IMO_REP_022

CONNECTION ASSESSMENT & APPROVAL PROCESS

SYSTEM IMPACT ASSESSMENT REPORT

For the following Proposed Developments in the Greater Toronto Area:

898MVA Sithe-Southdown Project	*CAA ID No. 2000-007*
1096MVA Sithe-Goreway Project	*CAA ID No. 2000-008*

Long Term Forecasts & Assessments Department

FINAL Version

Date: 5th March 2001

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System Impact Assessment Report

For the two Generation Projects proposed by Sithe Energies Canadian Development Ltd. for connection to the IMO-controlled grid in the Greater Toronto Area.

Acknowledgement

The IMO wishes to acknowledge the assistance of Hydro One in completing the fault level analysis together with some of the load flow analysis required for this assessment.

Disclaimers

IMO

This report has been prepared solely for the purpose of assessing whether the applicant's proposed connection to 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 for 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.

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 also reserves the right to revise this report at any time, without notice to the applicant. Although the IMO will use its best efforts to advise the connection applicant of any 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 System Impact Assessment are based on the information available to Hydro One, at the time of the study, suitable for a System Impact Assessment of a proposal for a new generation connection.

The short circuit and thermal loading levels have been computed based on the information provided by the connection applicant at the time of the assessment. 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 are 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 System Impact Assessment, 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 ampacity rating of Hydro One facilities are established based on assumptions used in Hydro One for transmission system planning studies and in accordance with the Market Rules. 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 that are required to incorporate the proposed connection have been identified to the extent permitted by a System Impact Assessment under the current IMO Connection Assessment & Approval process. At a more advanced stage of the project development, additional studies may identify the need for other facilities or upgrades not covered under this System Impact Assessment. Further studies may also be required to confirm constructability and the time required for construction.

SYSTEM IMPACT ASSESSMENT REPORT

For the Two Sithe Generation Projects in the Greater Toronto Area

EXECUTIVE SUMMARY

This System Impact Assessment has examined the combined impact of the following generation Projects on the transmission system in the Greater Toronto Area of the IMO-controlled grid:

- Sithe-Goreway Project - Installed capacity: 1096MVA 932MW
  Scheduled in-service date: Q2 2003
- Sithe-Southdown Project - Installed capacity: 898MVA 764MW
  Scheduled in-service date: Q1 2004

1. Incorporation Arrangements for the Individual Projects

The connection arrangement for each Project was found to be acceptable although disconnect switches will be required at the point of connection to the IMO-controlled grid.

2. Impact on Fault Levels

The connection of the two Sithe Projects to the IMO-controlled grid would result in an increase in the fault levels at both Claireville TS and Lakeview TGS that would be sufficient to exceed the fault interrupting capability of the following circuit breakers:

- at Claireville TS circuit breakers T16L75 & HL75 (associated with circuit V75R)
- at Lakeview TGS circuit breakers L24T8, T4T5, L22T4 and L22T3

In addition, should the asymmetrical fault level increase by just 1.38kA at Claireville TS then the fault interrupting capability of the following four circuit breakers would also be exceeded:

- circuit breakers L76L82 & HL82 (associated with circuit B82V)
- circuit breakers KL83 & T13L83 (associated with circuit B83V)

2.1 Fault Levels at Claireville TS

To respect the fault interrupting capability of the existing 230kV circuit breakers at Claireville TS, the IMO requires that the following system modifications be completed:

Reterminate the section of circuit V72R, between Claireville TS and Richview TS, on to the same position on the Claireville 230kV busbar as is currently occupied by the sections of circuit V75R to Richmond Hill TS and Kleinburg TS.

The proposed arrangement is shown in Diagram 35.

It has also been recommended that the present connection of the Richview DESN on circuit V72R should be reviewed with Hydro One to determine whether it needs to be reterminated on to another circuit. The intent of the work would be to reduce the exposure of circuit V72R (and hence V75R) to line faults, while also simplifying the protective relaying. This work is not a *requirement* of the IMO for connection of the two Sithe Projects.

Should the test results for the equipment that is eventually supplied for the two Sithe Projects result in higher fault levels than those that have been studied, Sithe would have the option of adopting either of the following measures, which would be acceptable to the IMO:

i. Install supplementary, series-connected reactors in the connections from the Sithe-Goreway Project to circuits V72R and V73R, to address minor changes in the parameters for the equipment supplied for each Project.

The installation of these reactors, which is intended to complement the retermination of circuit V72R, is to be considered an interim measure. Once the busbar at Claireville TS is eventually 'split', these reactors must be removed. The effective, combined impedance of each step-up transformer at the Goreway facility with the series-connected reactors installed, is not to exceed 8% on $100MVA_{base}$ and $220kV_{base}$.

ii. Permanently 'split' the 230kV busbar at Claireville TS.

If there is a significant change in the equipment parameters that would result in higher fault levels but would not increase the output from either facility then, subject to confirmation that the transient performance remains acceptable to the IMO, the IMO will require that the following work be completed:

- reterminate circuit V73R on to a new diameter on the western half of the Claireville 230kV busbar
- reterminate the section of circuit V74R between Claireville TS & Richview TS on to the position at Claireville TS that was previously occupied by circuit V73R
- terminate the idle circuit between Claireville TS & Richview TS (V75R) on to the same position at Claireville TS as is currently occupied by the radial section of circuit V74R, and terminate it on to a new position on the eastern half of the Richview 230kV busbar.
- permanently 'split' the 230kV busbar at Claireville TS.

For this work to be necessary, it is assumed that the increased fault levels cannot be addressed by the retermination of circuit V72R, together with the installation of supplementary series-connected reactors.

This work would be undertaken *instead of* the retermination of circuit V72R and the installation of series-connected reactors.

The proposed arrangement is shown in Diagrams 28 & 29.

2.2 Fault Levels at Lakeview TGS

To respect the fault interrupting capability of the existing 230kV circuit breakers at Lakeview TGS, the IMO requires that the following system modifications be completed:

Remove the following 230kV breakers and install busbar connections so that the vacated positions are by-passed:

circuit breaker L24T8
circuit breaker T4T5 ***OR*** L22T4
circuit breaker L22T3

Diagram 21shows the breakers that would be affected.

3. Circuit Overloading on the 230kV system in the Vicinity of the Sithe-Southdown Project

To address concerns related to possible post-contingency overloading of the 230kV circuits in the vicinity of the Southdown Project during periods of light load and/or high ambient temperatures, the IMO requires that a generation rejection scheme be installed. See Section 5 below, for details.

4. Impact on Transfer Capabilities

Although the Sithe-Southdown Project would restrict the scope for incorporating further generating capacity into the system, south of the Lakeview North Interface, neither Project was determined to have an adverse impact on transfer capabilities across any of the Transmission Interfaces that were examined.

5. Transient Stability

For all the cases that were examined, a stable and positively-damped response was obtained. The most pronounced responses that were obtained were for contingencies involving the 230kV circuits L23CK & L24CR. For these contingency conditions one of the generating units at the Sithe-Southdown facility would remain connected, post-contingency, via the LV busbar of the DESN Stations connected to circuits B15C & B16C. This unit was shown to experience pronounced initial transient oscillations. However, its damping performance was good and stability was maintained.

However, in order to ensure compliance with the existing System Control Order for the area, which limits the amount of generation capacity that can be retained in-service post-contingency on a single 230kV Lakeview circuit to three 300MW Lakeview units, the IMO requires that the following system modifications be completed:

Install a generation rejection scheme for the Southdown Project.

This Scheme would need to initiate generation rejection for contingencies and line-end-open conditions involving the 230kV circuits L23CK, L24CR, L21K & L22K. It would also need to respond to line-end-open conditions involving the 230kV circuits B15C & B16C.

6. Interim Connection Arrangement

In the event that the measures detailed in 2.1 and 2.1.i above, are adequate to address the fault level concerns at Claireville TS, then it would not be necessary to 'split' the busbar at this time.

However, should Sithe want to limit possible future disruption to the operation of their Goreway facility when circuit V73R needs to be relocated in preparation for the ultimate 'splitting' of the Claireville 230kV busbar, the IMO has no objections to this work being completed prior to the in-service date for this facility.

7. Budgetary Cost Estimates

Approximate budgetary cost estimates have been provided. These should be used with extreme caution due to the limited information available regarding site conditions and possible construction constraints. In addition, since the most recent work that has been undertaken involving gas-insulated-switchgear occurred approximately eight years ago, there is very little up-to-date information available on which to base the costs for the GIS work at Claireville TS.

8. Identification of 'Sole Beneficiaries'

For each Project, those modifications and upgrades that are deemed to be triggered by, and are for the sole benefit of a particular generator, have been identified.

*9. Notification of Approval of the Connection Proposal*s

Subject to acceptance of the IMO's requirements for incorporation into the IMO-controlled grid, it is recommended that Notification of Approval for Connection should be issued for each Project.

System Impact Assessment Report for the Two Sithe Projects in the Greater Toronto Area

1. Introduction

This Report presents the results of the studies that were performed to determine the impact on the reliability of the IMO-controlled grid of the two generation Projects that *Sithe Energies Canadian Development Ltd.* are planning to develop in the Greater Toronto Area:

- *Sithe - Goreway Project* Installed capacity: 1096MVA
  Scheduled in-service date: Q2 2003
- *Sithe - Southdown Project* Installed capacity: 898MVA
  Scheduled in-service date: Q1 2004

2. Generation Connection Feasibility Study

The two Sithe Projects were the subject of a Generation Connection Feasibility Study that was undertaken by Hydro One, prior to the implementation of the IMO's Connection Assessment & Approval Process.

In addition to the two Sithe Projects, this study also included a 275MW generator on each half of the Lakeview 230kV busbar, as proposed for the Lakeview New Generation Project.

The principal conclusions of the Feasibility Study were as follows:

- Split the 230kV busbar at Claireville TS and install bus-tie reactors in the range of 4 ohms to 6 ohms.
- Install a new 230kV breaker in the existing diameter on the eastern half of the 'split' busbar at Claireville TS and reterminate the radial sections of circuit V73R on to the new position.
- Uprate up to six of the 230kV breakers at Lakeview TGS.

Following the completion of this study, the IMO received notification that the Lakeview New Generation Project has been deferred. This Project is therefore not being included in any of the current analysis being performed by the IMO.

After reviewing the results of the Generation Connection Feasibility Study it was decided to proceed directly to the System Impact Assessment for the following reasons:

- Other than for the two Sithe Projects, the IMO has received no applications for any other projects that could be considered to be in direct 'electrical proximity', and that could therefore influence the results of the analysis.
- All of the analysis that would have been performed for separate Preliminary Assessments of the two Projects would still be undertaken as part of the analysis for the System Impact Assessment of the cluster.

3. Details of each Project

The principal details regarding the location, configuration, and connection arrangement for each Project are summarised in the following sections:

3.1 Sithe - Southdown Project

The Southdown Project is to be located approximately 1½km south of the existing 230kV right-of-way for circuits B15C & B16C, between Applewood Junction and Oakville TS. It is planned to tap on to each of these circuits between Lorne Park TS and Ford TS, via two cabled circuits. A manually-operated disconnect switch is to be located at the tapping point of each cabled circuit from the Sithe-Southdown project on to circuits B15C & B16C.

Diagram 1 shows the configuration of the proposed facility, while Diagram 2 shows the connection on to circuits B15C & B16C, together with the principal components of the transmission system in the area.

As detailed in Diagram 1 the Project is to comprise two 300MVA gas-turbine units, together with a single 300MVA steam-turbine unit. Each gas-turbine unit is dedicated to a specific 230kV circuit, while the steam-turbine unit is connected to both 230kV circuits via a three-winding step-up transformer.

HV circuit breakers are to be used both for isolation of transformer faults, as well as generator faults, and also for the synchronisation of each generating unit to the system. Each HV circuit breaker has a motorised disconnect associated with it.

3.2 Sithe - Goreway Project

The Goreway Project is to be located approximately 1½km north of the existing 230kV right-of-way for circuits V72R & V73R, between Claireville TS and Bramalea TS. The connection from the generating facility to the right-of-way is to be via a double-circuit 230kV overhead line.

Diagrams 3 & 4 show the configuration of the generating facility as originally proposed, and the arrangement of the 230kV circuits in the area, respectively. Minor modifications to the equipment specifications were made during the course of the assessment, and these are documented in Section 5.1.5.

The Goreway Project is to comprise four generating units: three gas-turbines, each rated at 240MVA and one steam-turbine rated at 370MVA. It is proposed to connect two of the gas-turbine units to one of the 230kV circuits, while the remaining gas-turbine unit and the single steam-turbine unit are to be connected to the other 230kV circuit.

Nominally, the two gas-turbine units have been shown connected to circuit V72R, while the gas-turbine/steam-turbine combination has been shown connected to circuit V73R.

4. Impact on the Local System

4.1 Sithe - Southdown Project

Circuits B15C & B16C, to which the Sithe-Southdown Project is to be connected, are rated as follows:

- 580MVA continuous rating
- 990MVA 15-minute limited-time rating
  (15-min. LTR assumes a pre-loading of 75%)

} 30°C ambient, 4km/hr wind

For the incorporation arrangement proposed for the Southdown Project, as shown in Diagram 1, a contingency involving either circuit B15C or circuit B16C would result in the automatic loss of the gas-turbine unit associated with the faulted circuit. This, in turn, would reduce the output from the steam-turbine generating unit, which would remain connected to the healthy circuit. The net output from the Southdown facility would fall to approximately half the maximum output, with all facilities in-service. This would be comparable to the 'normal' loading condition (with each circuit carrying half the output from the Sithe facility), and for which the circuits are adequately rated.

For the remaining circuits between Lakeview TGS and Richview TS, the effect of the Southdown Project on line loadings under contingency conditions for both the summer peak load condition and the light load condition, respectively, are summarised in the Tables below, for the following operating conditions.

- For both conditions, all four 300MW generating units at Lakeview TGS are assumed to be in-service, together with the Sithe-Southdown Project.
- The peak load supplied from circuits B15C & B16C has been assumed to be approximately 350MW. The light-load condition has been assumed to be 60% of the peak value, i.e. ~ 210MW.

- *No generation rejection has been assumed.*

  For an outage or contingency involving circuit L23CK or circuit L24CR, the associated circuit B15C or B16C is assumed to remain in-service and connected to its companion circuit via the LV busbars of each of the DESN stations.

Line Loadings with the Sithe Southdown Project in-service. Peak Summer Load Condition

Status of Lakeview 230kV Busbar	*Out-of-service condition* ***OR*** *Contingency Condition*	*Loading on Circuits*			
		L21K	*L22K*	*L23CK*	*L24CR*
		Sections: Applewood Junction to -			
		Manby West		Manby East	Richview
		*580/990MVA***		*880/1140MVA***	*980/1250MVA***
Horizontal 'split'	All elements in-service	293MVA	297MVA	649MVA	377MVA
	L23CK	293MVA	297MVA	-	989MVA
	L24CR	293MVA	297MVA	1006MVA	-
Vertical 'split'	All elements in-service	468MVA	348MVA	479MVA	319MVA
	L21K	-	439MVA	454MVA	713MVA
	L22K	526MVA	-	785MVA	297MVA
	L23CK	542MVA	588MVA	-	462MVA
	L24CR	590MVA	403MVA	611MVA	-

*Notes: ** Line ratings: Continuous/15-minute limited-time-ratings at 30^{O}C ambient, 4km/hr wind, and 75% pre-loading.*

The shaded cells indicate that the continuous rating of the circuit would be exceeded

Line Loadings with the Sithe Southdown Project in-service. Light Load Condition

Status of Lakeview 230kV Busbar	*Out-of-service condition* ***OR*** *Contingency Condition*	*Loading on Circuits*			
		L21K	*L22K*	*L23CK*	*L24CR*
		Sections: Applewood Junction to -			
		Manby West		Manby East	Richview
		*580/990MVA***		*880/1140MVA***	*980/1250MVA***
Horizontal 'split'	All elements in-service	293MVA	297MVA	736MVA	463MVA
	L23CK	293MVA	297MVA	-	1160MVA
	L24CR	293MVA	297MVA	***1181MVA***	-
Vertical 'split'	All elements in-service	492MVA	371MVA	539MVA	387MVA
	L21K	-	466MVA	511MVA	802MVA
	L22K	553MVA	-	872MVA	363MVA
	L23CK	607MVA	593MVA	-	572MVA
	L24CR	597MVA	460MVA	721MVA	-

*Notes: ** Line ratings: Continuous/15-minute limited-time-ratings at 30^{O}C ambient, 4km/hr wind, and 75% pre-loading*

The shaded cells indicate that the continuous rating of the circuit would be exceeded. Where the flow is shown in bold-italic, the 15-minute limited-time-rating would also be exceeded.

As shown in the Tables above for the Summer Peak Load and Light Load conditions, respectively, the loading on the companion circuit would exceed its *continuous* rating whenever the section of circuit L23CK or L24CR north of Applewood Junction is out-of-service. While this occurs for both the horizontal and the vertical 'split' arrangement of the Lakeview busbar, the extent of the overloading is much more pronounced for a horizontal 'split'.

Furthermore, the only *contingency* condition that would result in the 15-minute limited-time-rating of the companion circuit being exceeded would be the one involving circuit L24CR while the Lakeview busbar is 'split' horizontally, and Light Load conditions exist.

The studies also indicated that for a contingency involving either circuit L23CK or L24CR, the transfers through the DESN stations connected to circuits B15C and B16C, via their LV busbars, remained within their continuous ratings, except for Oakville TS. The transfers through the transformers at this TS, however, remained well within their 10-day limited-time-rating.

The following conclusions can be drawn from these results:

- That with all four generating units at Lakeview TGS, as well as the entire Sithe-Southdown facility in-service, overloading only occurs for an outage or contingency condition involving circuits L23CK or L24CR.
- The extent of the overloading is more pronounced with the 230kV busbar at Lakeview TGS 'split' horizontally than it is with it 'split' vertically.
- That the only contingency condition that would result in the 15-minute limited-time-rating being exceeded and would therefore require generation rejection to be initiated, involves circuit L24CR under high ambient temperature conditions, when the 230kV busbar at Lakeview TGS is 'split' horizontally. For all other conditions, controlled run-back of the generating units would suffice.
- That with the 230kV busbar at Lakeview GS 'split' vertically and with lower ambient temperatures (and higher line ratings) it should be possible for the Sithe-Southdown Project to continue to operate at full output under line-outage conditions, even when all four Lakeview units are in-service.

These results indicate that an automatic generation rejection/run-back scheme will be required for the Sithe-Southdown Project to address contingency conditions involving circuits L23CK and L24CR.

In addition, should Sithe wish to maximise the output from its Southdown facility during periods when elements are out-of-service (rather than be restricted to a level that would allow a subsequent contingency condition to be respected) then the scope of the generation rejection/run-back scheme would need to be expanded to address other contingency conditions.

4.2 Sithe - Goreway Project

Circuits V72R & V73R, to which the Sithe-Goreway Project is to be connected, are rated as follows:

- 710MVA continuous rating
- 900MVA 15-minute limited-time rating
  (15-min. LTR assumes a pre-loading of 75%)

} 30^{o}C ambient, 4km/hr wind

As shown in Diagram 3, the two halves of the Sithe-Goreway Project are totally independent. Consequently, in the event of a contingency involving either 230kV circuit, the half of the facility connected to that particular circuit would be lost.

In the event that the gas-turbine/steam-turbine combination is lost, then the transfer on the remaining circuit, to which the two gas-turbine combination would be connected, would remain at the same level as it was pre-contingency. However, if the two gas-turbine combination is lost, then with reduced output from the steam-turbine unit, the transfer on the remaining circuit would drop from approximately half the capacity of the entire facility, to approximately a third.

With a continuous rating of 710MVA, each circuit would be adequate, even with zero load at Bramalea TS.

4.3 Impact on Local Area Reliability

Both the Sithe-Southdown and the Sithe-Goreway Projects involve two incorporation circuits, each approximately 1½km in length. The increased exposure due to these additional circuits is expected to be minimal, and would be off-set by the support that the two Projects would provide to the load-meeting capability of the area.

5. Fault Level Analysis

Fault level studies were performed to determine the impact of the two Projects on the existing transmission facilities in the area.

The following system conditions were assumed when conducting these studies:

- All existing transmission facilities, together with those facilities that have been 'committed' are assumed to be in-service.
- The four generation Projects in the Sarnia-Windsor area, that were the subject of a System Impact Assessment were all assumed to be in-service.
- The generators at the Pickering 'A' & 'B' stations are all in-service
- The generators at the Bruce 'A' & 'B' station, except for unit 7, are all in-service
- The two 500/230kV auto-transformers at Lennox TS, together with units G1 to G4 at Lennox TGS are in-service.
- The 230kV busbars at Richview TS are operated 'split', while Cherrywood TS is operated with a separate North & South switchyard.
- All of the generators that were specified for each Sithe Project were assumed to be in-service and incorporated into the system in accordance with the arrangements detailed in Diagrams 1 to 4 inclusive.
- *The original (1995) representation for the Detroit Edison Company in the year-2000 was used to model that system*.
- *In addition, the initial 600MW phase of the new generation Project in the Belle River/St. Clair area of the Detroit Edison Transmission System, that is scheduled to be in-service in the Fall-2002, was also included in the system model used for the fault level analysis.*

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.

Status of the 230kV Busbar at Richview TS

With Pickering NGS and four generating units at both Darlington NGS in-service, it is an operating requirement to 'split' the 230kV busbar at Richview TS *whenever three or more generating units are in-service at Lakeview TGS*. Presently, this action is necessary only approximately 10% of the time.

Since all four units at Lakeview TGS were assumed to be in-service for the fault level analysis, the 230kV busbar at Richview TS was therefore considered to be permanently 'split', in accordance with the prevailing Operating Instruction. This would ensure that the fault level at Richview TS, *without either of the Sithe Projects*, would remain within the fault interrupting capability of the existing 230kV circuit breakers.

Fault Level Results

The results of the fault level analysis at Claireville TS and Lakeview TGS, the two most critical locations, are shown on the following Diagrams, which are contained in Appendix A:

At Claireville TS

Diagram 5 For a 3-phase Fault, for the existing system configuration.
Diagram 6 For a 3-phase Fault, with only the Southdown Project incorporated.
Diagram 7 For a 3-phase Fault, with only the Goreway Project incorporated.
Diagram 8 For a 3-phase Fault, with both the Southdown & Goreway Projects incorporated.
Diagram 9 For a Line-to-Ground Fault, for the existing system configuration
Diagram 10 For a Line-to-Ground Fault, with only the Southdown Project incorporated.
Diagram 11 For a Line-to-Ground Fault, with only the Goreway Project incorporated.
Diagram 12 For a Line-to-Ground Fault, with both the Southdown & Goreway Projects incorporated.

At Lakeview TGS

Diagram 13 For a 3-phase Fault, for the existing system configuration, with a 'horizontal' split of the busbar.
Diagram 14 For a 3-phase Fault, for the existing system configuration, with a 'vertical' split of the busbar.
Diagram 15 For a 3-phase Fault, with both Sithe Projects incorporated & a 'horizontal' split of the busbar.
Diagram 16 For a 3-phase Fault, with both Sithe Projects incorporated & a 'vertical' split of the busbar.
Diagram 17 For a Line-to-Ground Fault, for the existing system, with a 'horizontal' split of the busbar.
Diagram 18 For a Line-to-Ground Fault, for the existing system, with a 'vertical' split of the busbar.
Diagram 19 For a Line-to-Ground Fault, with both Sithe Projects incorporated & a 'horizontal' split of the bus.
Diagram 20 For a Line-to-Ground Fault, with both Sithe Projects incorporated & a 'vertical' split of the busbar

5.1 Fault levels at Claireville TS

The maximum fault levels are also summarised in the Table below:

Fault levels on the 230kV busbar at Claireville TS for a Pre-fault Voltage of 250kV						
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
	3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
Existing	65.06kA	68.40kA	83.21kA	81.40kA	80.0kA	96.0kA
With the Southdown facility only	67.93kA	70.52kA	87.02kA	83.92kA	80.0kA	96.0kA
	+2.87kA	*+2.12kA*	*+3.81kA*	*+2.52kA*		
With the Goreway facility only	71.95kA	74.02kA	92.39kA	88.08kA	80.0kA	96.0kA
	+6.89kA	*+5.62kA*	*+9.18kA*	*+6.68kA*		
With both the Southdown & Goreway facilities	74.82kA	76.05kA	***96.15kA***	90.50kA	80.0kA	***96.0kA***
	+9.76kA	*+7.65kA*	*+12.94kA*	*+9.10kA*		

From the Table above it can be seen that the Southdown Project, by itself, would add approximately 2kA to 4kA to the fault level at Claireville TS, while the Goreway Project, by itself, would be responsible for an approximate contribution of between 6kA and 9kA. The cumulative contribution from the two projects would be between 8kA and 13kA.

With both Sithe Projects in-service the asymmetrical fault levels for a 3-phase fault would marginally exceed the breaker ratings (96.15kA versus a rating of 96.00kA). However, if reference is made to Diagram 8, it is evident that the fault contribution from each individual circuit *except V75R*, is greater than 0.15kA and therefore sufficient to ensure that the fault interrupting duty imposed on the individual breakers would be less than their rating. Apart from circuit V75R, the minimum asymmetrical fault infeed into the Claireville busbar is 1.38kA from circuits B82V & B83V. This would have the effect of reducing the maximum duty that would be imposed on the breakers associated with each of these circuits, to 94.77kA, which would be within their rating.

For the breakers associated with circuit V75R there would be no comparable reduction, since the fault contribution from this circuit is 0kA. Therefore the maximum fault interrupting duty that would be imposed on these two breakers, T16L75 & HL75, would be 96.15kA; the same as the full fault level at the busbar.

Options for addressing the high fault levels at Claireville TS

There are a number of options available for addressing the fault level issue at Claireville TS, as follows:

i. Replace breakers T16L75 & HL75 with higher rated units. However, since the existing breakers are already rated at 80kA, and this is generally accepted to be the maximum *economic* rating for breakers at an operating voltage of 230kV, this is not considered to be a viable option.

   Furthermore, since the asymmetrical fault contribution from circuits B82V & B83V is only 1.38kA, any other developments in the area that increase the fault level at Claireville TS by more than this value, would necessitate the replacement of a further four circuit breakers. [KL83 & T13L83, and L76L82 & HL82]

ii. Install supplementary series-connected reactors to each step-up transformer so as to increase the impedance beyond the 13.3% value (on a transformer rating of 225MVA) specified by Sithe for their Goreway Project and as used in the fault level analysis.

   Since an impedance of 13.3% is considered to be the maximum that would be permitted under the Market Rules, the supplementary reactors would only be permitted as an interim measure until such time as the 230kV busbar has to be operated permanently 'split' in response to increasing fault levels within the GTA. At that time these reactors would have to be removed.

iii. Install bus-tie reactors in the main busbars at Claireville TS (as recommended in the Hydro One Feasibility Study).

   This would effectively add a finite length of transmission line between the two halves of the 'split' 230kV busbar at Claireville TS.

   The affect that different sizes of bus-tie reactors would have on the fault levels at Claireville TS has been examined as part of this Assessment, and the results are contained in Section 5.1.1 below.

iv. Permanently 'split' the 230kV busbar at Claireville TS.

   This is generally accepted as the preferred 'long-term' solution, and was also the main recommendation of the earlier Hydro One Feasibility Study. However, while it would provide an effective solution to the problem of ever increasing fault levels as more generation capacity is added to the system to meet increases in demand, the 'splitting' of the busbar would have an adverse impact on transformer loadings and transfer capabilities in the area. To restore these to their former levels, additional facilities would have to be added to the system. The more obvious alternatives that would need to be included as part of any future analysis are as follows:

   - Install an additional 230kV circuit between the eastern half of the 'split' busbar at Claireville TS and the 'split' busbar at Richview TS.

     This would 'balance' the two halves of the busbar, so that each half would have three circuits to Richview TS associated with it.

     This option is discussed in further detail in Section 5.1.2 below.

- Extend the sections of circuits V71R & V75R from Richmond Hill TS through to Cherrywood TS. This would have the same net effect as the previous option, by creating additional connections between Claireville TS and Richview TS, but via Cherrywood TS.

v. Reconfigure the termination of circuit V75R at Claireville TS so as to associate it with a fault infeed from one of the 230kV circuits to Richview TS.

This option is discussed in further detail in Section 5.1.3 below.

5.1.1 Installation of 230kV Bus-Tie Reactors at Claireville TS

If the option of installing bus-tie reactors at Claireville TS were to be adopted, then the effect on the fault levels (and the amount of margin provided for further increases in fault level) of different sizes of reactors is given in the Table below.

Impact of Bus-Tie Reactor size on the Fault Levels at Claireville TS							
Busbar Section	*Fault Type*		*Fault Levels with both Sithe Projects In-service*				*Breaker Rating*
			With a 'Solid' 230kV Busbar	With a 'Split' 230kV Busbar			
				Bus-Tie Reactor Rating			
				2-ohm	4-ohm	6-ohm	
Eastern	3-phase	sym	74.8kA	67.8kA	64.1kA	61.8kA	80.0kA
			Margin	*12.8kA*	*15.9kA*	*18.2kA*	
		asym	***96.2kA***	87.5kA	83.2kA	78.8kA	***96.0kA***
			Margin	*8.5kA*	*12.8kA*	*17.2kA*	
	Line-to-Ground	sym	76.1kA	69.4kA	65.5kA	63.1kA	80.0kA
			Margin	*10.6kA*	*14.5kA*	*16.9kA*	
		asym	90.5kA	82.6kA	78.0kA	76.2kA	96.0kA
			Margin	*13.4kA*	*18.0kA*	*19.8kA*	
Western	3-phase	sym	74.8kA	68.4kA	65.0kA	62.8kA	80.0kA
			Margin	*11.6kA*	*15.0kA*	*17.2kA*	
		asym	***96.2kA***	87.6kA	83.7kA	80.2kA	***96.0kA***
			Margin	*8.4kA*	*12.3kA*	*15.8kA*	
	Line-to-Ground	sym	76.1kA	70.0kA	66.4kA	64.1kA	80.0kA
			Margin	*10.0kA*	*13.6kA*	*15.9kA*	
		asym	90.5kA	83.3kA	79.0kA	77.4kA	96.0kA
			Margin	*12.7kA*	*17.0kA*	*18.6kA*	

Notes: 1. *'Margin'* represents the difference between the breaker rating and the fault level.
For individual breakers, making allowance for the associated fault infeeds could provide additional margin.

2. A 2ohm reactor installed in each busbar is approximately equivalent to connecting the two halves of the 'split' busbar via two, 230kV transmission lines, each 4km in length.

