IMO_REP_0084

CONNECTION ASSESSMENT & APPROVAL PROCESS

Preliminary Assessment Report

Project: *Winona TS*

Applicant: *Hydro One Networks Inc.*

CAA ID 2002-051

Final Report

Long Term Forecasts & Assessments Department
Consistent Information Set Department

November 11, 2002

Preliminary Assessment Report

Winona TS

Acknowledgement

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

Disclaimers

IMO

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

HYDRO ONE

Special Notes and Limitations of Study Results

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

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

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

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

The ampacity rating 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 IMO 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.

Executive Summary

This Preliminary Assessment has examined the impact of a new proposed transformer station, Winona TS, on the reliability of the IMO-controlled grid. This project was subject to an expedited Connection Assessment process and it is not required to undergo a System Impact Assessment.

Proposed Project

Hydro One Networks Inc. is proposing to build a new 115-27.6 kV Transformer Station, designated Winona TS, in the city of Hamilton. The proposed site for the TS is adjacent to the Hydro One corridor for 115 kV circuit Q2AH, approximately 18 km from Beamsville TS. The new TS will be normally supplied from Beach TS with provisions for switching to Beamsville section of Q2AH when supply from Beach TS is not available.

A schematic diagram of the 115 kV transmission in the Niagara-Hamilton area and the location of the proposed Transformer Station are shown in Figure 1.

The proposed new Winona TS will be a standard DESN arrangement with 2 x 50/66.6/83.3 MVA transformers and associated HV and LV equipment.

The *connection applicant* has indicated that the initial load supplied from the new TS is initially expected to be approximately 16 MVA and grow to about 83 MVA by 2015.

The proposed ready for service date for the new TS is June 30, 2003.

Impact on System Reliability

This Preliminary Assessment has examined the impact of connecting Winona TS to the 115 kV line Q2AH emanating from Beach TS, on the reliability of the *IMO-controlled grid*. The studies concluded that:

1. the proposed project will not materially affect the reliability of the IMO-controlled grid or the load-meeting capability of the existing system,

2. the addition of the new supply point does not have a significant effect on the short circuit currents observed at the other transformer stations connected to this circuit,

3. the thermal capability of the Beach TS x Beamsville TS section of Q2AH could be reached by 2010, when line outage conditions or Allanburg area operating restrictions would dictate that the Beamsville TS and Vineland TS loads be transferred to Beach TS,

4. if for peak load conditions, Beamsville TS and Vineland TS loads are supplied from Beach TS than the 115 kV voltages at these stations are at or below 113 kV.

It is recommended that, by 2010 Hydro One considering a plan to upgrade the Holland Jct. to St John Valley Jct. sections of the 115 kV line Q2AH to allow for the continuous supply of all three stations from the Beck to Allanburg section of Q2AH..

IMO's Requirements for Connection

It is required that Hydro One ensure that the load supplied by Beamsville TS and Vineland DS will be limited to the 10 day LTR of the stations.

The applicant is required to ensure that the new station load would meet the Market Rules power factor requirements.

Hydro One Networks Inc. is required to provide sufficient voltage support in the area to ensure that the voltage at Vineland TS is at least 113 kV, for situations when Winona TS, Beamsville TS and Vineland TS loads are supplied from Beach TS.

It is required that Hydro One Network Inc. provide the IMO with the following information as soon as it becomes available:

1. A confirmation that an underfrequency load shedding relay, which will have the capability of tripping up to 35% of the station load (12% at 59.3 Hz and additional 23% at 58.8 Hz) is to be installed. Appropriate settings for the relay will be provided by the IMO prior to commissioning.

2. A confirmation that voltage reduction facilities will be provided, with the capability of reducing the distribution voltage by 3% or 5%.

3. A confirmation that the transfer trip protection scheme was installed as required by the Transmission System Code.

Need for System Impact Assessment

The analysis that was performed under this Preliminary Assessment has covered all the system reliability issues related to the connection of the proposed development to the *IMO-controlled grid*. Therefore, a System Impact Assessment is considered to be unnecessary for this project.

Notification of Approval for Connection Proposal

It is recommended that Notification of Approval be granted for this connection proposal, subject to the implementation by Hydro One Networks Inc. of all the requirements listed in section 7 of the report.

Preliminary Assessment Report

1.0 Project Description

Hydro One Networks Inc. is proposing to build a new 115-27.6 kV Transformer Station, designated Winona TS, in the city of Hamilton. The proposed site for the TS is adjacent to the Hydro One corridor for 115 kV circuit Q2AH, approximately 18 km from Beamsville TS. Circuit Q2AH extends from Beck GS to Allanburg TS to Beach TS providing supply to Dunnville TS, Vineland DS and Beamsville TS. The circuit is operated normally open on the Beach TS side of Beamsville TS and also has a normally open connection to St Catharines Carlton TS. With this arrangement, the new TS will be normally supplied radially from Beach TS while Dunnville TS, Vineland DS and Beamsville TS will remain connected to Beck to Allanburg section of line. Alternatively, Winona TS may be supplied from Beck GS, if supply from Beach TS is not available.

A schematic diagram of the 115 kV transmission in the Niagara-Hamilton area and the location of the proposed Transformer Station are shown in Figure 1.

The proposed new Winona TS will be a standard DESN arrangement with 2 x 50/66.6/83.3 MVA transformers and associated HV and LV equipment.

The *connection applicant* has indicated that the initial load supplied from the new TS is initially expected to be approximately 16 MVA and grow to about 83 MVA by 2015.

The proposed ready for service date for the new TS is June 30, 2003.

2.0 Review of Connection Proposal

2.1 Connection Arrangement

The proposed Winona TS will be equipped with two new 110 kV-28 kV transformers that will be connected to the existing 115 kV circuit Q2AH.

Each transformer is to be connected to the *IMO-controlled grid* via one manually operated 700 A, 115 kV disconnect switch. Low voltage side isolation of each transformer is to be provided by one 2000A, 17 kA, 27.6 kV breaker. The LV bus-tie breaker is to be operated normally-closed. The station will have six feeders and each feeder position is to be equipped with one 1200 A, 17 kA breaker.

The transformers are both identical rated at 50/66.6/83 MVA and configured with an ungrounded wye winding on the high side, and zigzag winding on the low voltage side. Each of the low voltage side winding neutrals is grounded via a 1.5 ohms reactor. Each transformer is equipped with under-load tap changer with a range of about +10.0% to –17.5% that is to be achieved in $\pm$11 steps.

Figure 2 shows a detailed single line diagram of the proposed Transformer Station.

In addition two 115 kV circuit switchers will be installed, one on each side of the transformer tap point along the main Q2AH circuit as shown in Figure 2. This configuration will facilitate the switching of the Winona load from Beach TS, which is the normal supply configuration, to Allanburg TS.

The line taps from the station to the 115 kV circuit will be short and thus their impedance was considered negligible in this assessment. The points of connection or *defined meter points* will be located on the high voltage side of the transformer but the revenue meters are to be installed on the LV side of the station.

2.2 Power Factor

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

The information received with the connection application indicates that station design provides for installation of six 27.6 kV feeders. There is also space allocated for future installation of one shunt capacitor and capacitor breaker to meet that the load power factor requirements of the *Market Rules*.

