REPORT

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System Impact Assessment Report

CONNECTION ASSESSMENT & APPROVAL PROCESS

Issue 1.0

Final REPORT

Project: Essa x Stayner 230 kV Transmission
Applicant: Hydro One Networks Inc.

CAA ID 2005-190 &
CAA ID 2006-EX277

Transmission Assessments & Performance Department

October 18, 2006

SYSTEM IMPACT ASSESSMENT REPORT
Essa TS Reconfiguration &
Essa x Stayner 230 kV Transmission

System Impact Assessment Report

Essa x Stayner 230 kV Transmission

Acknowledgement

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

Disclaimers

IESO

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

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

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

HYDRO ONE

Special Notes and Limitations of Study Results

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

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

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

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

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

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

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SIA Findings

Conclusions

This System Impact Assessment has examined the effect of the following transmission changes as proposed by Hydro One on the reliability of the IESO-controlled grid:

- reconfiguration of the Essa 230 kV switchyard and
- a new 230 kV double-circuit line between Essa TS and Stayner TS, a new 230/115 kV transmission station at Stayner and an upgraded 230/44 kV load supply transformer station to replace the existing Stayner TS.

The assessment of the Essa 230 kV switchyard reconfiguration concluded that:

- The modifications will result in an increase in the reliability of power supply to Parry Sound TS and Midhurst TS.
- The proposed reconfiguration will not introduce any new critical contingencies in the area.
- The post-contingency voltage declines for the new contingencies are small and well within the acceptable voltage decline range.
- The new contingencies do not result in thermal overloading of the remaining lines.

The assessment of the current system capability - with the Essa TS switchyard reconfiguration but before the other proposed reinforcements – identified a number of reliability concerns as listed below:

- Essa 230/115 kV autotransformers will reach their capacity limit by 2007
- Stayner TS peak load will exceed the station capability starting in the winter of 2011.
- Meaford TS peak load is expected to exceed the station capability shortly after winter of 2014.
- The existing loads at Meaford TS and Stayner TS meet the Market Rules' requirements for power factor.
- Thermal overloading of S2S could occur during winter peak loads following the loss of S2E. Thermal overloading of the 115 kV loop might also occur under conditions of high flow out of the Bruce complex for a double contingency on B560V and B561M. Current operating procedures allow the opening of the Stayner in-line breaker when post-contingency thermal overloading of the S2S and S2E loop is anticipated.
- Post-contingency voltage declines at Stayner TS under winter peak load conditions can be as high as 15%, far exceeding the IESO transmission assessment voltage decline criteria.
- The IESO deliverability guidelines for this area are met for a permanent fault associated with either S2S or S2E if the faulted section can be isolated and the load can be restored by load transfers within 30 minutes.

The assessment concluded that the proposed transmission facilities:

- will resolve the existing system reliability concerns identified above,
- will not have an adverse material effect on the reliability of the IESO-controlled gird,
- will result in improved load supply reliability to the area loads,
- eliminate post-contingency thermal overloads and excessive voltage declines.

Specifically, the studies concluded that:

- The specifications provided for the new 115 kV and 230 kV equipment meet the market rules and the Transmission System Code requirements for rated symmetrical short circuit duty, rated interrupting time and continuous maximum operating voltage.
- With the new 230 kV transmission the Stayner TS load will be supplied off the 230 kV system resulting in the reduced loading of the Essa 230/115 kV autotransformers to well below their thermal capability.
- The 115 kV circuit from Owen Sound TS to Stayner TS, namely S2S, will carry about 25 % less power as compared to the existing configuration. Hence, overloading of S2S following a critical 500 kV contingency is less likely to occur than in the current configuration.
- All new contingencies resulting from the addition of the new transmission produce only small voltage declines not exceeding 2.8% and will not have an adverse material impact on system reliability.
- The transmission upgrade strengthens the supply to the load at Stayner and greatly improves the voltage performance over the Essa x Hanover loop.

IESO’s Requirements for Connection

With respect to the proposed Essa 230 kV switchyard reconfiguration, the IESO requires that Hydro One install all the equipment needed to monitor the information required by the IESO on a continuous basis as described in Appendix 4.16 of the market rules.

With respect to the proposed new 230 kV double circuit line between Essa TS and Stayner TS, the new 230/115 kV transmission station and the upgraded 230/44 kV transformer station, the IESO requires that:

- Hydro One retain the existing UFLS facilities at Meaford TS and Stayner TS and/or install new facilities if the existing ones do not meet the Market Rules requirements.
- Hydro One follow the Transmission System Code technical requirements for tapped transformer stations supplying load and for new transmission lines. Existing protection settings must be revised as required.
- Hydro One commit to install voltage reduction capability at the new Stayner TS that can provide 3% and 5% voltage reduction within five minutes.
- Hydro One install all the equipment needed to monitor the information required by the IESO on a continuous basis as described in Appendix 4.16 of the Market Rules. The IESO requires that the status of all isolating disconnect switches and breakers as well as voltages at the new Stayner TS, and power flows over the new transformers and the new transmission lines be monitored on a continual basis.

Notification of Approval for Connection Proposal

It is recommended that Notification of Conditional Approval for the proposed reconfiguration of the Essa 230 kV switchyard be granted, subject to the IESO’s Requirements for Connection listed above.

It is recommended that Notification of Conditional Approval for the connection of the new 230 kV double circuit line between Essa and Stayner, the new 230/115 kV transmission station and the upgraded 230/44 kV transformer station be granted to Hydro One, subject to the IESO’s Requirements for Connection listed above. Hydro One has concluded that a formal CIA will not be required for the connected customers that participated in the area supply study since these customers are the only ones directly affected by the proposed facilities.

– End of Section –

System Impact Assessment Report

1. Project Description

Hydro One Network Inc, is proposing to establish a new 230 kV transmission corridor between Essa TS and Stayner TS to address the additional capacity requirements due to projected load growth in the Simcoe County as identified in the "Simcoe County Supply Study" report jointly prepared by Hydro One and the local utilities. The contents of this Report have been used extensively by the IESO as the basis for its assessment of the proposal.

As requested by Hydro One and in support of their approval processes the System Impact Assessment for the proposed work was divided in two stages:

- An Expedited Assessment was performed for the re-configuration of the existing Essa 230 kV switchyard (2006-EX277)
- A full System Impact Assessment was performed for the new 230 kV double circuit line between Essa and Stayner and the other station upgrades at Stayner TS(2005-190).

The results of both assessments are presented in this report.

The purpose of the System Impact Assessment is to evaluate the results of the studies and identify the benefit of the new facilities and their effect on system reliability.
The results of both assessments are presented in this report.

1.1 Essa 230 kV Switchyard Reconfiguration

Due to the existing configuration of the Essa transformer station (TS) 230 kV switchyard, there are certain breaker failure conditions that would result in the loss of significant customer loads. Hydro One is proposing to modify the circuit terminations at Essa 230 kV switchyard to eliminate this situation.

Diagram 1 is a single line diagram showing the existing Essa TS 230 kV switchyard. A breaker failure condition of AL26 would result in the loss of 230 kV circuits E26 and E27 supplying Waubaushene TS and Parry Sound TS. A breaker failure condition on HL7 would result in the loss of 230 kV circuits M6E and M7E supplying Midhurst TS, Orillia TS, Bracebridge TS and Muskoka TS.

Hydro One proposes to relocate the termination of circuit E27 from the Essa 230 kV A bus to the Essa 230 kV H bus, and to relocate circuit M6E from the Essa 230 kV H bus to the Essa middle 230 kV diameter.

The relocation of M6E to the middle diameter requires the installation of a new 230 kV breaker, new 230 kV breaker disconnect switches and a new 230 kV line disconnect, utilizing the four breaker positions of the diameter such that M6E and the 500/230 kV autotransformer T3 will be terminated in adjacent positions.

Diagram 2 is a single line diagram showing the proposed final configuration of the re-terminated Essa TS 230 kV switchyard.

Due to the re-terminations of E27 and M6E and the installation of a new breaker, Hydro One will also modify the existing line and bus protections to provide the required coverage.

The scheduled in-service date of this project is June 2007.

1.2 Essa to Stayner 230 kV Transmission

After the reconfiguration of the Essa 230 kV switchyard is complete, a new 230 kV transmission corridor will be established between Essa TS and Stayner TS to reinforce the supply to southern Georgian Bay area.

Presently the area loads are supplied from Stayner TS and Meaford TS which are connected to the single 115 kV line running from Essa TS to Owen Sound TS. The corridor includes circuit S2E from Essa TS to Stayner TS and S2S from Stayner TS to Owen Sound TS.

A single line diagram showing the proposed transmission additions, modifications and removals in Stage 2 is shown the Diagram 3.

As part of this plan, Hydro One proposes to:

- remove the existing single circuit 115 kV transmission line S2E and replace it with a new 27 km double circuit 230 kV line.
- establish a new 230 kV two-breaker single-diameter station at Stayner for the termination of the two new 230 kV circuits and a new 230kV/115 kV autotransformer.
- install a 75/100/125 MVA, 230/115 kV autotransformer at Stayner TS to maintain the 115 kV connection to Meaford TS,
- remove all unused 115 kV equipment at Stayner TS including the 115kV/44 kV transformers,
- relocate existing Stayner 115 kV buses A1 and A2 to maintain the 115 kV connection to Meaford TS via circuit S2S, if necessary
- relocate and/or replace low voltage 44 kV structures and other station buildings/structures, as required,
- replace the 44 kV feeder breaker for each of M2, M3 and M4
- replace the 44 kV transformer breaker for each of the two new DESN transformers.
- replace the 115 kV A1A2 breaker and the two associated 3-phase *breaker* disconnect switches
- provide two (2) 75/100/125 MVA, 230 kV/44 kV transformers.

Under the plan the existing 115 kV, 26.75 km single circuit line between Essa TS and Stayner TS is to be replaced with a double circuit 230 kV line. A new 230/115 kV autotransformer station will provide the connection to Meaford TS via one 125 MVA autotransformer located at Stayner TS. The Stayner TS DESN is to be upgraded from a 115/44 kV 50/83 MVA DESN to a 230/44 kV 75/125 MVA DESN with an additional three feeder positions, for a total of eight feeder positions.

Essa TS 230 kV arrangement is to be re-configured as shown in Diagram 3 and described below to provide the new 230 kV circuit terminations.

A new 230 kV breaker will be added in the spare position between AL8 and L7L8 and create a new position for one of the new 230 kV circuit. The connection of the 230/115 kV autotransformer T1 will be moved to bus H and the 230 kV E9V circuit will be moved at the same location as the terminations of T3. The breaker position that is freed up by the relocation of T1 and E9V will be used for connecting the second new 230 kV circuit.

– End of Section –

2. Review of Connection Proposal

2.1 Connection Arrangement

The proposed Stayner TS will be equipped with two new 230 kV two-winding transformers that will be connected to the new 230 kV circuits from Essa TS, as shown in Diagram 3.

Each transformer will be connected to the IESO-controlled grid via one 230 kV motorized disconnect (not shown in the diagram) with a maximum operating voltage of 250 kV. The ratings of all other proposed equipment is described in section 3 of this report.

The exact location of the revenue meters has to be provided by the connection applicant as part of the Facility Registration process.

2.2 Power Factor

The Market Rules (Appendix 4.3) require that wholesale customers and distributors connected to the IESO-controlled grid shall operate at a power factor within the range 90% lagging to 90% leading as measured at the defined meter point.

Power factor correction devices in the form of low voltage shunt capacitors are normally used to provide compensation for loads that draw excessive reactive power from the system. At times with the low voltage shunt capacitors in service it is possible to have reactive power being injected from the low voltage side via the distribution transformers into the transmission system when active power is being consumed. A better measurement of the leading or lagging characteristic of the load together with the available reactive compensation is the actual load angle. Using the load angle, the power factor range required by the market rules translates into an angle range of $\pm$0.45 radians.