The existing fault level margin at Claireville TS is approximately 12kA symmetrical and 13kA asymmetrical (see the Table in Section 5.1.1). To restore this margin, bus-tie reactors rated at 4 ohms would need to be installed on the 230kV busbars at Claireville TS.

Furthermore, since the Goreway Project alone contributed approximately 9.2kA to the asymmetrical fault level at Claireville TS (refer to the same Table in Section 5.1.1), 4 ohm bus-tie reactors would ensure that there would be adequate scope for the incorporation of future developments of a similar size in the area.

5.1.2 'Splitting' the 230kV Busbar at Claireville TS

There are a number of factors to be considered in any decision to ensure that 'splitting' the 230kV busbar at Claireville TS would not have a detrimental impact on the transmission system:

- that the loading on the individual 500/230kV auto-transformers at Claireville TS remains approximately equal.
- that there is no degradation of the supply to the 'downstream' transmission system, in particular the supply to Manby TS.
- that there is no adverse impact on the transfer capabilities across the following interfaces:

Claireville TS	- Richview TS
Cherrywood TS	- Richview TS
Trafalgar TS	- Richview TS, and
Lakeview TS	- Richview TS

5.1.2.1 Loadings on the 500/230kV Auto-transformers at Claireville TS

Inspection of Diagram 22 shows that 'splitting' the 230kV busbar would result in an imbalance in the loading on the two halves of the Claireville busbar. [With the 230kV busbar operated 'closed', the loading on all four auto-transformers is the same, and this is therefore not an issue.]

The loads at Bramalea TS and Goreway TS, which currently total approximately 400MW, are all supplied from the western half of the busbar, while the loads on the following circuits are supplied from both halves of the busbar:

V75R (west) &	V71R (east)	to Vaughan MTS 1 & 2, and Richmond Hill MTS 1
B82V (west) &	B83V (east)	to Armitage TS and Brown Hill TS, and
V75R (west) &	V74R (east)	to Woodbridge TS and Kleinburg TS

Consequently, if there were to be no redistribution of these loads, then 'splitting' the Claireville busbar (without the introduction of bus-tie reactors) would result in each of the auto-transformers, T15 & T16 (that are connected to the western half of the busbar), being loaded by approximately 200MW more than the auto-transformers, T13 & T14.

Since the present peak transfers from the 500kV to the 230kV busbars at Claireville TS are typically around 2000MW, this would mean that auto-transformers T15 & T16 would each be loaded to approximately 600MW, while auto-transformer T13 & T14 would only be loaded to approximately 400MW each.

Once the Sithe-Goreway Project is placed in-service, and if the entire facility were to be connected to the western half of the Claireville busbar, it would unload auto-transformers T15 & T16, but have no impact on the other two auto-transformers.

In order to balance the loading on the auto-transformers at Claireville TS with the 230kV busbar 'split', and for the conditions with, and without the Sithe-Goreway plant operating at full output, the radial sections of circuit V73R would need to be reterminated into a new position on the existing diameter on the eastern half of the busbar.

The respective loadings on the two pairs of auto-transformers at Claireville TS would also be affected by the choice of whether to install bus-tie reactors or to open the busbars at Claireville TS and also install an additional 230kV circuit between the eastern halves of Richview TS and Claireville TS. This is discussed further in Section 5.6.

5.1.2.2 Retermination of Circuit V73R at Claireville TS

Reference to Diagrams 5 and 9 shows that, without the Sithe-Goreway Project, the fault infeeds to the eastern half (the H2-K2 bus) and western half (the H1-K1 bus) of the Claireville busbar are approximately equal. (The fault level for the western half is marginally higher, due primarily to the connection of three Richview circuits to that half, while only two Richview circuits terminate on the eastern half.)

Incorporating the Sithe-Goreway Project on to circuits V72R and V73R, that both terminate on to the western half of the busbar at Claireville TS, would increase the fault level of that half of the busbar by approximately 7kA (symmetrical) and 9kA (asymmetrical) for a 3-phase fault.

To obtain a better balance between the fault levels on the two halves of the busbar it is recommended that the two components of the Sithe-Goreway Project should be connected to the respective halves of the Claireville busbar.

Since it has already been recommended that the radial sections of circuit V73R that supply Bramalea TS and Goreway TS should be reterminated to the eastern half of the Claireville 230kV busbar in order to balance the loading on the 500/230kV auto-transformers, this would therefore provide further support for this action.

Diagram 23 shows the revised arrangement of the Claireville 230kV busbar with the radial sections of circuit V73R, together with that part of the Sithe-Goreway facility that is incorporated on to the circuit to Bramalea TS, reterminated into a new position on an existing diameter.

5.1.2.3 Comparison of Bus-Tie Reactors versus an additional 230kV Circuit between Claireville TS & Richview TS

Reference to Diagram 25 shows that, with the exception of the section between Claireville TS & Richview TS, there would be a reasonable degree of symmetry between the two halves of the system whenever the 230kV busbars at Claireville TS, Richview TS and Lakeview TGS are operated open. The obvious omission is the third 230kV circuit between the eastern halves of the Claireville TS and Richview TS busbars.

Installing the third circuit (together with reterminating the radial section of circuit V73R) would make both the Claireville TS and Richview TS busbars electrically symmetrical.

The Diagram also shows the 'cross-connection' that exists between the western half of the Lakeview busbar and the eastern half of the Richview busbar for a horizontal 'split' of the Lakeview busbar. A similar 'cross-connection' also occurs (but involving circuit L22R) whenever a vertical 'split' of the Lakeview busbar is in effect.

Whenever the Lakeview busbar is operated 'split', it is critical that the appropriate 'cross-connection' is available in order to secure the supply to either Manby East TS or Manby West TS for a contingency involving one of the Manby TS to Richview TS circuits, whenever the companion 230kV circuit is already out-of-service.

e.g. If circuit R1K is out-of-service, then in order to secure Manby East TS for a contingency involving the companion circuit R13K, the L24CR 'cross-connection' needs to be available.

Additional studies were performed to examine the relative performance of an arrangement with bus-tie reactors installed at Claireville TS compared to that with the two 230kV busbar disconnects at Claireville open and an additional circuit installed between the eastern halves of the Claireville TS and Richview TS busbars.

These studies assumed the following conditions:

- The Richview TS and Lakeview TGS busbars were 'split'.
- The Sithe-Goreway Project was in-service, operating at full capacity, while the Sithe-Southdown Project was out-of-service.
- Two units at Lakeview TGS were in-service.
- The total loading on the four 500/230kV auto-transformers at Claireville was 2400MW.

The results of the studies can be summarised as follows:

With bus-tie reactors

A contingency involving one of the eastern Claireville TS to Richview TS circuits would result in the following:

- an increase in the post-contingency flow on the companion circuit above its continuous rating (but within its 15-minute limited-time-rating)
- an increase the east-west transfers through the bus-tie reactors, while also increasing the post-contingency transfers through auto-transformers T15 & T16 on the western half of the Claireville busbar
- the creation of post-contingency circulating transfers via the parallel paths from Richview-west to Richview-east, via Trafalgar TS, Cherrywood TS and the Lakeview-east busbar.
- an increase in the post-contingency transfers to the Richview-east busbar, via the 500kV system from Claireville TS to Trafalgar TS, and from Claireville TS to Cherrywood TS.

With an increase in the rating of the bus-tie reactors (from 4 ohms to 6 ohms, and then possibly to 8 ohms) the east-west transfers through the bus-tie reactors would diminish, resulting in an increased transfer through the T15 & T16 auto-transformers, and through the 500kV system.

For a contingency involving one of the auto-transformers on the eastern half of the busbar at Claireville TS, the results were as follows:

- approximately 25% of the pre-loading on the faulted auto-transformer would be transferred to the companion auto-transformer, while approximately 40% would appear as a west-to-east transfer through the bus-tie reactors. The remaining 35% of the pre-loading would appear on the 500kV-230kV paths through Trafalgar TS and Cherrywood TS.

With an additional 230kV circuit between Claireville TS and Richview TS, and with no bus-tie reactors

A contingency involving one of the eastern Claireville TS to Richview TS circuits would result in the following:

- an increase in the post-contingency flows on the companion circuits, although these remained within the continuous ratings for these circuits.
- an increase in the transfers through the 500kV system to both Trafalgar TS (≈ 30MW) and Cherrywood TS (≈ 50MW), providing an indirect supply to the Richview-east busbar.

One interesting observation from these studies was the effect that an additional 230kV circuit between Claireville TS and Richview TS would be expected to have on the transfers through the 500kV system.

Comparing the pre-contingency flows for the case with the bus-tie reactors and that with an additional 230kV circuit showed that the additional circuit would be expected to result in a net increase of approximately 50MW in the transfer over the 230kV circuits between Claireville TS and Richview TS. This would result in a corresponding reduction in the flows from Trafalgar TS and Cherrywood TS to the Richview-east busbar (≈ 20MW & ≈ 30MW, respectively).

For a contingency involving one of the auto-transformers on the eastern half of the busbar at Claireville TS, the results were as follows:

- approximately 30% of the pre-loading on the faulted auto-transformer would be transferred to the companion auto-transformer, while a further 10% would appear on each of the two auto-transformers on the western half of the busbar. The remainder of the pre-loading would appear as an increase in the transfers through the 500kV system to both Trafalgar TS (≈ 25%) and Cherrywood TS (≈ 25%).

These studies also demonstrated the beneficial influence of the high degree of connectivity that exists between the 500kV system and the 230kV system into Richview TS, *even with the 230kV system operated 'split'*. As can be seen from Diagram 26, which shows the arrangement of the existing 500kV and 230kV system in the Claireville TS-Richview TS area, the two halves of the Richview busbar are supported not only directly from Claireville TS but also indirectly from both Trafalgar TS and Cherrywood TS.

Adding the additional 230kV circuit between Claireville TS and Richview TS would further reinforce the support provided to the Richview busbar.

However, while these studies did not indicate any major distinctions between the two options, the performance of the arrangement involving the additional 230kV circuit between Richview TS and Claireville TS was considered to be marginally superior, particularly for the more common contingency condition involving a transmission line rather than an auto-transformer. In addition the presence of new 230kV circuit would reduce the transfers via the parallel paths through the 500kV system while also providing greater operational flexibility with respect to line outages.

It should also be noted that if bus-tie reactors were not to be installed, that the existing configuration, with disconnects in each of the main busbars would remain untouched. Subject to a review of the prevailing fault level conditions, this would allow the busbars at Claireville TS to be 'commoned' should conditions necessitate. Obviously the situation would have to be extreme, such as an outage involving both of the auto-transformers associated with one half of the Claireville busbar. However, the added flexibility that retaining the disconnects would provide would need to be factored into any decision regarding which option to adopt.

5.1.2.4 Configuration of the Eastern Half of the 230kV Busbar at Claireville TS

If the 230kV busbar at Claireville were to be operated 'split' *with no bus-tie reactors*, then the eastern half of the 'split' busbar would form a ring.

Reference to Diagram 23 shows that, under breaker outage conditions, a contingency involving any of the circuits, or transformers associated with the eastern half of the 'split' busbar could isolate circuits and/or auto-transformers.

e.g. i. with breaker HT14 out-of-service, a contingency involving circuit V74R would completely isolate the radial circuits to Goreway TS and Bramalea TS (together with half the Sithe-Goreway facility) from the system.

ii. with breaker HT14 out-of-service, a contingency involving circuit B83V would leave circuit V74R and the radial circuits to Goreway TS and Bramalea TS connected to auto-transformer T13, while circuit V71R would be isolated on to auto-transformer T14.

etc.

This would severely constrain operation of those facilities associated with the eastern half of the Claireville busbar whenever circuit breakers on that half of the busbar are out-of-service.

To eliminate this restriction it would be necessary to establish a third diameter on the eastern half of the 230kV busbar at Claireville TS.

Consequently***, should it be decided not to install bus-tie reactors but instead to install a third 230kV circuit between the eastern halves of the Claireville TS and Richview TS busbars,*** then the IMO would require the radial sections of circuits V73R to be reterminated to a new terminal position, established on a new diameter, on the eastern half of the 230kV busbar at Claireville TS**.**

Diagram 24 shows the proposed arrangement.

For the situation with bus-tie reactors installed across the open-points in the busbars, this concern would not apply since connections would still be maintained, via the reactors, to those facilities on the western half of the 'split' busbar, thereby ensuring that no facilities become isolated.

5.1.2.5 Configuration of the 230kV circuits on the Claireville TS to Richview TS right-of-way

For a portion of their length, the five operational circuits between Richview TS and Claireville TS are located on six-circuit structures. Diagram 27 shows the existing termination arrangement of these 230kV circuits, with the busbars at Claireville TS and Richview TS operated closed.

Starting with circuit V71R, which occupies the extreme easterly position on these structures, the respective destinations for the individual circuits are as follows:

V71R	eastern half of Claireville & Richview busbars
V72R	western half of Claireville & Richview busbars
V73R	western half of Claireville & Richview busbars
V74R	eastern half of Claireville & Richview busbars
V75R	circuit is currently idle between Claireville TS & Richview TS
V76R	western half of Claireville & Richview busbars

This means that, with the 230kV busbars at Claireville TS & Richview TS operated 'split', a double-circuit contingency involving circuits V72R & V73R would leave only circuit V76R in-service between the western halves of the 'split' busbars. All other double-circuit contingencies would result in the loss of only one circuit on each half of the busbars.

As discussed later, this double-circuit contingency represents the most limiting condition for transfers between Claireville TS and Richview TS.

In order to minimise the impact of this contingency, retermination of circuits V73R and V74R at both Claireville TS and Richview TS would be necessary so that they are associated with the eastern and western halves of the 'split' busbars, respectively.

Diagrams 28 & 29 show the proposed arrangement following the retermination of these circuits.

For the 230kV busbar at Claireville TS to be operated permanently 'split', the IMO would therefore require the following work to be completed:

- Reterminate circuit V73R, *together with the radial sections to Bramalea TS and Goreway TS,* to the eastern half of the Claireville TS & Richview TS busbars.
- Terminate the idle 230kV circuit (V75R) between Claireville TS and Richview TS on to the eastern half of the 230kV busbars at Claireville TS and Richview TS.
- Reterminate circuit V74R, *without the radial sections to Kleinburg TS & Woodbridge TS and the taps to Rexdale TS & Richview TS*, to the western half of the Claireville TS & Richview TS busbars.
- Reterminate the radial sections to Kleinburg TS & Woodbridge TS as well as the taps to Rexdale TS & Richview TS, that were previously associated with circuit V74R, on to the circuit that was originally idle (V75R).

5.1.2.6 Fault level Results with the Claireville 230kV busbar 'split'

Studies were repeated with the arrangement as recommended above for the eventual 'splitting' of the 230kV busbar at Claireville TS.

The results, which are presented in Diagrams 30 & 31, are summarised in the Table below:

Fault levels on the 230kV busbars at Claireville TS				***for a Pre-fault Voltage of 250kV***		
System conditions: • *Both Sithe Projects in-service* • *The 6th circuit installed between Claireville TS & Richview TS* • *The 230kV busbar at Claireville TS operated 'split'* • *The Claireville TS to Richview TS circuits reconfigured to 'balance' the two busbars*						
Claireville 230kV Busbar Section	Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
	3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
For the Western Half	53.66kA *Margin: 26.34kA*	54.49kA *Margin: 25.51kA*	68.36kA *Margin: 27.64kA*	67.46kA *Margin: 28.54kA*	80.0kA	96.0kA
For the Eastern Half	55.16kA *Margin: 24.84kA*	55.31kA *Margin: 24.69kA*	70.33kA *Margin: 25.67kA*	65.81kA *Margin: 30.19kA*		

Notes: *'Margin'* represents the difference between the breaker rating and the fault level.
For individual breakers, making allowance for the associated fault infeeds could provide additional margin.

These studies show the following:

- that with the Claireville 230kV busbar 'split' and a 6th 230kV circuit in-service between Claireville TS and Richview TS, a margin of approximately 25kA will be provided between the maximum fault levels on the two halves of the 'split' busbar and the rating of the existing circuit breakers.

- that the reconfiguaration of the circuits at Claireville TS will achieve the desired 'balance' between the fault levels on the two halves of the 'split' busbar.

5.1.3 Reconfigure the termination of circuit V75R at Claireville TS to reduce the fault interrupting duty on the breakers

Reference to Diagram 8 shows that, apart from circuit V75R, all the other zero infeed circuits are associated with one of the circuits from Richview. These Richview circuits provide fault infeeds between 6.28kA and 8.63kA, and their net effect is to reduce the fault interrupting duty imposed on the associated circuit breakers under fault conditions.

i.e.	*Zero Infeed Circuit*		*Associated Fault Infeed from Richview Circuit*		
	V71R	to Richmond Hill	8.63kA	from circuit V71R	to Richview TS
	V74R	to Woodbridge	8.41kA	from circuit V74R	
	V73R	to Goreway	6.28kA	from circuit V73R	
	V76R	to Goreway	6.33kA	from circuit V76R	

The options that were considered for providing a fault infeed to be associated with circuit V75R were as follows:

i. Terminate the idle section of circuit V75R between Claireville TS and Richview TS.

   This circuit is strung for most of the route between Claireville TS and Richview TS. The missing sections would need to be strung on the existing transmission structures, and it would need to be terminated into a new position at Richview TS. At Claireville TS it would be terminated on to the same position as the existing radial sections of this circuit.

Diagram 32 shows the proposed arrangement.

This option has the attraction that it would form an intermediate step towards the ultimate arrangement required for the eventual 'splitting' of the 230kV busbar at Claireville TS.

Fault level studies were performed to determine the impact that the 6th 230kV circuit between Claireville TS and Richview TS would have on the fault levels at Claireville TS.

The results, which are presented in Diagrams 33 & 34, are summarised in the Table below:

Fault levels on the 230kV busbars at Claireville TS					***for a Pre-fault Voltage of 250kV***	
System conditions:	• *The 6th circuit installed between Claireville TS & Richview TS* • *Both Sithe Projects in-service*					
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
	3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
With both Sithe Projects in-service	76.57kA	77.42kA	***97.70kA***	92.13kA	80.0kA	***96.0kA***

These studies show that the presence of a 6th circuit between Claireville TS and Richview TS would increase the asymmetrical fault level for a three-phase and a line-to-ground fault by 1.55kA and 6.53kA, respectively. (Compared to the values given in the Table in Section 5.1)

The corresponding fault interrupting duties that would be imposed on the most critical breakers at Claireville TS are given in the Table below:

Fault Interrupting Duty on the most critical breakers at Claireville TS							
Circuit Breaker ID : Associated Circuit		Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
		3-phase	L-G	3-phase	L-G	Sym.	Asym.
T16L75 HL75	Circuit V75R to Woodbridge, Richmond Hill, & Richview	69.87kA *Margin: 10.13kA*	73.21kA *Margin: 6.79kA*	89.16kA *Margin: 6.84kA*	87.11kA *Margin: 8.89kA*	80.0kA	***96.0kA***
KL83 T13L83	Circuit B83V to Brown Hills TS	75.50kA *Margin: 4.50kA*	78.06kA *Margin: 2.92kA*	***96.34kA*** *Margin:* ***-0.34kA***	91.72kA *Margin: 4.28kA*		
L76L82 HL82	Circuit B82V to Brown Hills TS						

The results of these studies can be summarised as follows:

- the termination of the new 230kV circuit from Richview would achieve the desired reduction in the fault interrupting duty imposed on the two breakers associated with circuit V75R so that it would be within their rating.
- the increase in the fault level on the Claireville busbar that would result from terminating the new 230kV circuit from Richview would be sufficient to cause the fault interrupting duty that would be imposed on the four circuit breakers associated with circuits B82V & B83V to exceed their rating.

This option is therefore not viable.

ii Reterminate the section of circuit V72R between Claireville TS and Richview TS on to the same terminal at Claireville TS as circuit V75R.

As shown in Diagram 8, the terminations for circuits V72R and V73R have two infeeds associated with them; one from Richview TS and one from the Sithe-Goreway Project, via its connection to the Bramalea circuits. Consequently, if the Richview section of either circuit V72R or V73R were to be reterminated on to the same termination point at Claireville TS as the V75R circuits (to Richmond Hill and Woodbridge), this would effectively reduce the fault interrupting duty imposed on the breakers T16L75 & HL75.

Diagram 35 shows the arrangement that was reviewed with the section of circuit V72R to Richview TS reterminated on to the same position at Claireville TS as circuit V75R.

With the section of circuit V72R to Richview TS reterminated on to the same position at Claireville TS as circuit V75R, the fault interrupting duty that would then be imposed on the two breakers associated with circuit V75R would be reduced as shown in the Table below. This Table also shows the fault interrupting duty that would be imposed on the next four critical breakers at Claireville TS.

Fault Interrupting Duty on the most critical breakers at Claireville TS
Circuit V72R reterminated on to the V75R position at Claireville TS

Circuit Breaker ID : Associated Circuit		Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
		3-phase	L-G	3-phase	L-G	Sym.	Asym.
T16L75	Circuit V75R to Woodbridge, Richmond Hill, & Richview	68.39kA *Margin: 11.61kA*	73.25kA *Margin: 6.75kA*	87.89kA *Margin: 8.11kA*	87.18kA *Margin: 8.82kA*	80.0kA	96.0kA
HL75							
KL83	Circuit B83V to Brown Hills TS	73.75kA *Margin: 6.25kA*	75.73kA *Margin: 4.27kA*	94.77kA *Margin: 1.23kA*	90.12kA *Margin: 5.88kA*		
T13L83							
L76L82	Circuit B82V to Brown Hills TS						
HL82							

Note: 'Margin' represents the difference between the breaker rating and the maximum fault interrupting duty imposed on it.

This arrangement would achieve the desired objective of reducing the fault interrupting duty on the two 230kV breakers associated with circuit V75R (T16L75 & HL75) while not compromising any of the other breakers at Claireville TS. In fact it would provide a margin of 4.27kA symmetrical & 1.23kA asymmetrical before the next four breakers that are associated with circuits B82V & B83V would become critical.

The only concern that the IMO would have with this proposal would be the increased exposure that the additional circuit length would impose on circuit V75R. However, since the additional line length (Claireville TS to Richview TS would only be 9km and since the Richview circuits have demonstrated a high degree of reliability, this is considered to be acceptable.

In addition the exposure of the Richmond Hill load to a double-circuit contingency involving circuits V71R & V72R (which occupy adjacent positions on the Claireville TS to Richview TS right-of-way) would also increase. However, this load is already exposed to the risk of a double-circuit contingency involving circuits V71R & V75R so the increased risk is considered to be acceptable.

Diagram 35 also shows the supply to the Richview DESN being relocated from circuit V72R to another circuit. This work is not considered a *requirement* for connection of the two Sithe Projects to the IMO-controlled grid, but rather is intended as a proposal that would help reduce the exposure of circuit V72R (and hence V75R) to line faults, while also simplifying the protective relaying. It is recommended that the need for this work should be resolved between Sithe and Hydro One.

5.1.4 IMO's Preferred Approach for Addressing the Fault Level Issues at Claireville TS

The IMO's preference is for the following measures to be implemented to address the fault level problem at Claireville TS:

i. Reterminate the section of circuit V72R to Richview on to the same position at Claireville TS as is currently occupied by circuit V75R.

ii. If the parameters for the equipment that is eventually supplied for the two Sithe Projects are different from those that were studied, then the impact on the projected fault levels would need to be reviewed. Should it be determined that the new fault levels will exceed the margins that have been indicated in the Table above, Sithe would have the option of installing series-connected reactors in the connections to circuits V72R & V73R, at their Goreway Project.

The installation of these reactors must be complementary to the retermination of circuit V72R, as in i. above; it cannot be undertaken as an alternative to this work.

Furthermore, the installation of these reactors is only to be employed as an interim measure until such time as the 230kV busbar at Claireville TS is eventually 'split'. At that time they must be removed.

The IMO is also concerned that the amount of additional reactance that is installed be kept to an absolute minimum. The transformers that Sithe is planning to install have an impedance of approximately 6% on $100MVA_{base}$. Any supplementary, series-connected reactors should not increase the effective impedance for each transformer to more than 8% on $100MVA_{base}$.

The IMO also recommends that the amount of 'margin' that is incorporated into the reactors should be kept to an absolute minimum so that it only caters for engineering and manufacturing tolerances for the reactors.

iii. Should there be a significant change in the equipment parameters that would result in higher fault levels (but which would not result in an increase in output from either facility) then subject to confirmation that the transient performance remains acceptable to the IMO, Sithe would have the option of proceeding with the work required to permanently 'split' the 230kV busbar at Claireville TS. This assumes that the increased fault levels cannot be addressed by the installation of supplementary series-connected reactors.

This option is preferred to that involving the installation of bus-tie reactors at Claireville TS.

Note: Should Sithe elect to adopt Option i. above, and reterminate the section of circuit V72R on to the same position at Claireville TS that is currently occupied by circuit V75R, then provision should be made to allow the original V72R connection arrangement to be restored at a future date, when circumstances require the Claireville 230kV busbar to be operated 'split'.

5.1.5 Impact of Series-Connected Reactors on the Fault Levels at Claireville TS & Lakeview TS

In response to a request from Sithe to examine the impact of a different design of steam-turbine unit at their Goreway facility, together with the use of direct grounding of the HV neutral of the generator step-up transformer, additional fault levels studies were performed.

The steam-turbine unit would be rated at 416MVA (compared to 373MVA for the original proposal), while the sub-transient reactance would be 31.1% [7.48% on $100MVA_{base}$], compared to 28.0% [7.51% on $100MVA_{base}$]. The rating of the step-up transformer was also increased.

For these studies series-connected reactors with the following values were assumed at Sithe's Goreway facility:

- In the connection to circuit V72R (for the two gas-turbine component) a 4.6 Ω reactor.
- In the connection to circuit V73R (for the gas-turbine/steam-turbine component) a 5.1 Ω reactor.

The results of these fault level studies are summarised in the Table below:

Fault Levels with both the Southdown & Goreway facilities in-service for a Pre-fault Voltage of 250kV						
Location	Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
	3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
230kV busbar at Claireville TS	74.24kA	77.86kA	95.47kA	92.65kA	80.0kA	***96.0kA***
Values from Table in Section 5.1	*74.82kA*	*76.05kA*	***96.15kA***	*90.50kA*		
230kV busbar at Lakeview TGS: G1-G2	29.11kA	29.29kA	34.78kA	35.85kA	38.5kA	***46.2kA***
Values from Table in Section 5.2	*29.14kA*	*29.26kA*	*34.83kA*	*35.81kA*		
230kV busbar at Lakeview TGS: G5-G6	37.38kA	35.70kA	***46.43kA***	42.87kA		
Values from Table in Section 5.2	*37.44kA*	*34.81kA*	***46.50kA***	*42.33kA*		
230kV busbar at Richview TS: West	63.55kA	58.42kA	77.66kA	62.98kA	69.5kA	83.4kA
Values from Table in Section 5.3	*63.8kA*	*58.0kA*	*78.0kA*	*62.5kA*		
230kV busbar at Richview TS: East	62.20kA	58.18kA	76.63kA	61.61kA		
Values from Table in Section 5.3	*62.4kA*	*57.9kA*	*76.8kA*	*61.3kA*		

The results for Claireville TS and Lakeview TGS are also shown in the following drawings, for the following conditions:

- *with both Sithe Projects in-service*
- *with the larger-rated steam-turbine unit installed at the Goreway Project*
- *with series-connected reactors installed at the Goreway Project, in the connections to circuits V72R & V73R*
- *with the Claireville 230kV busbar 'closed'*

At Claireville TS

Diagram 36 For a 3-phase Fault
Diagram 37 For a Line-to-Ground Fault

At Lakeview TGS

Diagram 38 For a 3-phase Fault
Diagram 39 For a Line-to-Ground Fault

The results above confirm that the installation of series-connected reactors at the Sithe-Goreway Project would ensure that the installation of a higher-rated steam-turbine unit and step-up transformer, together with a change in the grounding arrangement adopted, would not result in the fault level at Claireville TS exceeding the rating of the existing breakers.

The projected fault levels at Lakeview TS and Richview TS would also remain within the rating of the existing equipment, except for those on the G5-G6 section of the Lakeview busbar. The issue of the fault levels at Lakeview TGS is dealt with in the next Section.

5.2 Fault levels at Lakeview TGS

In order to ensure that the fault levels at Lakeview TGS remain within the fault interrupting capability of the existing circuit breakers at that location, it is an Operating Requirement for the 230kV busbar to be operated 'split' whenever two or more generators at Lakeview TGS are in-service.

As shown in Diagram 21, the 230kV busbar at Lakeview TGS can be 'split' either 'horizontally' or 'vertically' so that two 230kV circuits remain associated with each pair of generating units. The Table below provides the details.

'Split'	*Breakers that are to be Open*	*Circuits associated with specific generating units*	
		Units G1 & G2	*Units G5 & G6*
'Horizontal' Split	T1T8 & T4T5	L21K & L22K	L23CK & L24CR
'Vertical' Split	T2T3 & T6T7	L21K & L24CR	L22K & L23CK

The fault level analysis considered both arrangements for 'splitting' the Lakeview busbar.

The maximum fault levels from this analysis are shown in Diagrams 13 to 20 inclusive, and are also summarised in the Table below:

Fault levels on the 230kV busbar at Lakeview TGS for a Pre-fault Voltage of 250kV									
		Symmetrical Fault		Asymmetrical Fault		Breaker Capability			
		3-phase	L-G	3-phase	L-G	Symmetrical		Asymmetrical	
For a 'horizontal' split of the Lakeview busbar									
Existing	*G1-G2*	28.17kA	28.56kA	34.08kA	34.96kA	*A*	38.5kA	*A*	46.2kA
	G5-G6	32.07kA	31.11kA	39.35kA	37.82kA	*B*	63.0kA	*B*	75.6kA
With both the Southdown & Goreway facilities in-service	*G1-G2*	29.14kA	29.26kA	34.83kA	35.81kA	*A*	38.5kA	*A*	46.2kA
		+0.97kA	*+0.70kA*	*+0.75kA*	*+0.85kA*	*B*	63.0kA	*B*	75.6kA
	G5-G6	37.44kA	34.81kA	***46.50kA***	42.33kA	*A*	38.5kA	*A*	***46.2kA***
		+5.37kA	*+3.70kA*	*+7.15kA*	*+4.51kA*	*B*	63.0kA	*B*	75.6kA
For a 'vertical' split of the Lakeview busbar									
Existing	*G1-G2*	31.46kA	32.43kA	38.60kA	39.80kA	*A*	38.5kA	*A*	46.2kA
	G5-G6	35.50kA	32.83kA	43.06kA	39.40kA	*B*	63.0kA	*B*	75.6kA
With both the Southdown & Goreway facilities in-service	*G1-G2*	35.03kA	35.19kA	43.02kA	43.18kA	*A*	38.5kA	*A*	46.2kA
		+3.57kA	*+2.76kA*	*+4.42kA*	*+3.38kA*	*B*	63.0kA	*B*	75.6kA
	G5-G6	***39.32kA***	35.27kA	***47.73kA***	42.33kA	*A*	***38.5kA***	*A*	***46.2kA***
		+3.82kA	*+2.44kA*	*+4.67kA*	*+2.93kA*	*B*	63.0kA	*B*	75.6kA

Note: The 'A' ratings are for breakers T4T5, L22T3, L22T4, L23T5, L23T6, L24T7, & L24T8
The 'B' ratings are for breakers T1T8, T2T3, T6T7, L21T1 & L21T2

These results show that with both Sithe Projects in-service, the fault level for a 3-phase fault on the **G5-G6 busbar** would exceed the rating of the existing equipment, for both a 'vertical' and a 'horizontal' split of the Lakeview busbar.