2.3 Underfrequency Load Shedding Requirements

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

2.4 Voltage Reduction Facilities Requirements

The *Market Rules* (Chapter 4 Appendix 4.3) requires that distributors connected to the *IMO 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 IMO.

2.5 On-line Monitoring

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

2.6 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 applicant has indicated that the station equipment and station control/protection will be designed to meet the intent of the Transmission System Code. Based on the single line diagram IP10251 A.R0 provided by HONI, each transformer is separated from the transmission system via a motorized disconnection switch. For this particular arrangement the Transmission System Code requires that transfer trip of the Transmitter’s breakers at the terminal stations be provided for transformer faults or for a condition of failure to operate of the LV breakers.

The protection systems associated with the 115 kV line Q2AH should be revised as required.

3.0 Data Verification

Based on standards for supply of municipal electrical utilities the capability of a DESN station is defined as the maximum load that one transformer can carry for a predefined period of time. This value is usually computed using specific transformer data and daily load curves, and temperature data specific to the transformer location. HONI has pointed out that no specific overloading capability has been requested of the manufacturer for Winona TS transformers. The applicant has indicated however, that if needed, typical value for long term limited time rating should be assumed in this assessment.

Information of the projected ultimate station loading indicates that by 2015 load supplied from Winona TS will reach the maximum continuous rating of one transformer.

The proposed Winona TS will be equipped with two new 110 kV-28 kV transformers that will be connected to the existing 115 kV circuit Q2AH via one disconnect switch each.

The positive sequence transformer impedance for one transformer is 12.5% on 50 MVA base.

The system performance standards listed in the Transmission System Code requires that the 115 kV and 27.6 kV systems fault levels not exceed 50 kA and 17 kA, respectively. The LV breakers proposed for installation at Winona TS meet the interrupting capability recommended by the TSC.

Since the design and specifications of the transformers and the associated breakers and disconnect switches have not been yet finalized, it is expected that the proponent will provide when available, the “as built” transformer information to meet the requirements of the facility registration process.

4.0 Fault Level Assessment

In general, radial loads do not have a large impact on the system fault levels, but a small contribution in short circuit currents can be observed due to the grounding of the transformers. In the case of Winona TS the high voltage winding is ungrounded, hence line-to-ground faults occurring on the distribution side will have no impact on the short circuit levels.

5.0 Impact on System Reliability

The connection assessment study concentrated on identifying the effect of the proposed DESN on thermal loading of the transmission lines and transformers, and system voltages for pre and post contingency situations.

In addition, this assessment investigated the adequacy of the existing Allanburg area transmission system to supply the area load until about 2010 and identified any limitation that may occur.

Thus, the results of this assessment are presented in two parts. Findings related to the effect of the new proposal on the reliability of the transmission system are presented in the main body of this report and the results of the area transmission adequacy of supply until 2010 are described in Appendix A.

Both studies were performed for a system with all elements in service under the assumption presented in section 5.2.

5.1 Description of Area Transmission

The 115 kV and 230 kV area transmission is shown in Figure 1 together with the proposed location of Winona TS. The Allanburg area load is supplied via a number of 115 kV circuits connecting Allanburg TS to Decew Falls to Beck No.1 and to Beach TS. The load is supplied from the four 230/115 kV autotransformers at Allanburg TS and the area local generation comprising of Beck No.1 GS generation connected to the E bus and Decew Falls GS,

The local 115 kV transmission comprises of:
- the double circuit 115 kV line Q4N/Q3L from Beck No.1 to Stanley TS; from Stanley TS, the 115 kV line Q4N continues as a single circuit to Niagara Murray TS, where ii connects into the double circuit line A37N/A36N, which terminates at Allanburg,
- the double circuit 115 kV line Q12S/Q11S to Glendale TS supplying Niagara-on-the-Lake TS, Bunting TS and GlendaleTS, which continues to Decew Falls GS as D9S/D10HS and supplies Carlton TS and Vansickle TS,
- the three-ended 115 kV single circuit extending from Beck GS to Allanburg TS and to Beach TS, Q2AH which normally supplies Dunville TS, Vineland TS and Beamsville TS and
- the double circuit 115 kV line D1A/D3A between Decew Falls GS and Allanburg TS supplying Thorold TS, Georgian Pacific, Atlas Steel and Donohue TS.

The area peak load is about 1000 MW, the maximum generating capabilities at Beck No.1 GS and Decew Falls GS are about 350 MW and 160 MW, respectively.

Normal Operation

Normally, the connection of Q2AH circuit into Beach TS is operated open, resulting in the supply of Vineland TS, Beamsville TS and Dunville TS loads from this circuit’s radial section originating at Holland Road Jct.

Under normal operation scenario the new Winona TS load will be supplied from Beach TS, thus having no impact on the transfer capability of the 115 kV circuits out of Beck No.1 and Allanburg TS.

Load Transfer Alternatives

In-line disconnect switches, that will provide for an alternative supply of the Winona TS load from the Q2AH radial section originating at Holland Road Jct., are proposed to be installed on each side of the new Winona TS.

Additionally, the existing in-line disconnects on Q2AH allow Beamsville TS, or Beamsville TS and Vineland TS loads to be supplied from Beach TS, when required.

5.2 Study Assumptions

The analysis was performed for system peak load conditions in years 2003 and 2010 and for various load supply arrangements.

Table 1 below lists the expected summer peak load grow at the stations that are connected to the single 115 kV circuit Q2AH, and also the load growth forecast for the entire Allanburg 115 kV area and Beach 115 kV area.

It should be noted that the summer peak load presently supplied from Beamsville TS and Vineland DS exceed the 10 day LTR of the respective transformer stations.

Table 1. Load Growth Forecast to 2010

Station	Forecast Summer Peak Loads (MVA) for Station Connected to Q2AH								
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
"Winona TS"	-	15.3	19.4	23.7	28.1	32.6	37.3	42.2	47.5
Beamsville TS	**69.5**	**71.3**	56.6	56.6	56.6	56.6	56.6	56.6	56.6
Vineland DS	**31.7**	**32.4**	27.8	27.8	27.8	27.8	27.8	27.8	27.8
Dunnville TS	26.1	26.3	26.6	26.8	27.1	27.4	27.7	27.9	28.2
Total	127	145	130.4	134.6	139.6	144.4	149.2	154.3	159.9
Total Allanburg 115 kV Area Load									
Load(MW)	-	1043	-	-	959	-	-	-	1052
Total Beach TS 115 kV Area Load									
Load(MW)	-	373	-	-	384	-	-	-	455

The assumptions used in determining the total 115 kV area loads were as follows:

- All loads were escalated based on the IMO official 10 Year Forecast which correspond to 1.63% peak load growth per year until 2010,
- Starting in 2004 Norfolk TS load was removed from the Allanburg load pocket under the assumption that Caledonia TS will be in service by summer 2004,
- Starting in 2004 Beamsville TS and Vineland DS station loads will be limited to the respective 10 day LTR of the stations, under the assumption that any further load increase in the area will be supplied from new DESNs that are planned to be connected to the neighbouring 230 kV circuits,
- All loads were modeled with a power factor equal or close to 0.9 measured at the 115 kV connection point.

