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CONNECTION ASSESSMENT & APPROVAL PROCESS

Preliminary Assessment Report For Ottawa Area Transmission Reinforcement

Applicant: Hydro One Networks Inc.

CAA ID 2002-062

Final Report

Long Term Forecasts & Assessments Department
Consistent Information Set Department

February 4, 2003

Preliminary Assessment Report

Ottawa Area Transmission Reinforcement

Acknowledgement

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

Disclaimers

IMO

This report has been prepared solely for the purpose of assessing, on a preliminary basis, whether the connection applicant's proposed connection with the IMO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether a System Impact Assessment of the proposed connection should be conducted under Chapter 4, section 6 of the *Market Rules*. This report has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. This report has been prepared solely for use by the connection applicant, Hydro One and the IMO in accordance with Chapter 4, section 6 of the *Market Rules*. The IMO assumes no responsibility to any third party for any use which it makes of this report. Any liability which the IMO may have to the connection applicant in respect of this report is governed by Chapter 1, section 13 of the *Market Rules*. In the event that the IMO provides a draft of this report to the connection applicant, you must be aware that the IMO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IMO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that it is using the most recent version of this report.

Preliminary Assessment Report

Executive Summary

Proposed Project

Hydro One Networks Inc. and Ottawa Hydro initiated a two-staged study to review the adequacy of the Ottawa area transmission facilities to supply the area load for the next ten years. The purpose of the first stage was to identify the deficiencies associated with the capability of the 230/115 kV transmission system to provide reliable supply to the area load and to propose a number of transmission reinforcement options. At the end of the study, Hydro One Networks Inc. identified a number of load supply deficiencies and decided on a preferred alternative for Ottawa Area transmission reinforcement. The results of the study and the description of the proposed transmission reinforcement options were summarized in the report titled "Ottawa Area Supply Study", which was included with the proponent's Connection Assessment Application.

Hydro One Networks Inc. (HONI) has submitted a Connection Assessment Application for the preferred Ottawa Area transmission reinforcement option. The proposal included:

- Installing a new 250MVA, 230/115kV autotransformer at Hawthorne TS together with the required switching equipment (in service by May 31, 2004),
- Building a double 115kV circuit line from Hawthorne to Blackburn Jct. (RH1/RH2) and string a second 115kV circuit from Blackburn Jct. to Riverdale Jct. (RH2) on the existing double circuit 115kV tower which presently supports 115kV circuit H2AR (in service by May 31, 2004),
- Adding three new breakers on the 115 kV Hawthorne switchyard to connect the new transformer and the two new 115 kV circuits,
- Opening H2AR at Blackburn Jct. and connecting the Russell TS end to one of the new 115 kV circuit HR1 (in service by May 31, 2004),
- Opening A3RM tap to Russell TS at Riverdale Jct. and connecting the tap to Russell TS to the new 115kV line RH2 (in service by May 31, 2004), and
- Opening H2AR east of Russell TS and connecting the Russell TS end to K1R at Riverdale Jct. and the other end to the new RH2 115kV circuit (in service by May 31, 2004).

The proposed reconfiguration of the 115 kV lines will result in the new double circuit line from Hawthorne TS supplying Russell TS load and the existing 115 kV circuit H2AR becoming a dedicated supply for the loads east of Ottawa.

A schematic representation of the existing Ottawa Area 230/115 kV transmission system is shown in Figure 1. The proposed additional circuits and the reconfigurations of the existing circuits are shown in Figure 2.

Data Verification

Upon reviewing the technical specifications for the new autotransformer the IMO concluded that:

1. The capacity and overloading capability listed in the planning specification are adequate and are likely to increase the total TS loading capability to about 800 MVA (based on 10 day Limited Time Rating).

2. The specified high-to-low voltage impedance, which is comparable to the impedance of the existing units, would ensure the even distribution of power flows over the transformer units that are in service.

3. The windings configuration is identical to that of the existing transformers providing for identical phase transformation. The tertiary of the new transformer will be initially operated open with provisions for being operated closed.

4. The new autotransformer will meet CSA-C88-M90 transformer specifications and be capable of operating at full load at 127 kV at a 90% lagging power factor. It will also be able to meet the maximum system high voltage of 250 kV.

5. The new autotransformer will be equipped with six off-load-tap-changer positions (OLTC), similar to the existing 230/115 kV autotransformer units at Hawthorne TS. It is expected that the range of OLTC positions will be adequate for the range of voltage variations that has been observed at Hawthorne TS. In addition, 230 kV voltage regulation is provided at Hawthorne TS by the three 500/230 kV autotransformers which are equipped with under-load tap changers.

Review of Connection Arrangement

The proposed connections of the new 230/115 kV autotransformer T9 to the 115 kV switchyard and 230 kV switchyard are shown in Figure 3 and 4, respectively. The existing layout of the 115 kV switchyard at Hawthorne together with the proposed connection of the new facilities is shown in Figure 3. The existing layout of the 230 kV switchyard at Hawthorne together with the new facilities is shown in Figure 4.

A detailed review of contingencies associated with various transmission elements concluded that, for the same contingency the post-contingency configurations for the present and proposed station arrangements would be similar. The proposed connectivity for the new autotransformer and 115 kV circuits does not result in a new critical contingency.

Hydro One Networks Inc. is planning to add new diameters at the 230 kV Hawthorne switchyard as part of the HQ interconnection project. At that time the re-connection of T9 to a dedicated position will be evaluated.

Fault Level Assessment

Hydro One Networks Inc. has performed short circuit studies which identify the impact of the new Ottawa area transmission facilities and system reconfiguration on the short circuit currents in the area. The system model used in these studies included all the existing transmission facilities and the impactive projects that have completed the CAA process and obtained approval for connection.

The studies concluded that, the new system reconfiguration and the addition of the new 230/115 kV transmission additions result in an increase in fault currents in the area. However, the new short circuit levels do not exceed the interrupting capability of the exiting breakers.

Power Transfer Capability Assessment

This area of the connection assessment concentrated on identifying the effect of the proposed Ottawa area 230/115 kV transmission system reinforcement and reconfiguration, on the bulk system power transfer capability and the system voltages.

Thermal Assessment

Since Hydro One Networks Inc. study covered in detail a large number of load and generation scenarios, this connection assessment study concentrated on one extreme case representing a 2011 load level with Hydro Quebec imports of 1250 MW and Ottawa river and Madawaska river hydraulic generation out of service. The Merivale 115 kV bus was assumed to be operated solid.

In considering the effect of the proposed transmission reinforcement on the bulk system, the study concluded that the proposed 230 kV and 115 kV Ottawa area transmission reinforcement will not affect the reliability of the 230 kV and 500 kV bulk power system.

In considering the effect of the proposed transmission reinforcement on the Ottawa area 115 kV system, the study concluded that by 2011:

- The pre-contingency power flows will remain within the summer thermal ratings of the respective transmission elements for most transmission elements, with the exception the 115 kV circuit H9A. It is expected however, that Hydro One Networks Inc will be upgrading this circuit as part of the proposed Ontario-Hydro Quebec interconnection project. In the meantime, interim relief from possible thermal overloading can be provided by power purchases from Maclaren Energie on 115kV circuit H9A from Masson, or by transferring the entire Bilberry Creek load to H2AR.

- Power flows on Hawthorne 230/115 kV autotransformers T5 and T6 could be slightly above the continuous rating, under the extreme system conditions that were assumed in study. With available generation on the Madawska and Ottawa rivers the flow on these autotransformers would be reduced to acceptable levels.

- Contingencies associated with T4 or T9 autotransformers at Hawthorne TS would result in the post- contingency flows on T5 and T6 autotransformers which are over the 10 day limited time rating of the respective units.

- Contingencies associated with T21 or T22 autotransformers at Merivale TS would result in the post- contingency flows on Hawthorne T5 and T6 autotransformers which are around the 10 day limited time rating of the respective units.

- For a contingency associated with either M30A or M31A the post-contingency, the flow over T6 autotransformer at Hawthorne approaches its the 10 day LTR.

- Contingencies associated with the new and reconfigured 115 kV circuits would result in post-contingency loading of the remaining circuits well under the emergency (127^0C) rating of the respective circuits.

Voltage Assessment

A detailed voltage analysis was performed by Hydro One Networks Inc. and the results were confirmed and accepted by the IMO. The results show that with the new autotransformer in service and the proposed system reconfiguration the steady state voltages for most of the Ottawa area meet the Market Rules requirements.

One concern with respect to system voltages is related to the 115 kV circuits designed H2AR, H9A and 79M1 which supply the loads northeast of Ottawa area. Hydro One Networks Inc. is planning to correct this problem by installing low voltage shunt capacitors at Wilhaven DS and Hawkesbury DS.

A second concern with respect to the voltages in the area, which was also identified by Hydro One Networks Inc., is the immediate post contingency voltage decline at Merivale TS for the loss of autotransformer T21 when Merivale bus is operated open and Madawaska generation is out of service. Presently, the fast recovery of the post-contingency voltage is achieved by closing the Merivale 115 kV bus-tie breaker in the event of this contingency. In the near future, Hydro One Networks Inc. will replace all the 115 kV breakers at Merivale TS allowing the bus to be operated closed, thus eliminating the post-contingency voltage decline problem.

Conclusions and Recommendations

This Preliminary Assessment has examined the impact of the fourth 230/115 kV autotransformer at Hawthorne TS, the incorporating of additional 115 kV circuits and reconfiguration of the existing 115 transmission in Ottawa area on the reliability of the power system and Ottawa area load supply.

The general conclusion of this assessment is that the proposed plan will result in a major improvement to the reliability of Ottawa area load supply and will not have a negative impact on the overall system reliability.

The following specific conclusions were drawn:

1. The new 230/115 kV autotransformer will increase the Hawthorne TS load supply capability to 922 MVA. Based on current load forecast this capability which should be adequate to supply the load until about 2011.
2. The proposed new 115 kV transmission is adequate to ensure reliable supply to the Ottawa area load beyond 2011 with all 115 kV transmission elements in service and following a contingency associated with one 115 kV circuit.
3. The short circuit study results provided by Hydro One Networks Inc. indicate that with the new system reconfiguration and the Hawthorne autotransformer in service, the resulting fault levels will be below the interrupting capability of the exiting breakers.
4. By 2011, contingencies associated with T4 or T9 autotransformers at Hawthorne TS would result in the post- contingency flows on T5 and T6 autotransformers which are over the 10 day limited time rating of the respective units.
5. By 2011, contingencies associated with T21 or T22 autotransformers at Merivale TS would result in the post- contingency flows on Hawthorne T5 and T6 autotransformers which are around the 10 day limited time rating of the respective units.

