



**IMO\_REP\_0036**

## **CONNECTION ASSESSMENT & APPROVAL PROCESS**

### **PRELIMINARY ASSESSMENT REPORT**

**APPLICANT:** *Hydro One Networks Inc.*

**PROJECT:** *Increase Capacity of Toronto Cecil TS*

**CAA ID No. 2001-038**

Long Term Forecasts & Assessments Department

Date: *November 26, 2001*

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# **PRELIMINARY ASSESSMENT REPORT**

## **HYDRO ONE NETWORKS INC. INCREASE CAPACITY OF TORONTO CECIL TS**

### **Disclaimer**

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. In particular, this report does not address any other Market-related, or any commercial, aspects of the connection proposal. This report has been prepared solely for use by the Connection Applicant 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. The IMO may revise this report at any time, in its sole discretion, without notice to the Applicant. Although the IMO will use its best efforts to advise you of any such changes, it is the responsibility of the Connection Applicant to ensure that it is using the most recent version of this report.

# **PRELIMINARY ASSESSMENT REPORT**

## **HYDRO ONE NETWORKS INC. INCREASE CAPACITY OF TORONTO CECIL TS**

### **1.0 PROPOSAL**

Toronto Cecil TS is an existing 115-13.8 kV TS in downtown Toronto consisting of two DESN stations (T1/T2 and T3/T4). All of the stations' transformers are rated 45/60/75 MVA. With one transformer out-of-service at each of the DESN units, the combined summer capacity (10-day LTR) is 186 MVA.

Toronto Hydro – Electric System Limited (THES) is planning to provide load relief to Terauley TS, John/Windsor TS and Esplanade TS by transferring approximately 40 MVA of load to Cecil TS in 2004. The breakdown of this load transfer is as follows: 16 MVA from John/Windsor TS, 15 MVA from Terauley TS and 8MVA from Esplanade TS.

To carry out the above mentioned load transfers to Cecil TS, THES needs to uprate the 13.8 kV A5-A6 bus associated with the T3/T4 DESN at Cecil TS (see Figure 2). The companion A7-A8 bus associated with the T3/T4 DESN has already been uprated and is considered adequate. To enable this work to be done, THES has requested that Hydro One increase the capacity of the T3/T4 DESN prior to undertaking the uprating of the bus. It is, therefore, proposed to carry out the Hydro One work at Cecil TS in two stages:

- (1) Replace the existing 45/60/75 MVA transformers T3 and T4 with 60/80/100 MVA units. This work must be completed before the THES bus uprating work can begin. The target in-service date for the replacement of the transformers is December 2002.
- (2) While the A5-A6 bus is out-of service for uprating by THES, replace the existing two 2000A, 13.8 kV, T3/T4 transformer breakers connected to the A5-A6 bus, with 3000A breakers. The estimated in-service date for the breaker replacement is December 2003.

The above work will result in a summer capacity (10-day LTR) increase at Cecil TS of about 50 MVA from 186 MVA to 236 MVA.

## **2.0 LOAD FORECAST**

The City of Toronto is supplied at 13.8 kV and 27.6 kV via 34 transformer stations; 17 of which are supplied at 115 kV and 17 at 230 kV. The 115 kV stations are supplied from two major sources; Leaside 230-115 kV TS from the east and Manby 230-115 kV TS from the west. The 230 kV stations are supplied from 230 kV circuits in the following major corridors: Cherrywood TS x Leaside TS, Cherrywood TS x Richview TS, Richview TS x Manby TS and Richview TS x Claireville TS.

The forecast summer peak loads of the transformer stations supplying Toronto are shown in Table 1. These are based on THES load forecasts submitted by Hydro One.

As shown in Table 1, the 2002 summer peak load at Cecil TS is forecast to be 156 MVA and is expected to reach 192 MVA or 6 MVA above the present LTR of the station by the summer of 2004. This includes the proposed load transfers. From 2004 to 2010, the Cecil TS peak load is expected to grow at an average annual rate of about 2.4%.

The sum of the forecast 2002 summer peak loads of the twelve 115 kV stations supplied from Leaside TS is 1439 MVA. This is expected to grow by about 110 MVA to 1548 MVA in 2004. This includes the 16 MVA of load transferred from John/Windsor TS to Cecil TS. From 2004 – 2010, the load is expected to grow at an average annual rate of about 1.6%.

## **3.0 REVIEW OF CONNECTION ARRANGEMENT**

### **3.1 High Voltage Isolation**

Based on information provided by Hydro One, each of the proposed new 60/100 MVA T3 and T4 transformers will be connected to the 115 kV bus at Cecil TS via motor-operated 115 kV disconnect switches. This is acceptable as long the requirements listed in the Transmission System Code for this type of connection are satisfied.

### **3.2 Voltage Reduction**

The proposed updated T3/T4 DESN station at Cecil TS is to be equipped with facilities that would allow a 3% and a 5% voltage reduction to be initiated remotely.

### **3.3 Under-Frequency Load Shedding**

The proposed updated T3/T4 DESN at Cecil TS is to be equipped with an automatic underfrequency load shedding system capable of rejecting up to 35% of the load supplied.

### **3.4 Power Factor**

Market rules require that wholesale customers and distributors connected to the IMO-controlled grid shall operate at a power factor within the range of 90% lagging to 90% leading as measured at the *defined meter point*. In this case, the distributor (THES) will be required to take corrective action if the power factor is outside the specified range.

### **3.5 Telemetry**

In order to permit the IMO to direct the operations of the IMO-controlled grid, wholesale customers and distributors connected to the IMO-controlled grid shall provide the IMO with data in accordance with Chapter 4, Section 7.5 of the Market Rules.

## **4.0 IMPACT ASSESSMENT**

### **4.1 Impact On Reliability**

The proposed uprating/modifications at Cecil TS should have no detrimental impact on existing levels of supply reliability.

### **4.2 Impact on Short Circuit Adequacy and LV Thermal Capability**

Based on information provided by Hydro One Networks, the neutral reactors on the 13.8 kV windings supplying the A5-A6 bus will be decreased from 7.5 ohms to 0.7 ohms. The new 300 Ampere breakers that Hydro One is proposing to install and the uprated A5-A6 bus that is to be installed by THES, are to be suitable for the higher short circuit levels that would result from this change.

### **4.3 Capacitor Switching**

Market Rules require that voltage changes shall not normally exceed 4% of steady state rms voltage for capacitor switching operations. Our studies show that, in order to keep the voltage changes below 4%, the maximum size of any future capacitor bank that could be installed on the LV bus at Cecil TS would be limited to approximately 9 Mvar, at a station load level of 214 MVA.

#### **4.4 Load Meeting Capability**

Cecil TS is normally supplied via 4x115 kV circuits emanating from Leaside. There is also a normally open connection to circuits H5E/H7E out of Hearn GS. The existing supply configuration is shown in Figure 1.

