IESO_REP_0655

REPORT

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Expedited System Impact Assessment Report

Connection Assessment & Approval Process

Final Report

CAA ID: 2010-EX495

Project: Lower Mattagami River Project

Applicant: Kiewit-Alarie, a Partnership (KAP)

Market Facilitation Department
Independent Electricity System Operator

October 14, 2010

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Expedited 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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Executive Summary

Description

The purpose of this Expedited System Impact Assessment is to examine the impacts of connecting the temporary station, Lower Mattagami River Project, on the reliability of the IESO-controlled grid. This station is proposed to be tapped off the 115kV overhead transmission line S3S near the existing Smoky Falls SS. The station has been proposed by Kiewit-Alarie, a Partnership (KAP) to supply power to the construction sites of the Lower Mattagami Generation Development.

SIA Findings

The assessment concludes that the connection of the Lower Mattagami River Project station is not expected to materially affect the reliability of the IESO-controlled grid if the IESO's requirements for connection are satisfied.

The findings of the assessment are summarized in the following:

(1) The thermal loading assessment shows that the pre-contingency and post-contingency thermal loadings of the monitored elements are within acceptable limits with Lower Mattagami River Project station in service. The maximum loading is observed on the section between Carmichael Falls JCT and Spruce Falls JCT of the H9K 115kV circuit. The loading of this section is close to its LTE rating when any of the 230kV circuits K38S or L21S are out of service pre-contingency. Moreover, the loading of the Kapuskasing voltage regulator is close to its LTE rating when K38S is out of service pre-contingency. Under these outage conditions, the loading of the H9K 115kV circuit and the Kapuskasing voltage regulator are highly dependent on the level of the dispatchable load at Spruce Falls Pulp and Paper and on the output of the generating units in the area. Thus, dispatching down the Spruce Falls load when there is lack of generation during these outage conditions is expected to mitigate the possible overloading issues.

(2) The voltage assessment shows that the pre-contingency and post-contingency voltage levels at the monitored HV buses are within the acceptable limits with Lower Mattagami River Project station in service. The loss of L21S might lead to a percentage voltage change slightly higher than 5% at the MV bus of the Lower Mattagami River Project station. This issue will be mitigated once KAP installs the reactive power compensation equipment required for power factor correction.

(3) The load that would be interrupted by configuration will not exceed the limits specified in the IESO's load security criteria after the connection of the proposed station. With Lower Mattagami River Project station connected to the 115 kV circuit S3S; the load that would be interrupted by configuration due to the loss of S3S would result in the highest load interruption of 6.9MW. With K38S out of service pre-contingency and all of TEMBEC loads being supplied from the Kapuskasing voltage regulator VR2, the loss of H9K would result in the highest load interruption of 167.9MW once the island is collapsed.

(4) The power factor at the Lower Mattagami River project station does not meet the market rule requirements. Thus, KAP has to develop a plan to improve the power factor at the new station.

IESO's Requirements for Connection

The Lower Mattagami River Project station shall satisfy the requirements and standards specified in the Market Rules and the Transmission System Code including, but not limited to, the following general requirements (detailed requirements are stated in Section 2):

(1) KAP shall ensure that all 115kV equipment at the proposed station is capable of continuously operating for a voltage level up to 132 kV as specified in Appendix 4.1 of the Market Rules. Fault interrupting devices must be able to interrupt fault current at the maximum continuous voltage of 132 kV. Protective relaying must be set to ensure that transmission equipment remains in service for voltages between 94% of the minimum continuous voltage and 105% of the maximum continuous voltage specified in Appendix 4.1 of the Market Rules.

(2) New protection systems at Lower Mattagami River Project station shall be designed to satisfy all the requirements of the Transmission System Code and any additional requirements identified by the transmitter. New protection systems must be coordinated with existing protection systems. In addition, KAP shall have adequate provision in the design of protections and controls at the facility to allow for future installation of Special Protection Scheme (SPS) equipment. From the IESO's perspective, Lower Mattagami River Project station is not currently designated as essential to the power system reliability. Thus, the IESO does not require the facility to be protected by two redundant protection systems.

(3) KAP shall ensure that the new equipment at Lower Mattagami River Project station be designed to sustain the fault levels in the area. If any future system enhancement results in an increased fault level higher than the equipment's capability, KAP is required to replace the equipment at its own expense with higher rated equipment capable of sustaining the increased fault level, up to maximum fault level specified in Appendix 2 of the Transmission System Code.

(4) KAP shall have the capability to maintain the power factor at the defined meter point of Lower Mattagami River Project station within the range of 0.9 lagging to 0.9 leading, as specified in Appendix 4.3 of the Market Rules.

(5) KAP shall ensure that the revenue metering installations at Lower Mattagami River Project station comply with the IESO's requirements specified in Chapter 6 of the Market Rules.

(6) KAP must complete the IESO Facility Registration/Market Entry process in a timely manner before IESO final approval for connection is granted.

IESO's Recommendations

(1) The inadvertent island operation of the Smoky Falls generating units with the Lower Mattagami River Project station might adversely impact the equipment at the load station. Thus, it is recommended that KAP takes the required measures to protect their equipment in such conditions.

(2) KAP should be aware that the voltage level in the area where the proposed Lower Mattagami River Project station is to be connected is currently maintained between 110kV and 119 kV using the Kapuskasing voltage regulator VR2 due to the needs of the customers in the area.

Notification of Conditional Approval

Connecting the new load, Lower Mattagami River Project station, to the IESO-controlled grid does not adversely impact the reliability of the grid. It is recommended that a Notification of Conditional

Approval for Lower Mattagami River Project station be issued to KAP, subject to the IESO's requirements being met.

– End of Section –

1. Project Description

KAP is proposing to build a temporary 115kV/12.47kV transformer substation to supply power to the construction sites at the Lower Mattagami River Generation Development. The new substation will be tapped off the 115kV overhead circuit S3S near the existing Smoky Falls Switching Station. The new substation will be connected to the existing 115kV circuit S3S via a 115kV overhead transmission line and a 145kV-1200A disconnect switch in series with a 145kV-1200A circuit breaker and a 145kV-75A fuse. The station will have two 115kV/12.47kV-10MVA step-down transformers, one of which will be in service while the other will be used as a backup. Each transformer will be connected to a high voltage 145kV-1200A disconnect switch and a medium voltage 15kV- 600A disconnect switch. The medium voltage disconnect switches will be mechanically interlocked to prevent paralleling of the transformers. The expected in-service date of the station is November 2010.

– End of Section –

2. IESO's General Requirements

Lower Mattagami River Project station shall satisfy the requirements and standards specified in the Market Rules, Market Manuals and the Transmission System Code. The following sections highlight some of the general requirements that are applicable to Lower Mattagami River Project station.

