



System Impact Assessment Report

CONNECTION ASSESSMENT & APPROVAL PROCESS

Issue 1.0

Project: Cyrville MTS
Applicant: Hydro Ottawa Limited

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System Impact Assessment Report

Cyrville MTS

Acknowledgement

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

Disclaimers

IESO

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

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

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

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Special Notes and Limitations of Study Results

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

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

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

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

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

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

PROJECT IESO SYSTEM IMPACT ASSESSMENT

SIA Findings

Conclusions

This System Impact Assessment examined the effect of a new Municipal Transformer Station, Cyrville MTS, on the reliability of the IESO-controlled grid.

The conclusions of the study are:

1. The proposed project will not materially affect the reliability of the IESO-controlled grid.
2. The proposed project will relieve the transformer station over-loading at Bilberry and Moulton.
3. The addition of the new station will have a small contribution to short circuit currents due to the grounding of the transformers but there is no material increase in the short circuit fault levels.
4. The following equipment loading concerns were identified for the monitored transmission circuits in the studied scenarios up to 2016.
 - In 2016, the immediate loading on the section of A4K between Hawthorn and Cyrville will exceed its 15 min. LTR following the loss of A5RK. This would have occurred, whether or not, Cyrville MTS was connected.
 - In 2013, the load security criteria described in the *Ontario Resource and Transmission Assessment Criteria* document will not be met. Circuit A4K will have to be upgraded by 2013 to meet these requirements (see Section 5.7). Cyrville MTS did not have an effect on this need date.
5. Pre-contingency and post-contingency voltage declines meet the IESO assessment criteria requirements up to 2016.
6. The power factor at the defined metered point will be slightly below 0.9 lagging when the stations is put in service. However, additional shunt capacitors are not needed as long as the power factor of the load remains at 0.91 and the load supplied by Cyrville grows at the rate shown in Table 5.3.
7. Cyrville MTS is not expected to reach its design capacity until past 2021.

8. Under load tap changing facilities are available at the new station as required by the Market Rules.

IESO's Requirements for the Cyrville MTS Connection

The IESO requirements for the connection of Cyrville MTS are as follows:

1. Hydro Ottawa is required to install all the equipment needed to monitor the information required by the IESO on a continuous basis as described in Appendix 4.16 of the Market Rules. The IESO requires that the status of all isolating disconnect switches and breakers as well as voltages at Cyrville MTS and active and reactive power flows over the new transformers to be monitored on a continuous basis.
2. Hydro Ottawa is required to install UFLS facilities at Cyrville TS to meet the Market Rules requirements.
3. Hydro Ottawa must provide voltage reduction capability at the new station that can provide 3% and 5% voltage reduction within five minutes.
4. Protection systems must be designed to meet all the requirements of the *Transmission System Code (TSC)* and any additional requirements identified by Hydro One. Existing lines protections and DESN protection settings must be revised and coordinated, as required.
5. All equipment must be capable of operating continuously with a system voltage as high as 127 kV.
6. Transmission equipment must be able to interrupt rated fault current for voltages up to the maximum continuous rating.
7. Transmission equipment must remain in service, and not automatically trip, for the voltages up to 5% above the maximum continuous rating, for up to 30 minutes, to allow the system to be re-dispatched to return voltages within their normal range.
8. Under load tap changing facilities at the new station must be available.

Notification of Approval for Connection Proposal

It is recommended that a Notification of Conditional Approval for connection be issued to Hydro Ottawa, subject to IESO's Requirements for Connection listed above, and any further requirements that may be identified by Hydro One Networks Inc. in the Customer Impact Assessment.

1. Project Description

To supply future load growth in the area, Hydro Ottawa is proposing to build a new Municipal Transformer Station called Cyrville MTS, which will off load Bilberry Creek TS and Moulton TS. The station will connect to circuits A2 and A4K, approximately 2.86 km away from the Hawthorne 115 kV bus. The proposed station layout is shown in Figure 1.1.

