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CONNECTION ASSESSMENT & APPROVAL PROCESS

PRELIMINARY ASSESSMENT REPORT

For Hydro One's Proposal to Quarter Terauley TS

CAA ID No. 2001-050

Consistent Information Set Department, and
Long Term Forecasts & Assessments Department

FINAL Version

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Preliminary Assessment Report

For the Proposal by Hydro One Networks Inc. to Install Facilities to Quarter Terauley TS

Acknowledgement

The IMO wishes to acknowledge the assistance of Hydro One in completing some of the studies for this assessment.

Disclaimers

IMO

This report has been prepared solely for the purpose of assessing 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 the IMO should issue a notice of approval or disapproval of the proposed connection 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 reserves the right to revise this report at any time, at its sole discretion, without notice to the connection applicant. Although the IMO will use its best efforts to advise the connection applicant of such changes, it is the responsibility of the connection applicant to ensure that the most recent version of this report is being used.

Hydro One

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 provided by the connection proponent 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. Additional facility studies may be necessary to confirm constructability and the time required for construction. System impact or further studies at more advanced stages of the project development may identify additional facilities that need to be provided or that require upgrading.

PRELIMINARY ASSESSMENT REPORT

For the Proposal by Hydro One Networks Inc. to Quarter Terauley TS

EXECUTIVE SUMMARY

This Preliminary Assessment has examined the expected impact on the IMO-controlled grid of the proposal by Hydro One Networks Inc. to Quarter Terauley TS.

The scheduled completion date for the work at Terauley TS is Q4-2002.

Proposed Changes at Terauley TS

Diagram 1 shows the existing configuration of the facilities at Terauley TS and its location in relation to Cecil TS and Hearn TGS. It also shows the typical operating arrangement with the two circuit breakers at Esplanade TS operated normally-open to avoid exceeding the fault interrupting capability of the existing 115kV circuit breakers at Esplanade TS, Leaside TS and Hearn TGS.

Diagram 2 shows the proposed arrangement once the two new circuit-switchers have been installed at Terauley TS and the normally-open points between Cecil TS and Hearn TGS have been relocated from Esplanade TS to Terauley TS. With the new circuit-switchers at Terauley TS operated normally-open, the 115kV supply at that TS would be 'quartered'. This would mean that the supply to Terauley TS would be obtained from four discrete radial circuits that are each terminated through a dedicated transformer.

Currently all of the load at Terauley TS is supplied via the sections of circuits C5E & C7E between Cecil TS and Terauley TS. During peak load periods, a contingency involving one of these circuits is expected to result in a post-contingency flow on the remaining circuit that exceeds its continuous rating. Quartering Terauley and operating with it open would result in approximately half the load being transferred on to the Hearn 115kV busbar so that it is supplied via the sections of circuits C5E & C7E between Esplanade TS and Terauley TS. This would relieve the loading on the sections of circuits C5E & C7E between Cecil TS and Terauley TS.

Impact on Reliability

Once Terauley TS has been quartered and circuits C5E & C7E are divided into two discrete sections, a contingency involving either section of circuit C5E or circuit C7E would result in the loss of only a single step-down transformer, together with the faulted section of the circuit. This would be an improvement over the existing arrangement which results in the loss of the entire circuit together with the two transformers that are directly associated with it.

While quartering Terauley TS and operating with the 115kV busbar open would be expected to have a positive impact on the actual supply to Terauley TS, there were concerns about the ability of the existing 115kV facilities between Leaside TS and Hearn TGS to support the load that would be transferred to them. The supply situation was expected to be particularly difficult should it become necessary to operate with the 115kV busbar at Hearn TGS open to respect the fault interrupting capability of the existing breakers.

Fault Level Analysis and Load Flow Analysis

A series of fault level studies were performed for different configurations of the transmission system, with and without the generating facilities at Pickering 'A' NGS and at the Sithe-Goreway Project in-service. In addition, separate Linear Load Flow analysis was performed to assess the load meeting capability of the transmission system under different operating conditions.

These studies showed that, while it would be desirable to operate with as few normally-open points as possible to maximise the load meeting capability of the existing transmission facilities, this would result in the highest fault levels. Conversely, while the introduction of additional normally-open points would constrain the fault levels, it would adversely effect the ability of the transmission facilities in the Leaside sector to supply the forecast load.

These studies have shown that the arrangement that would provide the preferred compromise between load meeting capability and the number of breakers that would need to be replaced would require the Leaside sector to be operated as follows:

With the 115kV busbar at Leaside TS ***open***
With the 115kV busbar at Hearn TGS operated ***closed***
With Terauley TS quartered and ***open***
With 18 breakers at Leaside TS and a further six breakers at Hearn TGS replaced.

While this arrangement would be expected to result in overloads for single-circuit contingencies, these would be within the range that it is expected could be managed through the use of immediate load transfers to the adjacent Manby sector, or through the use of shorter-time thermal ratings. However, for double-circuit contingencies, this arrangement would result in overloads that are expected to be too large to be managed through load transfers. They would therefore be expected to require load to be interrupted, which would be in addition to the load that would be lost as a direct result of their connection to the faulted circuits.

Introducing additional normally-open points into the transmission facilities that comprise the Leaside sector, although it would reduce fault levels, and hence the number of breakers that would need to be replaced, was shown to result in higher levels of overloads for both single-circuit and double-circuit contingencies.

However, while the 'preferred compromise' arrangement would require a total of 24 breakers to be replaced to allow the 115kV busbar at Hearn TGS to be operated ***closed,*** it would still require the Leaside 115kV busbar to be operated ***open.*** To be able to operate with the Leaside busbar ***closed*** it would require all 28 breakers at Leaside to be replaced, together with the six breakers at Hearn TGS. While this would result in an arrangement that would provide the optimum load meeting capability from the available transmission facilities, it would result in post-contingency flows, for single-circuit contingencies, as high as 96% of the continuous rating of the circuits. This indicates that even with the transmission facilities in the Leaside sector operated fully-closed, there would be little capacity available to securely supply future loads, under single-circuit contingency conditions.

Consequently, it was concluded that reinforcement of the transmission facilities in the Leaside sector would be required by about 2006. This was shown to be the year that there was expected to be insufficient capacity available within the adjacent Manby sector, due to increasing loads in that sector, to accommodate a post-contingency transfer from the Leaside sector equivalent to one third of the load at Esplanade TS. This represents the portion of the load at Esplanade TS that is directly associated with the 115kV circuit H2JK that can be connected to either sector.

Therefore, even if the compromise arrangement were adopted and a total of 24 breakers were replaced, the need to reinforce the system to enhance its load meeting capability, possibly through the installation of additional 230kV and/or 115kV circuits together with additional auto-transformer capacity, would be expected to increase fault levels. The increased fault levels would then be expected to require further breakers to be replaced.

Replacing breakers at Leaside TS and Hearn TGS

The IMO has concerns regarding the time required to replace a significant number of breakers at Leaside TS and at Hearn TGS. This could also increase significantly should it be determined that the buswork at either station would need to be replaced to meet the higher fault levels. Additional delays could also result from an inability to obtain the required outages to undertake the replacement work, particularly during peak periods when the existing transmission facilities are very highly utilised.

Interim Operation of the Facilities in the Leaside Sector

During the period following the return to service of the four generating units at Pickering 'A' NGS and the completion of the breaker replacement work at Leaside TS and at Hearn TGS, the fault levels are expected to exceed the ratings of the existing breakers at those locations.

However, with the 115kV busbar at Leaside operated *open*, the extent by which the fault levels at both Leaside TS and Hearn TGS are expected to exceed the ratings of the existing breakers is considered to be within the range that could be managed by adopting interim operating measures.

These measures could possibly involve imposing a *maximum* operating voltage of approximately 123kV at Leaside TS until the breaker replacement work can be completed. However, since there is an existing requirement to maintain a *minimum* voltage of 119kV at the Leaside 115kV busbar, this limitation would restrict the voltage range to just 4kV for operating the Leaside sector under different loading scenarios. This could be unduly restrictive and therefore other measures may need to be adopted, possibly in combination with a higher maximum voltage.

Requirement to enhance the Load Meeting Capability of the Leaside Sector

Since the ability to transfer loads to the Manby sector to relieve post-contingency overloads is expected to be extremely limited beyond 2006 during peak load periods, immediate action will need to be taken to implement measures that will ensure that the increasing loads within the Leaside and Manby sectors can continue to be supplied under contingency conditions.

These measures could include one or more of the following, or any other proposal that would provide an enhanced supply capability to the Leaside Sector:

i. *Install the additional generating capacity at Hearn TGS as proposed by OPG* (and addressed in the IMO's Preliminary Assessment Report).

It should be noted that for this generation to provide the required enhancement to the load meeting capability of the Leaside sector, that this generating capacity would need to be *constrained-on* during peak load periods.

ii. *Reinforce the existing transmission facilities to increase their load-meeting capability.*

iii. *Establish a third supply into downtown Toronto* - similar to that as originally proposed in the 1995 TIES (Toronto Integrated Electrical Services) Study.

Proposals for enhancing the Supply to downtown Toronto

This assessment has demonstrated that for the period commencing in 2006, it is expected that there will be supply interruptions in the event that a single-circuit contingency should occur during the peak load periods. Furthermore, due to the limited capability to transfer load to other supply points, these interruptions could be for extended periods until the faulted facilities can be returned to service.

Since it is expected that it will take a number of years before any proposal can be completed and the supply capability to downtown Toronto enhanced accordingly, the IMO will be endeavouring to obtain a firm commitment from one or more of the proponents as soon as possible, that they intend to proceed with their respective developments.

Need for a System Impact Assessment

Based on the results of this assessment it has been concluded that all the necessary analysis to determine the impact that the proposal to quarter Terauley TS will have on the IMO-controlled grid has been undertaken. A separate System Impact Assessment is therefore not considered necessary for this Project.

Customer Impact Assessment

Hydro One Networks Inc., in consultation with the IMO, has concluded that the Terauley Project will have no adverse impact on any other customers in the area, and that a formal Customer Impact Assessment is not required.

Notification of Approval of the Connection Proposal

The IMO has concluded that not only will the proposed changes at Terauley TS have no immediate adverse impact on the IMO-controlled grid but that the work needs to be completed as soon as possible to avoid possible overloading of the companion circuit between Cecil TS and Terauley TS under contingency conditions involving one of these cabled circuits, during peak load periods.

It has therefore been recommended that a *Notification of Approval for Connection* be issued for this Project.

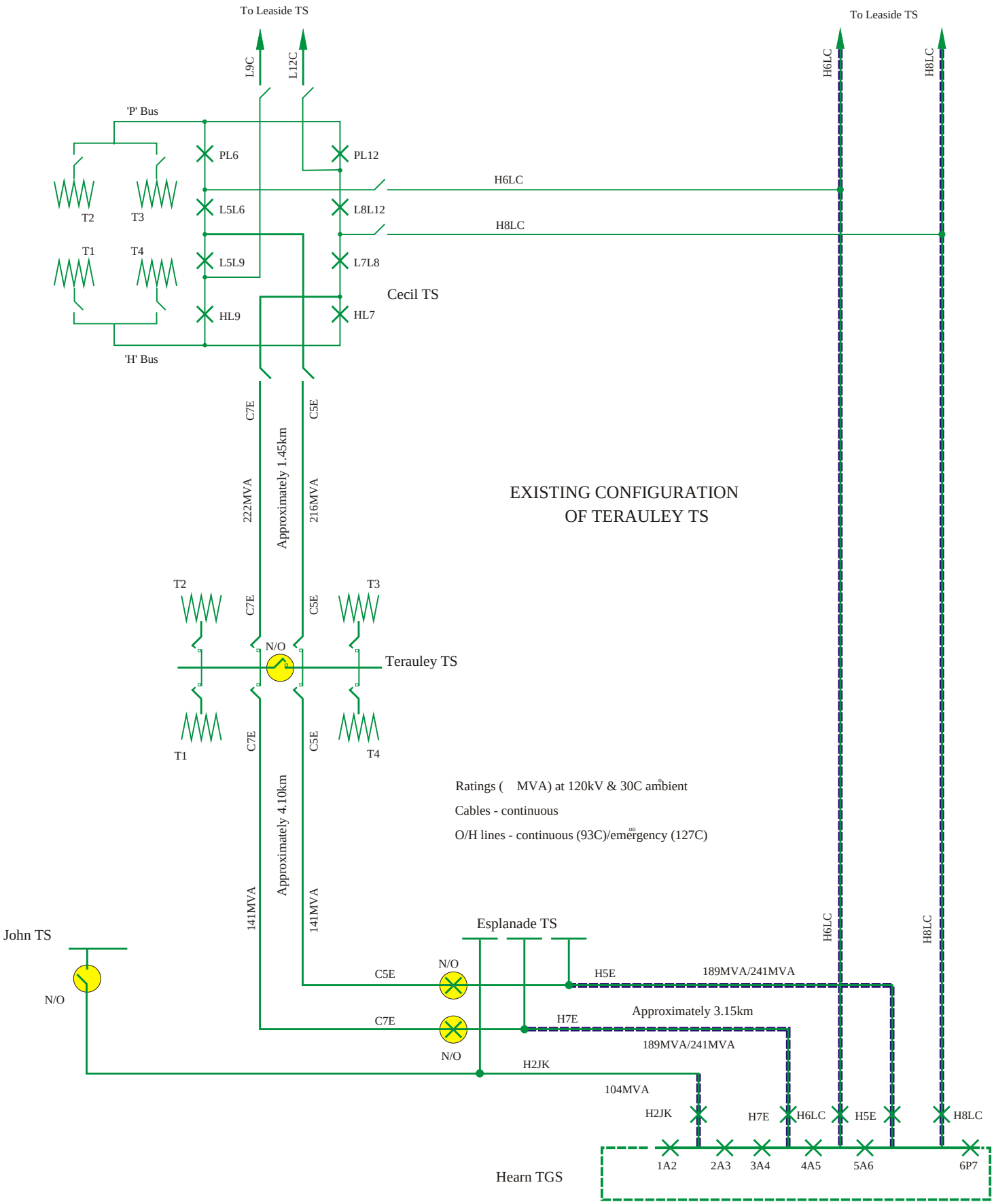


DIAGRAM 1

11th March 2002

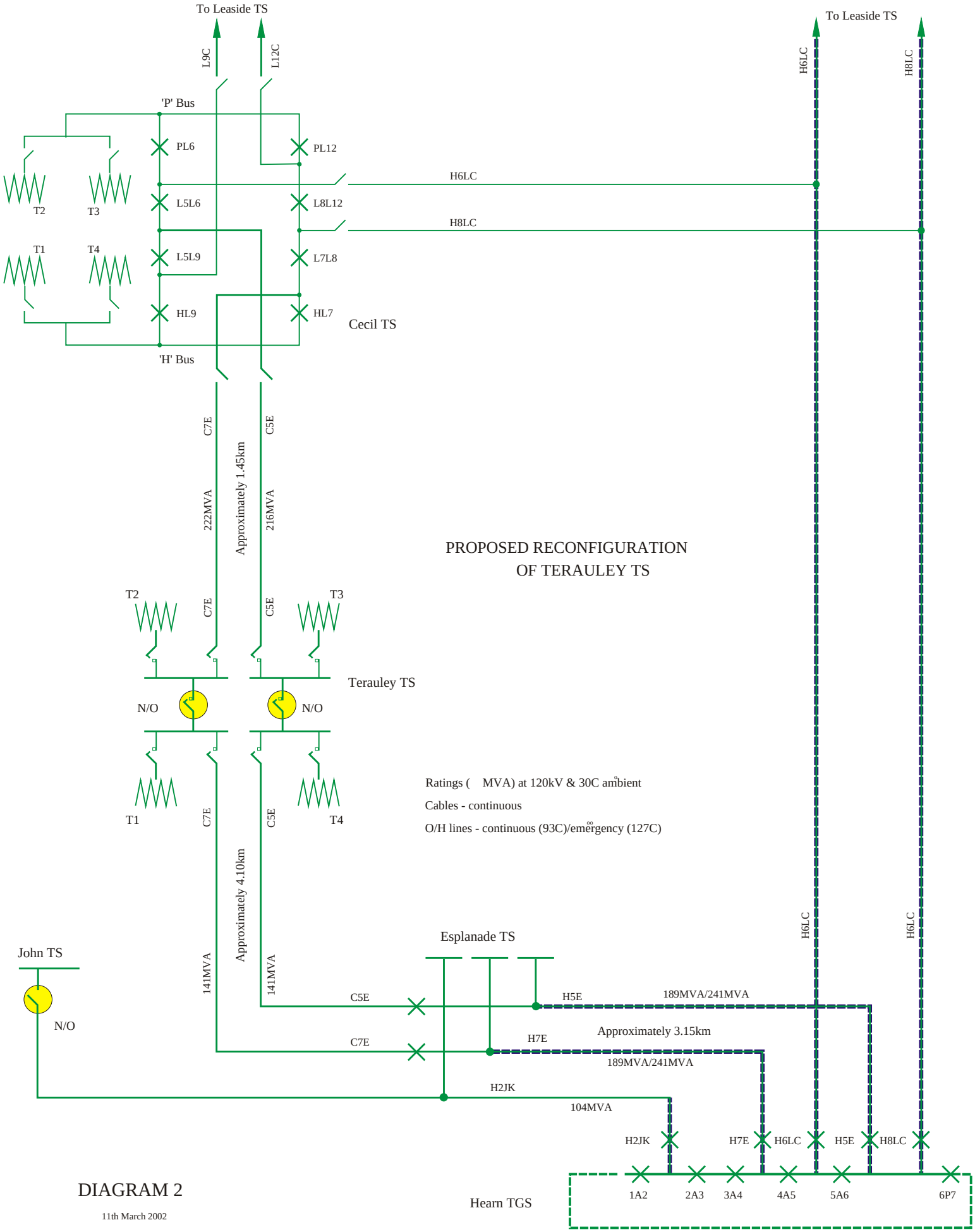


DIAGRAM 2

11th March 2002

PRELIMINARY ASSESSMENT REPORT

for the

Proposal by Hydro One Networks Inc.

To Install Facilities to Quarter Terauley TS

PRELIMINARY ASSESSMENT REPORT

For the Proposal by Hydro One Networks Inc. to Quarter Terauley TS

1. Introduction

Terauley TS, which comprises four step-down transformers arranged as a double-DESN station, is connected to the two 115kV cable circuits, C5E & C7E between Cecil TS and Esplanade TS, approximately 1.5km from Cecil TS and 4.1km from Esplanade TS.

To avoid exceeding the fault interrupting capability of the existing 115kV circuit breakers at Esplanade TS, Leaside TS and Hearn TGS, it is necessary to operate with at least one open point in each of the circuit-pairs C5E/H5E & C7E/H7E. This requirement is usually met by operating with the two in-line circuit breakers, C5E & C7E, at Esplanade TS open.

This arrangement results in Terauley TS being supplied from Cecil TS, while Esplanade TS is supplied from Hearn TGS.

The forecast peak loads at Terauley TS for the summer-2003 and the summer-2004 are 228MVA & 236MVA, respectively.

The continuous thermal ratings for the sections of circuits C5E & C7E between Cecil TS and Terauley TS are 216MVA & 222MVA, respectively, at an ambient temperature of 30^{o}C and a wind-speed of up to 4km/hr. Following a contingency involving either circuit C5E or C7E during peak load periods, the companion circuit would be expected to be overloaded.

To address this problem Hydro One Networks Inc. has proposed a plan to 'quarter' the 115kV busbar at Terauley TS so that each of the four step-down transformers at that location will be connected to one of the individual sections of circuits C5E & C7E between Cecil TS and Terauley TS, or between Esplanade TS and Terauley TS. The normally-open point in each of the circuit-pairs C5E/H5E & C7E/H7E is then to be relocated from Esplanade TS to the mid-point at Terauley TS.

This change to the existing arrangement would result in approximately half of the load at Terauley TS being supplied from Leaside TS, via Cecil TS, while the remainder would be supplied from Hearn TGS, via Esplanade TS.

This Report presents the results of the studies that were performed to determine the impact that the proposed reconfiguration of Terauley TS would be expected to have on the IMO-controlled grid.

The planned completion date for the work at Terauley TS is Q4-2002.

2. Details of the Proposed Changes at Terauley TS

Diagram 1 shows the existing configuration of the facilities at Terauley TS and its location in relation to Cecil TS and Hearn TGS. It also shows the typical operating arrangement with the two circuit breakers at Esplanade TS operated normally-open.

Diagram 2 shows the arrangement once the two new circuit-switchers have been installed at Terauley TS and the normally-open points between Cecil TS and Hearn TGS have been relocated from Esplanade TS to Terauley TS. With the new circuit-switchers at Terauley TS operated normally-open, the 115kV supply at that TS would be 'quartered'. This would mean that the supply to Terauley TS would be obtained from four discrete radial circuits that are each terminated through a dedicated transformer.

Diagram 3 provides a more detailed view of the facilities at Terauley TS once the two new circuit-switchers have been installed and the TS is operated 'quartered'.

3. Impact on Reliability

The proposed quartering of Terauley TS will improve the actual supply to Terauley TS because it will allow the sections of circuits C5E & C7E between Esplanade TS and Terauley TS, that are normally idle when the breakers at Esplanade TS are open, to be utilised.

Furthermore, the existing connection arrangement results in the loss of two step-down transformers at Terauley TS in response to a contingency involving either circuit C5E or circuit C7E. Once Terauley TS has been quartered and circuits C5E & C7E are divided into two discrete sections, a contingency involving either section of circuit C5E or circuit C7E would result in the loss of only a single step-down transformer, together with the faulted section of the circuit.

However, once Terauley TS has been quartered, approximately half the load at that TS would be supplied via the 115kV busbar at Hearn TGS. The IMO has concerns about the ability of the existing 115kV facilities between Leaside TS and Hearn TS to support the additional load, particularly should it become necessary to sectionalise the 115kV system to respect the fault interrupting capability of the existing 115kV breakers in the Leaside sector.

The results of the analysis that was performed to establish an approximate schedule for sectionalising the 115kV system to limit fault levels, and the impact that that sectionalising would have on the load-meeting capability of the existing transmission facilities are summarised in the following sections.

4. Fault Level Analysis

Fault level studies were performed to determine the extent to which the 115kV system in the Leaside sector would need to be sectionalised to allow the fault interrupting capability of the existing 115kV breakers to be respected.

The following system conditions were assumed for the base-case model that was used in the studies:

- All existing transmission facilities, together with those facilities that have been 'committed' were assumed to be in-service.
- The three Interconnections with Michigan reflect their final arrangement following the installation of the new phase-shifters.
- The generators at the *Bruce 'A' NGS* were *out-of-service*
- The four generators at the *Pickering 'A' NGS* were *out-of-service*
- The two 500/230kV auto-transformers at Lennox TS, together with units G1 to G4 at Lennox GS were in-service.
- The four generating units at *Lakeview TGS* were *in-service*
- The 230kV busbars at Richview TS were operated 'split'
- The 230kV busbar at Lakeview TGS was operated 'split'
- Cherrywood TS was operated with a separate North & South 230kV switchyards.
- All of the generators that were specified for each Project in the original Sarnia-Windsor cluster were assumed to be in-service and incorporated into the system in accordance with the arrangements detailed in the System Impact Assessment Report for this cluster.
- The proposed 950MW Project that is expected to be constructed in the St Clair area of the Detroit Edison System is in-service
- *The original (1995) representation for the Detroit Edison Company in the year-2000 was used to model that system*.

The full, quoted fault interrupting capability of the circuit breakers on the 230kV and 115kV systems was used when assessing the adequacy of the equipment for the projected fault interrupting duty that is likely to be imposed on it.

Pre-fault voltages of 250kV and 127kV were assumed throughout this analysis.

*Note: The facilities that are detailed above are considered to represent the **'existing'** system in all of the subsequent analysis and in the discussion of the results.*

4.1 System Conditions Examined

The four generating units at Pickering 'A' NGS are scheduled to be returned to service during 2002 & 2003. In addition, full commercial operation of the Goreway Project of Sithe Energies Canadian Development Ltd. is scheduled to commence in 2004.

Fault level studies were therefore performed for the following four scenarios:

Scenario	*System Representation*
1	The *'Existing'* system
2	The *'Existing'* system with the four Pickering 'A' units included
3	The *'Existing'* system with the Sithe - Goreway Project included
4	The *'Existing'* system with the four Pickering 'A' units & the Sithe - Goreway Project included

In addition, the fault level studies examined the effect of operating with different parts of the system open. Specifically, the particular open-points that were considered were as follows: (these are shown in Diagrams 4 & 5)

- Leaside 115kV busbar open at breaker positions EK & JP
- Hearn 115kV busbar open at breaker positions 6P7 & A1P8 (Vertical 'split')
  OR
  Hearn 115kV busbar open at breaker positions 5A6 & 7P8 (Diagonal 'split')
- 115kV circuits H3 & H11L open-ended at Hearn TGS
- Terauley TS quartered and operated open
- Cherrywood North 230kV busbar open at breaker positions 1D2 & 1K2, and Cherrywood South 230kV busbar open at breaker positions 3D4 & 3K4

Since it is an operating requirement that the Manby and Leaside 115kV systems be kept separate to limit fault levels, it was assumed that the line disconnect at John TS in circuit H2JK was open in all of the studies.