2.1 Voltage Requirements

Appendix 4.1 of the Market Rules states that under normal conditions voltages in the 115kV network are maintained within the range of 113kV to 132kV in northern Ontario. Thus, the IESO requires that the 115kV equipment must have maximum continuous voltage rating of at least 132kV.

Fault interrupting devices at Lower Mattagami River Project station must be able to interrupt fault currents at the maximum continuous voltage of 132kV.

Protective relaying at Lower Mattagami River Project station must be set to ensure that transmission equipment remains in-service for voltages between 94% of the minimum continuous voltage and 105% of the maximum continuous voltage specified in Appendix 4.1of the Market Rules.

KAP shall ensure that all 115kV equipment at Lower Mattagami River Project station is capable of continuously operating for a voltage level up to 132kV, as per Appendix 4.1 of the Market Rules. Fault interrupting devices must be able to interrupt fault currents at the maximum continuous voltage of 132kV. Protective relaying must be set to ensure that transmission equipment remains in service for voltages between 94% of the minimum continuous voltage and 105% of the maximum continuous voltage specified in Appendix 4.1 of the Market Rules.

2.2 Protection Systems Requirements

Protection systems at Lower Mattagami River Project station must be designed to satisfy all the requirements of the Transmission System Code as specified in Schedules E, F and G of Appendix 1 and any additional requirements identified by the transmitter. New protection systems must be coordinated with existing protection systems.

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 protections 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, Lower Mattagami River Project station is not designated as essential to power system reliability and therefore the above protection 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.

KAP is required to have adequate provision in the design of protections and controls at the facility to allow for future installation of Special Protection Scheme (SPS) equipment.

KAP is required to initiate an assessment of the protection systems proposed for the new facility with the transmitter. The transmitter shall identify any protection relay modifications (e.g. equipment and settings) required to incorporate Lower Mattagami River Project station into the integrated power system. To allow sufficient time to assess the impact on power system reliability, the transmitter must submit any proposed protection relay modifications to the IESO as soon as the protection assessment for the new facility is finished or at least six (6) months before any actual modifications are to be implemented on the existing protection systems.

The IESO will evaluate the impact on system reliability due to any protection relay modifications and any modifications to functionality, timing or reach. The IESO will not assess aspects of protection systems which are solely the accountability of the transmitter (e.g. coordination of protection relays).

KAP can send documentation for protection modifications triggered by new or modified primary equipment (i.e. new or replacement relays) to connection.assessments@ieso.ca.

For protection modifications that are not associated with new or modified equipment (i.e. protection setting modifications), KAP can send the documentation to protection.settings@ieso.ca.

New protection systems at Lower Mattagami River Project station must be designed to satisfy all the requirements of the Transmission System Code and any additional requirements identified by the transmitter. New protection systems must be coordinated with existing protection systems.

KAP shall have adequate provision in the design of protections and controls at the facility to allow for future installation of Special Protection Scheme (SPS) equipment.

2.3 Fault Levels

The TSC requires that new equipment be designed to sustain the fault levels in the area where the equipment is installed. KAP shall ensure that the new equipment at Lower Mattagami River Project station is designed to sustain the fault levels in the area. If any future system enhancement results in an increased fault level higher than the equipment's capability, KAP is required to replace the equipment at its own expense with higher rated equipment capable of sustaining the increased fault level, up to maximum fault level specified in Appendix 2 of the Transmission System Code.

Appendix 2 of the Transmission System Code (TSC), establishes maximum fault levels for the transmission system. For the 115kV system, the maximum 3 phase and single line to ground symmetrical fault levels are 50 kA.

KAP shall ensure that the new equipment at Lower Mattagami River Project station be designed to sustain the fault levels in the area. If any future system enhancement results in an increased fault level higher than the equipment's capability, KAP is required to replace the equipment at its own expense with higher rated equipment capable of sustaining the increased fault level, up to maximum fault level specified in Appendix 2 of the Transmission System Code.

2.4 Power Factor Requirements

Appendix 4.3 of the Market Rules requires the connected wholesale customers and distributers connected to the IESO-controlled grid to have the capability to maintain a power factor within the range of 0.9 lagging and 0.9 leading as measured at the defined meter point of the facility. For the proposed station, the defined meter point is the high voltage side of the transformer.

KAP shall have the capability to maintain the power factor at the defined meter point of Lower Mattagami River Project station within the range of 0.9 lagging to 0.9 leading.

2.5 Revenue Metering Requirements

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

KAP shall ensure that the revenue metering installations at Lower Mattagami River Project station comply with the IESO's requirements specified in Chapter 6 of the Market Rules.

2.6 Facility Registration/Market Entry Requirements

KAP must complete the IESO Facility Registration/Market Entry 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 energization to the IESO-controlled grid, to allow the IESO to incorporate this project into IESO work systems and to perform any additional reliability studies.

As part of the IESO Facility Registration/Market Entry process, KAP must provide evidence to the IESO confirming that the equipment installed meets the Market Rules requirements and matches or exceeds the performance predicted in this assessment. This evidence shall be either type tests done in a controlled environment or commissioning tests done on-site. In either case, the testing must be done not only in accordance with widely recognized standards, but also to the satisfaction of the IESO. Until this evidence is provided and found acceptable to the IESO, the Facility Registration/Market Entry process will not be considered complete and the connection applicant must accept any restrictions the IESO may impose upon this project's participation in the IESO-administered markets or connection to the IESO-controlled grid.

The evidence must be supplied to the IESO within 30 days after completion of commissioning tests. Failure to provide evidence may result in disconnection from the IESO-controlled grid.

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

KAP must complete the IESO Facility Registration/Market Entry process in a timely manner before IESO final approval for connection is granted.

– End of Section –

3. Data Verification

This section verifies the specifications for the new equipment proposed by KAP to be installed at Lower Mattagami River Project station.

Overhead Circuit Section

Quantity	1
Rated voltage	138kV
Length	0.115 km
Positive sequence impedance	R= 0.03046 Ω, X= 0.06807 Ω

Step-down Transformer

Quantity	2
Configuration	3 phase, 2 winding
Thermal ratings	10MVA
Winding rated voltage	115 kV/12.47kV
Winding connections	HV: Delta, LV: Star-G (R_{ground} = 12Ω)
Under-load taps	±1.078kV in 32 steps on the HV winding
Positive sequence Impedance	HX: 0.508+j8.48 % on 10MVA base

Circuit Breakers

Quantity	1
Maximum continuous rated voltage	145kV
Rated continuous current	1200A
Rated symmetrical short circuit capability	40kA
Rated asymmetrical short circuit capability	64kA
Interrupting Time	3 cycles
Normal operation	Closed

High Voltage Fuses

Quantity	3 (1 per phase)
Maximum continuous rated voltage	145kV
Continuous current rating	75A

High Voltage Disconnect Switches

Quantity	3
Type	Manual
Maximum continuous rated voltage	145kV
Continuous current rating	600A
Rated symmetrical short circuit capability	40kA

Meduim Voltage Disconnect Switches

Quantity	2
Type	Manual
Maximum continuous rated voltage	15kV
Continuous current rating	600A
Rated symmetrical short circuit capability	40kA

Feeder Reclosers

Quantity	4
Maximum continuous rated voltage	15.5kV
Rated continuous current	560A
Rated symmetrical interrupting capability	12kA
Normal operation	Closed

– End of Section –

4. System Impact Studies

This section provides an overview of the transmission system in the vicinity of Lower Mattagami River Project station. It also presents the results of the assessments carried out to investigate the impacts of the new station on the reliability of the IESO-controlled grid.