It can be observed that by 2010 the load in theAllanburg 115 kV area will be only about 9 MW higher that the 2003 peak load due to the Norfolk load transfer to Caledonia and the capping that will be imposed on the Beamsville and Vineland stations.

For the entire study period, the following generation resources were assumed to be in service in Allanburg area:

- six unit in service at Beck No.1 GS amounting to a total of 252MW and
- full output from Decew Falls GS for a total of 160MW.

For the critical sections of the 115 kV circuits in the Allanburg area the following ratings were used:

Table 2. 115 kV Lines Thermal Ratings

Circuit, Sections (Conductor)		Max Op. Temp. (^{0}C)	Thermal ratings		
			Continuous (30^{0}C ambient) at 93^{0}C Amps MVA @118 kV	**Emergency** Continuous at Max Op Temp or 127 C Amps, MVA @118 kV	**15 min LTR** At Max Operating Temperature Amps, MVA @118 kV
Q2AH	Allanburg TS x Holland Road Jct x St Johns Valley Jct and Holland Road Jct x Beck (732kcmil 16/7)	127	780 **159 MVA**	1,000 **204 MVA**	1,180 **241 MVA**
	St Johns Valley Jct x Louth Jct (997.2 kcmil 21/7)	127	950 **194 MVA**	1,220 **249 MVA**	1,510 **309 MVA**
	Louth Jct x Beamsville TS (605kcmil 54/7)	110	710 **145 MVA**	820 **168 MVA**	920 **188 MVA**
	Beamsville TS x Beach TS (605kcmil 54/7)	85	650 **133 MVA**	650 **133 MVA**	710 **145 MVA**
Q11S	Beck X GM	127	710 **145 MVA**	910 **186 MVA**	1,040 **213 MVA**
M11S	GM x Bunting Jct	127	710 **145MVA**	910 **186 MVA**	1,040 **213 MVA**
D10S	DeCew Falls GS x Louth Jct	150	710 **145 MVA**	910 **186 MVA**	1,170 **239 MVA**
	Louth Jct x Glendale TS	127	710 **145 MVA**	910 **186 MVA**	1,040 **213 MVA**
Q12S	Beck GS x Glendale TS	127	710 **145 MVA**	910 **186 MVA**	1,040 **213 MVA**
D9HS	DeCew Falls GS x Louth Jct	150	710 **145 MVA**	910 **186 MVA**	1,170 **239 MVA**
	Louth Jct x Glendale TS	127	710 **145 MVA**	910 **186 MVA**	1,040 **213 MVA**
D1A	Allanburg TS x Holland Road Jct	150	710 **145 MVA**	910 **186 MVA**	1,170 **239 MVA**
	Holland Road Jct X Hoopers Jct	127	950 **194 MVA**	1,220 **249MVA**	1,510 **309 MVA**
	Hoopers Jct x DeCew Falls GS	150	710 **145 MVA**	1,220 **249 MVA**	1,170 **239 MVA**
D3A	Allanburg TS x Gibson Jct	150	710 **145 MVA**	910 **186 MVA**	1,170 **239 MVA**
	Gibson Jct x DeCew Falls GS	150	710 **145 MVA**	910 **186 MVA**	1,120 **239 MVA**
Q4N	Beck GS x Stanley TS	150	950 **194 MVA**	1,220 **249 MVA**	1,702 **348 MVA**
	Stanley TS x Murray TS	127	690 **141 MVA**	880 **180 MVA**	1,010 **206 MVA**
Q3L	Beck GS x Stanley (the limiting section)	150	690 **141 MVA**	880 **180 MVA**	1,010 **206 MVA**
A36N/ A37N	Allanburg TS x Murray TS	125	1,080 **221 MVA**	1,390 **284 MVA**	1,740 **356 MVA**
A6C/ A7C	Allanburg TS x Crowland TS	127	950 **189 MVA**	1220 **249 MVA**	1410 **280 MVA**

The thermal ratings of the Beach TS and Allanburg TS autotransformers that were used in this study are summarized in Table 3.

Table 3. Transformer Ratings

Facility Name	Continuous (MVA)	10 Day LTR (MVA)	15 MinuteLTR (MVA)
Allanburg T1	225	227.1	302.6
Allanburg T2	250	402.1	415
Allanburg T3	250	304.3	415
Allanburg T4	250	402.1	415
Beach T1	250	291.6	373
Beach T7	255.6	309.7	421.4
Beach T8	255.6	309.7	421.4

5.3 Impact on 115 kV Transmission

This section covers the effect that the proposed development is going to have on the reliability of the area transmission system.

5.3.1 Thermal Loading – Q2AH

Power flow analysis was performed for 2003 and 2010 summer peak load conditions with all transmission elements in service, and for the loss of one critical transmission element. The transmission system losses were assumed to be 5% and were included in the total MVA flows.

In order to maintain the availability to supply the load, the loss of various sections of Q2AH circuit would require the transfer of load to other sections via switching of exiting and new disconnects.

Under normal operating conditions the proposed Winona TS load will be supplied from Beach TS and Beamsville TS, Vineland TS and Dunville TS will remain connected to the Q2AH radial section from Holland Road Jct. For this configuration the load connected to Q2AH will be distributed as follows:

- In 2003, 15.3 MVA will be supplied from Beach TS and 129.7 MVA from Allanburg TS
- In 2010, 47.5 MVA will be supplied from Beach TS and 112.4 MVA from Allanburg TS

For a single line contingency involving the Q2AH section from Beach TS to Winona TS (case A) and assuming that Winona load is transferred to Beamsville, all four stations will be connected to Q2AH sections feeding from Beck No.1 and Allanburg TS.

For a single line contingency involving the Q2AH section from Beamsville TS to Vineland TS (case B) and assuming that Beamsville load is transferred to Beach, only two stations will be connected to Q2AH section from Holland Jct..

For a single line contingency involving any of the Q2AH sections from Vineland TS to Allanburg or Beck (case C) Beamsville TS and Vineland TS loads are to be transferred to Beach TS.

It should be noted that the transfer to Beach of Beamsville and Vineland load could also be dictated by stressed system conditions associated with Allanburg area supply.

For each of these cases, the resulting loading of various sections of the 115 kV Q2AH line are shown in table 4 below for years 2003 and 2010.