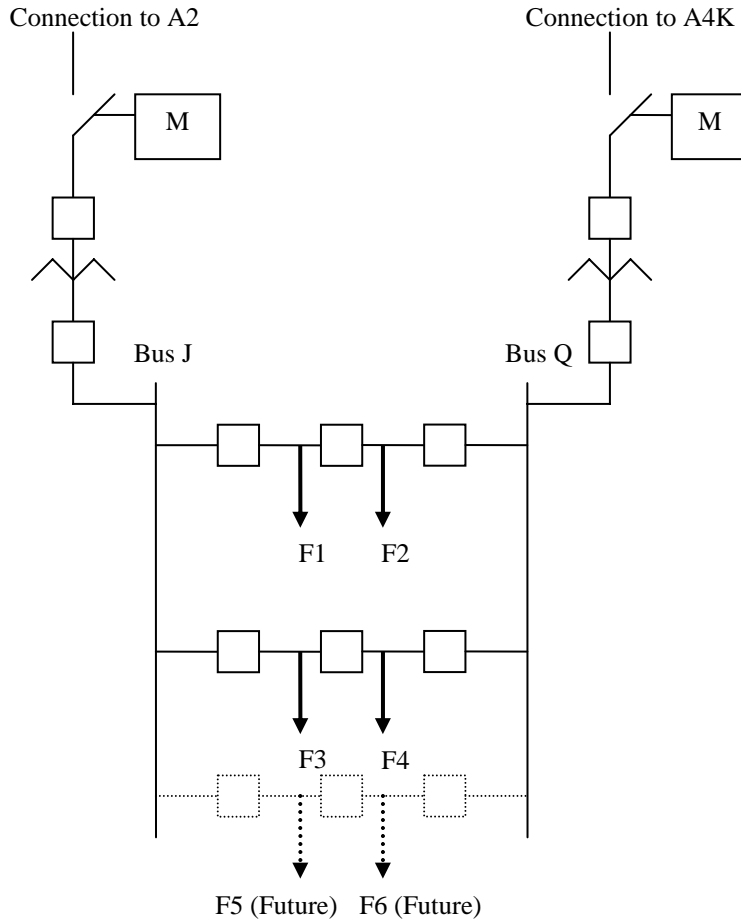


Figure 1.1 – Cyrville Station layout.

– End of Section –

2. General Requirements

2.1 Power Factor

The Market Rules 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.

2.2 Underfrequency Load Shedding Requirements

The Market Rules (Chapter 5 section 10.4) require that each distributor and connected wholesale customer, in conjunction with the relevant transmitter, make arrangements to enable the automatic disconnection of up to 35% of its peak demand for conditions of system under-frequency. To meet this requirement an under frequency load shedding (UFLS) scheme must be installed at the new station.

The under frequency automatic load shedding should be provided by tripping 28 kV feeder breakers to achieve:

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

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

2.3 Voltage Reduction Facilities Requirements

The Market Rules (Chapter 4 Appendix 4.3) requires 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 Connection Applicant is required to confirm that voltage control will be available from local or remote location to provide 3% or 5% reduction to support the operating obligations.

2.4 On-line Monitoring

The Market Rules (Chapter 4 section 7.5) require that each connected distributor shall provide the IESO on a continual basis with on-line monitored quantities as specified in Appendix 4.17. It is required that Hydro Ottawa Inc. install all the equipment needed to monitor the information required by the IESO on a continuous basis. The IESO requires that the status of all isolating disconnect switches and breakers as well as voltages at the new Cyrville TS station and power flows over the new transformers be monitored on a continual basis.

2.5 Protection Systems

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

The Transmission System Code requires duplicate battery protection for Protection Groups A and B unless otherwise agreed upon by the Transmitter. The applicant is required to confirm this with the Transmitter.