The proposed uprating of Cecil TS and the transfer of 16 MVA of load from Windsor/John TS to Cecil TS will result in a minimal increase in the loading of the 230 KV circuits out of Cherrywood TS, the Leaside TS autotransformers and the 115 kV circuits L9C/L12C and H6LC and H8LC out of Leaside TS. This small increase in loading is not expected to have any significant impact on the load meeting capability of the IMO-controlled grid.

#### **5.0 REQUIREMENTS FOR CONNECTION**

Based on the above analysis, it is concluded that the proposed upgrade of Cecil TS and load transfers will not have any significant adverse system impacts. The project may, therefore, proceed subject to meeting the requirements identified in Sections 3.0 and 4.0 as well as all other applicable market rules and regulatory requirements. Information on Market Entry can be found at the following IMO website. <http://www.theimo.com/imoweb/marketEntry/me.asp>

#### **6.0 SYSTEM IMPACT ASSESSMENT**

Based on the results of this Preliminary Assessment, it is concluded that no further analysis is required for the proposed load transfers and uprating/modifications at Cecil TS. It is, therefore, recommended that the System Impact Assessment for this work be foregone.

#### **7.0 CUSTOMER IMPACT ASSESSMENT**

Hydro One Networks has reviewed the effect of the proposed new facilities on the customers in the area and determined that there will be no adverse impact. It has, therefore, been agreed that a formal Customer Impact Assessment is not required for this Project.

#### **8.0 NOTIFICATION OF APPROVAL OF THE CONNECTION PROPOSAL**

Since a Customer Impact Assessment is not required, then, based on the results of this Assessment, it is recommended that the Applicant should receive a “Notification of Approval of the Connection Proposal” for this project. The Applicant is required to obtain the necessary approvals as may be required by the OEB and other regulatory authorities.

## **9.0 RELATED ISSUES**

### **LOAD MEETING CAPABILITY OF THE CHERRYWOOD TS SUPPLY TO TORONTO**

#### **9.1 Thermal Capability**

The existing six 230 kV circuits from Cherrywood TS to Leaside TS currently supply a peak load of approximately 2200 MW or about 45% of the total city of Toronto load. This load is supplied from the five 230-27.6 kV DESN stations connected to these circuits as well as the Leaside 230-27.6/13.8 kV TS and the twelve 115-13.8 kV DESN stations supplied from the 115 kV circuits out of Leaside TS. The individual stations and associated loads are listed in Table 1.

The 115 kV system out of Leaside TS is supplied from the six 230 kV Cherrywood to Leaside circuits via six 230-115 kV autotransformers at Leaside TS.

The supply facilities considered in this Assessment are listed below:

- Cherrywood TS x Leaside TS 230 kV Circuits C2L, C3L, C14L, C15L, C16L and C17L
- Leaside TS x Charles TS 115 kV Circuits L4C, L9C and L12C
- Charles TS x Cecil TS 115 kV Circuits L9C and L12C
- Leaside TS x Cecil TS x Hearn GS 115 kV Circuits H6LC and H8LC
- Leaside TS x Hearn GS 115 kV Circuits H1L, H3L, H7L, H11L
- Leaside TS 230-115 kV Autotransformers

##### **9.1.1 Assumptions**

- The transformer station loads shown in Table 1 were used in the assessments.
- The adequacy of the 230 kV and 115 kV transmission system has been assessed for single circuit contingencies as well as double-circuit (same tower) contingencies.
- For the purpose of this assessment, it has been assumed that all of the 230kV circuits, with the exception of circuit C3L, can be operated at their “sag” temperature of 127<sup>0</sup>C for up to 50 hours per year.

It has also been assumed that the following responses would occur in response to double- and single-circuit contingencies:

- For a double-circuit contingency, if the post-contingency flows on the remaining 230kV circuits remain within the 50-hour rating, action would be taken to restore at least one of the faulted circuits within the 50-hour period.

Once one of the faulted circuits has been returned to service, the flows on all the 230kV circuits would need to be maintained within their continuous rating for a 93<sup>o</sup>C operating temperature. It may be necessary to have the capability to transfer loads to alternative supply sources to comply with this requirement.

Should the post-contingency flows exceed the 50-hour rating but remain within the 15-minute LTR rating, then it would be necessary to be able to transfer loads to alternative sources, to respect the 50-hour rating in less than 15 minutes.

- For a single-circuit contingency, the expected response would be similar. This would allow the 50-hour rating to be utilized while repairs are made to the faulted circuit, if sufficient load cannot be transferred to alternative supply sources, to reduce the flows on the remaining 230kV circuits to within their continuous rating for a 93<sup>o</sup>C operating temperature.

Since the maximum operating temperature for circuit C3L is limited to 93<sup>o</sup>C, this circuit can only be operated at its continuous rating or its 15-minute LTR rating, based on 93<sup>o</sup>C.

- The 115 kV C5E/C7E circuit breakers at Esplanade TS were assumed open.
- The 115 kV bus tie breakers at Leaside TS were assumed open and those at Hearn GS were closed.
- The adequacy of the Leaside TS autotransformers has been assessed for single-element as well as double-element contingencies based on the following:
  - Pre-contingency flows must be less than continuous ratings
  - Post-contingency flows must be less than the 10-day LTR ratings for single-element contingencies
  - Post-contingency flows must be less than 2-hour LTR ratings for double-element contingencies. In this case the assumption is that one of the outaged autotransformers will be returned to service within 2 hours.
- For the purpose of this Assessment, the supply availability levels, with respect to double circuit contingencies have been assessed in accordance with the following criteria:
  - For affected loads totalling less than 250 MW, restoration is to be completed within 8 hours.
  - For affected loads totalling more than 250 MW but less than 500 MW, restoration is to be possible by switching within 30 minutes.
  - For affected loads totalling more than 500 MW, no interruption in supply is to occur.

## **9.1.2 Cherrywood TS x Leaside TS 230 kV Circuits & Autotransformers**

Table 2 shows the loading on the 230 kV transmission system elements, under various 230 kV single and double-element contingency conditions. Note that for contingencies involving each Cherrywood TS to Leaside TS circuit, the associated 230-115 kV autotransformer at Leaside TS is also lost by configuration. The results are summarized in the following Sections 9.1.2.1 to 9.1.2.3.

### **9.1.2.1 Pre-contingency Analysis**

- The pre-contingency loading on the Leaside TS autotransformers T11, T14, T15, T16 and T17 marginally exceeds the continuous rating of the autotransformers in 2008-2010.

### **9.1.2.2 Single-Element Contingencies**

- The post-contingency loading on 230 kV circuit C3L exceeds its continuous rating and 15-minute LTR rating following the loss of its companion circuit in 2004 and beyond.
- The post-contingency loading on the Leaside TS autotransformers T11, T14, T15, T16 and T17 exceeds the 10-day LTR of the autotransformers upon the loss of the companion autotransformer in 2007-2009 and beyond. However, the loading is within the 2-hour LTR rating of the transformers.