The results of the fault level studies have been summarised in Tables 1 to 9.

4.2 Discussion of the Results of the Fault Level Studies

4.2.1 Existing System

Table 1 summarises the results for the 'existing' system.

The 'existing' system conditions correspond with those defined in Section 4, and assume that none of the units at Pickering 'A' NGS or at Bruce 'A' NGS are in-service. Furthermore, with the units at Pickering 'A' out-of-service it was assumed that the individual 230kV busbars at the Cherrywood North and Cherrywood South switchyards could be operated closed without exceeding the fault interrupting capability of the breakers at that location.

[The convention that has been employed in the summary tables to distinguish between the various fault level results is to shade those cells that contain the symmetrical fault level values and ratings, and to leave those cells that contain the asymmetrical values unshaded.

Where the projected fault level at the main busbars exceeds the fault interrupting capability of the existing breakers, the relevant figures in the summary tables have been shown in ***bold-italic.***

The respective symmetrical and asymmetrical breaker ratings have been added at the top of the columns.]

These results show that if the 115kV busbar at Leaside TS were to be operated ***closed***, the fault interrupting capability of the breakers at Leaside TS would be exceeded.

Even with the 115kV busbar at Leaside TS operated ***open*** and the new circuit-switchers at Terauley TS operated ***closed***, the fault interrupting capability of the breakers at Hearn TGS would be exceeded if all the 115kV circuits between Leaside TS and Hearn TGS were to be operated closed.

However, the results also show that with Leaside TS operated ***open*** and with the new circuit-switchers at Terauley TS also operated ***open***, the fault interrupting capability of the breakers at both Leaside TS and at Hearn TGS could be respected without the need to open any of the circuits between Leaside TS and Hearn TGS.

Since the intent of quartering Terauley TS is to allow it to be operated ***open*** and since this arrangement would be preferable to operating with the two of the 115kV circuits between Leaside TS and Hearn TGS open, the following is considered to be the 'reference' arrangement that would allow the ratings of the existing equipment to be respected:

Operating Arrangement Recommended for the 'existing' system -
without any of the units at Pickering 'A' NGS in-service

- The 230kV busbars at Cherrywood North & Cherrywood South switchyards ***Closed***
- The 115kV busbar at Hearn TGS ***Closed***
- The 115kV busbar at Leaside TS ***Open***
- Terauley TS quartered and ***Open***
- All 115kV circuits between Leaside TS and Hearn TGS ***Closed***

It is worth noting that while this arrangement would result in fault levels that are below the breaker ratings, the margin remains relatively small:

- At Leaside TS, the maximum asymmetrical fault level for a line-to-ground fault has been computed at 45.24kA. This compares with a breaker rating of 45.5kA asymmetrical.

- Similarly, at Hearn TGS the maximum asymmetrical fault level for a three-phase fault has been computed at 33.20kA. This compares with a breaker rating of 34.1kA asymmetrical.

The fault levels that were computed for the busbars at Cherrywood TS have been summarised below:

Fault Levels on the 230kV busbars at Cherrywood North & South Switchyards
(with no units at Pickering 'A' NGS in-service)

Symmetrical		***Asymmetrical***		***Breaker Ratings (minimum)***	
3-phase	*L-G*	*3-phase*	*L-G*	*Symmetrical*	*Asymmetrical*
49.6kA	55.5kA	62.9kA	68.7kA	60.0kA	70.6kA

The results above confirm that with the four units at Pickering 'A' NGS out-of-service, the 230kV busbars at the Cherrywood North and South switchyards can be operated closed and still respect the ratings of the lowest-rated breakers at those locations. (Various designs of breakers are installed at Cherrywood TS with ratings varying from 60.0kA to 70kA symmetrical and 70.6kA to 80.4kA asymmetrical.)

4.2.2 With the four Pickering 'A' units In-service

Since each pair of units at Pickering 'A' NGS is connected to either the Cherrywood North or South switchyards by two 230kV circuits that are only 7km in length, the increased fault levels at Cherrywood TS resulting from the incorporation of these units would cause the rating of the breakers to be exceeded. Consequently, with the Pickering 'A' & 'B' units in-service it becomes necessary to 'split' the 230kV busbars at the Cherrywood North & South switchyards.

Table 2 summarises the results for the fault level studies with the four units at Pickering 'A' NGS in-service, and with the 230kV busbars at the Cherrywood North and South switchyards operated open.

These results show that, regardless of the state of Terauley TS and the 115kV circuits H3L & H11L at Hearn TGS, it would not be possible to operate with the 115kV busbar at Hearn TGS ***closed*** and respect the fault interrupting capability of the existing breakers at Leaside TS.

4.2.3 With the Sithe-Goreway Project In-service

Table 3 summarises the results for the fault level studies with the Sithe-Goreway Project in-service, without any of the units at Pickering 'A' NGS in-service. For these studies, it was assumed that the 230kV busbars at the Cherrywood North and South switchyards would be operated closed.

Comparing the results in this Table with those in Table 1 for the 'existing' system, shows that the incorporation of the Sithe-Southdown Project would only increase the fault levels by approximately 0.2kA and that this would not be sufficient to have any impact on the 'recommended' normally-open points for the 'existing' system.

i.e.

- The 115kV busbar at Hearn TGS ***Closed***
- The 115kV busbar at Leaside TS ***Open***
- Terauley TS quartered and ***Open***
- All 115kV circuits between Leaside TS and Hearn TGS ***Closed***

However, while the increase in the fault levels is small, the margin between the projected fault levels with the Sithe-Goreway Project in-service and the rating of the existing breakers will be further eroded:

- At Leaside TS, where the breakers are rated at 45.5kA asymmetrical, the maximum asymmetrical fault level has been computed at 45.46kA, and
- At Hearn TGS, where the breakers are rated at 34.1kA asymmetrical, the maximum asymmetrical fault level has been computed at 34.40kA.

Furthermore, while the Sithe-Goreway Project would also increase the fault levels on the 230kV busbars at the Cherrywood North & South switchyards, as shown in the Table below, the increase would not be sufficient to require the busbars to be operated split.

Fault Levels on the 230kV busbars at Cherrywood North & South Switchyards
(with the Sithe-Goreway Project in-service)

	Symmetrical		***Asymmetrical***		***Breaker Ratings (minimum)***	
	3-phase	*L-G*	*3-phase*	*L-G*	*Symmetrical*	*Asymmetrical*
North	50.0kA	56.3kA	64.2kA	69.7kA	60.0kA	70.6kA
South	48.9kA	55.9kA	62.7kA	69.2kA		

4.2.4 With the four units at Pickering 'A' NGS and the Sithe-Goreway Project In-service

Table 4 summarises the results for the fault level studies with both the Sithe-Goreway Project and all four units at Pickering 'A' NGS in-service. For these studies it was assumed that the 230kV busbars at the Cherrywood North and South switchyards would be operated open.

In general, the results are slightly higher than those recorded in Table 2, for the condition with only the four units at Pickering 'A' NGS in-service. Again they confirm that, regardless of the status of Terauley TS and the 115kV circuits H3L & H11L at Hearn TGS, it would not be possible to operate with the 115kV busbar at Hearn TGS ***closed*** with the units at Pickering 'A' NGS and the Sithe-Goreway Project in-service, and still be able to respect the fault interrupting capability of the existing breakers at Leaside TS.

The results for three-phase and single line-to-ground faults at Leaside TS and Hearn TGS, for the condition with the four units at Pickering 'A' NGS and the Sithe-Goreway Project in-service, have been transposed on to the following Diagrams:

	Fault Condition	*No. of Breakers effected*
Diagram 6	3-phase Fault Levels at Hearn TGS	*8*
Diagram 7	Single Line-to-Ground Fault Levels at Hearn TGS	*None*
Diagram 8	3-phase Fault Levels at Leaside TS	*None*
Diagram 9	Single Line-to-Ground Fault Levels at Leaside TS	*18*

These show that for the situation with Leaside TS operated *open* and with Hearn TGS operated *closed*, the projected fault levels at Leaside TS and Hearn TGS would exceed the fault interrupting capability of eight of the breakers at Hearn TGS and eighteen of the breakers at Leaside TS. These breakers would therefore need to be replaced.

[Note: That since the busbar positions at Hearn TGS between breakers 1A2 & A1P8, and between 2A3 & 3A4 are vacant, one breaker of each pair is effectively redundant. Therefore, only one breaker of each pair would need to be replaced and the other breaker could be removed and its position by-passed with new bus-work. This would reduce the number of breakers that would need to be replaced at Hearn TGS to six.]

Effect of opening the Hearn 115kV busbar

Since the fault levels on the two halves of the 115kV busbar at Leaside TS exceed the fault interrupting capability of the existing breakers when the 115kV busbar at Hearn TGS is operated closed, further studies were performed with the Hearn 115kV busbar operated split.

Two arrangements for splitting the 115kV busbar at Hearn TGS were examined:

i. With 115kV breakers 6P7 & A1P8 open at Hearn TGS.

   This has been referred to as the *'vertical'* split since with this arrangement those circuits that originate from the western half of the Leaside 115kV busbar would terminate on the western half of the Hearn busbar, while those from the eastern half of the Leaside busbar would terminate on the eastern half of the Hearn busbar.

ii. With 115kV breakers 5A6 & 7P8 open at Hearn TGS.

   This has been referred to as the *'diagonal'* split since circuit H8LC which originates from the western half of the Leaside busbar would terminate on the same section of busbar at Hearn TGS (the inner busbar) as circuits H1L & H3L from the eastern half of the split busbar at Leaside TS. Similarly, circuit H6LC from the western half of the Leaside busbar would terminate on the same section of busbar at Hearn TGS (the outer busbar) as circuits H7L & H11L from the eastern half of the Leaside busbar.

   Effectively with breakers 5A6 & 7P8 open at Hearn TGS, these two pairs of connections would bridge the two halves of the Leaside busbar via the two halves of the split 115kV busbar at Hearn TGS.

With the 115kV busbar at Hearn open at breaker positions 5A6 & 7P8 (a 'diagonal' split)

The results for this arrangement, with the four units at Pickering 'A' NGS and the Sithe-Goreway Project in-service, are shown in Table 5.

Comparing these results to those shown in Table 4 (for the same generation scenario but with the 115kV busbar at Hearn TGS closed), shows that a 'diagonal' split of the Hearn 115kV busbar would have little impact on the fault levels at Leaside TS, although it would reduce the fault levels at Hearn TGS.

Consequently, operating with the 115kV busbar at Hearn TGS open 'diagonally' would not be sufficient to allow the fault interrupting capability of the existing breakers at Leaside TS to be respected.

With the 115kV busbar at Hearn open at breaker positions 6P7 & A1P8 (a 'vertical' split)

The results for this arrangement, with the four units at Pickering 'A' NGS and the Sithe-Goreway Project in-service, are shown in Table 6.

These show that by adopting this arrangement the fault interrupting capability of the existing breakers at Leaside TS could be respected.

It is also worth noting that for this arrangement, with the 115kV busbars at Hearn split 'vertically', the two halves of the Leaside 115kV busbar (whenever it is being operated open) are not bridged via the busbar at Hearn TGS. Consequently, the projected fault levels at Leaside TS and at Hearn TGS are approximately 5kA lower than those for the corresponding arrangement with the Hearn 115kV busbar operated closed (refer to Rows 5 & 7 of Table 4, with Terauley TS operated open and closed, respectively). Adopting this arrangement would therefore provide a greater margin between the projected fault levels and the breaker ratings to accommodate possible future increases in the fault levels at Leaside TS and Hearn TGS.

Fault Levels at Cherrywood TS

The fault level results that are summarised in the following Table show that, for the condition with the four units at Pickering 'A' returned to service and with the Sithe-Goreway project in-service, operating with the 230kV busbars at Cherrywood North & South switchyards open, would be sufficient to allow the fault interrupting capability of the existing breakers to be respected.

Fault Levels on the individual sections of the 230kV busbars at Cherrywood North & South Switchyards
(with Pickering 'A' & the Sithe-Goreway Project in-service and the Cherrywood North & South busbars split)

Busbar Sections	***Symmetrical***		***Asymmetrical***		***Breaker Ratings (minimum)***	
	3-phase	*L-G*	*3-phase*	*L-G*	*Symmetrical*	*Asymmetrical*
North 1	47.6kA	51.2kA	61.7kA	64.8kA	60.0kA	70.6kA
North 2	47.6kA	51.5kA	61.7kA	65.2kA		
South 3	46.7kA	50.2kA	60.6kA	63.6kA		
South 4	46.0kA	50.3kA	59.2kA	63.7kA		

4.3 Conclusions from the Fault Level Analysis

The principal conclusions from the fault level analysis can be summarised as follows - in each case it has been assumed that Terauley TS has been quartered and that its busbars are operated open:

- The fault level analysis has shown that for the 'existing' system, with all facilities in-service, it will be necessary to operate with the 115kV busbar at Leaside TS open to respect the fault interrupting capability of the existing breakers at Leaside TS.

- Once the four units at Pickering 'A' NGS are returned to service then, in addition to having to operate with the 115kV busbar at Leaside TS open, it will be necessary to either replace breakers at Leaside TS and Hearn TGS, or to operate with the 115kV busbar at Hearn TGS open.

- While the subsequent incorporation of the Sithe-Goreway Project would increase the fault levels at Leaside TS and Hearn TGS by approximately 0.2kA, this would not be sufficient to affect the requirements for operating the Leaside sector once the four units at Pickering 'A' have been returned to service.

- With the four units at Pickering 'A' NGS and with the Sithe-Goreway Project in-service, it would be necessary to replace eight breakers at Hearn TGS (six after allowing for the two 'redundant' breakers) and a further eighteen breakers at Leaside TS in order to be able to operate with the 115kV busbar at Hearn TGS closed (and with Leaside open).

- Operating with the Hearn 115kV busbar split 'diagonally' (with breakers 5A6 & 7P8 open), would have only a minimal impact on the fault levels at Leaside TS although it would reduce the fault levels at Hearn TGS to within the ratings of the existing breakers.

- Operating with the Hearn 115kV busbar split 'vertically' (with breakers 6P7 & A1P8 open), would have the greatest impact on reducing the fault levels at both Leaside TS and at Hearn TGS so that they remain within the rating of the existing breakers.

  Recommended Operating Arrangement for the Leaside Sector with the four units at Pickering 'A' NGS and the Sithe-Goreway Project In-service

  - The 230kV busbars at Cherrywood North & Cherrywood South switchyards ***Open***
  - The 115kV busbar at Hearn TGS ***Open*** at breaker positions 6P7 & A1P8 (a 'vertical' split)
  - The 115kV busbar at Leaside TS ***Open***
  - Terauley TS quartered and ***Open***
  - All 115kV circuits between Leaside TS and Hearn TGS ***Closed***

  This arrangement would avoid the need to replace any of the existing breakers at Leaside TS or Hearn TGS.

Bruce 'A' NGS: Proposed return-to-service of units 3 & 4

Since the application from Bruce Power Inc. for the proposed return-to-service of two of the units at Bruce 'A' NGS has a later position in the Connection Assessments & Approvals 'Queue', the effect that these facilities will have on the fault levels at Leaside TS and Hearn NGS has not been addressed in this assessment.

However, it is intended to identify the expected contribution to the fault levels at these busbars in the assessment that is currently underway for the two generating units at Bruce 'A' NGS. Although the contributions are expected to be small because of the electrical distance between these facilities and the Leaside and Hearn busbars, they will further aggravate the high fault levels at these two locations.

5. Load Flow Analysis

Load Flow Analysis was performed for the new connection arrangement at Terauley TS using the forecast loads for the summer-2004. This time was selected because it was expected to be the first peak period following the scheduled return to service of the four units at Pickering 'A' NGS and the placing in-service of the new generating capacity at the Sithe-Goreway Project.

The forecast loads that were used corresponded to those supplied by Toronto Hydro during the summer-2001.

[A revised forecast was subsequently received from Toronto Hydro and this indicated a delay of approximately two years before the loads in the Leaside sector are expected to reach the levels that had been previously forecast.

- *The total load supplied from the 115kV TSs in the Leaside sector was originally forecast at 1505MVA for the summer-2004.*
- *From the new forecast, the total load is expected to be 1500MVA and 1525MVA for the summer-2006 and summer-2007, respectively.*

The effect that this reduction in the load forecast is expected to have will be addressed in the conclusions to this Report - Section 9.4.]

In all of the load flow studies the 125MVAr 115kV shunt capacitor bank that Hydro One Networks Inc. is proposing to install at Hearn TGS was assumed to be in-service.

In addition, the revised continuous summer ratings for the following cable circuits, which were provided by Hydro One Networks Inc. in their e-mail of 15th January 2002, were used in this analysis:

Circuits H7L & H11L - Toronto Leaside TS x Todmorden Junction	139MVA at 120kV	{both circuits
Circuits H1L & H3L - Toronto Basin TS x Mill Street Junction	129MVA at 120kV	{in-service.

The results of the studies, which examined the operating scenarios detailed below, are summarised in Tables 7 to 15, inclusive. The results have also been presented on Diagrams 10 to 18, inclusive. Since it is expected that measures could be implemented to address overloads that are less than 10%, only those overloads that exceeded 10% of the continuous rating of the cable circuits, or 10% of the emergency rating of the overhead line circuits, have been identified on the Diagrams. These operating measures could involve transferring load; operating for a very limited period at a rating that is higher than the quoted *continuous* rating for the cable circuits; or switching (i.e. closing some of the normally-open points).

The following table provides a summary of the results of the load flow analysis:

Relative Load Meeting Capabilities of the Scenarios that were Studied							
Terauley TS Quartered and Operated Open							
Diagram No./ Table No.		*Status of the 115kV busbars*		*Status of 115kV circuits at Hearn TGS*	*'Performance'/Ranking & Maximum Overloads*		
		at Leaside TS	*at Hearn TGS*				
10	7	*CLOSED*	*CLOSED*	All *CLOSED*	Very Good	1	104%
11	8	*OPEN*		All *CLOSED*	Good	2	106%
12	9			H3L & H6LC *OPEN*	Marginal	3	111%
13	10			H11L & H6LC *OPEN*	Poor	5	132%
14	11			H3L & H11L *OPEN*	Poor	6	139%
15	12			H7L & H11L *OPEN*	Poor	7	144%
16	13		*OPEN:* at breaker positions 5A6 & 7P8	All *CLOSED*	Marginal	4	111%
17	14			H3L & H11L *OPEN*	Very Poor	8	166%
18	15		*OPEN:* at breaker positions 6P7 & A1P8	All *CLOSED*	Very Poor	9	143%

Comments on the Load Flow Analysis

- *General*

  In each of the above studies, the cabled section of circuit H2JK between Don Fleet Junction and Esplanade TS, which has a continuous rating of only 104MVA, showed overloads of between 104% and 111% for the different scenarios that were considered.

  Implementing measures to increase the rating of the circuit to at least 115MVA would eliminate the overloads that were identified.

  Double-circuit Contingencies

  Double-circuit contingencies involving the following circuits will also involve a direct loss of load due to connectivity. Consequently, although the results may show either no overloading or only limited overloading of the remaining circuits, more extensive overloading could occur when attempts are made to restore the supply following isolation of the faulted sections should the two circuits remain permanently faulted.

Double-circuit Contingency	*Loads Effected*	*Forecast Peak Load Summer-2004*
Circuits H1L & H3L	Gerrard TS Carlaw TS Basin TS	191MVA
Circuits H7L & H11L	Main TS	76MVA

- *Table 7: Diagram 10*

  With circuit H2JK uprated to at least 115MVA and with the 115kV busbars at Leaside TS & Hearn TGS closed, the existing transmission facilities would be adequate to supply the forecast load for the summer-2004 while respecting a single contingency.

  A double-circuit contingency involving circuits H1L & H3L, even with a loss of over 190MVA of load, would still result in a post-contingency loading on circuits H7L & H11L of 91% of their continuous rating.

  A double-circuit contingency involving circuits H6LC & H8LC, which would result in no loss of load, would overload circuit L12C by approximately 15%.

- *Table 8: Diagram 11*

  Opening the 115kV busbar at Leaside TS would result in an overload of 106% on the Lumsden Junction to Main TS section of circuits H7L & H11L. On the assumption that these overloads can be 'managed' by implementing suitable operational measures post-contingency, then this arrangement would be acceptable for meeting the forecast loads for the summer-2004.

  A double-circuit contingency involving circuits H1L & H3L, even with a loss of over 190MVA of load, would overload circuits H7L & H11L by approximately 27% of their continuous rating.

  A double-circuit contingency involving circuits H6LC & H8LC, for which there would be no direct loss of load (due to connectivity), would overload circuit L12C by approximately 15%.

- *Table 9: Diagram 12*

  The results that are summarised in this Table show the effect of operating with two of the 115kV circuits from Leaside TS open at Hearn TGS (circuits H3L & H6LC), in order to reduce fault levels at Leaside TS and at Hearn TGS. Operating in this manner would increase the overloads on the Lumsden Junction to Main TS section of circuits H7L & H11L to 111% & 108%, respectively.

  Since the overloads on circuits H7L are expected to exceed the 10% threshold for which operational measures are expected to provide relief, then in order for this arrangement to be acceptable for meeting the forecast loads for the summer-2004, remedial action would need to be taken to increase the continuous rating of this circuit over the 1.5km section between Lumsden Junction & Main TS.

  A double-circuit contingency involving circuits H1L & H3L, with a loss of over 190MVA of load, would overload circuits H7L & H11L by approximately 31% of their continuous rating.

  Similarly, a double-circuit contingency involving circuits H7L & H11L, with an associated load loss of 76MVA would overload circuit H1L by approximately 16% of its continuous rating.

  A double-circuit contingency involving circuits H6LC & H8LC, for which there would be no direct loss of load, would overload circuit L12C by approximately 15%.

- *Table 10: Diagram 13*

  This Table shows the results for the same arrangement as before, but with circuit H11L open at Hearn TGS instead of circuit H3L.

  Since circuit H7L (the companion to circuit H11L) is more thermally limiting than circuit H1L (the companion to circuit H3L), opening circuit H11L at Hearn TGS rather than circuit H3L results in higher overloads on circuit H7L. However, as for the previous arrangement, remedial action would be required to increase the continuous rating of circuit H7L between Lumsden Junction & Main TS, in order for this arrangement to be acceptable for meeting the forecast loads for the summer-2004.

It should also be noted that the post-contingency flow on circuit H7L (~ 145MVA) would also exceed the continuous rating of 139MVA for the 0.8km cabled section between Leaside TS and Todmorden Junction. However, it would remain within the 10% threshold for which operational measures have expected to be able provide an acceptable response.

A double-circuit contingency involving circuits H1L & H3L, with an associated loss of over 190MVA of load, would overload circuit H7L by approximately 84% of its continuous rating.

A double-circuit contingency involving circuits H6LC & H8LC, for which there would be no direct loss of load, would overload circuit L12C by approximately 15%.

- *Table 11: Diagram 14*

  The results shown in this Table are for the same arrangement as in the two previous cases, but with circuits H3L & H11L open at Hearn TGS.

  This arrangement would result in a more pronounced overloading of circuit H7L between Lumsden Junction and Main TS (139%) which would require this section to be uprated to provide a higher continuous rating (of at least 153MVA) if this arrangement is to be acceptable for meeting the forecast load during the summer-2004.

  In addition, since the expected post-contingency flow of 153MVA on the section of circuit H7L between Leaside TS and Todmorden Junction would exceed the 10% threshold for which an operational response is expected to suffice, remedial action would also be required to increase the continuous rating of this section.

  A double-circuit contingency involving circuits H1L & H3L, with an associated loss of over 190MVA of load, would overload circuit H7L by approximately 75% of its continuous rating.

  A double-circuit contingency involving circuits H6LC & H8LC, for which there would be no direct loss of load, would overload circuit H7L by approximately 33% and circuit L12C by approximately 15%.

- *Table 12: Diagram 15*

  This Table shows the results for the same arrangement as in the three previous cases, but with circuits H7L & H11L open at Hearn TGS.

  Of the four arrangements considered with the Hearn 115kV busbar operated closed and with two of the Leaside TS to Hearn TGS circuits operated open at the Hearn 115kV busbar (in various combinations), this arrangement would result in the highest level of overloads.