6. By 2011, for a contingency associated with either M30A or M31A the post-contingency flow over T6 autotransformer at Hawthorne approaches its 10 day LTR.
7. By 2011, flows on Hawthorne 230/115 kV circuits T5 and T6 are slightly above the continuous rating.
8. Flow on H9A exceeds the continuous thermal rating of the circuit by about 15%. Hydro One Networks Inc. has plans to increase the capacity of this circuit as part of the proposed Ontario-Hydro Quebec interconnection project. In the meantime, interim relief from possible thermal overloading can be provided by power purchases from Maclaren Energie on 115kV circuit H9A from Masson, or by transferring the entire Bilberry Creek load to H2AR.
9. The loads connected to H9A circuit meet the minimum Market Rules requirements for 113kV voltages under normal conditions, but the stations connected to the radial 115 kV line 79M1 could experience lower than required voltages. Hydro One Networks Inc. has indicated that a connection assessment application will be submitted shortly for the installation of low voltage shunt capacitors at Wilhaven DS and Hawkesbury DS to correct this problem.

It is recommended that Hydro One Networks Inc. monitor the peak flows over the Hawthorne autotransformers and plan for replacing T5 and/or T6 when required.

It is recommended that Hydro One Networks Inc. monitor the loading of the 115 kV circuit H9A and if necessary initiate a plan for its upgrading.

IMO Requirements

The IMO's requirements that have been identified in this assessment, for the incorporation of the new 230/115 kV autotransformer at Hawthorne TS and the proposed 115 kV transmission and system reconfiguration, are as follows:

1. The status of all isolating disconnect switches and breakers must be monitored and made available to the IMO on a continual basis.

2. The proponent will provide when available, the "as built" transformer information to meet the requirements of the facility registration process.

3. All new facilities will have to be equipped with adequate protection schemes in accordance with the Transmission System Code.

In addition to the Connection Assessment and Approval process any new connection to the IMO-controlled grid has to fulfill, before coming into service, the following:

4. All the requirements of the IMO Facility Registration process.
5. The installation of all equipment needed to monitor the system operating information required by the IMO on a continuous basis as described in Chapter 4 section 7.5 and Appendix 4.17 of the *Market Rules*.
6. All the requirements of the IMO Meter Registration process.

Need for System Impact Assessment

This Preliminary Assessment evaluated all the aspects related to the impact of the proposed developments on the reliability of the IMO-controlled grid and no further analysis is required.

A separate System Impact Assessment is therefore not required for this project.

Notification of Approval

The "**IMO Requirements"** section of the Executive Summary lists all the requirements identified by the Connection Assessment and Approval process for the incorporation of the proposed 230/115 kV autotransformer installation at Hawthorne TS and the 115 kV new transmission and system reconfiguration. It is recommended that approval be granted and Notification of Approval be issued subject to the implementation by the proponent of the IMO requirements.

Preliminary Assessment Report

1.0 Background

The Ottawa area total load is currently about 1600 MW. Electrical supply to the area is provided by 500 kV, 230 kV and 115 kV transmission and step down transformation as shown in Figure 1. Part of the supply also comes from the hydraulic plants located on the Madawaska and Ottawa rivers and TransAlta generation. Presently, there are five 115 kV circuits out of Hawthorne TS that supply these loads; A4K, H2AR, A3RM, A8M and H9A.

Hydro One Networks Inc. and Ottawa Hydro initiated a study to review the adequacy of the Ottawa area transmission facilities to supply the area load for the next ten years. The study was divided in two stages.

The purpose of the first stage was to identify the deficiencies associated with the capability of the 230/115 kV transmission elements to provide reliable supply to the area load and to propose a number of transmission reinforcement options. A report was produced at the end of phase one, title ”Ottawa Area Supply Study”. The report identified the following problems:

- Loading on the Hawthorne autotransformer T6 exceeds the 10-day LTR for loss of T4 for peak load conditions in 2001.
- The short circuit capability of eight 115 kV breakers at Merivale TS is currently exceeded forcing the split operation of the station when both autotransformers are in service. With only one transformer in service, the station buses can be operated solid.
- Merivale West bus voltage drop exceeds 10% for contingencies involving T21 for peak load conditions even with Madawaska generation in service.
- The 115kV circuit H2AR summer rating is exceeded for the loss of A4K by 2004.
- The 115kV circuit A3RM will become overloaded for the loss of H2AR by 2004.
- The continuous thermal rating of H9A is exceeded for the contingencies involving H2AR.
- With all elements in service for peak load conditions the steady state voltage at Hawkesbury could be below 113 kV.

Hydro One Networks Inc. has studied a number of options for transmission reinforcement, which would address these concerns. After performing detailed analysis, a preferred alternative was selected. The results of this analysis, the description of the proposed transmission reinforcement options and their benefits were all summarized in the report titled ”Ottawa Area Supply Study”, which was included with the proponent’s Connection Assessment Application.

The purpose of the second stage, which has not been yet completed, is to assess the adequacy of transformer and distribution stations and provide for sufficient facilities to ensure reliable load supply.

2.0 Description of Proposed Plan

Hydro One Networks Inc. (HONI) has submitted a Connection Assessment Application for the preferred Ottawa Area transmission reinforcement option. The proposal includes:

- Installing a new 250MVA, 230/115kV autotransformer at Hawthorne TS together with the required switching equipment (in service by May 31, 2004),

- Building a double 115kV circuit line from Hawthorne to Blackburn Jct. (RH1/RH2) and string a second 115kV circuit from Blackburn Jct. to Riverdale Jct. (RH2) on the existing double circuit 115kV tower which presently supports 115kV circuit H2AR (i/s by May 31, 2004),
- Adding three new breakers on the 115 kV Hawthorne switchyard to connect the new transformer and the two new 115 kV circuits,
- Opening H2AR at Blackburn Jct. and connect the Russell TS end to one of the new 115 kV circuit HR1 (i/s by May 31, 2004),
- Opening A3RM tap to Russell TS at Riverdale Jct. and connect the tap to Russell TS to the new 115kV line RH2 (i/s by May 31, 2004), and
- Opening H2AR east of Russell TS and connect the Russell TS end to K1R at Riverdale Jct. and the other end to the new RH2 115kV circuit (i/s by May 31, 2004).

The proposed reconfiguration of the 115 kV lines will result in the new double circuit line from Hawthorne TS supplying Russell TS load and the existing 115 kV circuit H2AR becoming a dedicated supply for the loads east of Ottawa.

A schematic representation of the existing Ottawa Area 230/115 kV transmission system is shown in Figure 1. The proposed additional circuits and the reconfigurations of the existing circuits are shown in Figure 2. The existing layout of the 115 kV switchyard at Hawthorne together with the new facilities is shown in Figure 3. The existing layout of the 230 kV switchyard at Hawthorne together with the new facilities is shown in Figure 4.

3.0 Rating of New Transformer Station Facilities

115 kV Circuit Breakers & Breaker Disconnect Switch (Figure 3)

The ratings for the three new 115 kV SF6 circuit breakers are as follows:

Maximum operating voltage:	127 kV
Fault interrupting capability:	50 kA symmetrical
Continuous current rating:	3000 A
Rated interrupting time:	3-cycles
BIL	650 kV

The ratings for the new 115 kV breaker disconnect switches are as follows:

Maximum operating voltage:	127 kV
Continuous current rating:	2000 A

The disconnect switches will be motorized and be capable to be operated from Merivale TOC or Richview TOC.

Comments

The existing 115 kV breakers at Hawthorne TS are a combination of:

- nine bulk oil breakers (L4L8, LT6L8, QLT4, YLT5, QL9, LT5L9, YL2, QLT6, LT4L2) rated for a continuous current of 1600 A and interrupting capability of 45.5 kA asymmetrical current, and
- three SF6 breakers (YL3, QL3, YL4) rated for a continuous current of 2500 A and interrupting capability of 47.9 kA asymmetrical current.

The three new breakers that Hydro One Networks Inc. is proposing to install at Hawthorne TS meets the 50 kA short circuit levels for the 115 kV system required by the Transmission System Code. Short circuit analysis performed by Hydro One Networks Inc. shows that the ultimate short circuit levels at the Hawthorne 115 kV bus for a line-to-line-to-ground fault could be as high as 55 kA. But, the maximum short circuit current that would be experienced by the new breakers due to the line in-feed currents would be below 38 kA.

The continuous current rating of the new breaker disconnect switches is 2000 A which is less than the rating of the new circuit breakers but matches the rating of the existing station equipment.

230 kV Circuit Switcher (Figure 4)

The ratings for the new 230 kV circuit switcher that will be used to permanently isolate the transformer in the event of a fault are as follows:

Maximum operating voltage:	250 kV
Continuous current rating:	2000 A
Short Circuit Withstand Capability:	40 kA
BIL across air gap:	1050 kV

230/115 kV Autotransformer

The new autotransformer will be 3-phase oil-immersed with cooling provided by forced oil and /or forced air and the windings configuration is to be wye-wye delta. The autotransformer is to be rated as follows:

	Normal	Emergency	
		10 Day	½ Hour
Summer	250 MVA	400	500
Winter	250 MVA	468	500

The new transformer will be equipped with an off-load-tap-changer with the following tap positions:

248.6 kV, 242.7 kV, 236.8 kV, 231.1 kV, 225.5 kV and 220.1 kV
for a low voltage of 121 kV.

The HV to LV impedance should be as close as practical to 9.24% on 250 MVA in order to match the impedance of the other autotransformers at Hawthorne TS.

The autotransformer is to be protected by metal-oxide surge arresters.

Upon reviewing the technical specifications for the new autotransformer the IMO concluded that:

1. The capacity and overloading capability listed in the planning specification are adequate and are likely to increase the total TS loading capability to about 800 MVA (based on 10 day LTR).

2. The specified HL-LV impedance, which is comparable to the impedance of the existing units, would ensure the even distribution of power flows over the transformer units that are in service.

3. The windings configuration is identical to that of the existing transformers providing for identical phase transformation. The tertiary of the new transformer will be initially operated open with provisions for being operated closed.

4. The new autotransformer will meet CSA-C88-M90 transformer specifications and be capable of operating at full load at 127kV at a 90% lagging power factor. It will also be able to meet the maximum HV system voltage of 250kV.

5. The new autotransformer will be equipped with six off-load-tap-changer positions, similar to the existing 230/115 autotransformer units at Hawthorne TS. The Transmission System Code, Schedule H, Clause 1.1.2 requires that any new transformers shall have adequate on-load tap-changer or other voltage regulating facilities to operate continuously within the normal voltage variations on the transmission system as set in the Market Rules and to operate in emergencies with a further transmission system voltage variations of $\pm$ 6%. While the absence of ULTC' s on the new transformer does not appear to meet the TSC requirements it is expected that the range of OLTC positions will be adequate for the range of voltage variations that has been observed at Hawthorne TS[1]. In addition, 230 kV voltage regulation is provided at Hawthorne TS by the three 500/230 kV autotransformers which are equipped with ULTC's.

4.0 Review of Station Connection Arrangement

Autotransformer

Hydro One Networks Inc. proposed to connect the new 230/115 kV autotransformer designated as T9, in the following way:

- The 230 kV side will be connected to the D bus at the same location as T8 via a new circuit switcher,
- The 115 kV side will be connected to the same diameter as the 115 kV circuit A3RM between the existing YL3 breaker (which will be renamed) and a new breaker.