### **9.1.2.3 Double-Element Contingencies**

- The post-contingency loading on the 230 kV circuits C14L, and C15L exceeds both their continuous rating and 50-hour emergency rating, but is within their 15-minute LTR rating following the loss of the critical double circuit elements indicated in Table 2 for 2004 and beyond. For the same contingencies, the post-contingency loading on circuit C3L exceeds its 15-minute LTR rating.
- The post-contingency loading on the 230 kV circuits C2L, C16L, and C17L exceeds the 50-hour emergency rating of the circuits following the loss of the critical double circuit elements indicated in Table 2 for during 2009-2010. However, the loading is within the 15-min LTR rating of the circuits.
- The post-contingency loading on the Leaside TS autotransformer T15 exceeds the 2-hour LTR rating of the transformer following the loss of the critical double circuit elements indicated in Table 2 for 2008 and beyond.

### **9.1.3 115 kV Transmission Facilities**

Table 3 shows the loading on the 115 kV transmission system elements, under various 115 kV single-element and double-element contingency conditions. The results are summarized in the following Sections 9.1.3.1 and 9.1.3.2.

#### **9.1.3.1 Single-Element Contingencies**

- The post-contingency flows on each of the 115 kV circuits C5E and C7E will exceed their continuous rating, following the loss of the companion circuit, in 2004 and beyond.
- Sections of circuits L9C and L12C will become marginally overloaded following the critical single-element contingencies shown in Table 3 for the years 2009-2010.

It is noted that the proposed 15 MVA transfer from Terauley TS to Cecil TS will provide some relief to circuits C5E and C7E; however, further remedial measures will be required to bring the post-contingency loading on these circuits below their continuous rating.

#### **Possible Remedial Measure**

Hydro One is investigating a plan to reduce the loading on C5E/C7E by splitting the load at Terauley TS so that part of the load is supplied from the 115 kV bus at Cecil TS via the C5E/C7E circuits and part of the load via 115 kV circuits H5E/H7E out of Hearn GS. This work is expected to be the subject of a separate CAA application to be submitted by Hydro One Networks Inc.

#### **9.1.3.2 Double-Element Contingencies**

- The post-contingency loading of 115 kV circuits L9C and L12C exceeds the continuous rating of the circuits following the loss of 115 kV circuits H6LC and H8LC in 2004 and beyond.
- The post-contingency loading of 115 kV circuits H6LC and H9LC ( Gerrard Jct x Cecil TS) exceeds the continuous rating of the circuits following the loss of 115 kV circuits L9C and L12C in 2004 and beyond.
- The post-contingency loading of 115 kV circuits H7L and H11L ( Lumsden Jct x Main TS) exceeds the continuous rating of the circuits following the loss of 115 kV circuits L9C and L12C in 2007 and beyond.

## 9.2 System Availability

Using the criteria defined in 9.1.1, the impact of double circuit contingencies on the availability of supply was assessed. The results are described below and in Table 4.

### 9.2.1 Availability Analysis for 230 kV System

From Table 4, the total load affected by the double circuit 230 kV contingencies considered exceeds 2000 MW. This is the load that is normally supplied by the outaged circuits plus the load that is supplied by circuits that are overloaded as a result of the contingency.

Since the load affected by the contingencies considered is greater than 500 MW, a continuous supply is required to meet the supply availability criteria. Corrective measures would therefore be required to meet this criterion. Some possible measures include:

- Increasing the maximum conductor operating temperature for circuit C3L from 93°C to 127°C to match that of its companion 230 kV circuits.
- Increasing the 230 kV transmission capacity in the Cherrywood TS x Leaside TS corridor and the 230-115 kV autotransformer capacity at Leaside TS to avoid the post-contingency line and autotransformer overloads following double line contingencies.
- For 230 kV double circuit contingencies, immediate action would be required to reduce the post-contingency flows to below their 50-hour rating. It is then expected that one circuit would be returned to service within this 50-hour period. At that time, the system conditions would correspond to a single-circuit contingency and, as shown in the upper section of Table 2, the post-contingency flows would still be expected to exceed the *continuous* rating of all the remaining circuits. This would require the capability to transfer substantial amounts of load to alternative sources without any interruption in the supply (and without creating further problems in those parts of the system to which the load is transferred) OR the resources to ensure that *both* 230 kV circuits can be returned to service in under 50 hours.

The feasibility of these measures would have to be determined by Hydro One Networks. Other options may also be considered by Hydro One Networks Inc.

### 9.2.2 Availability Analysis for 115 kV System

From table 4, the total load affected by the double circuit 115 kV contingencies considered ranges from 68 MW to 385 MW in 2004 depending on the outage. This increases to a range of 73-439 MW in 2010.

For load levels below 500 MW, the supply availability criteria calls for restoration by switching within 30 minutes (for loads from 250-500 MW), and 8 hours (for loads less than 250 MW). Since all of the affected load can be restored by switching, the availability criterion for this group of loads would be met.

## **9.3 Transmission System Voltages**

### **9.3.1 Abrupt Voltage Changes**

Market Rules require that voltage changes shall not normally exceed 10% of steady state rms voltage for line switching operations. Our studies show that for double circuit 230 kV contingencies, the voltage change at the Leaside 115 kV bus exceeds 10%. This does not meet the Market Rule requirement for abrupt voltage changes. Therefore, corrective measures are required to keep abrupt voltage changes below 10%.

### **9.3.2 Steady State Voltages**

System Control Order (SCO) L-0311 requires the pre-contingency voltage at Leaside TS to be maintained above a minimum value of 119 kV. Table 5 shows the pre-contingency voltage at the Leaside TS 115 kV bus from 2004-2010. As shown in Table 5, the voltage ranges from 118.7-115.9 kV. Thus, it will not be possible to comply with the above SCO requirement with the facilities that are currently available. Therefore, corrective measures will be required to maintain the pre-contingency voltage at Leaside TS above 119 kV.