Low voltage shunt capacitors are available at both Meaford TS and Stayner TS. Meaford TS is equipped with one 17 Mvar 44 kV shunt capacitor and Stayner TS has two 20 Mvar and one 22 Mvar shunt capacitors available for service. IESO records indicate that the 2006 load power factor measured on the LV side at the existing Meaford TS and Stayner TS was for most part leading (reactive power was injected into the system) as indicated in Figure 1. This was most likely due to the LV shunt capacitors being in service. When the load power factor was lagging (with reactive power being drawn from the system) for the most part the power factor was within the acceptable range. In Figure 1, the instances when the power factor is outside the required range represent situations when the shunt capacitors were unavailable.

Our calculations indicate that the existing load at Meaford TS and Stayner TS meet the Market Rules' requirements for power factor.

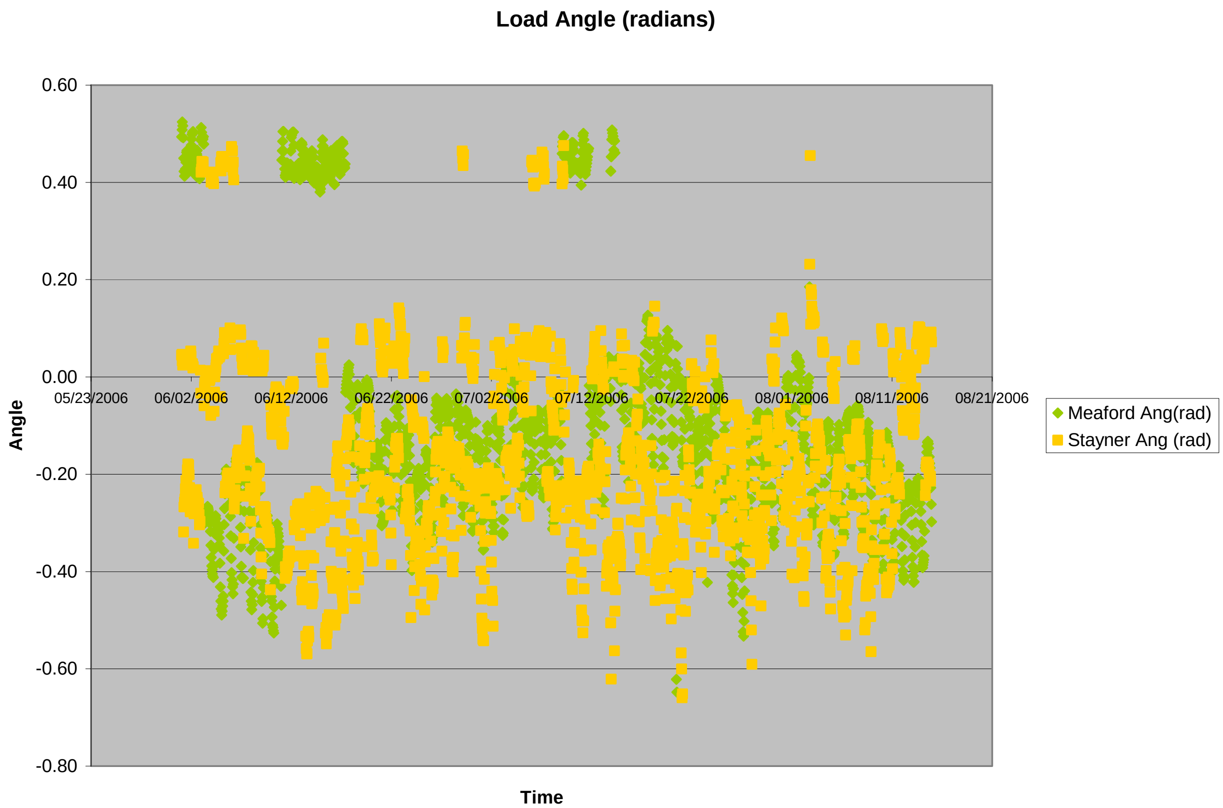

Figure 1. Power Angle at Meaford and Stayner for 2006

2.3 Underfrequency Load Shedding Requirements

The Market Rules (Chapter 5 section 10.4) require that each distributor and connected wholesale customer, in conjunction with the relevant transmitter, make arrangements to enable the automatic disconnection of up to 35% of its peak demand for system under-frequency conditions. To meet this requirement, an under-frequency load shedding (UFLS) scheme must be installed at the station. The single line diagram does not show the presence of the UFLS scheme.

Underfrequency automatic load shedding should be provided by tripping 44 kV feeder breakers to achieve:

- automatic load shedding of 12% of station load at a nominal set point of 59.3 Hz and
- automatic load shedding of an additional 23% of station load at a nominal set point of 58.8 Hz, for a total load reduction of 35% of the total station load.

The underfrequency threshold relays shall be set to a nominal operating time of 0.30 second, from the time when the frequency passes through the set point to the time of circuit breaker trip initiation (including any communications time delay), when the rate of frequency decay is 0.2 Hertz per second.

Hydro One will identify the UFLS feeder selection closer to the commissioning date and review the selection through the initial loading stages.

Hydro One is required to retain the existing UFLS facilities at Meaford TS and Stayner TS and/or install new facilities if the existing ones do not meet the Market Rules requirements.

2.4 Voltage Reduction Facilities Requirements

The market rules (Chapter 4 Appendix 4.3) require that distributors connected to the IESO controlled grid with directly connected load facilities of aggregated rating of 20 MVA or more and the capability to regulate distribution voltage under load, shall install and maintain facilities to provide voltage reduction capability to achieve load reduction during periods when supply resources are limited. Voltage reduction capability represents the capability of reducing demand by lowering the customer voltage by 3% or 5% within five minutes of receipt of the direction from the IESO.

Hydro One is required to commit to install voltage reduction capability at the new Stayner TS that provides 3% and 5% voltage reduction within five minutes.

2.5 On-line Monitoring

The market rules (Chapter 4 section 7.4) require that each transmitter shall provide the IESO on a continual basis with on-line monitored quantities as specified in Appendix 4.16. It is required that Hydro One install all the equipment needed to monitor the information required by the IESO on a continuous basis. The IESO requires that the status of all isolating disconnect switches and breakers as well as voltages at the new Stayner TS, and power flows over the new transformers and the new transmission lines be monitored on a continual basis.

2.6 Protection Systems

With respect to the protection and telecommunication requirements, Hydro One will have to follow the Transmission System Code technical requirements for transmission lines and tapped transformer stations supplying load.

The existing protection systems are to be revised as required.

2.7 Customer Impact Assessment

Hydro One Networks Inc.-Transmission, Barrie Hydro Distribution Inc., COLLUS Power Corp., Honda of Canada Manufacturing, Innisfil Hydro Distribution Systems Limited, Midland Power Utility Corp., Wasaga Distribution Inc. and Hydro One Networks Inc.-Distribution were joint participants in the study to determine suitable reinforcement for the existing facilities supplying the Simcoe County Area. The joint study addressed all of those concerns that would normally be addressed through the Customer Impact Assessment (CIA). Since COLLUS Power Corp., Wasaga Distribution Inc. and Hydro One Networks Inc.-Distribution are the only load customers directly affected by the upgraded Southern Georgian Bay facilities, Hydro One concluded that a formal CIA will not be required for these customers.

– End of Section –

3. Data Verification

Hydro One has provided the following equipment specifications for the new facilities proposed for installation in both project stages:

Essa TS 230 kV Switchyard

1. 230 kV Bus Work
    - Summer Continuous Rating – 4000 A

2. 230 kV breakers- Stage 1 & 2
    - Type – General Purpose
    - BIL – 900 kV
    - Continuous maximum operating voltage – 250 kV
    - Rated interrupting time – 3 cycles (50 ms)
    - Continuous current rating – 3,000 A
    - Short circuit symmetrical duty – 63 kA

3. 230 kV breaker disconnect switches - Stage 1 & 2
    - Type – Motorized Disconnect
    - Continuous maximum operating voltage – 250 kV
    - Continuous current rating – 3,000 A

4. 230 kV line disconnect switch –M6E
    - Type – Disconnect
    - Continuous maximum operating voltage – 250 kV
    - Continuous current rating – 2,000 A

Stayner TS 230 kV Switchyard

5. 230 kV Bus Work
    - Summer Continuous Rating – 2000 A

6. 230 kV breakers-
    - Type – General Purpose
    - BIL -900 kV
    - Continuous maximum operating voltage – 250 kV
    - Rated interrupting time – 3 cycles (50 ms)
    - Continuous current rating – 2,000 A
    - Short circuit symmetrical duty – 63 kA

7. 230 kV breaker disconnect switches
    - Type – Motorized Disconnect
    - Continuous maximum operating voltage – 250 kV
    - Continuous current rating – 2,000 A

8. 230 kV line disconnect switches
   - Type – Disconnect
   - Continuous maximum operating voltage – 250 kV
   - Continuous current rating – 2,000 A

9. 230/115 kV Autotransformer
   - Rating - 75/100/125 MVA,
   - Rated Voltage – 226 kV
   - Winding Configuration - HV wye solidly grounded/ LV wye solidly grounded/ TV delta,
   - Taps - Off Load 226/125 kV
     - Under-load tap-changer on the HV with +/-33.9 kV LL in 10 steps
   - Tertiary Rating - 40 Mvar lead or lag

Stayner 115 kV Equipment

Install one new 115 kV circuit breaker with a continuous rating of at least 1600A to replace the existing A1A2 breaker. The symmetrical interrupting capability of the breaker is to be at least 50 kA with a 3 cycle interrupting capability and BIL of 650 kV.
Install two 115 kV 3-phase *breaker* disconnect switches with a summer rating of at least 2000A.

Stayner TS – DESN

10. 230/44 kV 3 phase Transformers
    - Rating - 75/100/125 MVA,
    - Rated Voltage – 215.5 kV
    - Winding Configuration - HV wye ungrounded/ LV wye grounded via 5 ohm neutral reactor
    - Taps - underload tapchanger on HV

11. 230 kV Motorized Disconnect Switches
    - Type – Motorized Disconnect
    - Continuous maximum operating voltage – 250 kV
    - Rating – 200 MVA

12. 44 kV Equipment
    - Six new 44 kV feeder breakers with a 3-phase symmetrical interrupting capability of at least 20 kA and a continuous rating of 1200A. Three of them will replace the existing feeder breakers on M2, M3 and M4. The other three breakers will be used for the new feeders.
    - Two 44kV transformer breakers with a 3-phase interrupting capability of at least 12.5 kA and a continuous rating of 2000 A.
    - If inadequate, replace the 44 kV buses.

The specifications provided for the new 115 kV and 230 kV interrupting devices meet the Market Rules and the Transmission System Code requirements for rated symmetrical short circuit duty, rated interrupting time and continuous maximum operating voltage.

The double circuit 230 kV line will be approximately 27 km long with the following characteristics:

- Conductor Size: 795 MCM, 26/7
- Summer Rating – 840 A continuous, 1220 A 15 minute LTR,

- Maximum Operating Voltage – 250 kV
- Security Level – Class b

– End of Section –

4. System Description

4.1 Existing Transmission

Simcoe County load is supplied by a number of 230 kV and 115 kV circuits as shown in Diagram 4. In particular, Southern Georgian Bay is supplied by two transformer stations connected to one single 115 kV circuit which extends from Essa 115 kV switchyard to Owen Sound TS. Circuits S2E, from Essa TS to Stayner TS, and S2S, from Stayner TS to Owen Sound TS form the single 115 kV power supply to this area.

The report prepared in 2004 by Hydro One and the local utilities identifies a number of problems specific to the supply to Stayner and Meaford loads and also recommends various transmission solutions to alleviate these problems. The report concludes that:

- Meaford TS is expected to reach the station capacity limit by winter 2006;
- The 230/115 kV autotransformers at Essa TS are expected to be at their capacity limit by 2007;
- Stayner TS is currently experiencing voltage deficiencies during winter peak periods. It is expected to be below operation and planning standards in peak loading periods by summer 2007. A load rejection scheme was installed at Stayner TS ten years ago to reduce the risk of a voltage collapse in the area in the event of a contingency;
- Meaford TS is currently experiencing voltage deficiencies on long distribution lines supplying load that was originally transferred from Stayner TS in the last decade; and
- distribution lines emanating from Meaford TS are currently at capacity. These lines are supplying loads close to Stayner. However, voltage deficiencies at Stayner TS prohibit the transfer of these loads from Meaford TS to Stayner TS.