Upon reviewing the proposed connectivity the IMO concluded that:

1. The new proposed connection to the 115 kV switchyard involves the addition of one new breaker whose rated interrupting capability will meet the TSC requirements (50 kA at 115 kV level).

2. The proposed connection of the new autotransformer to the 230 kV switchyard is effectively onto the D bus. Existing transmission elements, T8 and SC22, are also connected to this bus. This configuration would result in an increased exposure of the existing and new equipment (SC22, T8 and T9) to faults associated with other transmission elements. In effect a fault involving T8 or T9 would take out of service both

[1] From the 2002 system operating records it was observed that the voltage at Hawthorne TS varied between 235 kV to 245 kV and 120 kV to 127 kV.

transformers and the shunt capacitor and for any stuck breaker condition (DLT3, DL31 or DL24) an additional line or auto would be removed from service.

Hydro One Networks Inc. decided to connect the new autotransformer T9 at the same point as the T8 transformer as there is no space available on the existing diameters. With the proposed arrangement the simultaneous loss of the T8 (230/44kV) and T9 (230/115kV) auto is a low probability event (the outage rate for 230kV transformers is 0.2 or once every five year). The event will not impact the customers or bulk system reliability since the T8 load can be transferred to transformer T7 and the T9 load will be shared between the remaining 230/115kV Hawthorne autotransformers T4, T5, T6 and Merivale T22.

In the event of loss of either T8 or T9 together with breaker failure condition, one of the 230kV circuits M31A or L24A or the 500/230kV auto T3 would also be lost. However, this results in post-contingency configuration not different than today's configuration in the event of a similar contingency.

Hydro One Networks Inc. is planning to add new diameters at the 230 kV Hawthorne switchyard as part of the HQ interconnection project. At that time the re-connection of T9 to a dedicated position will be evaluated.

5.0 On-line Monitoring

The *Market Rules* (Chapter 4 section 7.4) require that each transmitter shall provide the IMO on a continual basis with on-line monitored quantities as specified in Appendix 4.16. It is required that Hydro One Networks Inc. install all the equipment needed to monitor the information required by the IMO on a continuous basis. The IMO requires that the status of all isolating disconnect switches and breakers be monitored on a continual basis.

6.0 Protection Systems

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

7.0 Description of Area Transmission

Configuration

The existing 115 kV and 230 kV area transmission is shown in Figure 1 and the proposed additions and transmission system modifications are displayed in Figure 2. Hawthorne 230/115 kV and Merivale 230/115 kV transformer stations effectively supplying the entire 115 kV load in the area. The local 115 kV transmission with the proposed plan incorporated will comprises of:

- The 115 kV line H9A out of Hawthorne 115 kV switchyard will constitute a single source supply for Navan TS, Wilhaven TS, Cumberland, Orleans, Bilberry Creek (about half), and all the station connected to the 115 kV circuit 79M1, which are Rockland TS, Clarence TS, Wendover TS, Cassburn TS, Hawkesbury TS (year 2011 total estimated load is 137.8 MW),
- The 115 kV line H2AR from Hawthorne to Bilberry Creek which will become a single source supply for half of Bilberry Creek TS and National research TS (year 2011 total estimated load is 70 MW)

- The 115 kV line A4K to Overbrooke TS supplying Moulton TS, Overbrooke TS and King Edwards. At Overbrooke TS A4K connects to the 115 kV K1R that terminates at Slater TS. At Riverdale Jct. the 115 kV circuit K1R connects to the new 115 kV line RH1.
- The new double circuit 115 kV line RH1/RH2 from Hawthorne TS to Riverdale Jct.,
- The three ended 115 kV line A3RM terminating at Hawthorne TS, Merivale TS and Riverdale TS, with the three-way split at Elwood Jct., supplying Uplands TS and National Aero,
- The circuits described in the previous three bullets having a common connection point at Riverdale Jct., will be supplying by 2011 a total peak load of 571 MW.
- The 115 kV line A8M from Hawthorne TS to Merivale TS.

Normal Operation

Under normal operating conditions:
- About 60% of the Bilberry Creek load is supplied via H2AR and the remaining load via H9A.
- Uplands TS and National Aero are normally supplied from A3RM and
- Slater TS load is normally supplied by A3RM and K1R and M5G.

In-line disconnect switches are available to provide for alternative supplies for these area loads in case of an outage involving various section of lines.

Transformer Ratings

Hydro One Networks Inc. has provided the following ratings for the existing 230/115 kV autotransformers:

Autotransformer	Continuous Rating (MVA)	10 Day LTR (MVA)
Merivale T21	345	393
Merivale T22	225	311
Hawthorne T4	250	388
Hawthorne T5	225	267
Hawthorne T6	225	267

115 kV Circuits Thermal Rating

The following thermal ratings for an ambient temperature of 30^{o}C and a wind speed of 4km/hr were assumed in this assessment:

Table 1. 115 kV Circuit Summer Ratings with the Proposed Transmission Facilities

115kV Circuit H2AR: Hawthorne to Bilberry Creek	*Operating Temp.*	*Continuous rating at 93°C or at sag temp., if lower*		*Emergency Rating at 127°C or sag temp. if lower*	
Hawthorne-Blackburn	150°C	850 A	173.7 MVA	1230 A	251.4 MVA
Blackburn-Cyrville	150°C	850 A	173.7 MVA	1230 A	251.4 MVA
Cyrville- Jct. Point	150°C	950 A	194.2 MVA	1380 A	282.0 MVA
Jct. Point – Bilberry Creek	140°C	620 A	126.7MVA	840 A	171.7 MVA
New 115kV Circuit RH1: Hawthorne to Riverdale TS	*Operating Temp.*	*Continuous rating at 93°C or at sag temp., if lower*		*Emergency Rating at 127°C or sag temp. if lower*	
Hawthorne-Blackburn	127°C	1200 A	245.3 MVA	N/A	
Blackburn-Jct. Point *	93°C	1100 A	224.8 MVA	1340 A (sag-116 °C)	273.9 MVA
Jct. Point- Russell *	150°C	1160 A	237.1 MVA	1670 A	341.3 MVA
Russell – Jct. Point *	93°C	1100 A	224.8 MVA	1340 A (sag-116 °C)	273.9 MVA
Jct. Point-Riverdale Jct. *	150°C	1080 A	220.7 MVA	1580 A	322.9 MVA
Riverdale Jct.– Riverdale TS*	150°C	950 A	194.2 MVA	1380 A	282.0 MVA
New 115kV Circuit RH2: Hawthorne to Riverdale TS	*Operating Temp.*	*Continuous rating at 93°C or at sag temp., if lower*		*Emergency Rating at 127°C or sag temp. if lower*	
Hawthorne-Blackburn-Russell TS (new)	127°C	1200 A	245.3 MVA	N/a	
Russell – Riverdale Jct **	150°C	1080 A	220.7 MVA	1580 A	322.9 MVA
Riverdale Jct – Riverdale TS	121°C	950A	194.2 MVA	1220 A	249.3 MVA
115kV Circuit A4K: Hawthorne to Overbrooke	*Operating Temp.*	*Continuous rating at 93°C or at sag temp., if lower*		*Emergency Rating at 127°C or sag temp. if lower*	
Hawthorne-Blackburn	150°C	850 A	173.7 MVA	1230 A	251.4 MVA
Blackburn-Cyrville	150°C	850 A	173.7 MVA	1230 A	251.4 MVA
Cyrville-Overbrooke	135°C	950A	194.2 MVA	1280 A	261.6 MVA
Overbrooke TS – King Edward TS (cable)	85°C	1000 A	204 MVA	1000 A	204 MVA
115kV Circuit A8M: Hawthorne to Merivale	*Operating Temp.*	*Continuous rating at 93°C or at sag temp., if lower*		*Emergency Rating at 127°C or sag temp. if lower*	
Hawthorne-Merivale	93°C	1380 A	282.0 MVA	1800 A	367.9 MVA
115kV Circuit H9A: Hawthorne to Bilberry Creek	*Operating Temp.*	*Continuous rating at 93°C or at sag temp., if lower*	*Emergency Rating at 127°C or sag temp. if lower*	*Emergency Rating at 127°C or sag temp. if lower*	
Hawthorne-Borromee	69°C	610 A	125 MVA	610 A	125 MVA
Borromee -Cumberland	79°C	720 A	147 MVA	720 A	147 MVA
Cumberland-Orleans	66°C	420 A	86 MVA	420 A	86 MVA
Orleans – Bilberry Creek	66°C	420 A	86 MVA	420 A	86 MVA

115kV Circuit K1R: Overbrooke to Slater	*Operating Temp.*	*Continuous rating at 93°C or at sag temp., if lower*	*Emergency Rating at 127°C or sag temp. if lower*	*Emergency Rating at 127°C or sag temp. if lower*	
Overbrooke – Jct. Point	93°C	1380 A	282 MVA	1800A	368 MVA
Jct. Point-Riverdale Jct.	150°C	1380 A	282 MVA	1380 A	282 MVA
Riverdale Jct – Riverdale TS	150°C	1380 A	282 MVA	1380 A	282 MVA
Riverdale TS– Slater (cable)	85°C	800 A	163.5 MVA	800 A	163 MVA
Overbrooke TS – King Edward TS (cable)	85°C	1000 A	204 MVA	1000 A	204 MVA
115kV Circuit A3RM: Hawthorne to Merivale	*Operating Temp.*	*Continuous rating at 93°C or at sag temp., if lower*	*Emergency Rating at 127°C or sag temp. if lower*	*Emergency Rating at 127°C or sag temp. if lower*	
Hawthorne - Elwood	93°C	1380 A	282 MVA	1800A	368 MVA
Elwood-Merivale	93°C	1380 A	282 MVA	1380 A	282 MVA
Elwood - Riverdale	134°C	950 A	194 MVA	950 A	194 MVA

* Former section of H2AR
** Former section of A3RM

8.0 Fault Level Assessment

Hydro One Networks Inc. has submitted the results of short circuit studies which identify the impact of the new Ottawa area transmission facilities and system reconfiguration on the short circuit currents in the area. The system model used in these studies included all the existing transmission facilities and the impactive projects that have completed the CAA process and obtained approval for connection. The model included:

- Maximum system generation in service – four Darlington GS units, four Pickering GS units, four Bruce GS units, five Nanticoke GS units, four Lennox GS units, three Lakeview GS units, and sixteen Saunders units.
- 4 x 250MVA, 230/115kV autotransformers at Hawthorne TS
- 3 x 750MVA, 500/230kV autotransformers at Hawthorne TS
- the proposed 115 kV circuits RH1 and RH2 and the system reconfigurations at Riverdale Jct.
- 115kV circuit H9A and 230kV circuit D5A tied through the autotransformer at Masson
- 200 MVA injection at Masson
- 400 MVA injection at Beauharnois 230kV bus
- the 2x230kV circuits from Hawthorne to Outaouais (connected to a 1250 MW back –to-back HVDC station at Outaouais)

Merivale TS 115kV bus is currently operated open because of limited short circuit capability of a number of existing breakers. With future plans to replace these breakers and operate the Merivale 115kV bus solid, fault levels were calculated with Merivale 115kV bus-tie breakers in both the open and closed positions to identify any short circuit limitations. A comparison of the study results indicated that the short circuit currents on the high voltage network are higher with the Merivale bus operated solid. Table 2 summarizes the short circuit currents, with Merivale 115 kV bus solid, for the locations that were mostly impacted by the new system configuration and the addition of the new autotransformer at Hawthorne TS, and the available breaker ratings.