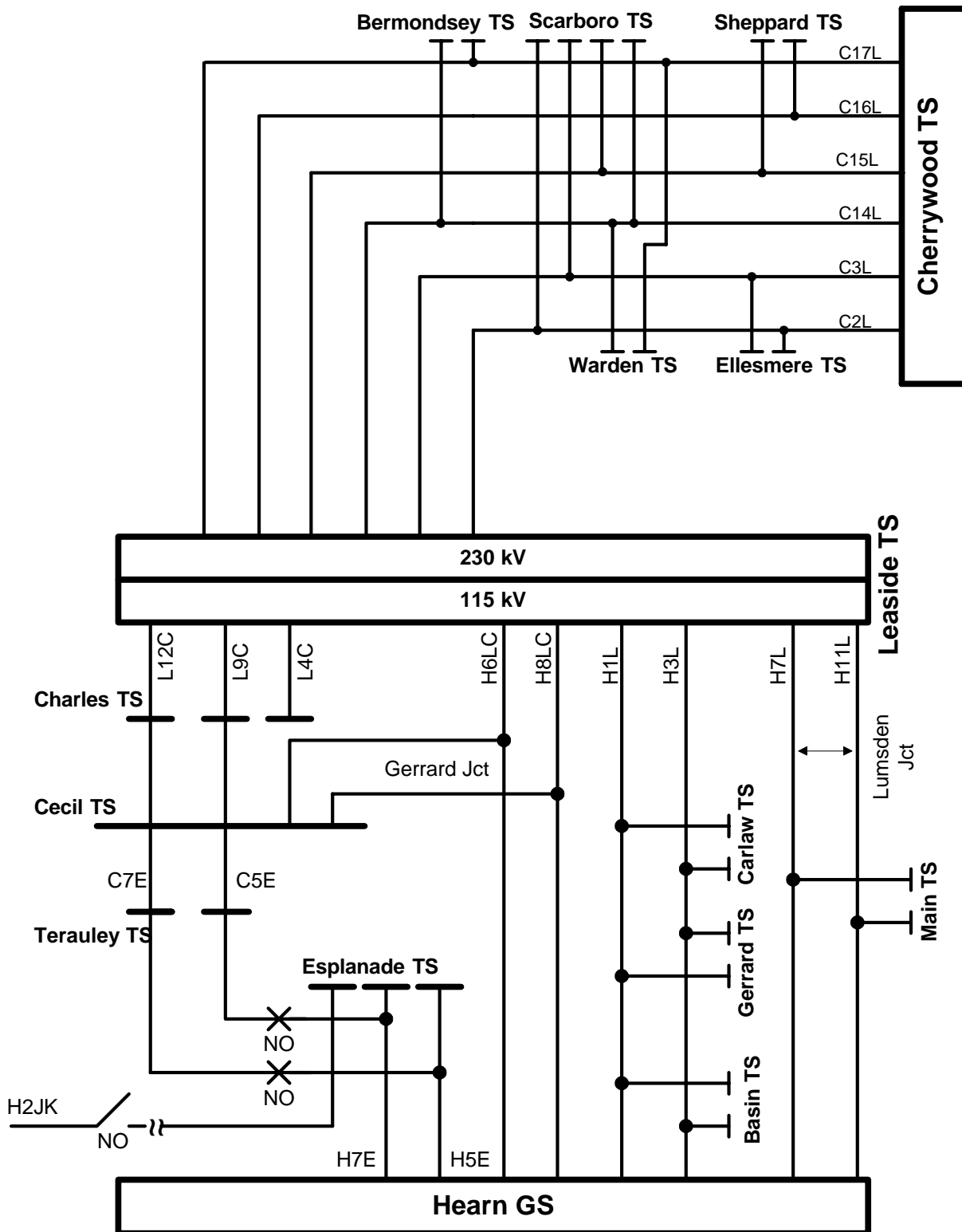
Figure 3 shows the actual measured voltage at the Leaside TS 115 kV bus during the year 2000. As shown, the voltage at Leaside TS varied from about 121.5 kV to 127 kV but was mostly in the 124-126 kV range. During the summer peak in 2000, the Leaside TS voltage was about 121.5 kV. During the summer 2001 peak on August 8, 2001, the Leaside TS voltage was about 122 kV. However, on that day, Dufferin TS and Bridgman TS had been transferred from the Leaside TS supply to the Manby TS supply because of 500-230 kV autotransformer loading problems at Cherrywood TS.

As indicated above, the simulated Leaside TS voltage for the period 2004-2010 is in the range of 118.7 kV to 115.9 kV. The reduction in voltage from actual 2000/2001 levels to the simulated 2004-2010 levels is mainly due to the effect of higher loads on an already heavily loaded system. This includes higher loading on the 115 kV stations as well as the 230 kV stations connected to the Cherrywood TS x Leaside TS 230 kV circuits. It is noted that for the simulations, the voltage at Cherrywood TS was about 240 kV. Possible measures that can raise this voltage would improve the Leaside TS voltage.

The voltage at the Cecil TS 115 kV bus is expected to be approximately 1.5 kV below the level at Leaside TS. Future voltage levels may vary depending on load and system developments.

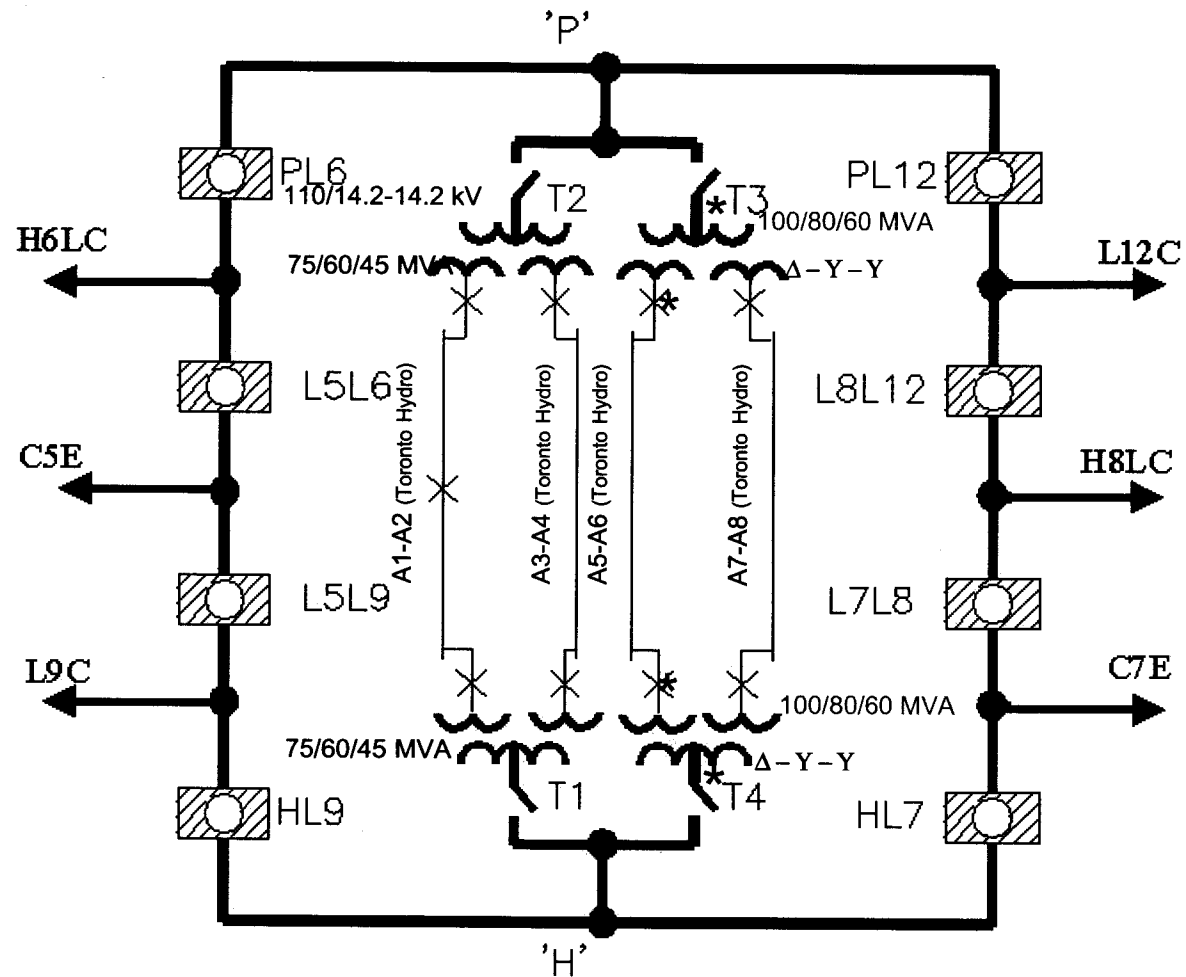
## **9.4 Conclusion**

It is expected that the deficiencies identified in Section 9.0 will be addressed through separate CAA applications by individual Market Participants. The appropriate criteria to be employed for the assessment of these proposals will be reviewed.