Table 4. Impact of Winona TS on the Transmission Loading

Transmission Element (Cont. Rating, Emerg. Rating)	**2003 System Loads (Norfolk Load Connected to Allanburg)**				**2010 System Loads (Norfolk Load Transferred to Caledonia)**			
	Normal Config. (A)	**Outage Section**			**Normal Config. (A)**	**Outage Section**		
	Actual flow (MVA) % Loading of Cont Rating	Actual flow (MVA) % Loading of Cont Rating % Loading of Emerg. Rating			Actual flow (MVA) % Loading of Cont Rating	Actual flow (MVA) % Loading of Cont Rating % Loading of Emerg. Rating		
		Beach x Winona (Case A)	**Beamsville x Vineland (Case B)**	**Vineland x Louth (Case C)**		**Beach x Winona (Case A)**	**Beamsville x Vineland (Case B)**	**Vineland x Louth (Case C)**
Q2AH Beach x Beamsville (133,133 MVA)	16. 12.0%	-	91 68.4%	125 93%	50 37.6%	-	109 82%	138 104% 104%
Q2AH Louth x Beamsville (145, 168 MVA)	109 75%	125 86.2% 74.4%	34 23.4% 20.2%	0	89 89%	139 96%	29 20%	-
Q2AH Holland Jct.x St John Jct. (159, 204 MVA)	136.5 85.8%	**152.3** **95.8%** **74.7%**	62 39% 30.4%	27.6	118 74%	160 100% 78%	59 37%	30 19%
Q2AH Beck x Holland Jct. (159, 204MVA)	4 2.5%	4 2.5%	Small	Small	2	7	Small	-
Q2AH Allanburg x Holland Jct (159, 204 MVA)	141 88.7%	**157.4** **99%** **77%**	96	30	116 73%	153 96%	60 38%	30 19%
	Actual flow (MVA) % Loading of Cont Rating		**Loss of T1**		Actual flow (MVA) % Loading of Cont Rating		**Loss of T1**	
	Normal Config.	**Case C**	**Normal Config.**	**Case C**	**Normal Config.**	**Case C**	**Normal Config.**	**Case C**
Beach T1 (250 MVA)	141 56.5%	177 71%	-	-	173 69%	216 86%	-	-
Beach T7 (255.6 MVA)	131 51%	168 65.7%	201 78.6% of contin. rating	256.5 88% of 10 day LTR	160 63%	203 79.5%	245 Less than contin. rating	311 74% of 15 min LTR
Beach T8 (255.6 MVA)	132 56%	168 65.7%	203 79% of contin. rating	256.5 88% of 10 day LTR	162 63%	205 79%	248 Less than contin. rating	313 74% of 15 min LTR

The results of this assessment indicate that *for normal operating configuration* and peak load conditions the thermal capability of Q2AH will be adequate until about 2010 provided that the peak load at Beamsville TS and Vineland TS are limited to the stations' 10 day LTR. For this scenario the flow out of

Beck No.1 GS on the 115 kV line Q2AH is very small resulting in heavy loading of the Allanburg to Holland Jct. section of this circuit.

For situations when *Winona TS is to be supplied from Beamsville TS (case A)* the Holland Jct. to St. John Valley JCT. could become loaded to about 96% of its continuous rating by 2003. It is expected that starting in 2004 the loading of this section of Q2AH circuit will be relieved due to the load limitations that will be observed at Beamsville TS and Vineland DS. Hence, the load flow results show that 2010 Holland Jct. to Louth Jct. sections of the 115 kV circuit Q2AH could become loaded close to its continuous rating.

For situations when at least *Beamsville TS is supplied from Beach TS (case B)* the flow on Beach TS to Beamsville TS section of Q2AH will be under its continuous rating before 2010.

For situation when *both Beamsville TS and Vineland DS (case C)* are supplied from Beach TS the power flow could reach the emergency rating of the Beach TS to Beamsville TS section of Q2AH, by 2010. This particular arrangement is of special interest since this load transfer is part of the current operating practices used to alleviate the overloading of the Allanburg transformers. Further discussion of this situation is given in Appendix A, together with the discussion on the Allanburg TS capability.

The results of the assessment show that the 230/115 kV transformers at Beach TS have adequate rating to support the supply of Winona TS, Beamsville TS and Vineland TS until at least 2010 with all elements in service and also for a contingency involving one of the Beach transformers.

The proposed IMO load supply guidelines indicate that the supply to a load which is less than 250 MW should be restorable by switching in the event of a single circuit line contingency. Based on the limitations recognized in the study and in order to respect the IMO's guidelines for supply availability the following requirements were identified:

> It is required that Hydro One ensure that by 2004 the peak loads supplied from Beamsville TS and Vineland DS do not exceed the 10 day LTR of the respective stations, thus alleviating the possible power overloading situations of the Beach TS to Beamsville TS section of Q2AH circuit, when all three municipal stations fare supplied from Beach TS.

By 2010, Hydro One should be considering a plan to upgrade the Holland Jct. to St John Valley Jct. sections of the 115 kV line Q2AH to allow for the continuous supply of all three stations from the Beck to Allanburg section of Q2AH..

5.3.2 Voltage Assessment

Examination of the results show that the by 2010 the voltage at Beach TS could be about 116 kV. Although this voltage level meets the Market Rules requirements the voltage experienced at Winona could be as low as 114 kV by 2010. The situation is aggravated when the Beamsville and Vineland loads are transferred to Beach TS. In this case the voltage at Beamsville TS will be as low as 113 kV as early as next year.

The study results indicate that, with a voltage of 119 kV at Beach TS the system is not capable of maintaining 113 kV voltage level, as it is required by the Market Rules, at Winona TS, Beamsville TS and Vineland TS for cases when these stations are radially supplied from Beach TS.

6. Conclusions and Recommendations

This Preliminary Assessment has examined the impact of connecting Winona TS to the 115 kV line Q2AH emanating from Beach TS, on the reliability of the *IMO-controlled grid*. The studies concluded that:

1. the proposed project will not materially affect the reliability of the IMO-controlled grid or the load-meeting capability of the existing system,

2. the addition of the new supply point does not have a significant effect on the short circuit currents observed at the other transformer stations connected to this circuit,

3. the thermal capability of the Beach TS x Beamsville TS section of Q2AH could be reached by 2010, when line outage conditions or Allanburg area operating restrictions would dictate that the Beamsville TS and Vineland TS loads be transferred to Beach TS,

4. if for peak load conditions, Beamsville TS and Vineland TS loads are supplied from Beach TS that the 115 kV voltages at these stations are at or below 113 kV.

It is recommended that, b y 2010 Hydro One considering a plan to upgrade the Holland Jct. to St John Valley Jct. sections of the 115 kV line Q2AH to allow for the continuous supply of all three stations from the Beck to Allanburg section of Q2AH..

5. IMO's Requirements for Connection

It is required that Hydro One ensure that the load supplied by Beamsville TS and Vineland DS will be limited to the 10 day LTR of the stations by 2004.

The applicant is required to ensure that the load would meet the Market Rules power factor requirements.

Hydro One Networks Inc. is required to provide sufficient voltage support at Beach TS to ensure that the voltage at Vineland TS is at least 113 kV, for situations when Winona TS, Beamsville TS and Vineland TS loads are supplied from Beach TS.

It is required that Hydro One Network Inc. provide the IMO with the following information as soon as it becomes available:

1. A confirmation that an underfrequency load shedding relay, which will have the capability of tripping up to 35% of the station load (12% at 59.3 Hz and additional 23% at 58.8 Hz) is to be installed. Appropriate settings for the relay will be provided by the IMO prior to commissioning.

2. A confirmation that voltage reduction facilities will be provided, with the capability of reducing the distribution voltage by 3% to 5%.

3. A confirmation that the transfer trip protection scheme was installed as required by the Transmission System Code.

8. Need for System Impact Assessment

The analysis that was performed under this Preliminary Assessment has covered all the system reliability issues related to the connection of the proposed development to the *IMO-controlled grid*. Therefore, a System Impact Assessment is considered to be unnecessary for this project.

9. Customer Impact Assessment

Hydro One Networks Inc., has concluded that this project will not have an adverse impact on any of the existing customers connected in the in the area and hence a detailed Customer Impact Assessment is not required.