  However, since the limiting section of circuit H3L consists of the 3km overhead line between Leaside TS & Bloor Street Junction then it might be viable to reconductor this section with larger conductors to provide a higher continuous rating. For the companion circuit H1L, in addition to having to reconductor the same section of the double-circuit overhead line, reinforcement of the 1.8km cabled section from Bloor Street Junction to Gerrard TS would also be required if this arrangement is to be suitable for supplying the projected loads for the summer-2004. (This latter reinforcement could be similar to that undertaken previously for circuit H3L involving the installation of a second cable between Bloor Street Junction to Gerrard TS and connecting it in parallel with the existing cable.)

  A double-circuit contingency involving circuits H6LC & H8LC, which would result in no loss of load, would overload circuit L12C by approximately 15%.

- *Table 13: Diagram 16*

  Operating with the Hearn 115kV busbar split at breaker positions 5A6 & 7P8 (a diagonal split) would increase the overloads on the Lumsden Junction to Main TS section of circuits H7L & H11L to 111% while also introducing post-contingency overloads of 107/108% on circuits H3L and H1L respectively.

Since the overloads on circuits H7L & H11L are shown to exceed the 10% threshold for which operational measures are expected to provide relief, then in order for this arrangement to be acceptable for meeting the forecast loads for the summer-2004, remedial action would need to be taken to increase the continuous rating of these circuits over the 1.5km section between Lumsden Junction & Main TS.

Since the post-contingency flows on these circuits (~142MVA) would also exceed the continuous rating of 139MVA for the 0.8km cabled section between Leaside TS and Todmorden Junction. However, it would remain within the 10% threshold for which operational measures have been assumed to provide an acceptable response.

A double-circuit contingency involving circuits H1L & H3L, with an associated loss of over 190MVA of load, would overload circuits H7L & H11L by approximately 19% of their continuous rating.

A double-circuit contingency involving circuits H6LC & H8LC, for which there would be no direct loss of load, would overload circuit L12C by approximately 19%.

- *Table 14: Diagram 17*

  The results that are summarised in this Table show the effect of operating with the Hearn 115kV busbar split (diagonally) and with two of the 115kV circuits from Leaside TS open at Hearn TGS (circuits H3L & H11L), in order to reduce fault levels at Leaside TS.

  With circuit H11L open at Hearn TGS, very heavy overloads (of up to 166%) have been identified on the companion circuit H7L. Furthermore, the post-contingency flows (of up to 183MVA) would exceed the continuous rating of the cabled section between Leaside TS and Todmorden Junction by approximately 32%. For this arrangement to be acceptable for meeting the forecast loads for the summer-2004, both cabled sections of circuit H7L (Leaside TS to Todmorden Junction and Lumsden Junction to Main TS) would need to be uprated.

  A double-circuit contingency involving circuits H1L & H3L, with an associated loss of over 190MVA of load, would overload circuit H7L by approximately 66% of its continuous rating.

  A double-circuit contingency involving circuits H6LC & H8LC, which would result in no loss of load, would overload circuit H7L by approximately 69% and circuit L12C by approximately 19%.

  A double-circuit contingency involving circuits L9C & L12C, which would result in no loss of load, would overload circuit H7L by approximately 25%.

- *Table 15: Diagram 18*

  The results shown in this Table correspond to the arrangement with the Hearn 115kV busbar split at breaker positions 6P7 & A1P8 (a vertical split).

  Operating in this manner would effectively reduce the utilisation of the 115kV 'eastern' circuits (H1L, H3L, H7L & H11L), while increasing the utilisation of the 'western' circuits (H6LC, H8LC, L9C & L12C). Consequently, circuits L9C & L12C are subjected to serious overloading under contingency conditions involving the companion circuit, or either circuit H6LC or circuit H8LC.

  For this arrangement to be acceptable for meeting the projected loads for the summer-2004, it would be necessary to upgrade circuits L9C & L12C throughout their entire 7.8km length.

  A double-circuit contingency involving circuits H6LC & H8LC, which would result in no loss of load, would overload circuit L12C by approximately 15%.

  A double-circuit contingency involving circuits L9C & L12C, with would result in no loss of load, would overload circuits H6LC & H8LC by approximately 33% of their continuous rating.

5.1 Discussion of the Results from the Load Flow Analysis

The results from the load flow analysis show very clearly the degradation in the load meeting capability of the existing transmission facilities that occurs with greater sectionalisation of the 115kV system.

With the 115kV busbars at Leaside TS and Hearn TGS operated *closed* (Table 7 & Diagram 10) the existing transmission facilities in the Leaside sector are shown to be adequate to supply the forecast load for the summer-2004 under single-circuit contingency conditions.

Under double-circuit contingency conditions for which there would be no loss of load due to connectivity, overloads of up to 15% (on the continuous ratings of the circuits) are expected to occur. If these cannot be addressed by immediate load transfers then it is expected that some load would need to be interrupted. For those double-circuit contingencies that result in an associated loss of load, while they do not result in immediate overloads, there could be problems restoring the load in the event that both circuits remain permanently faulted.

This would be the preferred operating arrangement for the existing facilities since there would be no overloads in response to single-circuit contingencies (apart from the common problem related to the de-rating of circuit H2JK that occurs for all the arrangements that were studied). However, reinforcement of the existing 115kV transmission system would be necessary -

i. to avoid overloads for double-circuit contingencies for which there is no accompanying loss of load, and

ii. to provide the capacity required to restore loads for those contingencies that result in an automatic supply interruption and for which the two circuits remain permanently faulted.

Opening the 115kV busbar at Leaside TS, while keeping that at Hearn TGS closed, would result in a maximum overload of 6% for single-circuit contingencies and these could probably be managed without any loss of load. However, double-circuit contingencies would result in overloads of up to 27%, even after losing more than 190MVA of load due to connectivity. If both circuits should remain permanently faulted then not only would it be difficult to restore the load that was automatically lost in response to the contingency, but additional load may need to be interrupted to respect the thermal ratings of the remaining circuits.

Consequently, this arrangement would be inferior to that with the 115kV busbars at Leaside TS and Hearn TGS operated closed. However, since the overloads resulting from single-circuit contingencies could probably be managed without any loss of load, it would represent the *minimum* arrangement that would be acceptable to the IMO until reinforcement of the 115kV system in the Leaside sector could be completed. For double-circuit contingencies during peak load periods, this arrangement is expected to require load to be interrupted to respect thermal ratings should immediate restoration of one of the faulted circuits not be possible.

For all the other arrangements that were examined, the post-contingency overloads become progressively more severe with further sectionalising of the 115kV system in the Leaside sector. None of these arrangements would therefore be acceptable to the IMO.

5.1.1 Load Transfer Capability

One of the three step-down transformers at Esplanade TS is connected to circuit H2JK. This circuit, which terminates at John TS, in the Manby sector, is normally operated with its line disconnect switch open at the John TS terminal. Closing this disconnect switch and opening the termination of this circuit at Hearn TS would therefore allow the load that is supplied from the transformer that is associated with circuit H2JK to be transferred to the Manby sector. Under peak load conditions, the load on this transformer would be approximately 65MVA.

The portion of the Manby sector that is supplied from Manby West TS is expected to be able to accommodate up to approximately 100MW of transferred load, and still be able to sustain a single-circuit contingency without overloading the local 115kV facilities, until 2006. Beyond that date, the increasing load in the area that is supplied from Manby West TS will reduce the amount of load that can be transferred.

[It should be noted that the revised load forecast that was recently received from Toronto Hydro was used in the analysis that determined the capability of the Manby sector to accommodate load transfers from the Leaside sector.]

5.1.2 Power Factor of the Loads in the Leaside Sector

Table 16 summarises the power factors measured at each of the low voltage busbars of those TSs in the Leaside sector. These range between 0.87 and 0.90 lagging, measured at the 13.8kV busbars.

Reference 1 of Appendix 4.3 of the Market Rules requires the power factor for Connected Wholesale Customers and Distributors to be within the range of 0.90 lagging and 0.90 leading as measured at the defined meter point. Since the defined meter point is required to be at a voltage greater than 50kV, this means that the power factor at the 115kV terminals of the individual TSs is required to exceed 0.90 lagging.

In order to comply with the Market Rules additional reactive compensation will need to be installed at each of the TSs. However, while the installation of facilities to raise the power factor at the TSs would help reduce the reactive power flows, while also improving the voltage profile, it would not be expected to result in a sufficient reduction in the post-contingency flows to make any of the arrangements with overloads of 10% or greater viable arrangements.

6. Combining the Results of the Fault Level Analysis with those from the Linear Load Flow Analysis

The results from the Fault Level and the Linear Load Flow analysis that was performed for this assessment show that there are two competing requirements that have a major influence on the ability to supply the load within the Leaside sector assuming that the four units at Pickering 'A' GS return to service and the Sithe-Goreway Project is developed:

i. a requirement to operate with the 115kV busbars at Leaside TS and at Hearn TGS ***closed*** to maximise the load meeting capability of the existing 115kV transmission facilities in the Leaside sector
and

ii. a requirement to operate with the 115kV busbars at Leaside TS and at Hearn TGS ***open*** to minimise fault levels and hence the number of circuit breakers that would need to be replaced.

The Table below provides an indication of the relative performance of the four principal arrangements that were examined in this assessment.

This Table concentrates on the more common single-circuit contingencies, while the second Table looks at the relative performance of the four arrangements for double-circuit contingencies.

	Status of 115kV Busbars	***Change in Post-contingency Flows on the Critical Circuits for Single-Circuit Contingencies***	***Breakers that would need to be replaced***
1	Leaside ***Closed*** Hearn ***Closed***	} Δ 10% [95% → 105% of continuous rating] *circuits H7L & H11L for H1L or H3L contingencies*	Leaside TS 28 Hearn TGS 8 (6)*
2	Leaside ***Open*** Hearn ***Closed***	} Δ 21% [90% → 111% of continuous rating] *circuits H7L & H11L for companion circuit contingency*	Leaside TS 18 Hearn TGS 8 (6)*
3	Leaside ***Open*** Hearn ***Open*** (diagonally)	} Δ 42% [85% → 127% of continuous rating] *circuit L12C for a H6LC or H8LC contingency*	Leaside TS 18 Hearn TGS 0
4	Leaside ***Open*** Hearn ***Open*** (vertically)		Leaside TS 0 Hearn TGS 0

*Note * After allowing for the two 'redundant' breakers at Hearn TGS*

Relative Performance of the Four Arrangements in Response to Double-circuit Contingencies				
Status of 115kV Busbars		***Post-contingency Flows for Double-circuit Contingencies***		
		H1L & H3L	***H6LC & H8LC***	***L9C & L12C***
1	Leaside ***Closed*** Hearn ***Closed***	91% on H7L & H11L	115% on L12C	91% on H7L
		191MVA Load Loss	No Load Loss	No Load Loss
2	Leaside ***Open*** Hearn ***Closed***	127% on H7L & H11L	115% on L12C	86% on H7L
		191MVA Load Loss	No Load Loss	No Load Loss
3	Leaside ***Open*** Hearn ***Open*** (diagonally)	119% on H7L & H11L	119% on L12C	75% on H6LC
		191MVA Load Loss	No Load Loss	No Load Loss
4	Leaside ***Open*** Hearn ***Open*** (vertically)	56% on H7L & H11L	115% on L12C	133% on H6LC & H8LC
		191MVA Load Loss	***286MVA Load Loss***	No Load Loss

Note: The shaded cells indicate those overloads that would be unacceptable.

Of the four arrangements examined, Arrangement 1, with the 115kV busbars at Leaside TS and Hearn TGS operated *closed* has the superior load supply capability, for both single- and double-circuit contingencies. However, it would require the greatest number of breakers (a total of 34) to be replaced at Leaside TS and at Hearn TGS.

The last option, Arrangement 4, although it would require no breakers to be replaced at Leaside TS or at Hearn TGS, would not be an acceptable operating arrangement because of the high level of overloads that would be expected to occur for both single- and double-circuit contingencies.

Although the two remaining arrangements require the same number of breakers (a total of 18) to be replaced at Leaside TS, only Arrangement 2 would require breakers to be replaced at Hearn TGS (a total of 6). However, this arrangement has a much better performance under single-circuit contingencies. The performance of Alternatives 2 & 3 under double-circuit contingencies would be approximately the same.

Consequently, of the four arrangements examined only Arrangements 1 & 2 represent suitable interim operating arrangements until reinforcement of the Leaside sector could be completed.

Furthermore, since it would require fewer breakers to be replaced (a total of 24 compared to 34), Alternative 2 is considered to represent the preferred compromise arrangement since it is expected that the overloads that have been identified under single-circuit contingency conditions could be managed by load transfers to the Manby sector or through the use of shorter-time thermal ratings.

7. Requirement to Enhance the Load Meeting Capability of the Leaside Sector

Since the ability to transfer loads to the Manby sector to relieve post-contingency overloads is expected to be extremely limited beyond 2006 during peak load periods, immediate action will need to be taken to implement measures that will ensure that the increasing loads within the Leaside and Manby sectors can continue to be supplied under contingency conditions.

These measures could include one or more of the following, or any other proposal that would provide an enhanced supply capability to the Leaside Sector:

i. *Install the additional generating capacity at Hearn TGS as proposed by OPG* (and addressed in the IMO's Preliminary Assessment Report).

It should be noted that for this generation to provide the required enhancement to the load meeting capability of the Leaside sector, that this generating capacity would need to be *constrained-on* during peak load periods.

ii. *Reinforce the existing transmission facilities to increase their load-meeting capability.*

iii. *Establish a third supply into downtown Toronto* - similar to that as was originally proposed in the 1995 TIES (Toronto Integrated Electrical Services) Study.

7.1 Hearn New Generation Project

Under the Hearn New Generation Project, it is proposed to install 550MW of additional generating capacity at Hearn TGS and incorporate it into the local 115kV busbar.

The analysis has shown that a total of 26 breakers at Leaside TS and a further six breakers at Hearn TGS would need to be replaced. With these breakers replaced and with the Hearn 115kV busbar operated diagonally split, the existing transmission facilities in the Leaside sector would be adequate to accommodate the full output from the new generating facilities under single-circuit contingency conditions.

The six breakers that would need to be replaced at Hearn TGS to allow the facilities proposed for the New Generation Project to be incorporated were as follows:

Breakers that would need to be replaced at Hearn TGS for the Hearn New Generation Project					
H2JK	H5E	H7E	T6A	T7P	T8P

With these six breakers replaced at Hearn TGS (together with the 26 at Leaside TS), the 550MW of new generating capacity could be incorporated into the Hearn 115kV busbar with it operated open at breaker positions 5A6 & 7P8 (a diagonal split)

From this assessment it has been determined that the following six breakers would need to be replaced at Hearn TGS to allow the Hearn 115kV busbar to be operated closed, without any new generating capacity incorporated.

Breakers that would need to be replaced to allow the Hearn 115kV busbar to be operated closed (with no new generating capacity incorporated)					
1A2 ***or*** A1P8	2A3 ***or*** 3A4	H2JK	H5E	H7E	4A5

Note: The shaded cells in the Tables above indicate those breakers that are common to both requirements.

Should the breakers identified in the two previous Tables be replaced (to allow new generation capacity to be incorporated and to allow the 115kV busbar at Hearn TGS to be operated closed whenever the new generation capacity is *not* in-service), then this would mean that only seven of the original breakers would remain. These breakers would be as follows:

Breakers at Hearn TGS that would not have been replaced						
H6LC	H8LC	H1L	H3L	H7L	H11L	T5A5

While the replacement of those breakers that have been identified in the first Table above would allow the new generation capacity to be dispatched it would still be necessary to operate with the 115kV busbar at Hearn TGS open at breaker positions 5A6 & 7P8 (a diagonal split) in order to maintain the fault levels within the ratings of the remaining breakers at Hearn TGS.

Whenever the new generating capacity is not dispatched, the Hearn 115kV busbar would need to be operated closed to maintain an acceptable load meeting capability. This would require those breakers identified in the second Table above to be replaced.

To avoid this need to routinely open and close the Hearn 115kV busbar to complement the prevailing operating status of the new generating capacity at Hearn TGS, the seven breakers identified in the third Table above would also need to be replaced.

With these seven remaining breakers also replaced, it would then be possible to keep the 115kV busbar at Hearn TGS closed under practically all conditions.

Furthermore, with the 26 breakers at Leaside TS and all of the breakers at Hearn TGS replaced (and with the two 'redundant' breakers at Hearn TGS by-passed) it would then be possible to install additional transmission facilities to enhance the supply capability of the Leaside sector without raising concerns about the effect they would have on increasing the fault levels.

7.2 Reinforce the existing transmission facilities to increase their load-meeting capability.

This assessment has indicated that the existing transmission facilities in the Leaside sector are expected to be marginally adequate for meeting the forecast load for the summer-2006. This assumes that post-contingency load transfers to the adjacent Manby sector together with the use of shorter-time thermal ratings would be used to address the overloads that could occur under single-circuit contingency conditions. For double-circuit contingencies, some loss of load is expected to occur during peak load periods until facilities can be returned to service.

In the absence of new generating capacity, then the existing transmission facilities would need to be reinforced to ensure that they are adequate to meet the forecast loads for the period beyond 2006.

However, from the results of this assessment it can be shown that should these new transmission facilities result in an increase in the asymmetrical fault level at Leaside TS of only 1.3kA, then all of the remaining eight 115kV breakers would need to be replaced. This would be in addition to the eighteen breakers that have already been identified for replacement.

At Hearn TGS there would need to be an increase in the asymmetrical fault level of approximately 3.2kA before the next two critical breakers would need to be replaced. Such an increase in the fault level is considered unlikely unless major reinforcement of the existing transmission system were to be occur.

Consequently, should it be decided to reinforce the existing transmission facilities to increase the load meeting capability of the Leaside sector, it has been assumed that a *minimum* of 34 breakers would need to be replaced (26 at Leaside TS and eight at Hearn TGS).

Replacing Existing Breakers

There are concerns within the IMO regarding the amount of time that is expected to be required to replace the number of breakers that have been identified at Leaside TS and Hearn TGS should it be decided to either install new generation capacity at Hearn TGS or to reinforce the existing transmission facilities to enhance the load meeting capability to the Leaside sector.

Furthermore, restrictions on when the necessary outages to undertake the replacement of the breakers can be obtained, particularly should it be determined that the existing 115kV buswork also needs to be replaced, could further extend the time required to complete the work.

Should it be decided to install new generating capacity or to reinforce the existing transmission facilities, or possibly to do both, then work would need to commence as soon as possible to ensure that the necessary breaker replacement work can be completed in time to ensure that the supply capability to the Leaside sector can be enhanced by 2006, at the latest.

7.3 Establish a third supply into downtown Toronto similar to that as originally proposed in the TIES Study

The IMO has recently completed, or is in the process of completing, a number of assessments for new or modified connections to the IMO-controlled grid in the GTA. These assessments have identified possible future deficiencies that will need to be addressed to ensure the continued reliability of the supply to the GTA and more particularly, the Leaside and Manby sectors.

Specifically, these issues are as follows:

- 230kV transmission circuits between Cherrywood TS and Leaside TS

  The post-contingency flows on the companion circuit for single-circuit contingencies involving any of these 230kV circuits is expected to exceed its continuous rating for the forecast peak loads from 2004 onwards. However, since these flows are expected to remain within the 50-hour emergency rating of the circuit until at least 2010, there is considered to be sufficient time to either return the faulted circuit to service or to transfer loads to other circuits so as to relieve the overloads.

  For double-circuit contingencies during peak load periods, the post-contingency flows are expected to exceed the 50-hour emergency rating, although they are expected to remain within the 15-minute limited-time-rating of the individual circuits, until the end of the decade. This would mean that there would only be a limited amount of time available in which to either return at least one of the faulted circuits to service or to transfer loads to relieve the overloads. If neither of these actions were successful then load would need to be rejected.

  Furthermore, since the post-contingency flows for double-circuit contingencies under peak load conditions are expected to exceed the 15-minute limited-time-ratings early in the next decade, there would be no time available to take corrective action. Consequently, if loss of load is to be avoided, reinforcement of the 230kV transmission facilities will be required by the end of the decade.

- 230/115kV auto-transformers at Leaside TS

  The post-contingency flow through the companion auto-transformer when one of the transformers is out-of-service (or its associated circuit experiences a contingency) is expected to exceed its 10-day emergency rating during peak load periods starting in 2007 (for T11), or 2008 (for T14, T15 & T17) or 2009 (for T16). However, since these flows are expected to remain within the 2-hour limited-time-ratings of the auto-transformers there would be a very limited amount of time available to return the transformer to service or to transfer load to relieve the overload. If neither of these actions were successful then load would need to be rejected.

  For contingencies that result in the simultaneous outage of transformers T16 & T17, the post-contingency transfer through the remaining auto-transformer, T15, during peak load periods for the period 2008 onwards is expected to exceed its 2-hr limited-time rating. This means that if it is not possible to return one of the outage transformers to service immediately, via switching, then it would be necessary to interrupt load. The situation for auto-transformers T14 & T16 is also expected to become critical starting in 2011.

  It is therefore expected that additional auto-transformer capacity will need to be installed at Leaside TS by 2008.

- 115kV transmission facilities in the Leaside sector

  This assessment has indicated that reinforcement of the 115kV facilities will be needed no later than 2006 if supply interruptions are to be avoided for single-circuit contingencies, under peak load conditions. This assumes that it will be possible to continue to operate with the 115kV busbar at Hearn TGS closed, and that post-contingency load transfers to the Manby sector and/or the use of shorter-time thermal ratings will be used to address overloads.

For double-circuit contingencies, reinforcement of the 115kV system will be needed by 2005, assuming that a combination of load transfers and the use of shorter-time thermal ratings are employed to address overloads during the intervening period.

It should be noted that the opportunity to transfer loads to the Manby sector during peak load periods is expected to be exhausted in 2006 due to the increasing loads in the two sectors.

- 230kV auto-transformer capacity at Manby TS

  With three 250MVA auto-transformers at both Manby East & Manby West TS, and a load of approximately 450MVA and 500MVA at each location, respectively, there is adequate transformer capacity to sustain the loss of a single transformer at each location. However, serious difficulties arise when attempting to schedule outages for each of the transformers at the two locations.

  With one transformer at Manby East or Manby West TS out-of-service, the subsequent loss of one of the two companion auto-transformers could severely overload the remaining auto-transformer, particularly during periods of high load. While there would be some scope to transfer some of the loads that are supplied from Manby East TS to the Leaside sector (as long as all the elements in the Leaside sector are in-service) there is only a very small transfer capability available from Manby West TS.

  The section of circuit H2JK, between Hearn TGS and John TS, via Esplanade TS, which is normally operated open at John TS, has recently been de-rated to 104MVA. Since this circuit is normally loaded to between 50MVA and 65MVA, representing approximately one third of the load at Esplanade TS, there is very little capacity available to transfer loads.

  It is therefore expected that additional transformer capacity will need to be installed at Manby West TS in the next two or three years, particularly should there be higher than forecast load growth in the are supplied from Strachan TS and John TS.

- 115kV transmission facilities in the Manby sector

  For single-circuit contingencies, while the post-contingency flows are expected to exceed the continuous ratings of the circuits, they are expected to remain within the emergency ratings, for the forecast loads through to the end of the decade. Consequently, the existing 115kV facilities would appear to be adequate to sustain a single-circuit contingency through to 2010.

  For double-circuit contingencies involving those 115kV circuits associated with Manby East TS, the post-contingency flows are not significantly higher than those for single-circuit contingencies, because of the automatic loss of load that occurs. For a K1W & K3W contingency, the loads at Fairbank TS and Wiltshire TS would be interrupted, while for a K11W & K12W contingency, the load at Runnymede TS would be automatically interrupted. However, restoring these loads for a permanent double-circuit fault would require load transfers to be made to the Leaside sector.

  For double-circuit contingencies involving circuits H2JK & K6J that are connected to Manby West TS, the load at Strachan TS would be similarly lost, and the post-contingency flows on the post-contingency flows on the remaining circuits are expected to remain within their emergency rating. Restoring the load at Strachan for a permanent double-circuit fault would require load transfers to be made to the Leaside sector. However, unless circuit H2JK is uprated this capability will not be available.

  For double-circuit contingencies involving circuits K13J & K14J, for which there would be no automatic loss of load, the emergency ratings are expected to be exceeded starting in 2003/2004 at the load levels forecast for those years.

  Without the capability to transfer a significant amount of load to the Leaside sector post-contingency it is expected that reinforcement of the 115kV transmission connected to Manby West TS will be required within the next two or three years.

