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# CONNECTION ASSESSMENT & APPROVAL PROCESS

## *ASSESSMENT SUMMARY*

*Applicant: Hydro One Networks Inc.*

*Project: Oshawa General Motors TS: New Transformer Station*

**CAA ID No. 2005-EX216**

***Long Term Forecasts & Assessments Department  
Consistent Information Set Department***

*Date: 9th March 2005*

## ASSESSMENT SUMMARY

### HYDRO ONE NETWORKS Inc.

#### *Oshawa General Motors TS*

##### **1. Introduction**

The General Motors assembly plant in Oshawa is presently supplied from an existing, customer-owned transformer station. This transformer station is equipped with two 84/140MVA 230/13.8/13.8kV step-down transformers.

General Motors has asked Hydro One to build a new TS to replace the existing facility. The new TS, which is to be built on Hydro One owned property adjacent to the existing TS, is to be equipped with two, similarly-rated 84/112/140MVA transformers.

Once the new TS is fully operational and all of the existing load has been transferred to it, the present facility is to be demolished. However, one of the transformers from this TS is to be transferred to Hydro One's Central Maintenance Store in Pickering for use as a spare.

General Motors is expecting the present peak load of approximately 82MW to increase gradually to a peak demand of 107MW.

The scheduled in-service date for the replacement TS is 31st March 2006, although the transfer of all of the existing load is not expected to be completed until 30th June 2006.

##### **2. Proposed Facilities**

Diagram 1 shows the existing supply arrangement for the TS from the 230kV circuits H24C & H26C. This will remain the same for the supply to the new TS.

Diagram 2 shows the configuration of the new TS, which includes two series-connected bus-tie disconnect switches so that, under outage conditions involving either circuit H24C or H26C, both transformers can be connected to the companion circuit.

In addition the new TS is to be equipped with four 7.2MVA shunt capacitor banks to replace the existing 4.6MVA units.

##### *Specification for the New Equipment*

- *Step-down Transformers*

|                                 |  |
|---------------------------------|--|
| Transformer ratings             | Two 84/112/140MVA, 230/13.8/13.8kV                                   |
| Transformer nominal turns ratio | 232kV : 13.8kV : 13.8kV  |
| Under-load tap-changer          | 15.75kV $\pm$ 20.3% in $\pm$ 16 steps in each LV winding             |
| Transformer connections         | HV Y - ungrounded with surge arrester protection<br>LV Delta - Delta |

|  |  |
|--|--|
| Insulation level                               | 950kV BIL on the HV phase windings<br>550kV BIL on the HV neutral<br>95kV BIL on the LV phase windings |
| Impedance                                      | 18.68% on 232kV - 13.8kV 42MVA   |
| • <i>13.8kV Grounding Transformers</i>         |  |
| Number of transformers                         | Four   |
| Rated voltage for the windings                 | 13.8kV   |
| Connection Arrangement                         | Zig-zag  |
| Continuous current rating                      | 30A  |
| Short time current rating                      | 600A for 10 seconds  |
| Impedance of winding                           | 0.44 + j5.36 ohms  |
| • <i>13.8kV Grounding Resistors</i>            |  |
| Number of resistors                            | Four   |
| Rated voltage of the resistors                 | 13.8kV   |
| Continuous current rating                      | 30A  |
| Short-time current rating                      | 600A for 10 seconds  |
| Resistance                                     | 13.33 ohms   |
| • <i>230kV Line Disconnect Switches</i>        |  |
| Type   | Motorised, gang operated with a manually-operated ground switch  |
| Rated voltage                                  | 230kV  |
| Maximum operating voltage                      | 250kV continuous   |
| Continuous current                             | 2000A rms  |
| Symmetrical short-circuit rating               | 63kA for 3 seconds   |
| Insulation level (minimum)                     | 1050kV BIL line-to-neutral<br>1300kV BIL across the open gap   |
| Operating Voltage                              | 125V dc  |
| • <i>230kV Transformer Disconnect Switches</i> |  |
| Type   | Motorised, gang operated with a manually-operated ground switch  |
| Rated voltage                                  | 230kV  |
| Maximum operating voltage                      | 250kV continuous   |
| Continuous current                             | 1200A rms  |
| Symmetrical short-circuit rating               | 63kA for 3 seconds   |
| Insulation level (minimum)                     | 900kV BIL line-to-neutral<br>1050kV BIL across the open gap  |
| Operating Voltage                              | 125V dc  |

