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System Impact Assessment Report

Connection Assessment & Approval Process

Final

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Project: Ellwood MTS
Applicant: Hydro Ottawa Ltd

Market Facilitation Department
Independent Electricity System Operator

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REPORT

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System Impact Assessment Report

Acknowledgement

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

Disclaimers

IESO

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

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

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

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

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

Hydro One

The results reported in this report are based on the information available to Hydro One, at the time of the study, suitable for a preliminary assessment of this transmission system reinforcement proposal.

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

This study does not assess the short circuit or thermal loading impact of the proposed facilities on load and generation customers.

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

The ampacity ratings of Hydro One facilities are established based on assumptions used in Hydro One for power system planning studies. The actual ampacity ratings during operations may be determined in real-time and are based on actual system conditions, including ambient temperature, wind speed and 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 facilities 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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Summary and Conclusions

Hydro Ottawa is planning to build a new 230/13.2 kV station, Ellwood Municipal Transformer Station (MTS), adjacent to Albion TS. The station will be supplied from the Hydro One 230kV overhead transmission lines M30A/M31A at Albion Junction and is to accommodate load growth in the south-east area of the City of Ottawa. The planned in-service date for the new station is November, 2010.

The following conclusions are achieved based on this assessment:

- The proposed connection arrangement and equipments for Ellwood MTS is acceptable.
- The voltage performance and thermal loading with Ellwood MTS is expected to be acceptable under both pre-contingency and post-contingency operating conditions.
- The applicant shall install capacitor banks of about 12 MVar@13.2kV at the LV side of Ellwood MTS.
- The proposed Ellwood MTS has no impact the HVdc runback SPS at the current stage. However, as the load at Ellwood MTS and Albion TS grows, the runback levels will have to be reviewed by the IESO.
- The area transmission system meets the IESO load security criteria in supplying Ellwood MTS.
- The proposed Ellwood MTS shall be capable of participating in the Ottawa Area Undervoltage SPS for automatic load rejection and automatic capacitor switching.
- Provide the applicant satisfy the requirements specified in the report, Ellwood MTS will be granted final approval via the IESO Market Entry process to be connected to the IESO-controlled grid.

– End of Section –

NOCA and IESO Requirements

Notification of Conditional Approval

It is recommended that a revised *Notification of Conditional Approval for Connection* be issued to Hydro Ottawa subject to the IESO receiving from Hydro Ottawa written acknowledgement that the requirements in this report will be implemented.

IESO Requirements

Provided the applicant satisfy the following requirements, Ellwood MTS will be granted final approval via the IESO Market Entry process to be connected to the IESO-controlled grid.

- The applicant must complete the IESO Market Entry/Facility Registration process in a timely manner before IESO final approval for connection is granted. Models and data, including any controls that would be operational, must be provided to the IESO. This information should be submitted at least seven months before first connection to the IESO-controlled grid, to allow the IESO to incorporate the Ellwood MTS into IESO work systems and to perform any additional reliability studies.

If the submitted models and data differ materially from the ones used in this assessment, then further analysis of the connection proposal will need to be completed by the IESO.

- The IESO requires that proposed 230 kV connection equipment:
 - must have a maximum continuous voltage rating of at least 250 kV; and
 - must be able to sustain operation at voltages up to 262.5 kV for up to 30 minutes and not automatically trip.

If revenue metering equipment is installed, revenue metering installations must comply with the appropriate Measurement Canada requirements as well as the Market Rules for the Ontario electricity market. For more details the applicant is encouraged to seek advice from their Metering Service Provider (MSP) or from the IESO metering group.

The Transmission System Code (TSC) requires that new equipment be designed to sustain the fault levels in the area where the equipment is installed. If any future system enhancement results in an increased fault level higher than the equipment's capability, the applicant is required to replace the equipment at its own expense with higher rated equipment capable of sustaining the increased fault level, up to the TSC's maximum fault level of 63 kA for the 230 kV system.

- The applicant is required to install facilities at the station to allow for the detection of under frequency conditions, and the selection and tripping of feeder circuit breakers for load shedding. In the event that the existing UFLS area load is insufficient in meeting the UFLS targets with the addition of the new load, the applicant is required to submit during the IESO Market Entry process a revised schedule of feeder selections and their related load amounts for each shedding stage that will ultimately satisfy the UFLS targets.