This assessment has concluded that even if there was no fault level problem and it were possible to operate with the 115kV busbars at both Leaside TS and Hearn TGS *closed,* then additional facilities would still be required to enhance the load-meeting-capability of the existing transmission system in downtown Toronto. These facilities could involve the installation of the new generation capacity that has been proposed for Hearn TGS or the installation of new transmission facilities, or possibly a combination of both to cater for the situation when the generation is not dispatched.

Since additional facilities will need to be installed to meet the longer-term needs of downtown Toronto and since there are expected to be significant difficulties associated with the replacement of the substantial number of circuit breakers that have been identified at Leaside TS and Hearn TGS, the IMO believes that consideration should be given to the installation of a third supply into downtown Toronto, similar to that which was recommended in the 1995 TIES (Toronto Integrated Electrical Services) Study.

A third supply would allow a portion of the load that is currently supplied from Cherrywood TS, via Leaside TS, to be transferred to it. This would avoid the need to reinforce the Cherrywood to Leaside TS corridor, while also allowing the 115kV busbars at Leaside TS and Hearn TGS to be operated open, thereby avoiding any increase in the fault level and the need to replace breakers.

It would also permit a portion of the load that is currently supplied from Manby West TS to be transferred to it. Based on the latest load forecast, reinforcement of the Manby sector is required immediately in order to meet the IMO's criterion that restoration of the supply to loads in excess of 250MW is to be possible through switching (i.e. within a maximum of 30 minutes), following a double-circuit contingency. Since the Leaside sector has no capability to accommodate transferred loads, then in order to meet this criterion the remaining facilities in the Manby sector would need to be capable of supporting all of the local load. Without further reinforcement, the existing facilities do not have this capability.

However, while the installation of a third supply into downtown Toronto is expected to meet the future supply requirements of the area, the IMO has concerns regarding the time that would be required to implement such a plan.

7.4 Proposed Interim Operating Mode

The analysis that has been performed for this assessment has shown that in order to minimise post-contingency overloads and the subsequent risk of supply interruptions, the 115kV busbar at Hearn TGS must be operated closed. However, with the 115kV busbar closed, the fault levels at Leaside TS and at Hearn TGS are expected to exceed the fault interrupting capability of the existing breakers.

To manage the situation until a permanent solution can be developed, it is proposed that the IMO review its operating instructions for the area.

This could involve imposing a restriction on the maximum voltage at which the 115kV busbars at Leaside TS and Hearn TGS can be operated when the critical generating facilities are in-service.

Furthermore, there is expected to be some relief in the fault levels at Leaside TS and Hearn TGS when Lakeview GS ceases operations in 2005. However, any reductions could be off-set by the contribution from the Sithe-Southdown Project should the development of this facility proceed on schedule.

Should restrictions be imposed on the maximum voltage at which the 115kV busbars at Leaside TS and Hearn TGS can be operated, then this could also require the installation of further shunt capacitance at Hearn TGS and/or Leaside TS beyond the 125MVAr that is currently proposed for installation at Hearn TGS in May 2003 to support the voltages in the Hearn area.

It should be emphasised that limiting the maximum voltage at the 115kV busbars at Leaside TS and at Hearn TGS to ensure that the fault levels remain within the ratings of the existing breakers would only be acceptable as a short-term measure because of the constraints that it would impose on the operation of the system. From the results in Table 4, that show an expected asymmetrical fault level at Leaside TS of 46.78kA for a pre-fault voltage of 127kV, the maximum voltage would need to be limited to approximately 123kV to respect the 45.5kA rating of the existing breakers.

However, the *minimum* pre-contingency voltage at which the Leaside 115kV busbar is currently allowed to be operated to maintain acceptable post-contingency voltages is 119kV. Consequently, imposing a maximum voltage of only 123kV would leave a voltage range of just 4kV in which to operate the area under different loading scenarios. This may well prove to be unduly restrictive.

It is worth noting that limiting the voltage at Leaside TS to allow the 115kV busbars at both Leaside TS and Hearn TGS to be operated *closed*, to take advantage of the superior load meeting capability of this arrangement, would not be an option. For the fault levels to be maintained within the rating of the existing breakers at Leaside TS, the voltage at that busbar would need to be limited to just 108kV. This would be less than the minimum voltage of 119kV at which this busbar is to be operated.

8. 115kV Capacitor Bank at Hearn TGS

Prior to commencing this assessment for the quartering of Terauley TS, Hydro One Networks Inc. submitted an application for an assessment of their proposal to install a 125MVAr shunt capacitor bank at Hearn TGS.

This new capacitor bank is to be connected to the 115kV busbar at Hearn TGS as shown in Diagram 19.
Hydro One Networks Inc. is proposing to replace the primary circuit breaker, SC11SC, on the existing capacitor bank, SC11, with a new IPO (independent pole operation) unit that will have a synchronised closing capability. The breaker that is to be removed will be used as the back-up breaker for the new capacitor bank. A second IPO breaker, that will be used for the primary switching duties on the new capacitor bank, is to be installed in series with the relocated breaker, SC11SC.

Current limiting reactors are also to be installed on both the new capacitor bank and the existing capacitor bank.

The new 125MVAr capacitor bank at Hearn TS was assumed to be in-service in all the analysis that was performed for this assessment.

The studies that were performed have confirmed the need for this new capacitor bank to maintain an acceptable voltage profile within the immediate area around Hearn TGS and also to reduce the reactive power transfers through the auto-transformers at Leaside TS.

Further capacitor banks are also expected to be required depending on the timing of any development to enhance the supply capability to the Leaside sector and on the particular measures that it is decided to adopt for addressing the fault levels problems at Leaside TS and Hearn TGS once the four units at Pickering 'A' NGS are returned to service.

Based on the results from this assessment it is proposed to address the application from Hydro One Inc. for the installation of a new capacitor bank at Hearn TGS through the expedited CAA Process

9. Conclusions and Recommendations

This assessment has concluded that the proposal to quarter Terauley TS and to operate with the two new circuit-switchers normally-open will have no immediate adverse impact on the IMO-controlled grid. However, to avoid possible overloading of the companion circuit between Cecil TS and Terauley TS under contingency conditions involving one of these cabled circuits, during peak load periods, it is considered crucial that this work be completed as soon as possible.

In addition, when Terauley TS is quartered and operated open, approximately half the load at this TS will be transferred to the circuits between Hearn TGS and Terauley TS, via Esplanade TS. This assessment has shown that, following the quartering of Terauley TS and the associated load transfer on to the Hearn 115kV busbar, it will be necessary to operate with the 115kV busbars at Leaside TS and Hearn TGS *closed* to secure the supply to the load under single-circuit contingency condition. For double-circuit contingencies, post-contingency load transfers will be necessary.

However, since operating with the Leaside 115kV busbar *closed* has been shown to result in fault levels that will exceed the rating of the existing breakers at that location, this busbar will therefore have to be operated *open*.

With the 115kV busbar at Leaside TS operated *open* and that at Hearn TGS operated *closed*, post-contingency load transfers will need to be made to the Manby sector to address the overloads that are expected to occur for both single- and double-circuit contingencies. In addition, where load transfers are not sufficient to address the overloads resulting from double-circuit contingencies, loads may have to be interrupted.

Once the four units at Pickering 'A' have been returned to service, the fault levels at Leaside TS, even with the 115kV busbar operated *open*, are expected to exceed the rating of the existing breakers. Since operating with the Hearn 115kV busbar *open* would not be acceptable because of its adverse effect on the supply capability of the Leaside sector, special *interim* measures will need to be implemented to address the high fault levels that will result from operating with the 115kV busbar at Hearn TGS *closed.* These measures could involve limiting the maximum voltage at which the Leaside 115kV busbar can be operated.

These *interim* measures will need to be employed until either action is taken to reduce the short circuit level to acceptable values in the Leaside sector or the 24 breakers (18 at Leaside TS and a further six at Hearn TGS) can be replaced that will allow the 115kV busbar at Hearn TGS to be operated *closed.*

In addition, it is expected that the overloads that would be expected to occur under single-circuit contingency conditions, during peak load periods, can only be managed until about 2006, by using post-contingency load transfers to the Manby sector and shorter-time thermal ratings for the transmission circuits. Beyond 2006, it is expected that the increasing loads in both the Manby and Leaside sectors will preclude the use of load transfers during peak load periods.

It has therefore been concluded that measures to enhance the supply to downtown Toronto will need to be implemented as soon as possible.

Although not intended to be exhaustive, the following list represents some alternatives that might be suitable for further consideration:

i. *Install the additional generating capacity at Hearn TGS as proposed by OPG* (and addressed in the IMO's Preliminary Assessment Report).

This would require a total of 32 breakers to be replaced; 26 at Leaside TS and six at Hearn TGS. It would also require the 115kV busbar at Hearn TGS to be opened (diagonally at breaker positions 5A6 & 7P8) whenever the generation capacity is dispatched.

ii. *Reinforce the existing transmission facilities to increase their load-meeting capability.*

This would require a total of at least 26 breakers to be replaced; a minimum of 18 at Leaside TS and eight at Hearn TGS.

iii. *Install the additional generating capacity at Hearn TGS as proposed by OPG* ***AND*** *Reinforce the existing transmission facilities.*

This would require a minimum of 35 breakers to be replaced; 26 at Leaside TS and nine at Hearn TGS.

Note: For Options i. & iii. above, in order to avoid having to routinely open the 115kV busbar at Hearn TGS whenever the new generating capacity is dispatched, it would be necessary to replace all of the remaining breakers at Hearn TGS.

This would therefore increase the total number of breakers that would need to be replaced for Options i. & iii. to 42; 26 at Leaside TS & 16 at Hearn TGS.

iv. *Establish a third supply into downtown Toronto similar to that as originally proposed in the TIES Study.*

On the assumption that the increased fault levels that will occur once the Pickering 'A' units are returned to service can be successfully 'managed' to allow the 115kV busbar at Hearn TGS to be operated closed, then it should be possible to avoid having to replace any of the breakers at either Leaside TS or Hearn TGS until a third supply into downtown Toronto can be completed.

9.1 Proposals to Enhance the Supply to downtown Toronto

The analysis performed for this assessment has demonstrated that for the period commencing in 2006, it is expected that there will be supply interruptions in the event that a single-circuit contingency should occur during the peak load periods. Furthermore, due to the limited capability to transfer load to other supply points, these interruptions could be for extended periods until the faulted facilities can be returned to service.

Since it is expected that it will take a number of years before any of the plans can be completed and the supply capability to downtown Toronto enhanced accordingly, the IMO will be endeavouring to obtain a firm commitment from one or more of the proponents as soon as possible, that they intend to proceed with their respective developments.

9.2 New 115kV Capacitor Bank at Hearn TGS

It has been determined that the new 115kV shunt capacitor bank that Hydro One Networks Inc. is proposing to install at Hearn TGS is required to maintain an acceptable voltage profile in the area and to limit reactive power flows within the Hearn area. Since minimal additional analysis is expected to be required to assess the impact of the connection of this new facility on the IMO-controlled grid, it is proposed to deal with this application through the expedited CAA Process.

9.3 Revised Load Forecast

As mentioned in Section 5, a revised load forecast was received from Toronto Hydro after the load flow analysis for this assessment had been completed.

After reviewing the new forecast it was concluded that the revised values represented a delay of approximately two years before the load levels represented in the earlier forecast would be reached. Consequently, the results presented in this assessment for the summer-2004 would now apply to the summer-2006.

This means that the severity of the overloads will be less pronounced during the period that includes the summer-2005. However, post-contingency load-transfers to the Manby sector are still expected to be required for both single-circuit and double-circuit contingencies.

Since the analysis that was performed on the Manby sector to determine its ability to accept load transfers from the Leaside sector used the *latest* load forecast from Toronto Hydro, 2006 will remain a critical year. Beyond that date, it is expected that the Manby sector will be unable to accommodate load transfers that are equivalent to a third of the load at Esplanade TS. Without the ability to transfer part of the load at Esplanade TS to the Manby sector, single-circuit contingencies that occur during peak load periods beyond 2006 are expected to require load interruptions.

Furthermore, since the fault level problems at Leaside TS and Hearn TGS become an issue once the four units at Pickering 'A' are returned to service, there will continue to be some urgency to implement a permanent solution.

10. Identification of 'Sole Beneficiary'

Since the IMO has not identified any additional system requirements that need to be completed for the proposed quartering of Terauley TS (other than those required under the Market Rules), there are no facilities for which a 'sole beneficiary' needs to be identified.

11. Need for a System Impact Assessment

Based on the results of this assessment it has been concluded that all the necessary analysis to determine the impact that the proposal to quarter Terauley TS will have on the IMO-controlled grid has been undertaken.

A separate System Impact Assessment is therefore not considered to be necessary for this Project.

12. Customer Impact Assessment

Hydro One Networks Inc., in consultation with the IMO, has concluded that this Project will have no adverse impact on any other customers in the area, and that a formal Customer Impact Assessment is not required.

13. Notification of Approval of the Connection Proposal

By extending the scope of this Preliminary Assessment, the IMO has completed its review of the proposal by Hydro One Networks Inc. to quarter Terauley TS. The IMO has concluded that not only will the proposed changes at Terauley TS have no immediate adverse impact on the IMO-controlled grid but that the work needs to be completed as soon as possible to avoid possible overloading of the companion circuit between Cecil TS and Terauley TS under contingency conditions involving one of these cabled circuits, during peak load periods.

It is therefore recommended that a *Notification of Approval for Connection* be issued for this Project.

TABLES

Table 1. Pickering 'A' out-of-service: Cherrywood North & South busbars closed Study Reference: 02hearnnewgen8.

	Status of 115kV busbars & 115kV circuits					***Fault Levels*** *(for a Pre-fault Voltage of 127kV)*							
						Leaside				***Hearn***			
						Symmetrical		***Asymmetrical***		***Symmetrical***		***Asymmetrical***	
						Breaker Rating: 39.3kA		*Breaker Rating: 45.5kA*		*Breaker Rating: 31.4kA*		*Breaker Rating: 34.1kA*	
	Hearn 115kV busbar	*Leaside 115kV busbar*	*Terauley 115kV busbar*	*115kV circuits at Hearn TGS*		***3-phase***	***L-G***	***3-phase***	***L-G***	***3-phase***	***L-G***	***3-phase***	***L-G***
1	***Closed***	Closed	Open	All Closed		35.05kA	***41.73kA***	45.29kA	***50.36kA***	29.06kA	28.83kA	34.03kA	29.61kA
2				H3L Open H11L Open		35.05kA	***41.74kA***	45.32kA	***50.37kA***	26.95kA	26.28kA	30.59kA	26.67kA
3			Closed	All Closed		35.06kA	***41.73kA***	45.33kA	***50.37kA***	29.70kA	29.72kA	***35.14kA***	29.72kA
4				H3L Open H11L Open		35.05kA	***41.73kA***	45.32kA	***50.36kA***	28.07kA	27.64kA	33.16kA	27.64kA
5		***Open***	***Open***	***All Closed***	*Leaside West*	30.87kA	35.33kA	39.70kA	44.76kA	28.78kA	28.36kA	33.20kA	29.12kA
					Leaside East	30.94kA	35.35kA	40.07kA	45.24kA				
6				H3L Open H11L Open	*Leaside West*	30.27kA	34.74kA	39.41kA	44.47kA	26.94kA	26.20kA	30.06kA	26.59kA
					Leaside East	30.33kA	34.70kA	39.42kA	44.87kA				
7			Closed	All Closed	*Leaside West*	31.30kA	35.82kA	39.15kA	44.88kA	29.63kA	29.52kA	***35.53kA***	31.83kA
					Leaside East	31.37kA	35.83kA	40.13kA	45.40kA				
8				H3L Open H11L Open	*Leaside West*	30.58kA	35.10kA	39.54kA	45.39kA	27.93kA	27.53kA	32.54kA	29.68kA
					Leaside East	30.64kA	35.05kA	39.87kA	45.33kA				

Table 2. Pickering 'A' in-service: Cherrywood North & South busbars split Study Reference: 02hearnnewgen8c.

	Status of 115kV busbars & circuits					Fault Levels (for a Pre-fault Voltage of 127kV)							
						Leaside				Hearn			
						Symmetrical		Asymmetrical		Symmetrical		Asymmetrical	
						Breaker Rating: 39.3kA		Breaker Rating: 45.5kA		Breaker Rating: 31.4kA		Breaker Rating: 34.1kA	
	Hearn 115kV busbar	Leaside 115kV busbar	Terauley 115kV busbar	115kV circuits at Hearn TGS		3-phase	L-G	3-phase	L-G	3-phase	L-G	3-phase	L-G
1	Closed	Closed	Open	All closed		36.66kA	**43.26kA**	**47.81kA**	**52.90kA**	30.16kA	29.54kA	**35.59kA**	30.34kA
						+1.61kA	**+1.53kA**	**+2.52kA**	**+2.54kA**	+1.10kA	+0.71kA	**+1.56kA**	+0.73kA
2				H3L Open H11L Open		36.66kA	**43.26kA**	**47.85kA**	**52.90kA**	27.89kA	26.87kA	31.66kA	27.27kA
						+1.61kA	**+1.52kA**	**+2.53kA**	**+2.53kA**	+0.94kA	+0.59kA	+1.07kA	+0.60kA
3			Closed	All closed		36.67kA	**43.26kA**	**47.85kA**	**52.90kA**	30.85kA	30.48kA	**36.50kA**	30.48kA
						+1.61kA	**+1.53kA**	**+2.52kA**	**+2.53kA**	+1.15kA	+0.76kA	**+1.36kA**	+0.76kA
4				H3L Open H11L Open		36.66kA	**43.25kA**	**47.84kA**	**52.20kA**	29.10kA	28.29kA	**34.37kA**	28.29kA
						+1.61kA	**+1.52kA**	**+2.52kA**	**+1.84kA**	+1.03kA	+0.65kA	**+1.21kA**	**+0.65kA**
5		Open	Open	All closed	*Leaside West*	32.11kA	36.41kA	41.59kA	**46.60kA**	29.85kA	29.05kA	**34.44kA**	29.83kA
						+1.24kA	+1.08kA	+1.89kA	**+1.84kA**				
					Leaside East	32.18kA	36.43kA	41.68kA	**46.63kA**				
						+1.24kA	+1.08kA	+1.61kA	**+1.39kA**	+1.07kA	+0.69kA	+1.24kA	+0.71kA
6				H3L Open H11L Open	*Leaside West*	31.46kA	35.78kA	40.93kA	**45.80kA**	27.87kA	26.78kA	31.63kA	27.18kA
						+1.19kA	+1.04kA	+1.52kA	**+1.33kA**				
					Leaside East	31.52kA	35.75kA	41.17kA	**46.22kA**				
						+1.19kA	+1.05kA	+1.75kA	**+1.35kA**	+0.93kA	+0.58kA	+1.57kA	+0.59kA
7			Closed	All closed	*Leaside West*	32.57kA	36.93kA	41.07kA	**46.27kA**	30.77kA	30.27kA	**36.89kA**	32.63kA
						+1.27kA	+1.11kA	+1.92kA	**+1.39kA**				
					Leaside East	32.65kA	36.94kA	41.76kA	**46.81kA**				
						+1.28kA	+1.11kA	+1.63kA	**+1.41kA**	+1.14kA	+0.75kA	+1.36kA	+0.80kA
8				H3L Open H11L Open	*Leaside West*	31.80kA	36.17kA	41.43kA	**46.77kA**	28.94kA	28.18kA	**34.18kA**	30.38kA
						+1.22kA	+1.07kA	+1.89kA	**+1.38kA**				
					Leaside East	31.86kA	36.12kA	41.68kA	**46.70kA**				
						+1.22kA	+1.07kA	+1.81kA	**+1.37kA**	+1.01kA	+0.65kA	+1.64kA	+0.70kA

Table 3. Pickering 'A' out-of-service: Sithe - Goreway in-service: Cherrywood North & South busbars closed Study Reference: 02hearnnewgen8d.

	Status of 115kV busbars & 115kV circuits					***Fault Levels*** *(for a Pre-fault Voltage of 127kV)*							
						Leaside				***Hearn***			
						Symmetrical		***Asymmetrical***		***Symmetrical***		***Asymmetrical***	
						Breaker Rating: 39.3kA		*Breaker Rating: 45.5kA*		*Breaker Rating: 31.4kA*		*Breaker Rating: 34.1kA*	
	Hearn 115kV busbar	*Leaside 115kV busbar*	*Terauley 115kV busbar*	*115kV circuits at Hearn TGS*		***3-phase***	***L-G***	***3-phase***	***L-G***	***3-phase***	***L-G***	***3-phase***	***L-G***
1	***Closed***	Closed	Open	All Closed		35.31kA	***41.97kA***	***45.61kA***	***50.66kA***	29.23kA	28.94kA	***34.49kA***	29.73kA
						+0.26kA	***+0.24kA***	***+0.32kA***	***+0.30kA***	*+0.17kA*	*+0.11kA*	*+0.46kA*	*+0.12kA*
2				H3L Open H11L Open		35.30kA	***41.97kA***	***45.65kA***	***50.66kA***	27.10kA	26.37kA	30.76kA	26.77kA
						+0.25kA	***+0.23kA***	***+0.33kA***	***+0.29kA***	*+0.15kA*	*+0.09kA*	***+0.17kA***	*+0.10kA*
3			Closed	All Closed		35.31kA	***41.97kA***	***45.65kA***	***50.66kA***	29.88kA	29.84kA	***35.35kA***	29.84kA
						+0.25kA	***+0.24kA***	***+0.32kA***	***+0.29kA***	*+0.18kA*	*+0.12kA*	*+0.21kA*	*+0.12kA*
4				H3L Open H11L Open		35.30kA	***41.97kA***	***45.65kA***	***50.65kA***	28.23kA	27.74kA	33.34kA	27.74kA
						+0.25kA	*+0.24kA*	*+0.33kA*	*+0.29kA*	*+0.16kA*	*+0.10kA*	*+0.18kA*	*+0.10kA*
5		***Open***	***Open***	***All Closed***	*Leaside West*	31.07kA	35.50kA	39.95kA	44.97kA	28.94kA	28.47kA	33.40kA	29.24kA
						+0.80kA	*+0.17kA*	*+0.25kA*	*+0.21kA*				
					Leaside East	31.14kA	35.52kA	40.32kA	45.46kA				
						+0.20kA	*+0.17kA*	*+0.25kA*	*+0.22kA*	*+0.16kA*	*+0.11kA*	*+0.20kA*	*+0.12kA*
6				H3L Open H11L Open	*Leaside West*	30.46kA	34.91kA	39.65kA	44.68kA	27.08kA	26.30kA	30.74kA	26.69kA
						+0.19kA	*+0.17kA*	*+0.24kA*	*+0.21kA*				
					Leaside East	30.52kA	34.87kA	39.67kA	45.08kA				
						+0.19kA	*+0.17kA*	*+0.25kA*	*+0.21kA*	*+0.14kA*	*+0.10kA*	***+0.68kA***	*+0.10kA*
7			Closed	All Closed	*Leaside West*	31.50kA	35.99kA	39.40kA	45.10kA	29.81kA	29.65kA	***35.74kA***	31.96kA
						+0.20kA	*+0.17kA*	*+0.25kA*	***+0.22kA***				
					Leaside East	31.58kA	36.00kA	40.38kA	***45.62kA***				
						+0.21kA	*+0.17kA*	*+0.25kA*	***+0.22kA***	*+0.18kA*	*+0.13kA*	*+0.21kA*	*+0.13kA*
8				H3L Open H11L Open	*Leaside West*	30.77kA	35.27kA	39.79kA	***45.60kA***	28.09kA	27.64kA	33.18kA	29.79kA
						+0.19kA	*+0.17kA*	*+0.25kA*	***+0.21kA***				
					Leaside East	30.84kA	35.22kA	40.12kA	***45.54kA***				
						+0.20kA	*+0.17kA*	*+0.25kA*	***+0.21kA***	*+0.16kA*	*+0.11kA*	*+0.64kA*	*+0.11kA*

Table 4. Pickering 'A' in-service: Sithe - Goreway in-service: Cherrywood North & South busbars split Study Reference: 02hearnnewgen8e.