– End of Section –

3. Data Verification and Station Assessment

Hydro Ottawa has provided the following equipment specification for the new equipment proposed for the installation:

High-side Equipement

- *Step-down Transformer*

Quantity	2
Thermal ratings	30/40/50 MVA
In-service tap	115 – 27.6 kV
Under-load tap changer (ULTC)	± 5.75 kV in 16 steps on the HV winding
Transformer connections	HV Winding - Delta LV Winding - Wye (Neutral is grounded)
Limited time rating (LTR)	65 MVA
Impedance	12 % on 30 MVA base

- *Disconnect Switches*

Quantity	2
Type	Motorized
Rated voltage	138 kV
Maximum continuous operating voltage	145
Rated continuous current	1200 A
Rated short-circuit capacity	63 kA (symmetrical)

- *Transformer Breakers*

Quantity	2
Rated voltage	138 kV
Short circuit interrupting capability	50A (symmetrical)
Rated continuous current	600 A or 1200 A
Interrupting Time	3-5 cycles

Low-side Equipement

- *Transformer Breakers*

Quantity	2
Rated voltage	36 kV
Short circuit interrupting capability	31.5 kA
Rated continuous current	2000 A

- *Bus Tie Breaker*

Quantity	1
Rated voltage	36 kV
Short circuit interrupting capability	31.5 kA
Rated continuous current	2000 A
Normal operation	Closed

- *Feeder Breakers*

Quantity	4
Rated voltage	36 kV
Short circuit interrupting capability	31.5 kA
Rated continuous current	1200 A
Normal operation	Closed

- *Feeder Tie Breakers*

Quantity	2
Rated voltage	36 kV
Short circuit interrupting capability	31.5 kA
Rated continuous current	1200 A
Normal Operation	Closed

The system performance standards listed in the Transmission System Code requires that the fault levels on the 115 kV transmission system not exceed 50 kA and on the <50kV distribution system not exceed 17 kA. This indicates that the equipment must be sized accordingly. The short circuit capacity of the disconnect switches and the interrupting capability of the proposed breakers are adequate.

The capacity of Cyrville TS is 50 MVA (the continuous rating of one of the transformers). This is adequate since the load is not expected to increase beyond that until past 2021 (see Table 5.3).

– End of Section –

4. Fault Level Assessment

A fault level assessment was not required because no material increase in short circuit fault levels is expected.

– End of Section –

5. Impact on System Reliability

The purpose of this connection assessment is to determine the effect of the proposed station on the thermal loading of the transmission lines and transformers and on the pre- and post-contingency system voltages.

5.1 Description of Area Transmission

Cyrville MTS will connect to circuits A2 and A4K, which are shown in Figure 5.1. Currently, circuit A4K supplies Moulton TS, Overbrook TS and King Edward TS and circuit A2, supplies National Research and Bilberry Creek TS.