10. Notification of Approval for Connection Proposal

It is recommended that Notification of Approval be granted for this connection proposal, subject to the implementation by Hydro One Networks Inc. of all the requirements listed in section 7.

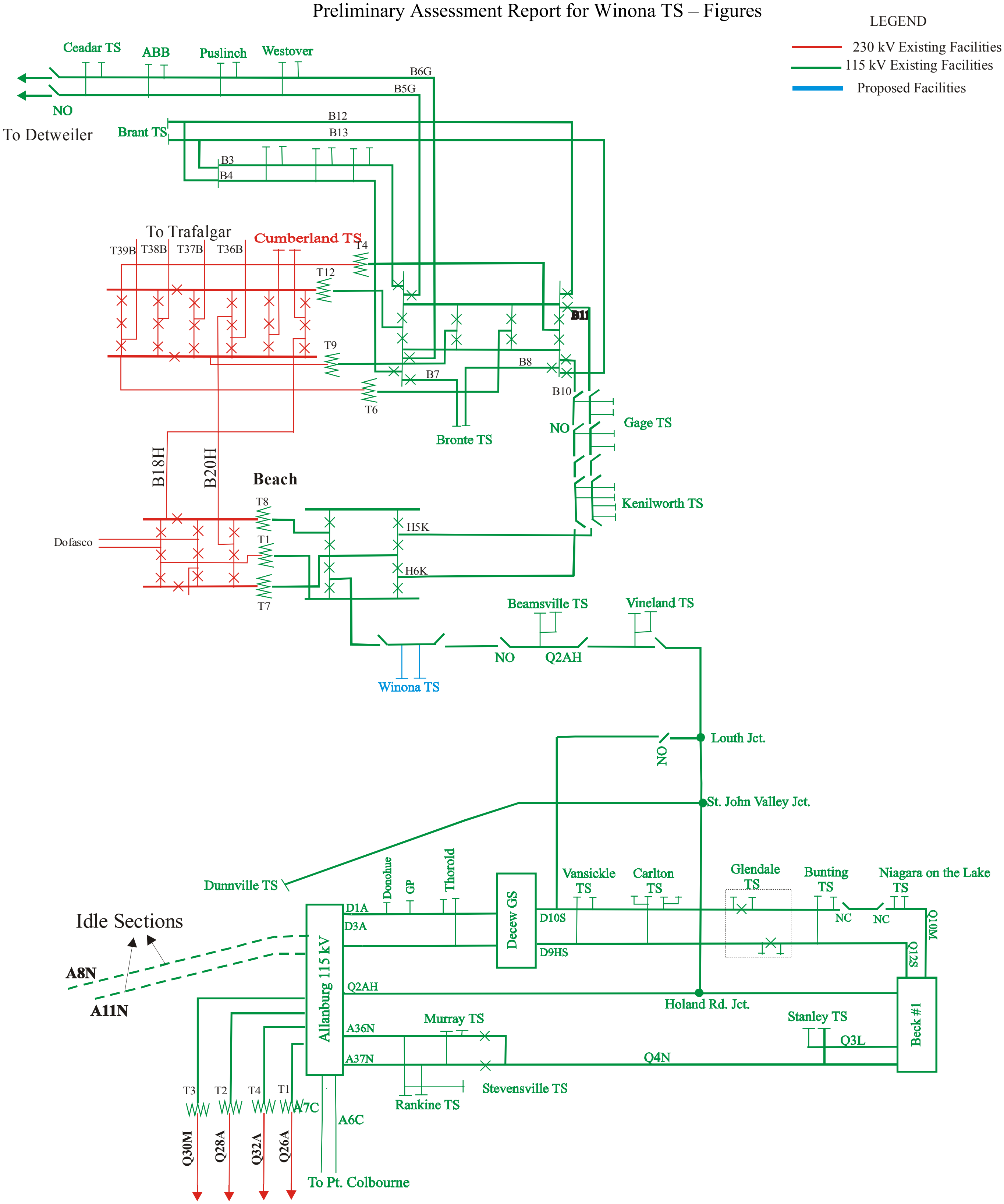
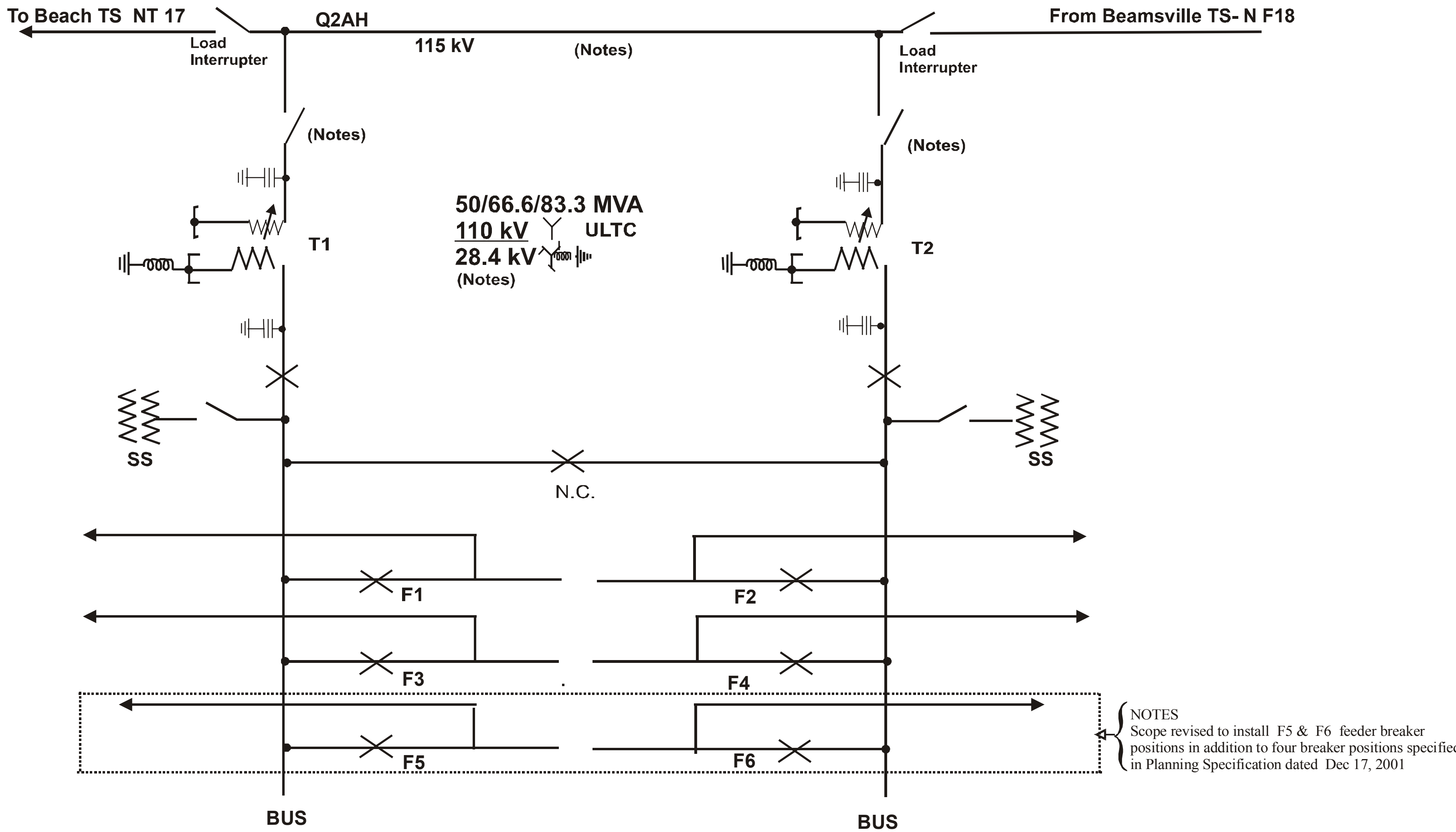


Figure 1. Allanburg Area 115 kV Transmission



Shows electrical connections only but not physical order

Transformer HV switching -115 kV motor operated disconnect switch.