The solution proposed to alleviate these problems include, as described in Section 1, a new double circuit 230 kV line from Essa to Stayner, a new 230/115 kV transmission station and an upgraded transformer station at Stayner TS.

4.2 Area Loads and Load Growth

Historical records for winter and summer peak loads were used to assess the capability of the transformer stations and area transmission.

Load Assumptions for Transformer Station Capability Assessment

IESO historical station peak loads for Meaford TS and Stayner TS under winter and summer conditions were used to assess the load meeting capabilities of the transformer stations in the next 10 years. Records of the non-coincident peak loads are shown in Table 1 and Table 2 respectively.

Table 1. Actual Winter Station Peak Loads (non-coincident)

Monitored Facility (MVA)	***Winter LTR***	***2003***	***2004***	***2005***	***2006***
Meaford TS	60.8	53.9	58	54	52
Stayner TS	126.5	105.8	131	126	120

Table 2. Actual Summer Station Peak Loads (non-coincident)

Monitored Facility (MVA)	***Summer LTR***	***2003***	***2004***	***2005***	***2006***
Meaford TS	53.9	28	29	39	45
Stayner TS	111.6	86	89	89	102

The records indicate that Meaford and Stayner winter loads reached their peak in 2004 and have slightly declined since, but the summer peak loads have been steadily increasing.

Historical records also show that the power flow over the Essa 230/115 kV autotransformers reached 188 MVA this past winter (2005/6) and was well above the station capability of 158 MVA. Currently, the Essa 230/115 kV autotransformer supply Barrie TS, and the 115 kV loop to Stayner TS and Meaford TS. With the new 230 kV transmission the Stayner TS load will be supplied off the 230 kV system resulting in the reduced loading of the Essa 230/115 kV autotransformers to well below their thermal capability.

Load forecasts provided by Hydro One indicate that electrical load growth in the Simcoe County area is expected to continue at a summer average rate of 3.1% per year and a winter average rate of 2.7% per year, for the next ten years. However the individual stations loads may be projected to increase at a slightly different rate as indicated by the individual utilities. Load growth factors for the specific stations were obtained from Hydro One load forecast and used in the calculations presented in the next two tables.

Table 3. Winter Station Peak Load Projections

Monitored Facility (MVA)	***Station LTR (MVA)***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***
Meaford TS	60.8	54.3	55.7	56.2	56.7	57.2	57.7	58.2	58.7
Stayner TS	126.5	121.4	122.8	123.9	125.4	126.9	128.5	130.0	131.6

Table 4. Summer Station Peak Load Projections

Monitored Facility (MVA)	***Station LTR (MVA)***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***
Meaford TS	53.9	47.0	48.9	49.4	50.0	50.5	51.0	51.7	52.2
Stayner TS	111.6	103.3	106.0	107.1	108.5	109.9	111.4	112.8	114.5

It can be concluded that the power transfer capability of the distribution transformers at Stayner TS will be exceeded starting in the winter of 2011.

Load Assumptions for Transmission Capability Assessment

The transmission system capability was assessed using IESO historical loads coincident with Ontario winter and summer peak loads until 2010 instead of the non-coincident station peak loads as in the assessment of transformer station capability, . The 2010 summer and winter loads were obtained by starting with area peak loads corresponding to the hottest summer (2005) and the coldest winter (2003). The station loads were then scaled up by a factor of 6.2% for summer and 9% for winter, as provided by IESO load forecast. The results are summarized below.

Table 5. 2010 Area Loads Coincident with Peak System Conditions

Station	***Summer***		***Winter***	
	MVA	***PF***	***MVA***	***PF***
Palmerston	49.1	0.88	60.4	0.95
Barrie	119.6	0.87	147.0	0.93
Hanover	96.2	0.89	110.9	0.95
Meaford	30.4	0.89	48.3	0.95
Owen Sound	104.2	0.92	147.5	0.96
Stayner	94.8	0.91	110.9	0.95

4.3 Deliverability Criteria

The deliverability levels for the IESO Controlled Grid are defined in the current IESO Supply Deliverability Guidelines. The guideline applicable to the Stayner-Meaford area is as follows:

For loads between 75MW and 150MW:
With all transmission elements in service, for any single element contingency that results in a supply interruption of between 75MW and 150MW, all load should be restored by switching operations within a typical period of 30 minutes.

The 115 kV line between Owen Sound and Essa has two sections separated by one in-line breakers located at Stayner TS between the two transformers. There is an additional circuit switcher available at Meaford TS which allows the Meaford load to be supplied either from Essa or Owen Sound. The breaker and the circuit switcher allow the load to be supplied from either the Essa end or the Owen Sound end in the event of a permanent fault associated with one of the sections.

Table 6 below gives a summary of the possible permanent contingencies, the corresponding load loss and the available measures for load transfer for a load corresponding to 2007 winter peak.

Table 6. 2007 Winter Peak – Maximum Loss of load due to contingency

Section Permanently Faulted	***Immediate Load Loss (MVA)***	***Load restored by transfer (MVA)***	***Unsupplied Load***	***Comments***
S2S (Owen Sound to Stayner)	53.6	53.6 (to Essa)	0	Voltage decline criteria is exceeded
S2E	0		0	Voltage decline criteria is exceeded

The IESO deliverability criteria for this area is met for a permanent fault on S2S or S2E if the faulted section can be isolated and the load restored by transfer within 30 minutes.

- End of Section -

5. Short Circuit Assessment

Because this project involves the connection of additional transmission facilities which results in a new 230 kV transmission loop a short circuit assessment is required. The purpose of this assessment is to identify if the new transmission proposal will result in short circuit currents that exceed rating of the existing equipment. Hydro One performed the short circuit studies and provided the results discussed in this section.

The following generation facilities were included in the system model used to perform the short circuit studies:

- 4 Sithe-Goreway units in service
- Portlands Energy Centre in-service.
- Parkway TS with four 500/230kV auto-transformers and with circuits V71R & V75R operated open.
- 8 Pickering units: Pic B G5-8, PicA G1 –G4
- GTAA generation – 44 kV buses at Bramalea TS and Woodbridge TS = 117 MW
- Renewable RFP contracts:
- Erie Shores Wind Farm (W8T) 99 MW
- Kingsbridge Wind Farm (Goderich TS) 39.6 MW
- Melancthon Grey Wind Farm (B4V) 200 MW
- 8 Bruce units: Bruce B G5-8, Bruce A G1-4
- 4 Darlington units
- 8 Nanticoke units
- 4 Lennox units

The following assumptions were made with respect to the transmission facilities and their operation as they were included short circuit model for the existing system configuration:

- Claireville TS 230 kV bus needs to be ***closed***
- Leaside TS 115 kV bus needs to be ***open***
- Richview TS 230 kV bus needs to be ***open***
- Cherrywood TS needs to be operated with separate north & south 230 kV switchyards, and the 230 kV buses at Cherrywood North TS & Cherrywood South TS need to be ***open***
- Hearn TS: 115kV bus open vertically.
- Cooksville TS 230 kV bus needs to be ***closed***
- Mid-point of Claireville TS to Parkway TS 230 kV circuits V71RP and V75P is ***closed***
- Ontario-Michigan phase shifters on neutral taps (minimum impedance taps)
- All new capacitor banks in service: Essa TS, Burlington TS, John TS, Leaside TS, Richview TS, & Trafalgar TS
- Circuit B3N in-service

The system model with Essa x Stayner included the double circuit 230 kV lines between Essa TS and the new Stayner TS, the 230/115 kV autotransformer and the upgraded 230/44 kV DESN supplying the Stayner load, with the electrical characteristics of the new equipment as detailed in Hydro One planning specifications.

Table 7: Short Circuit Study Results

BUS kV	**TOTAL FAULT CURRENT Symmetrical (kA)**						**Breaker Ratings Symmetrical (kA)***
	3-phase fault	**L-G**	**3-phase fault**	**L-G**	**3-phase fault**	**L-G**	
	Existing System		With 230 kV Reinforcement		Difference (kA)		
Essa 230 kV	22.1	25.7	22.1	25.8	0.0	0.2	63, 47
Essa 115 kV	11.4	13.5	10.4	12.5	-1.0	-1.0	22.7
Stayner 230 kV	-	-	11.3	9.1	11.3	9.1	63
Stayner 115 kV	5.0	3.3	6.0	6.5	1.0	3.2	22.7
Claireville 230 kV	67.4	74.3	67.4	74.3	0.0	0.0	80.0
Richview 230 kV north yard	54.4	54.8	54.4	54.8	0.0	0.0	69.5
Richview 230 kV south yard	54.4	51.9	54.4	51.9	0.0	0.0	69.5
Goreway 230 kV	29.1	32.5	29.1	32.5	0.0	0.0	63.0
Trafalgar 230 kV	49.9	51.4	49.9	51.4	0.0	0.0	63.0

*Based on a pre-fault voltage level of 250 kV and 127 kV for the 230 kV and 115 kV systems, respectively.

The results indicate that with the new transmission facilities in service, the short circuit currents will increase slightly at Essa 230 kV station and will decrease at Essa 115 kV. The proposed transmission will not result in short circuit levels exceeding the rating of the existing equipment.

– End of Section –

6. System Impact Studies

This connection assessment study focused on:

- identifying if the new contingencies introduced by the Essa 230 kV switchyard reconfigurations are more limiting than the current critical contingencies,
- providing supporting evidence that the existing 115 kV transmission between Essa and Owen Sound does not meet the IESO reliability requirements and
- identifying the effect of the proposed transmission additions and modifications on the IESO-controlled grid and their benefits.

The study was performed in two parts:

(A) the assessment of Essa 230 kV switchyard reconfiguration involving the evaluation of the impact of the critical contingencies on system voltages and thermal loadings, and

(B) the assessment of the proposed transmission reinforcement involving the evaluation of the impact of the critical contingencies on system voltages and thermal loadings, and a comparison between the performance of the existing system and the performance of the reinforced system.

The assumptions used in both parts of the studies are described below.

6.1 Study Assumptions

As a starting point, a 2008 extreme weather base case was used with all major Ontario generation stations and transmission elements in service along with the following power flows on the major Ontario transmission interfaces:

- FABC at 5140 MW
- FETT at 3300 MW
- BLIP at -1014 MW
- FS at 1203 MW
- QFW at 1530 MW

All renewable and other generation facilities that have already signed contracts with the Government or the OPA are assumed in service with the exception of Blue Highlands wind farm whose contract was cancelled due to a Force Majure situation.

Although the Georgian Bay area loads are higher in the winter, transmission restrictions are anticipated to occur in both winter and summer. Studies were therefore performed for both conditions.

Section 3.2 describes in detail the assumptions and rationale used in building the study scenarios. The following loads based on the 2010 forecast were used in the Essa to Hanover 115 kV loop:

Table 8. Station MVA Loads Used in the Study

	Barrie	***Stayner***	***Meaford***	***Owen Sound***	***Hanover***	***Palmerston***
Summer	119.6	94.8	30.4	104.2	96.2	49.1
Winter	147	110.9	48.3	147.5	110.9	60.4

6.2 Essa 230 kV Switchyard Reconfiguration (2006-EX277)

For the Essa 230 kV switchyard reconfiguration, this assessment investigated the severity of the new contingencies introduced by the proposed modifications.

With the current switchyard arrangement, a stuck breaker condition could result in complete loss of supply to Parry Sound TS and Waubaushene TS or the loss of the double-circuit 230 kV line to Minden TS. The reconfiguration will eliminate double line loss due to stuck breaker conditions. After the reconfiguration, the loss of both 230 kV circuits E26 and E27 or M7E and M6E will not occur.

The results of our assessment conclude that:

- the proposed reconfiguration will not introduce any new critical contingencies in the area,
- post-contingency voltage declines resulted from the new contingencies are small and well within the acceptable voltage decline range,
- the new contingencies will not cause thermal overloading, and
- the modifications will raise the reliability of the supply to Parry Sound TS, Waubaushene TS, Midhurst TS, Orilia TS, Muskoka TS and Bracebridge TS.