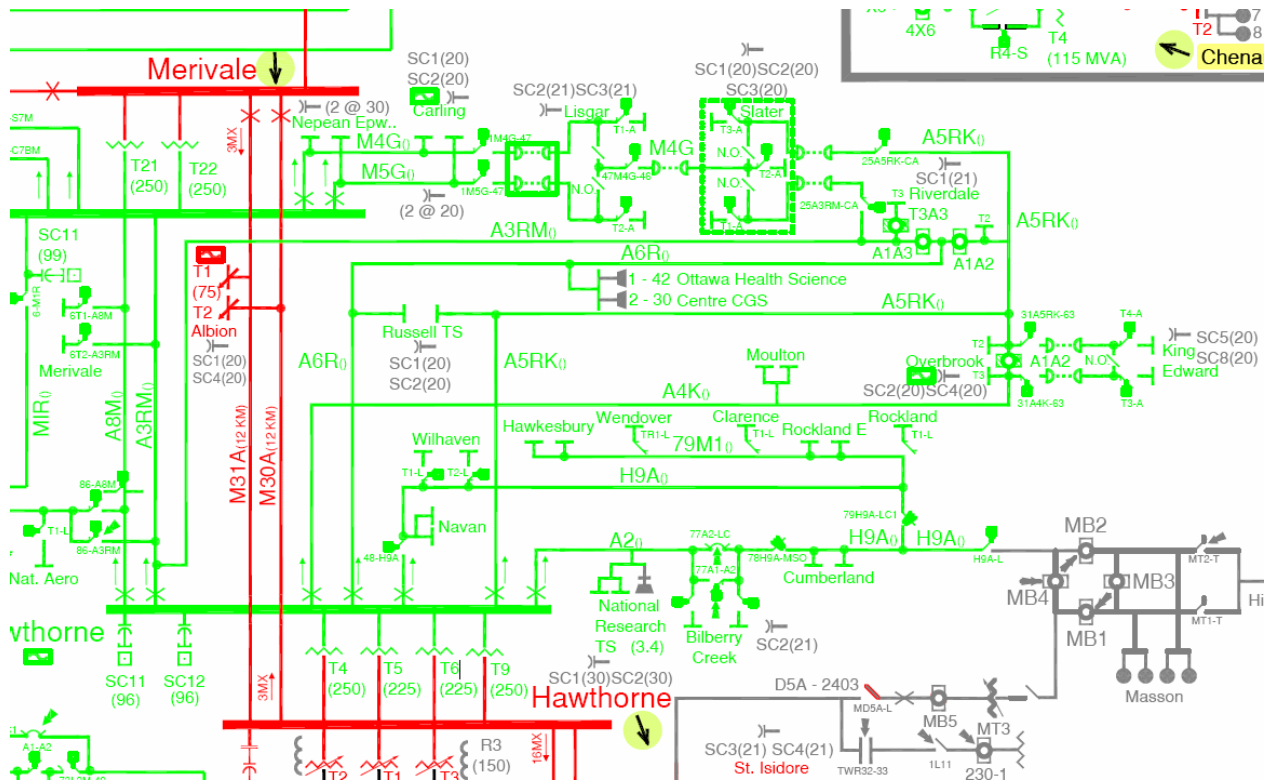


Figure 5.1 – One line diagram of the Ottawa area 115 kV transmission system.

5.2 Load Forecast

Hydro Ottawa provided a load forecast for Cyrville MTS, Moulton TS and Bilberry TS, which is shown in Tables 5.1, 5.2 and 5.3. The load forecast for other nearby loads that are critical for this study are shown in Table 5.4 and was determined in the following way:

1. The load level at those stations on the 16th hour of August 1, 2006 was determined (extreme weather conditions existed at this time).

2. To determine the extreme weather load levels from 2008 to 2016, the load forecasts for each station, which was supplied by either Hydro One or Hydro Ottawa, was used to determine a load growth rate at each station.
3. Those load growth rates were then used to scale up the August 1, 2006 load levels to 2008 and 2016 load levels.

Table 5.1 – Hydro Ottawa load forecast for Hydro Ottawa load supplied by Bilberry Creek TS.

Year	HOL Bilberry (MW)	HOL Bilberry (MVA)	Power Factor	Transferred to Cyrville (MVA)	Remaining on Bilberry HOL's portion (MVA)
2008	67.12	73.76	0.91	10.76	63
2009	68.46	75.23	0.91	12.23	63
2010	69.83	76.74	0.91	13.74	63
2011	71.23	78.27	0.91	15.27	63
2012	72.65	79.84	0.91	16.84	63
2013	74.11	81.44	0.91	18.44	63
2014	75.59	83.07	0.91	20.07	63
2015	77.1	84.73	0.91	21.73	63
2016	77.68	85.36	0.91	22.36	63
2017	78.26	86	0.91	23	63
2018	78.85	86.65	0.91	23.65	63
2019	79.44	87.3	0.91	24.3	63
2020	80.04	87.96	0.91	24.96	63
2021	80.64	88.62	0.91	25.62	63

Table 5.2 – Hydro Ottawa load forecast for load supplied by Moulton TS.

