	-3.26	117.4	-3.01	123.3	1.79	123.3	1.79
Bell River K2Z 115 kV	120.5	116.8	-3.10	117.5	-2.45	116.5	-3.34	117.3	-2.62	117.2	-2.72	117.3	-2.63	116.5	-3.34	116.8	-3.05	122.7	1.86	122.7	1.86
Bell River K6Z 115 kV	119.4	115.6	-3.19	116.4	-2.57	115.3	-3.42	116.2	-2.69	116.1	-2.79	116.2	-2.69	115.3	-3.43	115.6	-3.18	122.1	2.23	122.1	2.23
Kingsville K2Z 115 kV	118.6	115.5	-2.57	116.3	-1.91	115.3	-2.76	116.0	-2.19	115.9	-2.25	116.0	-2.20	115.3	-2.76	115.7	-2.41	120.4	1.54	120.4	1.55
Kingsville K6Z 115 kV	116.9	113.1	-3.27	113.7	-2.75	112.8	-3.51	113.7	-2.76	113.6	-2.86	113.7	-2.76	112.8	-3.51	113.0	-3.38	119.6	2.26	119.6	2.27
Tilbury West 115 kV	118.7	115.4	-2.82	116.1	-2.19	115.1	-3.03	115.9	-2.41	115.8	-2.47	115.9	-2.41	115.1	-3.03	115.5	-2.74	120.7	1.68	120.7	1.68
Kent 115 kV	118.9	115.5	-2.82	116.3	-2.19	115.3	-3.03	116.0	-2.41	116.0	-2.47	116.0	-2.41	115.3	-3.03	115.6	-2.74	120.9	1.68	120.9	1.68

Table 29: Voltage assessment results with all elements in-service for double contingencies – Scenario S2 (continued)

Bus Name	Pre-Cont.	Chatham 230 DL23 BF: C23Z + Chatham D Bus				Chatham 230 DL21 BF: C21J + Chatham D Bus				Lauzon T1L7 BF: Z7E+C23Z			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	234.2	232.2	-0.84	232.6	-0.69	231.1	-1.34	231.5	-1.17	233.4	-0.36	233.7	-0.22
Malden C21J 230 kV	234.2	232.1	-0.89	232.4	-0.74					233.4	-0.34	233.7	-0.20
Malden C22J 230 kV	234.2	232.1	-0.89	232.5	-0.74	230.3	-1.68	230.8	-1.47	233.4	-0.34	233.7	-0.20
Leamington C21J 230 kV	235.2	232.1	-1.34	232.5	-1.15					234.9	-0.12	235.3	0.04
Leamington C22J 230 kV	235.2	232.1	-1.33	232.5	-1.15	226.8	-3.56	227.8	-3.16	235.0	-0.11	235.3	0.05
Lauzon C23Z 230 kV	229.9					227.0	-1.25	227.9	-0.88				
Lauzon C24Z 230 kV	229.5	218.3	-4.86	221.7	-3.39	226.8	-1.17	227.4	-0.89	219.0	-4.56	222.6	-3.01
Chatham 230 kV	241.9	237.6	-1.77	238.1	-1.57	237.1	-1.97	237.9	-1.66	242.5	0.24	242.9	0.42
Keith 115 kV	123.8	122.0	-1.43	122.4	-1.11	122.8	-0.75	123.0	-0.61	122.1	-1.39	122.5	-1.05
Crawford J3E 115 kV	121.9	119.5	-2.02	120.0	-1.56	120.9	-0.84	121.1	-0.67	119.4	-2.07	120.0	-1.57
Crawford J4E 115 kV	122.1	119.7	-2.01	120.2	-1.55	121.1	-0.84	121.3	-0.67	119.6	-2.07	120.2	-1.57
Essex 115 kV	120.9	117.8	-2.59	118.5	-2.00	119.8	-0.90	120.0	-0.71	117.6	-2.74	118.4	-2.10
Windsor Transalta 115 kV	120.9	117.8	-2.59	118.5	-2.00	119.8	-0.90	120.1	-0.71	117.6	-2.79	118.3	-2.13
Walker Z1E 115 kV	120.8	117.6	-2.66	118.4	-2.05	119.7	-0.91	120.0	-0.71	117.2	-3.00	118.0	-2.32
Walker Z7E 115 kV	120.8	117.6	-2.66	118.3	-2.06	119.7	-0.92	119.9	-0.72				
Ford Essex Z1E 115 kV	121.0	117.2	-3.15	118.1	-2.43	119.8	-0.99	120.1	-0.77	116.7	-3.58	117.7	-2.71
Ford Essex Z7E 115 kV	121.0	117.2	-3.15	118.0	-2.43	119.8	-1.00	120.1	-0.77				
Lauzon 115 kV	121.1	117.0	-3.36	117.9	-2.60	119.8	-1.03	120.1	-0.79	116.4	-3.83	117.6	-2.88
Bell River K2Z 115 kV	120.5	116.4	-3.44	117.3	-2.62	119.2	-1.05	119.5	-0.80	115.8	-3.92	117.0	-2.90
Bell River K6Z 115 kV	119.4	115.2	-3.53	116.2	-2.68	118.1	-1.08	118.4	-0.82	114.6	-4.03	115.9	-2.96
Kingsville K2Z 115 kV	118.6	115.2	-2.85	116.0	-2.20	117.5	-0.87	117.8	-0.67	114.7	-3.24	115.7	-2.43
Kingsville K6Z 115 kV	116.9	112.7	-3.62	113.7	-2.75	115.7	-1.11	116.0	-0.83	112.1	-4.13	113.4	-3.02
Tilbury West 115 kV	118.7	115.0	-3.13	115.9	-2.42	117.6	-0.96	117.9	-0.74	114.5	-3.57	115.6	-2.68
Kent 115 kV	118.9	115.2	-3.13	116.0	-2.41	117.8	-0.96	118.0	-0.74	114.7	-3.56	115.7	-2.67

Table 30: Voltage assessment results under outage conditions – Scenario S1

Bus Name	KEITH A Bus O/S	KEITH A Bus + C23Z				KEITH A Bus + Keith H Bus				J3E O/S	J3E + C24Z				C21J Chatham end open	C21J Chatham end open + Keith C21J IBO			
	Pre-Cont.	Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-Cont.	Pre-ULTC		Post-ULTC		Pre-Cont.	Post-ULTC		Pre-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	234.6	234.2	-0.20	234.3	-0.13					235.3	234.5	-0.31	235.0	-0.12	234.3	234.0	-0.15	234.0	-0.15
Malden C21J 230 kV	240.1	240.8	0.26	241.1	0.39	231.2	-3.71	232.9	-2.99	235.3	234.6	-0.29	235.1	-0.10	234.2	234.0	-0.09	234.0	-0.07
Malden C22J 230 kV	234.7	234.2	-0.18	234.4	-0.10					235.4	234.7	-0.29	235.1	-0.10	234.5	233.9	-0.25	233.9	-0.25
Leamington C21J 230 kV	241.0	241.8	0.30	242.1	0.42	235.1	-2.45	236.2	-2.00	237.7	237.6	-0.05	238.1	0.17	234.2	234.6	0.15	234.6	0.17
Leamington C22J 230 kV	237.4	237.5	0.05	237.7	0.16					237.8	237.7	-0.04	238.2	0.17	237.4	236.4	-0.42	236.4	-0.42
Lauzon C23Z 230 kV	231.9					231.5	-0.17	231.6	-0.13	230.6	220.2	-4.51	224.3	-2.74	232.3	232.2	-0.06	232.2	-0.06
Lauzon C24Z 230 kV	231.4	222.8	-3.69	225.4	-2.59	230.8	-0.24	230.9	-0.20	230.1					231.8	231.7	-0.05	231.7	-0.05
Chatham 230 kV	243.3	244.3	0.39	244.6	0.52	243.9	0.24	244.1	0.32	242.6	243.4	0.31	244.0	0.55	243.7	243.5	-0.05	243.5	-0.05
Keith 115 kV	123.5	122.1	-1.19	122.4	-0.91	122.9	-0.54	122.9	-0.53	124.2	122.8	-1.11	123.4	-0.62	123.9	123.8	-0.07	123.8	-0.07
Crawford J3E 115 kV	122.2	120.1	-1.69	120.6	-1.29	121.7	-0.35	121.8	-0.33						122.5	122.4	-0.07	122.4	-0.07
Crawford J4E 115 kV	122.4	120.3	-1.68	120.8	-1.29	121.9	-0.35	122.0	-0.33	121.8	119.0	-2.26	120.1	-1.32	122.7	122.6	-0.07	122.6	-0.07
Essex 115 kV	121.6	119.0	-2.16	119.6	-1.67	121.4	-0.18	121.4	-0.16	120.8	117.1	-3.07	118.5	-1.95	121.9	121.8	-0.07	121.8	-0.07
Windsor Transalta 115 kV	121.7	119.0	-2.16	119.6	-1.67	121.4	-0.18	121.5	-0.15	120.9	117.2	-3.07	118.5	-1.95	121.9	121.8	-0.07	121.8	-0.07
Walker Z1E 115 kV	121.6	118.9	-2.22	119.5	-1.71	121.4	-0.17	121.4	-0.15	120.8	117.0	-3.13	118.4	-1.99	121.9	121.8	-0.07	121.8	-0.07
Walker Z7E 115 kV	121.6	118.9	-2.22	119.5	-1.72	121.3	-0.18	121.4	-0.15	120.8	117.0	-3.13	118.4	-1.99	121.8	121.7	-0.07	121.7	-0.07
Ford Essex Z1E 115 kV	122.1	118.9	-2.62	119.7	-2.03	122.0	-0.13	122.0	-0.10	121.4	117.1	-3.52	118.6	-2.27	122.4	122.3	-0.07	122.3	-0.07
Ford Essex Z7E 115 kV	122.1	118.9	-2.62	119.7	-2.03	122.0	-0.13	122.0	-0.10	121.4	117.1	-3.52	118.6	-2.27	122.4	122.3	-0.07	122.3	-0.07
Lauzon 115 kV	122.4	119.0	-2.80	119.7	-2.17	122.3	-0.11	122.3	-0.08	121.7	117.2	-3.69	118.8	-2.40	122.6	122.5	-0.07	122.5	-0.07
Bell River K2Z 115 kV	121.8	118.3	-2.88	119.1	-2.21	121.6	-0.11	121.7	-0.08	121.0	116.4	-3.80	118.1	-2.43	122.0	121.9	-0.07	121.9	-0.07
Bell River K6Z 115 kV	120.6	116.9	-3.05	117.8	-2.31	120.4	-0.12	120.5	-0.08	119.8	114.9	-4.05	116.8	-2.53	120.8	120.7	-0.08	120.7	-0.08
Kingsville K2Z 115 kV	118.6	115.3	-2.74	116.2	-2.00	118.5	-0.10	118.5	-0.07	117.9	113.6	-3.64	115.7	-1.86	118.8	118.7	-0.07	118.7	-0.07
Kingsville K6Z 115 kV	116.9	112.9	-3.42	114.0	-2.49	116.8	-0.13	116.8	-0.09	116.1	110.8	-4.55	112.9	-2.74	117.2	117.1	-0.09	117.1	-0.09
Tilbury West 115 kV	119.5	116.2	-2.76	117.0	-2.09	119.3	-0.11	119.4	-0.07	118.8	114.4	-3.66	116.2	-2.16	119.7	119.6	-0.07	119.6	-0.07
Kent 115 kV	119.6	116.3	-2.76	117.1	-2.09	119.5	-0.11	119.5	-0.07	118.9	114.6	-3.66	116.4	-2.16	119.9	119.8	-0.07	119.8	-0.07