Referring to Diagrams 15 & 16, the particular breakers for which the projected fault interrupting duty would exceed the breaker ratings are as follows (since they are associated with idle positions, for which the fault infeeds are zero):

Breakers L24T8 and T4T5 - Diagram 15: for a 'horizontal' split
Breakers L22T3 - Diagram 16: for a 'vertical' split

Since the only breakers that are affected are those associated with an idle position, the situation could be addressed by removing one of the breakers associated with each of these idle positions. This would result in the remaining breakers being associated with fault infeeds that are sufficient to reduce the fault interrupting duties to levels that are within the rating of the individual breakers.

Consequently, it is recommended that the following breakers should be removed at Lakeview TGS, and the busbars through-connected in order to by-pass the vacated positions:

L24T8
T4T5 ***OR*** L22T4 (If L22T4 were to be removed, T4T5 would be the open point for a horizontal 'split')
L22T3

Diagram 21 shows the breakers that would be affected.

5.3 Fault Levels at Richview TS

The results of the fault level analysis are summarised below for the condition with the busbar at Claireville operated 'closed', and that at Lakeview operated with a horizontal 'split'.

Fault levels on the 230kV busbars at Richview TS for a Pre-fault Voltage of 250kV						
	Symmetrical Fault		Asymmetrical Fault		Breaker Capability	
	3-phase	L-G	3-phase	L-G	Symmetrical	Asymmetrical
Existing A1H1 Busbar	56.9kA	54.4kA	70.1kA	58.6kA		
With the Southdown facility only	59.7kA	56.2kA	73.4kA	59.5kA		
	+2.8kA	*+1.8kA*	*+3.3kA*	*+0.9kA*		
With the Goreway facility only	59.7kA	56.2kA	73.5kA	59.5kA	69.5kA	83.4kA
	+2.8kA	*+1.8kA*	*+3.4kA*	*+0.9kA*		
With both the Southdown & Goreway facilities	62.4kA	57.9kA	76.8kA	61.3kA		
	+5.5kA	*+3.5kA*	*+6.7kA*	*+2.7kA*		
Existing A2H2 Busbar	57.2kA	54.0kA	69.9kA	59.2kA		
With the Southdown facility only	60.4kA	56.0kA	73.8kA	61.4kA		
	+3.2kA	*+2.0kA*	*+3.9kA*	*+2.2kA*		
With the Goreway facility only	60.6kA	56.0kA	74.1kA	61.5kA	69.5kA	83.4kA
	+3.4kA	*+2.0kA*	*+4.2kA*	*+2.3kA*		
With both the Southdown & Goreway facilities	63.8kA	58.0kA	78.0kA	62.5kA		
	+6.6kA	*+4.0kA*	*+8.1kA*	*+3.3kA*		

These results confirm that with the Richview 230kV busbar 'split', as required by the current Operating Instruction, the contributions from the two Sithe Projects would not be sufficient to raise the fault levels on the two halves of the Richview busbar so that it exceeds the fault interrupting capability of the existing switchgear.

These results also show that the fault level contributions to the halves of the 'split' busbar at Richview TS from the two Sithe Projects are approximately the same. The principal causes for the slightly lower contribution to the A1H1 busbar are the fewer number of circuits between Claireville TS and the A1H1 busbar at Richview (two, versus three on the A2H2 busbar), and the higher impedance connection between Lakeview TS and the A1H1 busbar at Richview TS due to the configuration of the circuits to Manby TS.

It is also worth comparing the contributions to the fault levels to the two halves of the Richview 230kV busbar from the Lakeview and Sithe generating facilities, respectively:

Generating Facility	*Contributions to the Fault Level at Richview TS*	
	Busbar Section A1H1	*Busbar Section A2H2*
Lakeview TGS (Σ4 units)	11.3kA	6.8kA
Sithe-Goreway & Southdown Projects (Σ7 units)	5.5kA	6.6kA

The values in the Table above indicate that the expected fault contribution from the two Sithe Projects to the fault level at Richview TS would be equivalent to approximately two-thirds of that from the four units at Lakeview TGS. This would mean that, with both Sithe Projects in-service (together with four units at both Darlington NGS and Pickering NGS), 'splitting' of the Richview busbar would become a requirement whenever one, or more units at Lakeview TGS are in-service.

Consequently, with both Sithe Projects in-service, the percentage of time when it will be necessary to operate with the Richview 230kV busbar 'split' is expected to rise significantly from the current level of approximately 10%.

6. Linear Load Flow Analysis

Diagram 40 shows the area that was the subject of this review.

For the area bounded by Bowmanville, in the East; Trafalgar, in the West; and Holland landing, to the North, a peak summertime load of 9600MW was assumed.

The existing generation in the area under review totals approximately 6700MW -

- Lakeview TGS 1200MW
- Pickering 'B' NGS 2000MW
- Darlington NGS 35000MW

This would leave a deficit of approximately 2900MW to be supplied from external sources, assuming no forced or maintenance outages at any of the Stations above.

On the assumption that this deficit would be supplied from South-western Ontario, then to allow for possible transfers to Eastern Ontario, a Flow East Towards Toronto (FETT) transfer of 4000MW *with the Sithe Projects in-service,* was evaluated. The Sithe generation was assumed to displace generation capacity in Northern and Eastern Ontario.

In addition, the situation with a negative or low FETT transfer was also evaluated, when the Sithe generation was assumed to displace generation capacity in South-western Ontario, while exports were being made to the US.

Existing Limits

The maximum FETT Interface flow is presently limited to 5700MW.

This level is constrained by voltage stability following a double-circuit contingency condition involving the Bruce to Milton 500kV circuit B561M and the Bruce to Claireville 500kV circuit B560V.

Currently, there is no limit for transfers westwards, since the maximum flows that can occur have not been determined to cause any system concerns.

Diagram 41 shows the historical distribution of FETT transfers.

Two FETT Transfer levels were selected for review, representing the extreme conditions that have been encountered during the past two years, as shown in Diagram 41. These were, respectively, a FETT Transfer of 4000MW; and a Negative FETT Transfer of 600MW.

4000MW FETT Transfer Condition

Diagram 42 shows the flow distribution in the area under High FETT Transfer conditions for the present system, with neither of the Sithe projects in-service. This shows the very heavy combined transfer of 2590MW through the four 750MVA auto-transformers at Claireville TS. At an assumed power factor of 95%, this would represent a loading on each transformer of approximately 90% of its nameplate rating.

Diagrams 43 & 44 show the incremental changes in the flow distribution for each 100MW of output from the Sithe-Southdown and Goreway Projects, individually. Diagram 45 shows the incremental change in flow distribution for a 100MW of combined output from the Sithe-Southdown and Goreway Projects (50MW from each).

The flows shown in these Diagrams demonstrate is that the two Sithe Projects will help reduce the transfers through the Claireville auto-transformers by the following amounts:

Sithe Projects	Expected Reduction in the Transfers through the Claireville auto-transformers
Southdown Project (in isolation)	≈ 53% of output
Goreway Project (in isolation)	≈ 55% of output
Southdown & Goreway Projects together	≈ 49% of their combined output

These Diagrams also show the individual and the combined effect of the two Sithe Projects on the following Interface transfers:

- Richview TS x Trafalgar TS
- Richview TS x Claireville TS
- Richview TS x Cherrywood TS
- Claireville 500/230kV auto-transformers, and
- FETT

With both Sithe Projects in-service (as shown in Diagram 45) all Interface transfers, except for the Lakeview North Interface are reduced.

600MW Negative FETT Transfer Condition

Diagram 46 shows the actual flows corresponding to a 600MW Negative FETT Transfer condition with both Sithe Projects in-service. Diagram 47 shows the effect of removing both Sithe Projects from service on these flows. The resulting Interface Transfer would become a Positive FETT Transfer of approximately 1020MW.

These Diagrams show similar reductions in the Interface transfers to those for the 4000MW FETT condition.

Lakeview North Interface

Diagram 48 shows the configuration of the local 230kV circuits, with a Horizontal 'split' of the Lakeview 230kV busbar.

The flows shown represent the situation with no local load on the DESN Stations that are supplied from circuits B15C & B16C.

From this Diagram, the following approximate limitations can be deduced:

With the 230kV busbar at Lakeview TGS 'split' horizontally				
Contingency Condition	Post-contingency Flow on the Companion Circuit	LTR of the Companion Circuit	Capacity Available on the Companion Circuit - up to its 15-minute Limited-Time-Rating	
			With no local load	*With 300MW of local load*
Existing System				
L21K or L22K	600MW (on L2#K)	990MVA *(940MW at 95% pf)*	≈ 340MW	≈ 340MW
L23CK	600MW (on L24CR)	1250MVA *(1187MW at 95% pf)*	≈ 587MW	≈ 887MW
L24CK	600MW (on L23CK)	1140MVA *(1083MW at 95% pf)*	≈ 483MW	≈ 783MW
With the Sithe-Southdown Project In-service				
L21K or L22K	600MW (on L2#K)	990MVA *(940MW at 95% pf)*	≈ 340MW	≈ 340MW
L23CK	1400MW (on L24CR)	1250MVA *(1187MW at 95% pf)*	- 212MW	≈ 87MW
L24CK	1400MW (on L23CK)	1140MVA *(1083MW at 95% pf)*	- 317MW	- 17MW

Diagram 49 shows the comparable configuration with a Vertical 'split' of the Lakeview 230kV busbar.

As before, the following approximate limitations can be deduced:

With the 230kV busbar at Lakeview TGS 'split' vertically				
Contingency Condition	Post-contingency Flow on the Companion Circuit	LTR of the Companion Circuit	Capacity Available on the Companion Circuit - up to its 15-minute Limited-Time-Rating	
			With no local load	*With 300MW of local load*
Existing System				
L21K	600MW (on L24CR)	1250MVA *(1187MW at 95% pf)*	≈ 587MW	≈ 737MW
L22K	600MW (on L23CK)	1140MVA *(1083MW at 95% pf)*	≈ 483MW	≈ 633MW
L23CK	600MW (on L22K)	990MVA *(940MW at 95% pf)*	≈ 340MW	≈ 340MW
L24CK	600MW (on L21K)	990MVA *(940MW at 95% pf)*	≈ 340MW	≈ 340MW
With the Sithe-Southdown Project In-service				
L21K	1000MW (on L24CR)	1250MVA *(1187MW at 95% pf)*	≈ 187MW	≈ 337MW
L22K	1000MW (on L23CK)	1140MVA *(1083MW at 95% pf)*	≈ 83MW	≈ 340MW
L23CK	1100MW (on L24CR)	1250MVA *(1187MW at 95% pf)*	≈ 87MW	≈ 387MW
L24CK	1100MW (on L23CK)	1140MVA *(1083MW at 95% pf)*	- 17MW	≈ 283MW

The limitations shown in these two Tables indicate the following:

With the Lakeview 230kV Busbar 'Split' Horizontally

- For the present situation, with no local load on circuits B15C & B16C, approximately 340MW of further generating capacity could be added to the eastern half of the Lakeview busbar, and a further 483MW could be added to the western half, without violating the 15-minute LTRs. The 483MW restriction would increase to 783MW with 300MW of local load.
- With the Sithe-Southdown Project in-service, it would still be possible to add a further 340MW of generating capacity to the eastern half of the Lakeview busbar. However, for the western half of the busbar, with no local load, the Sithe-Southdown Project will result in the LTR being violated for both an L23CK and a L24CR contingency. With a local load of 300MW, the LTR will be marginally exceeded for an L24CR contingency.
- This therefore means that there is no further transmission capacity available to accommodate additional generating Projects on the western half of the Lakeview busbar with it 'split' horizontally.
- The results also confirm the need for a Generation Rejection Scheme if operating restriction are to be avoided/minimised during periods of light load and high ambient temperatures.

With the Lakeview 230kV Busbar 'Split' Vertically

- For the present situation, approximately 340MW of further generating capacity could be added to both the eastern and the western halves of the Lakeview busbar. These values are not effected by the local load, and are therefore fixed.
- With the Sithe-Southdown Project in-service, and with no local loads, no further generating capacity could be added to the eastern half of the Lakeview busbar, and only 83MW of further capacity could be added to the western half. This would increase to 283MW and 340MW for the eastern & western halves, respectively if a local load of 300MW is assumed.

- As long as the local load is greater than just 17MW, it would be possible to respect the 15-minute limited-time ratings of the local circuits for a single-contingency condition. It would therefore be acceptable to employ generation run-back, instead of generation rejection (subject to acceptable transient stability performance).

7. Transient Stability Analysis

In response to concerns regarding transient stability, the System Control Order (SCO) that governs the operation of the Central System, restricts the number of generating units that can be connected radially to any single 230kV circuit emanating from Lakeview TGS to a maximum of three. Since each of the units at Lakeview TGS is rated at 300MW, this would restrict the maximum capacity that can be connected to a single 230kV circuit, to 900MW.

With a requirement to 'split' the Lakeview busbar to respect the rating of the existing circuit breakers at that location with, a contingency involving circuit L23CK or L24CR, with either a horizontal or a vertical 'split' of the Lakeview busbar, would result in two Lakeview generating units, together with all three units at the Sithe-Southdown facility, being connected to a single-circuit.

A contingency involving either L23CK or L24CR would therefore result in the total amount of generating *capacity* that would remain connected to a single 230kV circuit exceeding the limit specified in the SCO.

Transient stability studies were performed for a three-phase fault on circuit L23CK at Manby TS, assuming normal fault clearance, for the situations with, and without, generation rejection.

The results are shown in Diagrams 50 (without G/R) & 46 (with G/R).

For the situation without generation rejection, unit G1, together with part of unit G3, would remain connected to the 230kV system via the LV busbars of each of the DESN Stations connected to circuits B15C & B16C.

Diagram 50 shows that units G2 & G3 remain stable, even though the initial excursion is quite pronounced. With generation rejection initiated for unit G2, the performance of unit G3 shows a marked improvement, as shown in Diagram 51.

Although transient stability was not identified as a problem for the operating conditions that were examined, it is expected that more rigorous analysis, for different operating and outage conditions, will uphold the requirements of the current SCO.

It is therefore a requirement of the IMO that a Generation Rejection scheme should be installed to reject unit G1 or G2, as appropriate, at the Sithe-Southdown facility for contingency conditions involving circuits L23CK and L24CR.

This Scheme would also address the potential for thermal overloading of the 230kV circuits between Applewood Junction and Manby TS/Richview TS for the same contingency conditions. (See Section 4).

For a three-phase fault on the H2 busbar at Manby East TS with circuit breaker L1L23 out-of-service, the transient response showed a more pronounced initial excursion. This contingency condition would result in the loss of transformers T5 & T 7 and create a line-end-open (LEO) condition on circuit L23CK at Manby TS. However, as shown in Diagram 52, all the units remained stable.

While Generation Rejection of unit G2 at the Sithe-Southdown facility would improve the transient performance, it highlights the need for the Generation Rejection Scheme to recognise LEO conditions as well as normal condition conditions.

Transient stability analysis was also performed for all the fault conditions detailed in Table 1 both a High FETT Transfer of approximately 4300MW and a Negative FETT Transfer of 600MW. In all cases stability was maintained.

Of all these fault conditions, the most severe response was obtained for a three-phase fault applied at the Claireville terminal of the 500kV circuit M570V, between Milton TS and Claireville TS.

The results for this study are shown in Diagram 53.

A sensitivity test was performed with the FETT transfer increased to 4330MW, and the results are shown in Diagram 54.

A further study was performed for the same fault condition, but with a Negative FETT transfer of 600MW. The results for this study are shown in Diagram 55.

The Negative FETT condition was further accentuated by increasing the transfer to 1460MW. The results for the present system, without the two Sithe Projects, is shown in Diagram 56, while Diagram 57 shows the results for the same fault with the same Negative FETT transfer, but with both Sithe Projects in-service.

In all instances stability was maintained.

It is therefore concluded that the two Sithe Projects will have only minimal impact on the stability performance of the other generating units on the system. The only area of concern relates to the performance of the units at the Southdown facility in response to contingencies involving the 230kV circuits L23CK & L24CR. While none of the studies performed for this assessment identified any loss of stability, the employment of a Generation Rejection Scheme would ensure that acceptable performance would always be maintained.

Table 1: Contingency Conditions Examined for Transient Stability

Contingency Conditions Examined				
Three-phase fault, cleared in normal time *(87 msec at faulted terminal - 112 msec at remote terminal)*				
Designation of faulted circuit		Fault Location	Bus Voltage	Response
L23CK	Lakeview TGS to Manby W TS/Cooksville TS	Lakeview TGS	230kV	Stable
L24CR	Lakeview TGS to Richview TS/Cooksville TS			Stable
L21K	Lakeview TGS to Manby W TS			Stable
L22K				Stable
B15C	Oakville TS to Cooksville TS	Sithe-Southdown		Stable
V72R	Claireville TS to Richview TS	Claireville TS		Stable
V72R		Sithe-Goreway		Stable
M570V	Milton TS to Claireville TS	Claireville TS	500kV	Stable
B560V	Bruce NGS to Claireville TS			Stable
V586M	Claireville TS to Middleport TS			Stable
B561M	Bruce NGS to Milton TS	Bruce 'B'		Stable
Manby E	Bus Outage, with loss of load	Manby East	230kV	Stable
	Breaker L1L23 O/S: Transformers T5, T7 tripped; LEO of circuit L23CK at Manby	Manby East H2 bus		Stable
	Breaker L1L23 O/S: Transformers T5, T7 tripped; LEO of circuit L23CK at Manby. Light-load condition			Stable
R1K	Richview TS to Manby E TS: R13K O/S	Manby East		Stable
Line-Line-Ground Double-circuit fault, cleared in normal time *(87 msec at faulted terminal - 112 msec at remote terminal)*				
L23CK + L24CR	Lakeview TGS to Manby W TS/Cooksville TS + Lakeview TGS to Richview TS/Cooksville TS	Lakeview TGS	230kV	Stable
V72R + V73R	Claireville TS to Richview TS	Claireville TS		Stable
Line-Ground Fault, with delayed clearance on back-up protection *(additional delay of 150 msec)*				
V73R	Claireville TS to Richview TS	Claireville TS	230kV	Stable

8. Conclusions

This System Impact Assessment has examined the effect that incorporating the two Sithe Generation Projects into the IMO-controlled grid, in the GTA area, would have on the existing transmission facilities in the area.

The specific concerns that have been identified are as follows, assuming both Projects are developed and incorporated into the System:

i. At Claireville TS, the projected fault level would exceed the rating of two of the existing 230kV circuit breakers.

ii. At Lakeview TGS, the projected fault level would exceed the rating of three of the existing 230kV circuit breakers.

In addition, there are also specific concerns related to the Sithe-Southdown Project:

iii. Under contingency/outage conditions involving the 230kV transmission system in the local area, thermal overloading is expected to occur if the entire facility is maintained in operation, post-contingency. The situation would be aggravated during periods of high ambient temperatures and/or light load.

iv. For the contingencies involving the 230kV circuits L23CK or L24CR, instability of the portion of the Southdown facility that is directly associated with the faulted circuit, could occur.

The System Impact Assessment has identified appropriate measures that if implemented would address these concerns to the satisfaction of the IMO.

9. Requirements for Connection of the two Sithe Projects to the IMO-controlled grid

9.1 Fault Levels at Claireville TS

To address the fault level issue on the 230kV busbar at Claireville TS, the IMO requires that the following system modifications be completed:

Reterminate the section of circuit V72R, between Claireville TS and Richview TS on to the same position on the Claireville 230kV busbar as is currently occupied by the sections of circuit V75R to Richmond Hill TS and Kleinburg TS.

The proposed arrangement is shown in Diagram 35.

It has also been recommended that the present connection of the Richview DESN on circuit V72R should be reviewed with Hydro One to determine whether it needs to be reterminated on to another circuit. The intent of this work would be to reduce the exposure of circuit V72R (and hence V75R) to line faults, while also simplifying the protective relaying. This work is not a *requirement* of the IMO for connection of the Sithe Projects.

Should the test results for the equipment that is eventually supplied for the two Sithe Projects result in higher fault levels than those that have been studied, Sithe would have the option of adopting either of the following measures:

i. Install supplementary, series-connected reactors in the connections from the Sithe-Goreway Project to circuits V72R and V73R.

The installation of these reactors must complement the retermination of circuit V72R, as referred to above.

Furthermore, the installation of these reactors is to be considered only as an interim measure, and that once the busbar at Claireville TS is eventually 'split', these reactors must be removed. The IMO is also concerned that these reactors be used only to address minor changes in the equipment parameters, and has therefore recommended a maximum size.

ii. Permanently 'split' the 230kV busbar at Claireville TS.

If there is a significant change in the equipment parameters that would result in higher fault levels but would not increase the output from either facility then, subject to confirmation that the transient performance remains acceptable to the IMO, Sithe could initiate the work required to permanently 'split' the 230kV busbar at Claireville TS. This assumes that the increased fault levels cannot be addressed by the installation of supplementary series-connected reactors.

The proposed arrangement is shown in Diagrams 28 & 29.

9.2 Fault Levels at Lakeview TGS

To address the fault level issue on the 230kV busbar at Lakeview TGS, the IMO requires that the following system modifications be completed:

Remove the following breakers and through-connect the busbars so that the vacated positions are by-passed:

L24T8
T4T5 ***OR*** L22T4
L22T3

Diagram 21shows the breakers that would be affected.

9.3 Circuit Overloading and Stability Concerns related to the Sithe-Southdown Project

To address concerns related to possible overloading of the 230kV circuits in the vicinity of the Southdown Project, as well as stability concerns under contingency conditions, the IMO requires a generation rejection scheme to be installed for the Southdown Project.

This Scheme would need to initiate generation rejection for contingencies and line-end-open conditions involving the 230kV circuits L23CK, L24CR, L21K & L22K. It would also need to address line-end-open conditions involving the 230kV circuits B15C & B16C.

9.4 Project Specific Requirements

Both Projects are to be connected to the IMO-controlled grid via short taps, approximately 1.5km in length. Since both Projects are to employ HV circuit breakers with associated motorised line disconnect switches, the installation of manually-operated disconnect switches at the tapping points would meet the requirements of the Transmission System Code. These switches are to be capable of opening and closing all three phases simultaneously.

10. Interim Connection Arrangement

Relocation of the Radial Sections of Circuit V73R to the Eastern Half of the Claireville Busbar

In the event that the retermination of the section of circuit V72R between Claireville TS and Richview TS (possibly in conjunction with the installation of series-connected reactors in the connections for the Goreway Project) is sufficient to respect the rating of the existing 230kV breakers, then there would be no need to 'split' the Claireville busbar *at this time*.

However, since that will leave very little margin to accommodate future increases in fault level, it is expected that the next major development in the area will require the 230kV busbar at Claireville TS to be operated 'split' in order to respect the rating of the existing circuit breakers.

Sithe has expressed a concern regarding the impact that the outages that would be necessary for the work required to reconfigure the 230kV busbar, would have on the operation of their Goreway facility. In particular, the requirement to relocate circuit V73R on to a new diameter on the eastern half of the Claireville busbar, (as shown in Diagram 29) is expected to necessitate shutting-down the gas-turbine/steam-turbine component of the Goreway Project while this work is completed. At this time, there is no estimate of the possible duration of this shut-down.

One option that would allow the potential disruption to the operation of the Sithe-Goreway Project to be minimised, would be for part of this work to be completed *prior* to Sithe commencing commercial operations. Specifically, a new 230kV diameter could be established on the eastern half of the Claireville busbar and the *radial sections* of circuit V73R (to Goreway TS and Bramalea TS) could be reterminated to the new position.

The retermination of the section of circuit V73R between Claireville TS and Richview TS could be undertaken either at the same time, or later, since this work would be expected to have only minimal impact on Sithe's operations.

A budgetary cost estimate has been provided in Section 14 for this work.

11. Identification of 'Sole Beneficiaries'

Section 9.1.3 of the Transmission System Code states:

> *The cost of modifications and upgrades on specific network facilities that are triggered by and are for the sole benefit of the generator shall be borne by the generator.*

The IMO considers the following system modifications to be for the 'sole benefit' of the two Sithe Projects:

i. The retermination of circuit V72R on to the same position as is currently occupied by circuit V75R.

   Since this work will provide only a limited margin between the fault interrupting duties imposed on the most critical of the breakers at Claireville TS, and their ratings, this work is considered to be of an interim nature, which will only be of direct benefit to Sithe.

ii. The installation of series-connected reactors at the Sithe-Goreway Project

   Should Sithe elect to install series-connected reactors to limit the contribution of their Goreway Project to the fault levels at Claireville TS, then these will only be permitted as an interim measure until the 230kV busbar is eventually 'split'. These facilities are therefore considered to be temporary, and only of direct benefit to Sithe.

iii. The installation of a generation rejection/run-back scheme for the Sithe-Southdown Project

   The generation rejection/run-back scheme that would be required to ensure that the thermal limits of the local 230kV system are not exceeded, and also to address stability concerns under contingency conditions would allow Sithe to maximise the output of the Sithe-Southdown facility, particularly under outage conditions or during periods of light-load and/or high ambient temperature conditions. This scheme would therefore only be of benefit to Sithe.

iv. Facilities at the point of connection for both Sithe Projects

   The facilities to be installed at the point of connection to the IMO-controlled grid as well as those facilities required to integrate the two Sithe Generation Projects into the grid (protective relaying, monitoring of the status of equipment, SCADA information, communications, etc.) would also be for the sole benefit of Sithe.

12. Budgetary Cost Estimates

An attempt has been made to provide budgetary cost estimates for the work that would need to be done to incorporate the two Sithe Projects into the IMO-controlled grid.

These costs are based on approximate unit costs and do not make any allowance for site conditions. Neither do they take account of outage or construction constraints; associated work that may be triggered by the work identified; or other unforeseen difficulties.

11.1 *Reterminate the section of circuit V72R between Claireville TS & Richview TS on to the same position at Claireville TS as is currently occupied by circuit V75R*

Estimated Cost ≈ $2 to $3 million

12.2 *Connection of Each Sithe Project to the Existing Transmission Lines*

Estimated Cost ≈ $1 million *(for each Sithe Project)*

12.3 *The installation of a generation rejection/run-back scheme for the Sithe-Southdown Project*

Estimated Cost ≈ $0.5 million (*Hydro one costs only)*

12.4 *Establish a new Diameter & Relocate all the components of circuit V73R on to it (see Section 10)*

Estimated Cost ≈ $20 to $30 million

12.5 *Split the 230kV busbar at Claireville TS and install 6th Circuit between Claireville TS & Richview TS*

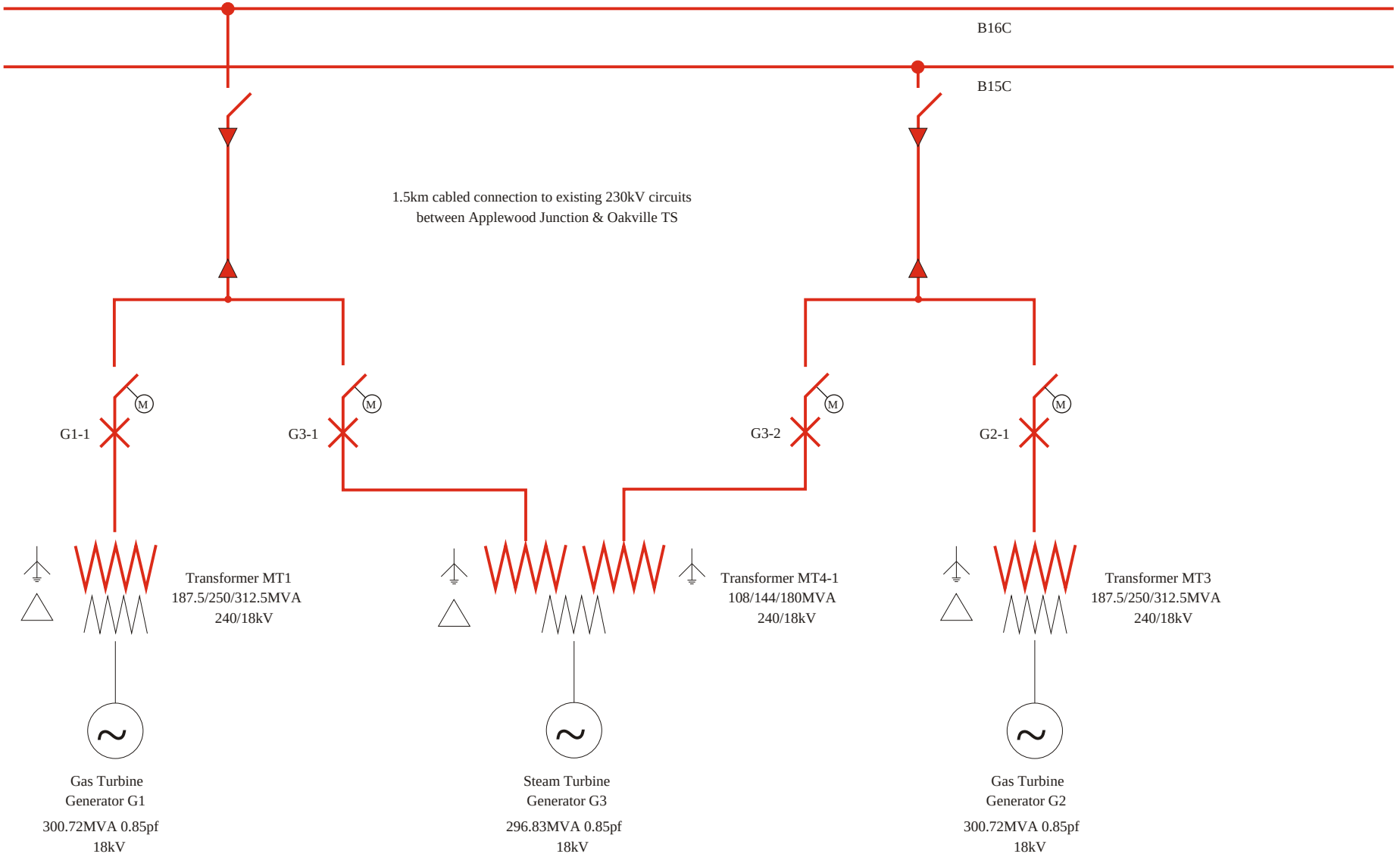
Estimated Cost ≈ $20 to 30 million *(In addition to the cost of Item 12.4)*

13. Notification of Approval

This System Impact Assessment has reviewed the applications from Sithe for the proposed connection of their Projects at Southdown and Goreway, and has identified the IMO's requirements for connection to ensure that neither of these Projects has a negative impact on the IMO-controlled grid.