- *230kV Bus-Tie Disconnect Switches*

|                                  |   |
|----------------------------------|---|
| Type                             | Motorised, gang operated                                    |
| Rated voltage                    | 230kV   |
| Maximum operating voltage        | 250kV continuous  |
| Continuous current               | 2000A rms   |
| Symmetrical short-circuit rating | 63kA for 3 seconds  |
| Insulation level (minimum)       | 900kV BIL line-to-neutral<br>1050kV BIL across the open gap |
| Operating Voltage                | 125V dc   |

- *13.8kV Metalclad Switchgear*

|  |  |
|--|--|
| Type                                   | Indoor, arc-resistant  |
| Rated Voltage                          | 15kV rms maximum   |
| Continuous current                     | 3000A (Main busbar)<br>3000A (Transformer breakers, bus-tie breakers & disconnect switches)<br>1200A (Feeder breakers & capacitor bank breakers) |
| Interrupting time                      | 5 cycles   |
| Symmetrical short-circuit rating       | 31.5kA (750MVA)  |
| Rated short-term current               | 31.5kA for 2 seconds   |
| Rated closing current                  | 85kA peak  |
| Rated insulation level                 | 95kV BIL   |
| Breaker Positions                      | 11 for each of the four switchgear banks, comprising:<br>10 feeder positions & one capacitor bank position.                                      |
| Station-service transformer connection | Two of the switchgear banks are to be equipped with fuses & disconnect switches for these transformers.  |

- *Surge Arresters*

*230kV - Two sets of three (one set for each step-down transformer)*

|   |   |
|---|---|
| Type  | Metal Oxide Gapless - station class   |
| Maximum Continuous Operating Voltage (MCOV)                     | 150kV rms (minimum)   |
| Maximum equivalent front-of-wave impulse level                  | Not more than 803kV crest   |
| Maximum discharge voltage for 8x20 $\mu$ s 10kA impulse current | Not more than 730kV crest   |
| Maximum switching surge protection level                        | Not more than 657kV crest at 1kA  |
| Temporary over-voltage capability                               | The arrester should be capable of withstanding power frequency over-voltage of not less than 252kV Phase-ground (rms) for a duration of not less than 0.5 second after the rated energy absorption. |

Maximum energy dissipation per arrester As recommended by ANSI/IEEE C62.11-1993 Standard

Pressure relief capability As recommended by ANSI/IEEE C62.11-1993 Standard: not less than 40kA rms.

*Transformer Neutral Terminals (one for each of the step-down transformers)*

Type Metal Oxide Gapless - station class

Maximum equivalent front-of-wave impulse level Not more than 465kV crest

Maximum discharge voltage for 8x20  $\mu$ s 10kA impulse current  
Not more than 423kV crest

Maximum switching surge protection level Not more than 380kV crest at 1kA

Temporary over-voltage capability The arrester should be capable of withstanding power frequency over-voltage of not less than 150kV Phase-ground (rms) for a duration of not less than 0.5 second after the rated energy absorption.

Maximum energy dissipation per arrester As recommended by ANSI/IEEE C62.11-1993 Standard

Pressure relief capability As recommended by ANSI/IEEE C62.11-1993 Standard: not less than 40kA rms.