Table 31: Voltage assessment results under outage conditions – Scenario S2

Bus Name	KEITH A Bus O/S	KEITH A Bus + C23Z				KEITH A Bus + Keith H Bus				J3E O/S	J3E + C24Z				C21J Chatham end open	C21J Chatham end open + Keith C21J IBO			
	Pre-Cont.	Pre-ULTC		Post-ULTC		* Pre-ULTC		Post-ULTC		Pre-Cont.	Pre-ULTC		Post-ULTC		Pre-Cont.	Post-ULTC		Pre-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	233.7	233.2	-0.20	233.4	-0.12					234.3	233.5	-0.34	234.1	-0.11	233.1	232.4	-0.29	232.6	-0.21
Malden C21J 230 kV	237.3	238.0	0.29	238.3	0.42	227.1	-4.30	224.3	-5.47	234.3	233.5	-0.32	234.1	-0.09	232.7	223.8	-3.85	225.7	-3.01
Malden C22J 230 kV	233.5	233.1	-0.18	233.3	-0.10					234.3	233.6	-0.32	234.1	-0.09	233.1	231.9	-0.51	232.2	-0.41
Leamington C21J 230 kV	237.5	238.2	0.33	238.6	0.46	228.8	-3.65	226.1	-4.80	235.1	234.9	-0.09	235.5	0.18	230.5	223.4	-3.12	225.2	-2.31
Leamington C22J 230 kV	234.3	234.5	0.05	234.7	0.16					235.1	234.9	-0.09	235.6	0.19	234.6	231.7	-1.22	232.1	-1.05
Lauzon C23Z 230 kV	229.6					229.3	-0.13	229.1	-0.21	228.3	217.0	-4.96	221.9	-2.83	230.2	229.8	-0.14	229.9	-0.11
Lauzon C24Z 230 kV	229.2	220.6	-3.77	223.2	-2.63	228.8	-0.19	228.6	-0.26	227.9					229.8	229.5	-0.13	229.5	-0.10
Chatham 230 kV	242.1	243.1	0.42	243.4	0.55	242.4	0.13	241.9	-0.10	241.6	242.3	0.29	243.1	0.60	242.8	242.4	-0.17	242.5	-0.14
Keith 115 kV	123.3	121.8	-1.22	122.1	-0.95	122.7	-0.50	122.6	-0.52	124.1	122.6	-1.24	123.3	-0.65	123.6	123.4	-0.14	123.5	-0.10
Crawford J3E 115 kV	121.5	119.4	-1.72	119.9	-1.35	121.1	-0.34	121.1	-0.36						121.8	121.6	-0.14	121.7	-0.11
Crawford J4E 115 kV	121.7	119.6	-1.72	120.1	-1.35	121.3	-0.34	121.3	-0.36	121.1	118.1	-2.49	119.4	-1.38	122.0	121.8	-0.14	121.9	-0.11
Essex 115 kV	120.5	117.9	-2.21	118.4	-1.74	120.3	-0.18	120.3	-0.22	119.5	115.4	-3.44	117.1	-2.09	120.8	120.6	-0.14	120.7	-0.11
Windsor Transalta 115 kV	120.6	117.9	-2.22	118.5	-1.74	120.3	-0.18	120.3	-0.21	119.6	115.5	-3.45	117.1	-2.09	120.8	120.7	-0.14	120.7	-0.11
Walker Z1E 115 kV	120.5	117.7	-2.27	118.3	-1.79	120.3	-0.18	120.2	-0.21	119.5	115.3	-3.51	117.0	-2.13	120.7	120.6	-0.14	120.6	-0.11
Walker Z7E 115 kV	120.4	117.7	-2.28	118.2	-1.80	120.2	-0.18	120.2	-0.21	119.5	115.3	-3.51	116.9	-2.14	120.7	120.5	-0.14	120.5	-0.11
Ford Essex Z1E 115 kV	120.7	117.4	-2.69	118.1	-2.13	120.5	-0.13	120.5	-0.17	119.8	115.1	-3.94	116.8	-2.46	120.9	120.8	-0.15	120.8	-0.12
Ford Essex Z7E 115 kV	120.6	117.4	-2.69	118.1	-2.13	120.5	-0.13	120.4	-0.17	119.8	115.1	-3.94	116.8	-2.46	120.9	120.7	-0.15	120.8	-0.12
Lauzon 115 kV	120.8	117.3	-2.88	118.0	-2.28	120.6	-0.11	120.6	-0.15	119.9	115.0	-4.13	116.8	-2.61	121.0	120.9	-0.15	120.9	-0.12
Bell River K2Z 115 kV	120.2	116.6	-2.95	117.4	-2.31	120.0	-0.11	120.0	-0.14	119.3	114.3	-4.24	116.2	-2.62	120.5	120.3	-0.15	120.3	-0.12
Bell River K6Z 115 kV	119.1	115.5	-3.03	116.2	-2.42	119.0	-0.11	118.9	-0.14	118.3	113.1	-4.36	115.1	-2.68	119.4	119.2	-0.15	119.2	-0.12
Kingsville K2Z 115 kV	118.3	115.4	-2.44	116.2	-1.79	118.2	-0.09	118.2	-0.12	117.6	113.5	-3.49	115.0	-2.20	118.5	118.4	-0.12	118.4	-0.10
Kingsville K6Z 115 kV	116.6	113.0	-3.10	113.6	-2.60	116.5	-0.11	116.4	-0.15	115.8	110.6	-4.48	112.6	-2.74	116.9	116.7	-0.16	116.8	-0.13
Tilbury West 115 kV	118.4	115.3	-2.68	116.0	-2.06	118.3	-0.10	118.3	-0.14	117.7	113.2	-3.84	114.8	-2.42	118.7	118.5	-0.14	118.6	-0.11
Kent 115 kV	118.6	115.4	-2.68	116.2	-2.06	118.5	-0.10	118.4	-0.14	117.8	113.3	-3.84	115.0	-2.42	118.8	118.7	-0.14	118.7	-0.11

* Leamington and Malden load was converted for this contingency Pre-ULTC

Table 32: Voltage assessment results with all elements in-service for single contingencies – Scenario S3

Bus Name	Pre-Cont.	C21J				C23Z				J5D				J3E				Z7E				Keith A Bus			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	232.1	230.1	-0.83	230.3	-0.77	230.0	-0.87	230.7	-0.57	238.2	2.63	237.8	2.48	231.8	-0.11	232.0	-0.04	231.7	-0.16	231.7	-0.14	232.1	0.00	232.1	0.00
Malden C21J 230 kV	232.3					230.3	-0.87	231.0	-0.57	238.5	2.67	238.2	2.50	232.1	-0.12	232.2	-0.05	232.0	-0.16	232.0	-0.14	237.2	2.08	237.2	2.08
Malden C22J 230 kV	232.3	229.9	-1.02	230.1	-0.94	230.2	-0.88	230.9	-0.58	238.5	2.69	238.1	2.52	232.0	-0.12	232.2	-0.05	231.9	-0.16	231.9	-0.14	232.4	0.06	232.4	0.06
Leamington C21J 230 kV	236.1					234.1	-0.83	234.9	-0.50	242.5	2.73	242.1	2.58	235.6	-0.19	235.8	-0.12	235.7	-0.14	235.8	-0.12	239.3	1.35	239.3	1.36
Leamington C22J 230 kV	235.8	233.1	-1.17	233.2	-1.11	233.8	-0.85	234.6	-0.51	242.4	2.80	242.0	2.64	235.4	-0.19	235.5	-0.12	235.5	-0.14	235.5	-0.12	236.5	0.28	236.5	0.28
Lauzon C23Z 230 kV	230.6	230.0	-0.23	230.1	-0.21					236.1	2.41	235.4	2.11	228.2	-1.00	228.7	-0.81	230.0	-0.25	230.1	-0.19	230.8	0.12	230.8	0.12
Lauzon C24Z 230 kV	230.3	229.7	-0.26	229.8	-0.24	216.1	-6.20	220.4	-4.30	236.0	2.46	235.3	2.16	228.0	-1.01	228.5	-0.82	229.8	-0.25	229.9	-0.19	230.6	0.11	230.6	0.11
Chatham 230 kV	243.4	244.5	0.45	244.6	0.47	242.2	-0.49	243.1	-0.13	248.6	2.13	248.3	1.98	242.7	-0.30	242.9	-0.23	243.2	-0.10	243.2	-0.08	244.4	0.41	244.4	0.41
Keith 115 kV	123.9	123.4	-0.41	123.4	-0.38	121.8	-1.70	122.5	-1.12	125.8	1.52	125.6	1.37	123.8	-0.13	123.9	0.02	123.4	-0.41	123.5	-0.36	123.8	-0.09	123.8	-0.09
Crawford J3E 115 kV	122.7	122.2	-0.34	122.3	-0.31	119.6	-2.52	120.6	-1.71	124.6	1.56	124.3	1.38					121.9	-0.59	122.0	-0.52	122.6	-0.04	122.6	-0.04
Crawford J4E 115 kV	122.9	122.5	-0.33	122.5	-0.31	119.8	-2.52	120.8	-1.71	124.8	1.56	124.6	1.37	121.5	-1.19	121.8	-0.90	122.2	-0.59	122.3	-0.52	122.9	-0.04	122.9	-0.04
Essex 115 kV	122.2	121.9	-0.26	121.9	-0.24	118.2	-3.30	119.4	-2.27	124.2	1.61	123.9	1.39	120.7	-1.25	121.0	-1.00	121.3	-0.77	121.4	-0.68	122.2	0.01	122.2	0.02
Windsor Transalta 115 kV	122.3	121.9	-0.26	122.0	-0.23	118.2	-3.32	119.5	-2.28	124.2	1.60	123.9	1.38	120.7	-1.25	121.0	-1.00	121.3	-0.79	121.4	-0.70	122.3	0.01	122.3	0.02
Walker Z1E 115 kV	122.2	121.9	-0.26	121.9	-0.23	118.1	-3.39	119.3	-2.33	124.2	1.63	123.9	1.40	120.7	-1.25	121.0	-1.00	121.1	-0.89	121.2	-0.79	122.2	0.02	122.2	0.02
Walker Z7E 115 kV	122.1	121.8	-0.26	121.8	-0.24	118.0	-3.39	119.3	-2.33	124.1	1.63	123.8	1.41	120.6	-1.25	120.9	-1.00					122.1	0.02	122.1	0.02
Ford Essex Z1E 115 kV	122.6	122.3	-0.24	122.3	-0.22	117.8	-3.94	119.2	-2.73	124.8	1.78	124.5	1.53	121.1	-1.21	121.4	-0.97	122.0	-0.49	122.1	-0.40	122.6	0.04	122.6	0.05
Ford Essex Z7E 115 kV	122.6	122.3	-0.24	122.3	-0.22	117.7	-3.94	119.2	-2.73	124.8	1.79	124.4	1.53	121.1	-1.21	121.4	-0.97					122.6	0.04	122.6	0.05
Lauzon 115 kV	122.8	122.5	-0.24	122.5	-0.21	117.6	-4.18	119.2	-2.90	125.1	1.85	124.7	1.59	121.3	-1.20	121.6	-0.96	122.4	-0.31	122.5	-0.23	122.8	0.06	122.8	0.06
Bell River K2Z 115 kV	122.1	121.8	-0.24	121.9	-0.22	116.8	-4.32	118.5	-2.95	124.5	1.91	124.1	1.62	120.6	-1.24	120.9	-0.98	121.7	-0.32	121.8	-0.23	122.2	0.06	122.2	0.06
Bell River K6Z 115 kV	121.1	120.8	-0.26	120.8	-0.23	115.5	-4.61	117.5	-3.02	123.6	2.03	123.2	1.68	119.5	-1.32	120.0	-0.96	120.7	-0.34	120.8	-0.25	121.2	0.06	121.2	0.06
Kingsville K2Z 115 kV	117.3	116.9	-0.30	116.9	-0.27	111.0	-5.36	113.5	-3.25	120.0	2.34	119.4	1.85	115.5	-1.52	115.6	-1.38	116.8	-0.39	116.9	-0.29	117.3	0.07	117.3	0.07
Kingsville K6Z 115 kV	117.3	116.9	-0.31	116.9	-0.27	110.9	-5.43	113.4	-3.27	120.0	2.37	119.4	1.86	115.5	-1.54	116.2	-0.94	116.8	-0.40	116.9	-0.29	117.4	0.07	117.4	0.07
Tilbury West 115 kV	118.8	118.5	-0.28	118.5	-0.25	113.0	-4.88	115.0	-3.17	121.3	2.14	120.9	1.76	117.1	-1.39	117.4	-1.18	118.4	-0.36	118.5	-0.26	118.9	0.06	118.9	0.07
Kent 115 kV	119.0	118.6	-0.27	118.7	-0.25	113.2	-4.87	115.2	-3.16	121.5	2.14	121.0	1.76	117.3	-1.39	117.5	-1.18	118.5	-0.36	118.6	-0.26	119.0	0.06	119.0	0.07