Subject to the implementation of these requirements, it is recommended that *Notifications of Approval for Connection* be issued for each Project.

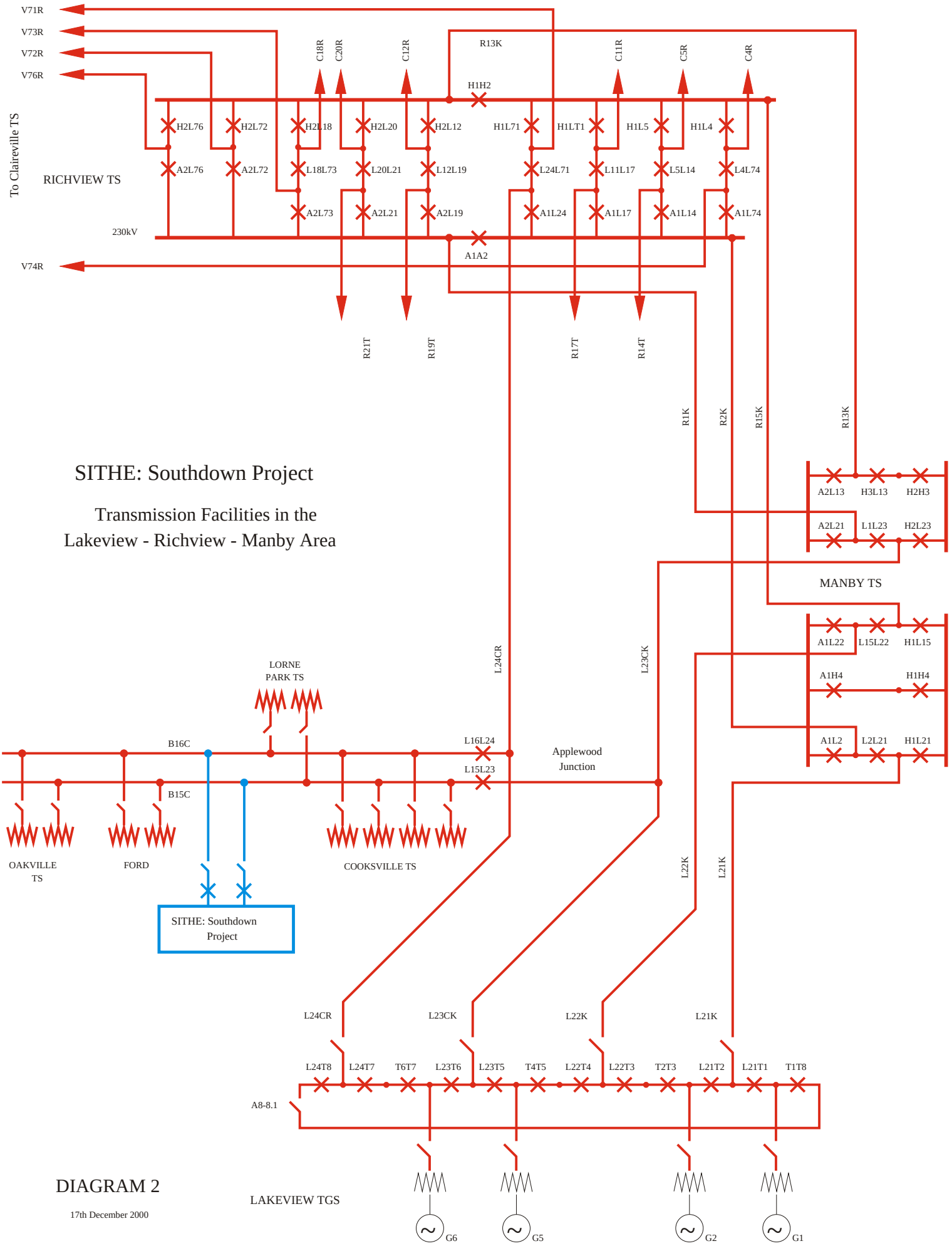
DIAGRAMS

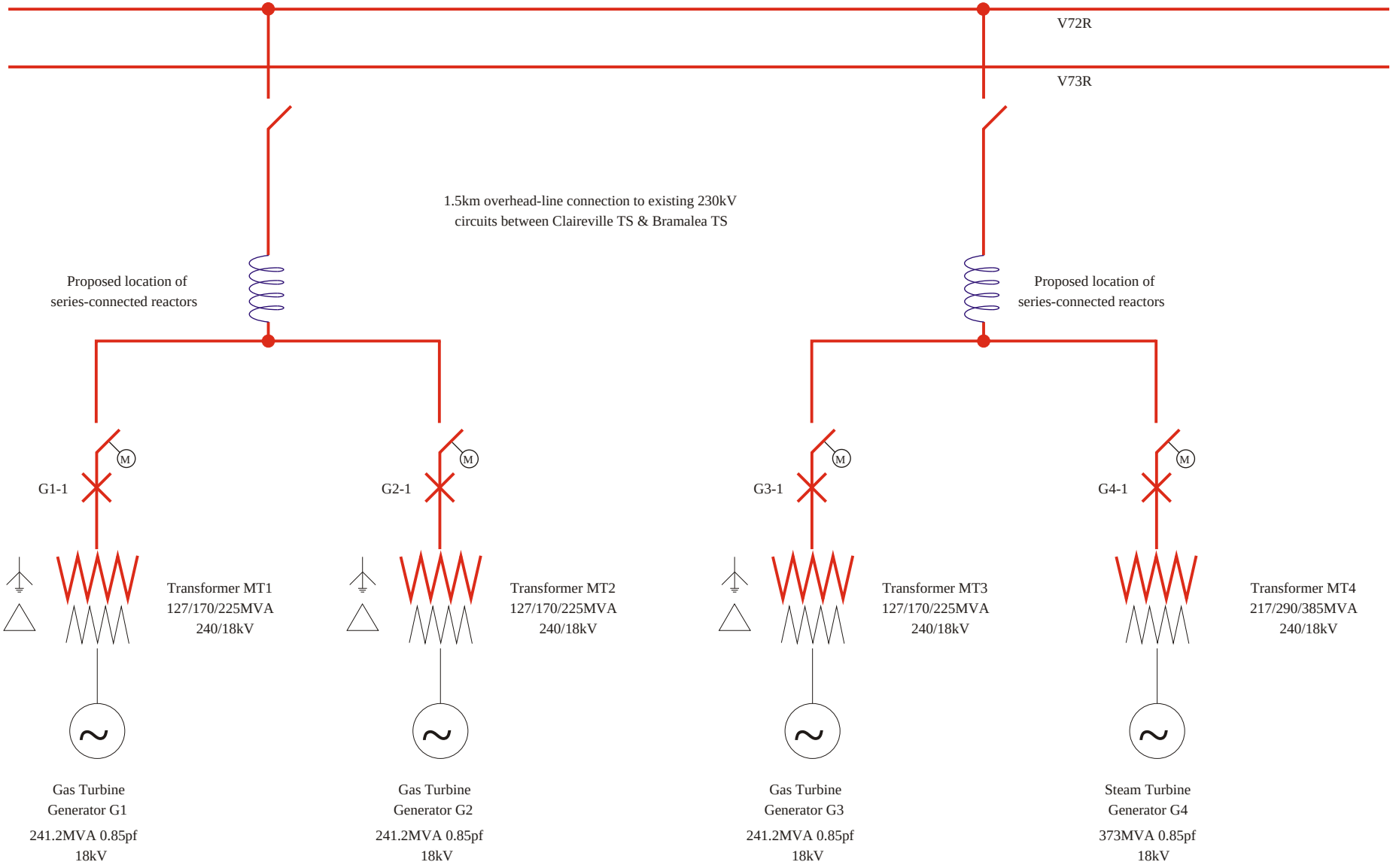


SITHE: SOUTHDOWN PROJECT

DIAGRAM 1

4th March 2001

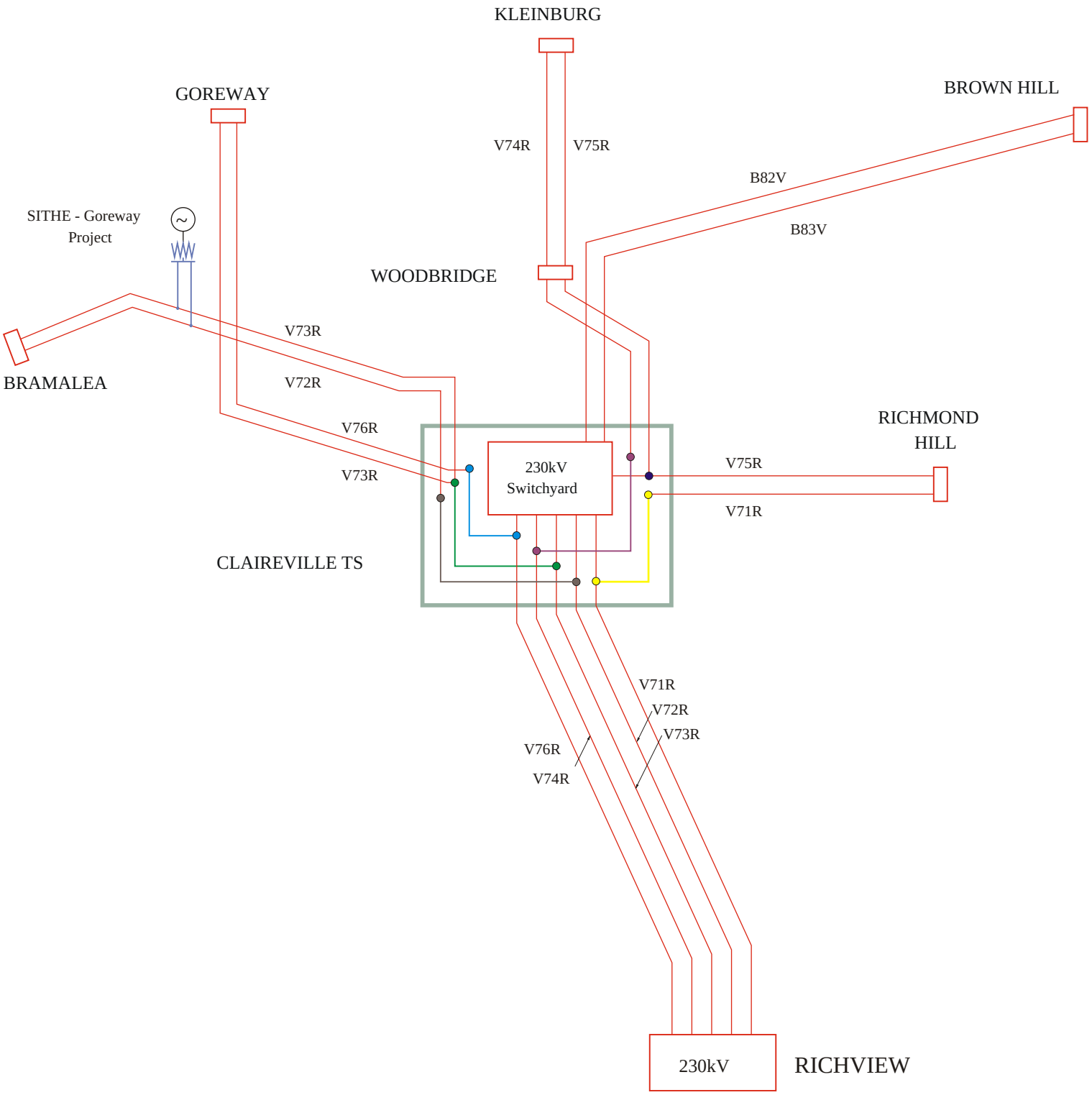

V71R
V73R
V72R
V76R
To Claireville TS
RICHVIEW TS
230kV
V74R
C18R
C20R
C12R
R13K
C11R
C5R
C4R
H1H2
H2L76
H2L72
H2L18
H2L20
H2L12
H1L71
H1LT1
H1L5
H1L4
A2L76
A2L72
L18L73
L20L21
L12L19
L24L71
L11L17
L5L14
L4L74
A2L73
A2L21
A2L19
A1L24
A1L17
A1L14
A1L74
A1A2
R21T
R19T
R17T
R14T
R1K
R2K
R15K
R13K
SITHE: Southdown Project
Transmission Facilities in the
Lakeview - Richview - Manby Area
A2L13
H3L13
H2H3
A2L21
L1L23
H2L23
MANBY TS
A1L22
L15L22
H1L15
A1H4
H1H4
A1L2
L2L21
H1L21
L24CR
L23CK
LORNE
PARK TS
B16C
B15C
L16L24
L15L23
Applewood
Junction
OAKVILLE
TS
FORD
COOKSVILLE TS
SITHE: Southdown
Project
L22K
L21K
L24CR
L23CK
L22K
L21K
L24T8
L24T7
T6T7
L23T6
L23T5
T4T5
L22T4
L22T3
T2T3
L21T2
L21T1
T1T8
A8-8.1
LAKEVIEW TGS
G6
G5
G2
G1
DIAGRAM 2
17th December 2000



SITHE- GOREWAY PROJECT

DIAGRAM 3

4th March 2001

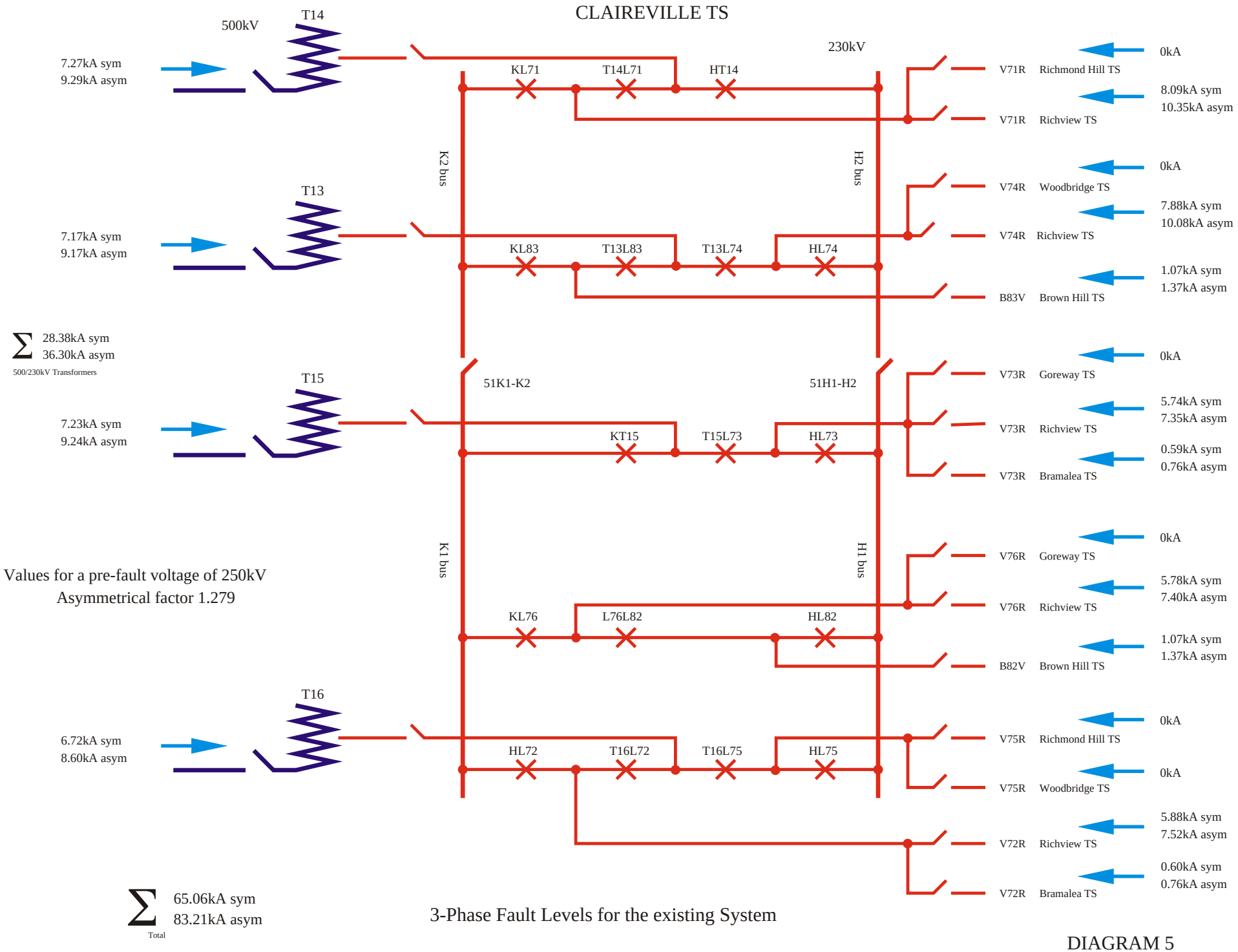


INCORPORATION OF SITHE-GOREWAY PROJECT INTO CLAIREVILLE TS

Configuration of 230kV Circuits at Claireville TS

DIAGRAM 4

14th December 2000

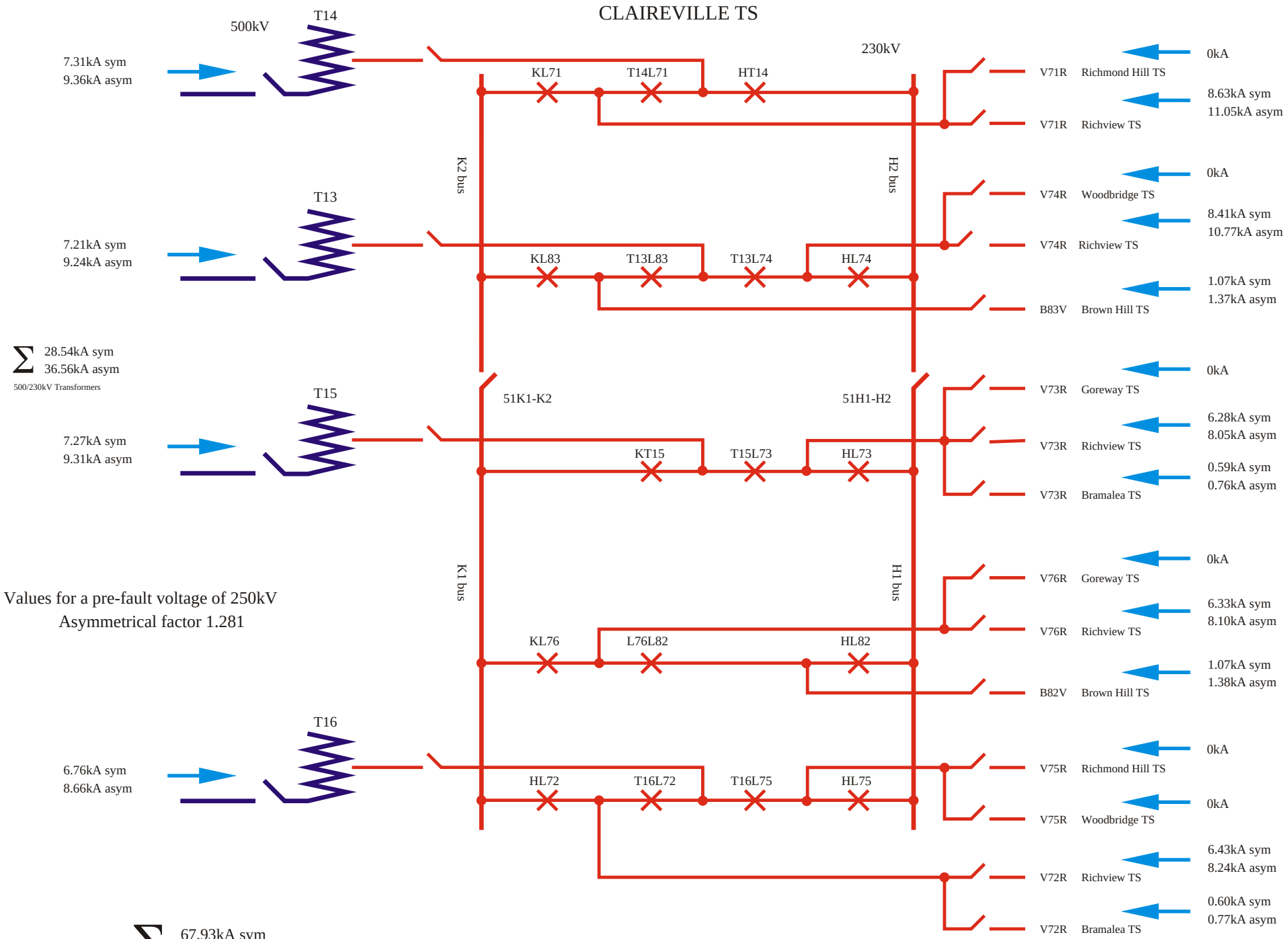


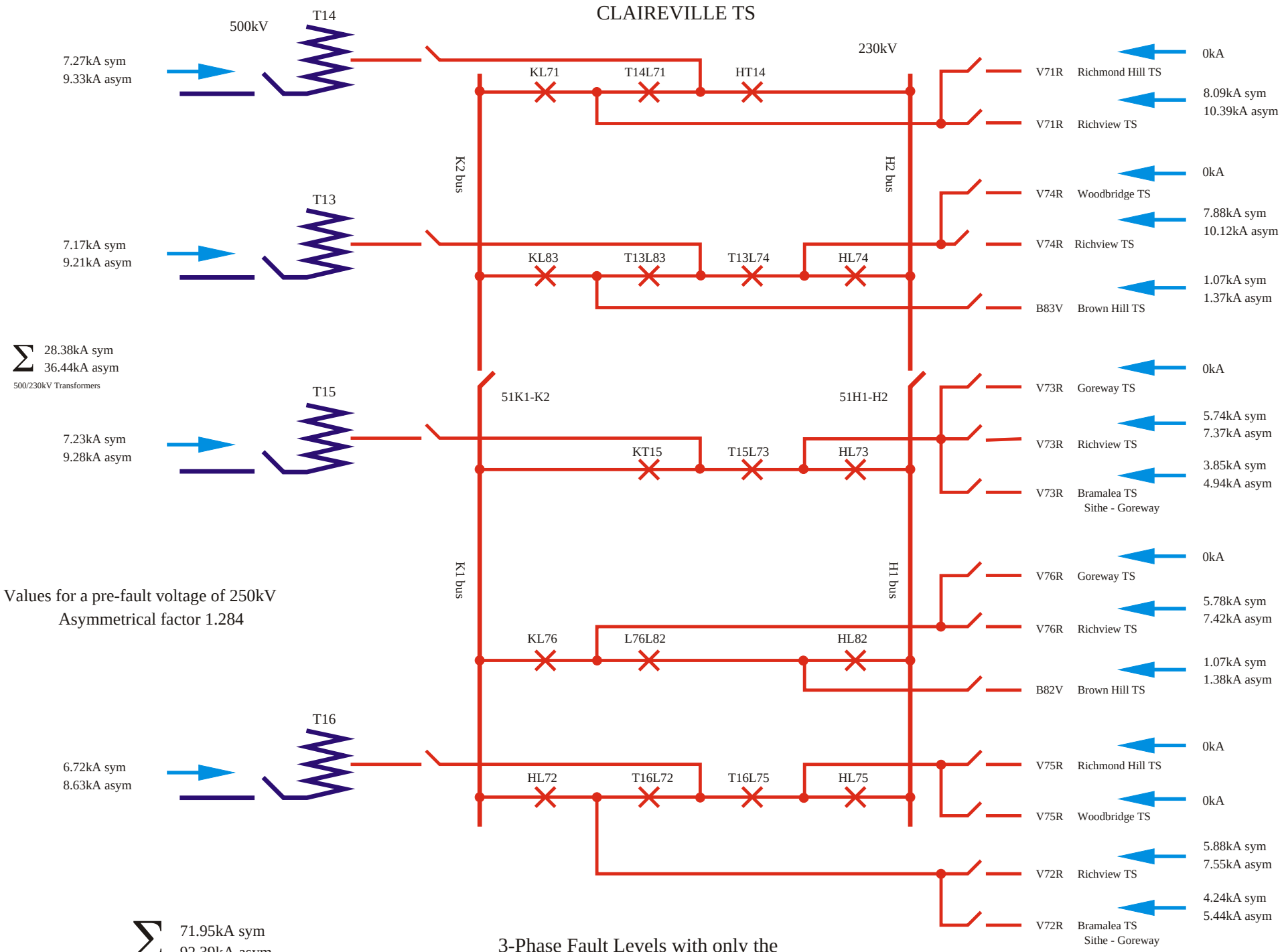
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.279

3-Phase Fault Levels for the existing System

DIAGRAM 5

15th December 2000


CLAIREVILLE TS
500kV
230kV
T14
7.31kA sym
9.36kA asym
KL71
T14L71
HT14
V71R Richmond Hill TS
0kA
V71R Richview TS
8.63kA sym
11.05kA asym
K2 bus
H2 bus
T13
7.21kA sym
9.24kA asym
KL83
T13L83
T13L74
HL74
V74R Woodbridge TS
0kA
V74R Richview TS
8.41kA sym
10.77kA asym
B83V Brown Hill TS
1.07kA sym
1.37kA asym
Σ 28.54kA sym
36.56kA asym
500/230kV Transformers
T15
51K1-K2
51H1-H2
7.27kA sym
9.31kA asym
KT15
T15L73
HL73
V73R Goreway TS
0kA
V73R Richview TS
6.28kA sym
8.05kA asym
V73R Bramalea TS
0.59kA sym
0.76kA asym
K1 bus
H1 bus
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.281
KL76
L76L82
HL82
V76R Goreway TS
0kA
V76R Richview TS
6.33kA sym
8.10kA asym
B82V Brown Hill TS
1.07kA sym
1.38kA asym
T16
6.76kA sym
8.66kA asym
HL72
T16L72
T16L75
HL75
V75R Richmond Hill TS
0kA
V75R Woodbridge TS
V72R Richview TS
6.43kA sym
8.24kA asym
V72R Bramalea TS
0.60kA sym
0.77kA asym
Σ 67.93kA sym
87.02kA asym
Total
3-Phase Fault Levels with only the
Sithe - Southdown Project Incorporated
DIAGRAM 6
15th December 2000