*13.8kV - Four sets of three (one set for each winding of the step-down transformers)*

Type Metal Oxide Gapless - station class

Maximum Continuous Operating Voltage (MCOV) 12kV rms (minimum)

Maximum equivalent front-of-wave impulse level Not more than 80kV crest

Maximum discharge voltage for 8x20  $\mu$ s 10kA impulse current  
Not more than 73kV crest

Maximum switching surge protection level Not more than 65kV crest at 500A

Temporary over-voltage capability The arrester should be capable of withstanding power frequency over-voltage of not less than 14.2kV Phase-ground (rms) for a duration of not less than 10 second after the rated energy absorption.

Maximum energy dissipation per arrester As recommended by ANSI/IEEE C62.11-1993 Standard

Pressure relief capability As recommended by ANSI/IEEE C62.11-1993 Standard: not less than 20kA rms.

• *13.8kV Power Cables*

Type Copper, with concentric neutrals

Insulation TRXLPE

Nominal Voltage 15kV

|                          |                             |
|--------------------------|-----------------------------|
| Size                     | 2000kcmil                   |
| No. of cables per phase  | 3                           |
| • <i>Capacitor Banks</i> |                             |
| Number                   | 4 (One per switchgear bank) |
| Rating                   | Not more than 7.2MVA        |

### 3. *Assessment*

The new TS is essentially a like-for-like replacement of the existing facility. and therefore, with the immediate peak load on the TS maintained at its present value of approximately 82MW, it will have no further adverse impact on the IESO-controlled grid.

The results summarised in the upper portion of Table 1 show the voltage declines that would be expected to occur at the *existing* facility with all four of the present 4.6MVA capacitor banks in-service, following a contingency involving the 230kV circuit H26C, during peak load periods. These show that for a load of 82MW, at a power factor of 0.9, and with the loads modelled as voltage-dependent, the maximum voltage decline that would occur, prior to the transformer tap-changers responding, would be 6.02%. This decline would be well within the IESO's criterion of 10%.

Once the tap-changers have responded, the voltages on the 13.8kV busbars would return to values that would be approximately the same as their pre-contingency values. The corresponding maximum voltage decline on the 230kV system would be 4.30%. For this situation with the tap-changers responding, a 'constant-MVA' representation was used for the loads.

It should also be noted that the post-contingency flow on the companion circuit, H24C, of 404MVA would be well within its continuous rating of 590MVA (at 240kV).

The results in the central portion of Table 1 show the corresponding voltage declines at the *new facility* for the same contingency and peak loading condition (82MW) at a power factor of 0.9, but with the higher rated capacitor banks in-service. With the loads modelled as voltage-dependent, these show a maximum voltage decline, prior to the transformer tap-changers responding, of 4.8% on the 13.8kV busbars of the new TS.

The results in the lower portion of Table 1 show the voltages declines at the new TS for the projected maximum demand of 107MW at a power factor of 0.90.

With the loads modelled as voltage-dependent, the immediate post-contingency voltage decline on the 13.8kV busbars at the new TS, before the transformer tap-changers have responded, is shown as 7.01%, which would be within the IESO's criterion of 10%.

Once the tap-changers have responded, with the loads modelled as 'constant-MVA', the corresponding maximum voltage decline on the 230kV system would be 4.77%.

At this load level, the post-contingency flow on the companion circuit, H24C, would increase to 435MVA. While this would remain within its continuous rating of 590MVA (at 240kV), it is worth noting that the reactive power component of this flow has increased to 228MVAR. This would suggest that for any further growth in the loads supplied from circuits H24C & H26C, additional compensation is expected to be required at the various supply points if acceptable post-contingency voltages are to be maintained. Furthermore, with an increase in the load at Oshawa GM TS to 107MW, the total peak load supplied exclusively from circuits H24C & H26C would total approximately 425MW. This would be approaching the IESO guideline of 500MW for the maximum amount of load that can be interrupted for a recognised contingency.