Table 33: Voltage assessment results with all elements in-service for single contingencies – Scenario S4

Bus Name	Pre-Cont.	C21J				C23Z				J5D				J3E				Z7E				Keith A Bus			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	231.3	229.0	-0.99	229.2	-0.88	229.6	-0.73	230.2	-0.47	237.0	2.49	236.9	2.42	231.1	-0.07	231.3	0.00	230.9	-0.18	230.9	-0.15	231.4	0.05	231.4	0.06
Malden C21J 230 kV	231.4					229.7	-0.73	230.4	-0.46	237.3	2.53	237.1	2.45	231.2	-0.08	231.4	-0.01	231.0	-0.18	231.1	-0.16	234.3	1.23	234.3	1.23
Malden C22J 230 kV	231.4	228.4	-1.26	228.7	-1.13	229.7	-0.74	230.3	-0.47	237.2	2.54	237.1	2.47	231.2	-0.08	231.3	-0.01	230.9	-0.18	231.0	-0.16	231.6	0.09	231.6	0.10
Leamington C21J 230 kV	233.5					231.9	-0.68	232.6	-0.36	239.7	2.68	239.6	2.61	233.1	-0.18	233.2	-0.12	233.1	-0.18	233.1	-0.16	235.5	0.87	235.5	0.87
Leamington C22J 230 kV	233.2	227.2	-2.57	227.7	-2.34	231.6	-0.69	232.3	-0.37	239.6	2.74	239.4	2.67	232.8	-0.18	232.9	-0.11	232.8	-0.18	232.8	-0.16	233.8	0.25	233.8	0.25
Lauzon C23Z 230 kV	228.7	227.8	-0.37	228.0	-0.31					233.9	2.26	233.6	2.14	226.1	-1.14	226.5	-0.96	227.6	-0.48	227.8	-0.40	229.0	0.15	229.0	0.15
Lauzon C24Z 230 kV	228.5	227.6	-0.39	227.7	-0.34	215.2	-5.83	219.5	-3.95	233.8	2.31	233.5	2.19	225.9	-1.15	226.3	-0.96	227.4	-0.48	227.6	-0.40	228.8	0.14	228.8	0.15
Chatham 230 kV	242.3	243.0	0.30	243.2	0.35	241.5	-0.34	242.4	0.01	247.3	2.07	247.2	2.01	241.6	-0.32	241.7	-0.26	241.9	-0.16	242.0	-0.14	243.1	0.33	243.1	0.33
Keith 115 kV	123.9	123.2	-0.52	123.3	-0.47	122.0	-1.52	122.6	-1.03	125.7	1.46	125.6	1.40	123.9	0.02	124.1	0.18	123.4	-0.40	123.4	-0.34	123.8	-0.01	123.8	-0.01
Crawford J3E 115 kV	122.2	121.6	-0.46	121.7	-0.41	119.4	-2.28	120.2	-1.60	124.0	1.49	123.9	1.39					121.5	-0.58	121.6	-0.50	122.2	0.02	122.2	0.02
Crawford J4E 115 kV	122.4	121.9	-0.46	121.9	-0.41	119.7	-2.28	120.5	-1.60	124.3	1.48	124.2	1.43	120.9	-1.25	121.3	-0.96	121.7	-0.58	121.8	-0.49	122.5	0.02	122.5	0.02
Essex 115 kV	121.3	120.8	-0.39	120.9	-0.34	117.6	-3.03	118.7	-2.16	123.1	1.51	123.0	1.42	119.4	-1.53	119.7	-1.29	120.4	-0.76	120.5	-0.65	121.4	0.06	121.4	0.06
Windsor Transalta 115 kV	121.4	120.9	-0.39	120.9	-0.34	117.7	-3.04	118.7	-2.17	123.2	1.51	123.1	1.42	119.5	-1.53	119.8	-1.28	120.4	-0.79	120.5	-0.67	121.4	0.06	121.4	0.06
Walker Z1E 115 kV	121.3	120.8	-0.39	120.8	-0.34	117.5	-3.11	118.6	-2.22	123.1	1.53	123.0	1.44	119.4	-1.53	119.7	-1.28	120.2	-0.91	120.3	-0.79	121.3	0.06	121.3	0.06
Walker Z7E 115 kV	121.2	120.7	-0.39	120.8	-0.34	117.4	-3.11	118.5	-2.21	123.0	1.53	122.9	1.45	119.3	-1.53	119.6	-1.28					121.2	0.06	121.2	0.06
Ford Essex Z1E 115 kV	121.3	120.9	-0.37	121.0	-0.32	116.9	-3.63	118.2	-2.60	123.3	1.65	123.2	1.56	119.6	-1.46	119.9	-1.22	120.5	-0.71	120.6	-0.61	121.4	0.08	121.4	0.08
Ford Essex Z7E 115 kV	121.3	120.9	-0.37	120.9	-0.32	116.9	-3.63	118.2	-2.60	123.3	1.66	123.2	1.56	119.6	-1.46	119.8	-1.22					121.4	0.08	121.4	0.08
Lauzon 115 kV	121.4	120.9	-0.36	121.0	-0.31	116.7	-3.86	118.0	-2.77	123.5	1.71	123.3	1.61	119.7	-1.42	119.9	-1.19	120.6	-0.63	120.8	-0.52	121.5	0.09	121.5	0.09
Bell River K2Z 115 kV	120.8	120.3	-0.37	120.4	-0.32	116.0	-3.96	117.4	-2.80	122.9	1.75	122.8	1.63	119.0	-1.46	119.3	-1.21	120.0	-0.64	120.1	-0.54	120.9	0.09	120.9	0.09
Bell River K6Z 115 kV	120.0	119.5	-0.38	119.6	-0.33	115.2	-4.03	116.6	-2.85	122.1	1.78	122.0	1.66	118.2	-1.49	118.5	-1.23	119.2	-0.65	119.3	-0.55	120.1	0.09	120.1	0.10
Kingsville K2Z 115 kV	117.3	116.8	-0.40	116.9	-0.34	112.3	-4.23	113.7	-3.03	119.5	1.87	119.3	1.75	115.4	-1.56	115.7	-1.30	116.5	-0.68	116.6	-0.57	117.4	0.10	117.4	0.10
Kingsville K6Z 115 kV	117.4	116.9	-0.40	117.0	-0.34	112.4	-4.24	113.8	-3.01	119.6	1.87	119.4	1.75	115.6	-1.56	115.9	-1.30	116.6	-0.69	116.7	-0.57	117.5	0.10	117.5	0.10
Tilbury West 115 kV	118.1	117.6	-0.39	117.7	-0.34	113.2	-4.16	114.6	-2.99	120.3	1.84	120.1	1.73	116.3	-1.53	116.6	-1.28	117.3	-0.67	117.4	-0.56	118.2	0.10	118.2	0.10
Kent 115 kV	118.3	117.8	-0.39	117.9	-0.34	113.3	-4.16	114.7	-2.99	120.4	1.84	120.3	1.73	116.4	-1.53	116.7	-1.28	117.5	-0.67	117.6	-0.56	118.4	0.10	118.4	0.10

Table 34: Voltage assessment results with all elements in-service for double contingencies – Scenario S3