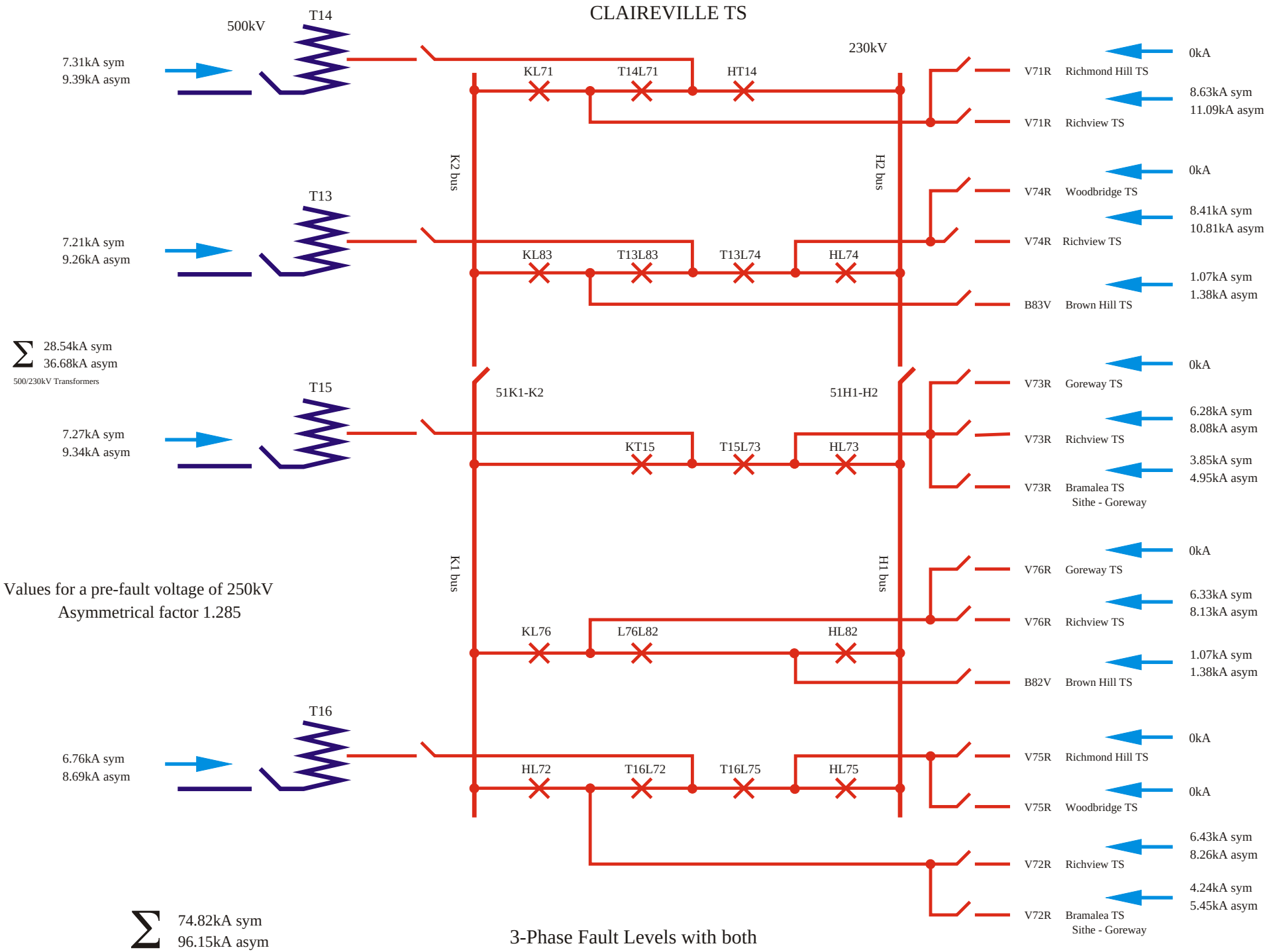


Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.284

3-Phase Fault Levels with only the
Sithe - Goreway Project Incorporated

DIAGRAM 7

15th December 2000

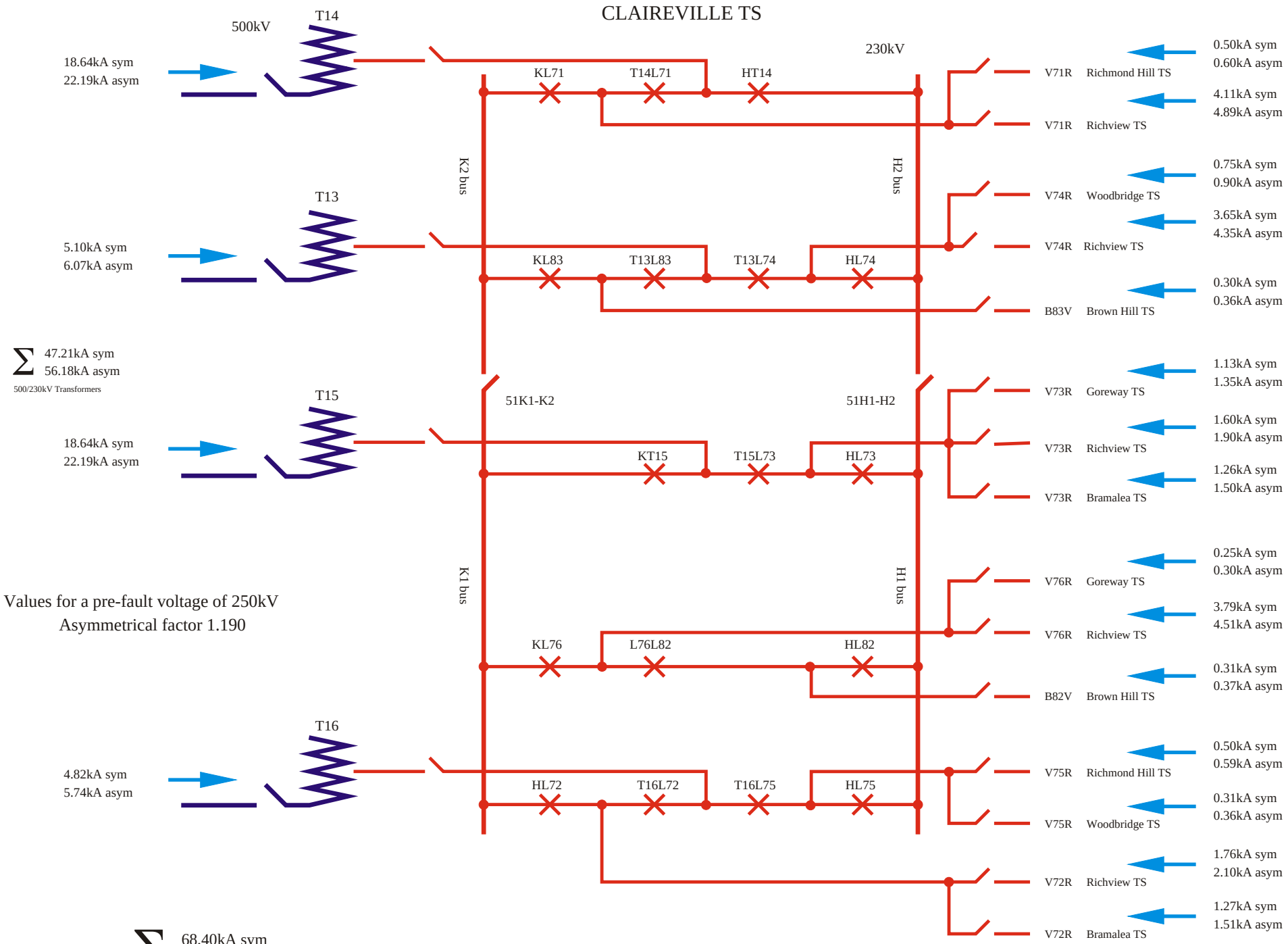


Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.285

3-Phase Fault Levels with both
Sithe Projects Incorporated

DIAGRAM 8

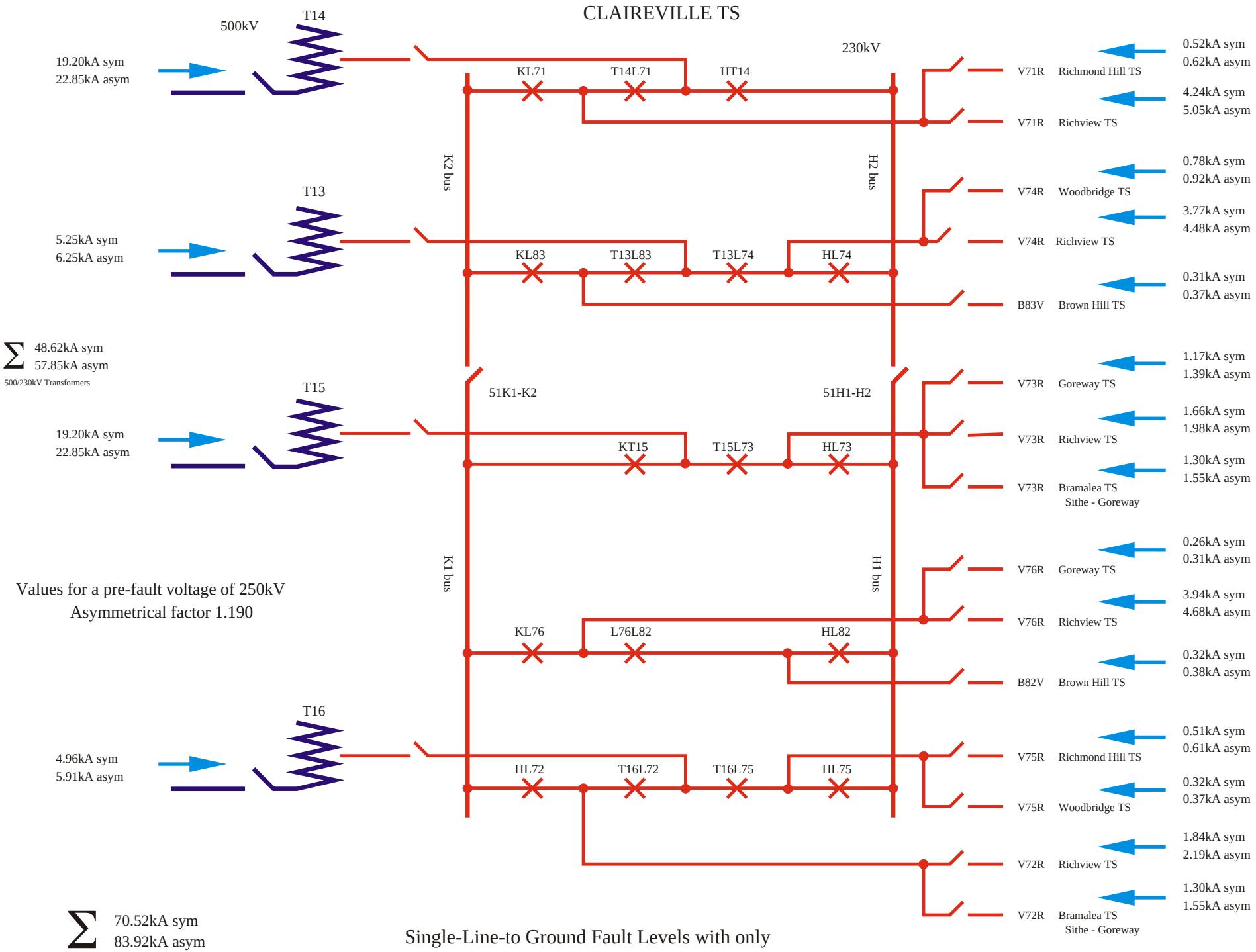
10th December 2000



Single-Line-to-Ground Fault Levels for the existing System

DIAGRAM 9

16th December 2000



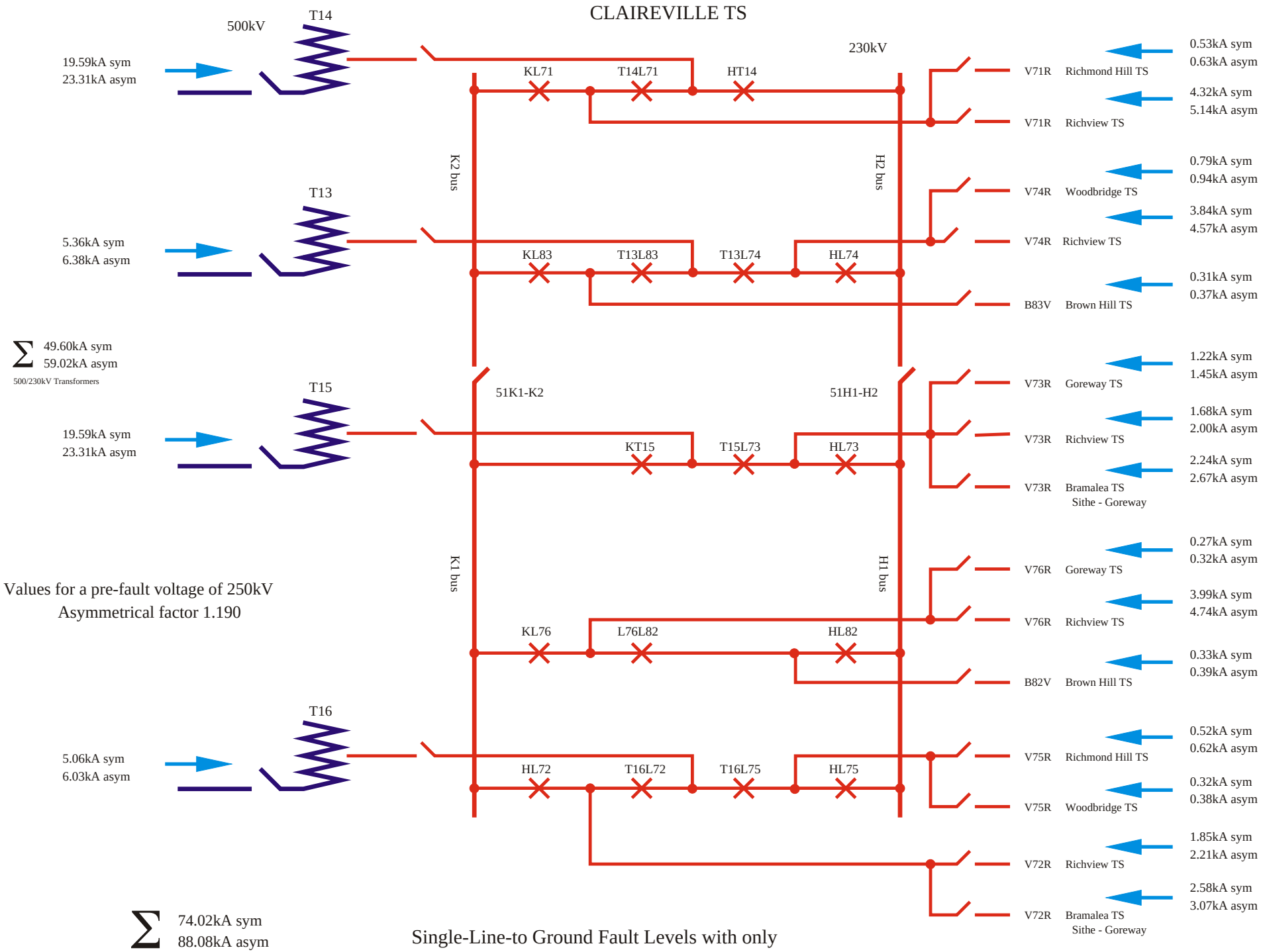
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.190

Σ 70.52kA sym
83.92kA asym
Total

Single-Line-to Ground Fault Levels with only
the Sithe - Southdown Project Incorporated

DIAGRAM 10

15th December 2000

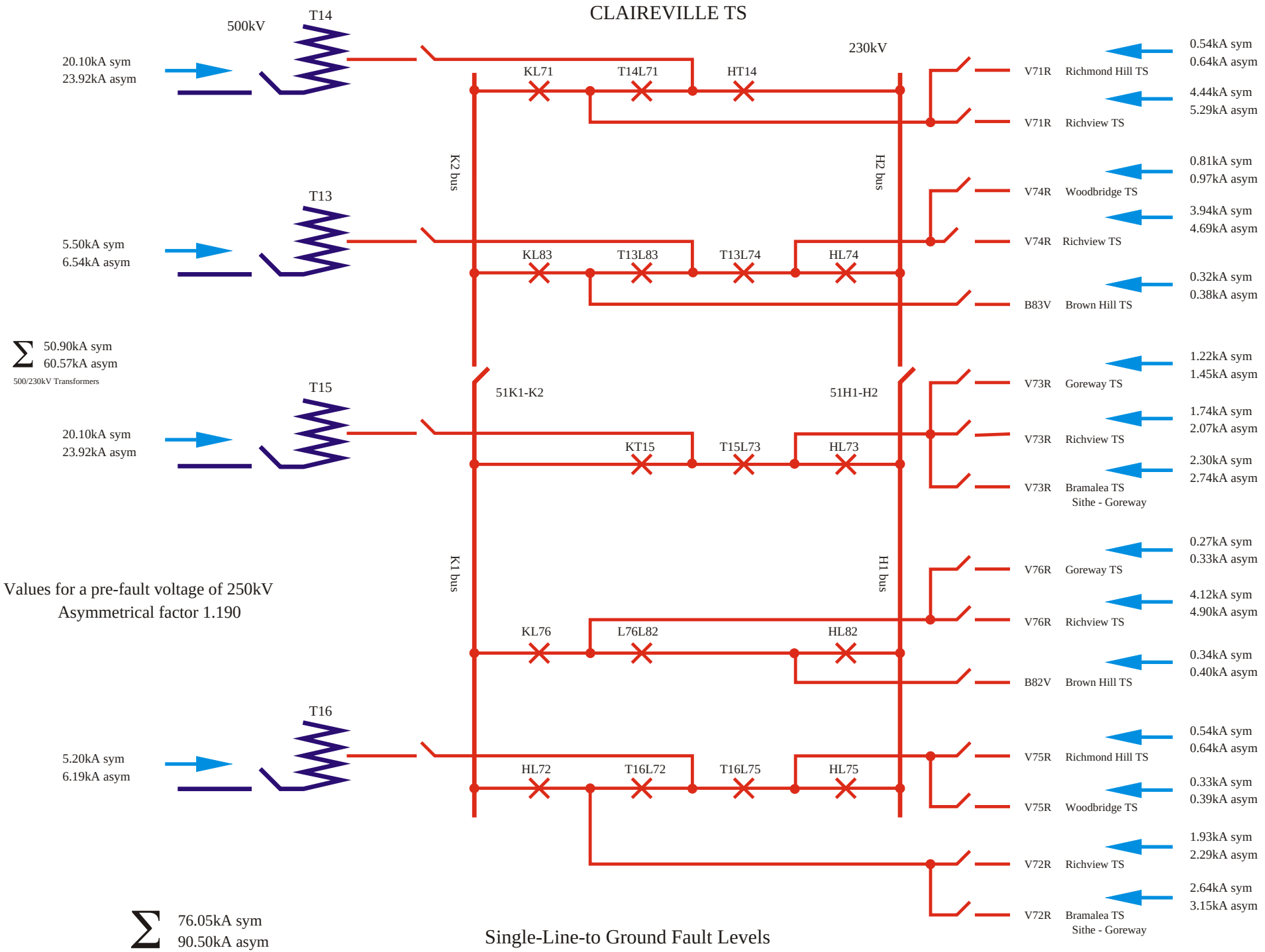


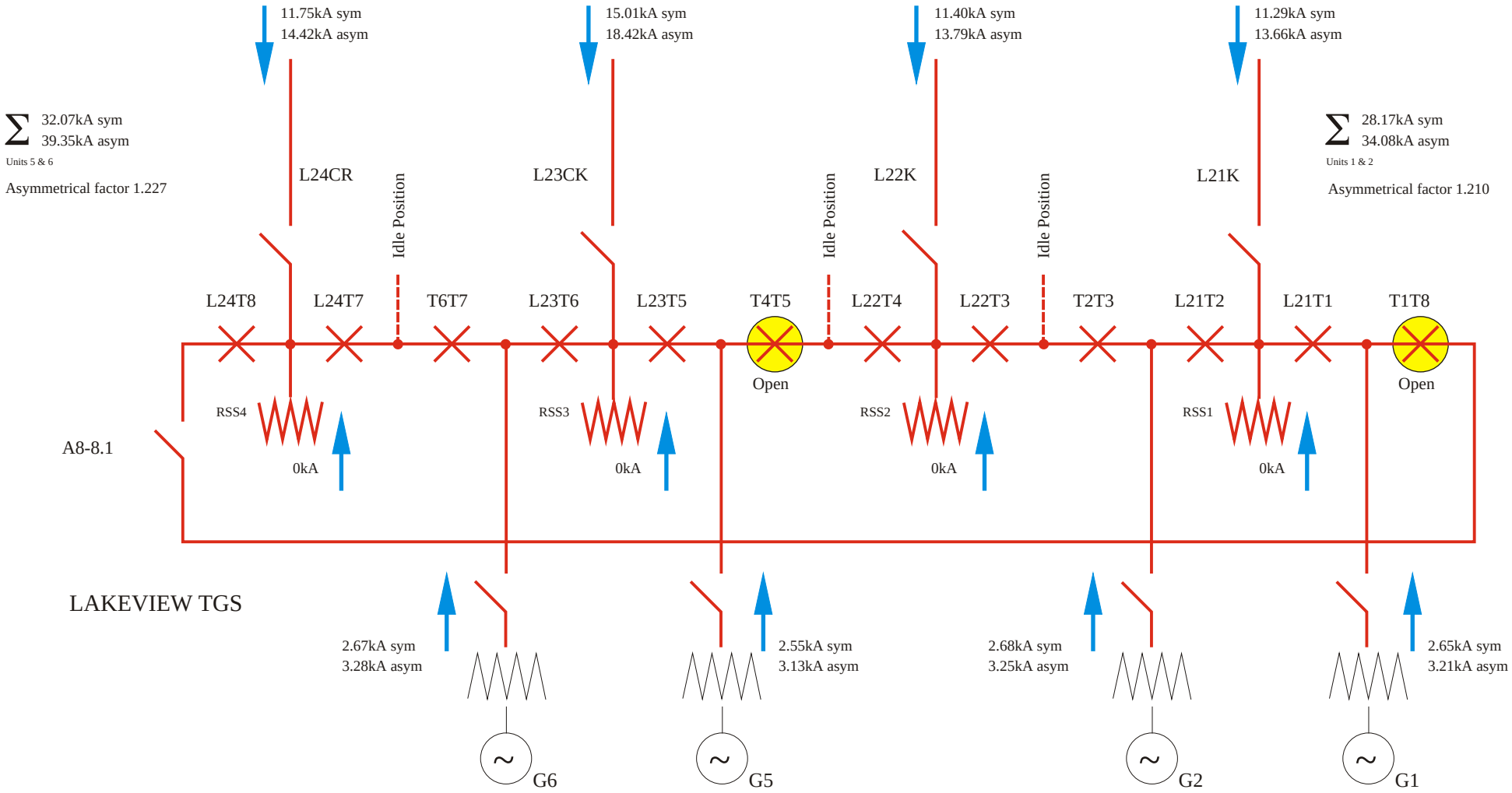
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.190

Single-Line-to Ground Fault Levels with only the Sithe - Goreway Project Incorporated

DIAGRAM 11

15th December 2000


CLAIREVILLE TS
500kV
230kV
T14
20.10kA sym
23.92kA asym
KL71
T14L71
HT14
T13
5.50kA sym
6.54kA asym
KL83
T13L83
T13L74
HL74
Σ 50.90kA sym
60.57kA asym
500/230kV Transformers
T15
20.10kA sym
23.92kA asym
KT15
T15L73
HL73
T16
5.20kA sym
6.19kA asym
HL72
T16L72
T16L75
HL75
K2 bus
H2 bus
51K1-K2
51H1-H2
K1 bus
H1 bus
KL76
L76L82
HL82
V71R Richmond Hill TS
0.54kA sym
0.64kA asym
V71R Richview TS
4.44kA sym
5.29kA asym
V74R Woodbridge TS
0.81kA sym
0.97kA asym
V74R Richview TS
3.94kA sym
4.69kA asym
B83V Brown Hill TS
0.32kA sym
0.38kA asym
V73R Goreway TS
1.22kA sym
1.45kA asym
V73R Richview TS
1.74kA sym
2.07kA asym
V73R Bramalea TS
Sithe - Goreway
2.30kA sym
2.74kA asym
V76R Goreway TS
0.27kA sym
0.33kA asym
V76R Richview TS
4.12kA sym
4.90kA asym
B82V Brown Hill TS
0.34kA sym
0.40kA asym
V75R Richmond Hill TS
0.54kA sym
0.64kA asym
V75R Woodbridge TS
0.33kA sym
0.39kA asym
V72R Richview TS
1.93kA sym
2.29kA asym
V72R Bramalea TS
Sithe - Goreway
2.64kA sym
3.15kA asym
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.190
Σ 76.05kA sym
90.50kA asym
Total
Single-Line-to Ground Fault Levels
with both Sithe Projects Incorporated
DIAGRAM 12
15th December 2000



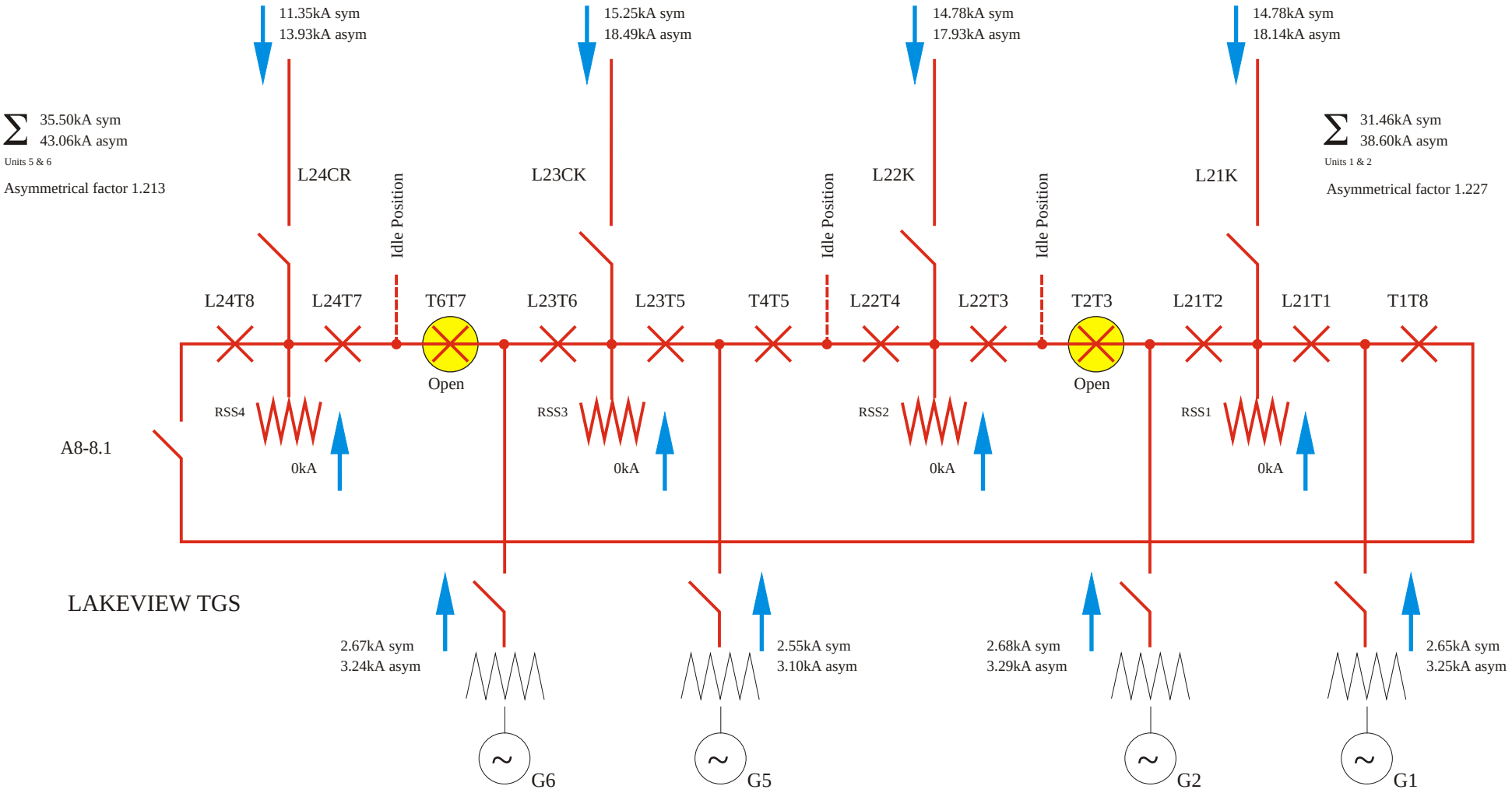
3-Phase Fault Levels for the existing System

'Horizontal' Split of Lakeview Busbar

Values for a pre-fault voltage of 250kV

DIAGRAM 13

16th December 2000



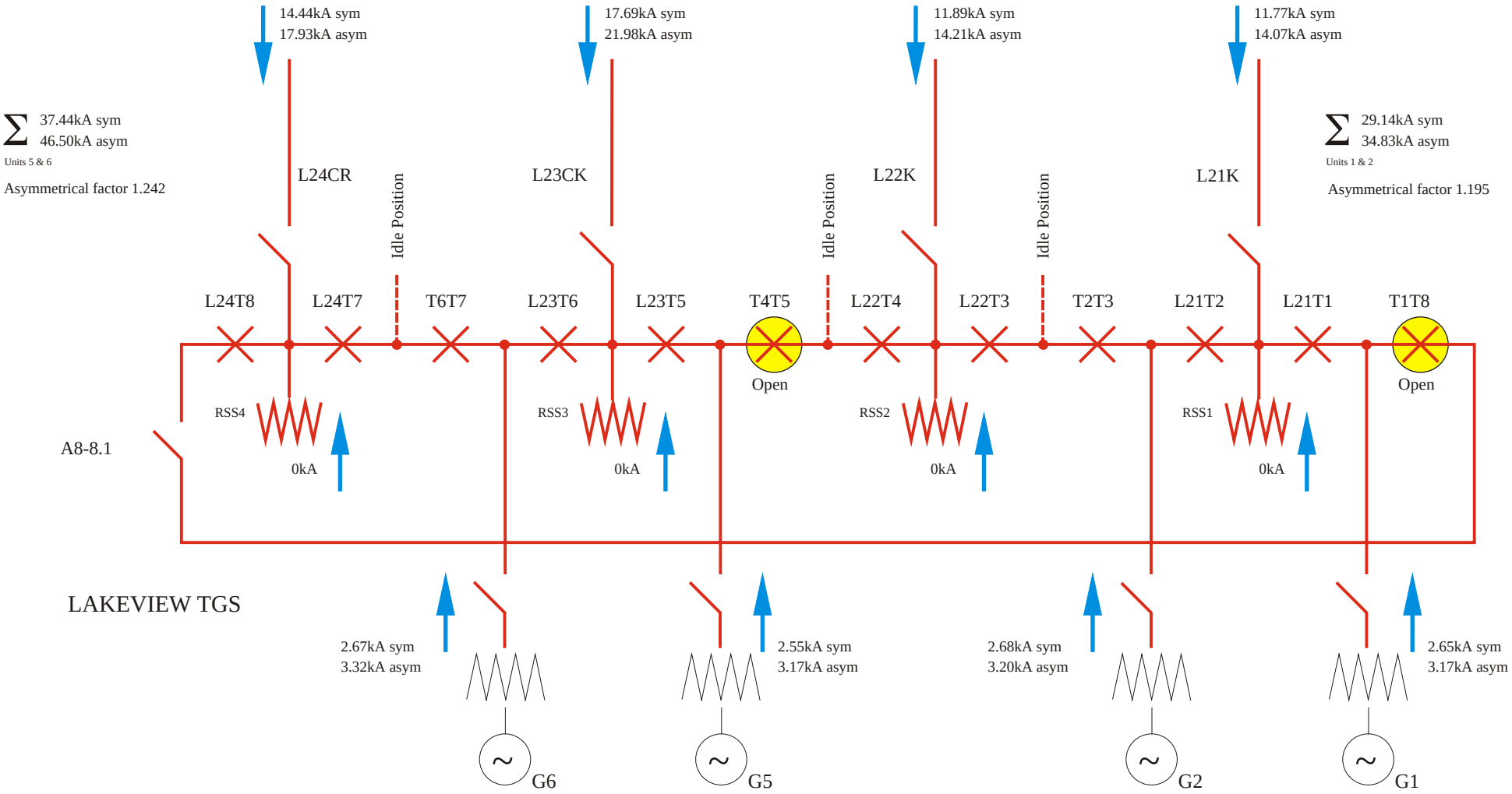
3-Phase Fault Levels for the existing System