	Status of 115kV busbars & circuits					Fault Levels (for a Pre-fault Voltage of 127kV)							
						Leaside				Hearn			
						Symmetrical		Asymmetrical		Symmetrical		Asymmetrical	
						Breaker Rating: 39.3kA		Breaker Rating: 45.5kA		Breaker Rating: 31.4kA		Breaker Rating: 34.1kA	
	Hearn 115kV busbar	Leaside 115kV busbar	Terauley 115kV busbar	115kV circuits at Hearn TGS		3-phase	L-G	3-phase	L-G	3-phase	L-G	3-phase	L-G
1	Closed	Closed	Open	All closed		36.84kA	**43.43kA**	**48.05kA**	**53.10kA**	30.29kA	29.63kA	**35.73kA**	30.43kA
						+1.79kA	**+1.70kA**	**+2.76kA**	**+2.74kA**	+1.23kA	+0.80kA	+1.70kA	+0.82kA
2				H3L Open H11L Open		36.85kA	**43.42kA**	**48.08kA**	**52.41kA**	28.00kA	26.94kA	31.78kA	27.34kA
						+1.80kA	**+1.68kA**	**+2.76kA**	**+2.04kA**	+1.05kA	+0.66kA	**+1.19kA**	+0.67kA
3			Closed	All closed		36.85kA	**43.43kA**	**48.08kA**	**52.42kA**	30.98kA	30.56kA	**36.65kA**	30.56kA
						+1.79kA	**+1.70kA**	**+2.75kA**	**+2.05kA**	+1.28kA	+0.84kA	**+1.51kA**	+0.84kA
4				H3L Open H11L Open		36.84kA	**43.43kA**	**48.07kA**	**52.41kA**	29.22kA	28.36kA	**34.51kA**	28.36kA
						+1.79kA	+1.70kA	+2.75kA	**+2.05kA**	+1.15kA	+0.72kA	**+1.35kA**	+0.72kA
5		Open	Open	All closed	Leaside West	32.25kA	36.53kA	41.77kA	**46.76kA**	29.97kA	29.13kA	**34.58kA**	29.92kA
						+1.38kA	+1.20kA	+2.07kA	**+2.00**				
					Leaside East	32.33kA	36.55kA	41.86kA	**46.78kA**				
						+1.39kA	+1.20kA	+1.79kA	**+1.54kA**	+1.19kA	+0.77kA	+1.38kA	+0.80kA
6				H3L Open H11L Open	Leaside West	31.59kA	35.90kA	41.10kA	**45.95kA**	27.98kA	26.85kA	31.76kA	27.25kA
						+1.32kA	+1.16kA	+1.69kA	**+1.48kA**				
					Leaside East	31.66kA	35.86kA	41.35kA	**46.37kA**				
						+1.33kA	+1.16kA	+1.93kA	**+1.50kA**	+1.04kA	+0.65kA	**+1.70kA**	+0.66kA
7			Closed	All closed	Leaside West	32.72kA	37.05kA	41.26kA	**46.43kA**	30.90kA	30.36kA	**37.05kA**	32.72kA
						1.42kA	+1.23kA	+2.11kA	**+1.55kA**				
					Leaside East	32.80kA	37.07kA	41.95kA	**46.96kA**				
						+1.43kA	+1.24kA	+1.82kA	**+1.56kA**	+1.27kA	++0.84kA	**+1.52kA**	+0.89kA
8				H3L Open H11L Open	Leaside West	31.93kA	36.29kA	41.61kA	**46.92kA**	29.05kA	28.25kA	**34.31kA**	30.45kA
						+1.35kA	+1.19kA	+2.07kA	**+1.53kA**				
					Leaside East	32.03kA	36.24kA	41.86kA	**46.85kA**				
						+1.39kA	+1.19kA	+1.99kA	**+1.52kA**	+1.12kA	+0.72kA	+1.77kA	+0.77kA

Table 5. Pickering 'A' in-service: Sithe - Goreway in-service: Cherrywood North & South busbars 'split' Study Reference: 02hearnnewgen8e1

Status of 115kV busbars & 115kV circuits						***Fault Levels*** *(for a Pre-fault Voltage of 127kV)*								
						Leaside					***Hearn***			
						Symmetrical		***Asymmetrical***			***Symmetrical***		***Asymmetrical***	
						Breaker Rating: 39.3kA		*Breaker Rating: 45.5kA*			*Breaker Rating: 31.4kA*		*Breaker Rating: 34.1kA*	
	Hearn 115kV busbar	Leaside 115kV busbar	Terauley 115kV busbar	115kV circuits at Hearn TGS		***3-phase***	***L-G***	***3-phase***	***L-G***		***3-phase***	***L-G***	***3-phase***	***L-G***
1	Hearn Open at 5A6 & 7P8 *Diagonal Split*	Closed	Open	All Closed		36.85kA	***43.44kA***	***48.08kA***	***52.42kA***	*Inner*	27.37kA	24.99kA	30.02kA	25.37kA
										Outer	25.11kA	23.40kA	27.54kA	23.75kA
2			Closed			36.85kA	***43.44kA***	***48.08kA***	***52.42kA***	*Inner*	28.66kA	26.59kA	33.07kA	29.65kA
										Outer	27.08kA	25.85kA	31.74kA	26.54kA
3		Open	Open		*Leaside West*	32.23kA	36.50kA	41.73kA	***46.71kA***	*Inner*	26.96kA	24.41kA	29.57kA	24.78kA
					Leaside East	32.30kA	36.52kA	41.80kA	***46.74kA***	*Outer*	25.02kA	23.27kA	26.97kA	23.43kA
4			Closed		*Leaside West*	32.69kA	37.03kA	41.23kA	***46.39kA***	*Inner*	28.51kA	26.29kA	32.90kA	28.84kA
					Leaside East	32.77kA	37.03kA	41.59kA	***46.92kA***	*Outer*	27.06kA	25.80kA	31.23kA	29.77kA

Table 6. Pickering 'A' in-service: Sithe - Goreway in-service: Cherrywood North & South busbars 'split' Study Reference: 02hearnnewgen8e2

	Status of 115kV busbars & 115kV circuits					***Fault Levels*** *(for a Pre-fault Voltage of 127kV)*								
						Leaside					***Hearn***			
						Symmetrical		***Asymmetrical***			***Symmetrical***		***Asymmetrical***	
						Breaker Rating: 39.3kA		*Breaker Rating: 45.5kA*			*Breaker Rating: 31.4kA*		*Breaker Rating: 34.1kA*	
	Hearn 115kV busbar	Leaside 115kV busbar	Terauley 115kV busbar	115kV circuits at Hearn TGS		***3-phase***	***L-G***	***3-phase***	***L-G***		***3-phase***	***L-G***	***3-phase***	***L-G***
1	***Hearn Open at 6P7 & A1P8*** *Vertical Split*	Closed	Open	***All Closed***		36.84kA	***43.52kA***	***48.08kA***	***53.87kA***	*West*	22.79kA	18.45kA	24.57kA	18.94kA
										East	27.56kA	26.27kA	30.24kA	26.45kA
2			Closed			36.84kA	***43.53kA***	***48.08kA***	***53.24kA***	*West*	25.58kA	21.64kA	29.52kA	24.54kA
										East	27.56kA	26.27kA	30.24kA	26.45kA
3		***Open***	Open		*Leaside West*	27.55kA	31.99kA	36.15kA	40.94kA	*West*	18.87kA	16.17kA	20.70kA	16.85kA
					Leaside East	27.60kA	31.66kA	36.51kA	36.54kA	*East*	22.04kA	21.46kA	25.01kA	21.78kA
4			Closed		*Leaside West*	27.56kA	32.00kA	36.15kA	40.96kA	*West*	20.74kA	18.54kA	25.02kA	19.03kA
					Leaside East	27.60kA	31.66kA	36.51kA	36.53kA	*East*	22.04kA	21.46kA	25.01kA	21.78kA

Table 7 ***Post-contingency Circuit Loadings:*** ***DIAGRAM 10***

With the 115kV busbars at Leaside TS & Hearn TGS Closed

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***

No new generation at Hearn TGS

Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H7L & H11L	Lumsden x Main	104	110	95%
H3L	H7L & H11L	Lumsden x Main	106	110	96%
H7L	H11L	Lumsden x Main	108	128	84%
H11L	H7L	Lumsden x Main	108	128	84%
H6LC	L12C		154	187	82%
H8LC	L12C		154	187	82%
L9C	L12C		152	187	81%
L12C	L9C		151	187	81%
H5E	H7E		229	243	94%
	H2JK		102	104	98%
H7E	H5E		222	243	91%
	H2JK		108	104	104%
H2JK	H7E	at Hearn	160	243	66%
Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C		199	187	106%
Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	H7L & H11L	at Leaside	100	110	91%
H7L + H11L	H1L	at Leaside	166	224	74%
H6LC + H8LC	L12C	Charles x Cecil	***179***	***156***	***115%***
	L9C		197	187	105%
	H7L	at Leaside	100	110	91%
	L12C	Leaside x Charles	***208***	***187***	***111%***
L9C + L12C	H6LC H8LC	Leaside x Gerrard	157	229	69%
	H7L		100	110	91%

Table 8 ***Post-contingency Circuit Loadings:*** ***DIAGRAM 11***

With the 115kV busbars at Leaside TS Open & Hearn TGS Closed

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***

No new generation at Hearn TGS

Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H7L & H11L	Lumsden x Main	115	110	105%
H3L	H7L & H11L	Lumsden x Main	117	110	106%
H7L	H11L	Lumsden x Main	115	128	90%
H11L	H7L	Lumsden x Main	115	128	90%
H6LC	L12C		154	187	82%
H8LC	L12C		154	187	82%
L9C	L12C		152	187	81%
L12C	L9C		151	187	81%
H5E	H7E		230	243	95%
	H2JK		102	104	98%
H7E	H5E		222	243	91%
	H2JK		109	104	105%
H2JK	H7E	at Hearn	164	243	67%

Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C		199	187	106%

Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	H7L & H11L	at Leaside	***140***	***110***	***127%***
H7L + H11L	H1L	at Leaside	194	224	87%
H6LC + H8LC	L12C	Charles x Cecil	***179***	***156***	***115%***
	L9C		197	187	105%
	H7L	at Leaside	100	110	91%
	L12C	Leaside x Charles	***208***	***187***	***111%***
L9C + L12C	H6LC H8LC	Leaside x Gerrard	170	229	74%
	H7L		95	110	86%

Table 9 ***Post-contingency Circuit Loadings:*** ***DIAGRAM 12***

With the 115kV busbars at Leaside TS Open & Hearn TGS Closed, and Circuits H3L & H6L Open at Hearn TGS

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***

No new generation at Hearn TGS

Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H7L	Lumsden x Main	***122***	***110***	***111%***
H3L	H7L	Lumsden x Main	121	110	110%
H7L	H11L	Lumsden x Main	138	128	108%
H11L	H7L	Lumsden x Main	138	128	108%
H6LC	H7L	at Leaside	102	110	93%
H8LC	H7L	at Leaside	118	110	107%
L9C	H7L	at Leaside	102	110	93%
L12C	H7L	at Leaside	102	110	93%
H5E	H7E		230	243	95%
	H2JK		103	104	99%
H7E	H5E		222	243	91%
	H2JK		109	104	105%
H2JK	H7L	at Leaside	100	110	91%
Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C		***208***	***187***	***111%***
Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	H7L & H11L	at Leaside	***144***	***110***	***131%***
H7L + H11L	H1L	at Leaside	***259***	***224***	***116%***
H6LC + H8LC	L12C	Charles x Cecil	***179***	***156***	***115%***
	H1L	at Leaside	191	224	85%
	H7L	at Leaside	118	110	107%
	L12C	Leaside x Charles	***208***	***187***	***111%***
L9C + L12C	H6LC & H8LC	Leaside x Gerrard	175	229	76%
	H7L		108	110	98%

Table 10 ***Post-contingency Circuit Loadings:*** ***DIAGRAM 13***

With the 115kV busbars at Leaside TS Open & Hearn TGS Closed, and Circuits H11L & H6LC Open at Hearn TGS

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***

No new generation at Hearn TGS

Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H7L	Lumsden x Main	***142***	***110***	***129%***
H3L	H7L	Lumsden x Main	***145***	***110***	***132%***
H7L	H1L	Leaside x Gerrard	190	224	85%
H11L	H7L	Lumsden x Main	118	128	92%
H6LC	H7L	Lumsden x Main	102	110	93%
H8LC	H7L	Lumsden x Main	113	110	103%
L9C	H7L	Lumsden x Main	102	110	93%
L12C	H7L	Lumsden x Main	102	110	93%
H5E	H7E		230	243	95%
	H2JK		103	104	99%
H7E	H5E		222	243	91%
	H2JK		109	104	105%
H2JK	H7L	Lumsden x Main	100	110	91%

Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading	Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C	***208***	***187***	***111%***

Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	H7L	at Leaside	***202***	***110***	***184%***
H7L + H11L	H1L	at Leaside	199	224	89%
H6LC + H8LC	L12C	Leaside x Charles	***208***	***187***	***111%***
	L12C	Charles x Cecil	***179***	***156***	***115%***
	H7L,	Lumsden x Main	113	110	103%
L9C + L12C	H6LC & H8LC	Leaside x Gerrard	175	229	76%

Table 11 ***Post-contingency Circuit Loadings:*** ***DIAGRAM 14***

With the 115kV busbars at Leaside TS Open & Hearn TGS Closed, and Circuits H3L & H11L Open at Hearn TGS

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***

No new generation at Hearn TGS

Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H7L	Lumsden x Main	***153***	***110***	***139%***
H3L	H7L	Lumsden x Main	***139***	***110***	***126%***
H7L	H1L	Leaside x Gerrard	230	224	103%
H11L	H7L	Lumsden x Main	132	128	103%
H6LC	H7L	at Leaside	120	110	109%
H8LC	H7L	at Leaside	120	110	109%
L9C	H7L	at Leaside	116	110	105%
L12C	H7L	at Leaside	116	110	105%
H5E	H7E		230	243	95%
	H2JK		103	104	99%
H7E	H5E		222	243	91%
H2JK	**H2JK**		109	104	105%
	H7L	at Leaside	113	110	103%

Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C		***218***	***187***	***117%***

Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	H7L	at Leaside	***192***	***110***	***175%***
H7L + H11L	H1L	at Leaside	246	224	110%
H6LC + H8LC	L12C	Charles x Cecil	***179***	***156***	***115%***
	H1L	at Leaside	239	224	107%
	H7L	at Leaside	***146***	***110***	***133%***
	L12C	Leaside x Charles	***208***	***187***	***111%***
L9C + L12C	H6LC & H8LC	Leaside x Gerrard	184	229	80%
	H7L		***125***	***110***	***114%***

Table 12 Post-contingency Circuit Loadings: ***DIAGRAM 15***

With the 115kV busbars at Leaside TS Open & Hearn TGS Closed, and Circuits H7L & H11L Open at Hearn TGS

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***

No new generation at Hearn TGS

Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H3L	Leaside x Gerrard	***327***	***229***	***143%***
H3L	H1L	Leaside x Gerrard	***322***	***224***	***144%***
H7L	H11L	Lumsden x Main	82	128	64%
H11L	H7L	Lumsden x Main	81	128	63%
H6LC	H8LC	at Leaside	134	229	59%
H8LC	H6LC	at Leaside	134	229	59%
L9C	L12C		161	187	86%
	H1L		191	224	85%
L12C	L9C		160	187	86%
	H3L		200	229	87%
H5E	H7E		230	243	95%
	H2JK		103	104	99%
H7E	H5E		223	243	92%
	H2JK		109	104	105%
H2JK	H7E		164	243	67%

Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading	Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C	***218***	***187***	***117%***

Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	L12C		167	187	89%
H7L + H11L	H1L	at Leaside	194	224	87%
H6LC + H8LC	L12C	Charles x Cecil	***179***	***156***	***115%***
	L9C	Leaside x Charles	197	187	105%
	H1L	at Leaside	239	224	107%
	L12C	Leaside x Charles	***208***	***187***	***111%***
L9C + L12C	H6LC & H8LC	Leaside x Gerrard	184	229	80%
	H3L		213	229	93%

Table 13 ***Post-contingency Circuit Loadings:*** ***DIAGRAM 16***

With the 115kV busbars at Leaside TS Open & Hearn TGS Open Diagonally
(at Breaker Positions 5A6 & 7P8)

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***
No new generation at Hearn TGS
Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H3L	Leaside x Gerrard	245	229	107%
H3L	H1L	Leaside x Gerrard	242	224	108%
H7L	H11L	Lumsden x Main	***143***	***128***	***111%***
H11L	H7L	Lumsden x Main	***142***	***128***	***111%***
H6LC	H8LC	Leaside x Gerrard	119	229	52%
	H7L & H11L	Lumsden x Main	114	110	104%
	L12C	Charles x Cecil	131	156	84%
H8LC	H6LC	Leaside x Gerrard	122	227	54%
	H7L & H11L	Lumsden x Main	92	110	84%
	L12C	Charles x Cecil	132	156	85%
L9C	L12C	Charles x Cecil	129	156	83%
L12C	L9C	Leaside x Charles	152	187	81%
H5E	H7E		221	243	91%
	H2JK		***115***	***104***	***111%***
H7E	H5E		220	243	91%
	H2JK		109	104	105%
H2JK	H5E		171	243	70%

Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading	Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C	***208***	***187***	***111%***

Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	H7L & H11L	at Leaside	***131***	***110***	***119%***
H7L + H11L	H6LC	Gerrard x Hearn	153	229	67%
H6LC + H8LC	L12C	Charles x Cecil	***186***	***156***	***119%***
	L12C	Leaside x Charles	200	187	107%
L9C + L12C	H6LC	Leaside x Gerrard	172	229	75%

Table 14 Post-contingency Circuit Loadings: ***DIAGRAM 17***

With the 115kV busbars at Leaside TS Open & Hearn TGS Open Diagonally
*(at Breaker Positions 5A6 & 7P8)****, and Circuits H3L & H11L Open at HearnTGS***

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***

No new generation at Hearn TGS

Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H7L	Lumsden x Main	***147***	***110***	***134%***
H3L	H7L	Lumsden x Main	***136***	***110***	***124%***
H7L	H1	Leaside x Gerrard	210	224	94%
H11L	H7L	Lumsden x Main	***148***	***128***	***115%***
H6LC	H7L	at Leaside	***183***	***110***	***166%***
H8LC	H7L	at Leaside	***123***	***110***	***112%***
L9C	H7L	at Leaside	***127***	***110***	***115%***
L12C	H7L	at Leaside	***128***	***110***	***116%***
H5E	H7E		222	243	91%
	H2JK		***115***	***104***	***111%***
	H7L	Lumsden x Main	***173***	***110***	***157%***
H7E	H5E		221	243	91%
	H2JK		110	104	106%
H2JK	H7L	at Leaside	114	110	104%
Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C		***221***	***187***	***118%***
Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	H7L	at Leaside	**183**	**110**	**166%**
H7L + H11L	H1L	at Leaside	224	224	100%
H6LC + H8LC	L12C	Charles x Cecil	***186***	***156***	***119%***
	L9C	Leaside x Charles	191	187	102%
	H7L	at Leaside	***186***	***110***	***169%***
	L12C	Leaside x Charles	200	187	107%
L9C + L12C	H6LC & H8LC	Leaside x Gerrard	189	229	83%
	H7L		***138***	***110***	***125%***

Table 15 ***Post-contingency Circuit Loadings:*** ***DIAGRAM 18***

With the 115kV busbars at Leaside TS Open & Hearn TGS Open Vertically
(at Breaker Positions 6P7 & A1P8)

115 kV Contingencies: Leaside Sector ***2004 Summer Peak Loads***

No new generation at Hearn TGS

Terauley TS Quartered

Single-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L	H3L	Leaside x Gerrard	137	229	60%
H3L	H1L	Leaside x Gerrard	134	224	60%
H7L	H11L	Lumsden x Main	71	128	55%
H11L	H7L	Lumsden x Main	71	128	55%
H6LC	H8LC	Leaside x Gerrard	224	229	98%
	L9C	at Leaside	***215***	***187***	***115%***
	L12C	at Leaside	***227***	***187***	***121%***
	L12C	Charles x Cecil	***198***	***156***	***127%***
H8LC	H6LC	Leaside x Gerrard	224	229	98%
	L9C	at Leaside	***215***	***187***	***115%***
	L12C	at Leaside	***227***	***187***	***121%***
	L12C	Charles x Cecil	***198***	***156***	***127%***
L9C	L12C	Charles x Cecil	***197***	***156***	***126%***
L12C	L9C	Leaside x Charles	***223***	***156***	***143%***
H5E	H7E		236	243	97%
H7E	H5E		226	243	93%
	H2JK		112	104	108%
H2JK	H5E & H7E		164	243	67%

Stuck breaker condition (L8L12 at Cecil TS)	Circuits with Maximum post-contingency loading	Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H8LC + L12C	L9C	***328***	***187***	***175%***

Double-Circuit Contingency	Circuits with Maximum post-contingency loading		Loading (MVA)	Rating (MVA)	(%)Loading/ Rating
H1L + H3L	H7L & H11L	at Leaside	62	110	56%
H7L + H11L	H1L		97	224	43%
H6LC + H8LC	L12C	Charles x Cecil	***179***	***156***	***115%***
	L12C	Leaside x Charles	***208***	***187***	***111%***
	Load disconnected at Esplanade TS & Terauley TS		**286 MVA Load Lost**		
L9C + L12C	H6LC & H8LC	Leaside x Gerrard	***304***	***229***	***133%***

Table 16 Power Factors at the TSs in the Leaside Sector

Transformer Station	*LV Busbar*	*Voltage*	*P*	*Q*	*MVA*	*Power Factor*
Basin TS	A5-A6	13.8kV	32	16	35.8	0.89
	A7-A8		41	20	45.6	0.90
Bridgman TS	5A6-A6 + 6H		30	15	33.5	0.89
	11A5-A6-YH		51	25	56.8	0.90
	12XH-YB		31	16	34.9	0.89
	13XH-YH		51	26	57.2	0.89
Carlaw TS	A1-A2		39	20	43.8	0.89
	A6-A7		31	16	34.9	0.89
Cecil TS	A1-A2		32	16	35.8	0.89
	A3-A4		35	18	39.4	0.89
	A5-A6		48	24	53.7	0.89
	A7-A8		56	28	62.6	0.89
Charles TS	A1-A2		28	14	31.3	0.89
	A3-A4		31	15	34.4	0.90
	A5-A6		39	20	43.8	0.89
	A7-A8		34	17	38.0	0.89
Dufferin TS	A1-A2		33	16	36.7	0.90
	A3-A4		25	12	27.7	0.90
	A5-A6		39	20	43.8	0.89
	A7-A8		28	14	31.3	0.89
Duplex TS	A1-A2		34	17	38.0	0.89
	A3-A4		31	16	34.9	0.89
	A5-A6		35	18	39.4	0.89
Esplanade TS	J1-J2		53	27	59.5	0.89
	Q1-Q2		58	29	64.8	0.89
	A1-A2		52	26	58.1	0.89
Gerrard TS	A1-A2		29	16	33.1	0.88
	A4-A5		25	14	28.7	0.87
Glengrove TS	A1-A2		23	12	25.9	0.89
	A5-A6		28	14	31.3	0.89
Main TS	A1-A2		36	18	40.2	0.89
	A3-A4		32	16	35.8	0.89
Terauley TS	A1-A2		58	29	64.8	0.89
	A3-A4		61	30	68.0	0.90
	A5-A6		51	26	57.2	0.89
	A7-A8		41	21	46.1	0.89
Total Load			***1381***	***697***	***1546.9***	***0.89***