- The applicant is required to install facilities at the Ellwood MTS to provide local and remote voltage reduction capability of 3% and 5%. The applicant will need to confirm during the IESO Market Entry process that this capability is available.
- The applicant shall install capacitor banks of 12 MVar@13.2kV at the LV side of Ellwood MTS.
- The proposed Ellwood MTS shall be capable of participating in the Ottawa Area Undervoltage SPS for automatic load rejection and automatic capacitor switching,
- The applicant must install equipment at the Ellwood MTS with specific performance standards that provides telemetry data to the IESO. The telemetry data is to consist of certain equipment status and operating quantities which will be identified to the applicant during the IESO Market Entry Process. End to end telemetry testing must be completed by the applicant along with the IESO to ensure that standards are met and sign conventions are understood.
- New protection systems must be coordinated with existing protection systems and must be designed to satisfy the requirements of the Transmission System Code (TSC).
- The connection applicant is required to initiate an assessment of the existing protection systems with the transmitter who shall identify any modifications to protection equipment or settings required to incorporate the new facility. The IESO will evaluate the impact of any protection modifications and associated changes to functionality, timing, or reach on system reliability. The IESO will not assess aspects of protection systems which are solely the accountability of the connection applicant (e.g. coordination of relay protections).
- To allow sufficient time to assess the impact on power system reliability, the connection applicant must submit any proposed protection changes to the IESO at least six (6) months before any actual changes are to be implemented on the existing protection systems.
- The IESO would deem the modifications acceptable if they do not cause any new and/or reduced operating security limits under normal operating conditions. Should the modifications be unacceptable, the IESO would require the connection applicant to investigate other mitigating measures.
- Prior to connecting to the IESO controlled grid, the proposed facility must be compliant with the applicable reliability standards set by the North American Electric Reliability Corporation (NERC) and the North East Power Coordinating Council (NPCC). A list of applicable standards, based on the proponent's/applicant's market role/OEB licence can be found at <http://www.ieso.ca/imoweb/ircp/reliabilityStandards.asp>

– End of Section –

1. Introduction

Based on Hydro Ottawa's projected load growth in the southeast part of Ottawa, the existing transformer capacity available to Hydro Ottawa will be inadequate to reliably supply the load in the area. Hydro Ottawa is proposing to develop a new Municipal Transformer Station (MTS) designated Ellwood MTS to augment the transformation capacity from the existing stations Albion TS, Russell TS and Riverdale TS.

The proposed station will be a Dual Element Spot Network (DESN) comprising of two 230/13.8 kV, 30/40/50 MVA transformers. Ellwood MTS will be supplied from the Hydro One 230 kV overhead transmission lines M30A and M31A.

The proposed in-service date for the station is November 2010.

The purpose of this System Impact Assessment (SIA) is to examine the system impact of the proposed Ellwood MTS, which is to be located adjacent to Albion TS on the reliability of the integrated power system. The report also provides Hydro Ottawa a list of requirements to the proposed station to ensure that the new facility, when connected, will not have material adverse impact on the reliability of the integrated power system.

– End of Section –

2. Project Description

The proposed Ellwood MTS is located adjacent to Albion TS, Ottawa. The station will be supplied from the Hydro One 230 kV overhead transmission lines M30A and M31A at Albion Junction.

The proposed Ellwood MTS will be a Dual Element Spot Network (DESN) station comprising of two 230/13.2 kV, 30/40/50 MVA transformers. Transformer primary switching is provided by 230 kV circuit breakers. It is intended that these breakers will operate, as necessary, to isolate faulted equipment within the new station. There are also motorized switches between the 230kV circuit breakers and the tap points on M30A/M31A.

Two 13.2 kV main breakers connect the transformer secondary windings to 13.2 kV Bus Q and J. The two transformer 13.2 kV secondary windings supply indoor air insulated metalclad switchgear line-ups. Each switchgear line-up comprises a 3-phase main bus, a 3-phase maintenance bus, a ground bus, and an insulated neutral bus.

One normally closed (N/C) 3000A bus tie breaker (bus coupler) provides a parallel connection between Buses J and Q.

The maintenance bus serves to supply a feeder for which the breaker has been taken out of service for maintenance. Supply for the maintenance bus is provided by the main bus of the other switchgear line-up through the maintenance bus-tie breakers.

Each 13.2 kV bus supplies seven 1200 A feeder breakers, one maintenance bus tie breaker, one station service load break switch, and two sets of PT.

The transformers are both identical and configured with a wye winding on the high side (ungrounded) and Zig-Zag (neutral grounded) winding on the low voltage side. Each transformer is equipped with under-load tap changer located on the high voltage winding with a range of about ± 34.88 kV that is to be achieved in 33 steps. The transformer impedance is 12% based on 30 MVA.

The proposed Ellwood MTS single line diagram is shown in Figure 3.