4.1 Overview of the Transmission Area

The Lower Mattagami River Project station is to be tapped off the 115kV circuit S3S near Smoky Falls SS. This circuit is connected to the 115kV circuits H9K and F1E through the 115kV circuit K3. The 115kV circuit F1E is connected to the 230kV circuit K38S via Spruce Falls T7. The generating stations in the area (on H9K, F1E, K38S, L20D, R21D and R22D) are either hydraulic plants or self-scheduling fossil fuel plants.

Figure 1 provides an overview of the transmission system in the vicinity of the proposed Lower Mattagami River Project station.

4.2 Basecase Setup

The winter 2010-2011 basecase modeled in PSS/E V30.2 was used as the starting point for assessing the impacts of the new station on the reliability of the IESO-controlled grid. The following general assumptions were considered for setting up the basecase:

- The new station was connected to the 115kV circuit S3S near Smoky Falls SS.
- The load was assumed to be 7.82MVA at a 0.88 lagging power factor.
- The generating units were dispatched to simulate the case when the area is under-generated which corresponds to the flow north conditions. This was done by turning off the hydraulic generators on H9K, F1E, R21D, H22D, L20D and K28S and setting the self-scheduling fossil fuel units on F1E and K38S at approximately 50% of their maximum output.
- Ontario loads were scaled to 23,143MW and Northeast zone loads were scaled to 1,748MW, which reflect the coincident extreme winter weather forecast for 2011.
- A constant power load model was used to represent Ontario loads.

4.3 Study Scenarios

To assess the impacts of the new station, the following scenarios were simulated:

Scenario 1: All elements in service:

- Loss of the 115kV circuit H9K
- Loss of the 230 kV circuit L21S (Control actions: Reject TEMBEC loads - cross trip K38S if required)
- Loss of the 500kV circuit D501P (Control actions: Reject TEMBEC loads - cross trip L21S/K38S if required)

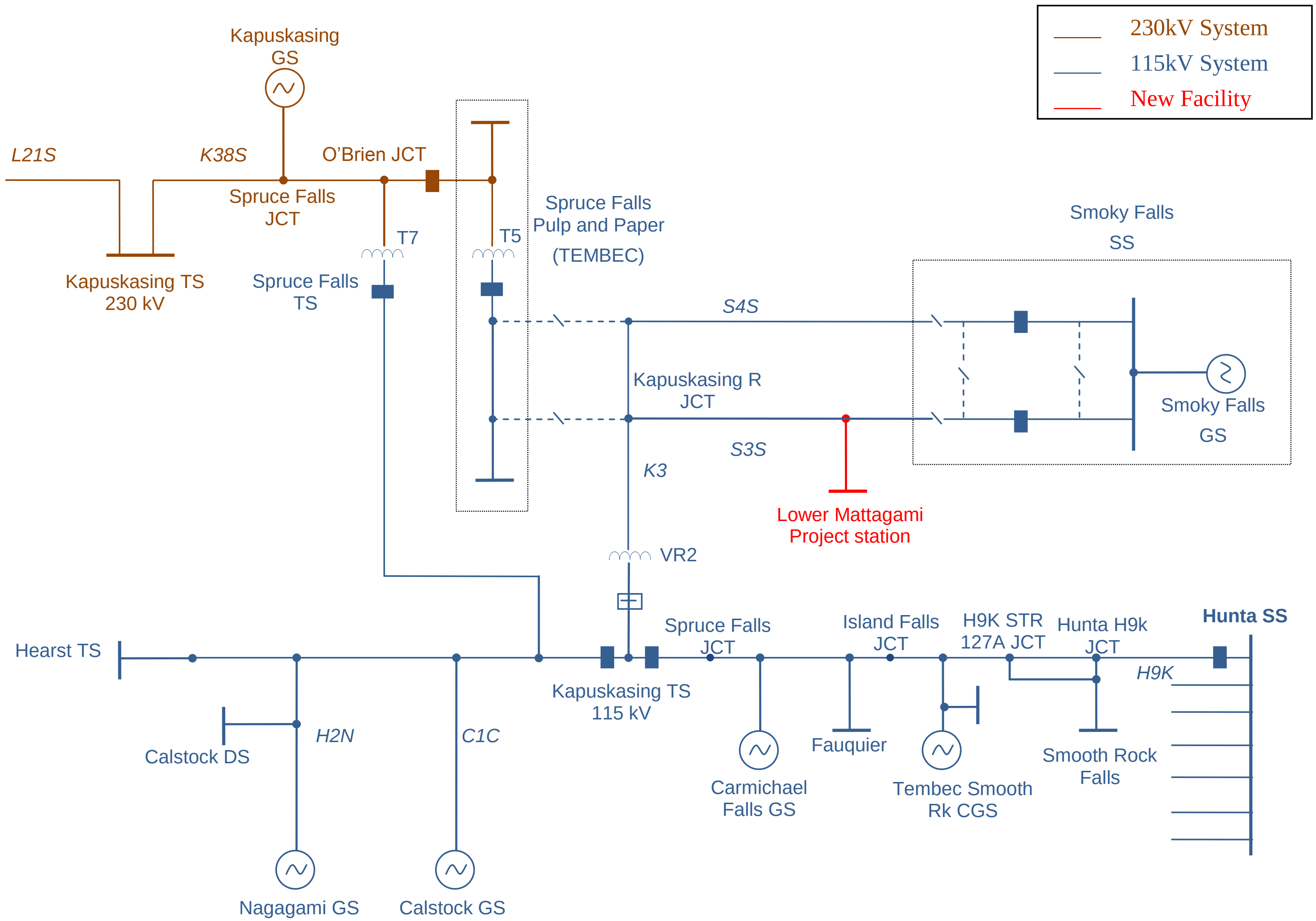

Figure 1: Transmission System in the vicinity of Lower Mattagami River Project station

Scenario 2: Spruce Falls T5 O/S (Control actions: TEMBEC 115kV Load connected to S3S/S4S)

- Loss of H9K
- Loss of the 230kV circuit L21S (Control actions: Reject TEMBEC loads - cross trip K38S if required)
- Loss of the 500kV circuit D501P (Control actions: Reject TEMBEC loads - cross trip L21S/K38S if required)
- Loss of Spruce Falls T7

Scenario 3: K38S O/S (Control actions: TEMBEC loads are dispatched at 60.7MVA)

Scenario 4: L21S O/S (Control actions: TEMBEC loads are dispatched at 52.8MVA)

It should be noted that under certain planned outage conditions, some contingencies can lead to islanding the local area (e.g., when L21S is out of service pre-contingency and H9K is lost following a contingency). For such conditions, the current operation practice is to collapse the island (H9K, F1E, S3S/S4S and K38S), and thus, the load at the new station will be interrupted.