6.3 Essa to Stayner 230 kV Transmission

Transmission thermal loading assessment and voltage decline analysis were performed under the assumptions described in section 5.1.

A comparison between the performance of the existing Essa to Owen Sound transmission system and the proposed 230 kV reinforcement is described in the sections below.

6.3.1 Thermal Loading Assessment

Tables in Appendix A summarize the results of the thermal analysis for the existing transmission configuration and the new 230 kV transmission reinforcement.

<u>The results in Table A1 indicate that under the current system configuration, thermal overloads will not occur for the loss of S2S or S2E under winter system peak load conditions.</u> However, if Stayner TS load were replaced by its winter peak which is about 25 MVA or 22% higher than the load level used in the study, thermal overloading of S2S could occur following the loss of S2E. Thermal overloading of the 115 kV loop might also occur under conditions of high flow out of the Bruce complex for a double contingency on B560V and B561M. Current operating procedures allow the opening of the Stayner in-line breaker when post-contingency thermal overloading of the S2S and S2E loop is anticipated.

To assess the effect of the new transmission on the possible post-contingency overloading of S2S, a comparison was performed between the pre-contingency steady state power flows and voltages with and without the transmission reinforcement. Results are tabulated below:

Table 9. Steady State Comparison of Power Flows and Voltages

	Owen Sound to Meaford	*Meaford to Stayner*	*Voltage at Meaford*
No Reinforcement	137 MW, 1 Mvar	86 MW, - 22.6 Mvar	118.7 kV
With Reinforcement	102 MW, -9.6 Mvar	52.4 MW, -21.8 Mvar	122.8 kV

Results in Table 9 indicate that for the same system conditions with the new transmission, the 115 kV circuit from Owen Sound to Stayner will carry about 25 % less power. The transmission upgrade therefore greatly reduces the possibility of having the 115 kV loop thermal overloaded.

Additional study results with the new transmission reinforcement are summarized in Tables A2 and A3 for both winter and summer peak system conditions, respectively. A large number of contingencies were simulated with the most thermally impacted transmission elements monitored. The results conclude that the transmission reinforcement will not introduce contingencies that may cause thermal overloading of any of the existing or new transmission elements.

The results also show that the loss of B4V and B5V and the loss of B560V and B561M (with one unit G/R) are the most impactive contingencies and the post-contingency flow on S1H or S2S is less than 3% below the thermal limit. If the Blue Highlands wind farm were in service, S1H or S2S would be overloaded. However, these overloads are not the result of the transmission reinforcement which is the subject of this assessment but the result of the deficiencies of the transmission out of the Bruce Complex.

6.3.2 Voltage Assessment

The IESO's market rules (Appendix 4.1) require the minimum continuous voltage be 113 kV at 115 kV stations and the IESO Transmission Assessment Criteria (Section 4.3 “Voltage Change Limits”) require the voltage declines following a recognized contingency be limited to less than 10%.

For the existing transmission system configuration, the voltage decline analysis was performed for the summer and winter peak system scenarios to determine which is the most limiting. Results are summarized in Tables B1 and B2. From the tables it can be concluded that the most severe voltage decline far exceeding the IESO voltage decline criteria occurs at Stayner TS during winter peak load conditions upon the loss of S2E.

The overall worst operating condition for the FABC interface and the Essa x Hanover 115 kV loop is with high negative BLIP and high FETT flow. However, with the 230 kV transmission reinforcement, conditions of high flows from Essa into the Stayner x Hanover loop might become critical. Therefore, simulations were performed for:

(a) a scenario with high west to east flows where the FETT flow is set at 3300 MW and the NBLIP flow at 1014 MW, and
(b) a scenario with high east to west flows where the FETT flow is set at 213 MW and the BLIP flow at 2709 MW.

For uncovering voltage problems caused by changes in the transmission system, only the new contingencies due to network changes need be assessed. Since, as part of the transmission changes, the Stayner load will be transferred away from the 115 kV loop and placed in the 230 kV system, the 115 kV loop will no longer be characterized by its bad winter voltage performance. Summer instead of winter peaks will become the worst operating condition for the loop from Essa to Hanover. Study results under summer peak loads are summarized in Table B3 and B4. Note that all except the first one, i.e. the loss of B560V and B561M, in the tables are new contingencies resulting from the transmission changes. As shown in the tables, all new contingencies produce only small voltage declines not exceeding 2.8% and so will not have an adverse impact on system reliability.

The most critical contingency, i.e. the loss of B560V and B561M with one Bruce unit G/R, in Table B3 will still result in excessive voltage declines due to deficiencies in the transmission out of the Bruce complex, which is the expected outcome.

The transmission upgrade therefore not only strengthens the supply to the load at Stayner after converting a single 115 kV circuit to two 230 kV circuits but greatly improves the voltage performance over the Essa x Hanover loop.