– End of Section –

3. General Requirements

3.1 Models & Data

The applicant must complete the IESO Market Entry/Facility Registration process in a timely manner before IESO final approval for connection is granted. Models and data, including any controls that would be operational, must be provided to the IESO. This information should be submitted at least seven months before first connection to the IESO-controlled grid, to allow the IESO to incorporate the Ellwood MTS into IESO work systems and to perform any additional reliability studies.

If the submitted models and data differ materially from the ones used in this assessment, then further analysis of the connection proposal will need to be completed by the IESO.

3.2 230 kV Connection Equipments

Appendix 4.1, reference 2 of the Market Rules states that equipment on the 230 kV grid may be exposed to voltages as high as 250 kV. In addition, some recognized contingencies (e.g. load shedding, open line end) can cause a temporary voltage increase above the maximum continuous voltage. For these conditions, connection equipment may be exposed to voltages 5% above the maximum continuous voltage for the period of time that it takes the IESO to direct operations to restore a normal voltage profile and to prepare for the next contingency. This re-preparation period will be as short as possible but it should not take longer than 30 minutes.

Thus, the IESO requires that 230 kV connection equipment in Ontario:

- must have a maximum continuous voltage rating of at least 250 kV; and
- must be able to sustain operation at voltages up to 262.5 kV for up to 30 minutes and not automatically trip.

If revenue metering equipment is installed, revenue metering installations must comply with the appropriate Measurement Canada requirements as well as the Market Rules for the Ontario electricity market. For more details the applicant is encouraged to seek advice from their Metering Service Provider (MSP) or from the IESO metering group.

The Transmission System Code (TSC), Appendix 2 establishes maximum fault levels for the transmission system. For the 230 kV voltage level, maximum 3-phase symmetrical fault level is 63 kA and single line to ground (SLG) symmetrical fault level is 80 kA (usually limited to 63 kA).

The Transmission System Code (TSC) requires that new equipment be designed to sustain the fault levels in the area where the equipment is installed. If any future system enhancement results in an increased fault level higher than the equipment's capability, the applicant is required to replace the equipment at its own expense with higher rated equipment capable of sustaining the increased fault level, up to the TSC's maximum fault level of 63 kA for the 230 kV system.

3.3 Under-frequency Load Shedding Facilities

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 conditions of system under-frequency. For the purposes of administrating this, the province is divided up into a number of UFLS areas and the UFLS targets must be met for each of these areas.

The under-frequency automatic load shedding (UFLS) should be provided by tripping feeder circuit breakers to achieve:

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

The applicant is required to install facilities at the station to allow for the detection of under frequency conditions, and the selection and tripping of feeder circuit breakers for load shedding. In the event that the existing UFLS area load is insufficient in meeting the UFLS targets with the addition of the new load, the applicant is required to submit during the IESO Market Entry process a revised schedule of feeder selections and their related load amounts for each shedding stage that will ultimately satisfy the above targets.

3.4 Voltage Reduction Facilities

The Market Rules (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% and 5% and having the controlling authority to be able to effect the voltage reduction within five minutes of receipt of the direction from the IESO.

The applicant is required to install facilities at the Ellwood MTS to provide local and remote voltage reduction capability of 3% and 5%. The applicant will need to confirm during the IESO Market Entry process that this capability is available.

3.5 IESO Telemetry Data

The Market Rules (Appendices 4.17 and Appendix 4.22) list the requirements with respect to the telemetry data that must be provided to the IESO and to the performance standards that must be achieved on a continual basis.

The applicant must install equipment at the Ellwood MTS with specific performance standards that provides telemetry data to the IESO. The telemetry data is to consist of certain equipment status and operating quantities which will be identified to the applicant during the IESO Market Entry Process. End to end telemetry testing must be completed by the applicant along with the IESO to ensure that standards are met and sign conventions are understood.

3.6 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.

The applicant must ensure that load power factor, when measured at the defined meter point location meets the Market Rules requirements.

3.7 Protection Systems

New protection systems must be coordinated with existing protection systems and must be designed to satisfy the requirements of the Transmission System Code (TSC).

Facilities designated as essential to power system reliability must be protected by two redundant protection systems according to section 8.2.1a of the TSC. These redundant protection systems must satisfy all requirements of the TSC but in particular they may not use common components, common battery banks or common secondary CT or PT windings.

As currently assessed, this facility is not designated as essential to power system reliability and therefore the above requirements do not apply. In the future, as the electrical system evolves, this facility may be designated as such and at that time the above requirements will apply.

Provided that the TSC requirements are satisfied, the IESO does not have additional requirements.