### *Conclusions*

These results show that with four 7.2MVAR shunt capacitor banks installed in the new Oshawa GM TS in place of the existing 4.6MVAR units, the maximum voltage decline on the 13.8kV busbar would be reduced from approximately 6% to 4.8%, following the loss of either of the 230kV circuits, H24C or H26C, during periods when a peak load of 82MW is being supplied.

Furthermore, with the higher-rated capacitor banks in-service, the voltage declines for the projected load of 107MW at the GM assembly plant would be only approximately 1% higher than those that would be experienced at the existing TS with four 4.6MVAR capacitor banks installed, and with the TS supplying a peak load of 82MW.

### *Under-Frequency Load-Shedding*

Reference 2 of Appendix 4.3 of the Market Rules requires the new supply point be equipped with an automatic under-frequency load-shedding scheme, and that it have the capability to reject up to 35% of the load supplied from the new facility in response to a declining system frequency. The appropriate settings for the under-frequency load-shedding scheme will be provided by the IESO prior to commissioning of the new facilities.

### *Voltage Reduction*

Reference 4 of Appendix 4.3 of the Market Rules requires facilities to be installed that will allow separate reductions in the supply voltage of 3% and 5% to be initiated remotely, to achieve reductions in load at the TS.

### *Monitoring*

Facilities are to be installed to meet the IESO's monitoring requirements as detailed in Appendices 4.16 & 4.17 of the Market Rules.

### *Auto-reclosure*

No changes are to be made to the existing auto-reclosure schemes on circuits H24C & H26C