**FIGURE 1**

**TRANSMISSION SYSTEM IN THE VICINITY OF TORONTO CECIL TS**

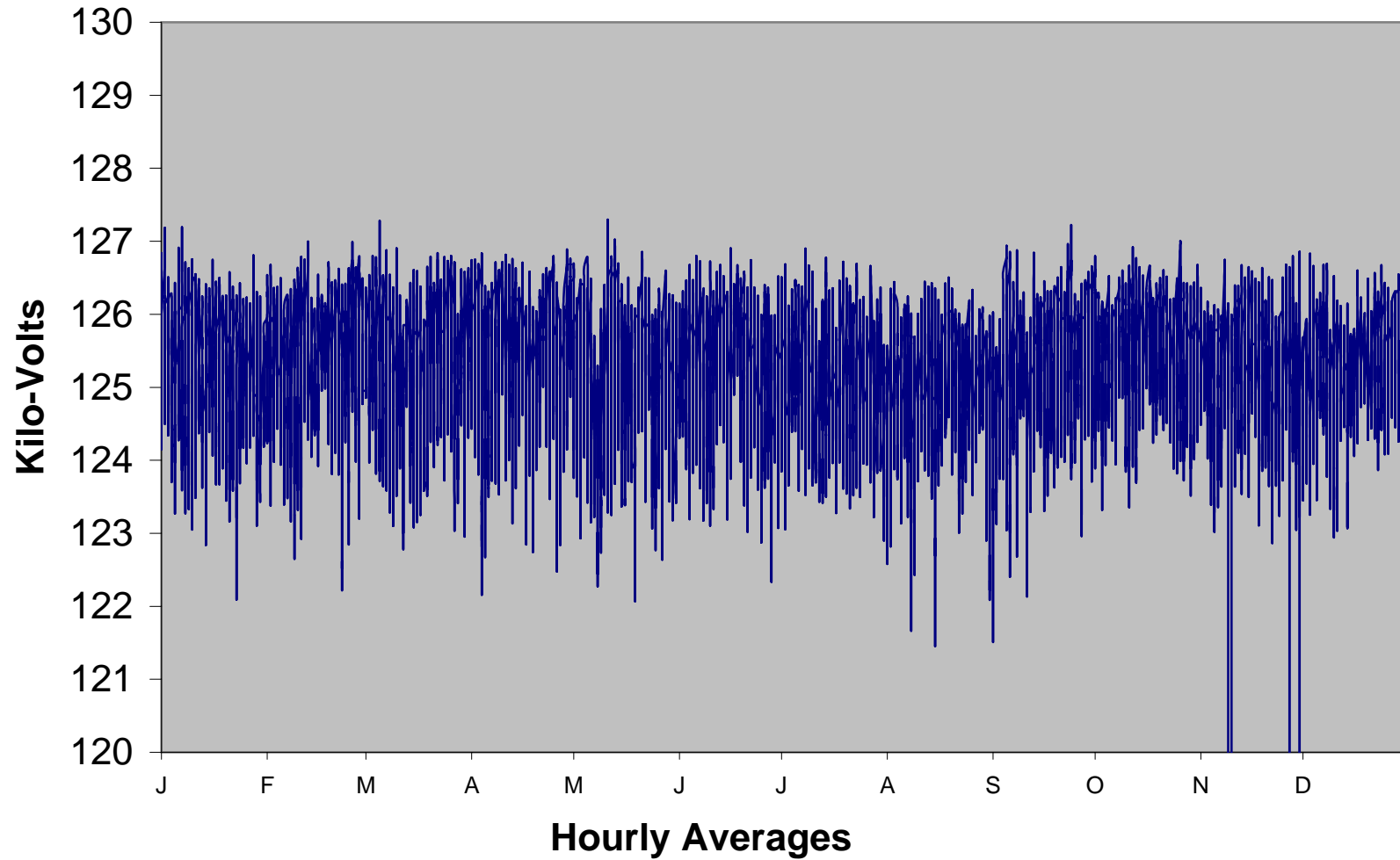


\* Equipment to be replaced as part of this project

**FIGURE 2**

**CECIL TS – PROPOSED REPLACEMENT OF T3 & T4 WITH LARGER UNITS**

**FIGURE 3**  
**Leaside TS 115 kV Voltage profile for the Year 2000**



**TABLE 1  
FORECAST LOADS AT TRANSFORMER STATIONS SUPPLYING  
THE CITY OF TORONTO**

| STATION  | SUMMER PEAK LOAD (MVA) (1) |              |              |              |              |              |              |              |              |
|--|----------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
|  | 2002                       | 2003         | 2004         | 2005         | 2006         | 2007         | 2008         | 2009         | 2010         |
| <b>115 kV Stations Supplied from Leaside TS</b>                            |                            |              |              |              |              |              |              |              |              |
| Basin TS   | 60                         | 65           | 81           | 87           | 92           | 94           | 94           | 95           | 97           |
| Bridgman TS  | 176                        | 178          | 182          | 183          | 187          | 190          | 193          | 196          | 198          |
| Carlaw TS  | 81                         | 78           | 79           | 79           | 80           | 81           | 81           | 83           | 83           |
| Cecil TS   | 156                        | 179          | 192          | 205          | 208          | 211          | 214          | 218          | 221          |
| Charles TS   | 144                        | 147          | 148          | 152          | 152          | 156          | 158          | 160          | 162          |
| Dufferin TS  | 131                        | 139          | 140          | 141          | 144          | 144          | 146          | 147          | 149          |
| Duplex TS  | 109                        | 110          | 112          | 113          | 113          | 115          | 116          | 118          | 118          |
| Esplanade TS   | 173                        | 183          | 183          | 190          | 193          | 196          | 196          | 200          | 203          |
| Gerrard TS   | 58                         | 60           | 62           | 62           | 64           | 64           | 64           | 66           | 66           |
| Glengrove TS   | 56                         | 56           | 57           | 57           | 58           | 59           | 59           | 59           | 61           |
| Main TS  | 75                         | 76           | 76           | 78           | 78           | 78           | 80           | 80           | 81           |
| Terauley TS  | 220                        | 228          | 236          | 235          | 242          | 246          | 256          | 261          | 267          |
| <b>TOTAL</b>   | <b>1,439</b>               | <b>1,499</b> | <b>1,548</b> | <b>1,582</b> | <b>1,611</b> | <b>1,634</b> | <b>1,657</b> | <b>1,683</b> | <b>1,706</b> |
| <b>115 kV Stations Supplied from Manby TS</b>                              |                            |              |              |              |              |              |              |              |              |
| Strachan TS  | 143                        | 159          | 189          | 211          | 226          | 241          | 257          | 266          | 270          |
| Fairbank TS  | 170                        | 173          | 165          | 167          | 176          | 178          | 180          | 184          | 186          |
| Runnymede TS   | 111                        | 113          | 115          | 116          | 113          | 115          | 117          | 118          | 120          |
| Wiltshire TS   | 90                         | 88           | 89           | 90           | 91           | 91           | 93           | 93           | 94           |
| Windsor TS   | 333                        | 332          | 337          | 345          | 350          | 359          | 366          | 375          | 382          |
| <b>230 kV Stations Supplied from Cherrywood TS x Leaside TS Circuits</b>   |                            |              |              |              |              |              |              |              |              |
| Bermondsey TS  | 197                        | 201          | 203          | 206          | 209          | 212          | 215          | 219          | 222          |
| Ellesmere TS   | 147                        | 149          | 151          | 153          | 156          | 158          | 160          | 163          | 165          |
| Leaside TS   | 135                        | 138          | 139          | 142          | 144          | 145          | 148          | 151          | 152          |
| Scarborough TS   | 289                        | 293          | 297          | 302          | 306          | 310          | 316          | 320          | 325          |
| Sheppard TS  | 161                        | 164          | 166          | 168          | 171          | 173          | 176          | 179          | 182          |
| Warden TS  | 118                        | 120          | 122          | 124          | 126          | 127          | 129          | 131          | 133          |
| <b>TOTAL</b>   | <b>1,047</b>               | <b>1,065</b> | <b>1,078</b> | <b>1,095</b> | <b>1,112</b> | <b>1,125</b> | <b>1,144</b> | <b>1,163</b> | <b>1,179</b> |
| <b>230 kV Stations Supplied from Cherrywood TS x Richview TS Circuits</b>  |                            |              |              |              |              |              |              |              |              |
| Fairchild TS   | 212                        | 216          | 218          | 222          | 231          | 234          | 237          | 241          | 244          |
| Finch TS   | 288                        | 293          | 302          | 306          | 312          | 316          | 323          | 328          | 332          |
| Leslie TS  | 269                        | 273          | 277          | 281          | 286          | 289          | 294          | 299          | 303          |
| Agincourt TS   | 105                        | 107          | 109          | 110          | 112          | 114          | 115          | 117          | 119          |
| Bathurst TS  | 255                        | 268          | 285          | 294          | 299          | 304          | 309          | 313          | 340          |