Year	Moulton (MW)	Moulton (MVA)	Power Factor	Transferred to Cyrville MVA	Remaining on Moulton (MVA)
2008	42.23	46.41	0.91	13.41	33
2009	43.07	47.33	0.91	14.33	33
2010	43.93	48.27	0.91	15.27	33
2011	44.81	49.24	0.91	16.24	33
2012	45.71	50.23	0.91	17.23	33
2013	46.62	51.23	0.91	18.23	33
2014	47.55	52.25	0.91	19.25	33
2015	48.5	53.3	0.91	20.3	33
2016	48.87	53.7	0.91	20.7	33
2017	49.23	54.1	0.91	21.1	33
2018	49.6	54.51	0.91	21.51	33
2019	49.98	54.92	0.91	21.92	33
2020	50.35	55.33	0.91	22.33	33
2021	50.73	55.75	0.91	22.75	33

Table 5.3 – Load forecast for load supplied by Cyrville TS.

Year	Total on Cyrville (MW)	Total on Cyrville (MVA)
2008	21.99	24.16
2009	24.17	26.56
2010	26.4	29.01
2011	28.68	31.52
2012	31	34.07
2013	33.37	36.67
2014	35.78	39.32
2015	38.24	42.02
2016	39.19	43.07
2017	40.13	44.1
2018	41.09	45.15
2019	42.06	46.22
2020	43.03	47.29
2021	44.01	48.36

Table 5.4 – Load forecast for loads critical to this study

	Russel TS (MW)	King Edward TS (MW)	Slater TS (MW)	Riverdale TS (MW)	Overbrook TS (MW)	NRCC (MW)
Demand in 2008	65.7	80.2	122.2	88.5	80.7	11.4
Demand in 2013	73.2	89.1	136	100.8	89.5	11.4
Demand in 2016	77.9	94.3	144	107.7	95.1	11.4

5.3 Power Factor at Defined Metering Point

From the load forecast provided by Hydro Ottawa (see Table 5.3), the power factor of the load supplied by Cyrville (measured on the low voltage side of the transformer) will be 0.91 lagging.

According to the IESO criteria the power factor at the defined metering point must be between 0.9 lagging and 0.9 leading.

A load flow study was carried out to determine the power factor at the defined metering point at Cyrville and at the other critical loads identified in Section 5.2. The load power factors entered into the basecase for Moulton, Bilberry Creek and Cyrville were the ones provided by Hydro Ottawa in Tables 5.1 and 5.2. For the other loads, the load power factor was determined using 2006 metering data (shown in Appendix A).

The study results are summarized in Table 5.5 for 2008 and Table 5.6 for 2013, which show the power factors at the defined metering point for Cyrville and all of the nearby loads. When Cyrville MTS is brought in service the power factor at the defined metering point will be slightly less than 0.9 lagging and, it will get slightly worse in 2013. However, additional shunt capacitors are not needed as long as the power factor of the load remains at 0.91 and the load supplied by Cyrville grows at the rate shown in Table 5.3.

Table 5.5 – Load Flow Results for 2008

Station	Bus Name	Power Factor at the low voltage side	MW at the Defined Metering Point	Mvar at the Defined Metering Point	Power Factor at the Defined Metering Point
Bilberry Creek TS	-	0.91	88.8	22.2	0.97
King Edward TS	J and Y Bus	0.85	80.4	16.7	0.98
	Q and Z Bus	0.87			
Moulton TS	-	0.91	30.1	16.2	0.88
Overbrook TS	J Bus	0.9	81	13.8	0.99
	Q Bus	0.88			
Russell TS	Y and B Bus	0.9	66	5.4	1.00
	Q and Z Bus	0.85			
Slater TS	B Bus	0.9	123	21.9	0.98
	J Bus	0.88			
	Q Bus	0.93			
Riverdale TS	Q and Z Bus	0.9	89.3	46	0.89
	J and Y Bus	0.89			
Cyrville	-	0.91	22	11	0.89

Table 5.6 – Load Flow Results for 2013

Station	Bus Name	Power Factor at the low voltage side	MW at the Defined Metering Point	Mvar at the Defined Metering Point	Power Factor at the Defined Metering Point
Bilberry Creek TS	-	0.91	89.4	21.5	0.97
King Edward TS	J and Y Bus	0.85	89.4	21.7	0.97
	Q and Z Bus	0.87			
Moulton TS	-	0.91	30.1	16.2	0.88
Overbrook TS	J Bus	0.9	89.8	18.6	0.98
	Q Bus	0.88			
Russell TS	Y and B Bus	0.9	73.5	9.5	0.99
	Q and Z Bus	0.85			
Slater TS	B Bus	0.9	136.8	28.9	0.98
	J Bus	0.88			
	Q Bus	0.93			
Riverdale TS	Q and Z Bus	0.9	101.8	56.6	0.87
	J and Y Bus	0.89			
Cyrville	-	0.91	33.4	17.6	0.88