The connection applicant is required to initiate an assessment of the existing protection systems with the transmitter who shall identify any modifications to protection equipment or settings required to incorporate the new facility. The IESO will evaluate the impact of any protection modifications and associated changes to functionality, timing, or reach on system reliability. The IESO will not assess aspects of protection systems which are solely the accountability of the connection applicant (e.g. coordination of relay protections).

To allow sufficient time to assess the impact on power system reliability, the connection applicant must submit any proposed protection changes to the IESO at least six (6) months before any actual changes are to be implemented on the existing protection systems.

The IESO would deem the modifications acceptable if they do not cause any new and/or reduced operating security limits under normal operating conditions. Should the modifications be unacceptable, the IESO would require the connection applicant to investigate other mitigating measures.

3.8 Reliability Standards

Prior to connecting to the IESO controlled grid, the proposed facility must be compliant with the applicable reliability standards set by the North American Electric Reliability Corporation (NERC) and the North East Power Coordinating Council (NPCC). A list of applicable standards, based on the proponent's/applicant's market role/OEB licence can be found at <http://www.ieso.ca/imoweb/ircp/reliabilityStandards.asp>.

In support of the NERC standard EOP-005, the proponent/applicant may meet the restoration participant criteria. Please refer to Section 3 (Market Manual 7.8 Ontario Power System Restoration Plan to determine its applicability to the proposed facility.)

The IESO monitors and assesses market participant compliance with these standards as part of the IESO Reliability Compliance Program. To find out more about this program, visit the webpage referenced above or write to ircp@ieso.ca.

Also, to obtain a better understanding of the applicable reliability obligations and find out how to engage in the standards development process, we recommend that the proponent/applicant join the IESO's Reliability Standards Standing Committee (RSSC) or at least subscribe to their mailing list at rssc@ieso.ca. The RSSC webpage is located at:

http://www.ieso.ca/imoweb/consult/consult_rssc.asp

– End of Section –

4. Data Verification

4.1 Connection Arrangement

The Ellwood MTS shown in Figure 3 will not reduce the level of reliability of the integrated power system and is, therefore, acceptable to the IESO.

4.2 Connection Equipment

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

4.2.1 230 kV Switches

Table 1: Specifications for 230kV Switches

Type	Motorized Disconnect
Voltage Rating	250 kV
Continuous Current Rating	1200 A
Short Circuit Symmetrical Rating	63 kA

All switches meet the maximum continuous voltage rating requirement of 250 kV.

4.2.2 230 kV Circuit Breakers

Table 2: Specifications for 230 kV Circuits Breakers

Type	SF6
Voltage Rating	250 kV
Interrupting time rating	2 cycles (33.3 ms)
Continuous Current Rating	2000 A
Short Circuit Symmetrical Rating	63 kA

All the circuit breakers meet the maximum continuous voltage rating requirement of 250 kV. The interrupting time and short circuit symmetrical duty ratings meet the requirements of the Transmission System Code (TSC).

4.3 Transformers T1 and T2

Table 3: Specifications for Transformers

Rated Voltages	Rating (MVA) (ONAN/ONAF/ONAF)	Impedance (pu)	Winding Connection		Taps
		$S_B = 30\text{MVA}$	HV	LV	
215/13.2 kV	30/40/50 MVA	j0.12	Y Ungrounded	Zig-Zag Grounded	ULTC: $\pm 34.88\text{kV}$ Number of Positions: 33

– End of Section –

5. Fault Level Assessment

Fault level studies were not required for this assessment.

– End of Section –

6. Impact on System Reliability

Power flow studies were carried out to assess whether the proposed Ellwood MTS would materially impact the reliability of the integrated power system. This included examining the voltage performance of the power system and the thermal loading of transmission circuits for pre-contingency and post-contingency conditions.

In addition, a power factor analysis was completed to assess whether there is an immediate need for the applicant to install LV capacitor banks.

Finally, a load security analysis of Ellwood MTS and Albion TS was completed to determine if the load security criteria detailed in the IESO Ontario Resource and Transmission Assessment Criteria document will be met.

6.1 Study Assumptions

In this assessment, the 2010 summer base case was used with the following assumptions:

- Transmission facilities – All existing and proposed major transmission facilities with 2010 in-service dates or earlier were assumed in service, primarily including the HVdc interconnection with Hydro Quebec power system.
- Generation facilities – All existing and proposed major generation facilities with 2010 in-service dates or earlier were assumed in service.
- System load – A load of approximately 28,092 MW with a load power factor of 0.91 was assumed.
- Equipment Ratings: Continuous and emergency ratings as provided by the equipment owners. Circuit thermal ratings used for 230 kV circuits surrounding Ellwood MTS are in Table 4.