4.4 Thermal Loading Assessment

The purpose of this assessment is to determine the impacts of Lower Mattagami River Project station on the thermal loadings of the conductors and auto-transformers in its vicinity. The criteria for the assessment are:

a) With all elements in service, equipment loadings shall be within the Continuous ratings.

b) With any one element out of service, equipment loadings shall be within the Long-term Emergency ratings (LTE).

c) With any two elements out of service, equipment loadings shall be within the 15-min Short-term Emergency ratings (STE). Equipment loading must be reduced to the applicable long-term emergency ratings in the time afforded by the short-time ratings. Planned load curtailment or load rejection exceeding 150MW is permissible only to account for local generation outages.

For overhead conductors, the continuous ampacity ratings are calculated at the lowest of the sag temperature or 93^{o}C operating temperature at 10^{o}C ambient temperature and 4 km/h wind speed. The LTE ratings are calculated at the lowest of the sag temperature and 127^{o}C operating temperature at 10^{o}C ambient temperature and 4 km/h wind speed. The 15-min STE ratings are calculated at the sag temperature of the conductor at 10^{o}C ambient temperature and 4 km/h wind speed for a pre-load equal to the continuous ratings.

The thermal ratings used for existing transmission elements (conductors and auto-transformers) are displayed in Appendix A.

The percentage loading of the equipment is calculated as follows:

$$\% L = \frac{Equipment\ Loading}{Equipment\ Rating} \times 100$$

The loadings and ratings are in Amperes for conductors and in MVA for transformers.

The results for the thermal loading assessment for different scenarios are presented in Appendix B, where the cells shaded in yellow show marginally acceptable values.

The results for the thermal loading assessment presented in Appendix B show that the loading of all monitored equipment is within the acceptable limits for all studied cases with the proposed station connected to S3S. The results displayed in Table B3 show that when K38S is out of service pre-contingency, and under the generation and load conditions considered for this scenario, the loading of the section between Carmichael Falls JCT and Spruce Falls JCT of H9K 115kV circuit is close to its LTE rating (97.3%). Moreover, the loading of the Kapuskasing voltage regulator VR2 is close to its LTE rating (90%). The results of Table B4 show a similar loading for the same section of the H9K 115kV circuit when L21S is out of service pre-contingency (99.3%). Under these outage conditions, the loading of the H9K 115kV circuit and the Kapuskasing voltage regulator are highly dependent on the level of the dispatchable load at Spruce Falls Pulp and Paper and on the output of the generating units in the area. Thus, dispatching down the Spruce Falls load when there is lack of generation during these outage conditions is expected to mitigate the possible overloading issues.

The thermal loading assessment shows that the pre-contingency and post-contingency thermal loading of the monitored elements are within acceptable limits with Lower Mattagami River Project station in service.

4.5 System Voltage Assessment

The IESO's voltage assessment criteria require the pre-contingency voltages to be within 113kV to 132kV in northern Ontario for 115kV buses, 220kV to 250kV for 230kV buses and 98% to 106% of the nominal voltage for buses less than 50kV. Post-contingency, the criteria requires the voltages to be within 108kV to 127kV for 115kV buses, 207kV to 250kV for 230kV buses and 88% to 112% of the nominal voltage for buses less than 50kV. In addition, the criteria require that the post-contingency voltage changes should remain within the following limits:

- Percentage change in voltage before the tap changer action should not be more than 10%.
- Percentage change in voltage after the tap changer action should not be more than 10% at the 115kV and 230kV buses and 5% at buses less than 50kV.

The percentage change in voltage is calculated as follows:

$$\%V_{ch} = \frac{V_{pre\text{-}contingency} - V_{post\text{-}contingency}}{V_{pre\text{-}contingency}} \times 100$$

The results for the system voltage assessment for different scenarios are presented in Appendix C, where the cells shaded in red show a violation of the assessment criteria.

The results for the system voltage assessment presented in Appendix C show that the voltages at all monitored nodes are within the acceptable limits for most of the studied cases with the proposed station connected to S3S. Table C1 shows that the loss of L21S might lead to a percentage change in voltage slightly higher than 5% at the medium voltage bus of the proposed station post the ULTC operation (5.6%). This issue is expected to be mitigated once KAP installs the reactive compensation equipment required for the power factor correction. If KAP corrects the power factor to 0.9 lagging at the high voltage bus of the station, the percentage change in voltage would be 4.3% at the medium voltage bus of the station for the same contingency.

The voltage assessment study shows that the pre-contingency and post-contingency voltage levels at most of the monitored buses are within the prescribed limits with Lower Mattagami River Project station in service. The loss of L21S might lead to a percentage change in voltage slightly higher than 5%. This issue will be mitigated once KAP installs the reactive power compensation equipment required for the power factor correction.

4.6 Load Security Assessment

The load security criteria for the IESO-controlled grid specified in Section 7.1 of the Ontario Resource and Transmission Assessment document are as follows:

1- With all transmission facilities in service, equipment loading must be within continuous ratings and voltages must be within normal ranges and transfers must be within applicable normal condition stability limits. This must be satisfied coincident with an outage to the largest local generation unit.

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

3- With any two elements out of service, voltages must be within applicable emergency ranges, equipment loading must be within applicable short-term emergency ratings and transfers must be within applicable emergency condition stability limits. Equipment loading must be reduced to the applicable long-term emergency ratings in the time afforded by the short-time ratings. Planned load curtailment or load rejection exceeding 150MW is permissible only to account for local generation outages. Not more than 600MW of load may be interrupted by configuration and by planned load curtailment or load rejection, excluding voluntary demand management.

The assessments for the thermal loading and voltage levels were presented in Sections 4.4 and 4.5, respectively.

With Lower Mattagami River Project station connected to S3S, the load that would be interrupted by configuration with any one element out of service is below 150MW for all studied system states. In this case, the loss of S3S would result in the highest load interruption of 6.9MW.