Table 2. Short Circuit Study Results

BUS kV	TOTAL FAULT CURRENTS New Configuration and Hawthorne T9, Merivale 115 kV Bus Solid Symmetrical (kA)		Breaker Ratings (kA)
	3-phase fault	The highest of L-G/LL-G	Symm.
Hawthorne TS 220 kV	22.8	28.4 (L-G)	39.7 kA
Hawthorne 115 kV	30.5	38.8 (L-G)	39.3 kA
Merivale TS 220 kV	18.1	19.22 (LL-G)	63 kA
Overbrooke 115 kV	19.5	18.7 (LL-G)	40 kA
Riverdale TS 115 kV	21.8	21.3 (LL-G)	19.9 kA
Health Centre H2AR TS 115 kV	20.2	19.7 (LL-G)	31.5 kA

The fault current that is experienced by the Riverdale TS 115 breakers for a fault associated with any of the lines connected to the junction would be well under the interrupting capability of the existing breakers due to the contribution of the line in-feed currents.

It can be concluded that, the new system reconfiguration and the addition of the new 230/115 kV Hawthorne autotransformer result in an increase in fault currents in the area. However, the new short circuit levels do not exceed the interrupting capability of the exiting breakers.

9.0 Transfer Capability Assessment

This connection assessment study concentrated on identifying the effect of the proposed Ottawa area 230/115 kV transmission system reinforcement and reconfiguration, on the system power transfer capability and the system voltages.

Hydro One Networks Inc. Study

The power flow and voltage study performed by Hydro One Networks Inc. covered the period to 2011 and the results showed that the proposed facilities would ensure reliable supply of the Ottawa area load.

Hydro One Networks Inc.'s study was carried out under the following assumptions:

- A study period of ten years (2002 to 2011) was selected to assess the transmission requirement.
- Weather corrected summer and winter peak loads are based on the latest forecast growth rates provided by Hydro Ottawa.
- The 115kV bus at Merivale TS is operating with the bus-tie opened.
- The Ottawa Health Science NUG connected to the 115kV circuit H2AR is assumed to available with both units in service (66MW).

- Chats Falls GS, Barrett Chute GS and Stewartville GS are assumed to be capable of supplying up to 285MW during peak hours in both summer and winter. Peak generation capacity available is 387MW.
- Equipment continuous Limited Time Ratings (LTR) are based on an ambient temperature of 30°C for summer and 0°C for winter.
- Minimum voltages on the 118kV and 230kV transmission system under normal conditions are 113kV and 230kV respectively. Maximum voltage decline is limited to 10% for a single element contingency.
- The new 230 kV Hydro Quebec interconnection into Hawthorne TS and associated 230kV station facilities were assumed unavailable before 2011.

9.1 Connection Assessments Study Assumptions

Since Hydro One Networks Inc. study covered in detail a large number of load and generation scenarios, this connection assessment study concentrated on one extreme case representing a 2011 load level with Hydro Quebec imports of 1250 MW and Ottawa river and Madawaska river hydraulic generation out of service. The Merivale 115 kV bus was assumed to be operated solid.

The studies were performed for a system with all elements in service under conditions of 2011 peak load conditions. The total load in the Ottawa area was assumed to be about 1970 MW comprising of 1370 MW of 115 kV load and 600 MW of 230 kV load.

The individual station loads for year 2011 are shown in Table 3.

Table 3. Ottawa Area Loads

HAWTHORNE EAST 115kV	2011	HAWTHORNE CENTER 115kV	2011	HAWTHORNE SOUTH 44kV	2011	230kV WEST	2011
BILBERRY CREEK	88.6	KING EDWARD	89.3	HAWTHORNE	115.9	NEPEAN	194.7
CASSBURN	1.4	MOULTON	52.3			KANATA	53.1
CLARENCE DS	1.4	NAT. RESEARCH	25.9			SOUTH MARCH	116.1
CUMBERLAND DS	4.5	OHSC	0.0				
HAWKESBURY	18.7	OVERBROOKE	86.5				
NAVAN DS	4.0	RIVERDALE	78.5				
ORLEANS	0.0	RUSSELL	74.9				
ROCKLAND DS	5.8	SLATER	146.7				
ROCKLAND EAST DS	8.5						
WENDOVER DS	7.4						
WILHAVEN DS	41.7						
SUB-TOTAL	**182.1**	**SUB-TOTAL**	**554.1**	**SUB-TOTAL**	**115.9**	**SUB-TOTAL**	**363.9**
MERIVALE EAST 115kV	**2011**	**MERIVALE WEST 115kV**	**2011**	**C7BM-W6MC**	**2011**	**A3RM 115kV SOUTH CENTER**	**2011**
CARLING	86.1	LINCOLN HEIGHT	51.3	ARNPRIOR	39.7	UPLANDS MS#2	4.9
HINCHEY	45.8	WOODROFFE	41.0	BRIDLEWOOD MS	23.2	UPLANDS NEW	26.1
LISGAR	88.0	**SUB-TOTAL**	**92.2**	CENTERPOINT MS	19.2	NATIONAL AERO. EST	11.7
MERIVALE MS	12.2	**MERIVALE SOUTH**		FALLOWFIELD DS	32.5	**SUB-TOTAL**	**42.7**
NEPEAN-EPWORTH	16.5	GREELY	8.1	MANORDALE MS	15.7		
		LIMEBANK MS#7	42.4	MANOTICK DS	7.2	**ALBION SOUTH 13.8kV**	
		MARIONVILLE DS	10.9	MARCHWOOD MS	45.9	ALBION	115.4
		RUSSELL DS	2.4	RICHMOND DS	3.8		
		SOUTH GLOUCESTER	2.0				
SUB-TOTAL	**248.5**	**SUB-TOTAL**	**65.8**	**SUB-TOTAL**	**187.2**	**SUB-TOTAL**	**115.4**

9.2 Transfer Distribution Factors

The study concentrated on determining the distribution of the power flowing on the 230/115 kV transformers at Hawthorne TS, Merivale TS and over the 115 kV Ottawa area circuits, with all transmission elements are in service. Table 4 below summarizes the system Transmission Distribution Factors over the transmission elements listed in the first column when the Chat Falls GS output or imports from Hydro Quebec displace the Lennox generation.

Table 4. Transmission Distribution Factors

CCT #	From	To	Base Case Flow (MW)	Chat Falls	Hydro Quebec
D5A	**Hawthorne**	**Cumberland**	**-29.7**	0.03842	0.05253
L24A	**Hawthorne**	**St. Lawrence**	**-176**	0.08071	0.11036
X522A	**Hawthorne**	**Lennox**	**-131.3**	0.25327	0.32305
X523A	**Hawthorne**	**Lennox**	**-131.3**	0.25327	0.32305
M30A	**Hawthorne**	**Albion**	**384**	-0.14126	0.07971
M31A	**Hawthorne**	**Albion**	**386**	-0.14126	0.07971
HAW_T4	**Hawthorne 230**	**Hawthorne 115**	**197.5**	-0.08344	0.00768
HAW_T5	**Hawthorne 230**	**Hawthorne 115**	**206.0**	-0.088	0.0082
HAW_T6	**Hawthorne 230**	**Hawthorne 115**	**212.2**	-0.08934	0.00823
HAW_T9(new)	**Hawthorne 230**	**Hawthorne 115**	**197.0**	-0.0834	0.0077
A3RM	**Hawthorne**	**Elwood**	**121.8**	-0.12435	0.01145
A3RM	**Elwood**	**Riverdale**	**66.7**	0.04901	-0.00451
A3RM	**Merivale**	**Elwood**	**-10.7**	0.17337	-0.01596
A8M	**Hawthorne**	**Merivale**	**60.6**	-0.15547	0.01431
A4K	**Hawthorne**	**Cyrville Jct.**	**147.8**	-0.0141	0.0013
RH2	**Hawthorne**	**Riverdale Jct.**	**128.4**	-0.02776	0.00255
RH1	**Hawthorne**	**Russell**	**140.1**	-0.02149	0.00198
K1R	**Riverdale TS**	**Riverdale Jct.**	**24.2**	0.03534	-0.00325
K1R	**Overbrooke**	**Riverdale Jct.**	**-78.5**	-0.0141	0.0013
Merivale T21	**Merivale 230**	**Merivale 115**	**163.4**	-0.221	-0.00172
Merivale T22	**Merivale 230**	**Merivale 115**	**158.4**	-0.2136	-0.00166
W6MC	**Merivale 115**	**West**	**-1.9**	-0.15752	0.01409
C7BM	**Merivale 115**	**West**	**-6.3**	-0.58952	0.01343

For a system model with all elements in service incorporating the new transmission facilities and proposed system reconfigurations, the results of the linear analysis studies indicate that:

- A decrease in the output of Chat Falls GS would be compensated as follows:
  - 34% via the Hawthorne 230/115 kV autotransformers,
  - 44% via the Merivale 230/115 kV autotransformers and,
  - 22% via the other 115 kV circuits into Merivale.
- About 97% of power that would be imported from Hydro Quebec would appear over the 230 kV and 500 kV Eastern Ontario transmission and only about 3% of imports are likely to flow via the 115 kV system. Importing 1250 MW from Hydro Quebec will result in an increase of about 38 MW over the Hawthorne autotransformers.

These results show that the 230/115 kV autotransformers at Hawthorne TS and Merivale TS are mainly utilized for the supply of the 115 kV Ottawa area load and that imports from Hydro Quebec would marginally increase the flow over the 230/115 kV autotransformers at Hawthorne.

9.3 Study Case Results – Thermal Loading

Linear analysis was also performed to determine the distribution of power flows over the Ottawa area transmission in the event of a contingency.

Using the results of the linear analysis and a base case with no hydraulic generation in the Ottawa area and high imports from Hydro Quebec, post-contingency power flows were calculated and summarized in Table 5, and possible thermal overloads identified. Also, Figure 5 shows pre-contingency power flows over the 230 kV and 115 kV Ottawa area transmission.

The study results show that by 2011 with all transmission facilities in service:

- The pre-contingency power flows are within the summer thermal ratings of the respective transmission elements for most transmission elements. There are a few exceptions:
  - Flow on H9A exceeds the continuous thermal rating of the circuit by about 15%. However, Hydro One Networks Inc. has plans to increase the capacity of this circuit as part of the proposed Ontario-Hydro Quebec interconnection project. In the meantime, interim relief from possible thermal overloading can be provided by power purchases from Maclaren Energie on 115kV circuit H9A from Masson, or by transferring the entire Bilberry Creek load to H2AR.
  - Flows on Hawthorne 230/115 kV autotransformers T5 and T6 are slightly above the continuous rating.