Table 4: Circuit Thermal Ratings

Circuit/Section	Conductor	Max Operating Temperature	Continuous ⁽¹⁾		LTE ⁽²⁾		15-MIN LTR ⁽³⁾	
			(A)	(MVA)	(A)	(MVA)	(A)	(MVA)
M30A/M31A(All sections)	1843.2 kcmil 72/7	127°C	1350	550	1800	734	2170	885

Note:

- (1) Continuous ratings are obtained based on 235-kV voltage, 35°C ambient temperature at 4 km/hr wind velocity, with 93°C maximum operating temperature.
 - (2) Long-term emergency ratings (LTE) are obtained based on 235-kV voltage, 35°C ambient temperature at 4 km/hr wind velocity, with 127°C maximum operating temperature.
 - (3) 15-minute limited time ratings (LTR) are obtained based on 235-kV voltage, pre-load equal to continuous rating, 35°C ambient temperature at 4 km/hr wind velocity, with 127°C maximum operating temperature.
- A worst condition, which may stress mostly M30A/M31A, was studied. The maximum Ottawa load used was the highest forecasted peak (1920 MW). The HVdc interconnection was importing the generation of 1240 MW from Hydro Quebec, thus, the FIO interface flow is about 680 MW.

6.2 Load forecasting

The applicant provided that there will be 40 MVA of load initially on Ellwood MTS, which is from the 10 feeders that are direct transfers from Albion TS. The load at Albion and Ellwood MTS has an estimated 2.5% increase per year in the next 10 years.

Figure 1 shows historical load data at Albion TS based on hourly average samples during the period of January 1, 2007 to December 31, 2008. It shows that the maximum load at Albion TS is about 101 MW.

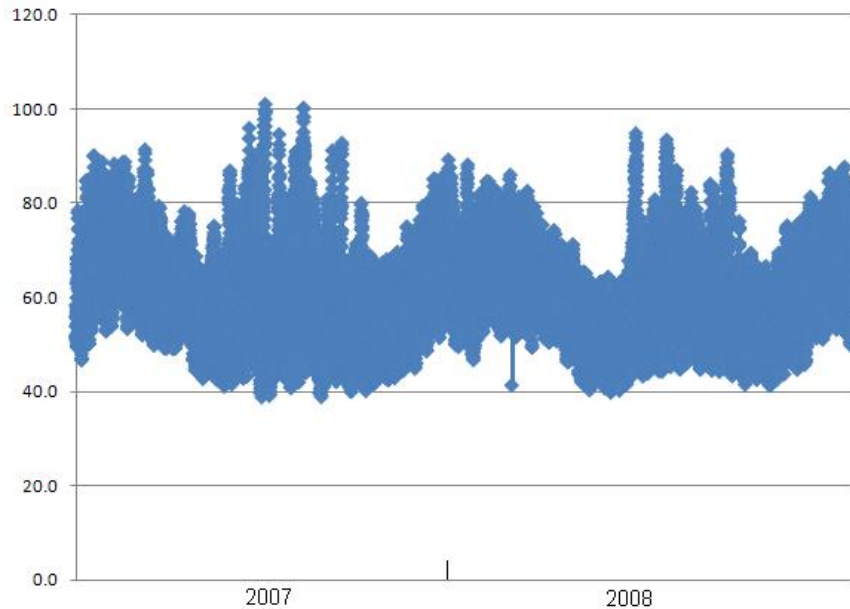


Figure 1: Historical Load of Albion TS

Based on the load growth of 2.5%, the load forecasting for Ellwood MTS and Albion TS are summarized in Table 5.

Table 5: Load Forecasting (MW)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Ellwood	40.0	41.0	42.0	43.1	44.2	45.3	46.4	47.5	48.7	50.0	51.2
Albion	61.0	62.5	64.1	65.7	67.3	69.0	70.7	72.5	74.3	76.2	78.1
Total	101.0	103.5	106.1	108.8	111.5	114.3	117.1	120.1	123.1	126.1	129.3

6.3 Voltage Analysis

The voltage performance of Hawthorne TS, Merivale TS and Albion TS was evaluated with the proposed Ellwood MTS incorporated. The following IESO criteria must be satisfied before any new equipment is connected to the transmission system:

- The pre-contingency voltage on 230 kV buses cannot be less than 220 kV.
- The post-contingency voltage on 230 kV buses cannot be less than 207 kV.
- The voltage drop following a contingency cannot exceed 10% pre-ULTC and 10% post-ULTC.

The voltage results prior to and following the loss of M30A are shown in Table 6.