DIAGRAMS

PROJECT TO QUARTER TERAULEY TS

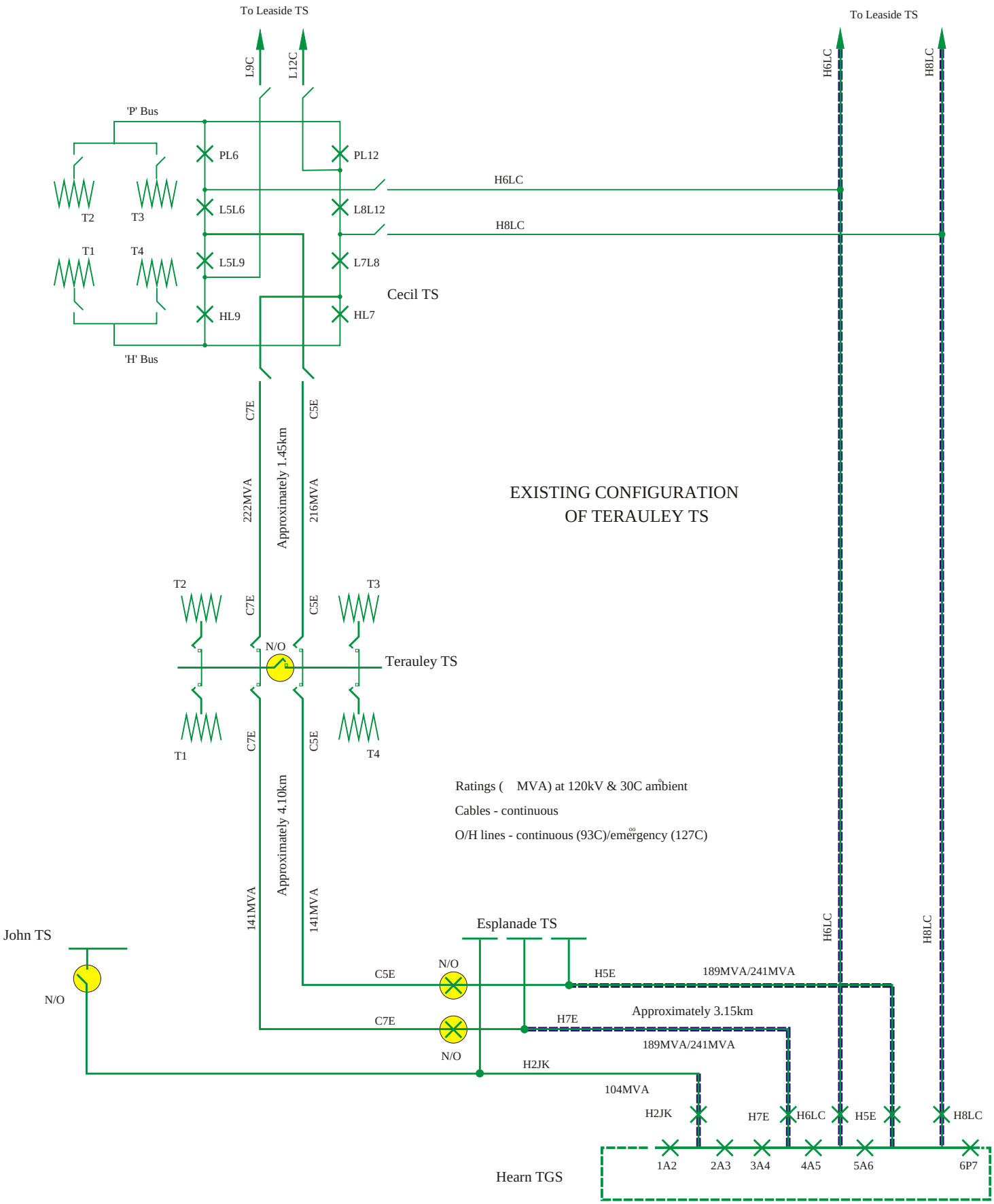


DIAGRAM 1

11th March 2002

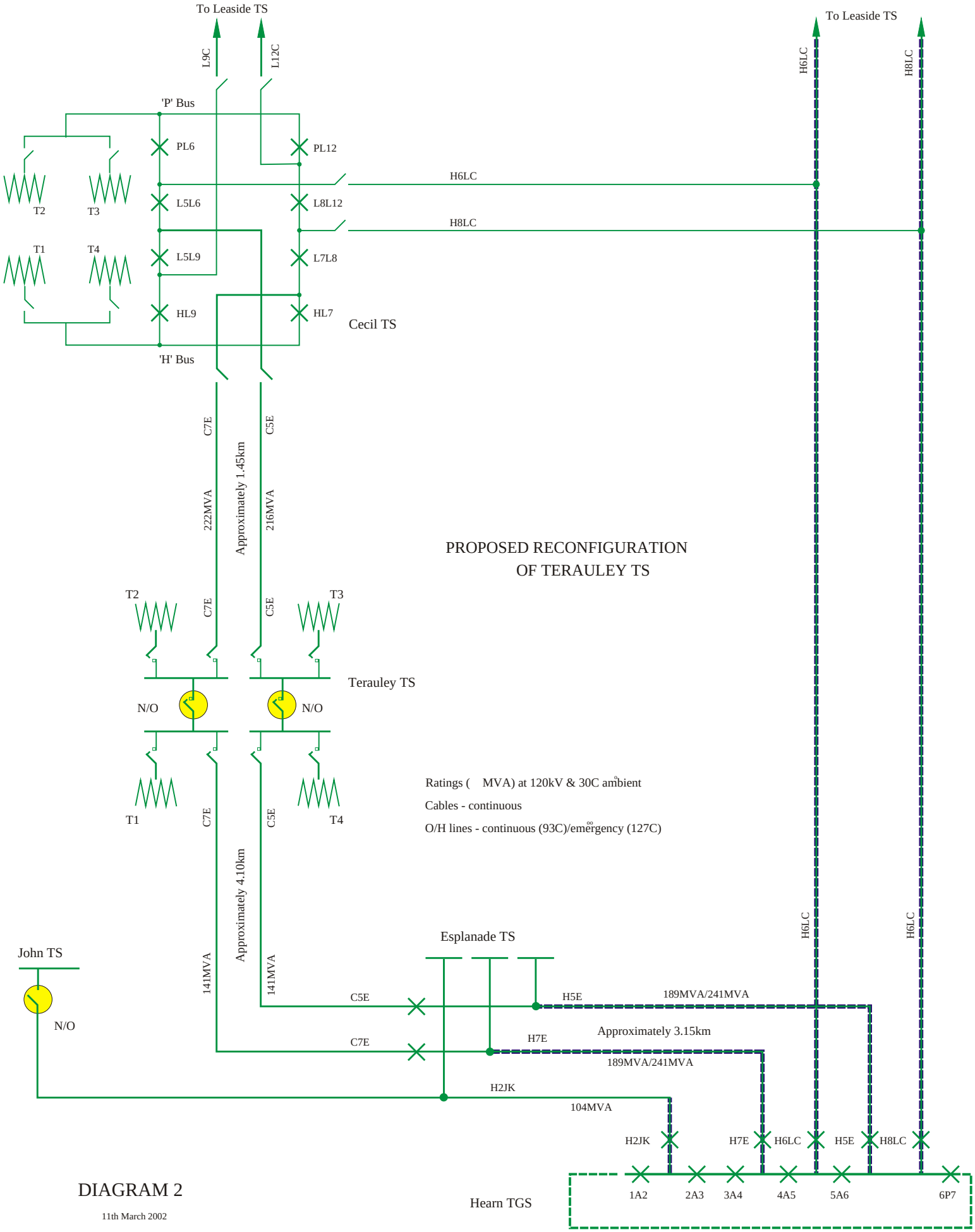


DIAGRAM 2

11th March 2002

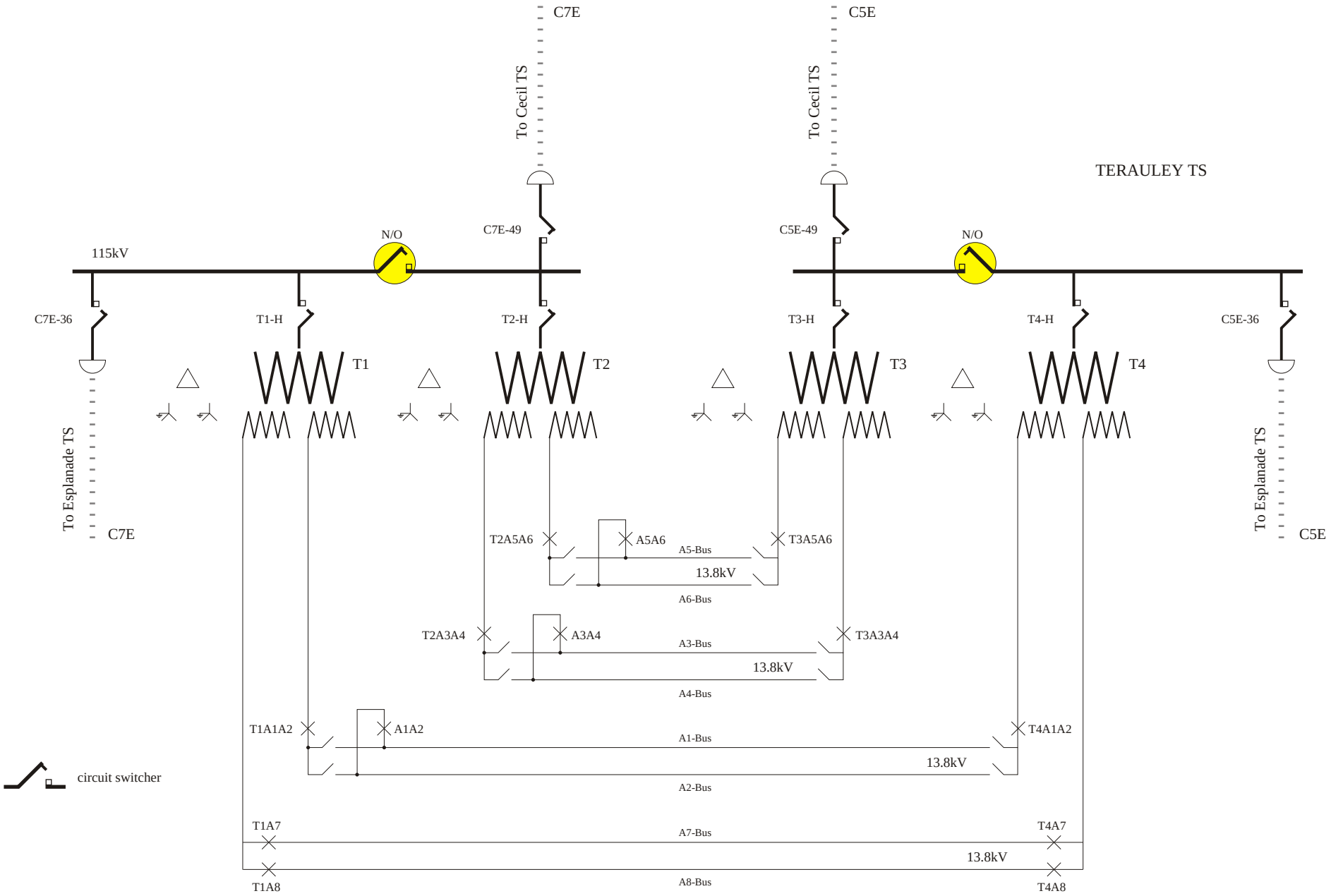
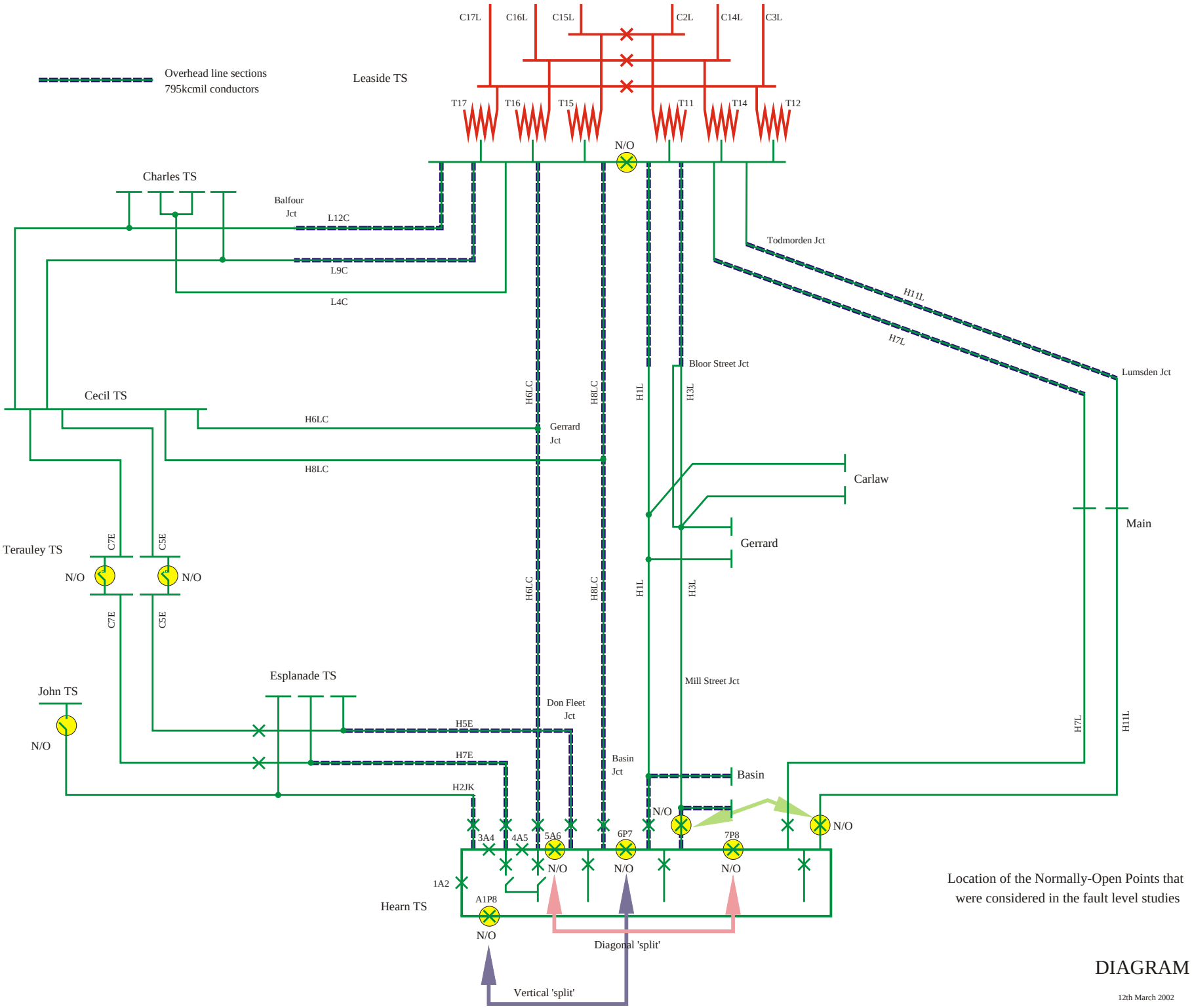


DIAGRAM 3

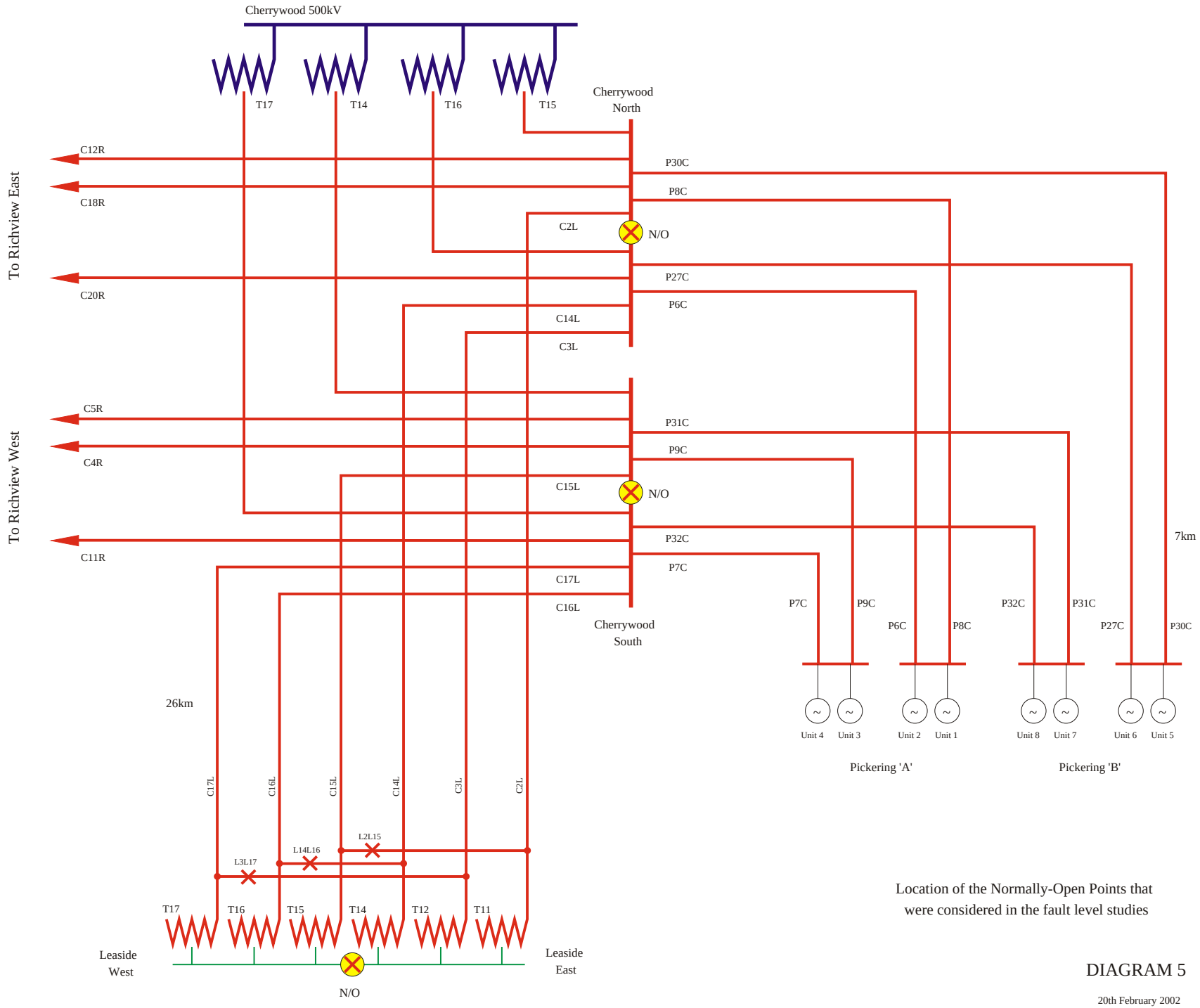
12th March 2002



Location of the Normally-Open Points that were considered in the fault level studies

DIAGRAM 4

12th March 2002



Location of the Normally-Open Points that were considered in the fault level studies

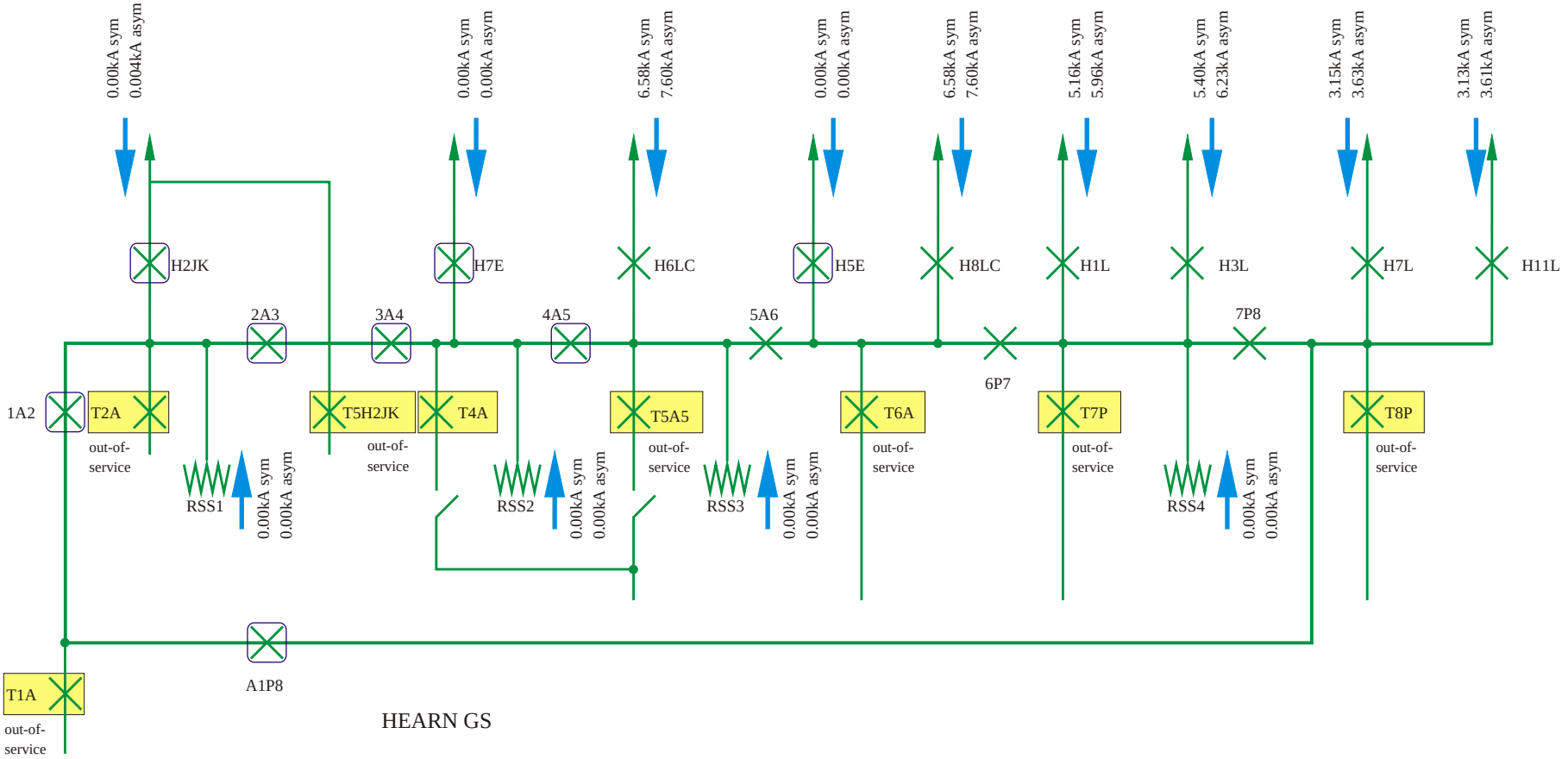
DIAGRAM 5

20th February 2002

Σ 29.97kA sym
34.58kA asym
115kV

Values for a pre-fault voltage of 127kV

Asymmetrical Factor 1.154



Breaker Ratings:	
H3L	38.8kA(sym)/45.5kA(asym)
H6LC	42.0kA(sym)/45.5kA(asym)
All others:	31.4kA(sym)/34.1kA(asym)

Breakers whose rating is exceeded

3-phase Fault Levels with Terauley TS Quartered

Leaside Busbars 'Open' - Hearn Busbar 'Closed'

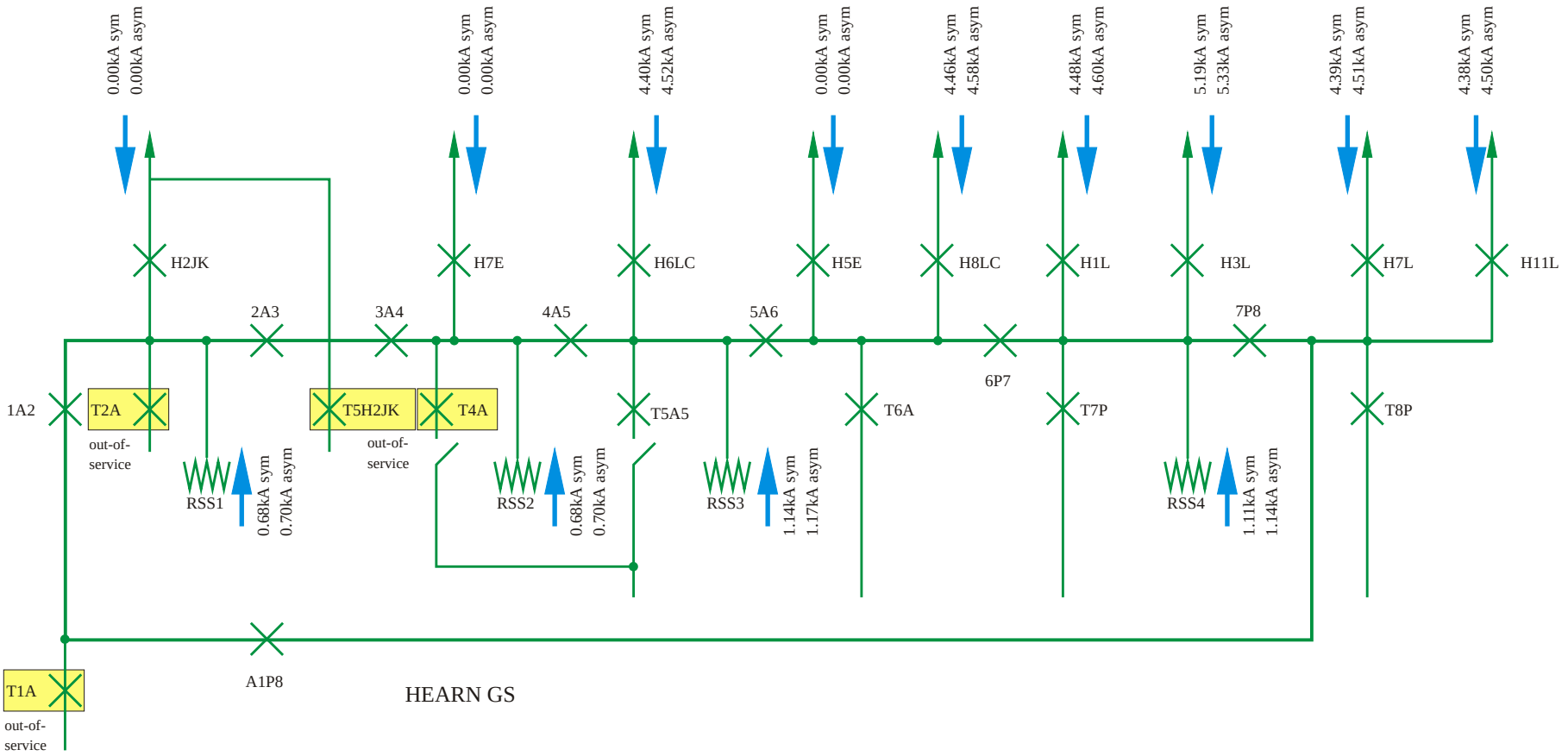
DIAGRAM 6

12th March 2002

Σ 29.13kA sym
29.92kA asym
115kV

Values for a pre-fault voltage of 127kV

Asymmetrical Factor 1.027



Breaker Ratings:	
H3L	38.8kA(sym)/45.5kA(asym)
H6LC	42.0kA(sym)/45.5kA(asym)
All others:	31.4kA(sym)/34.1kA(asym)