The load that would be interrupted by configuration with any two elements out of service is less than 600MW for all studied cases. With K38S out of service pre-contingency and all of TEMBEC loads being supplied from the Kapuskasing voltage regulator VR2, the loss of H9K will result in the highest load interruption of 167.9MW once the island is collapsed.

The load that would be interrupted by configuration will not exceed the limits specified in the IESO's load security criteria after the connection of the proposed load, Lower Mattagami River Project station.

4.7 Power Factor Assessment

Appendix 4.3 in the Market Rules states that wholesale customers and distributors connected to the IESO-controlled grid shall have the capability to operate at a power factor in the range of 0.9 lagging to 0.9 leading as measured at the defined meter point. For Lower Mattagami River Project station, the defined meter point is the high voltage side of transformers. The information provided by KAP indicates that the load power factor is 0.88 lagging at the low voltage side of the transformers which will lead to a power factor less than 0.9 lagging at the high voltage side of the transformers. Accordingly, reactive power compensating equipment must be installed in Lower Mattagami River Project station.

Table 1 displays the reactive power compensation required at the medium voltage bus of Lower Mattagami River Project station on a 12.47kV voltage level. The calculations are done based on the load forecast provided by KAP for the new station and a load power factor of 0.88 lagging at the medium voltage bus.

Table 1: Reactive power compensation for Lower Mattagami River Project station

Year	2010	2011	2012	2013	2014
Load (MW)	5.0	6.9	6.9	6.7	4.3
Load (MVAr)	2.7	3.7	3.7	3.6	2.3
Reactive power compensation (MVAr)	-1	-1	-1	-1	-1

It is worth to mention that the calculations provided in this section are only for KAP’s reference as the main requirement is to have the capability to maintain the power factor at the defined meter point within the IESO’s specified range.

KAP shall have the capability to maintain the power factor at the defined meter point of Lower Mattagami River Project station within the range of 0.9 lagging to 0.9 leading.

– End of Section –

Appendix A: Equipment Thermal Ratings

Table A1: Thermal ratings for overhead lines

Line	From	To	Cont (A)	LTE (A)	STE (A)
H9K	Hunta SS	Hunta H9K JCT	1000	1200	1490
	Hunta H9K JCT	H9K STR 127A JCT	350	350	350
	H9K STR 127A JCT	Tembec Smooth Rk JCT	430	510	570
	Tembec Smooth Rk JCT	Island FLS	420	420	420
	Island FLS	Fauquier JCT	420	420	420
	Fauquier JCT	Carmichael Falls JCT	430	510	560
	Carmichael Falls JCT	Spruce Falls JCT	370	370	370
	Spruce Falls JCT	Kapuskasing TS	1000	1100	1160
K3	Kapuskasing TS	Kapuskasing R Jct	580	600	600
S3S	Smoky Falls SS	Kapuskasing R Jct	330	330	330
S4S	Smoky Falls SS	Kapuskasing R Jct	330	330	330
K38S	Kapuskasing TS	Spruce Falls JCT	1300	1580	1890
	Spruce Falls JCT	O'brien JCT	1020	1170	1240
	O'brien JCT	Spruce Falls TS	1020	1230	1510
L21S	Little Long SS	C.P. Kapuskasing JCT	1020	1090	1120
	C.P. Kapuskasing JCT	Kapuskasing TS	1020	1130	1190
L20D	Little Long JCT	Pinard TS	1330	1610	1810
	Little Long SS	Little Long JCT	1330	1610	1810
D501P	Pinard TS	Porcupine TS	2080	2500	2720

Table A2 Thermal ratings for auto-transformers

Station	Auto-transformer	Cont (MVA)	LTE (MVA)	STE (MVA)
Spruce Falls TS	T7	125	231.7	259.8
Kapuskasing TS	VR2	60	75.1	75.1 (Assumed)

Appendix B: Thermal Loading Assessment Results

Table B1 Thermal loading assessment for Scenario 1 (all elements in service)

All Elements In Service												
Circuit	From	To	Pre-contingency		Loss of H9K		Loss of L21S (Reject TEMBEC Loads)		Loss of L21S (Reject TEMBEC Loads & Cross Trip K38S)		Loss of D501P (Reject TEMBEC Loads)	
			Amp	%L	Amp	%L	Amp	%L	Amp	%L	Amp	%L
H9K	Hunta SS	Hunta H9K JCT	140.6	14.1	-	-	260.7	21.7	36.6	3.1	274.1	22.8
H9K	Hunta H9K JCT	H9K STR 127A JCT	69.6	19.9	-	-	129.6	37.0	17.8	5.1	136.4	39.0
H9K	H9K STR 127A JCT	Tembec Smooth Rk JCT	127.6	29.7	-	-	248.0	48.6	20.1	3.9	259.7	50.9
H9K	Tembec Smooth Rk JCT	Island FLS	160.7	38.3	-	-	280.9	66.9	56.9	13.5	295.6	70.4
H9K	Island FLS	Fauquier JCT	159.9	38.1	-	-	280.3	66.7	55.0	13.1	294.5	70.1
H9K	Fauquier JCT	Carmichael Falls JCT	149.3	34.7	-	-	269.5	52.8	45.4	8.9	284.0	55.7
H9K	Carmichael Falls JCT	Spruce Falls JCT	148.1	40.0	-	-	268.4	72.5	42.4	11.5	282.1	76.2
H9K	Spruce Falls JCT	Kapuskasing TS	146.4	14.6	-	-	266.5	24.2	38.9	3.5	279.1	25.4
K3	Kapuskasing TS	Kapuskasing R Jct	37.6	6.5	37.6	6.3	38.1	6.4	37.3	6.2	37.9	6.3
S3S	Smoky Falls SS	Kapuskasing R Jct	35.2	10.7	35.1	10.6	36.7	11.1	33.2	10.1	36.1	10.9
S4S	Smoky Falls SS	Kapuskasing R Jct	17.9	5.4	17.9	5.4	17.3	5.2	18.8	5.7	17.5	5.3
K38S	Kapuskasing TS	Spruce Falls JCT	226.7	17.4	304.8	19.3	73.0	4.6	-	-	79.3	5.0
K38S	Spruce Falls JCT	O'brien JCT	274.7	26.9	352.5	30.1	27.8	2.4	-	-	48.8	4.2
K38S	O'brien JCT	Spruce Falls TS	55.1	5.4	29.1	2.4	113.5	9.2	-	-	116.5	9.5
L21S	Little Long SS	C.P. Kapuskasing JCT	297.6	29.2	376.3	34.5	-	-	-	-	8.0	0.7
L21S	C.P. Kapuskasing JCT	Kapuskasing TS	296.2	29.0	373.9	33.1	-	-	-	-	46.7	4.1
L20D	Little Long JCT	Pinard TS	300.4	22.6	378.5	23.5	30.2	1.9	30.3	1.9	-	-
L20D	Little Long SS	Little Long JCT	297.6	22.4	376.3	23.4	-	-	-	-	7.9	0.5
D501P	Pinard TS	Porcupine TS	171.1	8.2	201.1	8.0	106.7	4.3	106.9	4.3	-	-