Bus Name	Pre-Cont.	C21J+C23Z				C22J+C24Z				C23Z+C24Z				J3E +J4E				* Z1E+Z7E – (Kingsville capacitor switching with four caps. out)			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	232.1	227.8	-1.85	228.9	-1.37	228.4	-1.56	229.4	-1.15	230.5	-0.67	230.6	-0.63	232.5	0.18	232.6	0.25	231.9	-0.06	231.9	-0.06
Malden C21J 230 kV	232.3					228.1	-1.81	229.2	-1.36	230.9	-0.62	231.0	-0.59	232.7	0.14	232.8	0.22	232.2	-0.04	232.2	-0.04
Malden C22J 230 kV	232.3	227.4	-2.09	228.6	-1.58					230.8	-0.63	230.9	-0.60	232.6	0.15	232.8	0.23	232.2	-0.04	232.2	-0.04
Leamington C21J 230 kV	236.1					230.8	-2.22	232.0	-1.72	236.2	0.06	236.2	0.07	235.4	-0.28	235.8	-0.13	236.3	0.12	236.3	0.11
Leamington C22J 230 kV	235.8	230.4	-2.31	231.6	-1.77					235.8	0.02	235.9	0.03	235.2	-0.26	235.6	-0.11	236.1	0.12	236.1	0.12
Lauzon C23Z 230 kV	230.6					213.5	-7.41	219.5	-4.81					221.0	-4.13	222.9	-3.33	229.3	-0.56	229.1	-0.62
Lauzon C24Z 230 kV	230.3	213.3	-7.42	219.3	-4.81									220.7	-4.19	222.6	-3.38	233.1	1.18	233.1	1.21
Chatham 230 kV	243.4	243.3	-0.06	244.6	0.46	242.2	-0.49	243.5	0.03	247.5	1.69	247.5	1.68	240.8	-1.07	241.4	-0.84	244.0	0.22	244.0	0.22
Keith 115 kV	123.9	120.9	-2.40	122.0	-1.52	120.7	-2.63	121.9	-1.63	122.3	-1.34	122.4	-1.21	125.5	1.26	125.5	1.30	123.6	-0.27	123.6	-0.26
Crawford J3E 115 kV	122.7	118.7	-3.25	120.1	-2.07	118.5	-3.43	120.0	-2.14	120.1	-2.10	120.3	-1.89					122.3	-0.29	122.3	-0.28
Crawford J4E 115 kV	122.9	118.9	-3.25	120.4	-2.07	118.7	-3.43	120.3	-2.14	120.3	-2.10	120.5	-1.93					122.6	-0.29	122.6	-0.28
Essex 115 kV	122.2	117.2	-4.06	119.0	-2.60	117.1	-4.19	119.0	-2.64	118.8	-2.76	119.1	-2.52	116.3	-4.80	117.4	-3.89	121.8	-0.32	121.8	-0.31
Windsor Transalta 115 kV	122.3	117.3	-4.08	119.1	-2.61	117.1	-4.21	119.0	-2.65	118.9	-2.78	119.2	-2.53	116.4	-4.79	117.5	-3.89				
Walker Z1E 115 kV	122.2	117.1	-4.15	118.9	-2.66	117.0	-4.28	118.9	-2.70	118.7	-2.83	119.0	-2.58	116.3	-4.80	117.4	-3.89				
Walker Z7E 115 kV	122.1	117.0	-4.15	118.9	-2.65	116.9	-4.28	118.8	-2.70	118.7	-2.83	119.0	-2.58	116.3	-4.80	117.4	-3.89				
Ford Essex Z1E 115 kV	122.6	116.8	-4.76	118.8	-3.06	116.6	-4.87	118.8	-3.09	118.6	-3.25	119.0	-2.97	116.8	-4.73	117.9	-3.79				
Ford Essex Z7E 115 kV	122.6	116.7	-4.76	118.8	-3.06	116.6	-4.87	118.8	-3.09	118.6	-3.25	118.9	-2.97	116.8	-4.73	117.9	-3.79				
Lauzon 115 kV	122.8	116.6	-5.03	118.8	-3.24	116.5	-5.13	118.8	-3.26	118.6	-3.43	118.9	-3.13	117.0	-4.69	118.2	-3.75	125.0	1.80	125.1	1.86
Bell River K2Z 115 kV	122.1	115.8	-5.20	118.1	-3.29	115.7	-5.30	118.1	-3.31	117.8	-3.54	118.2	-3.19	116.2	-4.84	117.5	-3.82	123.9	1.42	123.9	1.46
Bell River K6Z 115 kV	121.1	114.4	-5.56	117.0	-3.39	114.3	-5.67	117.0	-3.41	116.5	-3.78	117.1	-3.33	114.9	-5.18	116.3	-3.96	117.8	-2.78	117.6	-2.91
Kingsville K2Z 115 kV	117.3	109.7	-6.48	112.9	-3.68	109.5	-6.60	112.9	-3.71	112.1	-4.39	112.9	-3.70	110.2	-6.02	112.2	-4.34	112.9	-3.68	113.2	-3.45
Kingsville K6Z 115 kV	117.3	109.6	-6.56	112.9	-3.69	109.4	-6.69	112.9	-3.72	112.1	-4.44	112.9	-3.72	110.1	-6.10	112.1	-4.38	109.9	-6.25	109.6	-6.52
Tilbury West 115 kV	118.8	111.8	-5.88	114.6	-3.56	111.7	-5.99	114.5	-3.59	114.1	-3.99	114.6	-3.51	112.3	-5.47	113.9	-4.16	118.1	-0.59	118.3	-0.45
Kent 115 kV	119.0	112.0	-5.88	114.7	-3.56	111.8	-5.99	114.7	-3.58	114.2	-3.99	114.8	-3.50	112.4	-5.47	114.0	-4.16	118.2	-0.59	118.4	-0.45

* Control Actions shown in brackets

Table 34: Voltage assessment results with all elements in-service for double contingencies – Scenario S3 (continued)

Bus Name	Pre-Cont.	Chatham 230 DL23 BF: C23Z + Chatham D Bus				Chatham 230 DL21 BF: C21J + Chatham D Bus				Lauzon T2K BF: C24Z + Lauzon cap				Lauzon T1L7 BF: Z7E+C23Z			
		[1] Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		[2] Pre-ULTC		Post-ULTC		[1] Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	232.1	227.7	-1.89	228.5	-1.52	228.3	-1.63	228.5	-1.52	229.6	-1.06	229.7	-1.02	229.7	-1.02	230.4	-0.73
Malden C21J 230 kV	232.3	227.7	-1.99	228.6	-1.62					229.9	-1.06	229.9	-1.03	230.0	-1.02	230.6	-0.73
Malden C22J 230 kV	232.3	227.6	-1.99	228.5	-1.62	227.7	-1.95	228.1	-1.81	229.8	-1.06	229.9	-1.03	229.9	-1.03	230.5	-0.74
Leamington C21J 230 kV	236.1	229.7	-2.71	230.6	-2.30					233.8	-0.97	233.7	-0.99	233.8	-0.97	234.5	-0.64
Leamington C22J 230 kV	235.8	229.4	-2.73	230.3	-2.32	228.6	-3.06	228.9	-2.93	233.5	-0.99	233.4	-1.01	233.5	-0.98	234.3	-0.66
Lauzon C23Z 230 kV	230.6					224.7	-2.55	225.2	-2.32	218.0	-5.45	217.4	-5.68				
Lauzon C24Z 230 kV	230.3	211.5	-8.20	216.8	-5.89	224.4	-2.58	224.9	-2.35					214.4	-6.94	219.1	-4.87
Chatham 230 kV	243.4	235.5	-3.25	236.6	-2.81	237.3	-2.52	237.5	-2.42	242.0	-0.59	241.8	-0.66	241.9	-0.62	242.8	-0.26
Keith 115 kV	123.9	120.9	-2.46	121.7	-1.78	122.3	-1.28	122.5	-1.15	121.2	-2.18	121.4	-2.07	121.3	-2.07	122.0	-1.51
Crawford J3E 115 kV	122.7	118.5	-3.36	119.7	-2.45	120.9	-1.48	121.0	-1.32	118.8	-3.16	119.0	-3.00	118.9	-3.03	119.9	-2.27
Crawford J4E 115 kV	122.9	118.8	-3.36	119.9	-2.49	121.1	-1.47	121.3	-1.32	119.0	-3.16	119.2	-3.05	119.2	-3.02	120.1	-2.26
Essex 115 kV	122.2	117.0	-4.21	118.4	-3.13	120.2	-1.66	120.4	-1.48	117.2	-4.10	117.4	-3.96	117.4	-3.93	118.5	-2.99
Windsor Transalta 115 kV	122.3	117.1	-4.23	118.4	-3.15	120.2	-1.67	120.4	-1.48	117.2	-4.12	117.4	-3.98	117.4	-3.99	118.6	-3.03
Walker Z1E 115 kV	122.2	116.9	-4.31	118.3	-3.21	120.1	-1.70	120.4	-1.51	117.1	-4.21	117.2	-4.06	117.1	-4.21	118.3	-3.22
Walker Z7E 115 kV	122.1	116.8	-4.31	118.2	-3.20	120.0	-1.70	120.3	-1.50	117.0	-4.21	117.2	-4.06				
Ford Essex Z1E 115 kV	122.6	116.5	-4.93	118.1	-3.69	120.3	-1.89	120.5	-1.68	116.6	-4.89	116.8	-4.74	116.7	-4.78	118.2	-3.57
Ford Essex Z7E 115 kV	122.6	116.5	-4.93	118.0	-3.69	120.3	-1.89	120.5	-1.68	116.6	-4.89	116.8	-4.74				
Lauzon 115 kV	122.8	116.4	-5.21	118.0	-3.91	120.4	-1.97	120.6	-1.75	116.4	-5.19	116.6	-5.04	116.6	-5.03	118.2	-3.73
Bell River K2Z 115 kV	122.1	115.6	-5.33	117.3	-3.97	119.6	-2.04	119.9	-1.79	115.6	-5.36	115.9	-5.13	115.8	-5.15	117.5	-3.79
Bell River K6Z 115 kV	121.1	114.6	-5.36	116.2	-4.08	118.5	-2.17	118.9	-1.87	114.2	-5.73	114.7	-5.32	114.8	-5.18	116.4	-3.88
Kingsville K2Z 115 kV	117.3	110.9	-5.45	112.1	-4.39	114.3	-2.52	114.8	-2.08	109.4	-6.68	110.4	-5.86	111.1	-5.26	112.4	-4.16
Kingsville K6Z 115 kV	117.3	110.9	-5.46	112.1	-4.41	114.3	-2.55	114.8	-2.09	109.3	-6.76	110.4	-5.90	111.1	-5.28	112.4	-4.18
Tilbury West 115 kV	118.8	112.3	-5.50	113.7	-4.28	116.1	-2.29	116.5	-1.97	111.6	-6.06	112.1	-5.61	112.5	-5.32	114.0	-4.07
Kent 115 kV	119.0	112.4	-5.50	113.9	-4.27	116.2	-2.29	116.6	-1.96	111.7	-6.06	112.3	-5.60	112.6	-5.31	114.1	-4.06

1) Kingsville load was converted for this contingency Pre-ULTC
2) Lauzon load was converted for this contingency Pre-ULTC

Table 35: Voltage assessment results with all elements in-service for double contingencies – Scenario S4