Table 6: Voltage Declines due to the Loss of M30A

Bus	Pre-Contingency (kV)	Post-Contingency			
		Pre-ULTC (kV)	Change (%)	Post-ULTC (kV)	Change (%)
Merivale 230 kV	241.5	239.1	-1.0	239.1	-0.99
Hawthorne 230kV	243.3	242.4	-0.4	242.5	-0.33
Albion 230kV	242.6	240.9	-0.7	241	-0.66
Ellwood 13.2kV	13.3	12.5	-6.0	13.1	-1.50

As shown, the 230 kV pre-contingency and post-contingency voltages are within the normal voltage range of 220 kV to 250 kV. In addition, the pre-ULTC and post-ULTC voltage declines do not exceed the maximum voltage decline criteria of 10%.

6.4 Thermal Analysis

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

- With all elements in-service, loading of any line shall be within its continuous rating; and
- For the single circuit contingency, post-contingency flow on any circuit shall not exceed the long-term emergency (LTE) rating.

The thermal loading on 230 kV circuit M31A was examined for the loss of M30A.

Table 7 summarizes the pre-contingency and post-contingency loading on the circuit sections of M31A between Hawthorne TS and Merivale TS. The circuit ratings are from Table 4.

Table 7: Thermal Loading of M31A due to the Loss of M30A

Circuit Sections		Pre-Contingency				Post-Contingency				Ratings(MVA)		
		P (MW)	Q (MX)	S (MVA)	% of Cont.	P (MW)	Q (MX)	S (MVA)	% of LTE	Cont.	LTE	15-Min LTR
Hawthorne	Albion Jct	423.2	57.4	427.1	77.6	754.8	121.9	764.6	104.2	550	734	885
Albion Jct	Merivale	373.3	43.1	375.8	68.3	652.9	74.6	657.1	89.5	550	734	885

The pre-contingency loadings on M30A and M31A are well within the continuous ratings of the circuit sections. On loss of M30A (one element out of service), the post contingency loading of circuit

M31A is within its 15-minute LTR, and however, higher than its long-term emergency rating. Post-contingency control actions are needed to reduce the loading within the long-term emergency rating. Currently, the HVdc runback SPS (Special Protection System) at Hawthorne TS is used to address this situation by running back the HVdc power level.

6.5 HVdc Runback SPS at Hawthorne

HVdc Runback SPS at Hawthorne aims to improve FIO transfer by running back the HVdc power setting. Primarily, under a maximum export through the HVdc interconnection, the HVdc is required to runback to a certain level to avoid post-contingency system voltage instability, and under a maximum import situation, the HVdc is required to runback to eliminate post-contingency thermal overloading on some circuits, such as loss M30A or M31A.

Post-contingency voltage stability issues are addressed by taking the Ottawa load as a whole, thus, the proposed Ellwood MTS has no impact on the SPS in this regard.

Under the maximum import conditions, the loss of M30A would result in the overloading of the companion circuit M31A, as the result in Section 6.4. The runback is required under this situation.

However, the new Ellwood MTS will initially take the load from Albion TS. Since the two stations have the same tap points on circuit M30A/M31A, it will not have impact on the runback setting of the SPS.

In the future, the increasing load at Ellwood MTS and Albion TS will have some impact on the loading of circuit M30A/M31A. To show the impact, the load at Ellwood was increased by 10MW and the contingency of loss of M30A was studied. The loading of circuit M31A under pre-contingency and post-contingency conditions are summarized in Table 8. As compared with Table 7, the post-contingency MVA flow from Hawthorne TS to Albion Junction was increased by 11.5 MVA. The post-contingency loading of circuit M31A was significantly impacted.

Thus, the proposed Ellwood MTS has no impact the HVdc runback SPS at the current stage. However, as the load at Ellwood MTS and Albion TS grows, the runback levels will have to be reviewed by the IESO.

Table 8: Thermal Loading of M31A due to the Loss of M30A

(The Ellwood load is increased from 40 MW to 50 MW with fixed power factor.)

Circuit Sections		Pre-Contingency				Post-Contingency				Ratings(MVA)		
		P (MW)	Q (MX)	S (MVA)	% of Cont.	P (MW)	Q (MX)	S (MVA)	% of LTE	Cont.	LTE	15-Min LTR
Hawthorne	Albion Jct	427.0	60.3	431.2	78.4	764.2	135.4	776.1	105.7	550	734	885
Albion Jct	Merivale	372.1	42.3	374.5	68.1	652.3	78.0	656.9	89.5	550	734	885

6.6 Ottawa Area Undervoltage SPS

The Ottawa Area Undervoltage SPS is to provide automatic correction measures to maintain satisfactory post-contingency voltage levels in the Ottawa Area for 230/500 kV contingencies, primarily during equipment outages. The Ottawa Area Undervoltage SPS includes high-speed reclosure, automatic load rejection, automatic capacitor switching and automatic reactor switching.