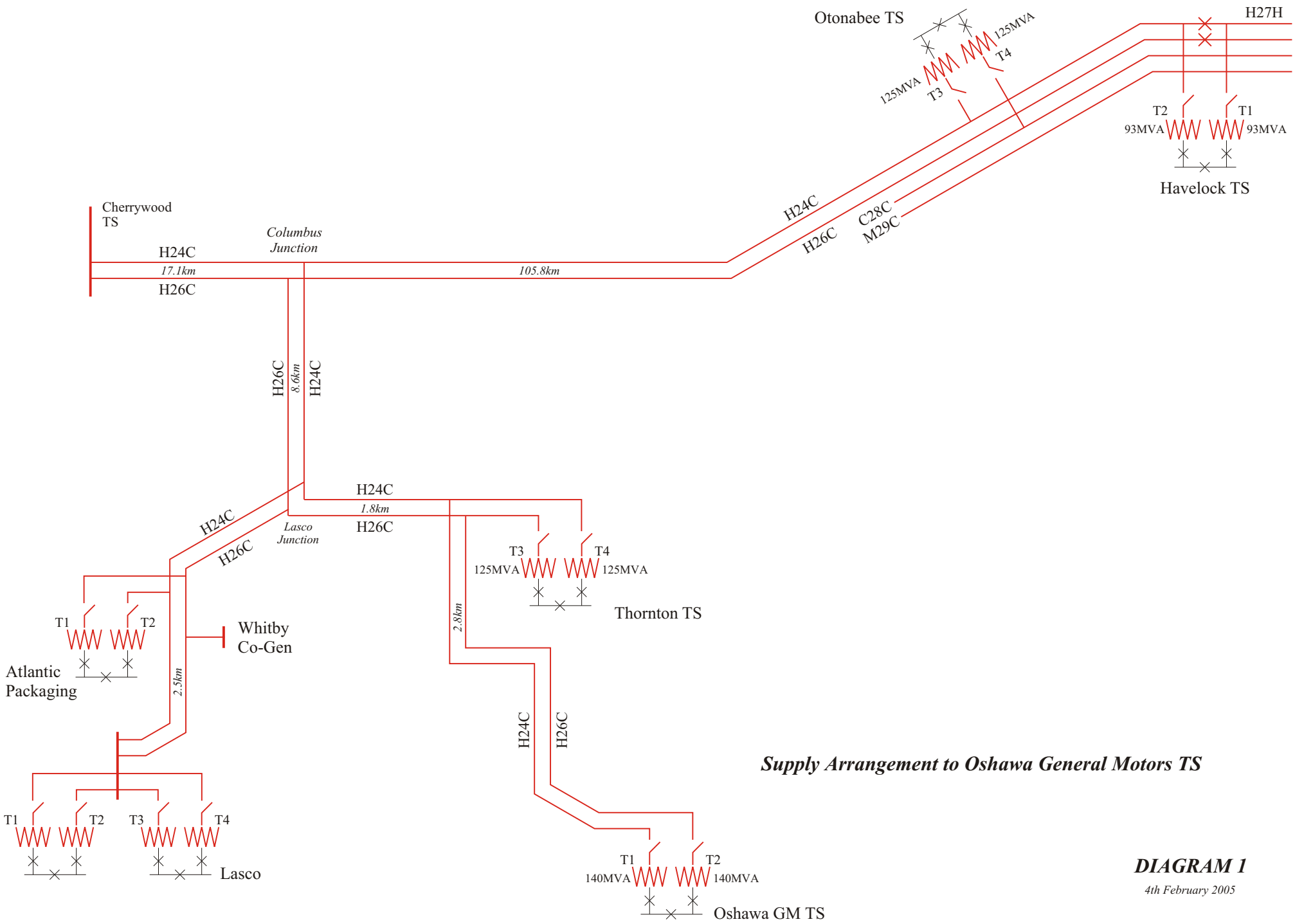
| <b>TABLE 1</b>  |                         | <b>Voltage Decline Studies for a Contingency involving the 230kV Circuit H26C: Cherrywood TS to Havelock TS</b> |                     |   |         |          |          |                      |                   |
|---|-------------------------|---|---------------------|---|---------|----------|----------|----------------------|-------------------|
|   |                         | Cherrywood  |                     | Oshawa GM TS  |         |          |          | Havelock TS          |                   |
|   |                         | DK1 (H24C)  | DK2 (H26C)          | H24C  | H26C    | AB13.8kV | CD13.8kV | H24C                 | H26C              |
| <b>With a Peak Load of 82MW at Oshawa GM TS (Power Factor of 0.90)</b>                |                         |   |                     | <b>With four 4.6MVAR capacitor banks in-service</b> |         |          |          |                      |                   |
| Pre-Contingency Flows into Circuits H24C & H26C at their respective terminal stations |                         | 146.7MW<br>67.4MVAR   | 133.4MW<br>39.2MVAR |   |         |          |          | 95.6MW<br>-20.8MVAR  | 42.4MW<br>4.1MVAR |
| Pre-Contingency Voltages  |                         | 244.5kV   | 244.1kV             | 240.4kV   | 240.5kV | 14.16kV  | 14.16kV  | 237.1kV              | 246.9kV           |
| Post-Contingency:<br>Voltage dependent loads  | Pre Tap-changer Action  | 243.6kV   | 243.9kV             | 232.9kV   | -       | 13.30kV  | 13.30kV  | 234.3kV              | -                 |
|   | Difference              | -0.38%  | -0.07%              | -3.11%  | -       | -6.02%   | -6.02%   | -1.17%               | -                 |
| Post-Contingency Flows into Circuit H24C at its respective terminal stations          |                         | 345.9MW<br>209.6MVAR  | -                   |   |         |          |          | 112.2MW<br>-9.2MVAR  | -                 |
| Post-Contingency:<br>Constant MVA loads   | Post Tap-changer Action | 242.9kV   | 243.4kV             | 230.1kV   | -       | 14.17kV  | 14.17kV  | 232.9kV              | -                 |
|   | Difference              | -0.68%  | -0.31%              | -4.30%  | -       | +0.13%   | +0.13%   | -1.76%               | -                 |
| <b>With a Peak Load of 82MW at Oshawa GM TS (Power Factor of 0.90)</b>                |                         |   |                     | <b>With four 7.2MVAR capacitor banks in-service</b> |         |          |          |                      |                   |
| Pre-Contingency Flows into Circuits H24C & H26C at their respective terminal stations |                         | 146.7MW<br>61.8MVAR   | 133.4MW<br>33.6MVAR |   |         |          |          | 95.6MW<br>-21.5MVAR  | 42.4MW<br>3.6MVAR |