5.4 Study Method

This section describes the study methods and assumptions used in the thermal loading and voltage decline studies, which are presented in sections 5.5 and 5.6. The study methods and assumptions are:

1. The study period was 2008 to 2016.

2. Generation dispatch in Ontario and area interchange schedules are not critical to this study and was, therefore, set to a typical summer scenario.
3. The load levels were adjusted according to the forecasts shown in Tables 5.1 to 5.4 and the load power factors were adjusted to the values shown in Table 5.5..
4. To determine post-contingency thermal loading and voltage declines, the loads were modeled as voltage dependant loads; P was modeled as 50% constant impedance and 50% constant current and Q was modeled as 100% constant impedance.

5.5 Post-contingency Thermal Loading

Following the loss of A4K, the power flow on the section of circuit A2 between Cyrville and Hawthorne will be higher with Cyrville connected than with current system configuration. The same is true for the power flow on circuit A4K following the loss of A2. The continuous and limited-time-ratings for the sections of A4K and A2 between Cyrville and Hawthorne are shown in Table 5.7. The IESO's criteria on the permissible thermal loading of transmission facilities immediately following a contingency are the following:

- With all elements in-service, all line loadings must be less than their continuous (operating) ratings.
- If there are actions available to reduce the post-contingency loading on a line to its continuous rating, then immediately following the contingency the loading on the line must be less than its 15 min. LTR. Otherwise, the post-contingency loading on the line must be less than its continuous rating.

A thermal study was carried out to determine if the criteria mentioned above is violated with Cyrville connected. The results are shown in Table 5.8 for 2008, in Table 5.10 for 2013 and Table 5.11 for 2016. The contingencies considered are the loss of circuit A2, the loss of circuit A5RK and the loss of circuit A4K. For comparison, the same study was also carried out for the current system configuration, where Moulton and Bilberry load was not transferred to Cyrville. The results for the current system configuration are shown in Table 5.9.

From these results the following conclusions were reached:

- 1 The pre-contingency loading on A2 and A4K with Cyrville connected is similar to what it would be with the current system configuration. This is seen by comparing the results in Table 5.8 with those in Table 5.9.
- 2 In 2016, the post-contingency loading on circuit A4K will reach its 15 min. LTR following the loss of A5RK. This is an existing problem that was not made worse by connecting Cyrville.

Table 5.7 – Circuit ratings

Circuit	From	To	Distance	Continuous Rating	15 min. LTR
A2	Hawthorne TS	Blackburn JCT	2.543 km	1072 A	1240 A
	Blackburn JCT	Cyrville JCT	2.021 km	1209 A	1393 A
A4K	Hawthorne TS	Blackburn JCT	2.543 km	1072 A	1240 A
	Blackburn JCT	Cyrville JCT	2.021 km	1209 A	1393 A

Table 5.8 – With Cyrville, in 2008

Circuit	Direction	Contingency	P	Q	Current (A)	Rating*	% of Rating
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	No Contingency	125	29	613	1072	57
Hawthorne to Cyrville A2	Hawthorne to Cyrville	No Contingency	84	38	442	1072	41
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	Loss of A2	134	34	659	1240	53
Hawthorne to Cyrville A2	Hawthorne to Cyrville	Loss of A4K	95	45	499	1240	40
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	Loss of A5RK	203	69	1021	1240	82
Hawthorne to Cyrville A2	Hawthorne to Cyrville	Loss of A5RK	85	39	447	1240	36

* Continuous rating for pre-contingency and 15 min. LTR for post-contingency.