Breakers whose rating is exceeded

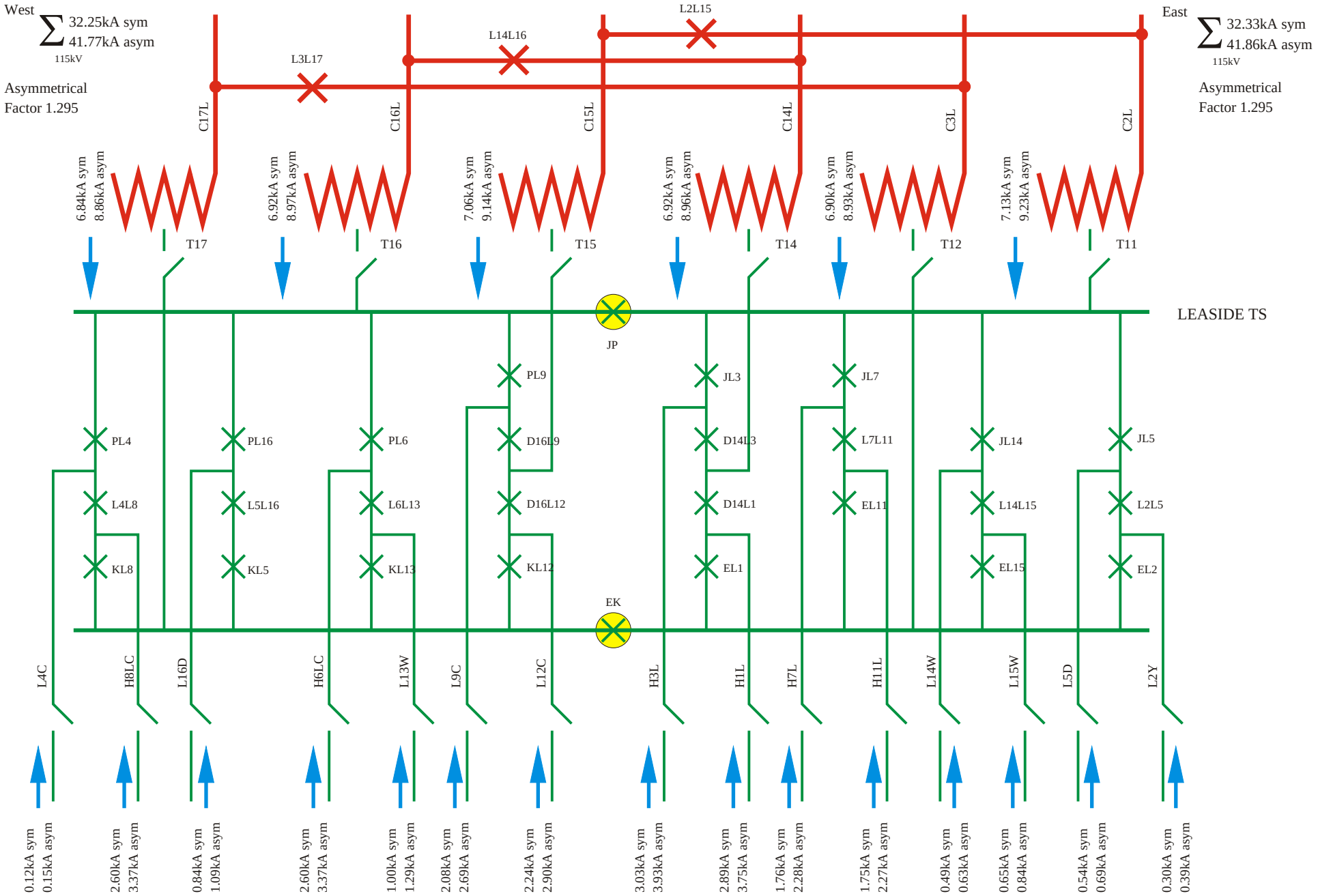
None exceeded

Single Line-to-Ground Fault Levels with Terauley TS Quartered

Leaside Busbars 'Open' - Hearn Busbar 'Closed'

DIAGRAM 7

4th March 2002



Breaker Ratings:

All: 39.3kA(sym)/45.5kA(asym)

Breakers whose rating is exceeded

None exceeded

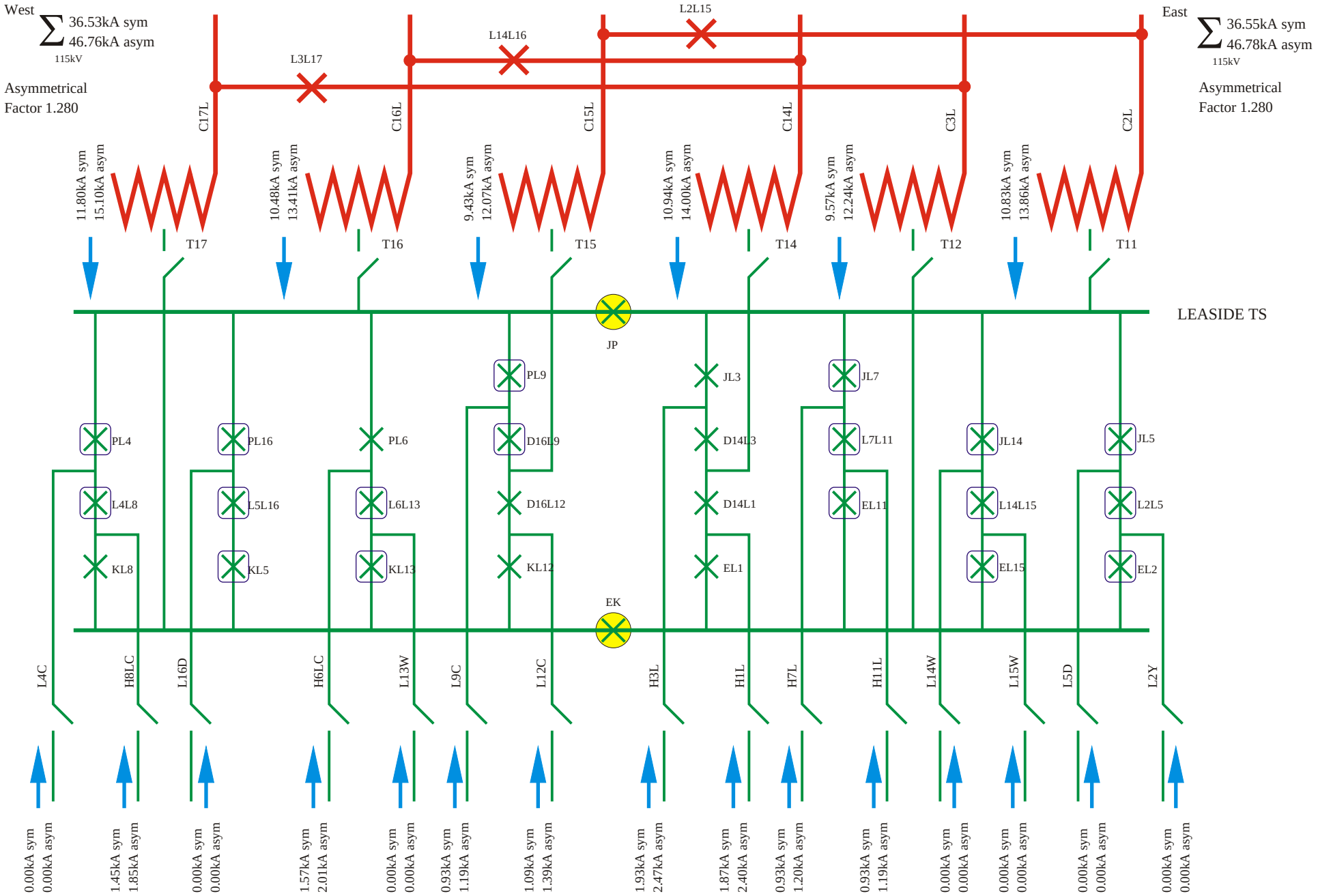
3-phase Fault Levels with Terauley TS Quartered

Leaside Busbars 'Open' - Hearn Busbar 'Closed'

Values for a pre-fault voltage of 127kV

DIAGRAM 8

20th February 2002



Breaker Ratings:

All: 39.3kA(sym)/45.5kA(asym)

Breakers whose rating is exceeded

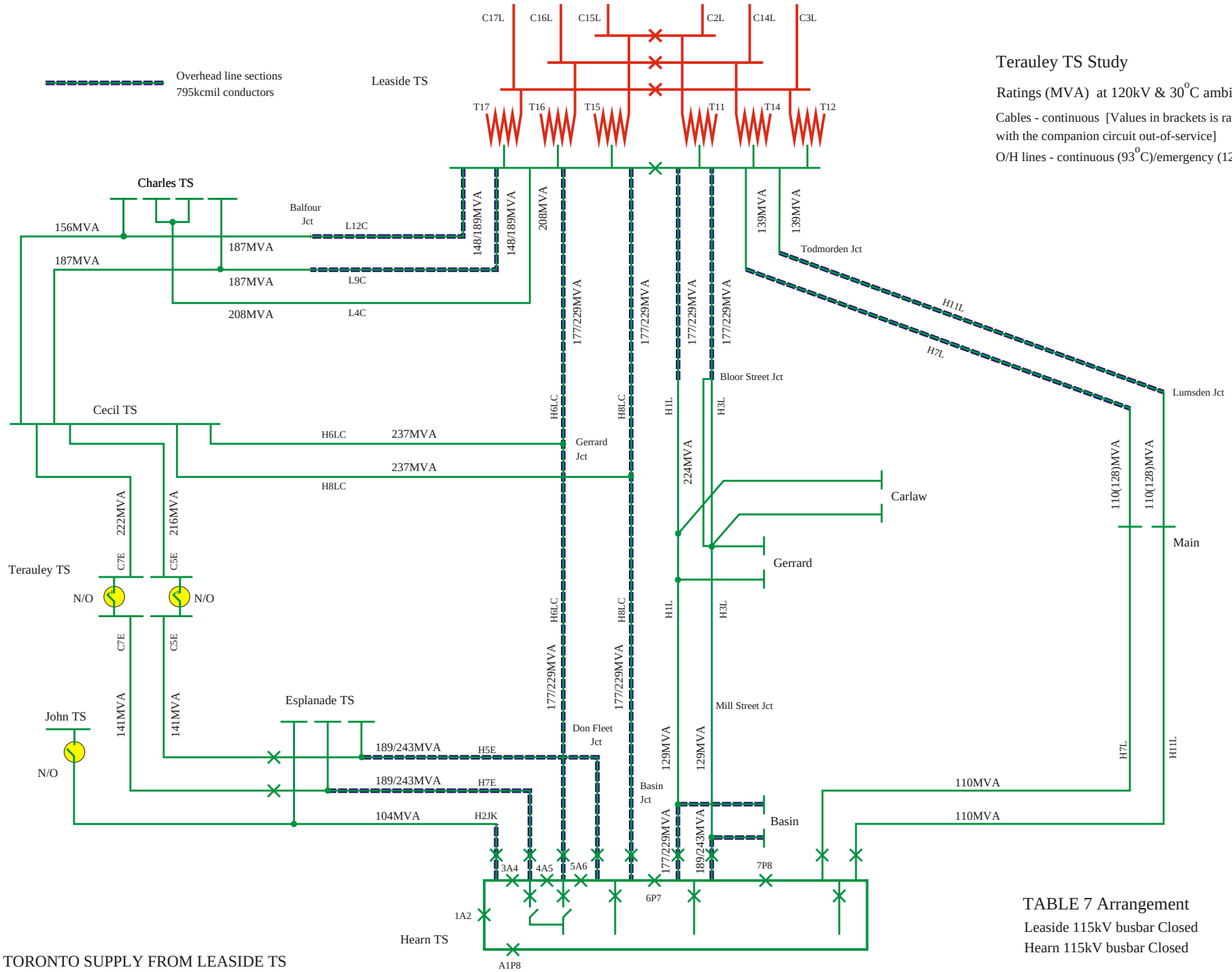
Single Line-to-Ground Fault Levels with Terauley TS Quartered

Leaside Busbars 'Open' - Hearn Busbar 'Closed'

Values for a pre-fault voltage of 127kV

DIAGRAM 9

20th February 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TABLE 7 Arrangement

Leaside 115kV busbar Closed

Hearn 115kV busbar Closed

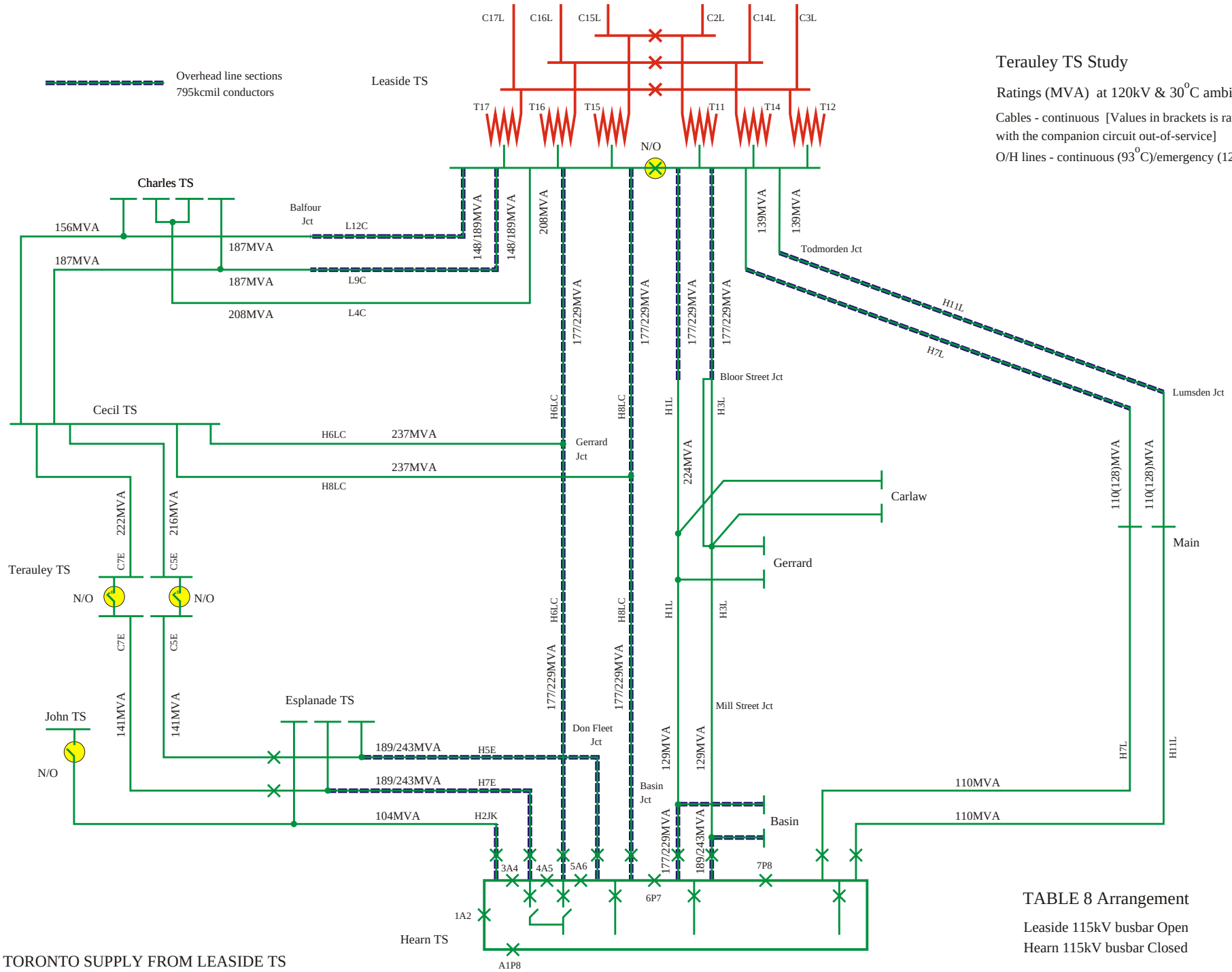
TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

NO OVERLOADS > 10%

DIAGRAM 10

17th January 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TABLE 8 Arrangement

Leaside 115kV busbar Open

Hearn 115kV busbar Closed

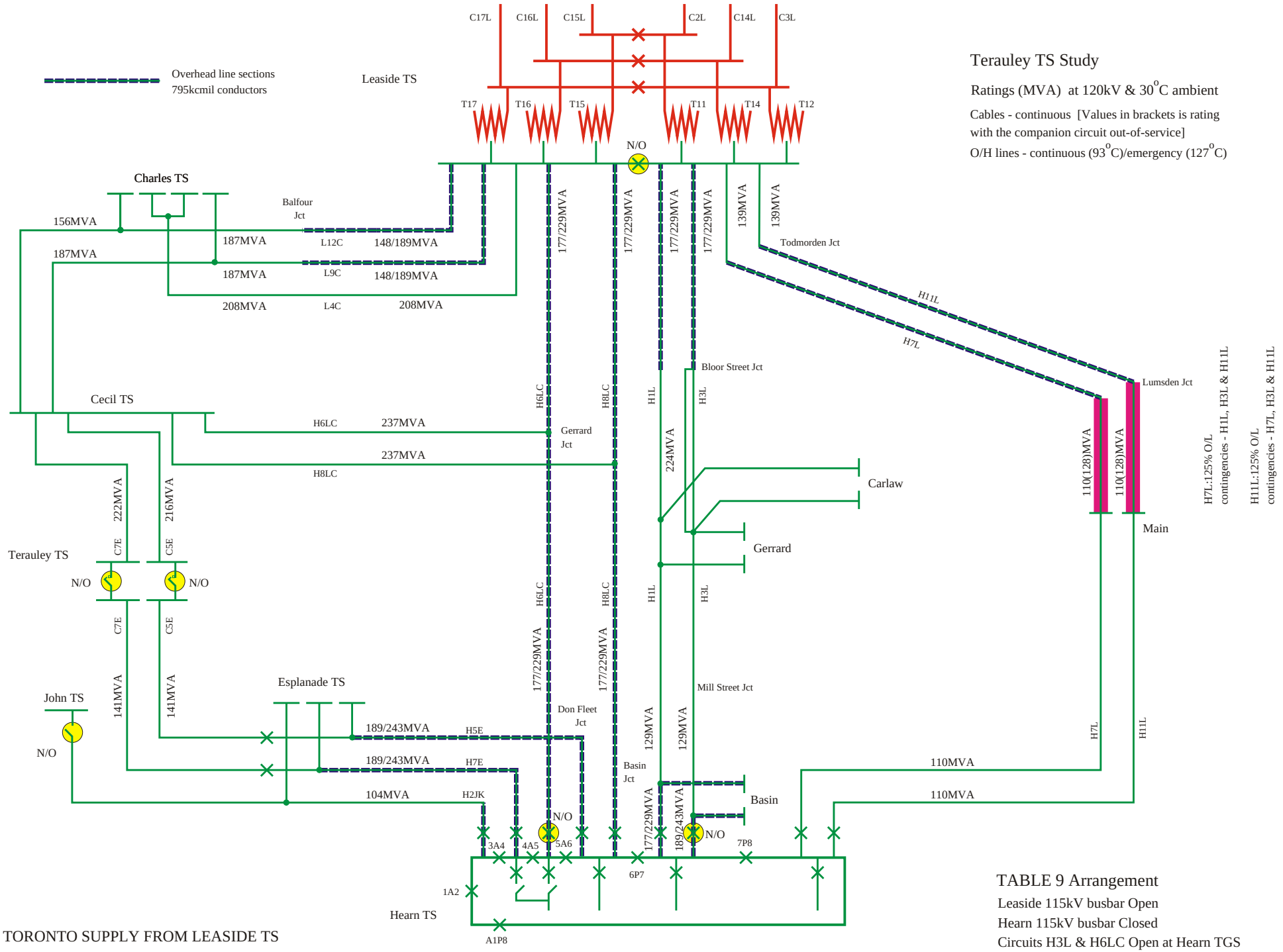
TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