- Contingencies associated with T4 or T9 autotransformers at Hawthorne TS would result in the post- contingency flows on T5 and T6 autotransformers which are over the 10 day limited time rating of the respective units.

- Contingencies associated with T21 or T22 autotransformers at Merivale TS would result in the post- contingency flows on Hawthorne T5 and T6 autotransformers which are around the 10 day limited time rating of the respective units.

- For a contingency associated with either M30A or M31A the post-contingency, the flow over T6 autotransformer at Hawthorne approaches its the 10 day LTR.

- A contingency associated with A3RM (Figure 6) would result in temporary loss of supply to Uplands and National Aerospace (a total load of about 103 MVA), but load transfer schemes are available to switch the supply to A8M. The post- contingency power flows over the remaining circuits do not appear to exceed the continuous rating of these circuits

- A contingency associated with the new 115 kV circuit RH2 (Figure 7) would result in the tripping of the TransAlta generation and the opening of the two 115 kV breakers at Riverdale. Under this configuration, the 115 kV circuits A4K, RH1 and K1R will continue to supply the Russell TS load, half of the Riverdale TS load, a portion of Slater load, Overbrooke and King Edwards loads, and Moulton TS (a total load of about 392 MVA). The A3RM branch emanating from Elwood will supply the remaining load at Slater TS. With the exception of A4K, which becomes loaded over its continuous rating but under the emergency (127^0C) rating, the other 115 kV circuits in the area would experience post-contingency power flows that are well within the continuous ratings of the lines.

- The loss of the new 115 kV circuit RH1 (Figure 8) will result in Russell TS load (75 MVA) being supplied off circuit RH2; King Edwards TS Overbrooke TS and Moulton TS loads (a total load of 228 MVA) being radially supplied via A4K; and Riverdale TS and Slater TS loads (a total load of 190 MVA) being fed via A3RM and RH2. The post-contingency power flow across the 115 kV circuit A4K would exceed the continuous rating but would be under the emergency (127^0C) rating of the circuit.

It has been noted that with the proposed reconfiguration of the system a contingency associated with the new 115 kV line RH2 could result in part of the power supplying Slater TS passing through the low voltage side of Riverdale TS.

Although the Connection Assessment results indicate that in 2011 the load supply capability of the Hawthorne 230/115 kV autotransformers may reach their maximum capability, it is recognized that the system conditions assumed in the study are extreme and create a very stressed scenario. With available generation on the Madawska and Ottawa rivers the flow on these autotransformers would be reduced to acceptable levels.

Outaged Element	Pre-contingency Flows (MVA)	Monitored Elements: Post contingency Flows								
		Haw_T4 (MVA)	Haw_T5 (MVA)	Haw_T6 (MVA)	Haw_T9 (MVA)	A8M (MVA)	A3RM (HxE) (MVA)	A4K (MVA)	RH2 (HxR) (MVA)	RH1 (HxR) (MVA)
Ratings	*Continuous Emergency*	*250MVA 388MVA*	*225 MVA 267MVA*	*225 MVA 267MVA*	*250 MVA 400MVA*	*282MVA 368MVA*	*282MVA 282MVA*	*174MVA 251MVA*	*245MVA*	*245MVA*
D5A	34.8	230.2	239.2	246.4	230.2	108.2	162.2	154.6	138.5	148.7
L24A	186.3	229.2	238.8	245.4	229.2	106.3	160.7	154.4	138.2	148.5
X522A	281.4	225.7	235.1	241.6	225.7	106.5	161.5	155.	138.	148.9
X523A	281.4	224.1	233.6	239.7	224.1	106.5	161.5	155.	138	148.9
M30A	434.2	249.1	259.5	*266.7*	249.1	140.9	188.6	157.7	144.3	1533
M31A	436.3	249.2	259.6	*266.8*	249.2	141	188.7	157.6	144.3	153.3
HAW_T4	230.3	0	*296.3*	*304.5*	284.5	88.5	147.1	152.7	135.9	146.1
HAW_T5	239.9	287.5	*0*	*307.7*	287.5	87.5	146.4	152.6	135.8	146
HAW_T6	246.5	289.7	*301.7*	*0*	289.7	86.7	145.7	152.6	135.6	145.9
HAW_T9 (new)	230.3	284.5	296.3	304.5	0	88.5	147.1	152.7	135.9	146.1
A8M	108.6	216.1	225.1	231.3	216.1	0	196.2	158.3	146	154.5
A3RM (HxE)	162.5	208	216.7	222.7	208	153	0	161.5	151.9	159.0
A3RM (ExR)	55.6									
A3RM (RxM)	67.2									
A3RM (RxS)	62.1									
A4K	156.0	219.3	228.4	234.8	219.3	115.6	184.8	0	167.3	201.5
RH2	136.7	229.2	238.7	245.3	229.2	113	200.3	*188.2*	0	205.3
RH1	149.4	225.2	234.6	241.1	225.2	118.2	186.6	*230*	177.6	0
K1R (RxO)	75.4									
K1R (RjxRt)	36.8									
Merivale T21	235.2	257.1	267.8	275.2	257.1	164.4	208.3	159.6	149.3	156.6
Merivale T22	227.3	255.5	266.1	273.5	255.5	161.8	206.1	159.3	148.8	156.3

Table 5. Contingency Analysis Result

9.4 Study Case Results - Voltage Assessment

A detailed voltage analysis was performed by Hydro One Networks Inc. and the results were confirmed and accepted by the IMO. The results show that with the new autotransformer in service and the proposed system reconfiguration the steady state voltages for most of the Ottawa area meet the Market Rules requirement.

One concern with respect to system voltages is related to the 115 kV circuits designed H2AR, H9A and 79M1 which supply the loads northeast of Ottawa area. The loads connected to H9A circuit meet the minimum Market Rules requirements for 113kV voltages under normal conditions, but the stations connected to the radial 115 kV line 79M1 could experience lower than required voltages. Hydro One Networks Inc. has indicated that a connection assessment application will be submitted shortly for the installation of low voltage shunt capacitors at Wilhaven DS and Hawkesbury DS to correct this problem. Due to the lower then acceptable pre-contingency voltage, the voltage drop that could be experienced for the loss of H2AR is excessive.

It is suggested that Hydro One Networks Inc. assess moving the normally open point at Bilberry Creek TS to the east side of the station to allow the supply of the entire Bilberry Creek load from H2AR, thus better balancing the power flows on H9A and H2AR. This will result in a reduction in the loading of H9A and consequently better voltage profile all along this circuit and 79M1. Hydro One Networks Inc. should investigate the benefit of the suggested reconfiguration together with the proposed installation of low voltage shunt capacitors.

A second concern with respect to the voltages in the area, which was also identified by Hydro One Networks Inc., is the immediate post contingency voltage decline at Merivale TS for the loss of autotransformer T21 when Madawaska generation is out of service. However, a protection scheme is in place, which allows closing the Merivale 115 kV bus tie-breaker in the event of this contingency. This ensures the fast recovery of the post-contingency voltage. An additional available measure for conditions of peak load would be running the Madawaska generation to back up the flows on these transformers and ease the post contingency voltage decline situation.

Additionally, Hydro One Networks Inc. has indicated that work started on a plan to replace all the 115 kV breakers at Merivale TS. It is expected that the Merivale TS 115kV breakers will be replaced in the next few years allowing the Merivale 115kV bus-tie breakers to be closed, thus eliminating the post-contingency voltage decline problem.

10 Customer Impact Assessment

Hydro One Networks Inc. has performed a Customer Impact Assessment and concluded that:

- The proposed transmission system improvements/additions will increase the load meeting capability of the transmission system in the Ottawa area and assist in meeting the expected loads in the eastern Ottawa area for about the next 10 years. It will also improve the supply reliability for customers that are supplied from Slater TS, Riverdale TS, King Edward TS and Overbrooke TS in Ottawa. Supply reliability for other customers in the area will not be adversely impacted.

- There will be small increase in short circuit levels at the customer connection points. These increased levels remain within the capability of the existing customer interface facilities. Customers will be advised to review the increased levels to confirm that internal customer facilities are not adversely impacted.

- The proposed construction work can be accommodated with minimal supply impact on the existing transmission customers in the area.

11.0 Conclusions and Recommendations

This Preliminary Assessment has examined the impact of the fourth 230/115 kV autotransformer at Hawthorne TS, the incorporating of additional 115 kV circuits and reconfiguration of the existing 115 transmission in Ottawa area on the reliability of the power system and Ottawa area load supply.

The general conclusion of this assessment is that the proposed plan will result in a major improvement to the reliability of Ottawa area load supply and will not have a negative impact on the overall system reliability.

The following specific conclusions were drawn:

1. The new 230/115 kV autotransformer will increase the Hawthorne TS load supply capability to 922 MVA. Based on current load forecast this capability which should be adequate to supply the load until about 2011.
2. The proposed new 115 kV transmission is adequate to ensure reliable supply to the Ottawa area load beyond 2011 with all 115 kV transmission elements in service and following a contingency associated with one 115 kV circuit.
3. The short circuit study results provided by Hydro One Networks Inc. indicate that with the new system reconfiguration and the Hawthorne autotransformer in service, the resulting fault levels will be below the interrupting capability of the exiting breakers.
4. By 2011, contingencies associated with T4 or T9 autotransformers at Hawthorne TS would result in the post- contingency flows on T5 and T6 autotransformers which are over the 10 day limited time rating of the respective units.
5. By 2011, contingencies associated with T21 or T22 autotransformers at Merivale TS would result in the post- contingency flows on Hawthorne T5 and T6 autotransformers which are around the 10 day limited time rating of the respective units.
6. For a contingency associated with either M30A or M31A the post-contingency flow over T6 autotransformer at Hawthorne approaches its 10 day LTR.

7. By 2011, flows on Hawthorne 230/115 kV circuits T5 and T6 are slightly above the continuous rating.
8. Flow on H9A exceeds the continuous thermal rating of the circuit by about 15%. Hydro One Networks Inc. has plans to increase the capacity of this circuit as part of the proposed Ontario-Hydro Quebec interconnection project. In the meantime, interim relief from possible thermal overloading can be provided by power purchases from Maclaren Energie on 115kV circuit H9A from Masson, or by transferring the entire Bilberry Creek load to H2AR.
9. The loads connected to H9A circuit meet the minimum Market Rules requirements for 113kV voltages under normal conditions, but the stations connected to the radial 115 kV line 79M1 could experience lower than required voltages. Hydro One Networks Inc. has indicated that a connection assessment application will be submitted shortly for the installation of low voltage shunt capacitors at Wilhaven DS and Hawkesbury DS to correct this problem.

It is recommended that Hydro One Networks Inc. monitor the peak flows over the Hawthorne autotransformers and plan for replacing T5 and/or T6 when required.

It is recommended that Hydro One Networks Inc. monitor the loading of the 115 kV circuit H9A and if necessary initiate a plan for its upgrading.