Bus Name	Pre-Cont.	C21J+C23Z				C22J+C24Z				C23Z+C24Z				J3E +J4E				Z1E+Z7E			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		* Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	231.3	227.1	-1.82	228.1	-1.37	227.6	-1.57	228.5	-1.18	230.3	-0.42	230.3	-0.40	232.2	0.39	232.5	0.51	232.1	0.37	232.1	0.35
Malden C21J 230 kV	231.4					227.1	-1.89	228.1	-1.45	230.6	-0.36	230.6	-0.35	232.2	0.33	232.5	0.46	232.4	0.41	232.3	0.38
Malden C22J 230 kV	231.4	226.4	-2.13	227.6	-1.64					230.5	-0.37	230.5	-0.36	232.1	0.33	232.4	0.47	232.3	0.41	232.2	0.38
Leamington C21J 230 kV	233.5					225.6	-3.39	227.0	-2.78	234.3	0.34	234.3	0.34	232.9	-0.26	233.5	-0.01	235.1	0.67	234.9	0.62
Leamington C22J 230 kV	233.2	224.9	-3.53	226.5	-2.87					233.9	0.31	233.9	0.31	232.6	-0.24	233.2	0.00	234.8	0.67	234.6	0.62
Lauzon C23Z 230 kV	228.7					213.6	-6.61	218.5	-4.46					217.0	-5.12	219.8	-3.87	235.2	2.83	234.5	2.56
Lauzon C24Z 230 kV	228.5	212.6	-6.95	217.7	-4.72									216.7	-5.16	219.6	-3.91	234.2	2.49	233.6	2.21
Chatham 230 kV	242.3	242.3	-0.02	243.4	0.46	241.4	-0.37	242.6	0.09	246.9	1.87	246.8	1.86	239.4	-1.19	240.3	-0.84	244.6	0.95	244.4	0.87
Keith 115 kV	123.9	121.2	-2.16	121.9	-1.54	121.2	-2.14	122.0	-1.51	122.4	-1.15	122.5	-1.08	126.5	2.11	126.5	2.17	124.6	0.57	124.5	0.56
Crawford J3E 115 kV	122.2	118.6	-2.94	119.6	-2.09	118.7	-2.87	119.7	-2.03	119.9	-1.88	120.0	-1.78					123.2	0.84	123.2	0.84
Crawford J4E 115 kV	122.4	118.9	-2.93	119.9	-2.09	118.9	-2.86	120.0	-2.02	120.1	-1.88	120.3	-1.78					123.5	0.84	123.5	0.84
Essex 115 kV	121.3	116.8	-3.69	118.1	-2.63	117.0	-3.57	118.2	-2.53	118.2	-2.56	118.3	-2.44	113.0	-6.86	114.8	-5.36	122.6	1.10	122.6	1.11
Windsor Transalta 115 kV	121.4	116.8	-3.71	118.1	-2.65	117.0	-3.59	118.3	-2.54	118.2	-2.57	118.4	-2.45	113.0	-6.85	114.9	-5.35				
Walker Z1E 115 kV	121.3	116.7	-3.78	118.0	-2.69	116.8	-3.65	118.1	-2.59	118.1	-2.62	118.2	-2.50	113.0	-6.83	114.8	-5.33				
Walker Z7E 115 kV	121.2	116.6	-3.78	117.9	-2.69	116.7	-3.65	118.0	-2.59	118.0	-2.62	118.1	-2.50	112.9	-6.84	114.7	-5.33				
Ford Essex Z1E 115 kV	121.3	116.1	-4.34	117.6	-3.10	116.3	-4.18	117.7	-2.97	117.6	-3.06	117.8	-2.92	113.5	-6.50	115.2	-5.05				
Ford Essex Z7E 115 kV	121.3	116.1	-4.34	117.6	-3.10	116.2	-4.18	117.7	-2.97	117.6	-3.06	117.8	-2.92	113.4	-6.50	115.2	-5.05				
Lauzon 115 kV	121.4	115.8	-4.59	117.4	-3.29	116.0	-4.42	117.6	-3.14	117.4	-3.25	117.6	-3.11	113.7	-6.35	115.4	-4.92	124.7	2.71	124.3	2.40
Bell River K2Z 115 kV	120.8	115.1	-4.71	116.8	-3.33	115.3	-4.53	116.9	-3.18	116.8	-3.33	117.0	-3.15	112.9	-6.50	114.8	-4.98	124.2	2.84	123.8	2.52
Bell River K6Z 115 kV	120.0	114.2	-4.80	115.9	-3.39	114.5	-4.61	116.1	-3.24	115.9	-3.39	116.2	-3.21	112.2	-6.51	113.9	-5.07	124.0	3.34	123.6	3.02
Kingsville K2Z 115 kV	117.3	111.4	-5.04	113.0	-3.59	111.6	-4.84	113.2	-3.43	113.1	-3.56	113.3	-3.40	109.6	-6.54	110.9	-5.39	120.9	3.09	120.5	2.76
Kingsville K6Z 115 kV	117.4	111.5	-5.06	113.2	-3.58	111.7	-4.86	113.4	-3.42	113.2	-3.57	113.4	-3.38	109.7	-6.56	111.1	-5.36	121.4	3.41	121.0	3.07
Tilbury West 115 kV	118.1	112.2	-4.96	113.9	-3.54	112.5	-4.77	114.1	-3.38	114.0	-3.51	114.1	-3.35	110.2	-6.67	111.8	-5.31	121.6	2.97	121.2	2.64
Kent 115 kV	118.3	112.4	-4.96	114.1	-3.54	112.6	-4.77	114.3	-3.38	114.1	-3.50	114.3	-3.35	110.4	-6.66	112.0	-5.30	121.8	2.97	121.4	2.64

* Kingsville load was converted for this contingency Pre-ULTC

Table 35: Voltage assessment results with all elements in-service for double contingencies – Scenario S4 (continued)

Bus Name	Pre-Cont.	Chatham 230 DL23 BF: C23Z + Chatham D Bus				Chatham 230 DL21 BF: C21J + Chatham D Bus				Lauzon T1L7 BF: Z7E+C23Z			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	231.3	227.0	-1.87	228.0	-1.44	227.1	-1.81	227.6	-1.59	228.9	-1.01	229.8	-0.64
Malden C21J 230 kV	231.4	226.9	-1.97	227.9	-1.53					229.1	-1.02	230.0	-0.63
Malden C22J 230 kV	231.4	226.8	-1.97	227.8	-1.53	226.3	-2.20	226.8	-1.95	229.0	-1.03	229.9	-0.64
Leamington C21J 230 kV	233.5	227.1	-2.74	228.3	-2.23					231.2	-1.00	232.2	-0.54
Leamington C22J 230 kV	233.2	226.8	-2.75	228.0	-2.24	222.6	-4.56	223.5	-4.17	230.8	-1.01	231.9	-0.55
Lauzon C23Z 230 kV	228.7					222.8	-2.60	223.4	-2.32				
Lauzon C24Z 230 kV	228.5	209.3	-8.39	215.4	-5.73	222.5	-2.63	223.1	-2.35	211.4	-7.51	217.5	-4.80
Chatham 230 kV	242.3	234.5	-3.24	235.8	-2.71	235.9	-2.66	236.3	-2.49	240.7	-0.67	241.9	-0.16
Keith 115 kV	123.9	120.9	-2.42	121.7	-1.71	122.2	-1.35	122.4	-1.20	121.2	-2.10	122.1	-1.41
Crawford J3E 115 kV	122.2	118.0	-3.40	119.3	-2.40	120.3	-1.54	120.5	-1.36	118.4	-3.12	119.6	-2.13
Crawford J4E 115 kV	122.4	118.3	-3.39	119.5	-2.40	120.6	-1.54	120.8	-1.36	118.6	-3.12	119.8	-2.13
Essex 115 kV	121.3	116.0	-4.33	117.6	-3.07	119.2	-1.71	119.5	-1.51	116.3	-4.11	117.8	-2.84
Windsor Transalta 115 kV	121.4	116.1	-4.36	117.6	-3.09	119.3	-1.72	119.5	-1.52	116.3	-4.18	117.8	-2.90
Walker Z1E 115 kV	121.3	115.9	-4.44	117.4	-3.15	119.1	-1.74	119.4	-1.54	115.9	-4.43	117.5	-3.11
Walker Z7E 115 kV	121.2	115.8	-4.44	117.4	-3.15	119.1	-1.74	119.3	-1.54				
Ford Essex Z1E 115 kV	121.3	115.1	-5.11	116.9	-3.64	119.0	-1.92	119.3	-1.69	114.9	-5.33	116.9	-3.68
Ford Essex Z7E 115 kV	121.3	115.1	-5.12	116.9	-3.64	119.0	-1.92	119.3	-1.69				
Lauzon 115 kV	121.4	114.8	-5.42	116.7	-3.86	119.0	-1.99	119.3	-1.76	114.4	-5.73	116.6	-3.94
Bell River K2Z 115 kV	120.8	114.1	-5.56	116.1	-3.91	118.3	-2.04	118.6	-1.79	113.7	-5.88	116.0	-3.98
Bell River K6Z 115 kV	120.0	113.2	-5.66	115.2	-3.98	117.5	-2.08	117.8	-1.82	112.8	-5.99	115.1	-4.06
Kingsville K2Z 115 kV	117.3	110.3	-5.95	112.3	-4.23	114.7	-2.18	115.0	-1.93	109.9	-6.29	112.2	-4.31
Kingsville K6Z 115 kV	117.4	110.4	-5.97	112.5	-4.20	114.8	-2.19	115.1	-1.92	110.0	-6.31	112.4	-4.28
Tilbury West 115 kV	118.1	111.2	-5.85	113.2	-4.17	115.6	-2.15	115.9	-1.90	110.8	-6.19	113.1	-4.25
Kent 115 kV	118.3	111.3	-5.85	113.3	-4.16	115.7	-2.15	116.0	-1.90	110.9	-6.19	113.2	-4.24

Table 36: Voltage assessment results under outage conditions – Scenario S3

Bus Name	KEITH A Bus O/S	KEITH A Bus + C23Z				J3E O/S	J3E + C23Z				CHATHAM D Bus O/S	CHATHAM D BUS + CHATHAM K BUS				C21J Chatham end open	C21J Chatham end open + Keith C21J IBO			
	Pre-Cont.	Pre-ULTC		Post-ULTC		Pre-Cont.	* Pre-ULTC		Post-ULTC		Pre-Cont.	Pre-ULTC		Post-ULTC		Pre-Cont.	Post-ULTC		Pre-ULTC	
	kV	kV	%	kV	%	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	232.1	230.3	-0.78	231.0	-0.46	232.0	230.5	-0.63	230.5	-0.63	229.7	228.9	-0.36	229.2	-0.22	231.3	231.1	-0.09	231.1	-0.09
Malden C21J 230 kV	237.2	234.9	-0.95	236.1	-0.47	232.2	230.8	-0.63	230.7	-0.64	229.8	228.9	-0.36	229.3	-0.22	231.2	230.8	-0.21	230.7	-0.21
Malden C22J 230 kV	232.4	230.5	-0.81	231.3	-0.48	232.2	230.7	-0.63	230.7	-0.64	229.7	228.9	-0.36	229.2	-0.22	231.4	231.1	-0.13	231.1	-0.13
Leamington C21J 230 kV	239.3	237.2	-0.84	238.4	-0.37	235.8	234.6	-0.51	234.4	-0.59	231.8	230.8	-0.42	231.1	-0.30	232.0	231.5	-0.20	231.5	-0.20
Leamington C22J 230 kV	236.5	234.4	-0.88	235.4	-0.47	235.5	234.3	-0.52	234.1	-0.61	231.5	230.5	-0.42	230.8	-0.30	234.3	233.6	-0.31	233.6	-0.31
Lauzon C23Z 230 kV	230.8					228.7					225.9	216.7	-4.09	218.6	-3.24	230.5	230.4	-0.04	230.4	-0.04
Lauzon C24Z 230 kV	230.6	214.2	-7.10	219.8	-4.67	228.5	217.1	-4.99	215.5	-5.68	225.7	216.4	-4.12	218.3	-3.26	230.2	230.1	-0.04	230.1	-0.04
Chatham 230 kV	244.4	243.0	-0.58	244.2	-0.11	242.9	242.6	-0.11	242.2	-0.28	237.0					244.9	244.7	-0.07	244.7	-0.07
Keith 115 kV	123.8	121.1	-2.15	122.2	-1.29	123.9	122.3	-1.34	122.4	-1.22	122.9	121.3	-1.27	121.8	-0.91	123.7	123.6	-0.04	123.6	-0.04
Crawford J3E 115 kV	122.6	118.9	-3.03	120.3	-1.90						121.4	119.2	-1.80	119.8	-1.31	122.5	122.5	-0.04	122.5	-0.04
Crawford J4E 115 kV	122.9	119.2	-3.02	120.6	-1.90	121.8	118.5	-2.69	118.8	-2.46	121.6	119.5	-1.80	120.1	-1.31	122.8	122.7	-0.04	122.7	-0.04
Essex 115 kV	122.2	117.5	-3.86	119.2	-2.48	121.0	116.5	-3.69	116.6	-3.58	120.7	117.9	-2.33	118.6	-1.71	122.1	122.1	-0.04	122.1	-0.04
Windsor Transalta 115 kV	122.3	117.5	-3.88	119.2	-2.49	121.0	116.6	-3.70	116.7	-3.60	120.7	117.9	-2.35	118.7	-1.72	122.2	122.1	-0.04	122.1	-0.04
Walker Z1E 115 kV	122.2	117.4	-3.96	119.1	-2.54	121.0	116.4	-3.75	116.6	-3.65	120.7	117.8	-2.39	118.5	-1.76	122.1	122.1	-0.04	122.1	-0.04
Walker Z7E 115 kV	122.1	117.3	-3.96	119.0	-2.54	120.9	116.4	-3.75	116.5	-3.65	120.6	117.7	-2.39	118.5	-1.75	122.0	122.0	-0.04	122.0	-0.04
Ford Essex Z1E 115 kV	122.6	117.0	-4.56	119.0	-2.96	121.4	116.4	-4.14	116.4	-4.09	120.8	117.5	-2.79	118.3	-2.07	122.5	122.5	-0.04	122.5	-0.04
Ford Essex Z7E 115 kV	122.6	117.0	-4.57	119.0	-2.96	121.4	116.4	-4.14	116.4	-4.09	120.8	117.4	-2.79	118.3	-2.07	122.5	122.5	-0.04	122.5	-0.04
Lauzon 115 kV	122.8	116.9	-4.83	119.0	-3.14	121.6	116.4	-4.31	116.4	-4.28	120.9	117.3	-2.97	118.3	-2.20	122.7	122.7	-0.04	122.7	-0.04
Bell River K2Z 115 kV	122.2	116.1	-4.99	118.3	-3.20	120.9	115.5	-4.47	115.7	-4.34	120.2	116.5	-3.07	117.5	-2.24	122.1	122.0	-0.04	122.0	-0.04
Bell River K6Z 115 kV	121.2	114.7	-5.34	117.2	-3.29	120.0	114.1	-4.86	114.6	-4.49	119.2	115.2	-3.33	116.4	-2.31	121.1	121.0	-0.05	121.0	-0.05
Kingsville K2Z 115 kV	117.3	110.0	-6.22	113.2	-3.56	115.6	109.4	-5.43	110.0	-4.90	115.2	110.6	-3.99	112.3	-2.53	117.2	117.1	-0.05	117.1	-0.05
Kingsville K6Z 115 kV	117.4	110.0	-6.29	113.1	-3.58	116.2	109.3	-5.94	110.4	-4.94	115.2	110.5	-4.04	112.2	-2.54	117.2	117.2	-0.05	117.2	-0.05
Tilbury West 115 kV	118.9	112.2	-5.65	114.8	-3.45	117.4	111.5	-4.99	111.8	-4.73	116.8	112.7	-3.54	114.0	-2.44	118.8	118.7	-0.05	118.7	-0.05
Kent 115 kV	119.0	112.3	-5.64	114.9	-3.45	117.5	111.7	-4.99	112.0	-4.73	117.0	112.8	-3.54	114.1	-2.44	118.9	118.8	-0.05	118.8	-0.05