| Cavanagh TS  | 105                        | 107          | 108          | 110          | 112          | 113          | 115          | 117          | 118          |
| Malvern TS   | 93                         | 94           | 96           | 97           | 98           | 100          | 101          | 103          | 104          |
| <b>230 kV Stations Supplied from Richview TS x Manby TS Circuits</b>       |                            |              |              |              |              |              |              |              |              |
| Horner TS  | 165                        | 168          | 170          | 173          | 175          | 178          | 181          | 183          | 186          |
| Manby TS   | 240                        | 244          | 248          | 253          | 256          | 260          | 264          | 268          | 272          |
| <b>230 kV Stations Supplied from Richview TS x Claireville TS Circuits</b> |                            |              |              |              |              |              |              |              |              |
| Rexdale TS   | 144                        | 146          | 148          | 151          | 153          | 155          | 157          | 160          | 162          |
| Richview TS  | 305                        | 309          | 313          | 319          | 323          | 328          | 332          | 338          | 344          |

Note (1) : Based on Load Forecast submitted by Hydro One Networks

**TABLE 2**  
**LOAD MEETING CAPABILITY ANALYSIS**  
**230 KV CIRCUITS AND 230-115 KV AUTOTRANSFORMERS**

| MONITORED SYSTEM ELEMENT                       | CRITICAL CONTINGENCY | SUMMER RATINGS (Amperes) (1) | SUMMER PEAK LOADING (Amperes) (2) |      |      |      |          |          |          |
|--|----------------------|------------------------------|-----------------------------------|------|------|------|----------|----------|----------|
|  |                      |                              | 2004                              | 2005 | 2006 | 2007 | 2008     | 2009     | 2010     |
| <b>Single Element 230 kV Contingencies</b>     |                      |                              |                                   |      |      |      |          |          |          |
| C2L, Cherrywood TS x Ellesmere Jct             | C3L + T12            | 1350 / <b>1790</b> / 2376    | 1385                              | 1419 | 1455 | 1491 | 1528     | 1566     | 1605     |
| C3L, Cherrywood TS x Ellesmere Jct             | C2L + T11            | <b>1350</b> / - / 1640       | 1380                              | 1414 | 1448 | 1483 | 1519     | 1556     | 1594     |
| C14L, Cherrywood TS x Scarboro Jct             | C2L + T11            | 1350 / <b>1790</b> / 2376    | 1380                              | 1414 | 1448 | 1483 | 1519     | 1556     | 1594     |
| C15L, Cherrywood TS x Sheppard TS              | C16L + T16           | 1350 / <b>1790</b> / 2376    | 1455                              | 1495 | 1536 | 1579 | 1622     | 1667     | 1713     |
| C16L, Cherrywood TS x Sheppard TS              | C15L + T15           | 1350 / <b>1790</b> / 2376    | 1390                              | 1428 | 1468 | 1508 | 1550     | 1593     | 1637     |
| C17L, Cherrywood TS x Warden TS                | C14L + T14           | 1350 / <b>1790</b> / 2376    | 1220                              | 1257 | 1295 | 1334 | 1374     | 1415     | 1458     |
| Leaside Autotransformer T11                    | C15L + T15           | 1342 / <b>1640</b> / 2390    | 1533                              | 1580 | 1629 | 1680 | 1732 (3) | 1786     | 1841     |
| Leaside Autotransformer T12                    | C17L + T17           | 1518 / <b>1826</b> / 2390    | 1478                              | 1523 | 1569 | 1617 | 1666     | 1717     | 1769     |
| Leaside Autotransformer T14                    | C16L + T16           | 1342 / <b>1665</b> / 2390    | 1503                              | 1548 | 1594 | 1642 | 1691     | 1742 (3) | 1794     |
| Leaside Autotransformer T15                    | C2L + T11            | 1376 / <b>1670</b> / 2296    | 1518                              | 1564 | 1612 | 1661 | 1712     | 1764     | 1818 (3) |
| Leaside Autotransformer T16                    | C14L + T14           | 1342 / <b>1665</b> / 2390    | 1448                              | 1491 | 1536 | 1582 | 1630     | 1679     | 1729 (3) |
| Leaside Autotransformer T17                    | C3L + T12            | 1376 / <b>1670</b> / 2296    | 1503                              | 1548 | 1594 | 1642 | 1691     | 1742     | 1794 (3) |
| <b>Double Element 230 kV Contingencies (4)</b> |                      |                              |                                   |      |      |      |          |          |          |
| C2L, Cherrywood TS x Ellesmere Jct             | C14L+C15L, T14+T15   | 1350 / <b>1790</b> / 2376    | 1636                              | 1671 | 1707 | 1744 | 1782     | 1820     | 1860     |
| C3L, Cherrywood TS x Ellesmere Jct             | C14L+C15L, T14+T15   | <b>1350</b> / - / 1640       | 1665                              | 1701 | 1738 | 1776 | 1814     | 1853     | 1893     |
| C14L, Cherrywood TS x Scarboro Jct             | C2L+C3L, T11+T12     | 1350 / <b>1790</b> / 2376    | 1885                              | 1920 | 1956 | 1993 | 2030     | 2068     | 2107     |
| C15L, Cherrywood TS x Sheppard TS              | C16L+C17L, T16+T17   | 1350 / <b>1790</b> / 2376    | 2006                              | 2038 | 2069 | 2102 | 2135     | 2169     | 2203     |
| C16L, Cherrywood TS x Sheppard TS              | C14L+C15L, T14+T15   | 1350 / <b>1790</b> / 2376    | 1586                              | 1623 | 1661 | 1700 | 1740     | 1781     | 1823     |
| C17L, Cherrywood TS x Warden TS                | C14L+C15L, T14+T15   | 1350 / <b>1790</b> / 2376    | 1622                              | 1660 | 1699 | 1739 | 1780     | 1822     | 1865     |
| Leaside Autotransformer T14                    | C2L+C3L, T11+T12     | 1342 / 1665 / <b>2390</b>    | 2049                              | 2093 | 2138 | 2183 | 2230     | 2278     | 2326     |
| Leaside Autotransformer T15                    | C16L+C17L, T16+T17   | 1376 / 1670 / <b>2296</b>    | 2160                              | 2197 | 2235 | 2273 | 2312     | 2352     | 2392     |
| Leaside Autotransformer T16                    | C14L+C15L, T14+T15   | 1342 / 1665 / <b>2390</b>    | 2094                              | 2135 | 2177 | 2220 | 2264     | 2309     | 2354     |