It is recommended that Hydro One Networks Inc. consider moving the normally open point at Bilberry Creek TS to the east side of the station to allow the supply of the entire Bilberry Creek load from H2AR, thus better balancing the power flows on H9A and H2AR. This will result in a reduction in the loading of H9A and consequently better voltage profile all along this circuit and 79M1. Hydro One Networks Inc. should investigate the benefit of the suggested reconfigurations against the installation of low voltage shunt capacitors along the 115 kV circuit 79 M1.

12. IMO Requirements

The IMO's requirements that have been identified in this assessment, for the incorporation of the new 230/115 kV autotransformer at Hawthorne TS and the proposed 115 kV transmission and system reconfiguration, are as follows:

10. The status of all isolating disconnect switches and breakers must be monitored and made available to the IMO on a continual basis.

11. The proponent will provide when available, the "as built" transformer information to meet the requirements of the facility registration process.

12. All new facilities will have to be equipped with adequate protection schemes in accordance with the Transmission System Code.

In addition to the Connection Assessment and Approval process any new connection to the IMO-controlled grid has to fulfill, before coming into service, the following:

13. All the requirements of the IMO Facility Registration process.
14. The installation of all equipment needed to monitor the system operating information required by the IMO on a continuous basis as described in Chapter 4 section 7.5 and Appendix 4.17 of the *Market Rules*.
15. All the requirements of the IMO Meter Registration process.

13.0 Need for System Impact Assessment

This Preliminary Assessment evaluated all the aspects related to the impact of the proposed developments on the reliability of the IMO-controlled grid and no further analysis is required.

A separate System Impact Assessment is therefore not required for this project.

14.0 Notification of Approval

Section 12.0 of the Preliminary Assessment Report lists all the requirements identified by the Connection Assessment and Approval process for the incorporation of the proposed 230/115 kV autotransformer installation at Hawthorne TS and the 115 kV new transmission and system reconfiguration. It is recommended that approval be granted and Notification of Approval be issued subject to the implementation by the proponent of the IMO requirements.

FIGURES

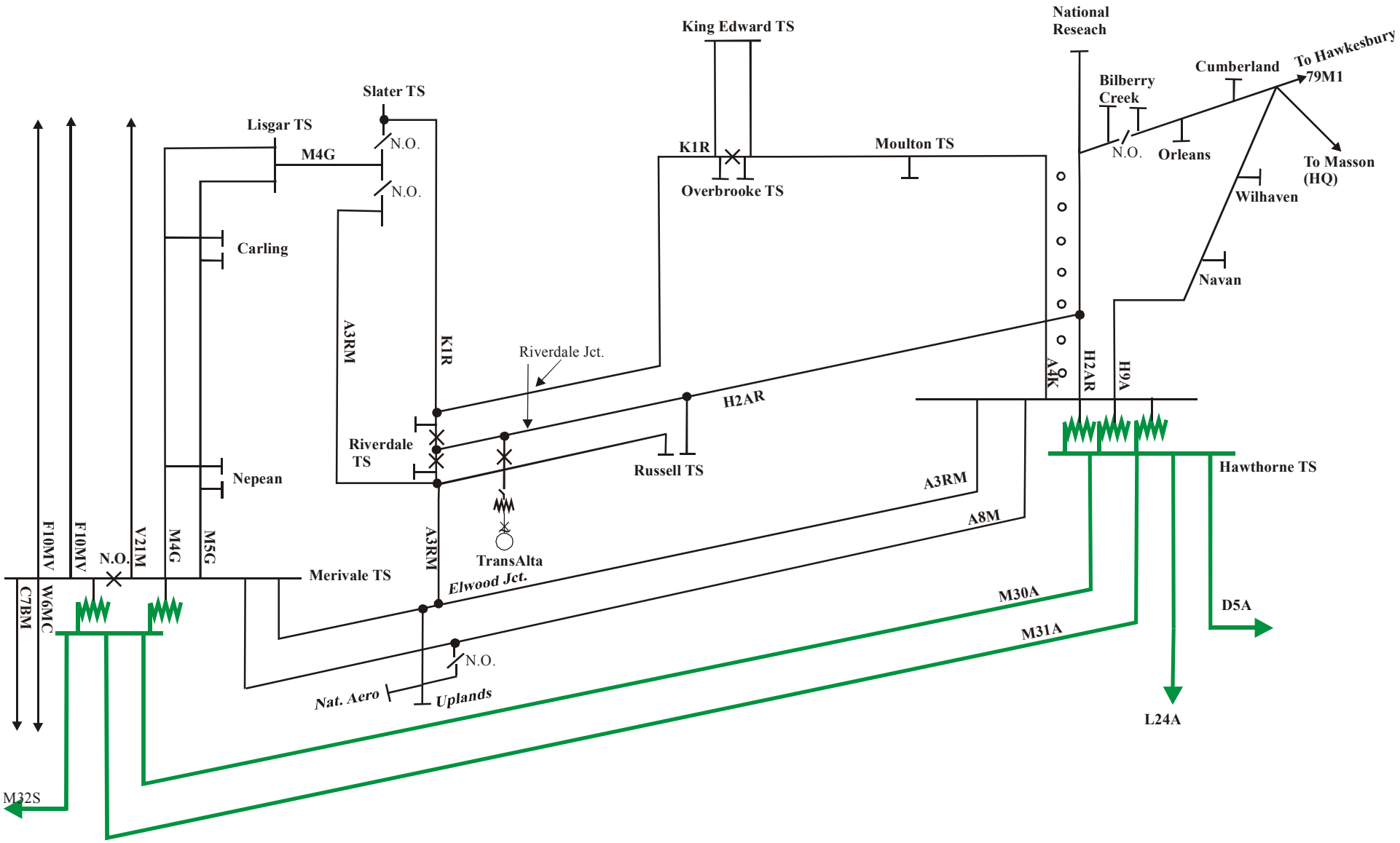

Figure 1. Ottawa Area 115 kV Transmission System - Existing Facilities

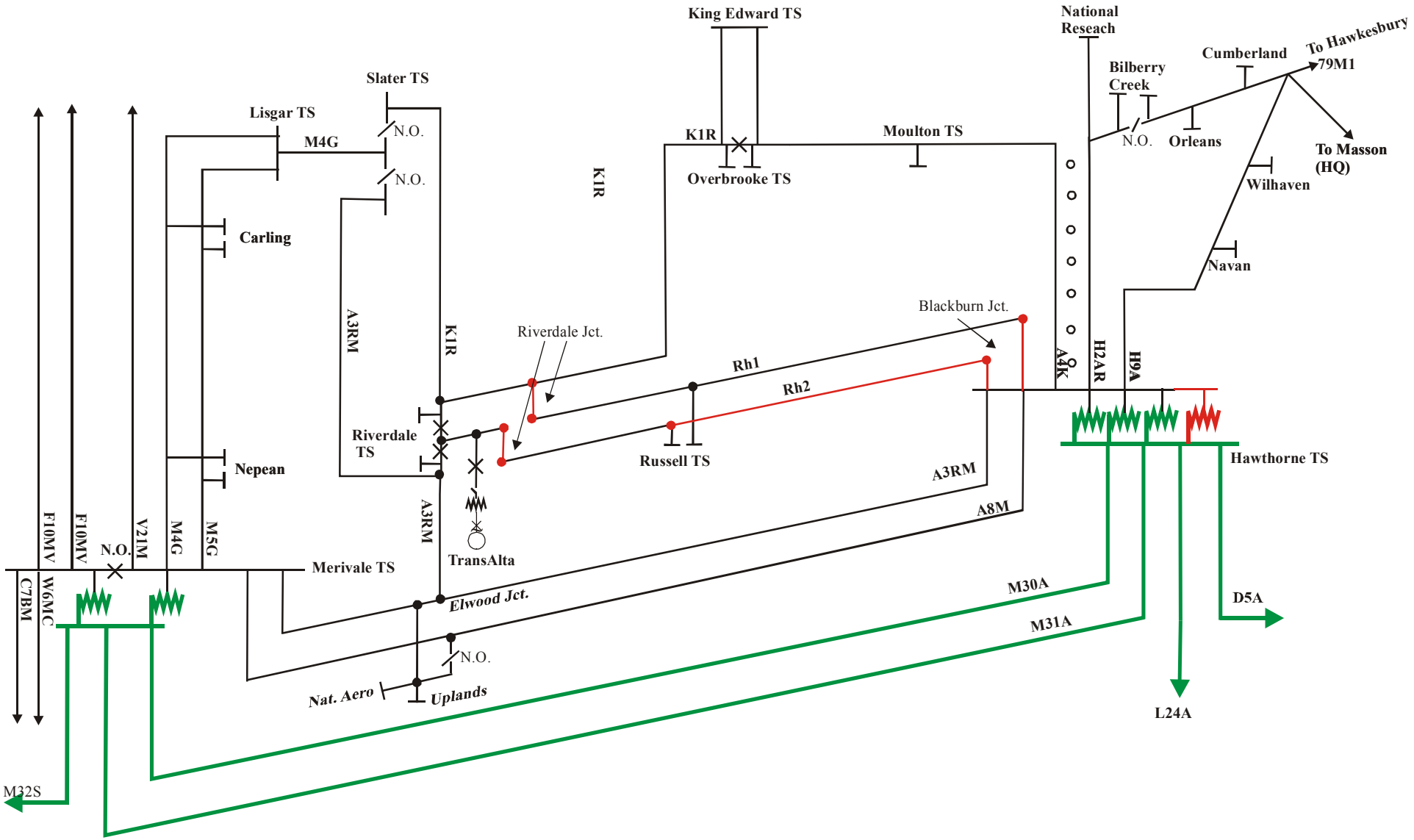

Figure 2. Ottawa Area 115 kV Transmission System - Existing and Proposed Facilities