– End of Report –

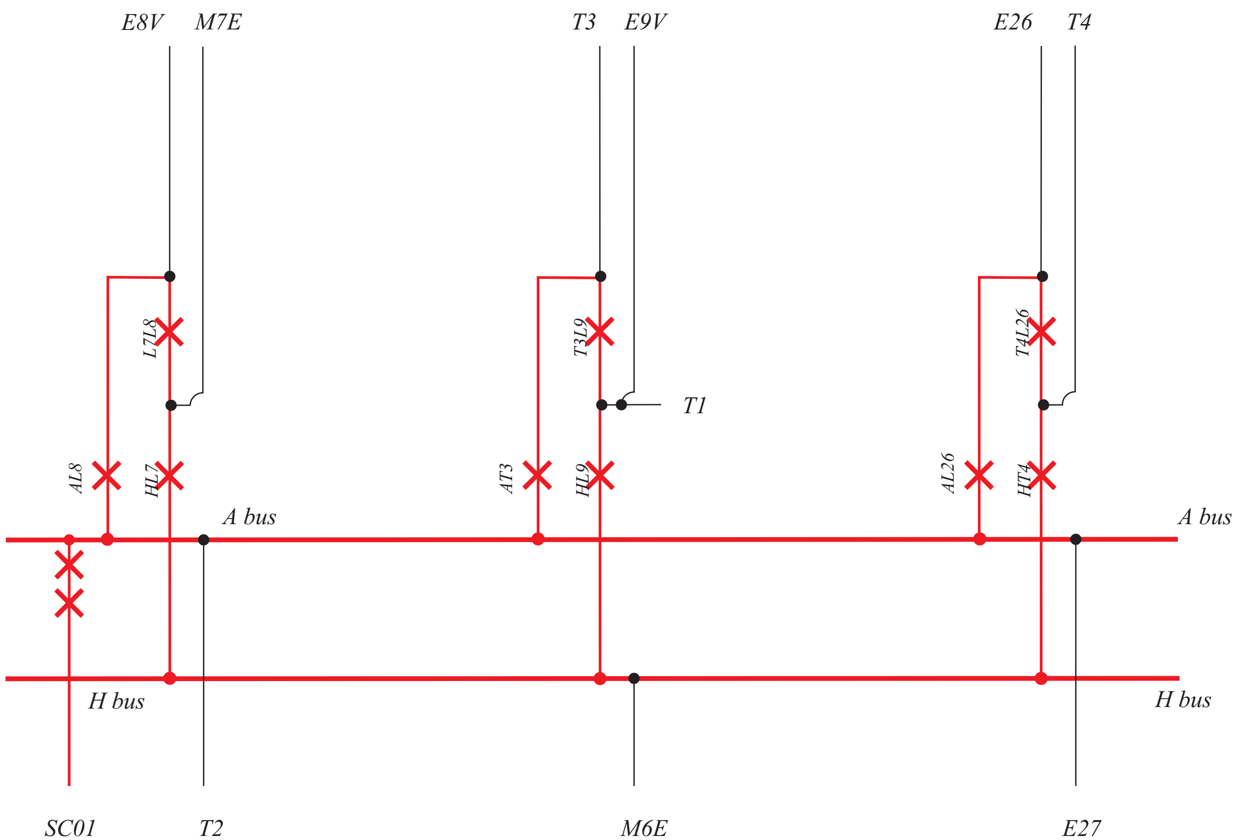

DIAGRAM 1. **Essa TS Existing 230 kV Switchyard Single Line Diagram**

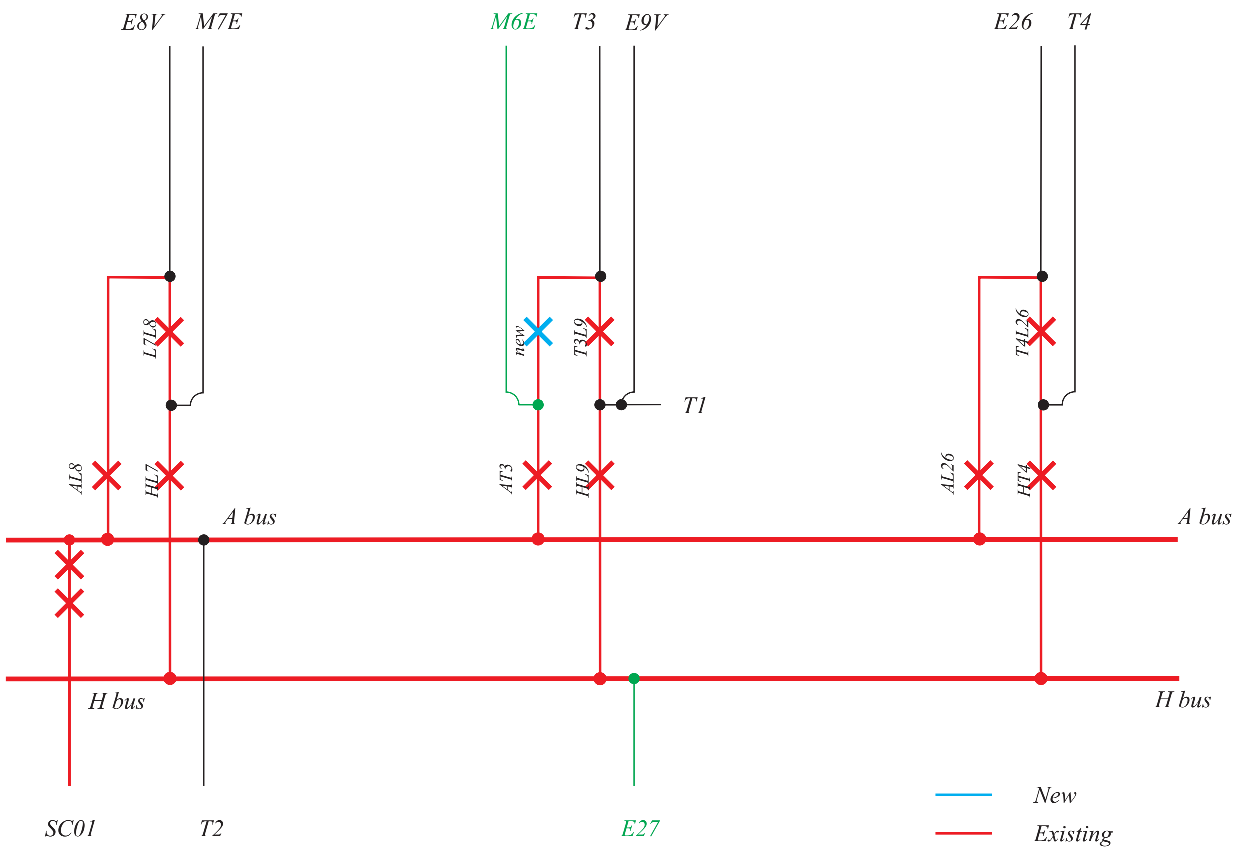

DIAGRAM 2. **Essa TS Reterminated 230 kV Switchyard Single Line Diagram**

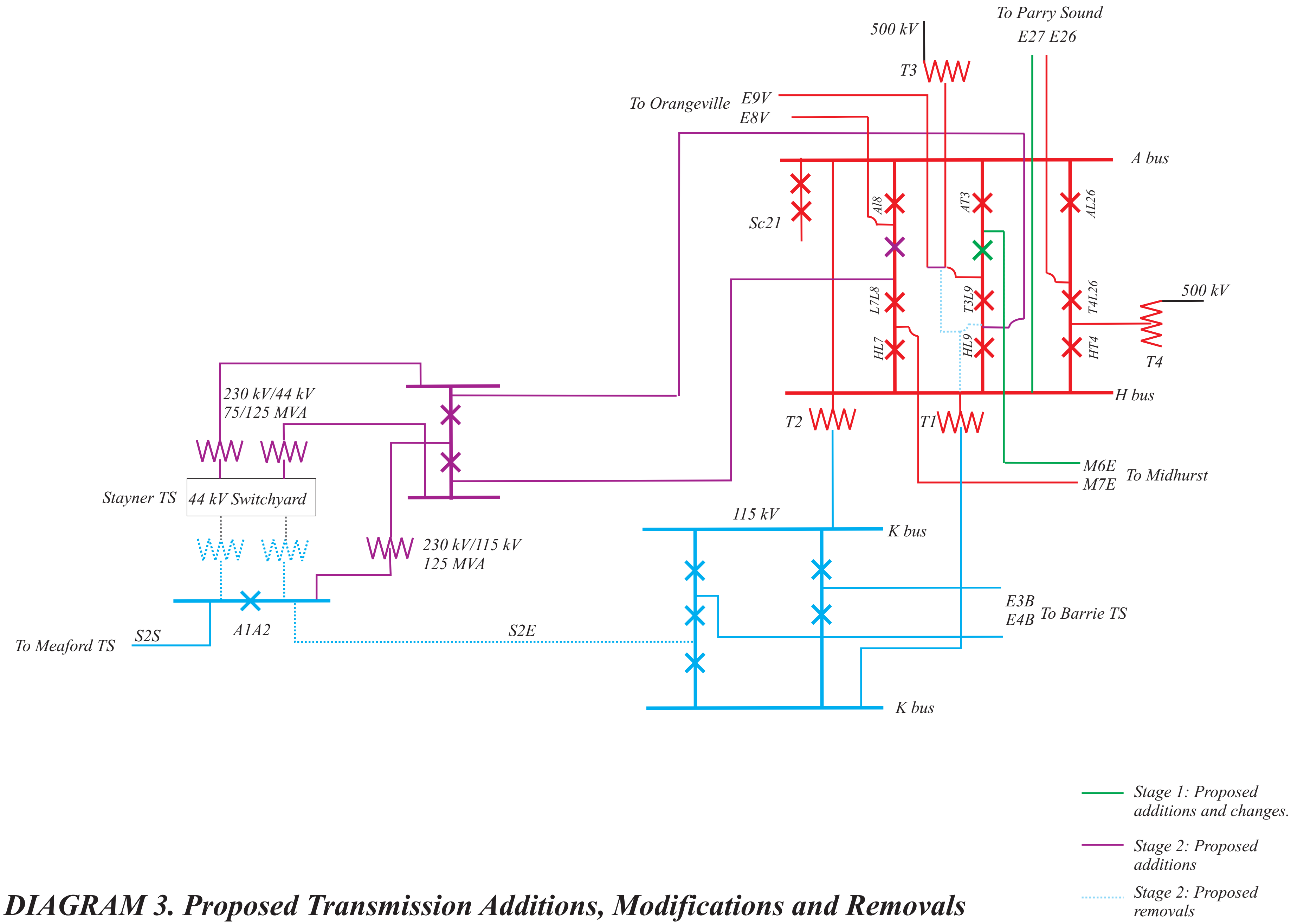

DIAGRAM 3. Proposed Transmission Additions, Modifications and Removals

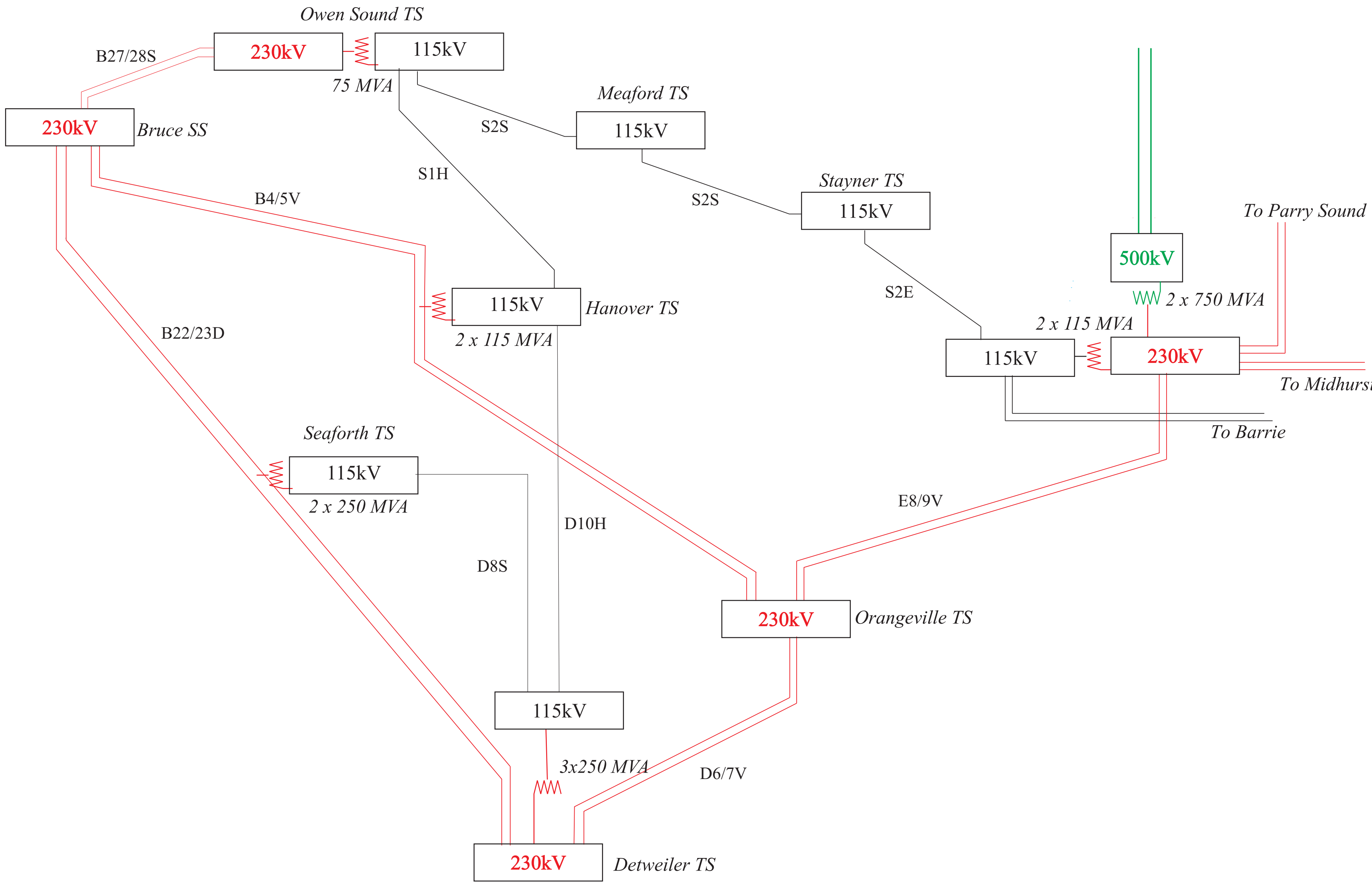

DIAGRAM 4. Existing Area Transmission

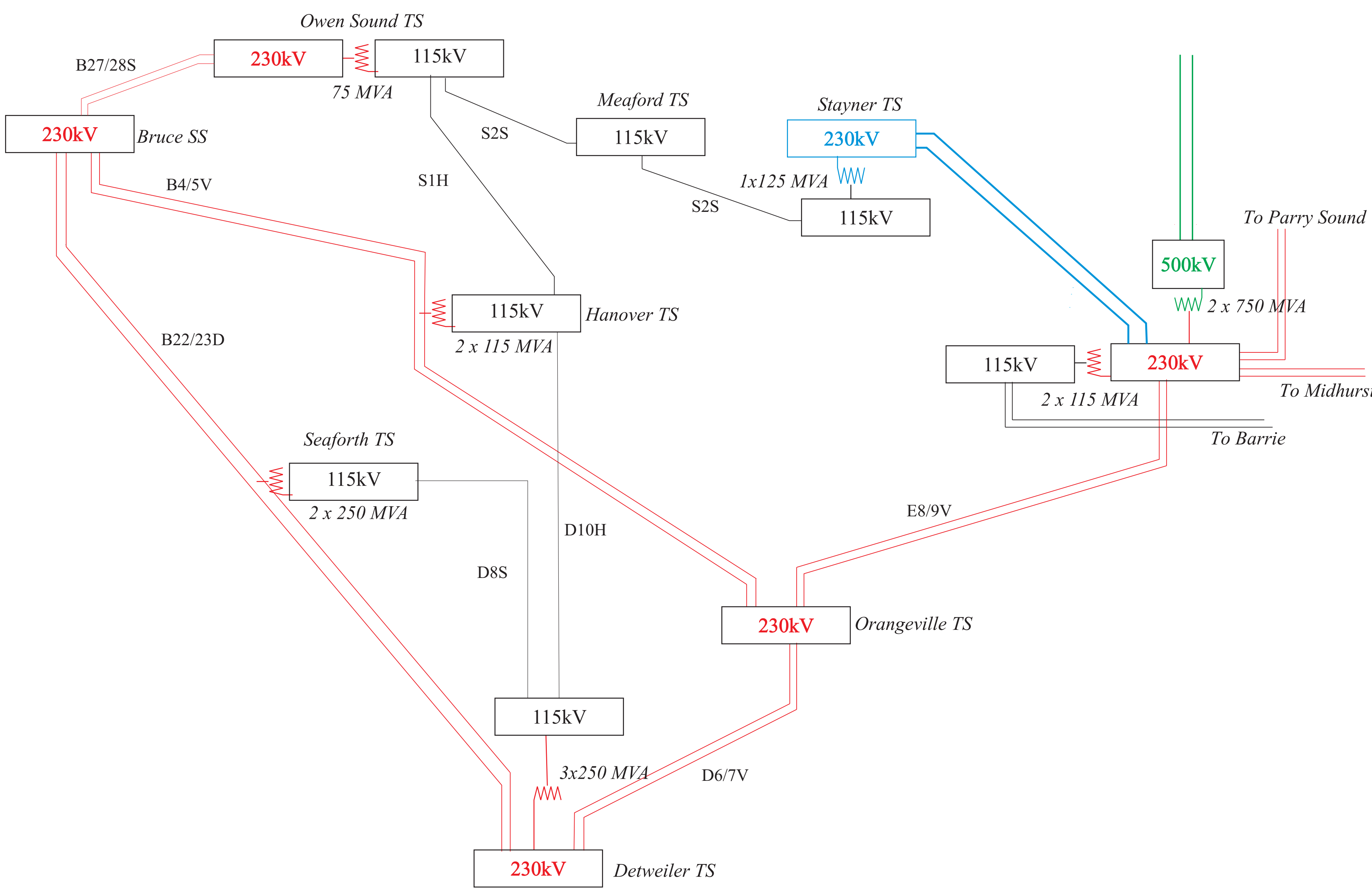

DIAGRAM 5. Proposed Area Transmission

Appendix A. Thermal Analysis Results

Table A1. Thermal assessment for Existing System Configuration with Winter Peak Loads

Monitored Element			Pre-Contingency Flow				Pre-ULTC Flow			Post-ULTC Flow			Pre-ULTC Flow			Post-ULTC Flow		
Circuit	Line Section	Cont. Rating (A)	MVA	I(A)	% of Continuous Rating	15 min LTR (A)	MVA	I(A)	% of LTR	MVA	I(A)	% of Cont Rating	MVA	I(A)	% of LTR	MVA	I(A)	% of Cont. Rating
Winter							S2E Contingency						S2S Contingency					
S2S	Owen Sound to Meaford	720	137	664	92.2	1030	146	754	73.2	168	826	114.7	0		-			-
	Meaford to Stayner	720	88	428	59.4	940	94	488	52.0	108	580	80.6			-			-
S2E	Essa to Stayner	720	36	175	24.3	1030		0	-		0	-	110	518	50.2	110	518	71.9