'Vertical' Split of Lakeview Busbar

Values for a pre-fault voltage of 250kV

DIAGRAM 14

16th December 2000



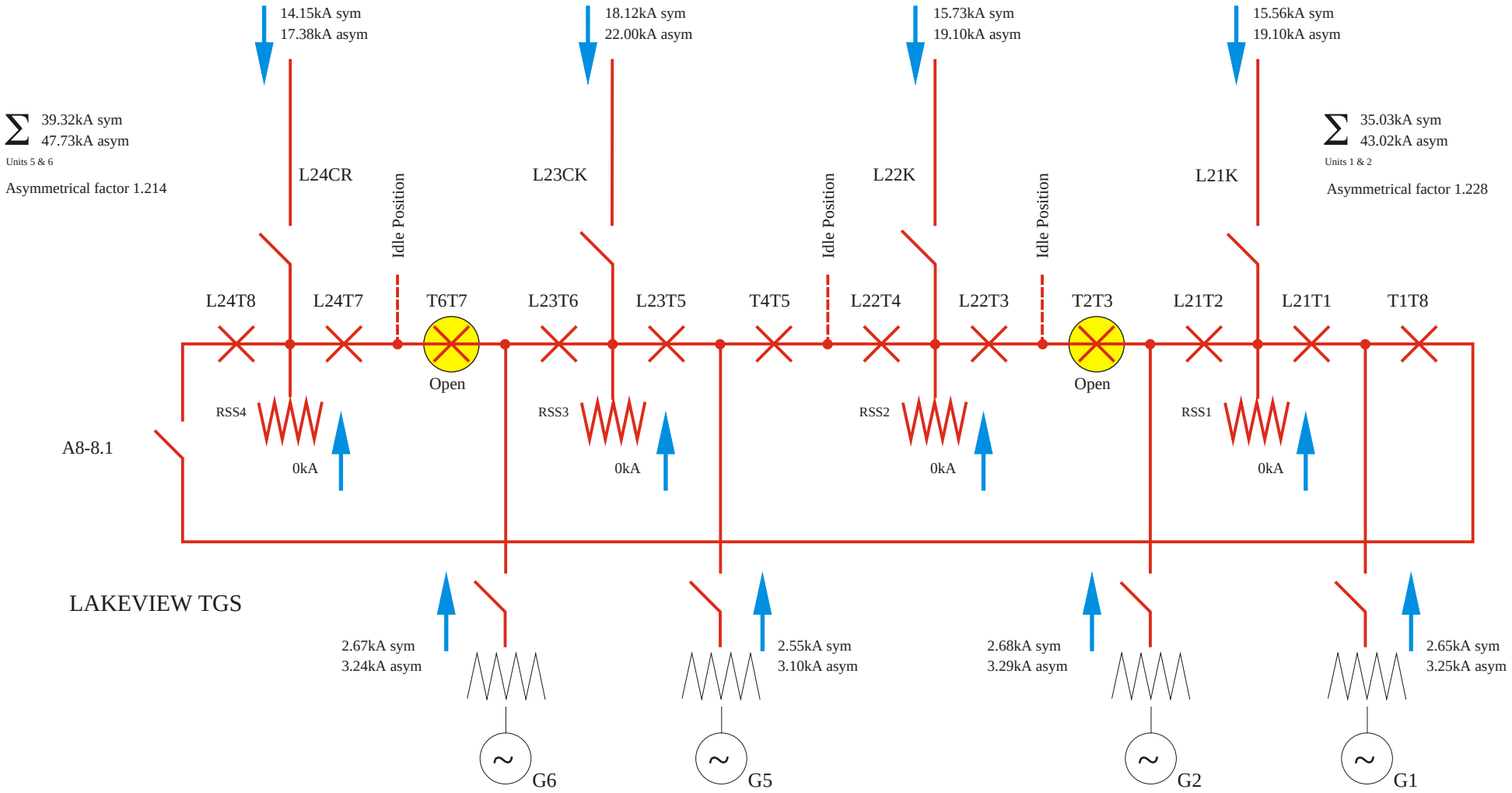
3-Phase Fault Levels with both
Sithe Projects Incorporated

'Horizontal' Split of Lakeview Busbar

Values for a pre-fault voltage of 250kV

DIAGRAM 15

16th December 2000



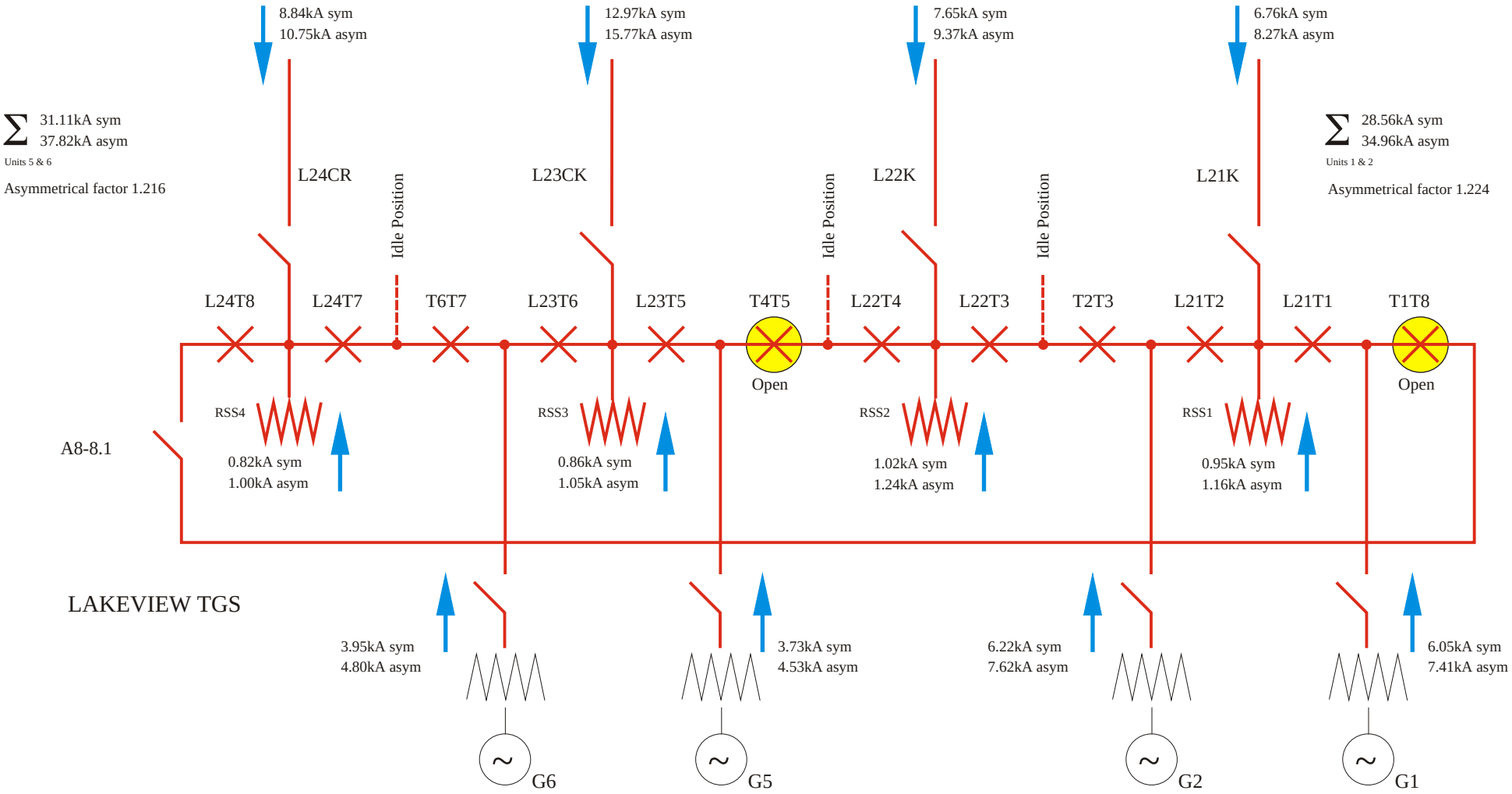
3-Phase Fault Levels with both
Sithe Projects Incorporated

'Vertical' Split of Lakeview Busbar

Values for a pre-fault voltage of 250kV

DIAGRAM 16

16th December 2000



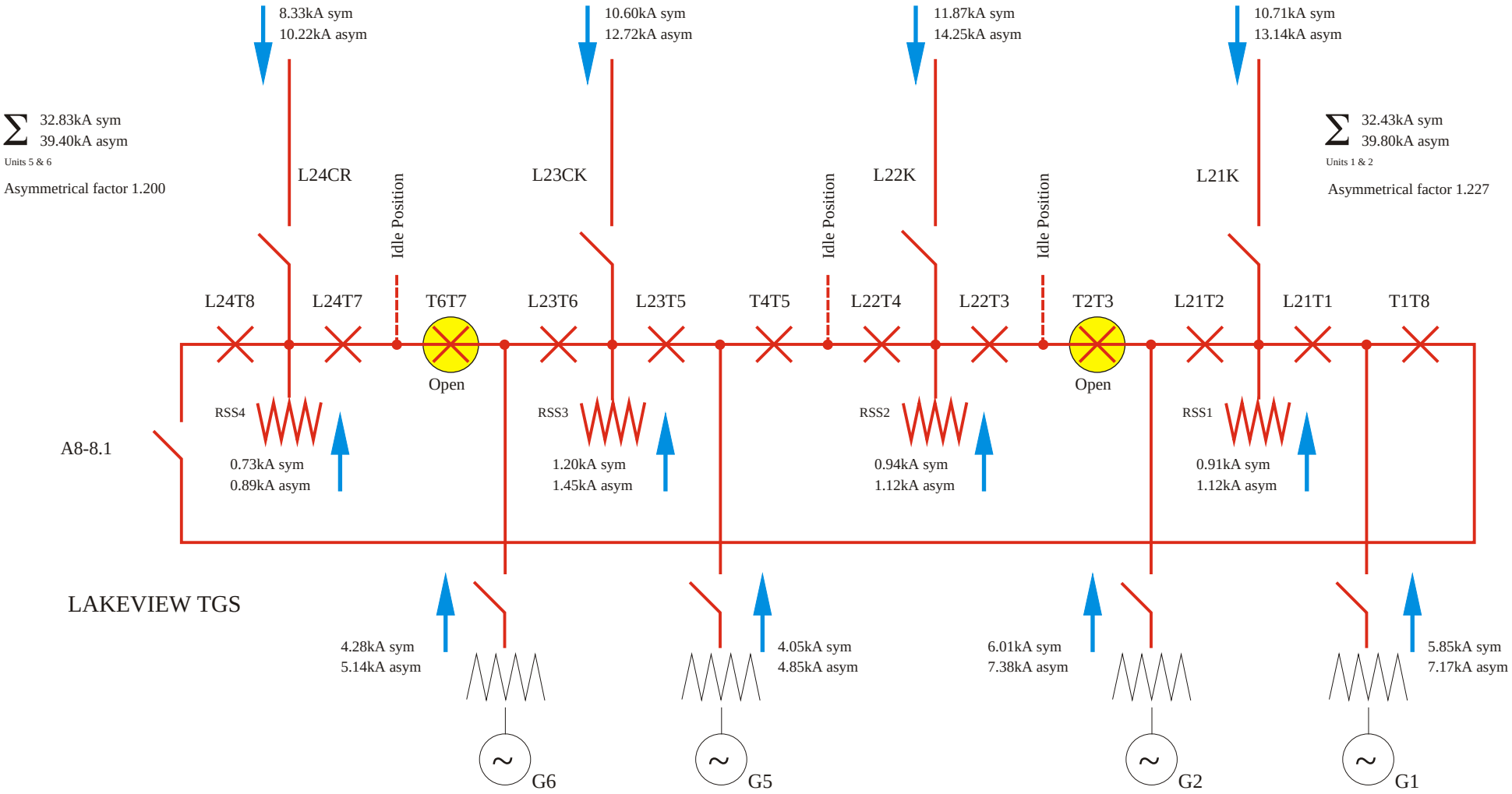
Single Line-to-Ground Fault Levels for the existing System

'Horizontal' Split of Lakeview Busbar

Values for a pre-fault voltage of 250kV

DIAGRAM 17

16th December 2000



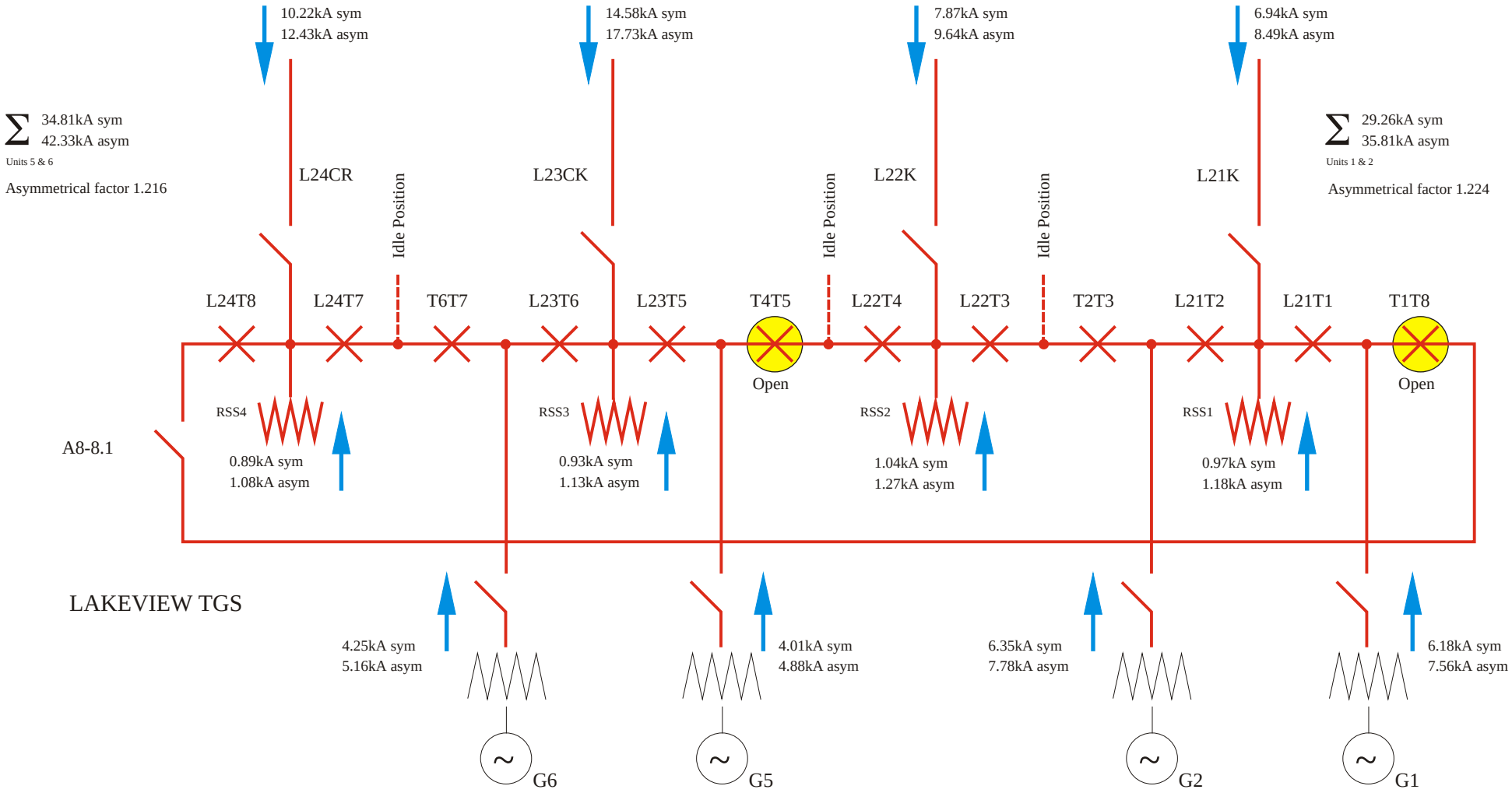
Single Line-to-Ground Fault Levels for the existing System

'Vertical' Split of Lakeview Busbar

Values for a pre-fault voltage of 250kV

DIAGRAM 18

16th December 2000



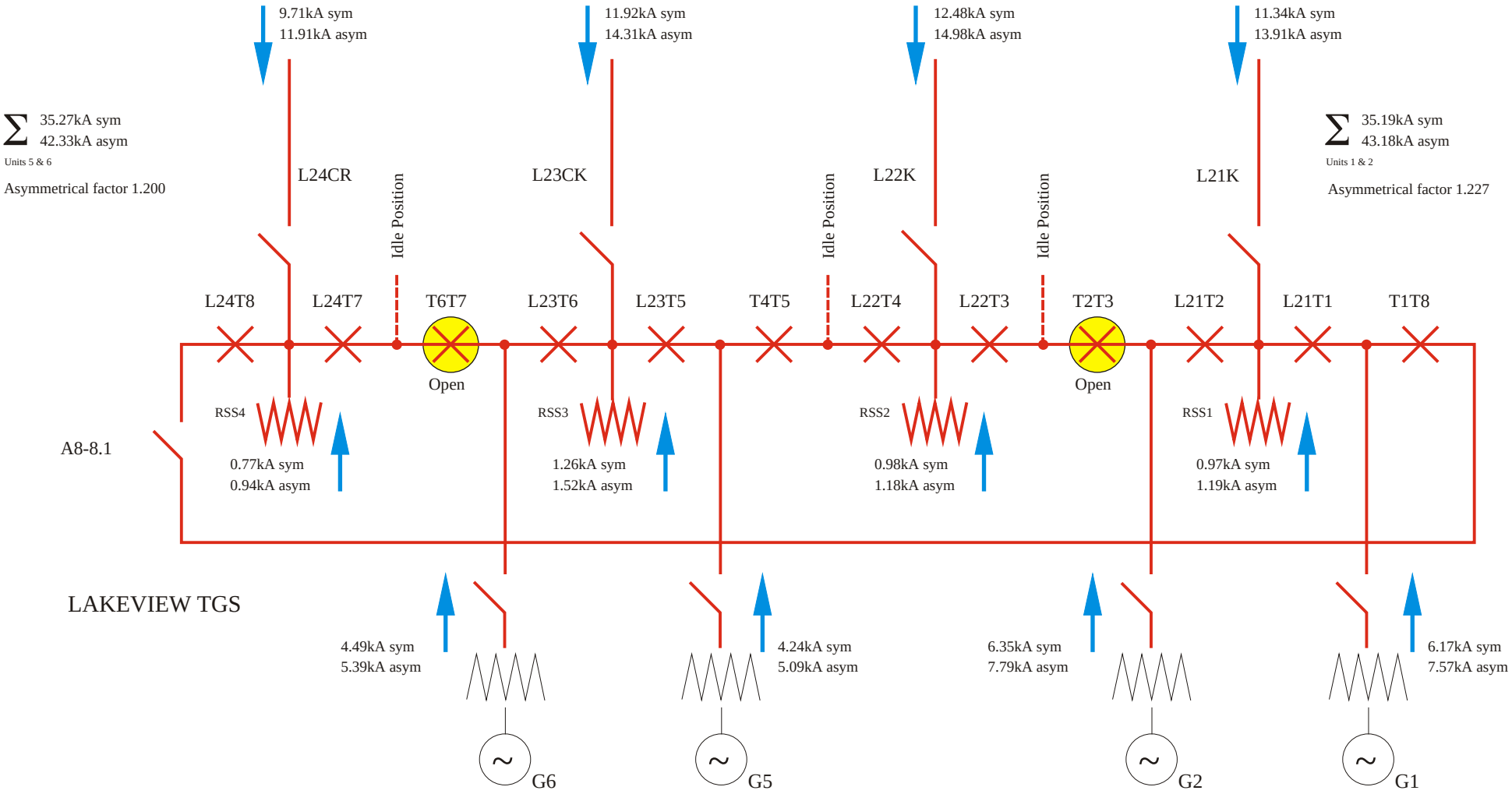
Single Line-to-Ground Fault Levels with
both Sithe Projects Incorporated

'Horizontal' Split of Lakeview Busbar

Values for a pre-fault voltage of 250kV

DIAGRAM 19

16th December 2000



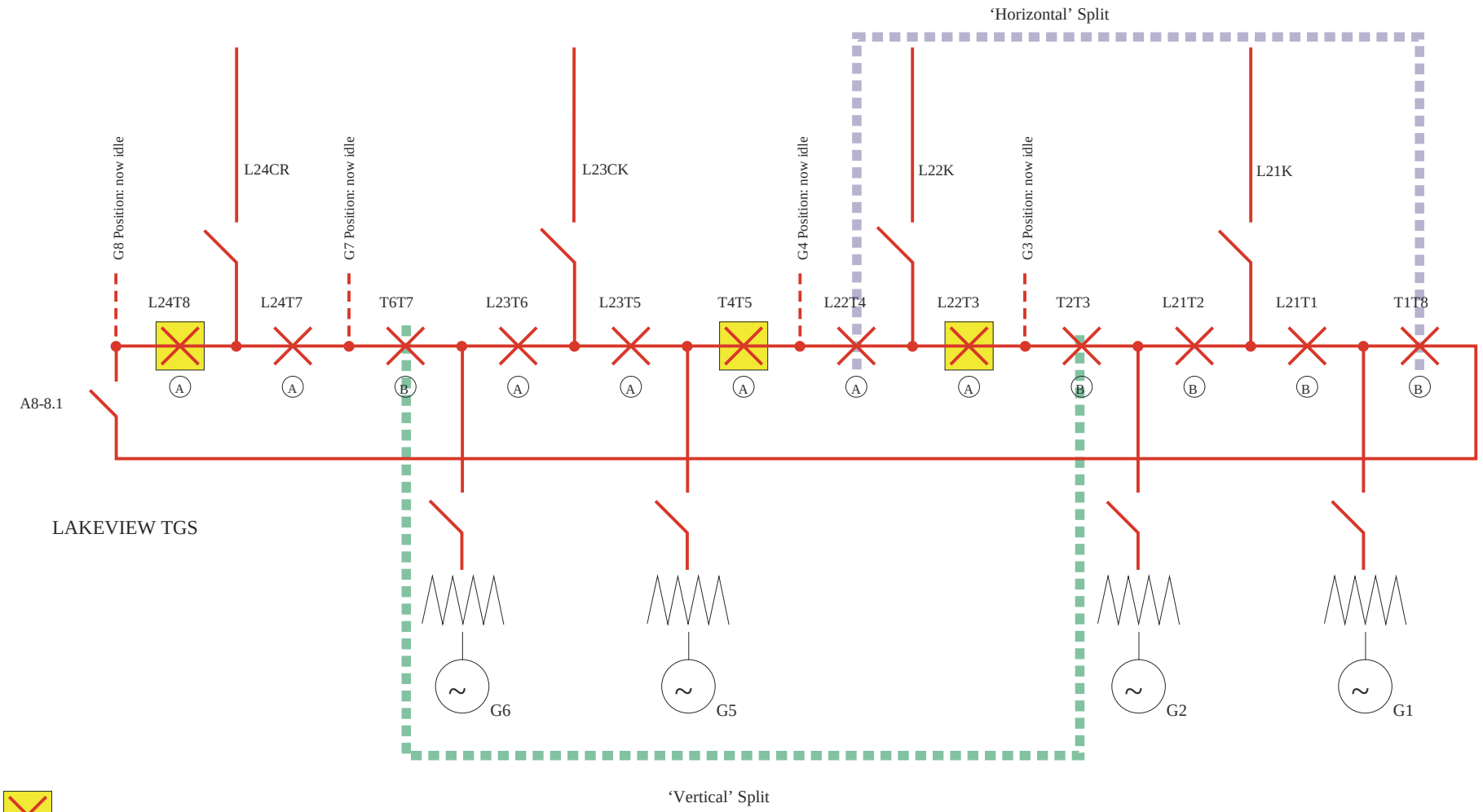
Single Line-to-Ground Fault Levels with
both Sithe Projects Incorporated

'Vertical' Split of Lakeview Busbar

Values for a pre-fault voltage of 250kV

DIAGRAM 20

16th December 2000



Breaker to be removed

Note: Breaker L22T4 could be removed Instead of breaker T4T5

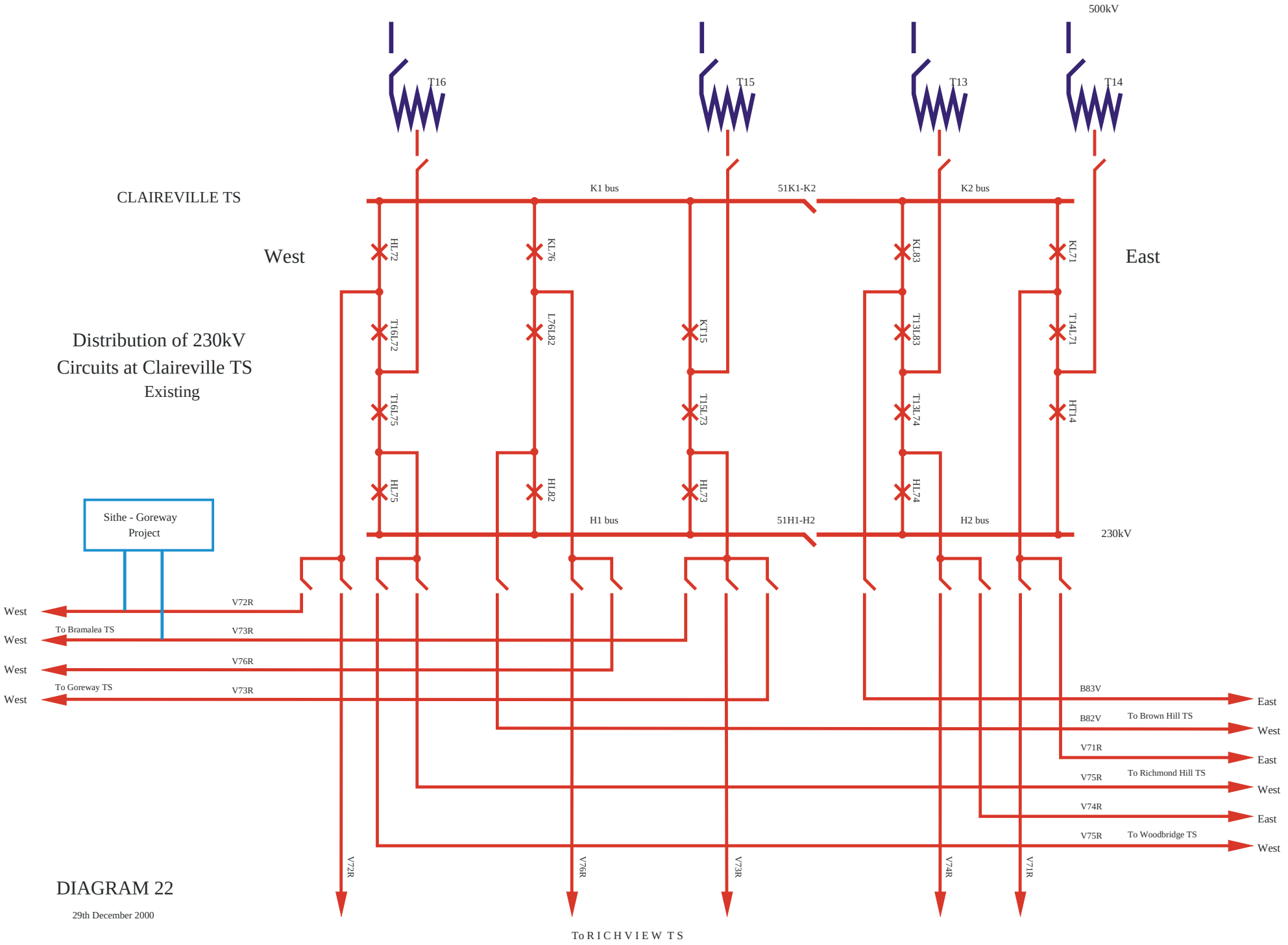
A 38.5kA breakers

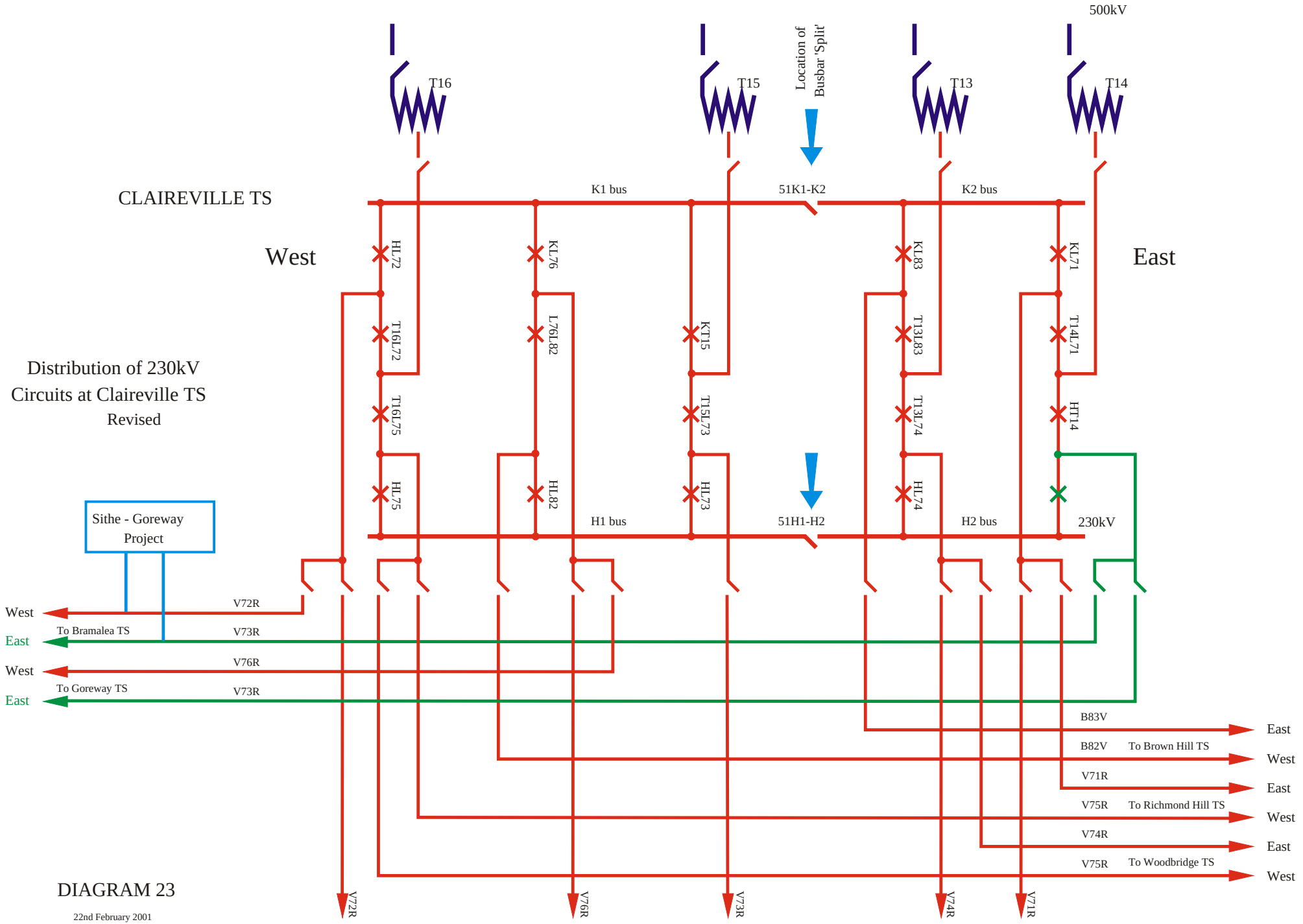
B 63.0kA breakers

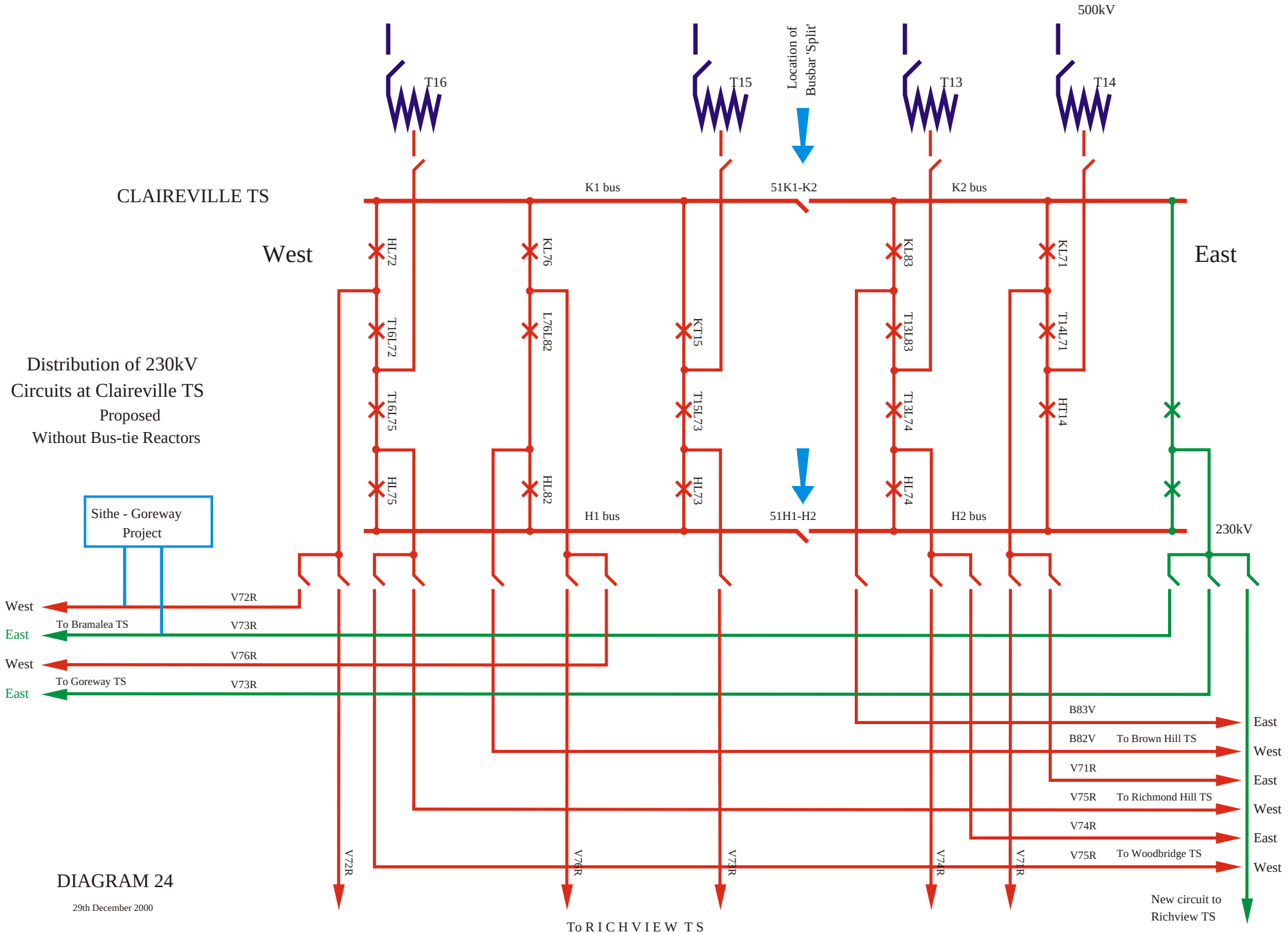
Options for operating with the 230kV busbar at Lakeview TS 'split'