Table B1 (Continued)

Station	Auto-transformer	Pre-contingency		Loss of H9K		Loss of L21S (Reject TEMBEC Loads)		Loss of L21S (Reject TEMBEC Loads & Cross Trip K38S)		Loss of D501P (Reject TEMBEC Loads)	
		MVA	%L	MVA	%L	MVA	%L	MVA	%L	MVA	%L
Spruce Falls TS	T7	23.0	18.4	12.0	5.2	45.6	19.7	-	-	47.5	20.5
Kapuskasing TS	VR2	7.6	12.7	7.6	10.1	7.4	9.9	7.9	10.5	7.5	10.0

Table B2 Thermal loading assessment for Scenario 2 (Spruce Falls T5 out of service)

Spruce Falls T5 Out of Service - TMBEC loads 115kV connected to S3S/S4S														
Circuit	From	To	Pre-contingency		Loss of H9K		Loss of L21S (Reject TEMBEC Loads)		Loss of L21S (Reject TMP Load & Cross Trip K38S)		Loss of D501P (Reject TEMBEC Loads)		Loss of Spruce Falls T7	
			Amp	%L	Amp	%L	Amp	%L	Amp	%L	Amp	%L	Amp	%L
H9K	Hunta SS	Hunta H9K JCT	139.1	11.6	-	-	232.7	15.6	55.1	3.7	245.3	16.5	55.2	3.7
H9K	Hunta H9K JCT	H9K STR 127A JCT	68.8	19.7	-	-	115.6	33.0	26.8	7.7	122.0	34.9	26.9	7.7
H9K	H9K STR 127A JCT	Tembec Smooth Rk JCT	126.4	24.8	-	-	220.2	38.6	44.4	7.8	230.8	40.5	43.8	7.7
H9K	Tembec Smooth Rk JCT	Island FLS	159.1	37.9	-	-	252.6	60.1	74.3	17.7	266.7	63.5	74.9	17.8
H9K	Island FLS	Fauquier JCT	158.4	37.7	-	-	252.1	60.0	73.7	17.5	265.6	63.2	74.2	17.7
H9K	Fauquier JCT	Carmichael Falls JCT	147.7	29.0	-	-	241.3	43.1	63.1	11.3	255.1	45.6	63.6	11.4
H9K	Carmichael Falls JCT	Spruce Falls JCT	146.7	39.6	-	-	240.3	64.9	62.5	16.9	253.2	68.4	62.7	16.9
H9K	Spruce Falls JCT	Kapuskasing TS	145.2	13.2	-	-	238.7	20.6	62.2	5.4	250.2	21.6	62.1	5.4
K3	Kapuskasing TS	Kapuskasing R Jct	87.3	14.6	87.4	14.6	90.1	15.0	84.6	14.1	88.8	14.8	85.1	14.2
S3S	Smoky Falls SS	Kapuskasing R Jct	35.3	10.7	35.3	10.7	36.5	11.1	34.1	10.3	35.9	10.9	34.3	10.4
S4S	Smoky Falls SS	Kapuskasing R Jct	17.8	5.4	17.8	5.4	17.4	5.3	18.4	5.6	17.6	5.3	18.3	5.5
K38S	Kapuskasing TS	Spruce Falls JCT	214.8	13.6	292.3	15.5	72.4	3.8	-	-	79.0	4.2	257.3	13.6
K38S	Spruce Falls JCT	O'brien JCT	262.8	22.5	340.1	27.4	24.2	2.0	-	-	42.8	3.5	305.3	24.6
K38S	O'brien JCT	Spruce Falls TS	41.6	3.4	34.2	2.3	87.9	5.8	-	-	94.8	6.3	-	-
L21S	Little Long SS	C.P. Kapuskasing JCT	285.7	26.2	363.7	32.5	-	-	-	-	8.1	0.7	328.5	29.3
L21S	C.P. Kapuskasing JCT	Kapuskasing TS	284.2	25.2	361.4	30.4	-	-	-	-	47.1	4.0	326.6	27.4
L20D	Little Long JCT	Pinard TS	288.8	17.9	366.1	20.2	30.2	1.7	30.3	1.7	-	-	331.2	18.3
L20D	Little Long SS	Little Long JCT	285.7	17.7	363.7	20.1	-	-	-	-	7.9	0.4	328.5	18.1
D501P	Pinard TS	Porcupine TS	166.1	6.6	196.1	7.2	106.7	3.9	106.8	3.9	-	-	182.4	6.7

Table B2 (Continued)

Station	Auto-transformer	Pre-contingency		Loss of H9K		Loss of L21S(Reject TEMBEC Loads)		Loss of L21S Reject TMP Load & Cross Trip K38S)		Loss of D501P		Loss of Spruce Falls T7	
		MVA	%L	MVA	%L	MVA	%L	MVA	%L	MVA	%L	MVA	%L
Spruce Falls TS	T7	17.4	7.5	14.1	5.4	35.6	13.7	-	-	38.9	15.0	-	-
Kapuskasing TS	VR2	17.6	23.4	17.6	23.4	17.6	23.4	17.5	23.3	17.6	23.4	17.5	23.3

Table B3 Thermal loading assessment for Scenario 3 (K38S out of service)

K38S Out of Service				
Circuit	From	To	Pre-contingency	
			Amp	%L
H9K	Hunta SS	Hunta H9K JCT	352.7	29.4
H9K	Hunta H9K JCT	H9K STR 127A JCT	175.5	50.1
H9K	H9K STR 127A JCT	Tembec Smooth Rk JCT	341.2	66.9
H9K	Tembec Smooth Rk JCT	Island FLS	372.1	88.6
H9K	Island FLS	Fauquier JCT	371.9	88.5
H9K	Fauquier JCT	Carmichael Falls JCT	360.7	70.7
H9K	Carmichael Falls JCT	Spruce Falls JCT	360.1	97.3
H9K	Spruce Falls JCT	Kapuskasing TS	359.0	32.6
K3	Kapuskasing TS	Kapuskasing R Jct	334.6	55.8
S3S	Smoky Falls SS	Kapuskasing R Jct	34.9	10.6
S4S	Smoky Falls SS	Kapuskasing R Jct	18.0	5.5
K38S	Kapuskasing TS	Spruce Falls JCT	50.3	3.2
K38S	Spruce Falls JCT	O'brien JCT	-	-
K38S	O'brien JCT	Spruce Falls TS	-	-
L21S	Little Long SS	C.P. Kapuskasing JCT	24.6	2.3
L21S	C.P. Kapuskasing JCT	Kapuskasing TS	35.0	3.1
L20D	Little Long JCT	Pinard TS	47.2	2.9
L20D	Little Long SS	Little Long JCT	24.6	1.5
D501P	Pinard TS	Porcupine TS	101.7	4.1
P502X	Porcupine TS	Hanmer TS	259.7	9.1
A8K	Ansonville TS	A8K-19EO JCT	205.0	73.2
A9K	Ansonville TS	Monteith DS JCT	217.4	62.1