| Pre-Contingency   |                         | 244.6kV   | 244.3kV             | 240.9kV   | 241.0kV | 14.35kV  | 14.35kV  | 237.3kV              | 247.2kV           |
| Post-Contingency:<br>Voltage dependent loads  | Pre Tap-changer Action  | 243.7kV   | 244.0kV             | 233.7kV   | -       | 13.66kV  | 13.66kV  | 234.6kV              | -                 |
|   | Difference              | -0.37%  | -0.09%              | -2.96%  | -       | -4.79%   | -4.79%   | -1.13%               | -                 |
| Post-Contingency Flows into Circuit H24C at its respective terminal stations          |                         | 345.7MW<br>196.4MVAR  | -                   |   |         |          |          | 112.2MW<br>-10.6MVAR | -                 |
| Post-Contingency:<br>Constant MVA loads   | Post Tap-changer Action | 243.0kV   | 243.5kV             | 231.1kV   | -       | 14.30kV  | 14.30kV  | 233.3kV              | -                 |
|   | Difference              | -0.66%  | -0.32%              | -4.06%  | -       | +0.37%   | +0.37%   | -1.69%               | -                 |
| <b>With a Peak Load of 107MW at Oshawa GM TS (Power Factor of 0.90)</b>               |                         |   |                     | <b>With four 7.2MVAR capacitor banks in-service</b> |         |          |          |                      |                   |
| Pre-Contingency Flows into Circuits H24C & H26C at their respective terminal stations |                         | 158.2MW<br>70.9MVAR   | 145.0MW<br>42.7MVAR |   |         |          |          | 97.0MW<br>-20.6MVAR  | 43.3MW<br>4.2MVAR |
| Pre-Contingency   |                         | 244.5kV   | 244.1kV             | 240.1kV   | 240.2kV | 14.27kV  | 14.27kV  | 237.0kV              | 246.8kV           |
| Post-Contingency:<br>Voltage dependent loads  | Pre Tap-changer Action  | 243.5kV   | 243.9kV             | 232.0kV   | -       | 13.27kV  | 13.27kV  | 234.0kV              | -                 |
|   | Difference              | -0.40%  | -0.08%              | -3.37%  | -       | -7.01%   | -7.01%   | -1.27%               | -                 |
| Post-Contingency Flows into Circuit H24C at its respective terminal stations          |                         | 369.7MW<br>228.3MVAR  | -                   |   |         |          |          | 114.4MW<br>-7.8MVAR  | -                 |
| Post-Contingency:<br>Constant MVA loads   | Post Tap-changer Action | 242.6kV   | 243.2kV             | 228.6kV   | -       | 14.33kV  | 14.33kV  | 232.0kV              | -                 |
|   | Difference              | -0.75%  | -0.34%              | -4.77%  | -       | +0.43%   | +0.43%   | -1.96%               | -                 |