DIAGRAM 21

4th January 2001


CLAIREVILLE TS
500kV
T16
T15
T13
T14
K1 bus
51K1-K2
K2 bus
West
East
HL72
KL76
KL83
KL71
T16L72
L76L82
KT15
T13L83
T14L71
T16L75
T15L73
T13L74
HT14
HL75
HL82
HL73
HL74
H1 bus
51H1-H2
H2 bus
230kV
Distribution of 230kV
Circuits at Claireville TS
Existing
Sithe - Goreway
Project
To Bramalea TS
To Goreway TS
V72R
V73R
V76R
V73R
B83V
B82V
To Brown Hill TS
V71R
V75R
To Richmond Hill TS
V74R
V75R
To Woodbridge TS
V72R
V76R
V73R
V74R
V71R
To R I C H V I E W T S
DIAGRAM 22
29th December 2000


500kV
T16
T15
Location of Busbar 'Split'
T13
T14
CLAIREVILLE TS
K1 bus
51K1-K2
K2 bus
West
East
HL72
KL76
KL83
KL71
T16L72
L76L82
KT15
T13L83
T14L71
T16L75
T15L73
T13L74
HT14
HL75
HL82
HL73
HL74
Distribution of 230kV
Circuits at Claireville TS
Revised
Sithe - Goreway
Project
H1 bus
51H1-H2
H2 bus
230kV
West
V72R
To Bramalea TS
East
V73R
West
V76R
To Goreway TS
East
V73R
B83V
East
B82V
To Brown Hill TS
West
V71R
East
V75R
To Richmond Hill TS
West
V74R
East
V75R
To Woodbridge TS
West
V72R
V76R
V73R
V74R
V71R
To R I C H V I E W T S
DIAGRAM 23
22nd February 2001


500kV
T16
T15
Location of Busbar 'Split'
T13
T14
CLAIREVILLE TS
K1 bus
51K1-K2
K2 bus
West
East
HL72
KL76
KL83
KL71
T16L72
L76L82
KT15
T13L83
T14L71
T16L75
T15L73
T13L74
HT14
HL75
HL82
HL73
HL74
H1 bus
51H1-H2
H2 bus
230kV
Distribution of 230kV Circuits at Claireville TS
Proposed
Without Bus-tie Reactors
Sithe - Goreway Project
West
V72R
To Bramalea TS
East
V73R
West
V76R
To Goreway TS
East
V73R
B83V
East
B82V
To Brown Hill TS
West
V71R
East
V75R
To Richmond Hill TS
West
V74R
East
V75R
To Woodbridge TS
West
V72R
V76R
V73R
V74R
V71R
New circuit to Richview TS
To R I C H V I E W T S
DIAGRAM 24
29th December 2000

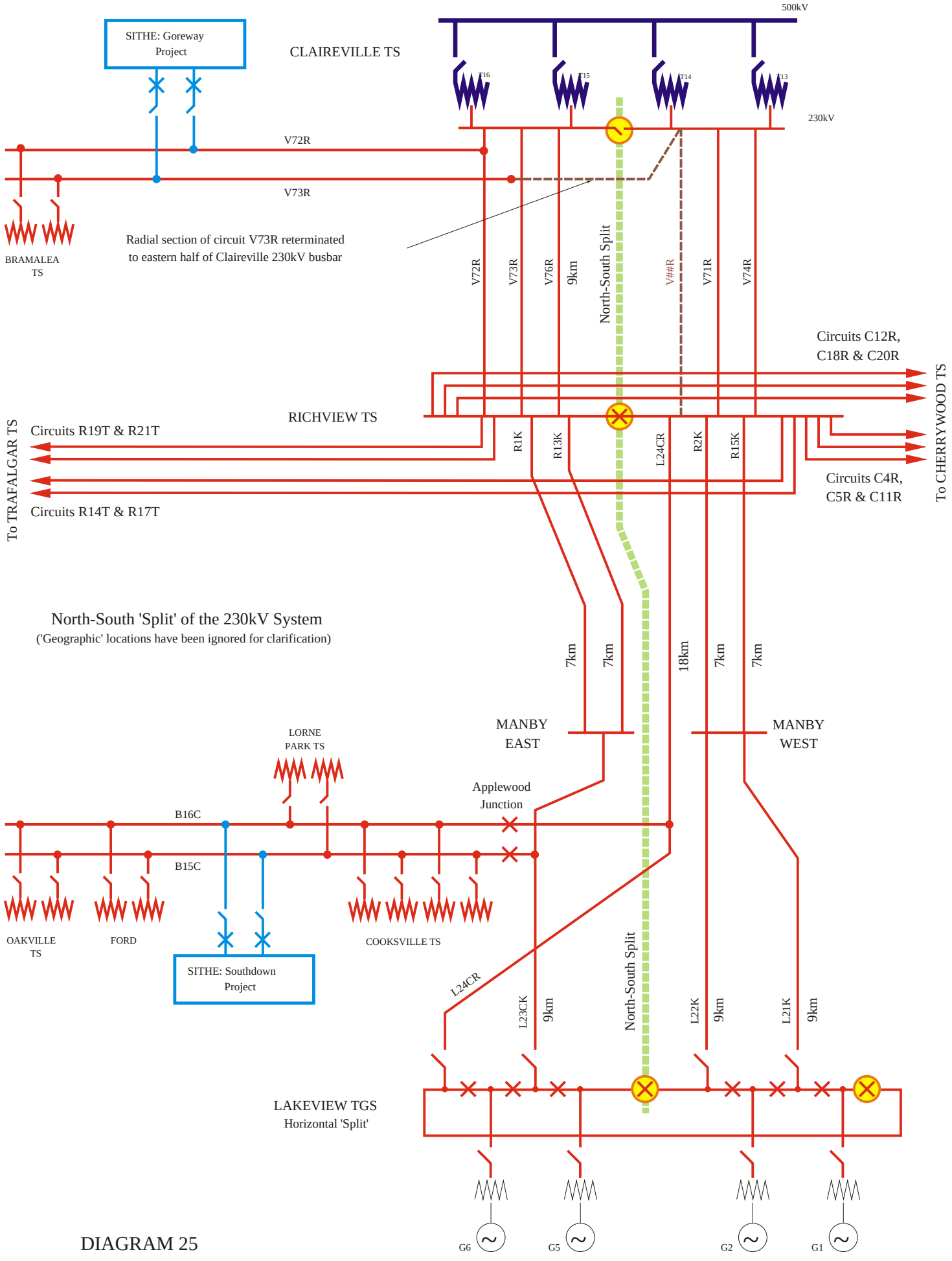
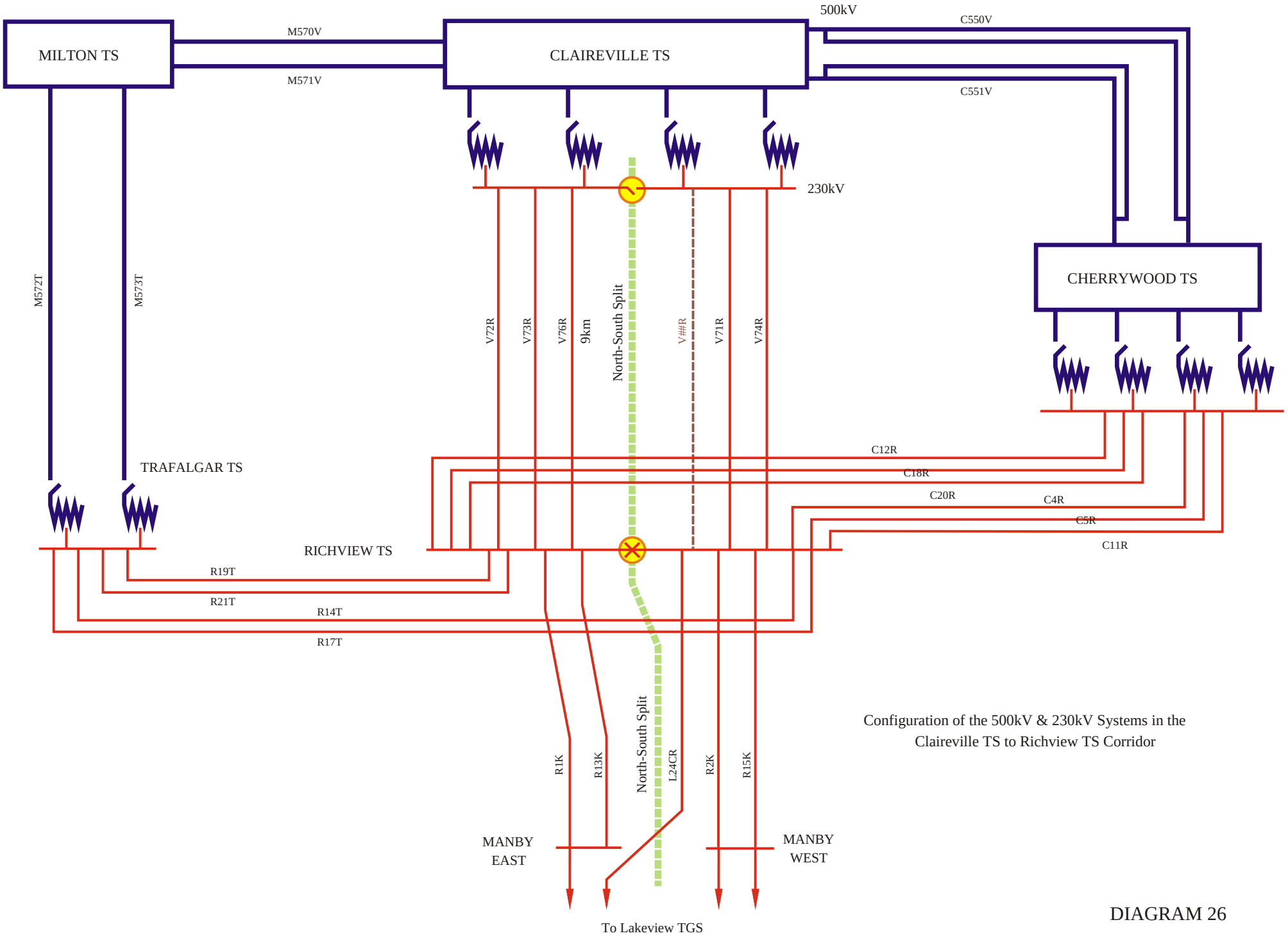


DIAGRAM 25

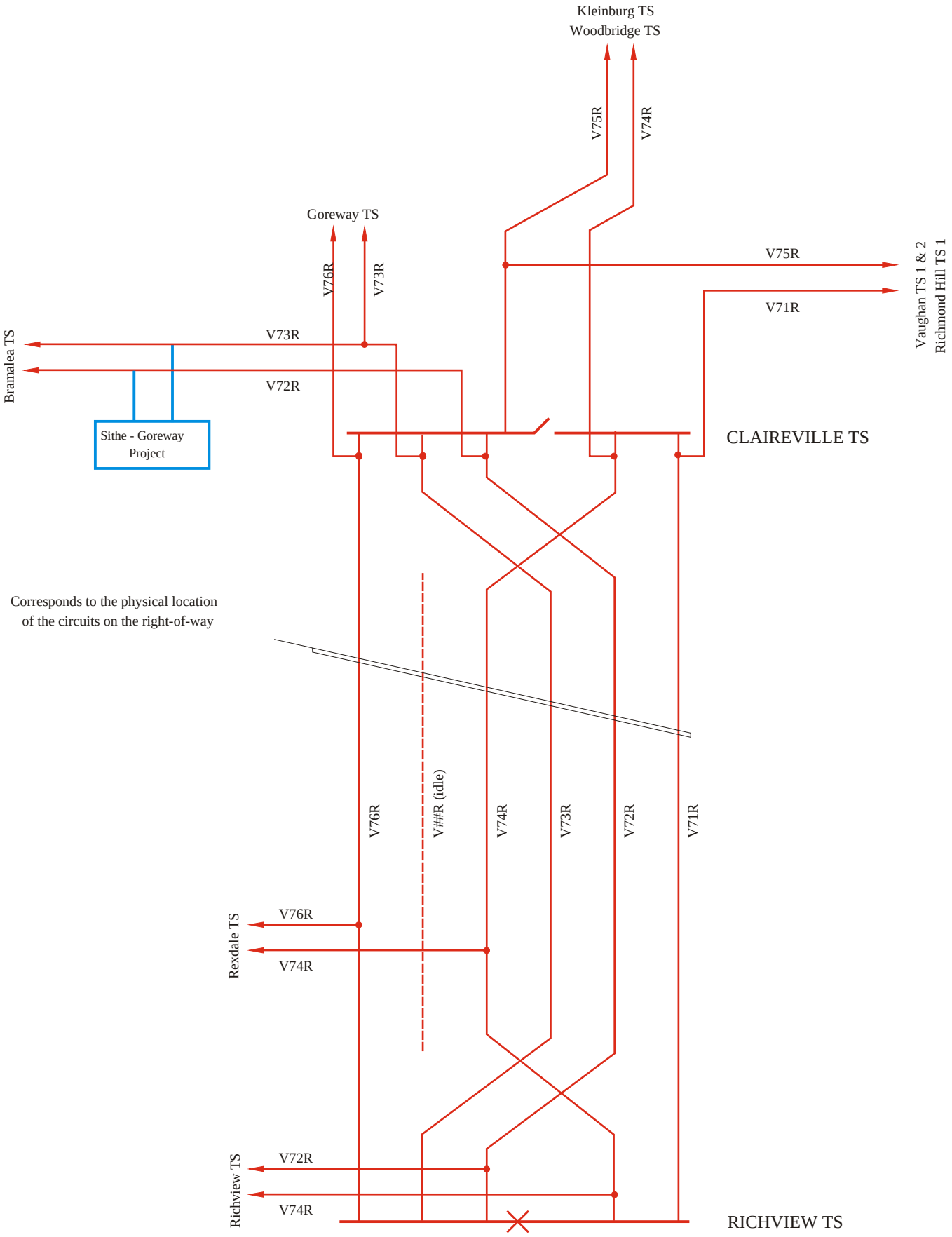
5th January 2001



Configuration of the 500kV & 230kV Systems in the Claireville TS to Richview TS Corridor

DIAGRAM 26

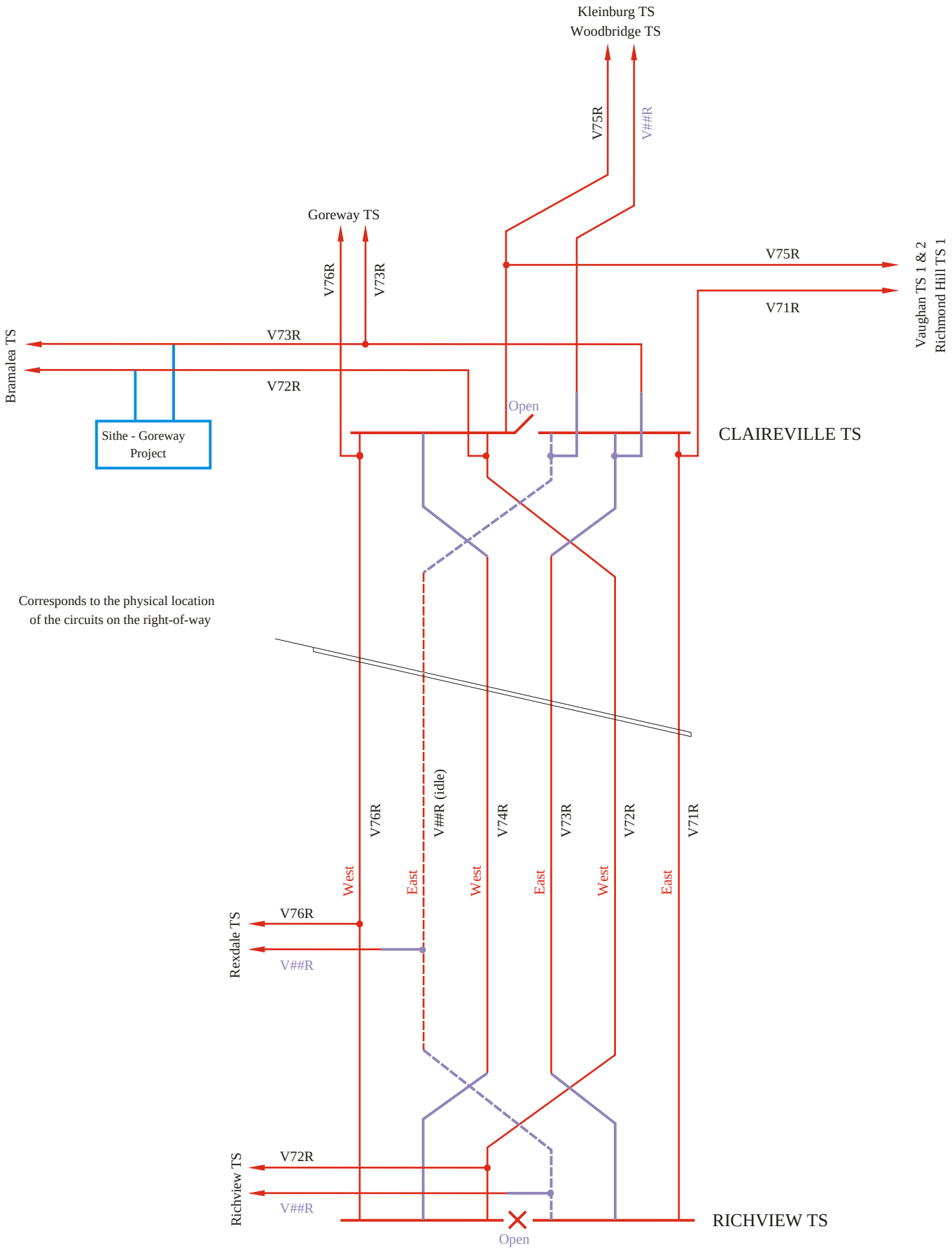
8th January 2001



Existing Arrangement of the 230kV Circuits on the Richview TS to Claireville TS right-of-way

DIAGRAM 27

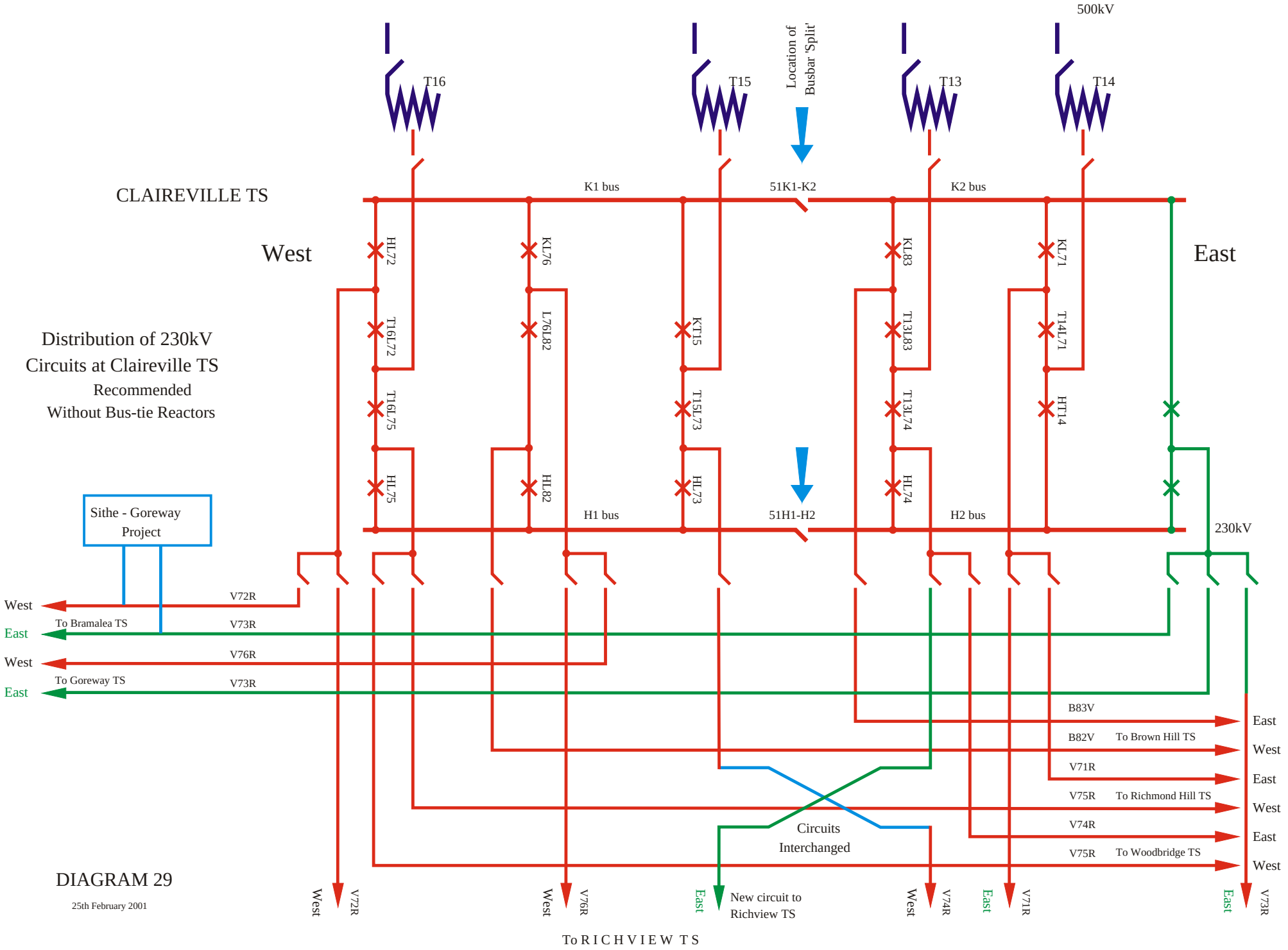
19th February 2001

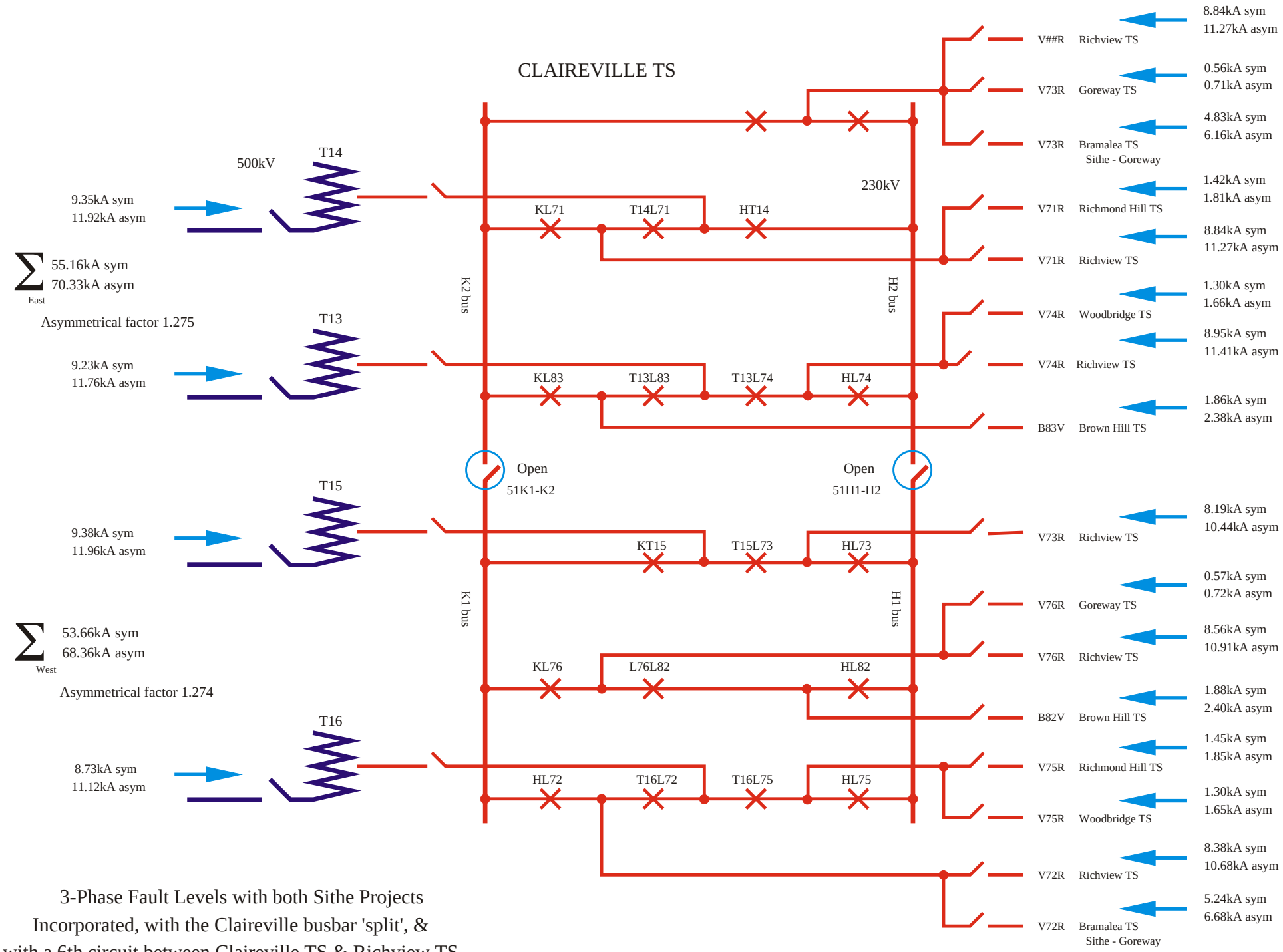


Proposed retermination of the
Richview TS to Claireville TS 230kV Circuits

DIAGRAM 28

19th February 2001


500kV
T16
T15
Location of
Busbar 'Split'
T13
T14
CLAIREVILLE TS
K1 bus
51K1-K2
K2 bus
West
East
HL72
KL76
KL83
KL71
T16L72
L76L82
KT15
T13L83
T14L71
T16L75
T15L73
T13L74
HT14
HL75
HL82
HL73
HL74
Distribution of 230kV
Circuits at Claireville TS
Recommended
Without Bus-tie Reactors
Sithe - Goreway
Project
H1 bus
51H1-H2
H2 bus
230kV
West
V72R
To Bramalea TS
East
V73R
West
V76R
To Goreway TS
East
V73R
B83V
East
B82V
To Brown Hill TS
West
V71R
East
V75R
To Richmond Hill TS
West
V74R
East
V75R
To Woodbridge TS
West
Circuits
Interchanged
DIAGRAM 29
25th February 2001
West
V72R
West
V76R
East
New circuit to
Richview TS
West
V74R
East
V71R
East
V73R
To R I C H V I E W T S