* Lauzon load was converted for this contingency Pre-ULTC

Table 37: Voltage assessment results under outage conditions – Scenario S4

Bus Name	KEITH A Bus O/S	KEITH A Bus + C23Z				J3E O/S	J3E + C23Z				CHATHAM D Bus O/S	CHATHAM D BUS + CHATHAM K BUS				C21J Chatham end open	C21J Chatham end open + Keith C21J IBO			
	Pre-Cont.	Pre-ULTC		Post-ULTC		Pre-Cont.	* Pre-ULTC		Post-ULTC		Pre-Cont.	Pre-ULTC		Post-ULTC		Pre-Cont.	Post-ULTC		Pre-ULTC	
	kV	kV	%	kV	%	kV	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%	kV	%
Keith 230 kV	231.4	230.1	-0.58	230.6	-0.35	231.3	230.2	-0.48	230.2	-0.45	229.0	228.3	-0.31	228.5	-0.22	230.2	229.6	-0.26	229.8	-0.16
Malden C21J 230 kV	234.3	232.7	-0.69	233.6	-0.30	231.4	230.3	-0.47	230.4	-0.44	228.9	228.2	-0.33	228.4	-0.23	230.0	221.3	-3.76	223.0	-3.02
Malden C22J 230 kV	231.6	230.2	-0.60	230.7	-0.36	231.3	230.2	-0.48	230.3	-0.45	228.8	228.1	-0.32	228.3	-0.22	230.2	229.2	-0.41	229.5	-0.30
Leamington C21J 230 kV	235.5	234.1	-0.60	235.0	-0.21	233.2	232.5	-0.33	232.4	-0.35	229.2	228.1	-0.49	228.3	-0.38	228.7	220.9	-3.39	222.6	-2.66
Leamington C22J 230 kV	233.8	232.3	-0.64	233.0	-0.31	232.9	232.1	-0.34	232.1	-0.37	228.9	227.8	-0.48	228.1	-0.38	231.2	228.6	-1.11	229.0	-0.96
Lauzon C23Z 230 kV	229.0					226.5					224.3	216.1	-3.66	217.5	-3.02	228.6	228.2	-0.18	228.3	-0.14
Lauzon C24Z 230 kV	228.8	214.4	-6.32	219.1	-4.27	226.3	216.2	-4.46	215.5	-4.79	224.1	215.8	-3.68	217.3	-3.03	228.4	228.0	-0.18	228.1	-0.13
Chatham 230 kV	243.1	242.3	-0.35	243.2	0.04	241.7	241.9	0.09	241.7	-0.01	236.0					244.0	243.4	-0.23	243.5	-0.20
Keith 115 kV	123.8	121.7	-1.75	122.4	-1.19	124.1	122.7	-1.14	122.8	-0.99	122.8	121.5	-1.07	121.8	-0.85	123.5	123.4	-0.13	123.4	-0.08
Crawford J3E 115 kV	122.2	119.1	-2.54	120.0	-1.77						121.0	119.1	-1.52	119.5	-1.21	122.0	121.8	-0.14	121.8	-0.09
Crawford J4E 115 kV	122.5	119.4	-2.54	120.3	-1.77	121.3	118.4	-2.35	118.8	-2.08	121.2	119.4	-1.52	119.8	-1.21	122.2	122.1	-0.14	122.1	-0.09
Essex 115 kV	121.4	117.4	-3.31	118.5	-2.34	119.7	115.8	-3.27	116.0	-3.12	119.9	117.5	-1.97	118.0	-1.57	121.2	121.0	-0.14	121.0	-0.10
Windsor Transalta 115 kV	121.4	117.4	-3.33	118.6	-2.36	119.8	115.9	-3.28	116.0	-3.13	119.9	117.5	-1.99	118.0	-1.58	121.2	121.0	-0.14	121.1	-0.10
Walker Z1E 115 kV	121.3	117.2	-3.39	118.4	-2.41	119.7	115.7	-3.33	115.9	-3.18	119.8	117.4	-2.03	117.9	-1.61	121.1	121.0	-0.15	121.0	-0.10
Walker Z7E 115 kV	121.2	117.1	-3.39	118.3	-2.40	119.6	115.6	-3.33	115.8	-3.18	119.7	117.3	-2.03	117.8	-1.61	121.0	120.9	-0.15	120.9	-0.10
Ford Essex Z1E 115 kV	121.4	116.7	-3.94	118.0	-2.81	119.9	115.4	-3.69	115.6	-3.59	119.7	116.8	-2.37	117.4	-1.89	121.3	121.1	-0.15	121.1	-0.11
Ford Essex Z7E 115 kV	121.4	116.6	-3.94	118.0	-2.81	119.8	115.4	-3.69	115.5	-3.59	119.7	116.8	-2.37	117.4	-1.89	121.2	121.0	-0.15	121.1	-0.11
Lauzon 115 kV	121.5	116.4	-4.18	117.9	-2.99	119.9	115.3	-3.85	115.4	-3.77	119.6	116.6	-2.52	117.2	-2.02	121.3	121.1	-0.16	121.2	-0.12
Bell River K2Z 115 kV	120.9	115.7	-4.29	117.2	-3.02	119.3	114.6	-3.97	114.8	-3.81	119.0	115.9	-2.60	116.6	-2.04	120.7	120.5	-0.16	120.6	-0.12
Bell River K6Z 115 kV	120.1	114.9	-4.37	116.4	-3.08	118.5	113.7	-4.04	113.9	-3.88	118.2	115.1	-2.65	115.8	-2.08	119.9	119.7	-0.17	119.8	-0.12
Kingsville K2Z 115 kV	117.4	112.0	-4.59	113.5	-3.27	115.7	110.8	-4.24	111.0	-4.13	115.4	112.2	-2.77	112.9	-2.21	117.2	117.0	-0.17	117.0	-0.13
Kingsville K6Z 115 kV	117.5	112.1	-4.60	113.7	-3.25	115.9	110.9	-4.26	111.1	-4.11	115.5	112.3	-2.79	113.0	-2.20	117.3	117.1	-0.17	117.2	-0.13
Tilbury West 115 kV	118.2	112.9	-4.52	114.4	-3.22	116.6	111.7	-4.17	111.8	-4.07	116.3	113.1	-2.72	113.7	-2.18	118.0	117.8	-0.17	117.9	-0.12
Kent 115 kV	118.4	113.0	-4.51	114.6	-3.22	116.7	111.9	-4.16	112.0	-4.07	116.4	113.3	-2.72	113.9	-2.18	118.2	118.0	-0.17	118.0	-0.12

* Lauzon load was converted for this contingency Pre-ULTC

Appendix C Protection Impact Assessment

Hydro One Networks Inc.
483 Bay Street
Toronto, Ontario
M5G 2P5

PROTECTION IMPACT ASSESSMENT

LIMINGTON TS

NEW 75/125MVA 215.5/27.6/27.6KV TRANSFORMER STATIONS

PCT – 517

Executive Summary

Date: November 19, 2013

Prepared by:

P&C Planning Group

Disclaimer

This Protection Impact Assessment has been prepared solely for the IESO for the purpose of assisting the IESO in preparing the System Impact Assessment for the proposed connection of the proposed generation facility to the IESO–controlled grid. This report has not been prepared for any other purpose and should not be used or relied upon by any person, including the connection applicant, for any other purpose.

This Protection Impact Assessment was prepared based on information provided to the IESO and Hydro One by the connection applicant in the application to request a connection assessment at the time the assessment was carried out. It is intended to highlight significant impacts, if any, to affected transmission protections early in the project development process. The results of this Protection Impact Assessment are also subject to change to accommodate the requirements of the IESO and other regulatory or legal requirements. In addition, further issues or concerns may be identified by Hydro One during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with the Transmission System Code legal requirements, and any applicable reliability standards, or to accommodate any changes to the IESO-controlled grid that may have occurred in the meantime.

Hydro One shall not be liable to any third party, including the connection applicant, which uses the results of the Protection Impact Assessment under any circumstances, whether any of the said liability, loss or damages arises in contract, tort or otherwise.