Number of feeder breaker positions changed from four to six. Ready for service June 30, 2003.

Loops to be provided at convenient connection between the load interrupter switches

Checked ______________________________

Approved ______________________________

Figure 2. Winona TS: Build 115-27.6 kV Transformer Station

IP 10251 A. R1
Sep 05, 2002

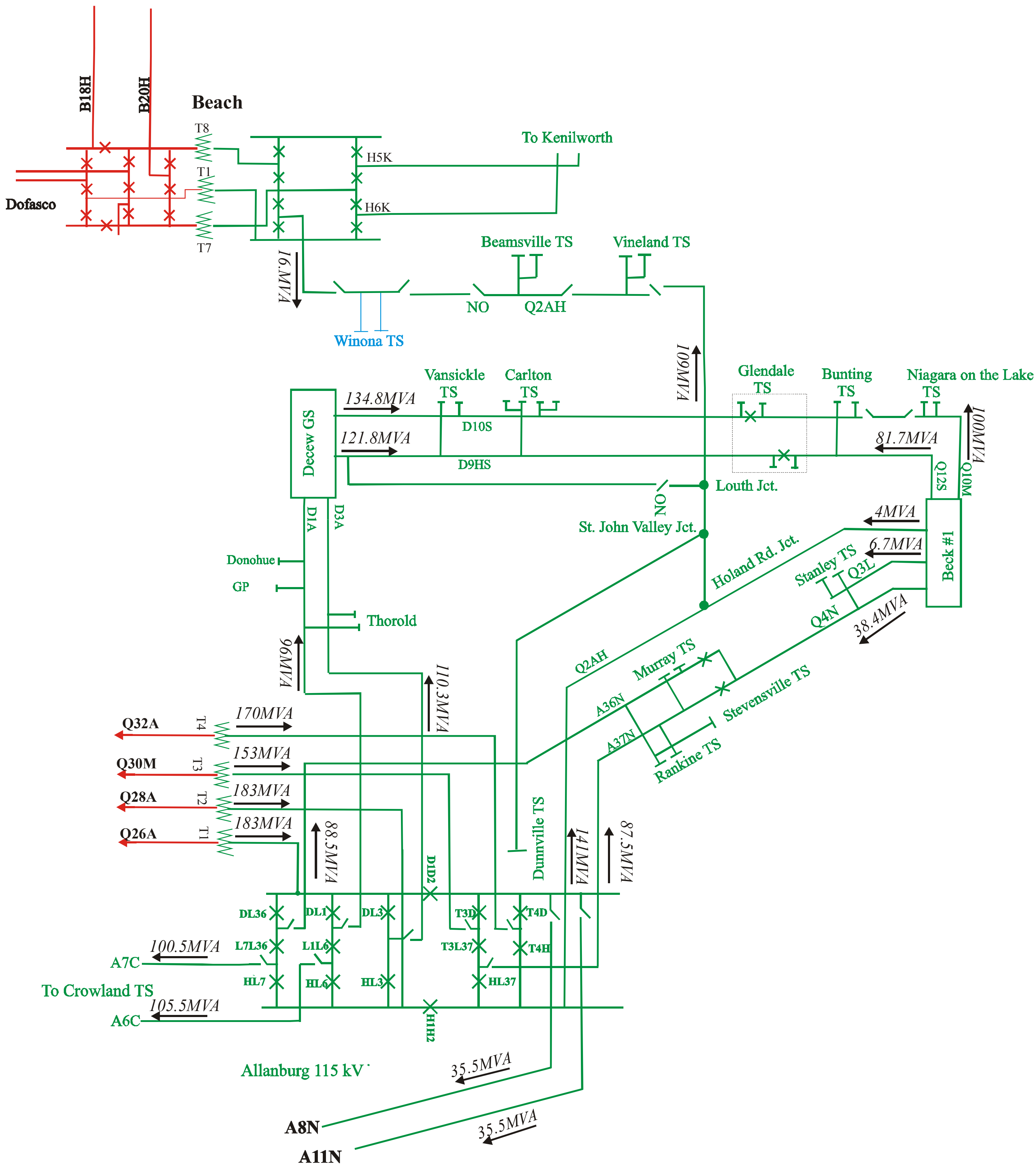


Figure 3. Year 2003 Power Flows

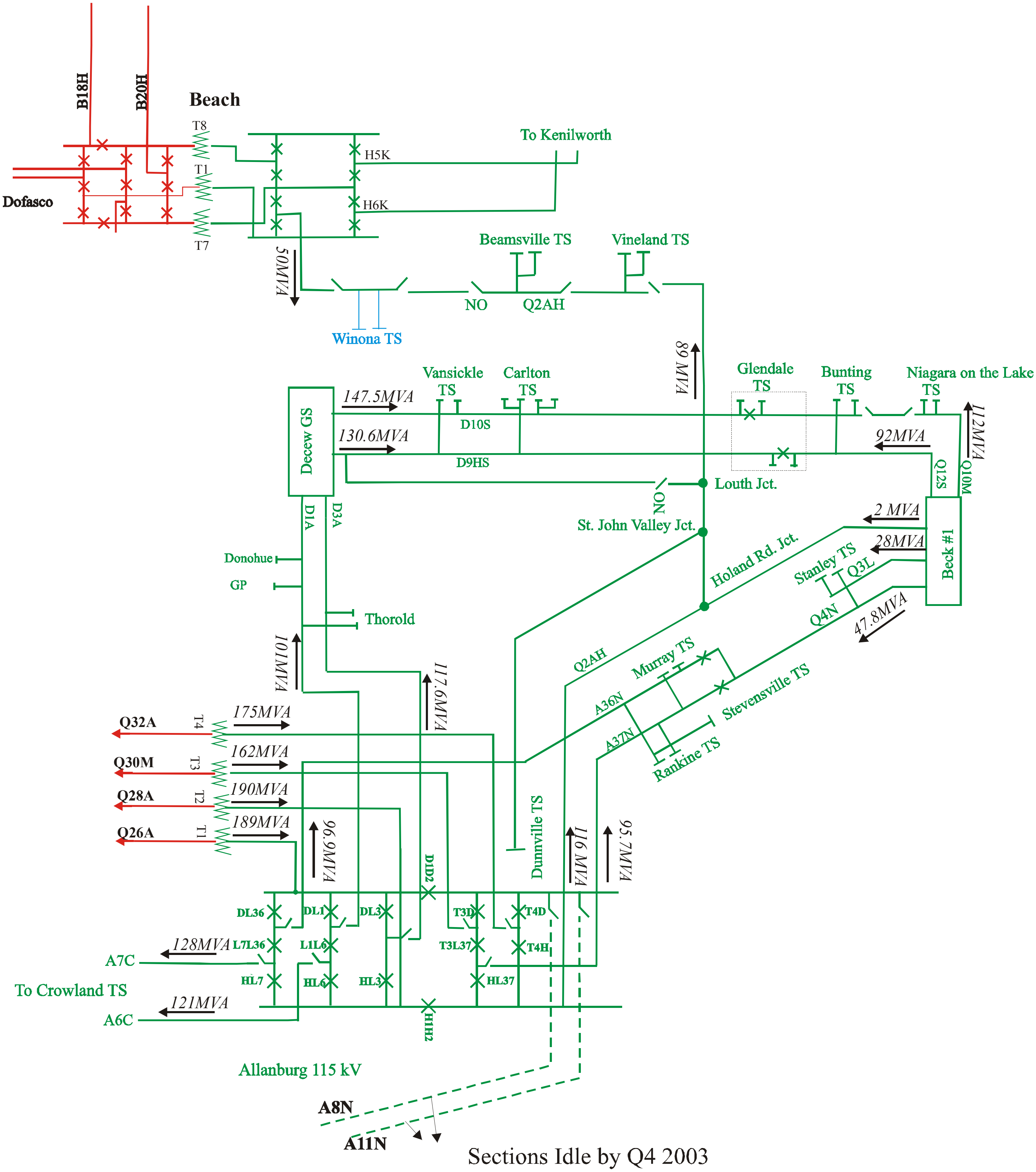


Figure 3. Year 2010 Power Flows

Appendix A

Allanburg 115 kV Area Transmission Review

1.0 Introduction

This review was carried out in conjunction with the Connection Assessment that was performed for the incorporation of Winona TS. It focuses on the adequacy of the existing Allanburg area transmission system to supply the area load until about 2010 and identified any limitation that may occur.

Detailed descriptions of the Allanburg area transmission system and all the study assumptions are given in sections 5.1 and 5.2 of the PA report.

2.0 IMO Guidelines for Connection Assessments

The IMO has been developing on set of proposed guidelines for determining the effect of new developments on the system reliability and establishing the need to reinforce the transmission system. It has been proposed that the following contingencies constitute the "design criteria contingencies" set:

- Single transmission element contingency,
- Double-circuit line contingency,
- Stuck breaker condition.

The proposed guidelines that were used in this study specify that with all transmission elements in service in pre-contingency:

- any design-criteria contingency must not result in the loss of 500 MW or more of load.
- if any design criteria contingency results in the loss of 250MW to 500 MW at least half of the load must be restored within 30 minutes and the remaining load in eight hours.
- if any design-criteria contingency will result in a supply interruption to 150 MW to 250 MW load then, the supply must be restored within eight hours.
- the power flows over the transmission elements must be within their continuous thermal ratings,
- any design-criteria contingency must not result in power flows which exceed the limited time ratings of the equipment,
- the steady state voltages must be within the ranges required by the Market Rules,
- the post-contingency decline in voltage must be less than 10%.

3.0 Thermal Loading – Allanburg 115 kV Area

Thermal Loading – Allanburg 115 kV Transmission

A line diagram of the Allanburg 115 kV area transmission is shown in Figure 1.

The St. Catharines transmission corridor, comprising of two 115 kV circuits Q11S and Q12S out of Beck No.1 GS and two 115 kV circuits D10S and D9HS out of Decew GS, supplies a total peak load that is estimated to be about 438 MVA in 2003 and about 482 MVA in 2010. Outage distribution factors that were calculated for this interface and are shown in Table 5, were used to compute the post contingency flows listed in Table 6.