Table A2. Thermal Assessment with 230 kV Essa to Stayner Transmission - Summer Peak and High Negative BLIP Flow

Elements Lost in a Contingency	Most Impacted Element		Pre-Contingency Flow			15 min LTR (A / MVA) **	Pre-ULTC Flow			Post-ULTC Flow		
	Circuit	Cont. Rating (A / MVA) *	MVA	I(A) / S(MVA) *	% of Cont. Rating		MVA	I(A) / S(MVA) *	% of LTR	MVA	I(A) / S(MVA) *	% of LTR
Owen Sound T5	Hanover T3	115	61	61	53.0	196	96	96	49.0	96	96	49.0
Hanover T3	Hanover T4	115	57	57	49.6	217	97	96	44.2	97	97	44.7
S1H	S2S	869	96	443	51.0	960	100	467	48.6	101	467	48.6
S2S	Essa T1	115	63	63	54.8	187	64	64	34.2	64	64	34.2
B4V	S2S	869	96	443	51.0	960	99	462	48.1	99	463	48.3
One Essa to Stayner 230 kV Circuit & One Stayner 230/44 kV Autotransformer	S2S	869	96	443	51.0	960	96	446	46.4	96	446	46.4
E9V & Essa T3	S2S	869	96	443	51.0	960	104	484	50.4	104	487	50.7
Stayner 230/115 kV Autotransformer	Essa T1	115	63	63	54.8	187	64	64	34.2	64	64	34.2
B4V & B5V	S1H	595	22	100	16.7	691	117	575	83.2	136	675	97.6
B562L & B563L	S2S	869	96	443	51.0	960	113	526	54.8	113	526	54.8
B560V & B561M (with One Unit G/R) ***	S2S	869	96	443	51.0	960	182	884	92.0	187	933	97.2
Both Essa to Stayner 230 kV Circuits, Stayner 230/115 kV Autotransformer, Both Stayner 230/44 kV Autotransformers & Stayner Load	Essa T1	115	63	63	54.8	187	64	64	34.2	64	64	34.2
E8V, E9V & Essa T3	S2S	869	96	443	51.0	960	111	515	53.7	111	515	53.7
E8V & A Bus (with Essa T2 & SC21)	Essa T1	115	63	63	54.8	187	107	107	57.2	110	110	58.8
E9V, Essa T3 & M6E	S2S	869	96	443	51.0	960	101	470	48.9	102	474	49.3
One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer & M7E	S2S	869	96	443	51.0	960	95	443	46.2	96	445	46.4
One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer, E9V & Essa T3	S2S	869	96	443	51.0	960	104	483	50.3	104	487	50.7

Table A2. Cont.

Elements Lost in a Contingency	Most Impacted Element	Cont. Rating (A / MVA) *	Pre-Contingency Flow			15 min LTR (A / MVA) **	Pre-ULTC Flow			Post-ULTC Flow		
One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer & Essa H Bus (with E27 + Essa T1)	Essa T2	125	47	47	37.6	202	108	108	53.5	111	111	55.0
One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer & Stayner 230/115 kV Autotransformer	Essa T1	115	63	63	54.8	187	63	63	33.7	63	63	33.7

* Circuit ratings are in amperes while transformer ratings are in MVA
** LTR ratings are based on 35oC, 4 km/hr wind speed and a preload of 75%.

*** At least one Bruce unit has to be armed for G/R to prevent from post-contingency voltage collapse when the contingency is the loss of B560V and B561M.

Table A3. Thermal Assessment with 230 kV Essa to Stayner Transmission - Winter Peak Loads High Negative BLIP Flow

	Most Impacted Element		Pre-Contingency Flow				Pre-ULTC Flow			Post-ULTC Flow		
Elements Lost in a Contingency	Circuit	Cont. Rating (A / MVA) *	MVA	I(A) / S(MVA) *	% of Cont. Rating	15 min LTR (A / MVA) **	MVA	I(A) / S(MVA) *	% of LTR	MVA	I(A) / S(MVA) *	% of LTR
Owen Sound T5	Hanover T3	115	79	79	68.7	224	117	117	52.2	117	117	52.1
Hanover T3	Hanover T4	115	73	73	63.5	230	126	126	54.8	126	126	54.8
S1H	S2S	978	102	102	10.4	1153	106	497	43.1	106	497	43.1
S2S	Essa T1	115	81	81	70.7	213	81	81	38.3	81	81	38.3
B4V	Hanover T4	115	79	79	68.7	224	121	121	53.8	121	121	54.2
One Essa to Stayner 230 kV Circuit & One Stayner 230/44 kV Autotransformer	S2S	978	102	102	10.4	1153	103	482	41.8	103	482	41.8
E9V & Essa T3	S2S	978	102	102	10.4	1153	111	519	45.0	112	524	45.4
Stayner 230/115 kV Autotransformer	Essa T1	115	81	81	70.7	213	81	81	38.3	81	81	38.3
B4V & B5V	S1H	771	21	21	2.7	913	141	705	77.2	161	820	89.9
B562L & B563L	S2S	978	102	102	10.4	1153	120	557	48.3	120	557	48.3
B560V & B561M (with One Unit G/R) ***	S2S	978	102	102	10.4	1153	186	906	78.6	191	956	82.9
Both Essa to Stayner 230 kV Circuits, Stayner 230/115 kV Autotransformer, Both Stayner 230/44 kV Autotransformers & Stayner Load	Essa T1	115	81	81	70.7	213	82	82	38.3	82	82	38.3
E8V, E9V & Essa T3	S2S	978	102	102	10.4	1153	118	551	47.8	118	551	47.8
E8V & A Bus (with Essa T2 & SC21)	Essa T1	115	81	81	70.7	213	138	138	64.9	140	140	65.7
E9V, Essa T3 & M6E	S2S	978	102	102	10.4	1153	108	506	43.8	109	510	44.2
One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer & M7E	S2S	978	102	102	10.4	1153	103	479	41.6	103	481	41.8

One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer, E9V & Essa T3	S2S	978	102	102	10.4	1153	111	522	45.3	112	527	45.7
One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer & Essa H Bus (with E27 + Essa T1)	Essa T2	125	62	62	49.7	240	139	139	58.0	141	141	58.9
One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer & Stayner 230/115 kV Autotransformer	Essa T1	115	81	81	70.7	213	81	81	38.1	81	81	38.1

*Circuit Ratings are in ampere while transformer ratings are in MVA.

Appendix B. Voltage Analysis Results

Table B1. Voltage Decline Assessment for Existing System -Winter Peak Loads High Negative BLIP Flow

Bus	Pre-Contingency kV	Pre-ULTC kV	Pre-ULTC Voltage Decline (%)	Post-ULTC kV	Post-ULTC Voltage Decline (%)
S2E Contingency					
Bruce A 230 kV	250.1	249.4	0.26	249.3	0.34
Detweiler 230 kV	244.6	242.6	0.79	242.6	0.82
Essa 115 kV	122.4	123.6	-1.04	123.6	-1.02
Essa 230 kV	246.4	246.3	0.02	246.3	0.03
Hanover 115 kV	124.0	123.0	0.84	122.6	1.17
Hanover 230 kV	246.2	245.1	0.44	244.8	0.58
Meaford 115 kV	119.0	111.5	6.31	107.4	9.74
Orangeville 230 kV	247.6	246.7	0.37	246.6	0.41
Owen Sound 115 kV	122.6	119.5	2.56	117.8	3.96
Owen Sound 230 kV	245.8	241.9	1.59	239.7	2.50
Stayner 115 kV	118.8	106.0	10.78	100.2	15.59
Palmerston 115 kV	120.2	119.1	0.89	118.7	1.23
S2S Contingency					
Bruce A 230 kV	250.1	249.9	0.09	249.9	0.09
Detweiler 230 kV	244.6	242.4	0.87	242.4	0.87
Essa 115 kV	122.4	122.2	0.13	122.2	0.13
Essa 230 kV	246.4	245.3	0.42	245.3	0.42
Hanover 115 kV	124.0	123.7	0.27	123.7	0.27
Hanover 230 kV	246.2	245.6	0.25	245.6	0.25
Orangeville 230 kV	247.6	246.3	0.54	246.3	0.54
Owen Sound 115 kV	122.6	124.3	-1.37	124.3	-1.37
Owen Sound 230 kV	245.8	248.7	-1.15	248.7	-1.15
Stayner 115 kV	118.8	118.3	0.38	118.3	0.38
Palmerston 115 kV	120.2	119.8	0.31	119.8	0.31

Table B2. Voltage Decline Assessment for Existing System -Summer Peak Loads High Negative BLIP Flow

Bus	Pre-Contingency kV	Pre-ULTC kV	Pre-ULTC Voltage Decline (%)	Post-ULTC kV	Post-ULTC Voltage Decline (%)
S2E Contingency					
Bruce A 230 kV	250.3	249.7	0.25	249.6	0.28
Detweiler 230 kV	244.5	241.7	1.12	241.7	1.13
Essa 115 kV	122.8	123.8	-0.78	123.8	-0.78
Essa 230 kV	246.6	246.1	0.19	246.1	0.19
Hanover 115 kV	124.1	123.2	0.72	123.0	0.86
Hanover 230 kV	246.4	245.3	0.45	245.2	0.51
Meaford 115 kV	120.8	116.0	4.00	114.0	5.62
Orangeville 230 kV	247.6	246.3	0.55	246.2	0.56
Owen Sound 115 kV	123.7	121.6	1.68	120.8	2.33
Owen Sound 230 kV	247.9	245.4	1.03	244.3	1.45
Stayner 115 kV	120.0	111.2	7.30	108.3	9.74
Palmerston 115 kV	120.7	119.8	0.77	119.6	0.91
S2S Contingency					
Bruce A 230 kV	250.3	249.9	0.16	249.9	0.16
Detweiler 230 kV	244.5	241.5	1.20	241.5	1.21
Essa 115 kV	122.8	122.6	0.17	122.6	0.17
Essa 230 kV	246.6	245.3	0.51	245.3	0.51
Hanover 115 kV	124.1	123.5	0.47	123.5	0.47
Hanover 230 kV	246.4	245.5	0.38	245.5	0.38
Orangeville 230 kV	247.6	245.9	0.71	245.8	0.71
Owen Sound 115 kV	123.7	124.7	-0.81	124.7	-0.81
Owen Sound 230 kV	247.9	249.7	-0.73	249.7	-0.73
Stayner 115 kV	120.0	119.2	0.63	119.2	0.64
Palmerston 115 kV	120.7	120.1	0.51	120.1	0.51

Table B3. Voltage Decline Assessment with 230 kV Essa to Stayner Transmission - summer and High Negative BLIP Conditions FETT =3300 MW, NBLIP=1014 MW

Double Contingencies:

Contingency	Bus	Pre-Contingency kV	Pre-ULTC kV	Pre-ULTC Voltage Decline (%)	Post-ULTC kV	Post-ULTC Voltage Decline (%)	
Loss of B560V & B561M with One Unit G/R (Bruce G7 tripped) ***	Bruce A 230 kV	250.4	248.4	0.78	245.0	2.15	
	Detweiler 230 kV	244.4	227.3	7.00	214.4	12.26	**
	Essa 115 kV	123.4	117.5	4.76	113.6	7.96	
	Essa 230 kV	245.2	233.7	4.72	226.3	7.71	
	Hanover 115 kV	124.2	117.2	5.58	113.3	8.72	
	Hanover 230 kV	246.4	232.4	5.67	225.0	8.67	
	Meaford 115 kV	123.3	113.4	8.09	109.3	11.37	**
	Orangeville 230 kV	247.1	229.3	7.21	218.5	11.59	**
	Owen Sound 115 kV	124.7	118.7	4.84	115.5	7.39	
	Owen Sound 230 kV	249.3	240.3	3.64	235.0	5.76	
	Stayner 115 kV	123.5	112.7	8.78	108.4	12.20	**
	Stayner 230 kV	244.6	231.9	5.17	224.4	8.23	
	Palmerston 115 kV	120.8	113.9	5.69	109.6	9.27	
Loss of Both Essa to Stayner 230 kV Circuits, Stayner 230/115 kV Autotransformer, Stayner 230/44 kV Autotransformers and Stayner Load	Bruce A 230 kV	250.4	250.0	0.16	250.0	0.16	
	Detweiler 230 kV	244.4	242.2	0.90	242.2	0.90	
	Essa 115 kV	123.4	123.2	0.20	123.2	0.20	
	Essa 230 kV	245.2	244.8	0.17	244.8	0.17	
	Hanover 115 kV	124.2	123.7	0.41	123.7	0.41	
	Hanover 230 kV	246.4	245.7	0.28	245.7	0.28	
	Meaford 115 kV	123.3	124.1	-0.60	124.1	-0.60	
	Orangeville 230 kV	247.1	246.0	0.45	246.0	0.45	
	Owen Sound 115 kV	124.7	124.7	0.02	124.7	0.02	
	Owen Sound 230 kV	249.3	249.6	-0.11	249.6	-0.11	
	Stayner 115 kV	123.5	124.3	-0.60	124.3	-0.61	
	Stayner 230 kV	244.6	241.5	1.24	241.5	1.24	**
	Palmerston 115 kV	120.8	120.3	0.45	120.3	0.45	
Loss of One Essa to	Bruce A 230 kV	250.4	249.9	0.18	249.9	0.20	

Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer & M7E	Detweiler 230 kV	244.4	242.1	0.95	241.9	1.00	
	Essa 115 kV	123.4	122.7	0.56	122.5	0.75	
	Essa 230 kV	245.2	243.9	0.53	243.5	0.72	
	Hanover 115 kV	124.2	123.7	0.35	123.7	0.40	
	Hanover 230 kV	246.4	245.6	0.32	245.5	0.37	
	Meaford 115 kV	123.3	122.6	0.59	122.5	0.70	
	Orangeville 230 kV	247.1	245.7	0.57	245.5	0.67	
	Owen Sound 115 kV	124.7	124.3	0.37	124.2	0.43	
	Owen Sound 230 kV	249.3	248.6	0.30	248.5	0.34	
	Stayner 115 kV	123.5	122.5	0.84	122.3	1.01	
	Stayner 230 kV	244.6	242.1	0.99	241.7	1.17	**
	Palmerston 115 kV	120.8	120.3	0.39	120.3	0.44	
Loss of One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer, E9V and Essa T3	Bruce A 230 kV	250.4	249.9	0.21	249.8	0.23	
	Detweiler 230 kV	244.4	241.9	1.03	241.8	1.08	
	Essa 115 kV	123.4	121.4	1.61	121.1	1.87	
	Essa 230 kV	245.2	241.4	1.59	240.8	1.81	
	Hanover 115 kV	124.2	123.6	0.45	123.5	0.51	
	Hanover 230 kV	246.4	245.4	0.40	245.2	0.46	
	Meaford 115 kV	123.3	121.7	1.35	121.5	1.50	
	Orangeville 230 kV	247.1	245.2	0.79	244.9	0.89	
	Owen Sound 115 kV	124.7	123.9	0.69	123.8	0.76	
	Owen Sound 230 kV	249.3	248.0	0.52	247.9	0.57	
	Stayner 115 kV	123.5	121.1	1.97	120.8	2.17	
	Stayner 230 kV	244.6	239.6	2.04	239.0	2.26	**
	Palmerston 115 kV	120.8	120.2	0.50	120.1	0.55	
Loss of One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer and Stayner 230/115 kV Autotransformer	Bruce A 230 kV	250.4	249.9	0.18	249.9	0.18	
	Detweiler 230 kV	244.4	242.0	0.99	242.0	0.99	**
	Essa 115 kV	123.4	122.9	0.37	122.9	0.38	
	Essa 230 kV	245.2	244.4	0.35	244.4	0.35	
	Hanover 115 kV	124.2	123.6	0.48	123.6	0.48	
	Hanover 230 kV	246.4	245.5	0.36	245.5	0.36	
	Meaford 115 kV	123.3	124.0	-0.56	124.0	-0.56	
	Orangeville 230 kV	247.1	245.7	0.56	245.7	0.56	
	Owen Sound 115 kV	124.7	124.6	0.06	124.6	0.06	

	Owen Sound 230 kV	249.3	249.5	-0.08	249.5	-0.07	
	Stayner 115 kV	123.5	124.2	-0.56	124.2	-0.56	
	Stayner 230 kV	244.6	243.2	0.55	243.2	0.55	
	Palmerston 115 kV	120.8	120.2	0.52	120.2	0.52	
Loss of E9V, Essa T3 & M6E	Bruce A 230 kV	250.4	250.0	0.15	250.0	0.17	
	Detweiler 230 kV	244.4	242.3	0.85	242.1	0.92	
	Essa 115 kV	123.4	122.6	0.68	122.1	1.06	
	Essa 230 kV	245.2	243.7	0.65	242.7	1.04	
	Hanover 115 kV	124.2	123.9	0.25	123.8	0.33	
	Hanover 230 kV	246.4	245.8	0.23	245.6	0.30	
	Meaford 115 kV	123.3	122.6	0.59	122.3	0.81	
	Orangeville 230 kV	247.1	245.9	0.47	245.6	0.62	
	Owen Sound 115 kV	124.7	124.3	0.34	124.2	0.45	
	Owen Sound 230 kV	249.3	248.6	0.28	248.4	0.35	
	Stayner 115 kV	123.5	122.6	0.76	122.2	1.09	**
	Stayner 230 kV	244.6	242.9	0.66	242.0	1.04	
	Palmerston 115 kV	120.8	120.5	0.29	120.4	0.37	
Loss of E8V, E9V & Essa T3	Bruce A 230 kV	250.4	250.3	0.04	250.3	0.04	
	Detweiler 230 kV	244.4	243.0	0.59	243.0	0.58	
	Essa 115 kV	123.4	123.3	0.09	123.3	0.09	
	Essa 230 kV	245.2	245.1	0.07	245.1	0.07	
	Hanover 115 kV	124.2	124.5	-0.28	124.5	-0.28	
	Hanover 230 kV	246.4	247.2	-0.32	247.2	-0.32	
	Meaford 115 kV	123.3	122.7	0.52	122.7	0.52	
	Orangeville 230 kV	247.1	248.0	-0.36	248.0	-0.37	
	Owen Sound 115 kV	124.7	124.5	0.17	124.5	0.17	
	Owen Sound 230 kV	249.3	249.0	0.14	249.0	0.14	
	Stayner 115 kV	123.5	122.8	0.60	122.8	0.60	**
	Stayner 230 kV	244.6	244.3	0.12	244.3	0.12	
	Palmerston 115 kV	120.8	121.1	-0.25	121.1	-0.25	
Loss of M6E & Essa 230 kV A Bus	Bruce A 230 kV	250.4	249.8	0.23	249.8	0.25	
	Detweiler 230 kV	244.4	241.7	1.12	241.5	1.18	
	Essa 115 kV	123.4	120.2	2.56	119.9	2.83	**
	Essa 230 kV	245.2	240.5	1.95	240.0	2.16	

	Hanover 115 kV	124.2	123.5	0.55	123.4	0.61
	Hanover 230 kV	246.4	245.1	0.52	245.0	0.57
	Meaford 115 kV	123.3	122.2	0.96	122.0	1.09
	Orangeville 230 kV	247.1	244.3	1.14	244.0	1.25
	Owen Sound 115 kV	124.7	124.0	0.57	123.9	0.64
	Owen Sound 230 kV	249.3	248.3	0.42	248.2	0.47
	Stayner 115 kV	123.5	121.7	1.49	121.5	1.67
	Stayner 230 kV	244.6	239.9	1.90	239.4	2.11
	Palmerston 115 kV	120.8	120.1	0.59	120.0	0.65

Single Contingencies:

Contingency	Bus	Pre-Contingency kV	Pre-ULTC kV	Pre-ULTC Voltage Decline (%)	Post-ULTC kV	Post-ULTC Voltage Decline (%)	
Loss of E9V & Essa T3	Bruce A 230 kV	250.4	249.9	0.20	249.9	0.22	
	Detweiler 230 kV	244.4	241.9	1.01	241.8	1.05	
	Essa 115 kV	123.4	121.6	1.46	121.4	1.62	
	Essa 230 kV	245.2	241.7	1.43	241.3	1.60	
	Hanover 115 kV	124.2	123.7	0.41	123.6	0.46	
	Hanover 230 kV	246.4	245.4	0.38	245.3	0.42	
	Meaford 115 kV	123.3	122.0	1.08	121.9	1.19	
	Orangeville 230 kV	247.1	245.3	0.74	245.1	0.83	
	Owen Sound 115 kV	124.7	124.0	0.58	123.9	0.63	
	Owen Sound 230 kV	249.3	248.2	0.45	248.1	0.49	
	Stayner 115 kV	123.5	121.7	1.49	121.5	1.64	**

	Stayner 230 kV	244.6	241.1	1.43	240.7	1.60	
	Palmerston 115 kV	120.8	120.3	0.45	120.2	0.50	
Loss of One Essa to Stayner 230 kV Circuit & One Stayner 230/44 kV Autotransformer	Bruce A 230 kV	250.4	249.9	0.18	249.9	0.18	
	Detweiler 230 kV	244.4	242.1	0.95	242.1	0.95	**
	Essa 115 kV	123.4	122.8	0.46	122.8	0.46	
	Essa 230 kV	245.2	244.2	0.44	244.2	0.44	
	Hanover 115 kV	124.2	123.7	0.34	123.7	0.34	
	Hanover 230 kV	246.4	245.6	0.32	245.6	0.32	
	Meaford 115 kV	123.3	122.6	0.57	122.6	0.57	
	Orangeville 230 kV	247.1	245.8	0.54	245.8	0.54	
	Owen Sound 115 kV	124.7	124.3	0.36	124.3	0.36	
	Owen Sound 230 kV	249.3	248.6	0.29	248.6	0.29	
	Stayner 115 kV	123.5	122.5	0.79	122.5	0.79	
	Stayner 230 kV	244.6	242.4	0.90	242.4	0.90	
	Palmerston 115 kV	120.8	120.4	0.38	120.4	0.38	
Loss of Stayner 230/115 kV Autotransformer	Bruce A 230 kV	250.4	250.0	0.18	250.0	0.18	
	Detweiler 230 kV	244.4	242.0	0.97	242.0	0.97	**
	Essa 115 kV	123.4	123.1	0.25	123.1	0.25	
	Essa 230 kV	245.2	244.7	0.22	244.7	0.22	
	Hanover 115 kV	124.2	123.6	0.46	123.6	0.46	
	Hanover 230 kV	246.4	245.5	0.34	245.5	0.34	
	Meaford 115 kV	123.3	124.0	-0.57	124.0	-0.57	
	Orangeville 230 kV	247.1	245.8	0.51	245.8	0.51	
	Owen	124.7	124.7	0.05	124.7	0.05	

	Sound 115 kV					
	Owen Sound 230 kV	249.3	249.5	-0.08	249.5	-0.08
	Stayner 115 kV	123.5	124.2	-0.57	124.2	-0.57
	Stayner 230 kV	244.6	244.4	0.07	244.4	0.07
	Palmerston 115 kV	120.8	120.2	0.50	120.2	0.50

** bus with the largest post-ultc voltage decline in nearby areas.

Table B4. Voltage Decline Assessment with 230 kV Essa to Stayner Transmission - Summer and High Positive BLIP Conditions
FETT=213 MW, BLIP=2709 MW

Double Contingencies:

Contingency	Bus	Pre-Contingency kV	Pre-ULTC kV	Pre-ULTC Voltage Decline (%)	Post-ULTC kV	Post-ULTC Voltage Decline (%)	
Loss of B560V & B561M	Bruce A 230 kV	248.9	249.5	-0.24	249.4	-0.20	
	Detweiler 230 kV	244.8	238.6	2.54	238.2	2.72	
	Essa 115 kV	123.1	120.5	2.10	120.1	2.43	
	Essa 230 kV	243.4	238.3	2.09	237.6	2.36	
	Hanover 115 kV	123.8	120.8	2.50	120.6	2.64	
	Hanover 230 kV	245.8	239.5	2.58	239.1	2.72	
	Meaford 115 kV	123.5	118.9	3.76	118.6	3.99	
	Orangeville 230 kV	246.1	238.7	3.00	238.1	3.25	
	Owen Sound 115 kV	124.4	122.0	1.89	121.9	2.03	
	Owen Sound 230 kV	248.6	245.3	1.35	245.0	1.45	
	Stayner 115 kV	123.7	118.2	4.43	117.9	4.68	**
	Stayner 230 kV	242.8	237.2	2.31	236.6	2.58	
	Palmerston 115 kV	120.5	117.5	2.53	117.3	2.67	
Loss of Both Essa to Stayner 230 kV Circuits, Stayner 230/115 kV Autotransformer, Stayner 230/44 kV Autotransformers and Stayner Load	Bruce A 230 kV	248.9	248.9	0.02	248.9	0.02	
	Detweiler 230 kV	244.8	244.6	0.10	244.6	0.10	
	Essa 115 kV	123.1	123.2	-0.06	123.2	-0.06	
	Essa 230 kV	243.4	243.5	-0.06	243.5	-0.06	
	Hanover 115 kV	123.8	123.7	0.12	123.7	0.12	
	Hanover 230 kV	245.8	245.7	0.04	245.7	0.04	
	Meaford 115 kV	123.5	123.8	-0.21	123.8	-0.21	
	Orangeville 230 kV	246.1	246.0	0.04	246.0	0.04	
	Owen Sound 115 kV	124.4	124.3	0.03	124.3	0.03	
	Owen Sound 230 kV	248.6	248.8	-0.08	248.8	-0.08	
	Stayner 115 kV	123.7	123.9	-0.21	123.9	-0.21	
	Stayner 230 kV	242.8	241.0	0.76	241.0	0.76	**
	Palmerston 115 kV	120.5	120.4	0.12	120.4	0.12	
Loss of One Essa to Stayner 230 kV	Bruce A 230 kV	248.9	248.8	0.03	248.8	0.04	

Circuit, One Stayner 230/44 kV Autotransformer & M7E	Detweiler 230 kV	244.8	244.5	0.12	244.5	0.15	
	Essa 115 kV	123.1	122.8	0.24	122.5	0.49	
	Essa 230 kV	243.4	242.8	0.24	242.2	0.46	
	Hanover 115 kV	123.8	123.7	0.08	123.7	0.13	
	Hanover 230 kV	245.8	245.6	0.07	245.5	0.12	
	Meaford 115 kV	123.5	123.1	0.32	123.0	0.44	
	Orangeville 230 kV	246.1	245.8	0.14	245.6	0.23	
	Owen Sound 115 kV	124.4	124.2	0.15	124.1	0.20	
	Owen Sound 230 kV	248.6	248.4	0.10	248.3	0.14	
	Stayner 115 kV	123.7	123.0	0.53	122.8	0.71	
	Stayner 230 kV	242.8	241.3	0.63	240.8	0.84	**
	Palmerston 115 kV	120.5	120.4	0.09	120.4	0.13	
Loss of One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer, E9V and Essa T3	Bruce A 230 kV	248.9	248.9	0.02	248.8	0.04	
	Detweiler 230 kV	244.8	244.9	-0.02	244.8	0.02	
	Essa 115 kV	123.1	121.9	0.95	121.6	1.24	
	Essa 230 kV	243.4	241.0	0.95	240.4	1.20	
	Hanover 115 kV	123.8	123.7	0.15	123.6	0.21	
	Hanover 230 kV	245.8	245.5	0.12	245.4	0.17	
	Meaford 115 kV	123.5	122.5	0.77	122.4	0.91	
	Orangeville 230 kV	246.1	246.1	0.01	245.9	0.11	
	Owen Sound 115 kV	124.4	124.0	0.31	123.9	0.38	
	Owen Sound 230 kV	248.6	248.1	0.22	247.9	0.27	
	Stayner 115 kV	123.7	122.1	1.24	121.9	1.46	
	Stayner 230 kV	242.8	239.6	1.32	239.0	1.57	**
	Palmerston 115 kV	120.5	120.4	0.16	120.3	0.21	
Loss of One Essa to Stayner 230 kV Circuit, One Stayner 230/44 kV Autotransformer and Stayner 230/115 kV Autotransformer	Bruce A 230 kV	248.9	248.9	0.02	248.9	0.02	
	Detweiler 230 kV	244.8	244.6	0.08	244.6	0.08	
	Essa 115 kV	123.1	123.0	0.09	123.0	0.09	
	Essa 230 kV	243.4	243.1	0.09	243.1	0.09	
	Hanover 115 kV	123.8	123.7	0.15	123.7	0.15	
	Hanover 230 kV	245.8	245.6	0.07	245.6	0.07	
	Meaford 115 kV	123.5	123.7	-0.20	123.7	-0.20	
	Orangeville 230 kV	246.1	245.9	0.08	245.9	0.08	
	Owen Sound 115 kV	124.4	124.3	0.04	124.3	0.04	

	Owen Sound 230 kV	248.6	248.8	-0.07	248.8	-0.07	
	Stayner 115 kV	123.7	123.9	-0.20	123.9	-0.20	
	Stayner 230 kV	242.8	241.9	0.37	241.9	0.37	**
	Palmerston 115 kV	120.5	120.4	0.16	120.4	0.16	
Loss of E9V, Essa T3 & M6E	Bruce A 230 kV	248.9	248.9	-0.01	248.9	0.01	
	Detweiler 230 kV	244.8	245.0	-0.08	244.9	-0.02	
	Essa 115 kV	123.1	123.1	0.02	122.5	0.52	
	Essa 230 kV	243.4	243.3	0.02	242.2	0.48	
	Hanover 115 kV	123.8	123.8	0.01	123.7	0.09	
	Hanover 230 kV	245.8	245.8	0.00	245.6	0.08	
	Meaford 115 kV	123.5	123.4	0.10	123.1	0.34	
	Orangeville 230 kV	246.1	246.7	-0.22	246.3	-0.06	
	Owen Sound 115 kV	124.4	124.4	0.03	124.2	0.14	
	Owen Sound 230 kV	248.6	248.5	0.03	248.3	0.11	
	Stayner 115 kV	123.7	123.5	0.13	123.0	0.52	**
	Stayner 230 kV	242.8	242.8	0.03	241.7	0.48	
	Palmerston 115 kV	120.5	120.5	0.01	120.4	0.10	
Loss of E8V, E9V & Essa T3	Bruce A 230 kV	248.9	249.1	-0.08	249.1	-0.08	
	Detweiler 230 kV	244.8	245.9	-0.42	245.9	-0.42	
	Essa 115 kV	123.1	123.5	-0.32	123.5	-0.32	
	Essa 230 kV	243.4	244.1	-0.32	244.1	-0.32	
	Hanover 115 kV	123.8	124.2	-0.28	124.2	-0.28	
	Hanover 230 kV	245.8	246.6	-0.32	246.6	-0.32	
	Meaford 115 kV	123.5	123.8	-0.24	123.8	-0.24	
	Orangeville 230 kV	246.1	248.9	-1.11	248.9	-1.12	
	Owen Sound 115 kV	124.4	124.6	-0.19	124.6	-0.19	
	Owen Sound 230 kV	248.6	248.9	-0.14	248.9	-0.14	
	Stayner 115 kV	123.7	124.0	-0.29	124.0	-0.29	
	Stayner 230 kV	242.8	243.6	-0.32	243.6	-0.32	
	Palmerston 115 kV	120.5	120.9	-0.28	120.9	-0.28	
Loss of M6E & Essa 230 kV A Bus	Bruce A 230 kV	248.9	248.6	0.12	248.6	0.14	
	Detweiler 230 kV	244.8	243.7	0.46	243.6	0.50	
	Essa 115 kV	123.1	119.5	2.91	118.9	3.40	**
	Essa 230 kV	243.4	239.2	1.70	238.5	1.99	

	Hanover 115 kV	123.8	123.4	0.36	123.3	0.42
	Hanover 230 kV	245.8	245.0	0.34	244.8	0.40
	Meaford 115 kV	123.5	122.5	0.77	122.3	0.93
	Orangeville 230 kV	246.1	244.1	0.81	243.8	0.93
	Owen Sound 115 kV	124.4	123.9	0.42	123.8	0.50
	Owen Sound 230 kV	248.6	247.9	0.28	247.8	0.34
	Stayner 115 kV	123.7	122.1	1.26	121.8	1.51
	Stayner 230 kV	242.8	238.8	1.65	238.1	1.94
	Palmerston 115 kV	120.5	120.1	0.36	120.0	0.43

Single Contingencies:

Contingency	Bus	Pre-Contingency kV	Pre-ULTC kV	Pre-ULTC Voltage Decline (%)	Post-ULTC kV	Post-ULTC Voltage Decline (%)
Loss of E9V & Essa T3	Bruce A 230 kV	248.9	248.9	0.01	248.9	0.02
	Detweiler 230 kV	244.8	244.9	-0.04	244.9	-0.01
	Essa 115 kV	123.1	122.1	0.79	121.8	1.07 **
	Essa 230 kV	243.4	241.5	0.78	240.8	1.03
	Hanover 115 kV	123.8	123.7	0.11	123.6	0.17
	Hanover 230 kV	245.8	245.6	0.09	245.5	0.14
	Meaford 115 kV	123.5	122.9	0.50	122.7	0.64
	Orangeville 230 kV	246.1	246.2	-0.04	246.0	0.06
	Owen Sound 115 kV	124.4	124.1	0.20	124.0	0.27
	Owen Sound 230 kV	248.6	248.2	0.15	248.1	0.20
	Stayner 115 kV	123.7	122.7	0.79	122.4	1.00
	Stayner 230 kV	242.8	241.0	0.78	240.4	1.02
	Palmerston 115 kV	120.5	120.4	0.12	120.3	0.17
Loss of One Essa to Stayner 230 kV Circuit & One Stayner 230/44 kV Autotransformer	Bruce A 230 kV	248.9	248.9	0.02	248.9	0.02
	Detweiler 230 kV	244.8	244.7	0.07	244.7	0.07
	Essa 115 kV	123.1	123.0	0.13	123.0	0.13
	Essa 230 kV	243.4	243.0	0.13	243.0	0.13
	Hanover 115 kV	123.8	123.8	0.05	123.8	0.05
	Hanover 230 kV	245.8	245.7	0.04	245.7	0.04
	Meaford 115 kV	123.5	123.2	0.27	123.2	0.27

	Orangeville 230 kV	246.1	245.9	0.08	245.9	0.08	
	Owen Sound 115 kV	124.4	124.2	0.12	124.2	0.12	
	Owen Sound 230 kV	248.6	248.4	0.08	248.4	0.08	
	Stayner 115 kV	123.7	123.1	0.45	123.1	0.45	
	Stayner 230 kV	242.8	241.6	0.53	241.6	0.53	**
	Palmerston 115 kV	120.5	120.5	0.06	120.5	0.06	
Loss of Stayner 230/115 kV Autotransformer	Bruce A 230 kV	248.9	248.9	0.01	248.9	0.01	
	Detweiler 230 kV	244.8	244.7	0.06	244.7	0.06	
	Essa 115 kV	123.1	123.2	-0.04	123.2	-0.04	
	Essa 230 kV	243.4	243.5	-0.04	243.5	-0.04	
	Hanover 115 kV	123.8	123.7	0.13	123.7	0.13	
	Hanover 230 kV	245.8	245.7	0.05	245.7	0.05	
	Meaford 115 kV	123.5	123.8	-0.22	123.8	-0.22	
	Orangeville 230 kV	246.1	246.1	0.02	246.1	0.02	
	Owen Sound 115 kV	124.4	124.3	0.03	124.3	0.03	
	Owen Sound 230 kV	248.6	248.8	-0.08	248.8	-0.08	
	Stayner 115 kV	123.7	123.9	-0.21	123.9	-0.21	
	Stayner 230 kV	242.8	243.1	-0.11	243.1	-0.11	
	Palmerston 115 kV	120.5	120.4	0.14	120.4	0.14	**

** bus with the largest post-ultc voltage decline in nearby areas.