Revision History

Revision	Date	Change
R0	November 19, 2013	Released

EXECUTIVE SUMMARY

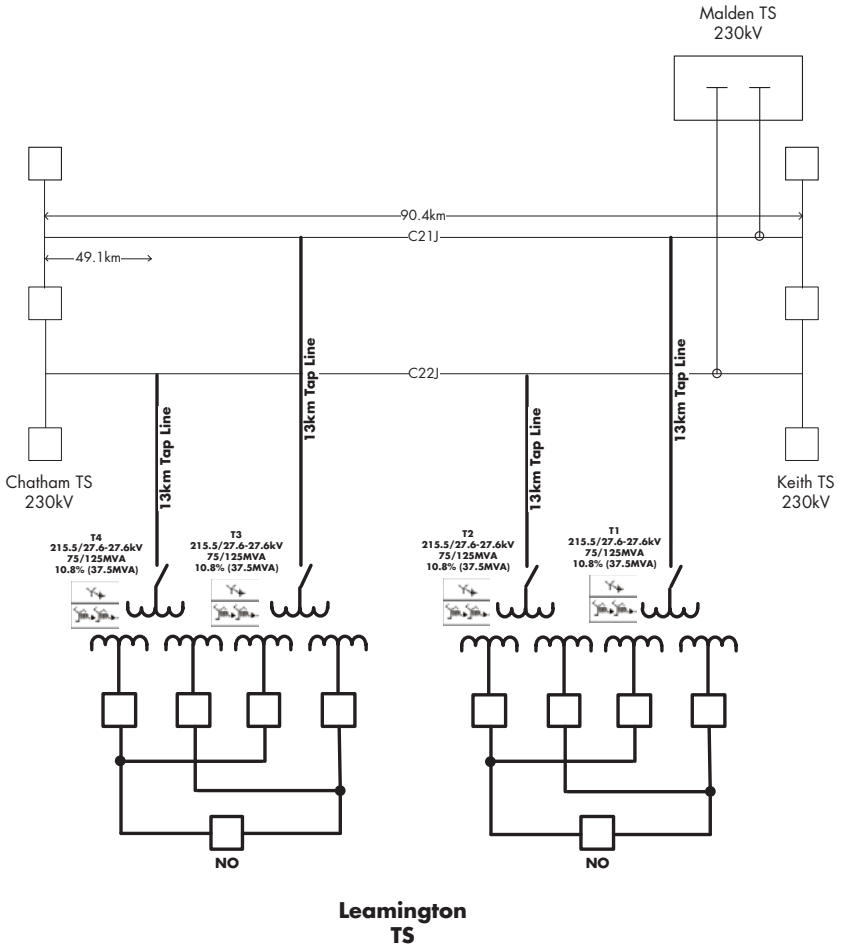

Figure #1 – Leamington TS on HONI Circuits C21J and C22J
(This figure is to be used for illustrative purpose only.)

The installation of the proposed DESN station connection is feasible as long as the proposed changes/additions are made.

PROTECTION HARDWARE

Existing protection "A" POTT and "B" POTT schemes of terminal stations have to be modified to receive the transfer trip signal from Leamington TS. Hardware addition may be required.

PROTECTION SETTING

Zone settings changes at both terminal stations are not required.

TELECOMMUNICATIONS

New dual communication links between Leamington TS and one of the terminal stations are required to send transfer trip signals. The cascading to the other terminal and other tapped facilities will be required.

Modifications in existing schemes at the selected terminal station are required to receive and cascade the transfer trip signals.

LEAMINGTON TS SITE

Standard transformer protections are required that are compliant with the requirements of Transmission System Code.

New communication links between Leamington TS and both terminal stations are required.

CUSTOMER IMPACT ASSESSMENT

483 Bay Street
Toronto, Ontario
M5G 2P5

CUSTOMER IMPACT ASSESSMENT

SUPPLY TO ESSEX COUNTY TRANSMISSION REINFORCEMENT PROJECT

Plan/Project # : **AR 17503**

Revision: **Final**

Date: **June 9, 2014**

Issued by: **Transmission System Development Department**
Network Development & Regional Planning Division
Hydro One Networks Inc.

Prepared by:

Hamid Hamadanizadeh
Senior Engineer/Officer
Transmission System Development

Reviewed by:

Ibrahim El Nahas, P.Eng.
Manager - Transmission Planning
Transmission System Development

DISCLAIMER

This Customer Impact Assessment was prepared based on preliminary information available about the proposed *Supply to Essex County Transmission Reinforcement Project*, consisting of construction of a 230/27.6-27.6 kV, 75/125 MVA transformer station in the Town of Leamington and construction of a connecting 13 km, double-circuit, 230 kV overhead transmission line between the new station and the existing 230 kV transmission lines. This report is intended to highlight significant impacts, if any, to affected transmission customers early in the project development process and thus allow an opportunity for these parties to bring forward any concerns that they may have, including those needed for the review of the connection and for any possible application for Leave to Construct. Subsequent changes to the required modifications or the implementation plan may affect the impacts of the proposed connection identified in this Customer Impact Assessment. The results of this Customer Impact Assessment and the estimate of the outage requirements are subject to change to accommodate the requirements of the IESO and other regulatory or municipal authority requirements. The fault levels computed as part of this Customer Impact Assessment are meant to assess current conditions in the study horizon and are not intended to be for the purposes of sizing equipment or making other project design decisions. Many other factors beyond the existing fault levels go into project design decisions.

Hydro One Networks Inc. shall not be liable, whether in contract, tort or any other theory of liability, to any person who uses the results of the Customer Impact Assessment under any circumstances whatsoever for any damages arising out of such use unless such liability is created under some other contractual obligation between Hydro One Networks Inc. and such person.

EXECUTIVE SUMMARY

Hydro One is planning the reinforcement of the supply to Essex County to address the supply capacity needs in the Windsor – Essex region, minimize the impact of outages, and ensure compliance with IESO's Ontario Resource and Transmission Assessment Criteria. These needs were identified in a planning study carried out by the Ontario Power Authority with input from Hydro One, the IESO and the Local Distribution Companies in the region. This Customer Impact Assessment (CIA) is concerned with the potential impact of this plan on the area customers.

The plan consists of:

- Construction of a 230/27.6-27.6 kV, 75/100/125 MVA DESN station in the Town of Leamington
- Construction of a connecting 13 km, double-circuit, 230 kV overhead transmission line from the Leamington station to the existing Chatham-Keith circuits C21J and C22J.
- Installation of Optic Ground Wire (OPGW) on the towers of the new line and existing C21J/C23Z towers (near Leamington Junction).

An assessment of voltage performance and loading capability of the transmission facilities in the area has been carried out and documented in an IESO System Impact Assessment (**SIA**) Draft Report of the proposed transmission reinforcement, "Leamington TS - Supply to Essex County Transmission Reinforcement Project", CAA ID 2013-507, June 9, 2014. The report concludes that with the allowed operation measures (use of Windsor SPS) voltage performance of all connection points remains within the Market Rules requirements and the thermal loading of the facilities remains within their ratings. The thermal overloads that require the use of operating measures are less significant with the incorporation of this project compared to the existing situation (without this project).

The following potential impacts on existing customers in the area are reviewed is this CIA:

- Short circuit impact
- Impact on customer power supply reliability.

The findings of this CIA are as follows:

1. The plan has no significant impact on Short-Circuit Levels in the area since it does not introduce additional sources of short circuit current. The distributed generators that are expected to connect to the low-voltage side of the new Leamington station are those that were previously planned to connect to the Kingsville station.

2. The plan does not result in deterioration of the area's customer power supply reliability. The new 13 km line tap to the existing Chatham-Keith circuits will marginally increase their exposure to faults; however, this will not result in increased disruptions to customers in normal conditions.

3. The plan will result in reduced frequency and amount of armed load rejection that would be required in the event of 230 kV supply interruption to Lauzon TS.

CUSTOMER IMPACT ASSESSMENT
SOUTH-ESSEX COUNTY TRANSMISSION REINFORCEMENT

1.0 INTRODUCTION

1.1 Background

The Ontario Power Authority (**OPA**) conducted a planning study for the Windsor - Essex region, with input from Hydro One Networks Inc (**Hydro One**), the Independent Electricity System Operator (**IESO**) and area Local Distribution Companies, to assess the supply adequacy and security in the region. The study identified the need to increase supply capacity in the region, minimize the impact of outages, and ensure compliance with IESO's Ontario Resource and Transmission Assessment Criteria (ORTAC). A map of the region is shown in Figure 1.

This Customer Impact Assessment (**CIA**) examines the impact of the recommended plan which consists of:

- **Leamington DESN Station**
  A new 230/27.6-27.6 kV, 75/100/125 MVA DESN transformer station will be built in the Town of Leamington. Six feeders will initially be provided at the station, and some load will be transferred to the new station from Kingsville TS.

- **Leamington DESN Connection Line**
  This new Leamington station will be supplied by a new 13 km 230 kV double-circuit overhead line which will be tapped from the existing Chatham to Keith circuits C21J and C22J at about 20 km east of Sandwich Junction.

A schematic diagram of the existing and proposed facilities is shown in Figure 2.

As part of the Connection Assessment and Approval (**CAA**) process, the IESO has carried out System Impact Assessment (**SIA**) of the proposed transmission reinforcement and has documented the findings in the draft SIA report CAA ID 2013-507, "Leamington TS - Supply to Essex County Transmission Reinforcement Project", dated June 9, 2014.

Hydro One has carried out this CIA to assess the impact that the proposed transmission reinforcement may have on facilities owned by load and generation customers in the Windsor - Essex area. This is in accordance with the requirements of the Ontario Energy Board Transmission System Code.

Transmission connected customers potentially impacted by the incorporation of this project were requested to provide comments to a draft report of this study. The 30-day review period ended on June 6, 2014. All comments received on the draft report were incorporated.

1.2 Customer List

Table 1 lists all transmission customers in the Windsor-Essex area.

Table 1: Transmission Customers in Area

No.	*Station*	*Supply Circuits*	*Connected Customer*
1	Keith TS	230 kV C21J, C22J, J5D 115 kV J3E, J4E, J1B, J2N	• Brighton Beach Power LP • West Windsor Power • Enwin Powerlines Ltd. • Essex Power Corp. • Hydro one Networks Inc.
2	Lauzon TS	230 kV C23Z, 24Z	• Enwin Powerlines Ltd. • Hydro One Networks Inc.
3	Malden TS	230 kV C21J, C22J	• Enwin Powerlines Ltd. • Essex Power Corp. • Hydro One Networks Inc.
4	Essex TS	115 kV J3E, J4E Z1E, Z7E	• Enwin Powerlines Ltd.
5	Crawford TS	115 kV J3E, J4E	• Enwin Powerlines Ltd.
6	Chrysler MTS, General Motors MTS, Ford Annex MTS, Ford Windsor MTS	115 kV E8F, E9F	• Enwin Powerlines Ltd.
7	Walker TS	115 kV Z1E, Z7E	• Enwin Powerlines Ltd.
8	Walker MTS #2	115 kV Z1E, Z7E	• Enwin Powerlines Ltd.
9	Ford Essex CTS	115 kV Z1E, Z7E	• Enwin Powerlines Ltd.
10	Windsor TransAlta CGS	115 kV Z1E	• TransAlta Energy Corporation
11	Belle River TS	115 kV K2Z, K6Z	• Hydro One Networks Inc.
12	Kingsville TS	115 kV K2Z, K6Z	• E.L.K. Energy Inc. • Essex Power Corp. • Hydro One Networks Inc.
13	Tilbury TS	115 kV K2Z	• Hydro One Networks Inc.
14	Tilbury West DS	115 kV K2Z	• Hydro One Networks Inc.
15	Comber WFCGS	230 kV C23Z, C24Z	• Comber Wind LP
16	Port Alma #1 WFCGS	230 kV C23Z, C24Z	• Kruger Energy Port Alma LP
17	Port Alma #2 WFCGS	230 kV C23Z, C24Z	• Kruger Energy Port Alma LP
18	Dillon WFCGS	230 kV C23Z	• Raleigh Wind Power Partnership
19	Gosfield WFCGS	115 kV K2Z	• Gosfield Wind LP
20	Pte-Aux Roches WFCGS	115 kV K6Z	• Pte-Aux Roches Wind Inc.
21	East Windsor CGS	115 kV E8F and E9F	• East Windsor Cogeneration LP

2.0 Customer Impact Assessment Scope

The purpose of this CIA is to assess the potential impacts of the proposed new transmission facilities on the existing connected load and generation customers in the Windsor Essex area. This is in accordance with the requirements of the Ontario Energy Board Transmission System Code.