NO OVERLOADS > 10%

DIAGRAM 11

12th March 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

Circuit Overloads > 10%

TABLE 9 Arrangement

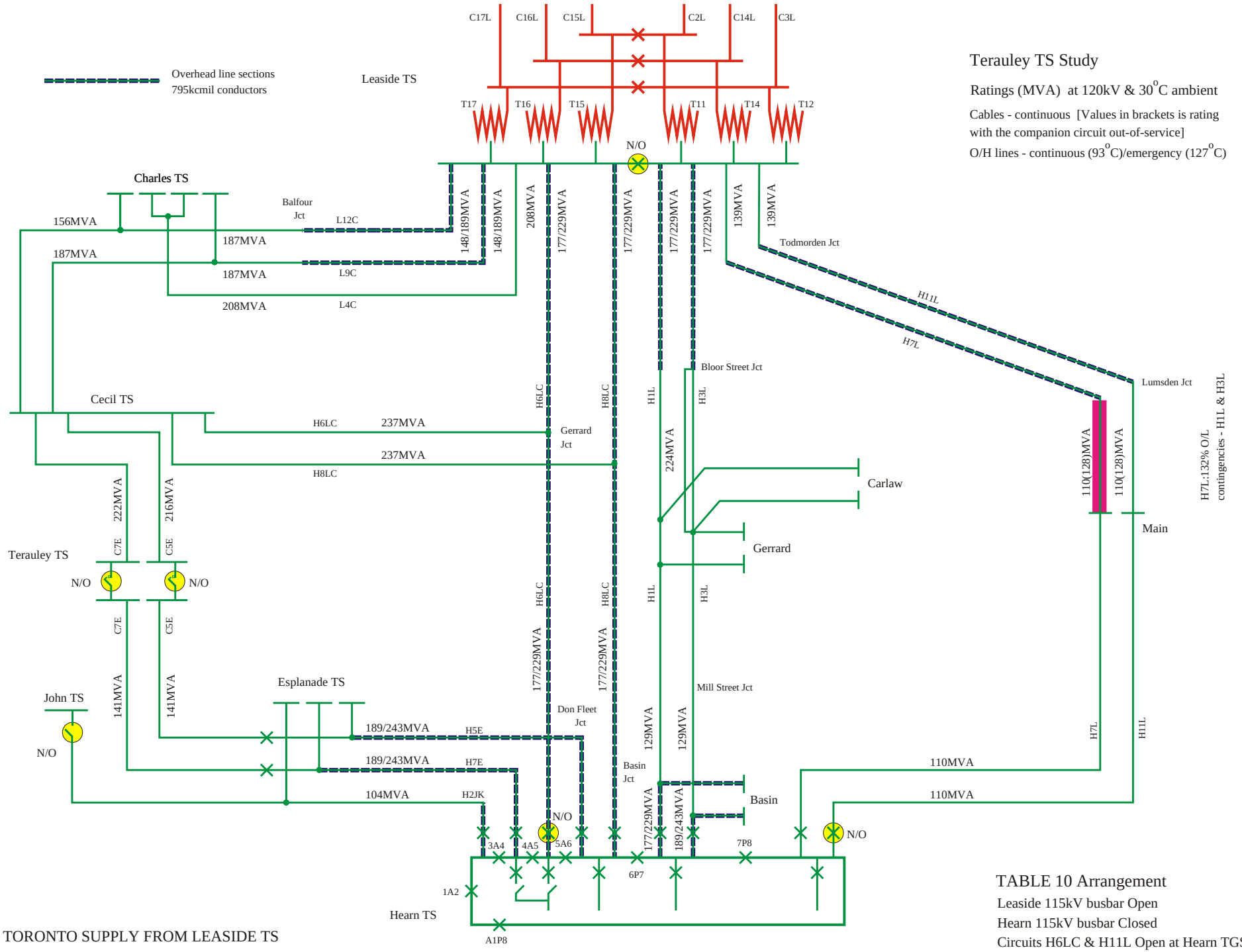
Leaside 115kV busbar Open

Hearn 115kV busbar Closed

Circuits H3L & H6LC Open at Hearn TGS

DIAGRAM 12

12th March 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

Circuit Overloads > 10%

TABLE 10 Arrangement

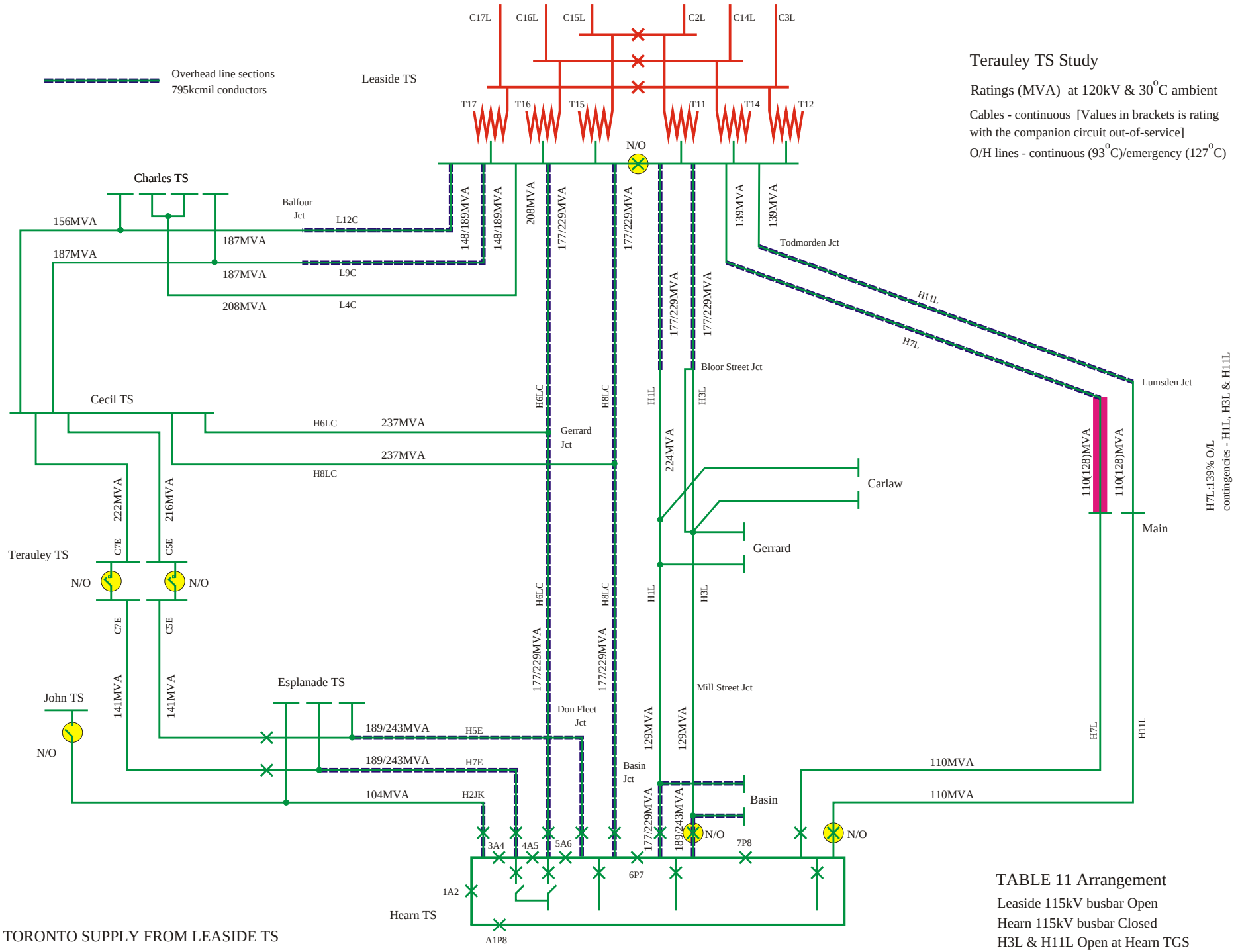
Leaside 115kV busbar Open

Hearn 115kV busbar Closed

Circuits H6LC & H11L Open at Hearn TGS

DIAGRAM 13

12th March 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TABLE 11 Arrangement

Leaside 115kV busbar Open

Hearn 115kV busbar Closed

H3L & H11L Open at Hearn TGS

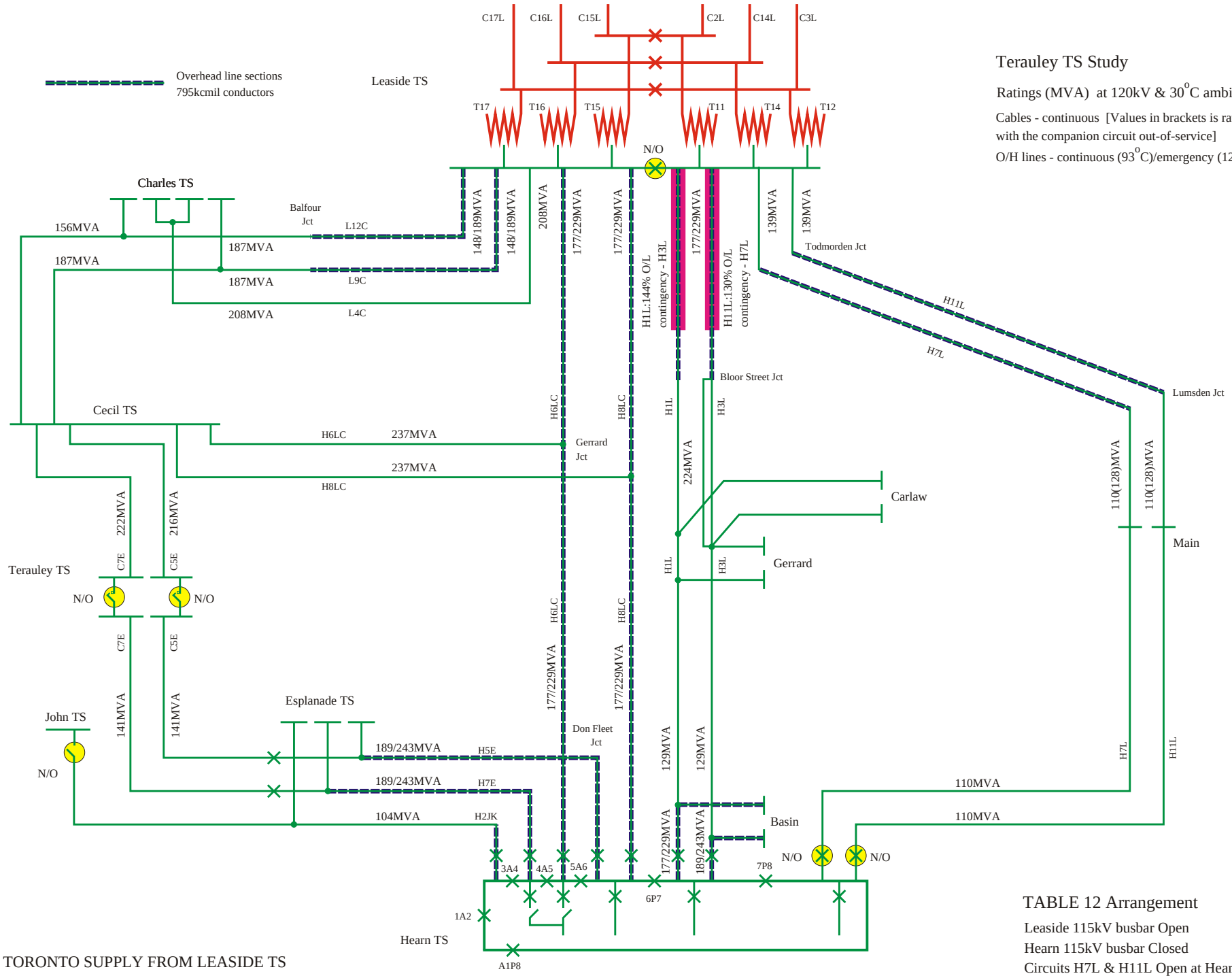
TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

Circuit Overloads > 10%

DIAGRAM 14

12th March 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TABLE 12 Arrangement

Leaside 115kV busbar Open

Hearn 115kV busbar Closed

Circuits H7L & H11L Open at Hearn TGS

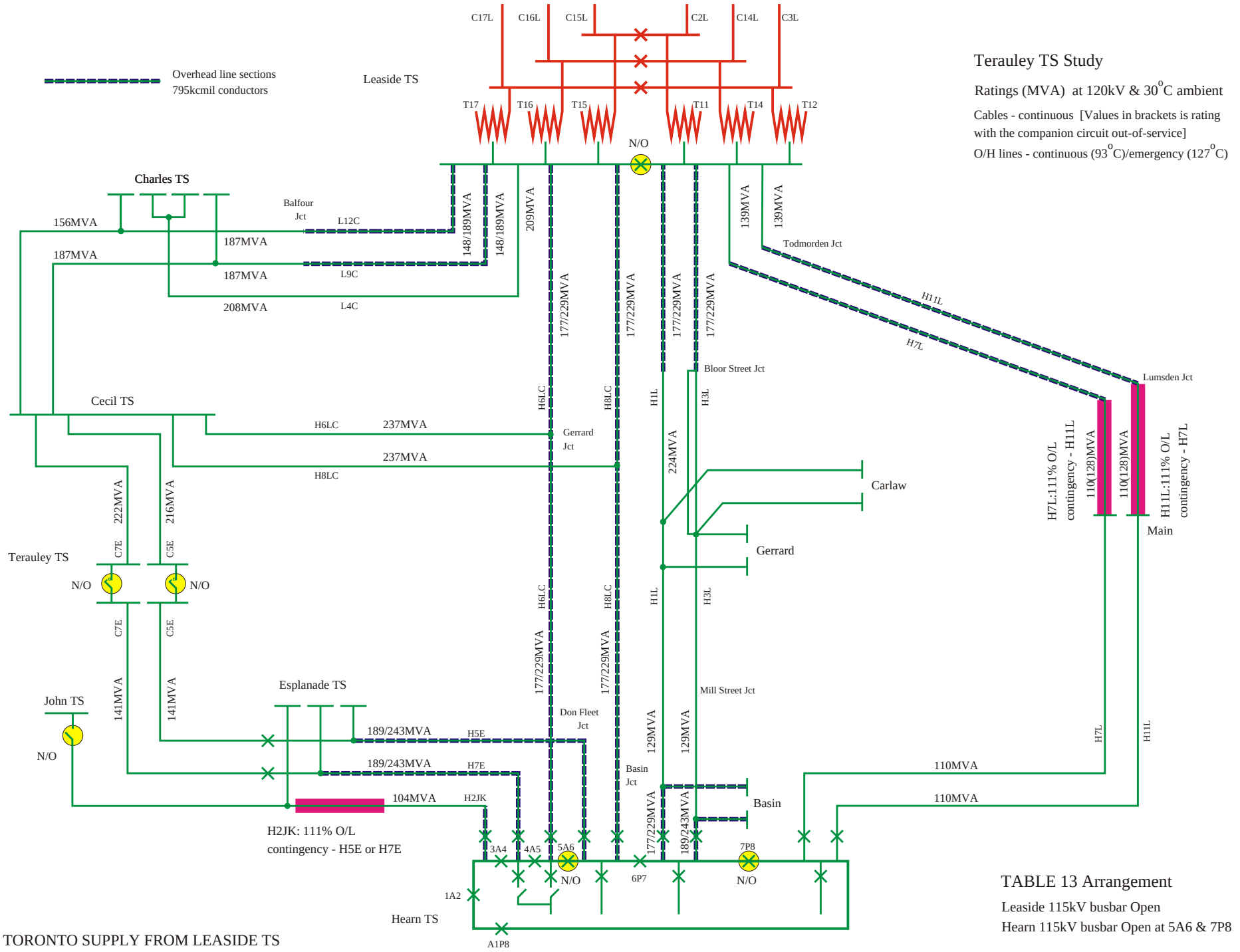
TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

Circuit Overloads > 10%

DIAGRAM 15

12th March 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TABLE 13 Arrangement

Leaside 115kV busbar Open

Hearn 115kV busbar Open at 5A6 & 7P8

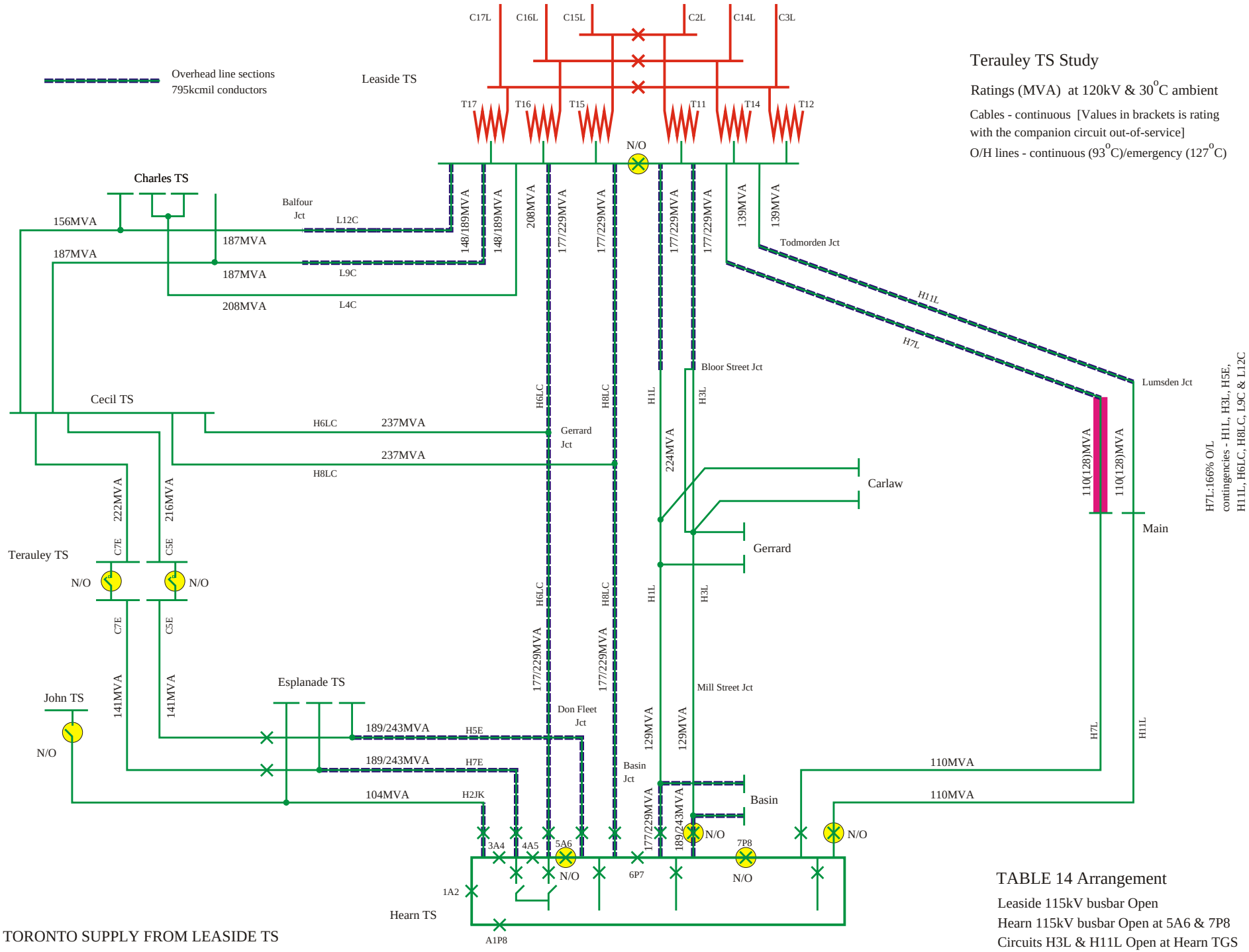
TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

Circuit Overloads > 10%

DIAGRAM 16

12th March 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TABLE 14 Arrangement

Leaside 115kV busbar Open
Hearn 115kV busbar Open at 5A6 & 7P8
Circuits H3L & H11L Open at Hearn TGS

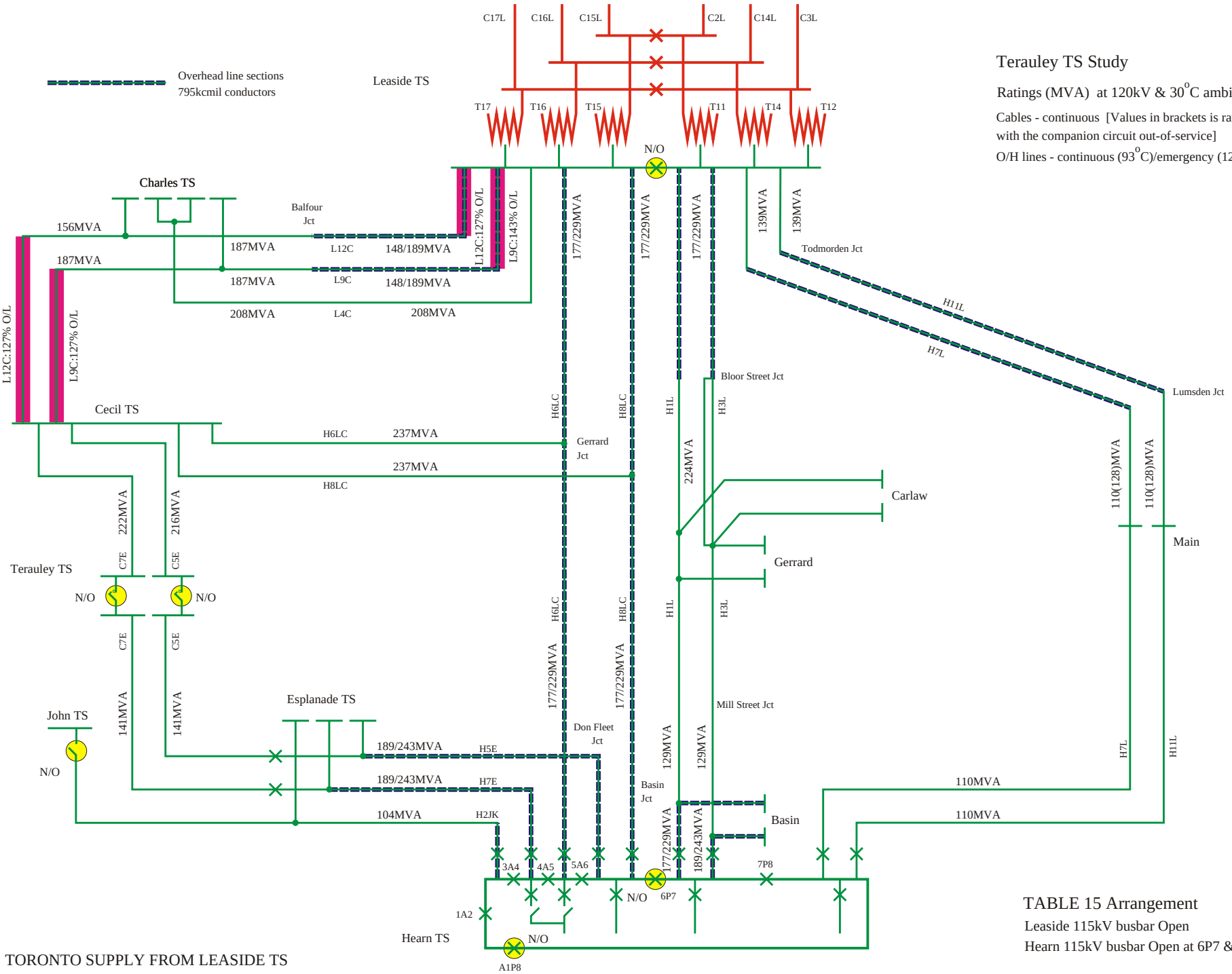
TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

Circuit Overloads > 10%

DIAGRAM 17

12th March 2002



Terauley TS Study

Ratings (MVA) at 120kV & 30°C ambient

Cables - continuous [Values in brackets is rating with the companion circuit out-of-service]

O/H lines - continuous (93°C)/emergency (127°C)

TORONTO SUPPLY FROM LEASIDE TS

Overloads for Single-circuit Contingencies

Circuit Overloads > 10%

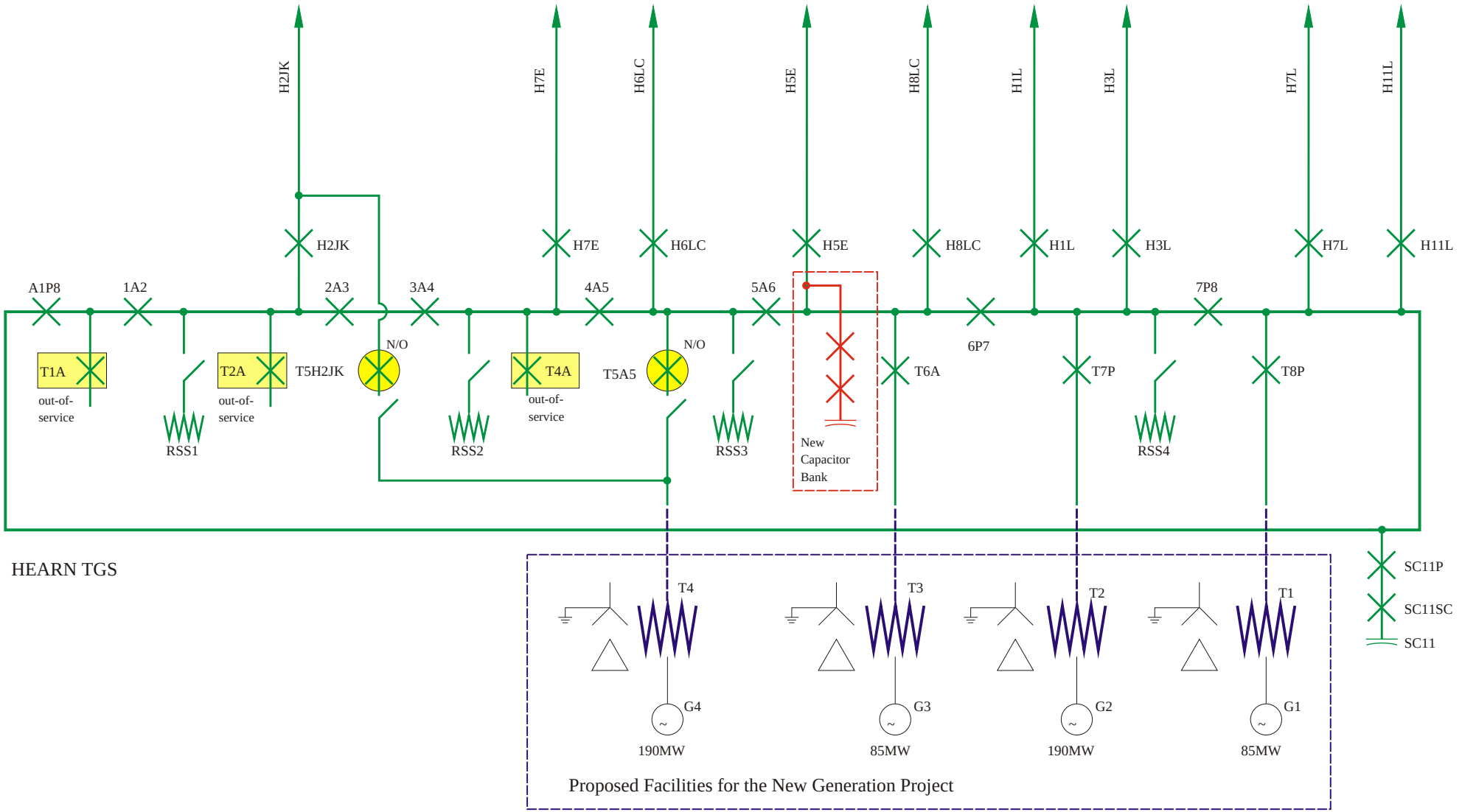
TABLE 15 Arrangement

Leaside 115kV busbar Open

Hearn 115kV busbar Open at 6P7 & A1P8

DIAGRAM 18

12th March 2002



Location of Proposed 125MVAr Shunt Capacitor Bank at Hearn TGS

DIAGRAM 19

6th March 2002