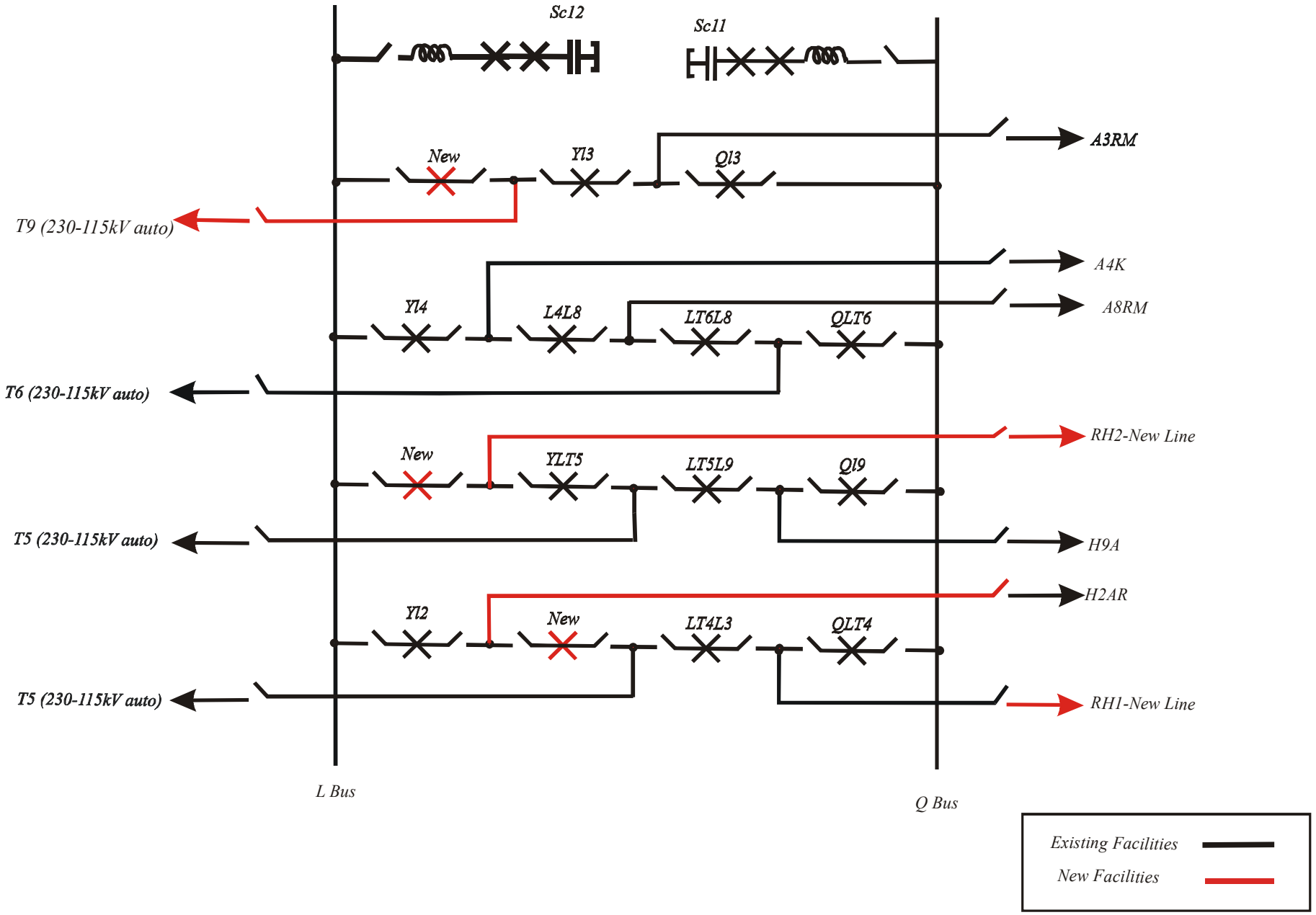

Figure 3. Ottawa Hawthorne TS: 115 kV Existing and New Facilities

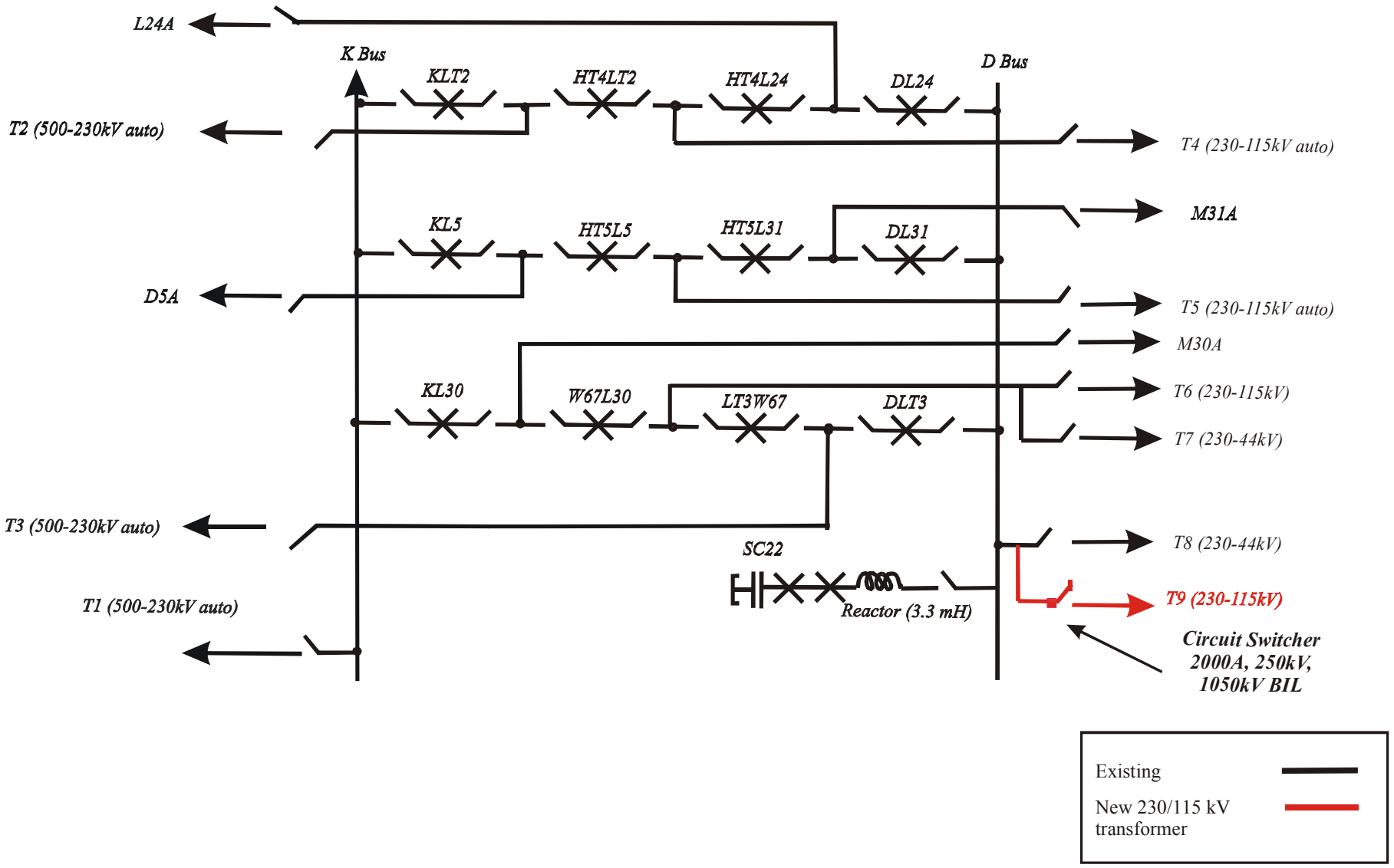

Figure 4. Ottawa Hawthorne TS: 230 KV New AutotransformerFacilities

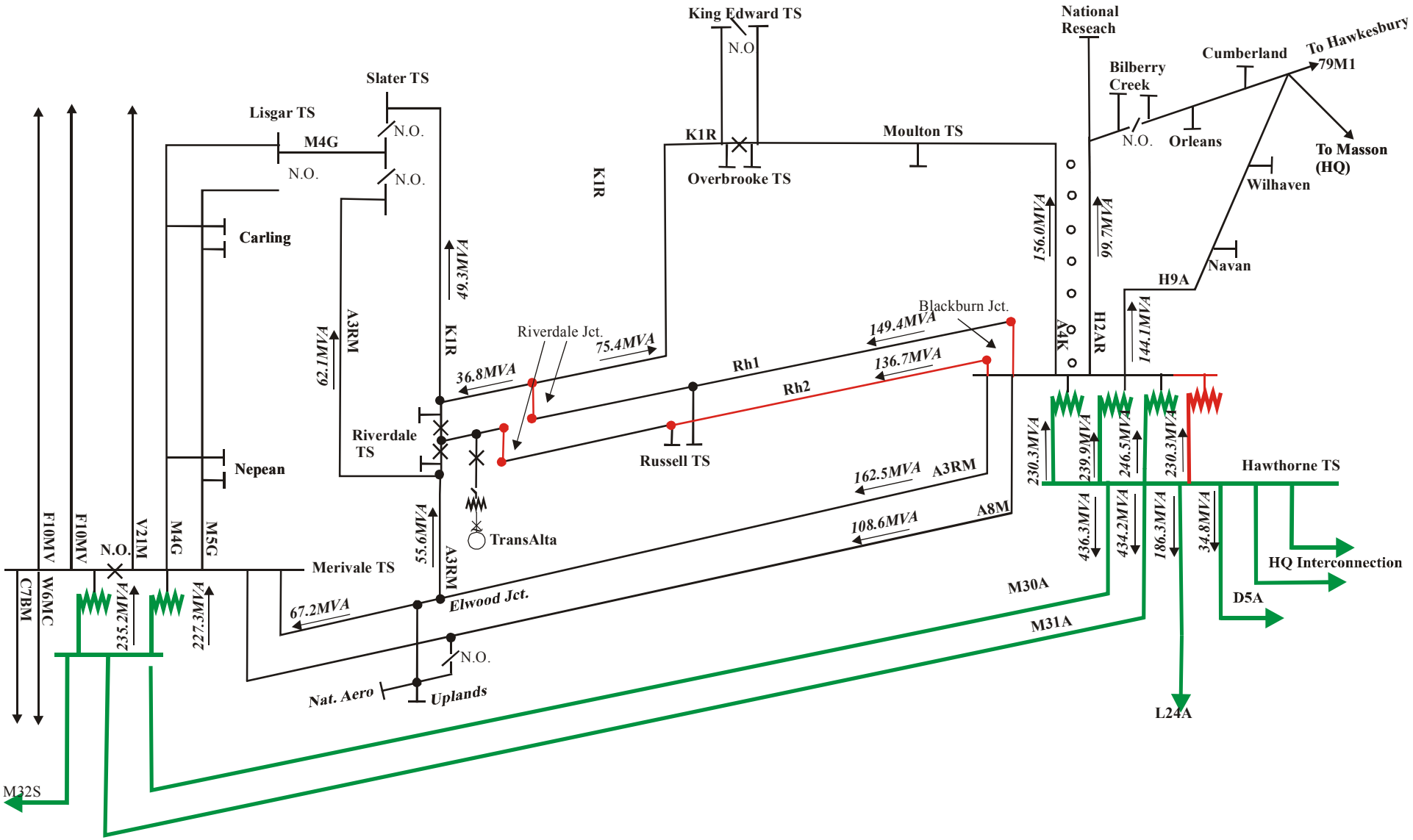

Figure 5. Ottawa Area 115 kV Transmission System - 2011 Power Flows

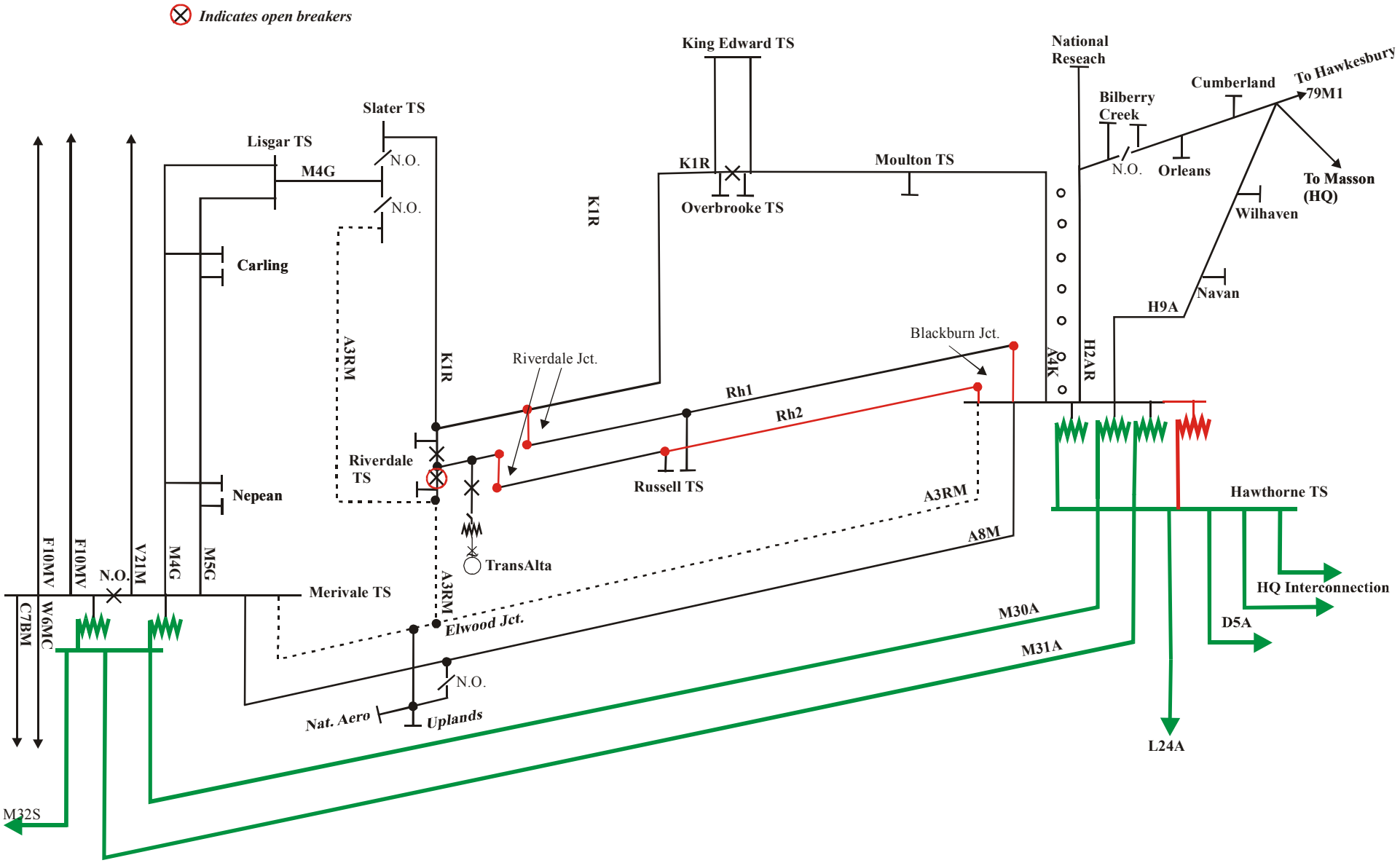