A review of the following potential impacts on existing customers is conducted in this CIA:

- Short circuit impact at the connection point
- Impact on customer power supply reliability

3.0 SHORT-CIRCUIT STUDY ANALYSIS

The proposed transmission reinforcement has no significant impact on Short-Circuit Levels in the area since,

a) It does not create new or reinforced connection to the existing sources of short circuit current, i.e., it does not change the "Fault Impedance" in the area.

b) It does not add new sources of short circuit current. The distributed generators that are expected to connect to the low-voltage side of the new Leamington station are those that were previously planned to connect to the Kingsville station.

The impact of potential new generation that may apply in the future to connect to Leamington station or its connecting lines will be assessed at that time.

4.0 SUPPLY RELIABILITY TO CUSTOMERS

With the incorporation of the proposed plan, up to 95 MW of load will be transferred from Kingsville TS, which is supplied from the 115 kV transmission in the Windsor-Essex area, to the new Leamington TS, which will be supplied from the 230 kV transmission. The loads transferred will be primarily from within, and east of, the Town of Leamington. This transfer will alleviate concerns of thermal overload of the Kingsville TS supply circuits K2Z and K6Z following the loss of either supply circuit, and therefore eliminate the need for special operating measures at Kingsville TS such as opening of the bus tie breaker in the summer months when the station load exceeds line capability. It will also alleviate low voltage concerns at Kingsville TS for which the Windsor Area SPS is currently used to reject load at the station.

With the establishment of Leamington TS, loads in, and to the east of the Town of Leamington will be closer to the supply station. This will improve the reliability for these loads by reducing their exposure to supply interruptions caused by faults in the distribution system.

The transfer of load to Leamington TS will ease the loading on the Windsor-Essex 115 kV transmission facilities, which would require load rejection in the event of 230 kV supply interruption to Lauzon TS. With reduced loading on the 115 kV circuits, the frequency and the amount of arming of load rejections in the area to protect the system for double-circuit faults on the Chatham-Lauzon circuits will be reduced.

The new 13 km Leamington DESN tap lines will marginally increase the exposure of the existing 90 km circuits C21J and C22J to faults. However, under normal conditions, this will not deteriorate the reliability of supply for the customers since the system is always operated such that the loss of these two lines will not violate the system reliability requirements.

As a result of the above observations, it is expected that the plan will not result in deterioration of the area's customer power supply reliability.

The IESO SIA report concludes that the projects do not adversely affect the reliability of the grid. It further concludes that with the use of operating measures, thermal loading of transmission facilities remain within their capabilities, and that voltage performance at customer connection

points meets Market Rules requirements. This project will result in improvement of the system performance compared to the existing system.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This CIA report describes the impact of the proposed South-Essex County Transmission Reinforcement on the customers in the area.

The short-circuit levels at customer transmission connection points will not be materially affected as a result of this transmission reinforcement.

The proposed transmission reinforcement has no material adverse reliability impact on existing customers in the area.

The voltage assessment as reported in the SIA document shows that voltage performance remains within the Planning Criteria for all the scenarios studied.

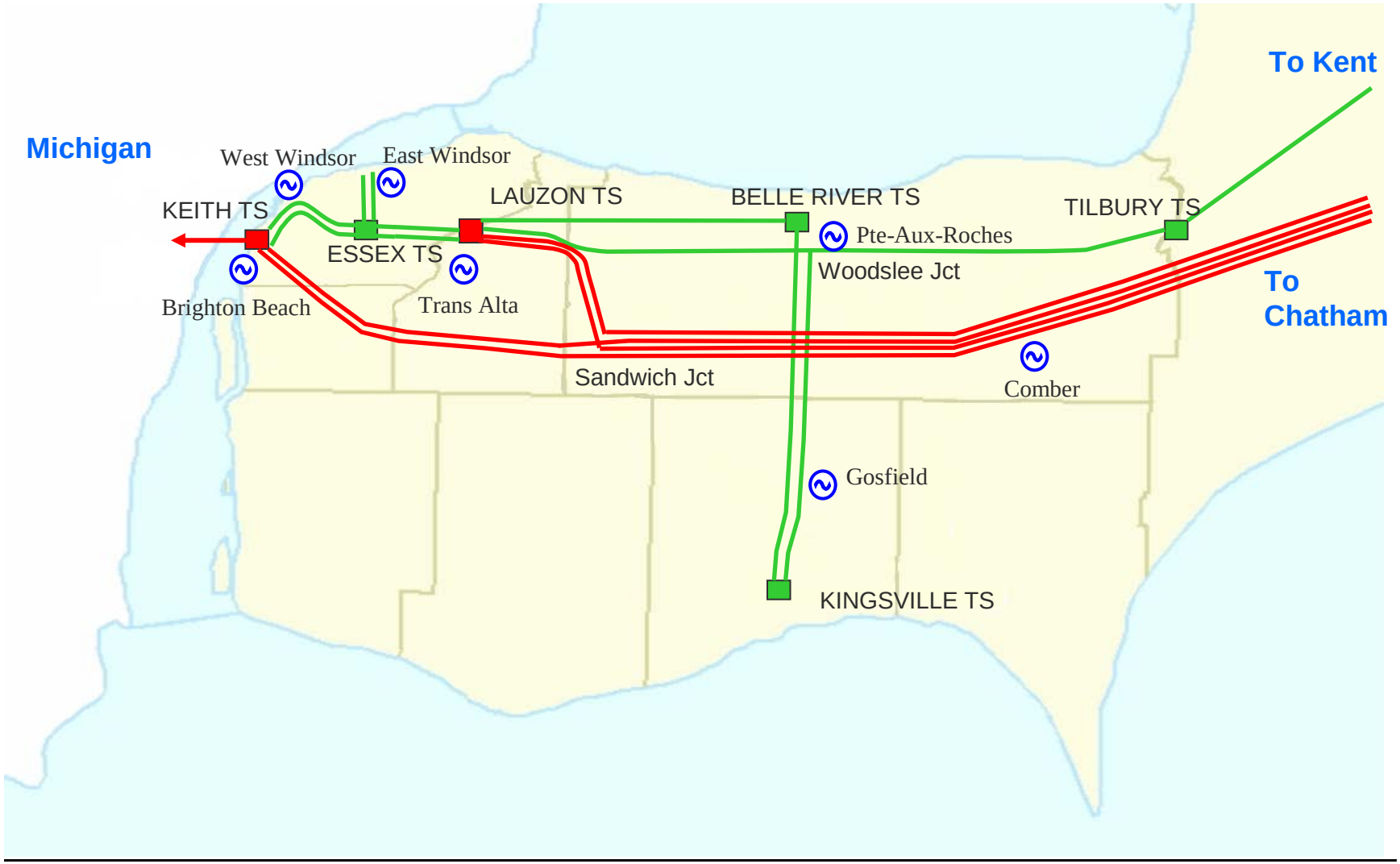

Figure 1: Map of Windsor – Essex Area: Existing Facilities

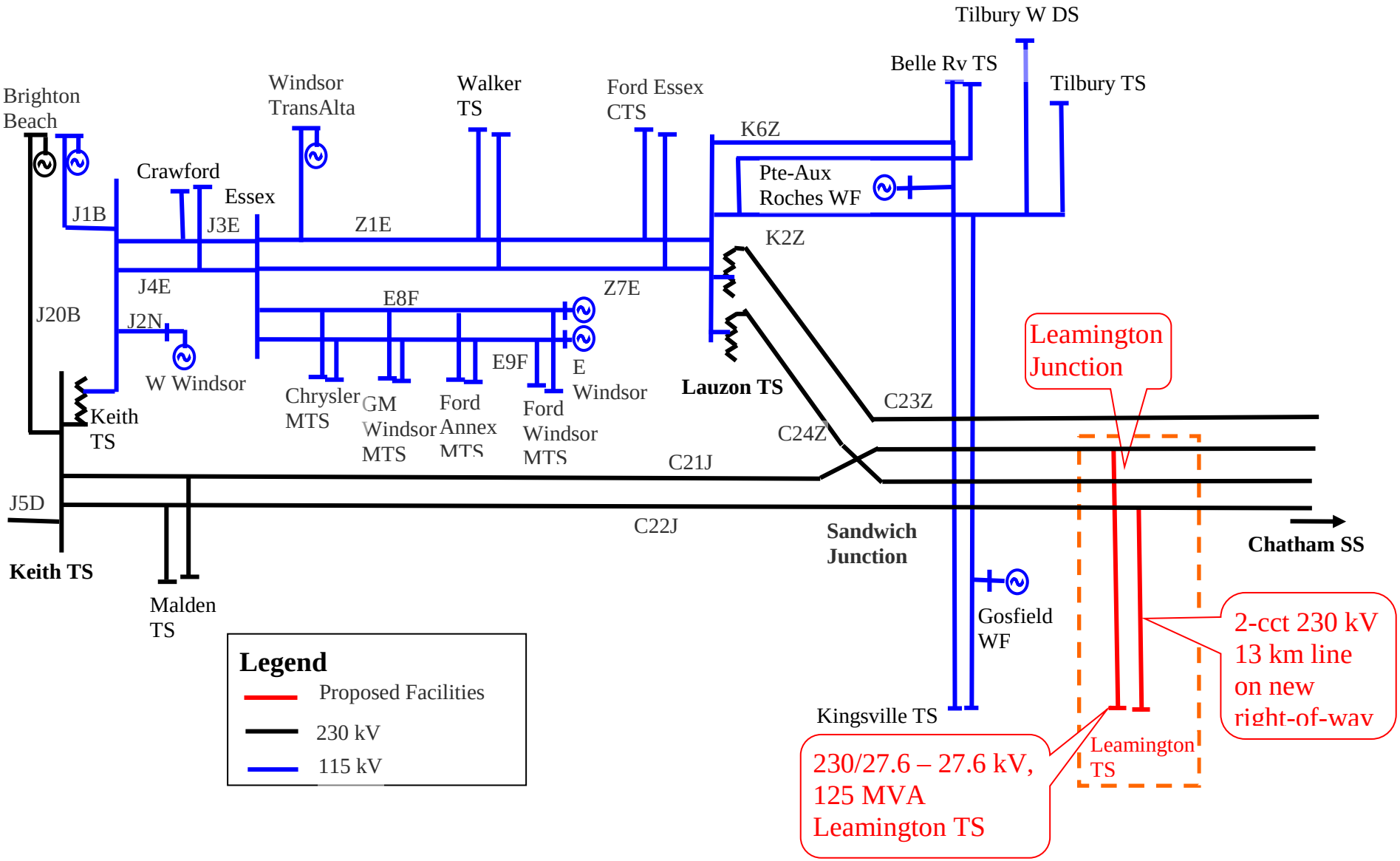

Figure 2: Schematic Diagram of Existing and Proposed Transmission Facilities