Table 5.9 – Current system configuration, in 2008

Circuit	Direction	Contingency	P	Q	Current (A)	Rating*	% of Rating
Hawthorne to Blackburn Jn (A4K)	Hawthorne to Blackburn Jn	No Contingency	124	29	609	1072	57
Hawthorne to Blackburn Jn (A2)	Hawthorne to Blackburn Jn	No Contingency	79	38	418	1072	39
Hawthorne to Blackburn Jn (A4K)	Hawthorne to Blackburn Jn	Loss of A2	124	28	608	1240	49
Hawthorne to Blackburn Jn (A2)	Hawthorne to Blackburn Jn	Loss of A4K	79	38	418	1240	34
Hawthorne to Blackburn Jn (A4K)	Hawthorne to Blackburn Jn	Loss of A5RK	205	72	1036	1240	84
Hawthorne to Blackburn Jn (A2)	Hawthorne to Blackburn Jn	Loss of A5RK	79	37	417	1240	34

* Continuous rating for pre-contingency and 15 min. LTR for post-contingency.

Table 5.10 – With Cyrville, in 2013

Circuit	Direction	Contingency	P	Q	Current (A)	Rating*	% of Rating
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	No Contingency	142	39	701	1072	65
Hawthorne to Cyrville A2	Hawthorne to Cyrville	No Contingency	91	42	478	1072	45
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	Loss of A2	154	47	768	1240	62
Hawthorne to Cyrville A2	Hawthorne to Cyrville	Loss of A4K	105	52	560	1240	45
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	Loss of A5RK	223	87	1142	1240	92
Hawthorne to Cyrville A2	Hawthorne to Cyrville	Loss of A5RK	92	43	484	1240	39

* Continuous rating for pre-contingency and 15 min. LTR for post-contingency.

Table 5.11 – With Cyrville, in 2016

Circuit	Direction	Contingency	P	Q	Current (A)	Rating*	% of Rating
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	No Contingency	151	47	757	1072	71
Hawthorne to Cyrville A2	Hawthorne to Cyrville	No Contingency	94	44	499	1072	47
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	Loss of A2	165	56	836	1240	67
Hawthorne to Cyrville A2	Hawthorne to Cyrville	Loss of A4K	111	57	595	1240	48
Hawthorne to Cyrville A4K	Hawthorne to Cyrville	Loss of A5RK	236	104	1235	1240	100
Hawthorne to Cyrville A2	Hawthorne to Cyrville	Loss of A5RK	95	46	505	1240	41

* Continuous rating for pre-contingency and 15 min. LTR for post-contingency.