#### ***4. CUSTOMER IMPACT ASSESSMENT***

Since this work is essentially a like-for-like replacement of an existing facility, Hydro One has notified the IESO that a Customer Impact Assessment will not be required for this Project.

#### ***5. NOTIFICATION OF APPROVAL***

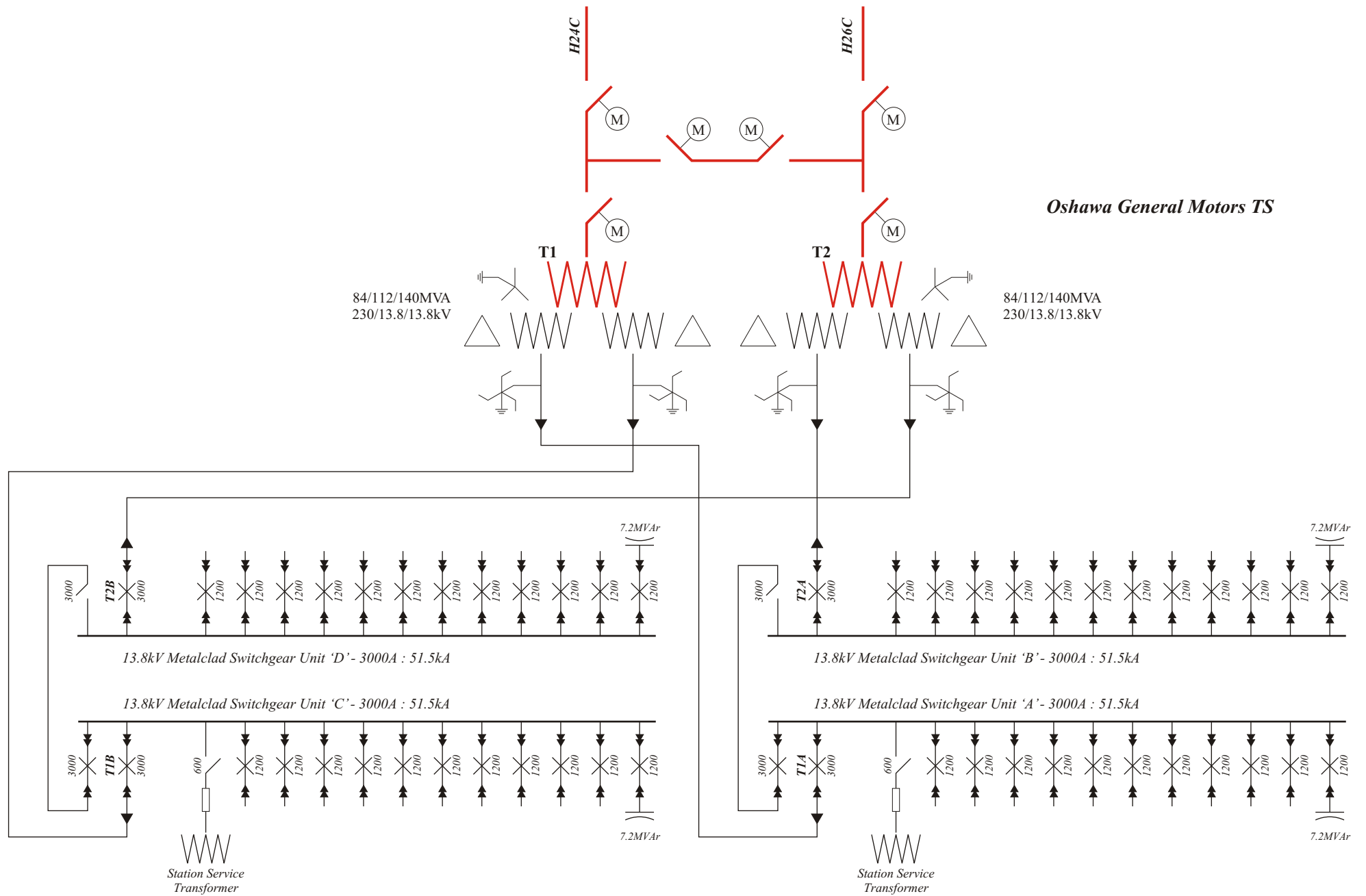
This assessment has concluded that this Project will have no adverse impact on the IESO-controlled grid and it is therefore recommended that a Notification of Approval of the Connection Proposal be issued.



**Supply Arrangement to Oshawa General Motors TS**

**DIAGRAM 1**

4th February 2005



*Oshawa General Motors TS*

**Proposed Arrangement of the New Oshawa GM TS**

**DIAGRAM 2**

15th March 2005