**NOTES**

- (1) Line ratings are for **(continuous / 50hr / 15min)** based on 35°C ambient, 4 km/hr wind, and sunny conditions. The continuous ratings are based on a conductor operating temperature of 93°C. The 50hr ratings are based on a conductor operating temperature corresponding to the clearance rating limit of the circuits (see Section 8.1.1). This limit is 93°C for C3L and 127°C for the other circuits. The 15min ratings are based on a conductor operating temperature corresponding to the clearance limit, assuming a preloading of 75% of the continuous rating. Transformer ratings are for **(continuous / 10day / 2hr)**.
- (2) Shaded areas indicate loading is above the critical (highlighted) ratings in the "SUMMER RATINGS" column
- (3) Precontingency flow marginally exceeds continuous rating (by 0.2 - 2%)
- (4) For double-circuit contingencies, it has been assumed that one of the faulted circuits would be returned to service within the 50 hour period for which the LTR rating is applicable and that one of the autotransformers would be returned to service within 2 hours (see Section 8.1.1)

**TABLE 3  
LOAD MEETING CAPABILITY ANALYSIS  
115 KV TRANSMISSION FACILITIES**

| MONITORED SYSTEM ELEMENT                   | CRITICAL CONTINGENCY | SUMMER RATINGS<br>(Amperes) (1) | SUMMER PEAK LOADING (Amperes) (2) |      |      |      |      |      |      |
|--|----------------------|---------------------------------|-----------------------------------|------|------|------|------|------|------|
|  |                      |                                 | 2004                              | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| <b>Single Element 115 kV Contingencies</b> |                      |                                 |                                   |      |      |      |      |      |      |
| L12C, Leaside TS x Charles TS              | H6LC or H8LC         |                                 |                                   |      |      |      |      |      |      |
| Overhead Section                           |                      | 1020 / 1230                     | 899                               | 926  | 954  | 983  | 1013 | 1044 | 1075 |
| Cable Section                              |                      | 900 / 1200                      | 899                               | 926  | 954  | 983  | 1013 | 1044 | 1075 |
| L12C, Charles TS x Cecil TS (Cable)        |                      | 750 / 920                       | 766                               | 791  | 817  | 844  | 872  | 901  | 930  |
| L9C, Leaside TS x Charles TS               | L12C                 |                                 |                                   |      |      |      |      |      |      |
| Overhead Section                           |                      | 1020 / 1230                     | 859                               | 887  | 916  | 946  | 977  | 1009 | 1042 |
| Cable Section                              |                      | 900 / 1000                      | 859                               | 887  | 916  | 946  | 977  | 1009 | 1042 |
| L9C, Charles TS x Cecil TS (Cable)         |                      | 900 / 1000                      | 740                               | 768  | 798  | 828  | 860  | 893  | 927  |
| H6LC, Leaside TS x Gerrard Jct (Overhead)  | H8LC                 | 1090 / 1390                     | 673                               | 694  | 715  | 737  | 759  | 782  | 806  |
| H6LC, Gerrard Jct x Cecil TS (Cable)       |                      | 1020 / 1140                     | 786                               | 812  | 839  | 866  | 895  | 925  | 955  |
| H8LC, Leaside TS x Gerrard Jct (Overhead)  | H6LC                 | 1230 / 1560                     | 673                               | 694  | 715  | 737  | 759  | 782  | 806  |
| H8LC, Gerrard Jct x Cecil TS (Cable)       |                      | 1020 / 1140                     | 786                               | 812  | 839  | 866  | 895  | 925  | 955  |
| C5E, Cecil TS x Terauley TS (Cable)        | C7E                  | 1,040                           | 1344                              | 1400 | 1458 | 1518 | 1581 | 1647 | 1715 |
| C7E, Cecil TS x Terauley TS (Cable)        | C5E                  | 1070 / 1210                     | 1344                              | 1400 | 1458 | 1518 | 1581 | 1647 | 1715 |
| <b>Double Element 115 kV Contingency</b>   |                      |                                 |                                   |      |      |      |      |      |      |
| L9C, Leaside TS x Charles TS               | H6LC + H8LC          |                                 |                                   |      |      |      |      |      |      |
| Overhead Section                           |                      | 1020 / 1230                     | 1234                              | 1275 | 1317 | 1360 | 1405 | 1451 | 1499 |
| Cable Section                              |                      | 900 / 1000                      | 1234                              | 1275 | 1317 | 1360 | 1405 | 1451 | 1499 |
| L9C, Charles TS x Cecil TS (Cable)         |                      | 900 / 1000                      | 1066                              | 1105 | 1145 | 1187 | 1230 | 1275 | 1321 |
| L12C, Leaside TS x Charles TS              | H6LC + H8LC          |                                 |                                   |      |      |      |      |      |      |
| Overhead Section                           |                      | 1020 / 1230                     | 1308                              | 1351 | 1396 | 1442 | 1490 | 1539 | 1590 |
| Cable Section                              |                      | 900 / 1200                      | 1308                              | 1351 | 1396 | 1442 | 1490 | 1539 | 1590 |
| L12C, Charles TS x Cecil TS (Cable)        |                      | 750 / 920                       | 1186                              | 1226 | 1268 | 1311 | 1355 | 1401 | 1448 |
| H6LC, Gerrard Jct x Cecil TS (Cable)       | L9C + L12C           | 1020 / 1140                     | 1107                              | 1146 | 1186 | 1227 | 1270 | 1314 | 1360 |
| H8LC, Gerrard Jct x Cecil TS (Cable)       |                      | 1020 / 1140                     | 1107                              | 1146 | 1186 | 1227 | 1270 | 1314 | 1360 |
| H7L, Lumsden Jct x Main TS (Cable)         |                      | 540 / 620                       | 520                               | 527  | 534  | 541  | 548  | 555  | 563  |
| H11L, Lumsden Jct x Main TS (Cable)        |                      | 540 / 620                       | 520                               | 527  | 534  | 541  | 548  | 555  | 563  |
| All  |                      | H1L + H3L<br>H7L + H11L         | No Circuit Overloads              |      |      |      |      |      |      |