Figure 6 . Ottawa Area 115 kV Transmission System - 2011 Power Flows-A3RM Contingency

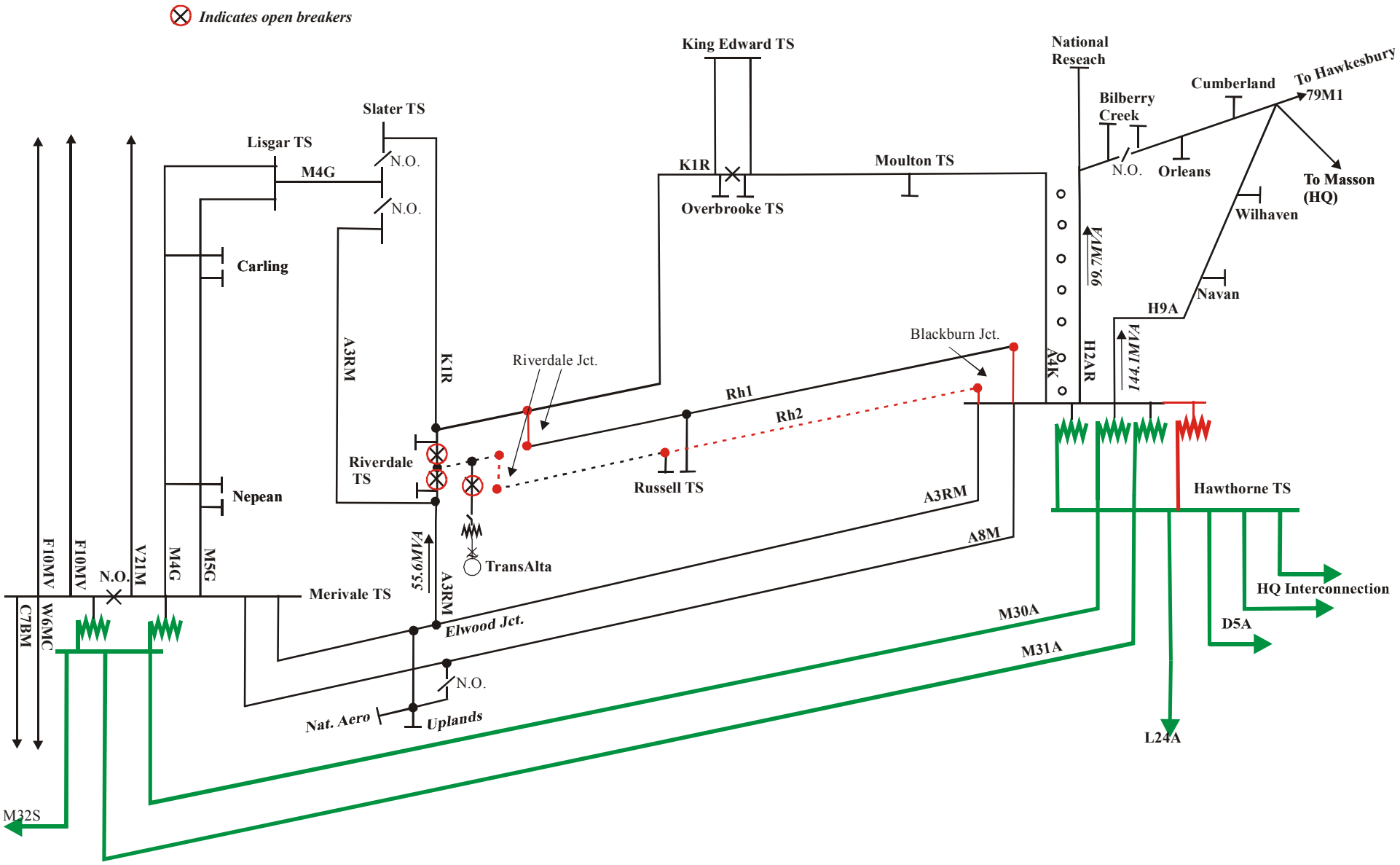

Figure 7. Ottawa Area 115 kV Transmission System - 2011 Power Flows-RH2 Contingency

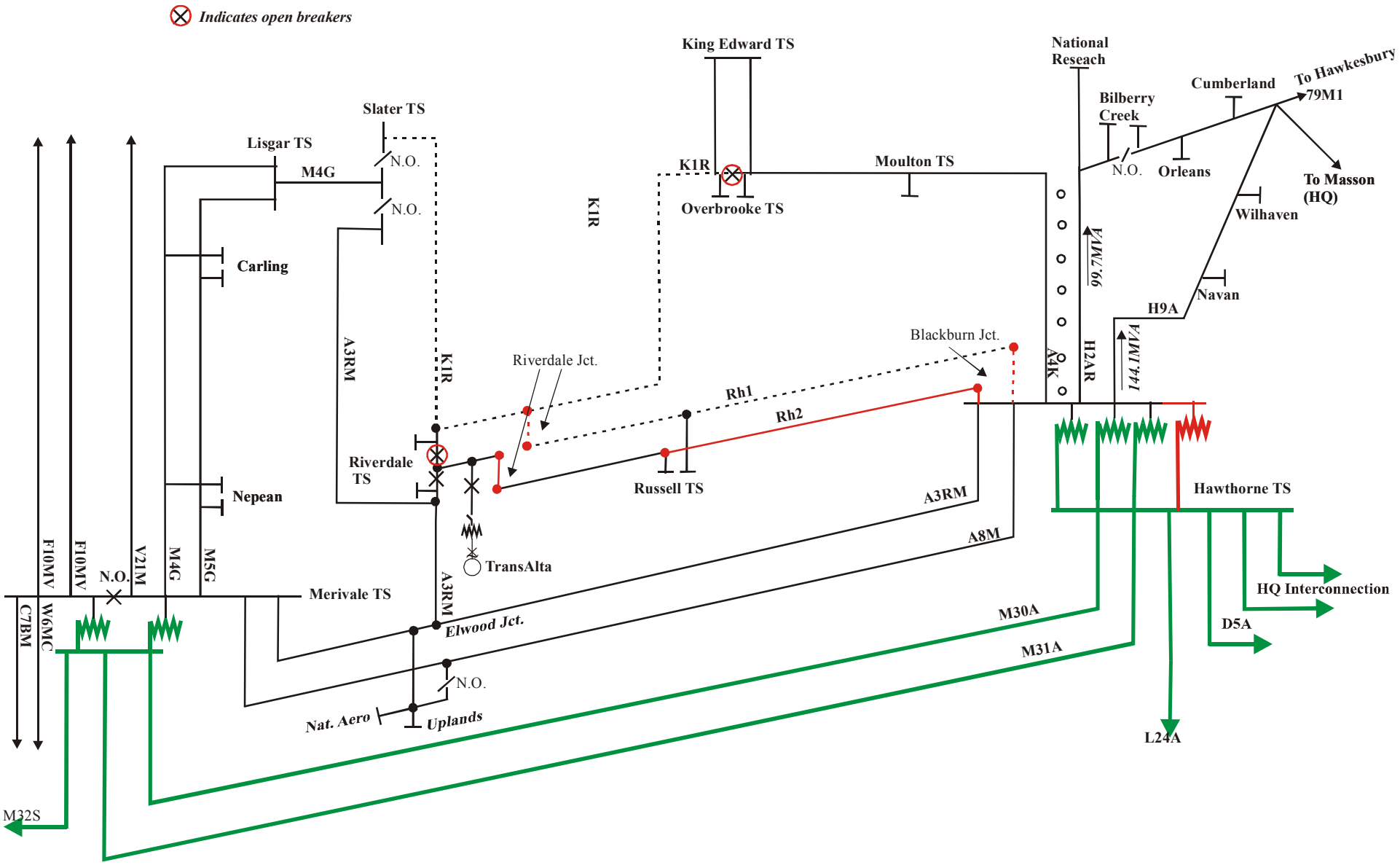

Figure 8. Ottawa Area 115 kV Transmission System - 2011 Power Flows-RH1 Contingency