Table B3 (Continued)

Station	Auto-transformer	Pre-contingency	
		MVA	%L
Spruce Falls TS	T7	-	-
Kapuskasing TS	VR2	67.7	90.1

Table B4 Thermal loading assessment for Scenario 4 (L21S out of service)

L21S Out of Service				
Circuit	From	To	Pre-contingency	
			Amp	%L
H9K	Hunta SS	Hunta H9K JCT	359.6	30.0
H9K	Hunta H9K JCT	H9K STR 127A JCT	179.1	51.2
H9K	H9K STR 127A JCT	Tembec Smooth Rk JCT	346.8	68.0
H9K	Tembec Smooth Rk JCT	Island FLS	380.2	90.5
H9K	Island FLS	Fauquier JCT	379.6	90.4
H9K	Fauquier JCT	Carmichael Falls JCT	368.6	72.3
H9K	Carmichael Falls JCT	Spruce Falls JCT	367.4	99.3
H9K	Spruce Falls JCT	Kapuskasing TS	365.3	33.2
K3	Kapuskasing TS	Kapuskasing R Jct	37.7	6.3
S3S	Smoky Falls SS	Kapuskasing R Jct	35.3	10.7
S4S	Smoky Falls SS	Kapuskasing R Jct	17.8	5.4
K38S	Kapuskasing TS	Spruce Falls JCT	74.6	4.7
K38S	Spruce Falls JCT	O'brien JCT	41.8	3.6
K38S	O'brien JCT	Spruce Falls TS	159.7	13.0
L21S	Little Long SS	C.P. Kapuskasing JCT	-	-
L21S	C.P. Kapuskasing JCT	Kapuskasing TS	-	-
L20D	Little Long JCT	Pinard TS	30.2	1.9
L20D	Little Long SS	Little Long JCT	0.2	0.0
D501P	Pinard TS	Porcupine TS	106.6	4.3
P502X	Porcupine TS	Hanmer TS	250.5	8.8
A8K	Ansonville TS	A8K-19EO JCT	202.2	72.2
A9K	Ansonville TS	Monteith DS JCT	215.1	61.5

Table B4 (Continued)

Station	Auto-transformer	Pre-contingency	
		MVA	%L
Spruce Falls TS	T7	62.4	26.9
Kapuskasing TS	VR2	7.5	10.0

Appendix C: System Voltage Assessment Results

Table C1 System Voltage Assessment for Scenario 1 (all elements in service)

All Elements in Service																		
Circuit	Bus Name	Pre-contingency	Loss of H9K				Loss of L21S (Reject TEMBEC Loads)				Loss of L21S (Reject TEMBEC Loads & Cross Trip K38S)				Loss of D501P(Reject TEMBEC Loads)			
			Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
		kV	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$
S3S	Lower Mattagami River Project station JCT	113.5	113.5	0.0	113.5	0.0	109.3	3.7	109.3	3.7	119.9	-5.6	119.6	-5.4	110.2	2.9	110.7	2.5
S3S	Kapuskasing VR (K3 Side)	116.2	116.2	0.0	116.2	0.0	112.2	3.4	112.2	3.4	122.4	-5.3	122.1	-5.1	113.1	2.7	113.5	2.3
HV Bus	Kapuskasing TS (115 kV)	125.3	125.3	0.0	125.3	0.0	121.0	3.4	121.0	3.4	132.0	-5.3	131.7	-5.1	121.9	2.7	122.4	2.3
H9K	Faquier JCT	127.5	-	-	-	-	124.7	2.2	124.7	2.2	132.3	-3.8	131.9	-3.5	123.9	2.8	124.6	2.3
H9K	Malette Kraft JCT	129.3	-	-	-	-	128.1	0.9	128.1	0.9	132.4	-2.4	132.1	-2.2	126.2	2.4	127.0	1.8
H9K	Smooth Rock Falls JCT	129.5	-	-	-	-	128.5	0.8	128.4	0.8	132.4	-2.2	132.1	-2.0	126.4	2.4	127.2	1.8
HV Bus	Hunta TS	130.6	130.9	-0.2	130.9	-0.2	130.5	0.1	130.5	0.1	132.5	-1.5	132.1	-1.1	127.9	2.1	128.8	1.4
F1E	Calstock JCT	126.5	126.5	0.0	126.5	0.0	123.8	2.1	123.8	2.1	130.5	-3.2	130.4	-3.1	124.4	1.7	124.7	1.4
HV Bus	TMP Spruce Falls 115kV	116.9	116.3	0.5	116.3	0.5	113.3	3.1	117.6	-0.6	-	-	-	-	115.5	1.2	115.8	0.9
K38S	O'Brien JCT	239.6	238.4	0.5	238.4	0.5	232.3	3.0	232.2	3.1	-	-	-	-	236.7	1.2	237.4	0.9
	Kapuskasing 230 kV JCT	239.7	238.5	0.5	238.4	0.5	232.2	3.1	232.2	3.1	-	-	-	-	236.8	1.2	237.5	0.9
HV Buses	Pinard 230 kV	242.5	241.7	0.3	241.6	0.4	244.9	-1.0	244.8	-0.9	245.9	-1.4	245.5	-1.2	-	-	-	-
	Pinard 500 kV	540.3	538.6	0.3	538.6	0.3	545.6	-1.0	545.4	-0.9	547.8	-1.4	547.0	-1.2	-	-	-	-
LV Buses	Lower Mattagami River Project station	13.8	13.8	0.0	13.8	0.0	13.3	3.6	13.5	2.2	14.7	-6.5	14.6	-5.8	13.4	2.9	13.6	1.4
	Faquier DS	16.5	-	-	-	-	16.1	2.4	16.1	2.4	17.1	-3.6	17.1	-3.6	16.0	3.0	16.1	2.4
	Smooth Rock Falls DS	13.5	-	-	-	-	13.3	1.5	13.3	1.5	13.8	-2.2	13.7	-1.5	13.1	3.0	13.2	2.2

Table C2 System Voltage Assessment for Scenario 2 (Spruce Falls T5 Out of Service)