**NOTES**

- (1) Overhead Circuit ratings are for **(continuous / 15min / 5min)** based on 35°C ambient, 4 km/hr wind, and sunny conditions. Short time ratings are based on preloading of 75% of cont rating. Cable Circuit ratings are continuous ratings for **(companion I/S / companion O/S)**
- (2) Shaded areas indicate loading is above the continuous rating for lines and above the 10-day LTR for autotransformers.

## TABLE 4 SUPPLY AVAILABILITY ANALYSIS

| CRITICAL CONTINGENCIES                                     | CIRCUITS OVERLOADED<br>NOTE (2) | LOAD AFFECTED (MW) (NOTE 1)             |      |      |      |      |      |      |
|--|---------------------------------|---|------|------|------|------|------|------|
|  |                                 | 2004                                    | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| <b>230 KV TRANSMISSION CIRCUITS &amp; AUTOTRANSFORMERS</b> |                                 |   |      |      |      |      |      |      |
| C2L+C3L, T11+T12   | C14L, C15L, C17L                | *****GREATER THAN 2000 MW (NOTE 3)***** |      |      |      |      |      |      |
| C14L+C15L, T14+T15   | C2L, C3L, C16L, C17L            |   |      |      |      |      |      |      |
| C16L+C17L, T16+T17   | C3L, C14L, C15L                 |   |      |      |      |      |      |      |
| <b>115 KV TRANSMISSION CIRCUITS</b>                        |                                 |   |      |      |      |      |      |      |
| H6LC+H8LC  | L9C, L12C (NOTE 4)              | 385                                     | 396  | 405  | 411  | 423  | 431  | 439  |
| L9C + L12C   | H6LC, H8LC NOTE(5)              | 385                                     | 396  | 405  | 411  | 423  | 431  | 439  |
| H1L + H3L  | NOTE(6)                         | 200                                     | 205  | 212  | 215  | 215  | 220  | 221  |
| H7L + H11L   | NOTE(6)                         | 68                                      | 70   | 70   | 70   | 72   | 72   | 73   |

### NOTES

(1) The shaded areas indicate cases where the availability criteria specified in Section 8.1.1 are not met. In the 230 kV assessment, the affected load exceeds 500 MW, and no interruption of supply should occur. Hence, the availability criteria in Section 8.1.1 are not satisfied for the load affected by the 230 kV contingencies. In the 115 kV assessment, the load affected totals less than 500 MW and the supply can be restored by switching within the time frames indicated in Section 8.1.1. Hence, the availability criteria in Section 8.1.1 are satisfied for the load affected by the 115 kV contingencies.

(2) Based on circuit ratings and loading shown in Table 2, for each contingency.

(3) The load affected by each of the 230 kV contingencies considered includes all of the load supplied by the six Cherrywood TS x Leaside TS 230 kV circuits. This includes all of the 230 kV TS's connected to these circuits as well as the 115 kV stations supplied from Leaside TS. From Table 1, the total load on the 115 kV TSs in 2004 is 1548 MVA and the total load on the 230 kV TSs is 1078 MVA for a total load of 2626 MVA supplied from the Cherrywood TS x Leaside TS 230 kV circuits. Assuming a 0.9 power factor this works out to 2363 MW affected by the outage considered.

(4) An outage of the H6LC/H8LC circuits results in an overload of circuits L9C/L12C, Leaside TS x Cecil TS. Under these conditions, circuits L9C/L12C would be supplying Cecil TS and Terauley TS (Charles TS is supplied from L4C). Based on the loads shown in Table 1, the total forecast load on these stations in 2004 is 428 MVA or 385 MW (assuming 0.9 power factor) increasing to 439 MW in 2010. This is considered to be the load affected by an outage of the H6LC/H8LC circuits.

(5) An outage of the L9C/L12C circuits results in an overload of circuits H6LC/H8LC, Gerrard Jct x Cecil TS. Under these conditions, circuits H6LC/H8LC would be supplying Cecil TS and Terauley TS. Based on the loads shown in Table 1, the total forecast load affected by this outage is 385 MW (assuming 0.9 power factor) increasing to 439 MW in 2010.

(6) These contingencies result in loss of supply to the TSs normally supplied by the outaged circuits but do not result in overloads of other circuits. The affected load shown is the total load normally supplied by the outaged circuits.

**TABLE 5**  
**ASSESSMENT OF SYSTEM VOLTAGES**

| MONITORED ITEM                | LIMIT  | VOLTAGE LEVEL (kV) OR % CHANGE (1) |       |       |       |       |       |       |
|-------------------------------|--|------------------------------------|-------|-------|-------|-------|-------|-------|
|                               |  | 2004                               | 2005  | 2006  | 2007  | 2008  | 2009  | 2010  |
| <b>STEADY STATE VOLTAGE</b>   |  |                                    |       |       |       |       |       |       |
| LeasideTS 115 kV Bus (KV)     | Minimum 119 kV (as per System Control Order L-0311)                      | 118.7                              | 118.2 | 117.7 | 117.3 | 116.8 | 116.3 | 115.9 |
| <b>ABRUPT VOLTAGE CHANGES</b> |  |                                    |       |       |       |       |       |       |
| Capacitor Switching (2)       | Maximum 4% (as per Market Rule Requirements in Chapter 4, Appendix 4.4)  | Less than 4% (2)                   |       |       |       |       |       |       |
| Line Contingency (3)          | Maximum 10% (as per Market Rule Requirements in Chapter 4, Appendix 4.4) | Greater than 10% (4)               |       |       |       |       |       |       |

**NOTES**

- (1) Shaded cells indicate that the voltage criteria based on the limit shown is not met.
- (2) Based on switching 1x9 Mvar, 13.8 kV capacitor at Cecil TS. Voltage change is at Cecil TS 13.8 kV bus.
- (3) Based on double circuit contingency of Cherrywood x Leaside 230 kV circuits
- (4) Calculated voltage change at the Cecil TS 115 kV bus.