Table 5. Outage Distribution Factors

Monitored Element	Outage Element			
	D10S	D9HS	Q11S	Q12S
D10S	-	0.6	0.78	-0.2
D9HS	0.62	-	-0.23	0.79
Q11S	0.53	0.15	-	0.41
Q12S	-0.15	0.56	0.45	-

The results of this assessment as shown in Table 6, indicate that for peak load conditions with all elements in service the following thermal overloads could occur:

- Circuit D10S following the loss of D9HS,
- Circuit Q11S following the loss of D10S, or
- Circuit D9HS following the loss of D10S.

Because the load connected to these circuits is less than 500 MW, it can be concluded that the load supply reliability criterion is met.

The 115 kV circuits D1A, D3A appear to have sufficient spare thermal capability to accommodate peak load power flow even beyond year 2010.

A cursory investigation of the thermal capability of the Beck No.1 GS to Allanburg TS lines Q3L, Q4N, A36N and A37N shows that the thermal capability of these circuits, with all elements in service and under contingency situations, will not be exceeded until 2010.

Table 6. Allanburg 115 kV Transmission Thermal Loading

Transmission Element (Cont. Rating, 15 min LTR)	**2003 System Loads (Norfolk Load Connected to Allanburg)**					**2010 System Loads (Norfolk Load Transferred to Caledonia)**				
	Pre-cont Flow (MVA) % Loading of Cont. Rating	Post-contingency Flow(MVA) % loading of LTR Contingency				Pre-cont Flow (MVA) % Loading of Cont. Rating	Post-contingency Flow(MVA) % loading of LTR Contingency			
		Q11S	Q12S	D10S	D9HS		Q11S	Q12S	D10S	D9HS
Q11S @Q (145,213 MVA)	100 69%	-	134	172	81	112.4 77.5%	-	150	190.7	91.8
Q12S @Q (145,213 MVA)	81.7 56.3%	127	-	61	149	92 63.4%	142	-	69.6	164.7
D10S @D (145, 213 MVA)	134.8 93%	213.5 100%	118	-	207 97%	**147.5 102%**	236 111%	128	-	225.5 106%
D9HS @D (145,213 MVA)	121.5 83.8%	98	186	205 96%	-	130.6 90%	104	203 95%	221.7 104%	-
Q2AH@Q (159,241 MVA)	4	29	25	-19	-18	6.7	35	31	-19	-17
(Cont. Rating, Emerg. Rating)		**D1A %Loading of Emerg.**		**D3A %Loading of Emerg.**			**D1A %Loading of Emerg.**		**D3A %Loading of Emerg.**	
D1A @A (145, 186 MVA)	96.2 66.3	-		159.2		101 70%	-		168	
D3A @A (145, 186 MVA)	110.3 76%	166 89%		-		117.6 81%	176		-	

Thermal Loading – Allanburg TS Transformers

With the addition of the four 115 kV 2 ohms in-line reactors next to the Allanburg autotransformers the fault level currents were reduced to a level which permits the Allanburg station to be operated solid at all times.

Although the loss of a double circuit line is not considered a recognized contingency in this area this assessment includes a brief review of the impact of the loss of the double circuit 230 kV lines into Allanburg TS. The results of this study are shown in Table 7.