Currently, Albion TS is a part of Ottawa Area Undervoltage SPS for automatic load rejection and automatic capacitor switching. The Ellwood load will be a part of Ottawa Area load, same as the Albion load. Thus, the proposed Ellwood MTS may also be required to participate in the Ottawa Area Undervoltage SPS for automatic load rejection and automatic capacitor switching.

The proposed Ellwood MTS shall be capable of participating in the Ottawa Area Undervoltage SPS for automatic load rejection and automatic capacitor switching.

6.7 Power Factor Analysis

The Market Rules (Appendix 4.3, reference 1) require that wholesale customers and distributors connected to the IESO-controlled grid shall operate at a power factor within the range of 90% lagging to 90% leading as measured at the defined meter point. For the proposed Ellwood MTS, the defined meter point would be considered the HV sides of transformers T1 and T2.

Figure 2 shows the power factor profile at the LV side of Albion TS based on hourly samples for 2007 and 2008. The power factor profile has been corrected to remove the reactive power contributions from capacitor bank SC1 and SC4.

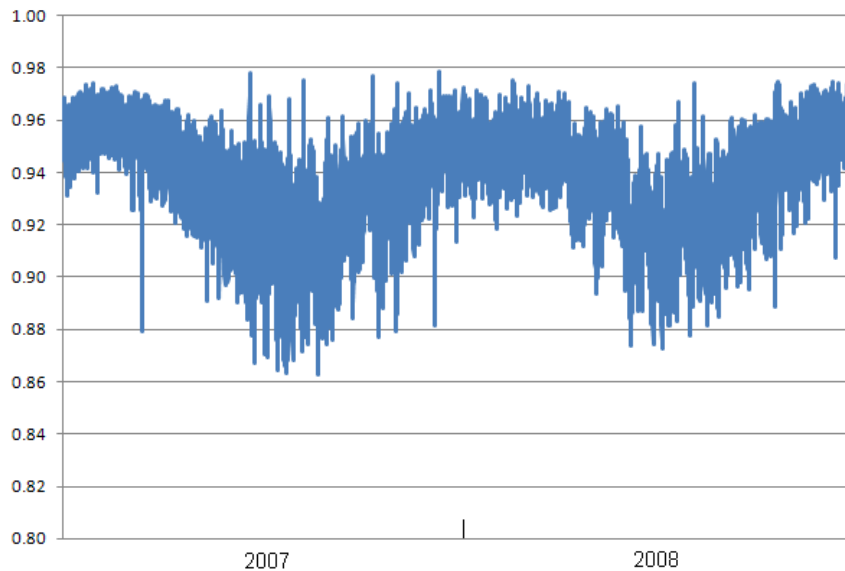


Figure 2: Historical Load Power Factor of Albion TS

Figure 2 indicates that historically, without the capacitor banks SC1 and SC4, the local load power factor would have dropped below 0.9 for some length of time. The lowest power factor is about 0.865

that would have occurred during the summer period. To meet the requirement of the Market Rules, capacitor banks are required to be installed on the LV side.

Power flow simulations were completed to determine the amount of capacitor banks to be installed at Ellwood MTS. The power factor was assumed 0.865 during simulations for both years 2015 and 2020. The results are shown in Table 9.

Table 9: Required Capacitor Banks for Ellwood MTS

Year	P(MW)	Q at LV (MVar)	Q at HV (MVar)	Q Allowed @ HV (MVar)	Capacitor Required (MVar)
2015	45.3	26.3	31.8	21.9	9.9
2020	51.2	29.7	37.0	24.8	12.2

The applicant shall install capacitor banks of 12 MVar@13.2kV at the LV side of Ellwood MTS.

6.8 Load Security

The load security criteria for the IESO-controlled grid are defined in Section 7.1 of the Ontario Resource and Transmission Assessment document. The following criteria apply to Albion TS and Ellwood MTS:

- 1) With all transmission facilities in service, equipment loading must be within continuous ratings.
- 2) With one element out of service, equipment loading must be within applicable long-term emergency ratings.
- 3) For a single element contingency, not more than 150 MW of load may be interrupted by configuration.
- 4) For a double element contingency, not more than 600 MW of load may be interrupted by configuration.