Table 5.12 – Voltage declines in 2016

	Pre-contingency (kV)	Post-contingency, Pre-ULTC (%)			Post-contingency, Post-ULTC (%)		
		Loss of A2	Loss of A4K	Loss of A5RK	Loss of A2	Loss of A4K	Loss of A5RK
Hawthorne 115 kV	120.6	-0.1	0.0	0.3	-0.2	-0.1	0.1
Cyrville MTS A2 115 kV Connection	120.0	-	-0.1	0.3	-	-0.2	0.1
Cyrville MTS A4K 115 kV Connection	119.9	-0.2	-	-0.3	-0.3	-	-0.6
Cyrville 27.6 kV	29.3	-3.8	-3.7	0.0	-4.0	-3.8	-0.3
Bilberry 115 kV	118.7	-	-0.1	0.3	-	-0.2	0.1
Bilberry 27.6 kV	29.2	-10.8	-0.1	0.3	-4.0	-0.2	0.1
National Research 115 kV	119.5	-	-0.1	0.3	-	-0.2	0.1
Moulton 115 kV	119.3	-0.1	-	-0.8	-0.3	-	-1.1
Moulton 27.6 kV	28.3	-0.1	-	-0.8	-0.3	-	-1.1
Overbrook 115 kV	119.1	-0.1	-0.9	-1.2	-0.3	-1.0	-1.6
Overbrook Bus J 12.5 kV	13.3	-0.1	-3.6	-1.2	-0.3	-1.4	-1.7
Overbrook Bus Q 12.5 kV	13.3	-0.1	-5.6	-5.7	-0.3	-2.4	-2.1
King Edward A5RK 115 kV Connection	118.9	-0.1	-1.0	-	-0.3	-1.2	-
King Edward A4K 115 kV Connection	119.0	-0.1	-	-1.4	-0.3	-	-1.7
King Edward Bus JY 12.5 kV	13.2	-0.1	-4.0	-7.3	-0.3	0.1	-1.1
King Edward Bus QZ 12.5 kV	13.2	-0.1	-3.1	-4.8	-0.3	-0.3	-1.1
Russell A5RK 115 kV Connection	119.5	-0.1	-0.4	-	-0.2	-0.6	-
Russell A6R 115 kV Connection	119.6	-0.1	-0.2	0.3	-0.2	-0.3	0.1
Russell Bus BY 12.5 kV	13.3	-0.1	-0.3	-1.7	-0.2	-0.4	-1.9
Russell Bus QZ 12.5 kV	13.3	-0.1	-0.3	-2.0	-0.2	-0.4	-0.8
Slater A5R 115 kV Connection	119.0	-0.1	-0.3	-	-0.2	-0.4	-
Slater A3R 115 kV Connection	119.0	-0.1	-0.3	0.4	-0.2	-0.4	0.2
Slater M4G 115 kV Connection	117.5	0.0	0.0	-0.2	-0.1	-0.1	-0.4
Slater Bus Q 12.5 kV	13.2	-0.1	-0.2	-2.8	-0.2	-0.3	-0.2
Slater Bus B 12.5 kV	13.3	-0.1	-0.3	-6.7	-0.2	-0.5	-1.3
Slater Bus J 12.5 kV	13.3	-0.1	-0.2	0.4	-0.2	-0.3	0.2

5.6 Post-Contingency Voltage Declines

Connecting Cyrville should improve the 115 kV voltages at the stations supplied by A2 and A4K because load is being transferred closer to Hawthorne and, therefore, the voltage drops are

smaller. A voltage study was carried to determine the expected pre-contingency voltages and post-contingency voltages following the loss of circuit A2, the loss of circuit A4K and the loss of A5RK. The results are shown in Tables 5.12 for a 2016 extreme weather load level.

The post-contingency voltage declines are within criteria up to 2016.

5.7 Load Security

According to the load security criteria in the *Ontario Resource and Transmission Assessment Criteria* document, with any one element out of service, the equipment loading must be within the long-term emergency ratings (i.e. continuous operating ratings). Load curtailment to meet this requirement is not allowed. With any two elements out of service, the equipment loading must be within the short-term emergency ratings (i.e. 15 min. LTR) and must be reduced to the long-term emergency ratings in the time allowed by the short-term rating. Load curtailment up to 150 MW is allowed to meet this requirement.

As shown in section 5.5, in 2013, immediately following the loss of A5RK, the loading on A4K will exceed its long-term emergency rating. Opening the connection between Cyrville and A4K will reduce the loading on A4K to 1090 A, which is close to its summer-time long-term emergency rating. After 2013, it will not be possible to reduce the circuit loading back to its long-term emergency rating. For this outage condition, transferring some of the Moulton load to Cyrville MTS helped reduce the loading on A4K.

With A5RK and A2 out of service, circuit A4K will have to supply all of the Cyrville, Overbrooke, King Edward and Moulton load. The loading on A4K in 2013 with A5RK and A2 out of service will be 1280 A, which is slightly greater than its short term ratings. This violates the load security criteria and, therefore, circuit A4K must be upgraded by 2013. For these outage conditions, transferring some of the Bilberry load to Cyrville increased the loading on A4K.

The load security criteria also requires that with one element out of service, not more than 150 MW of load can be interrupted by configuration. With two elements out of service not more than 600 MW of load can be interrupted by configuration and by planned load curtailment. Both of these criteria are satisfied for all of the loads supplied by circuits A4K, A5RK and A2.

– End of Section –

Appendix A – Power Factors of Nearby Loads