Spruce Falls T5 Out of Service														
Circuit	Bus Name	Pre-contingency	Loss of H9K				Loss of L21S (Reject TEMBEC Loads)				Loss of L21S (Reject TEMBEC Loads & Cross Trip K38S)			
			Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
		kV	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$
S3S	Lower Mattagami River Project station JCT	113.2	113.0	0.2	113.0	0.2	109.8	3.0	109.8	3.0	116.9	-3.3	116.6	-3.0
S3S	Kapuskasing VR (K3 Side)	115.9	115.8	0.1	115.7	0.2	112.7	2.8	112.7	2.8	119.5	-3.1	119.3	-2.9
HV Bus	Kapuskasing TS (115 kV)	125.1	124.9	0.2	124.9	0.2	121.6	2.8	121.6	2.8	128.9	-3.0	128.7	-2.9
H9K	Faquier JCT	127.4	-	-	-	-	125.2	1.7	125.2	1.7	130.3	-2.3	130.0	-2.0
H9K	Malette Kraft JCT	129.3	-	-	-	-	128.4	0.7	128.4	0.7	131.3	-1.5	131.0	-1.3
H9K	Smooth Rock Falls JCT	129.4	-	-	-	-	128.7	0.5	128.7	0.5	131.3	-1.5	131.0	-1.2
HV Bus	Hunta TS	130.6	131.0	-0.3	130.9	-0.2	130.7	-0.1	130.6	0.0	131.9	-1.0	131.6	-0.8
F1E	Calstock JCT	126.5	126.4	0.1	126.4	0.1	124.4	1.7	124.4	1.7	128.9	-1.9	128.7	-1.7
HV Bus	TMP Spruce Falls 115kV	115.9	115.7	0.2	115.7	0.2	112.7	2.8	112.7	2.8	119.4	-3.0	119.2	-2.8
K38S	O'Brien JCT	240.2	238.8	0.6	238.8	0.6	234.2	2.5	234.1	2.5	-	-	-	-
	Kapuskasing 230 kV JCT	240.2	238.8	0.6	238.8	0.6	234.1	2.5	234.1	2.5	-	-	-	-
HV Buses	Pinard 230 kV	242.7	241.9	0.3	241.8	0.4	245.0	-0.9	244.8	-0.9	245.6	-1.2	245.3	-1.1
	Pinard 500 kV	540.8	539.0	0.3	539.0	0.3	545.8	-0.9	545.5	-0.9	547.1	-1.2	546.5	-1.1
MV Buses	Lower Mattagami River Project station	13.8	13.8	0.0	13.8	0.0	13.4	2.9	13.6	1.4	14.3	-3.6	14.2	-2.9
	Faquier DS	16.5	-	-	-	-	16.2	1.8	16.2	1.8	16.8	-1.8	16.8	-1.8
	Smooth Rock Falls DS	13.5	-	-	-	-	13.4	0.7	13.4	0.7	13.7	-1.5	13.6	-0.7

Table C2 (Continued)

Spruce Falls T5 Out of Service									
Circuit	Bus Name	Loss of D501P(Reject TEMBEC Loads)				Loss of Spruce Falls T7			
		Pre-ULTC		Post-ULTC		Pre-ULTC		Post-ULTC	
		kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$	kV	$\%V_{ch}$
S3S	Lower Mattagami River Project station JCT	110.8	2.1	111.3	1.7	116.1	-2.6	116.0	-2.5
S3S	Kapuskasing VR (K3 Side)	113.7	1.9	114.1	1.6	118.7	-2.4	118.7	-2.4
HV Bus	Kapuskasing TS (115 kV)	122.7	1.9	123.1	1.6	128.1	-2.4	128.1	-2.4
H9K	Faquier JCT	124.5	2.3	125.2	1.7	129.3	-1.5	129.3	-1.5
H9K	Malette Kraft JCT	126.6	2.1	127.3	1.5	130.2	-0.7	130.2	-0.7
H9K	Smooth Rock Falls JCT	126.7	2.1	127.5	1.5	130.3	-0.7	130.2	-0.6
HV Bus	Hunta TS	128.0	2.0	128.9	1.3	130.8	-0.2	130.8	-0.2
F1E	Calstock JCT	125.0	1.2	125.3	0.9	128.4	-1.5	128.3	-1.4
HV Bus	TMP Spruce Falls 115kV	113.6	2.0	114.1	1.6	118.7	-2.4	118.7	-2.4
K38S	O'Brien JCT	238.7	0.6	239.4	0.3	239.4	0.3	239.4	0.3
	Kapuskasing 230 kV JCT	238.8	0.6	239.5	0.3	239.5	0.3	239.4	0.3
HV Buses	Pinard 230 kV	-	-	-	-	242.3	0.2	242.3	0.2
	Pinard 500 kV	-	-	-	-	539.9	0.2	539.8	0.2
MV Buses	Lower Mattagami River Project station	13.5	2.2	13.7	0.7	14.2	-2.9	14.2	-2.9
	Faquier DS	16.1	2.4	16.2	1.8	16.7	-1.2	16.7	-1.2
	Smooth Rock Falls DS	13.2	2.2	13.3	1.5	13.5	0.0	13.5	0.0

Table C3 System Voltage Assessment for Scenario 3 (K38S Out of Service)

K38S Out of Service		
Circuit	Bus Name	Pre-contingency kV
S3S	Lower Mattagami River Project station JCT	113.0
S3S	Kapuskasing VR (K3 Side)	115.8
H9K	Kapuskasing TS (115 kV)	122.5
H9K	Faquier JCT	126.0
H9K	Malette Kraft JCT	129.1
H9K	Smooth Rock Falls JCT	129.3
HV Bus	Hunta TS	131.1
F1E	Calstock JCT	124.7
HV Bus	TEMBEC Spruce Falls 115 kV	115.7
K38S	O'Brien JCT	-
	Kapuskasing 230 kV JCT	244.6
HV Buses	Pinard 230 kV	244.5
	Pinard 500 kV	544.7
MV Buses	Lower Mattagami River Project station	13.9
	Faquier DS	16.3
	Smooth Rock Falls DS	13.4

Table C4 System Voltage Assessment for Scenario 4 (L21S Out of Service)

L21S Out of Service		
Circuit	Bus Name	Pre-contingency
		kV
S3S	Lower Mattagami River Project station JCT	113.0
S3S	Kapuskasing VR (K3 Side)	115.8
H9K	Kapuskasing TS (115 kV)	117.5
H9K	Faquier JCT	121.9
H9K	Malette Kraft JCT	126.5
H9K	Smooth Rock Falls JCT	126.9
HV Bus	Hunta TS	129.8
F1E	Calstock JCT	121.7
HV Bus	TEMBEC Spruce Falls 115 kV	119.5
K38S	O'Brien JCT	227.2
	Kapuskasing 230 kV JCT	227.2
HV Buses	Pinard 230 kV	244.4
	Pinard 500 kV	544.5
MV Buses	Lower Mattagami River Project station	13.8
	Faquier DS	15.7
	Smooth Rock Falls DS	13.4

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