For criteria 1 and 2, the results in Section 6.4 of this SIA show that the pre-contingency loadings on circuits M30A and M31A are within continuous ratings, and the post-contingency loadings are within 15-min LTR. By control actions of HVdc runback SPS at Hawthorne TS, the loadings could be reduced within the long-term emergency ratings.

For criterion 3, a contingency involving M30A would result in no load interruption at the Ellwood MTS and Albion TS.

For criterion 4, a contingency involving the double circuit line M30A and M31A would result in the interruption of all loads at Albion TS and Ellwood MTS. Based on a total 2020 load forecast of 129.3 MW for these two stations, the interrupted load would not exceed 600 MW.

Thus the transmission system supplying Ellwood MTS meets the IESO load supply criteria.

– End of Section –

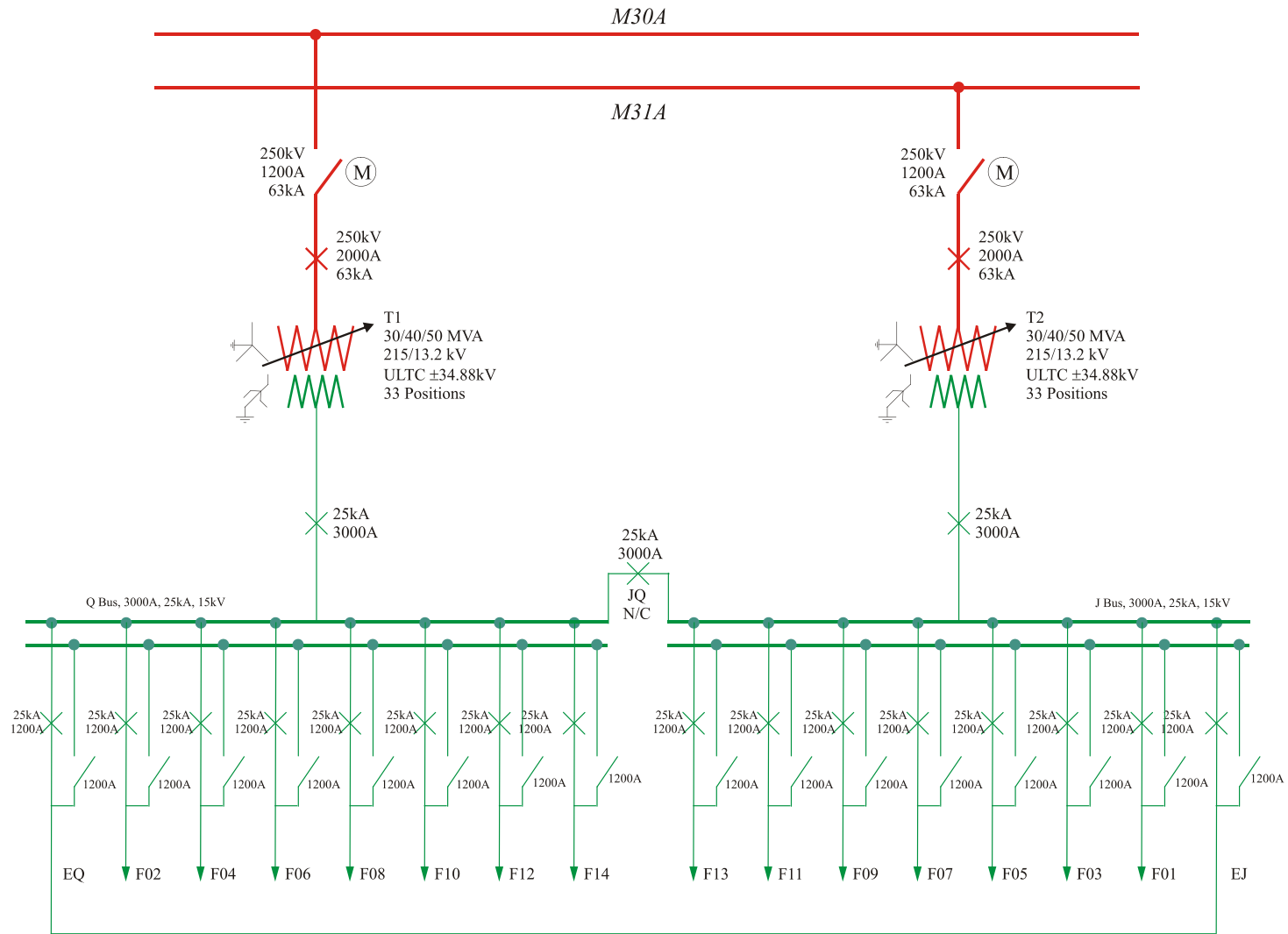


Figure 3: Single Line Diagram of Ellwood MTS

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