Table 7. Allanburg Transformers Thermal Loadings

Transformer (cont., 15 min LTR)	2003 System Loads (Norfolk Load Connected to Allanburg) Power Flow (MVA)				2010 System Loads (Norfolk Load Transferred to Caledonia) Power Flow (MVA)			
	Pre-cont. Flow	T2	Q26A & Q28A (T1 & T2)	Q30M & Q32A (T3 & T4)	Pre-cont. Flow	T2	Q26A & Q28A (T1 & T2)	Q30M & Q32A (T3 & T4)
Allanburg T1 (225, 302 MVA)	201 89%	265	-	**377 125%**	204	272	-	**357.5 118%**
Allanburg T4 (250, 415 MVA)	186	253	388	-	189	253	365	-
Allanburg T2 (250, 415 MVA)	203	-	-	379 91%	206	-	-	358.5 86.4%
Allanburg T3 (250, 415 MVA)	167	234	369	-	171	234	352	-

The results of the study and system operating experience indicate that the main concern at Allanburg TS is the overloading of T1, which has the lowest limited time rating.

Past system operating experience indicates that during summer month high flows on the 230 kV circuit Q30M towards Middleport could cause power circulation through the Allanburg autotransformers *causing the overloading of T1 over its continuous rating*.

The results of the analysis show that for peak load conditions post-contingency loading of *T1 will be over its 15 minute LTR following the loss of the double circuit 230 kV line Q30M and Q32A*. Because the flow over Allanburg autotransformers is directly dependent on the area dispatched generation, the same situation could occur for off peak load conditions when the Decew GS or Beck No1 generation is reduced and the Allanburg area load is being supplied mainly over the Allanburg autotransformers. In this case re-dispatching the hydraulic generation could correct the post-contingency problem. In the open market this can only be achieved by constraining on Decew or Beck No.1, at a cost which is to be shared by all consumers.

The current operating practices require that in order to maintain the pre-contingency voltages in the Allanburg 115 kV area when Decew GS units are unavailable, a minimum number of Beck units be connected to the Beck E bus. The number of required units depends on the amount of load in the Allanburg area. In this situation the loss of the Beck E-bus *could result in the overloading of Allanburg T1*.

To alleviate the concerns associated the overloading of T1, the present operating practices require that the Allanburg area load be reduced by transferring the Beamsville TS and Vineland DS loads to Beach TS and/or re-dispatching the internal generation. However, as identified in section 5.3.1 this measure could be continued past year 2004 only if Beamsville TS and Vineland DS loads are to be limited to the stations' 10 day LTR, thus avoiding the overloading of the Q2AH line section from Beach TS.

The loss of the double circuit 230 kV line Q30M and Q32A will not result in the disconnection of other transmission elements that are connected to the Allanburg 115 kV switchyard. But, a contingency involving the double circuit 230 kV line Q26A and Q28A (T1 &T2) will result, due to the configuration of Allanburg TS, in:

- A7C radially connected to A36N
- A6C radially connected to D1A, and
- The loss of D3A

Recently, Hydro One Networks Inc. received approval to transfer Norfolk TS load from Allanburg TS to Caledonia TS and de-energize A8N and A11N circuits. The connection of Norfolk TS to Caledonia TS is planned for Q4 2003. This will result in a reduction of the Allanburg area peak load by about 85 MVA. Additionally, the limitation of Beamsville TS and Vineland DS loads will result in a reduction of the total area load by about 19 MW .

Assuming comparable generation dispatch conditions, the load reduction will translate directly in a decrease in the power flowing over the Allanburg transformers thus alleviating some of the concerns related to the overloading of these transformers in the near future.

4.0 Voltage Assessment

Current operating practices require that voltage on the 115 kV bus side at Allanburg TS, Beck No.1 GS and Decew Fall GS be maintained between 120 kV and 124 kV, in order to maintain the Allanburg area customer voltages at acceptable levels.

The study scenario that was selected for this assessment respects these voltage limits during pre-contingency system conditions. The area load was modelled as real power proportional to $V^{1.5}$ and reactive power proportional to V^2 in the post-contingency situation. Voltage studies were performed for year 2003 and 2010.

As identified above a contingency involving the double circuit 230 kV line Q26A and Q28A (T1 &T2) will result, due to the configuration of Allanburg TS, in A7C becoming radially connected to A36N, A6C being radially connected to D1A, and the loss of D3A. The post-contingency voltages at Crowland TS, which is connected to A6C and A7C could become excessively low.

The results of the study indicate that for peak load conditions with all transmission elements in service the pre-contingency voltages in the Allanburg 115 kV area are higher that the minimum 113 kV level required by the Market Rules. The immediate post fault voltages for 2003 and 2010 respect the 10% voltage decline criterion at all monitored 115 kV station with the exception of Crowland TS. However, after transformers' under load tap changers action the 115 kV voltages at Crowland TS could reach very low levels.

Table 8. Voltage Assessment

	Year 2003			Year 2010		
	Pre-contingency (kV) One Shunt Cap I/S @ Allanburg	Loss of Q26A & Q28A % Voltage		Pre-contingency (kV) Two Shunt Caps I/S @ Allanburg	Loss of Q26A & Q28A % Voltage	
		Immed.	Post ULTC		Immed.	Post ULTC
Beach TS	119.4	119.4	119.4	116	115.9	115.9
Winona TS	118.9	118.9 0%	118.8 0%	114.1	114.1 0%	114 0%
Allanburg TS	123.3	120.8 2%	116 6%	124.6	119.9 3.8%	114.2 8.3%
Beck No.1	121.4	114.3 5.8%	107 12%	123.2	114.8 6.8%	106.1 14%
Decew Falls	121.5	107.3 11.7%	98.0 19%	121.2	110.6 8.7%	99.47 18%
Glendale TS	117.9	107.6 8.7%	99.9 15%	119.7	109.9 6.8%	99.5 17%
Beamsville TS	114.3	110.9 3%	104.4 8.7	114.0	108.8 4.6%	102.8 9.8%
Vineland TS	115.4	112.0 3%	105.6 8.4%	115.5	110.2 4.6%	104.1 9.6%
Crowland TS	121.4	105.1 13.4%	95.5 21%	121.6	105.4 13.3%	93.5 23%

4.0 Conclusions –Allanburg Area Transmission Assessment

The examination of the Allanburg 115 kV area concluded that there are a number of concerns associated with the capability of the present system to supply the peak load in the area.

This assessment concluded that:

- The existing 115 kV circuits between Decew GS and Beck No1. GS, D10S. D9HS,Q11S and Q12S could become loaded over their 15 minute LTR for a contingency associated with a section of the companion circuit,
- The overloading of Allanburg T1 could occur in pre-contingency situations for high power flows on Q30M to Middleport, or after a contingency associated with the double circuit 230 kV line Q30M & Q32A or Beck No.1 E-bus.
- The pre-contingency voltages in the Allanburg 115 kV area are within the acceptable limits.
- The voltage decline at Crowland TS exceeds 10% for the loss of the double circuit 230 kV line Q26A & Q28A.

The planned transfer by 2004 of about 85 MW of load to Caledonia TS and the capping of the Beasmville TS and Vineland DS loads to the stations' capabilities appear to relieve the loading on the Allanburg autotransformers for the next six to seven years. As the load continues to grow however, it may be necessary that additional transmission solutions be sought by the transmitter to address concerns related to the Allanburg TS, especially the rating of T1 autotransformer.

One other concern is the heavy reliance on Beck No.1 generation for situations when the Allanburg area load exceeds 670 MW and the fact that this generation could be entirely lost following a contingency associated with the Beck No.1 E-bus.