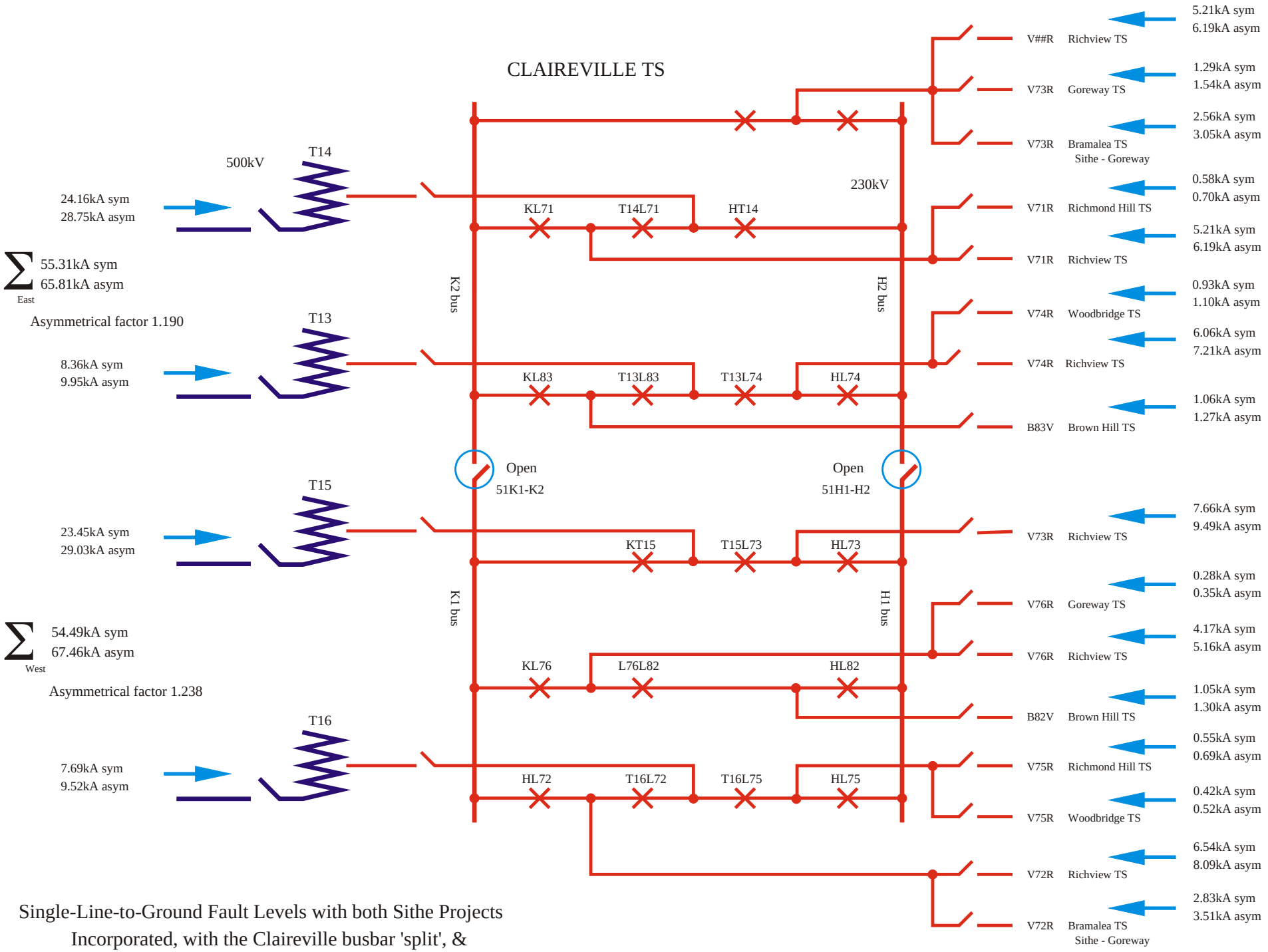


3-Phase Fault Levels with both Sithe Projects Incorporated, with the Claireville busbar 'split', & with a 6th circuit between Claireville TS & Richview TS

Values for a pre-fault voltage of 250kV

DIAGRAM 30

19th February 2001

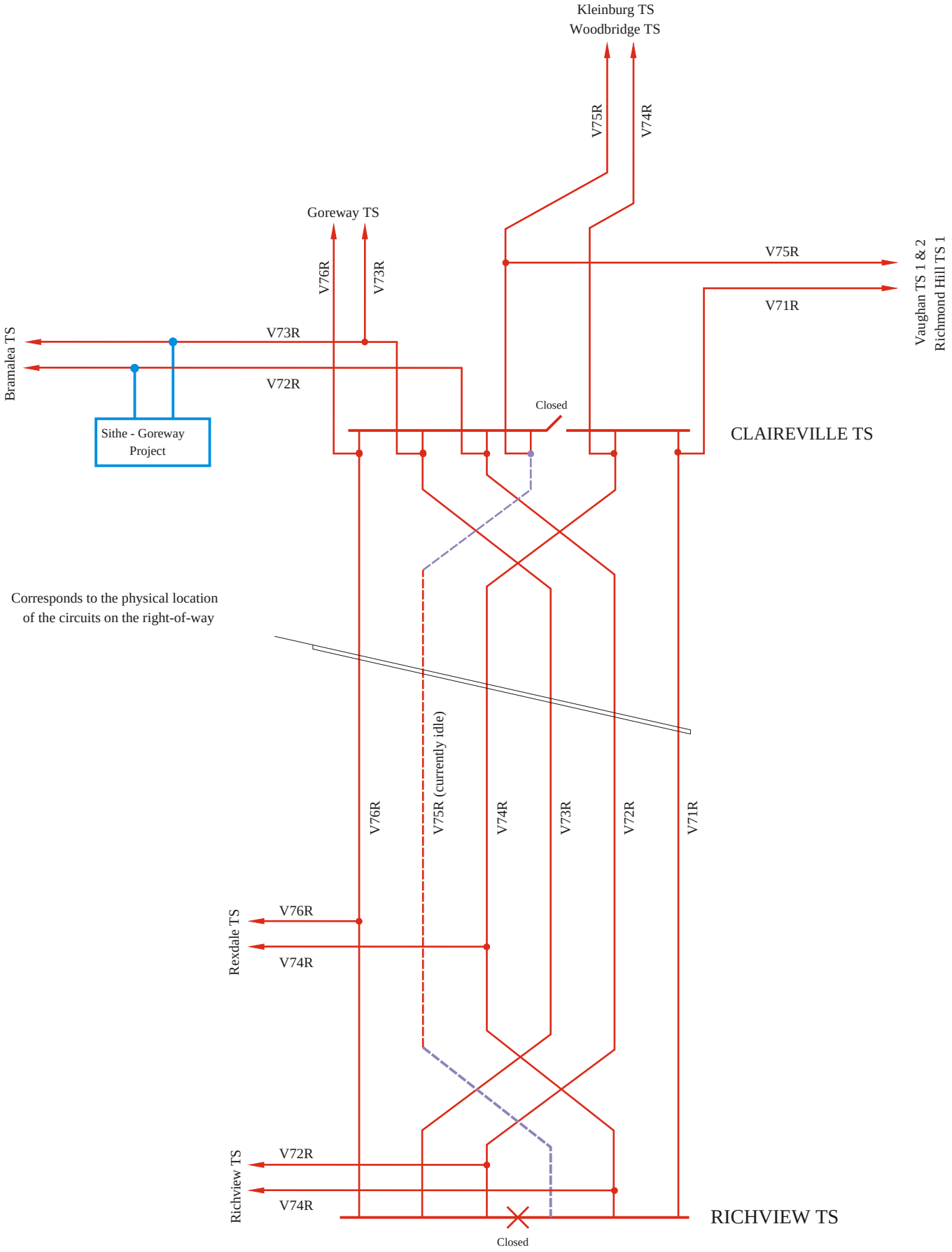


Single-Line-to-Ground Fault Levels with both Sithe Projects Incorporated, with the Claireville busbar 'split', & with a 6th circuit between Claireville TS & Richview TS

Values for a pre-fault voltage of 250kV

DIAGRAM 31

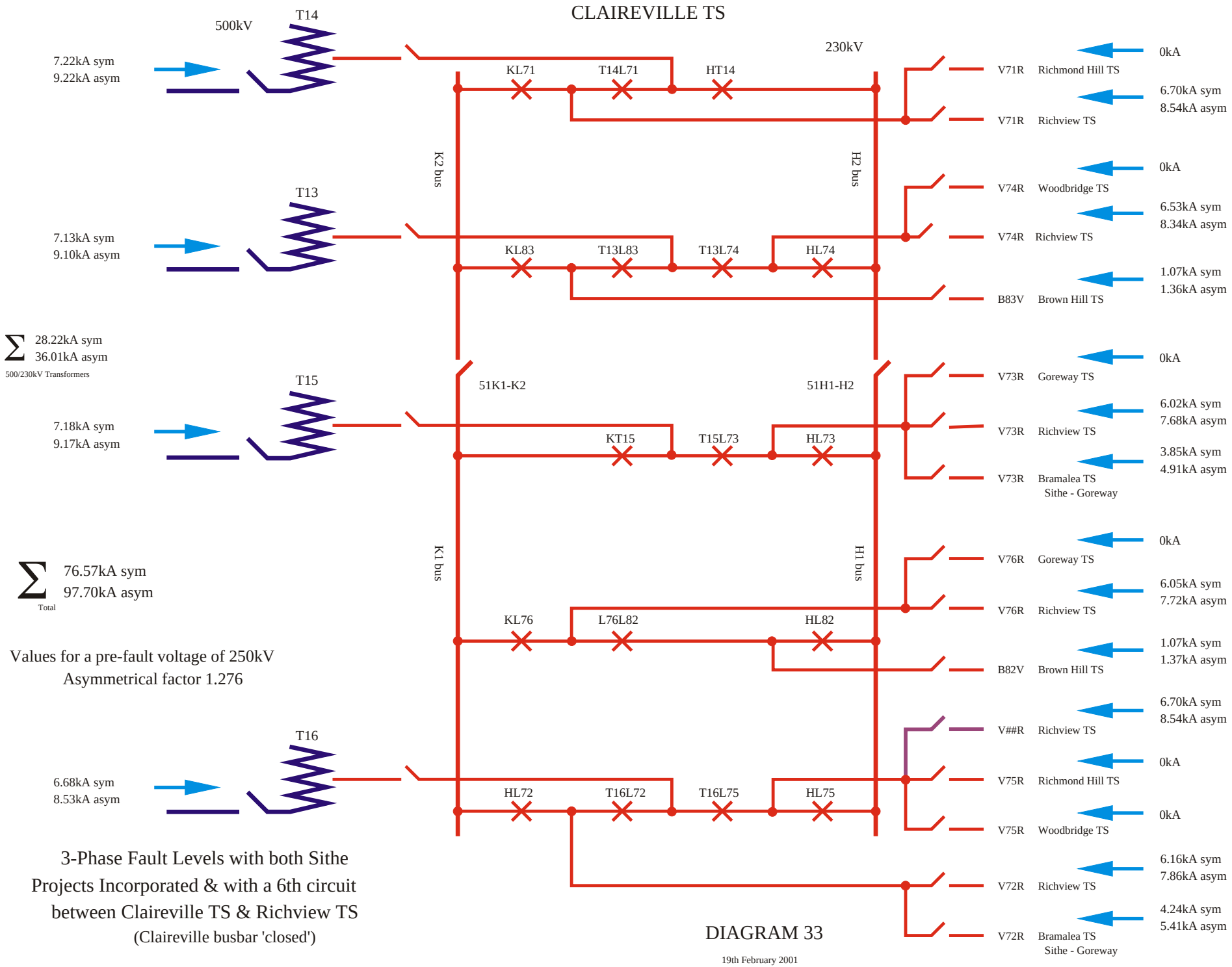
4th March 2001

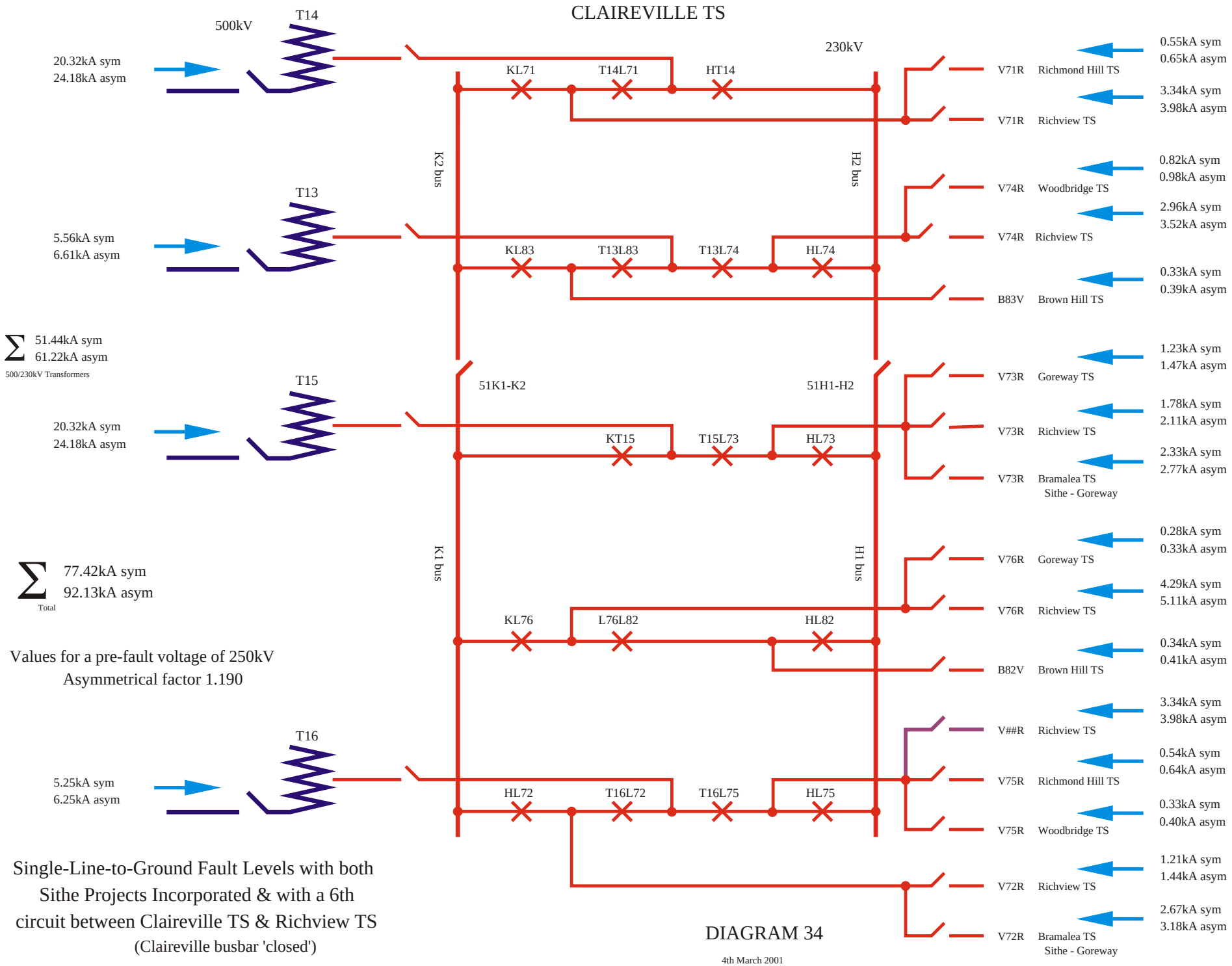


Proposed termination of the idle section of 230kV circuit V75R between Richview TS to Claireville TS

DIAGRAM 32

19th February 2001

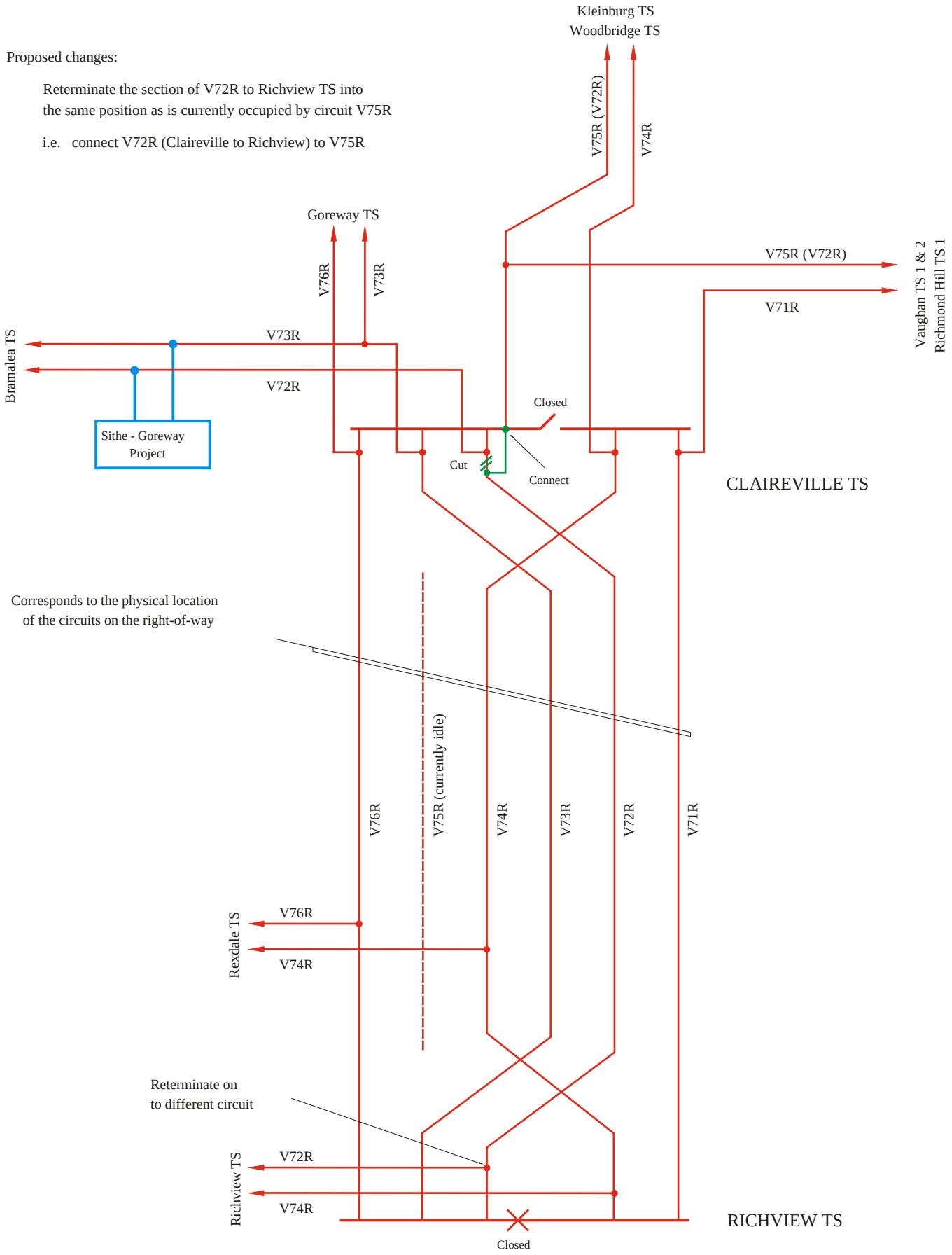

CLAIREVILLE TS
500kV
230kV
T14
7.22kA sym
9.22kA asym
KL71
T14L71
HT14
V71R Richmond Hill TS
0kA
V71R Richview TS
6.70kA sym
8.54kA asym
K2 bus
H2 bus
T13
7.13kA sym
9.10kA asym
KL83
T13L83
T13L74
HL74
V74R Woodbridge TS
0kA
V74R Richview TS
6.53kA sym
8.34kA asym
B83V Brown Hill TS
1.07kA sym
1.36kA asym
Σ 28.22kA sym
36.01kA asym
500/230kV Transformers
T15
51K1-K2
51H1-H2
7.18kA sym
9.17kA asym
KT15
T15L73
HL73
V73R Goreway TS
0kA
V73R Richview TS
6.02kA sym
7.68kA asym
V73R Bramalea TS
Sithe - Goreway
3.85kA sym
4.91kA asym
Σ 76.57kA sym
97.70kA asym
Total
K1 bus
H1 bus
KL76
L76L82
HL82
V76R Goreway TS
0kA
V76R Richview TS
6.05kA sym
7.72kA asym
B82V Brown Hill TS
1.07kA sym
1.37kA asym
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.276
T16
6.68kA sym
8.53kA asym
HL72
T16L72
T16L75
HL75
V##R Richview TS
6.70kA sym
8.54kA asym
V75R Richmond Hill TS
0kA
V75R Woodbridge TS
0kA
3-Phase Fault Levels with both Sithe
Projects Incorporated & with a 6th circuit
between Claireville TS & Richview TS
(Claireville busbar 'closed')
V72R Richview TS
6.16kA sym
7.86kA asym
V72R Bramalea TS
Sithe - Goreway
4.24kA sym
5.41kA asym
DIAGRAM 33
19th February 2001


CLAIREVILLE TS
500kV
230kV
T14
T13
T15
T16
20.32kA sym
24.18kA asym
5.56kA sym
6.61kA asym
20.32kA sym
24.18kA asym
5.25kA sym
6.25kA asym
KL71
T14L71
HT14
KL83
T13L83
T13L74
HL74
51K1-K2
51H1-H2
KT15
T15L73
HL73
KL76
L76L82
HL82
HL72
T16L72
T16L75
HL75
K2 bus
H2 bus
K1 bus
H1 bus
V71R Richmond Hill TS
0.55kA sym
0.65kA asym
V71R Richview TS
3.34kA sym
3.98kA asym
V74R Woodbridge TS
0.82kA sym
0.98kA asym
V74R Richview TS
2.96kA sym
3.52kA asym
B83V Brown Hill TS
0.33kA sym
0.39kA asym
V73R Goreway TS
1.23kA sym
1.47kA asym
V73R Richview TS
1.78kA sym
2.11kA asym
V73R Bramalea TS
Sithe - Goreway
2.33kA sym
2.77kA asym
V76R Goreway TS
0.28kA sym
0.33kA asym
V76R Richview TS
4.29kA sym
5.11kA asym
B82V Brown Hill TS
0.34kA sym
0.41kA asym
V##R Richview TS
3.34kA sym
3.98kA asym
V75R Richmond Hill TS
0.54kA sym
0.64kA asym
V75R Woodbridge TS
0.33kA sym
0.40kA asym
V72R Richview TS
1.21kA sym
1.44kA asym
V72R Bramalea TS
Sithe - Goreway
2.67kA sym
3.18kA asym
Σ 51.44kA sym
61.22kA asym
500/230kV Transformers
Σ 77.42kA sym
92.13kA asym
Total
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.190
Single-Line-to-Ground Fault Levels with both Sithe Projects Incorporated & with a 6th circuit between Claireville TS & Richview TS
(Claireville busbar 'closed')
DIAGRAM 34
4th March 2001

Proposed changes:

Reterminate the section of V72R to Richview TS into the same position as is currently occupied by circuit V75R

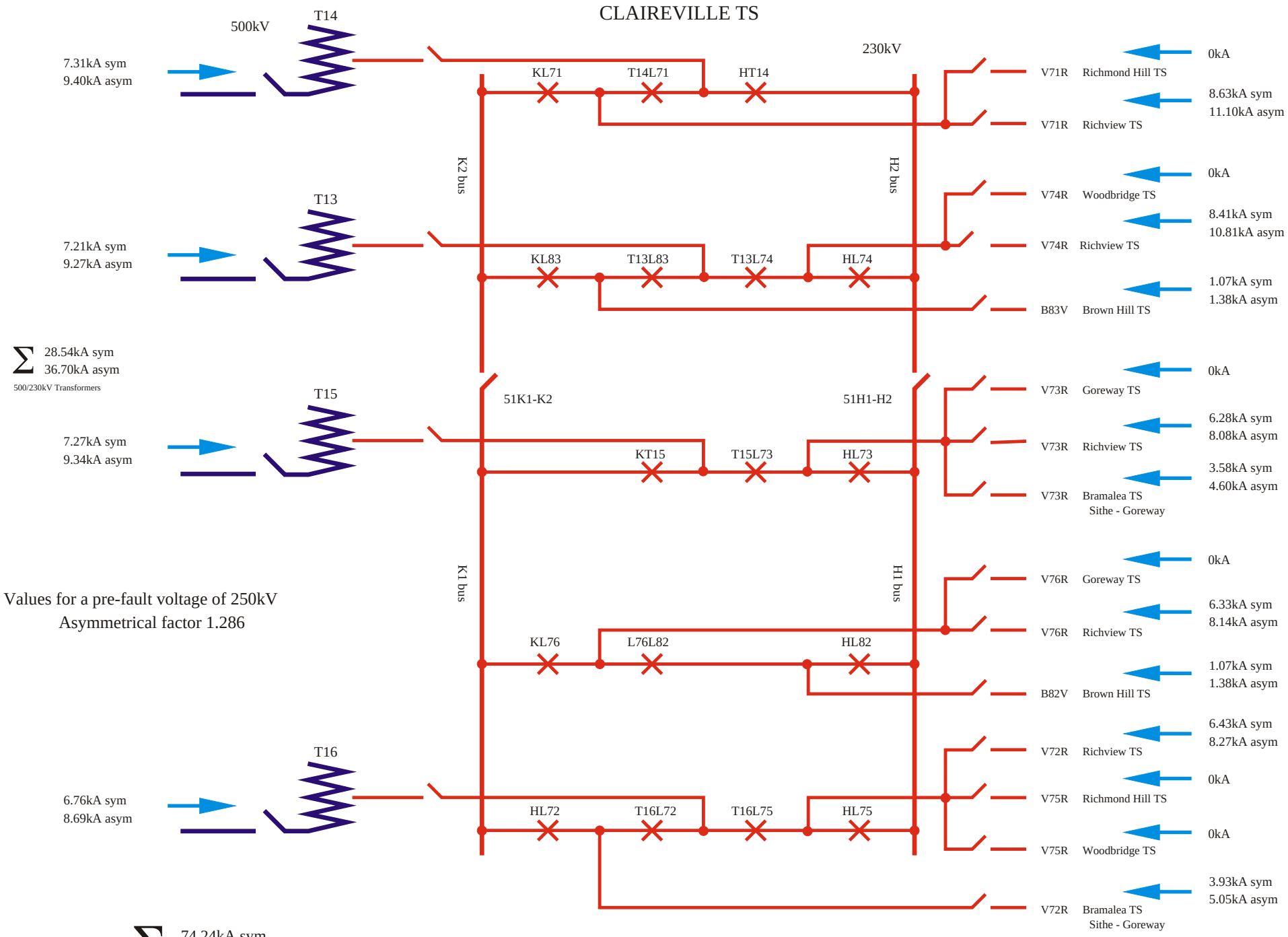
i.e. connect V72R (Claireville to Richview) to V75R



Proposed retermination of circuit V72R between Richview TS to Claireville TS on to circuit V75R

DIAGRAM 35

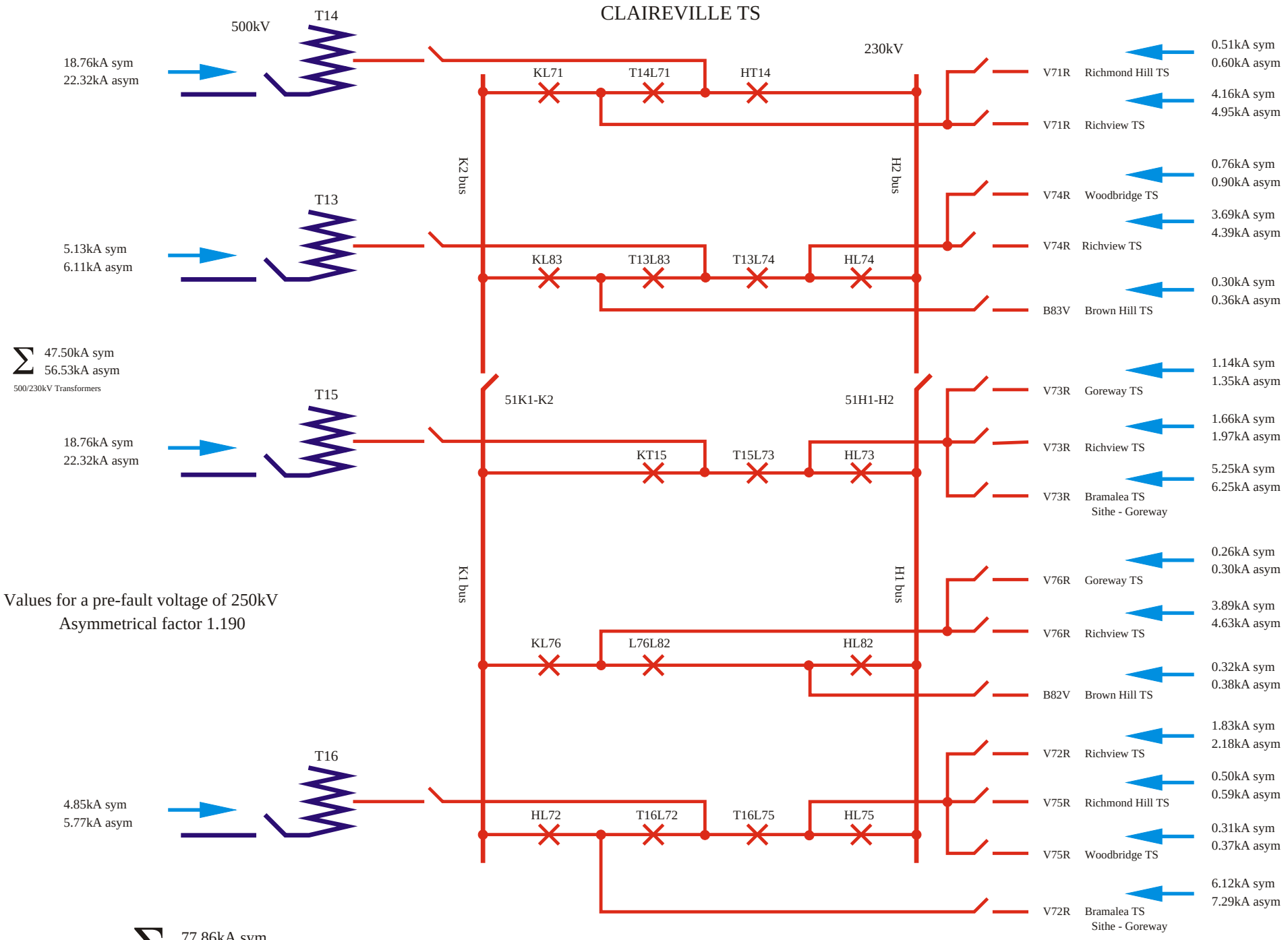
19th February 2001



3-Phase Fault Levels with both
Sithe Projects Incorporated
(With series-reactors at the Goreway Project)

DIAGRAM 36

19th February 2001



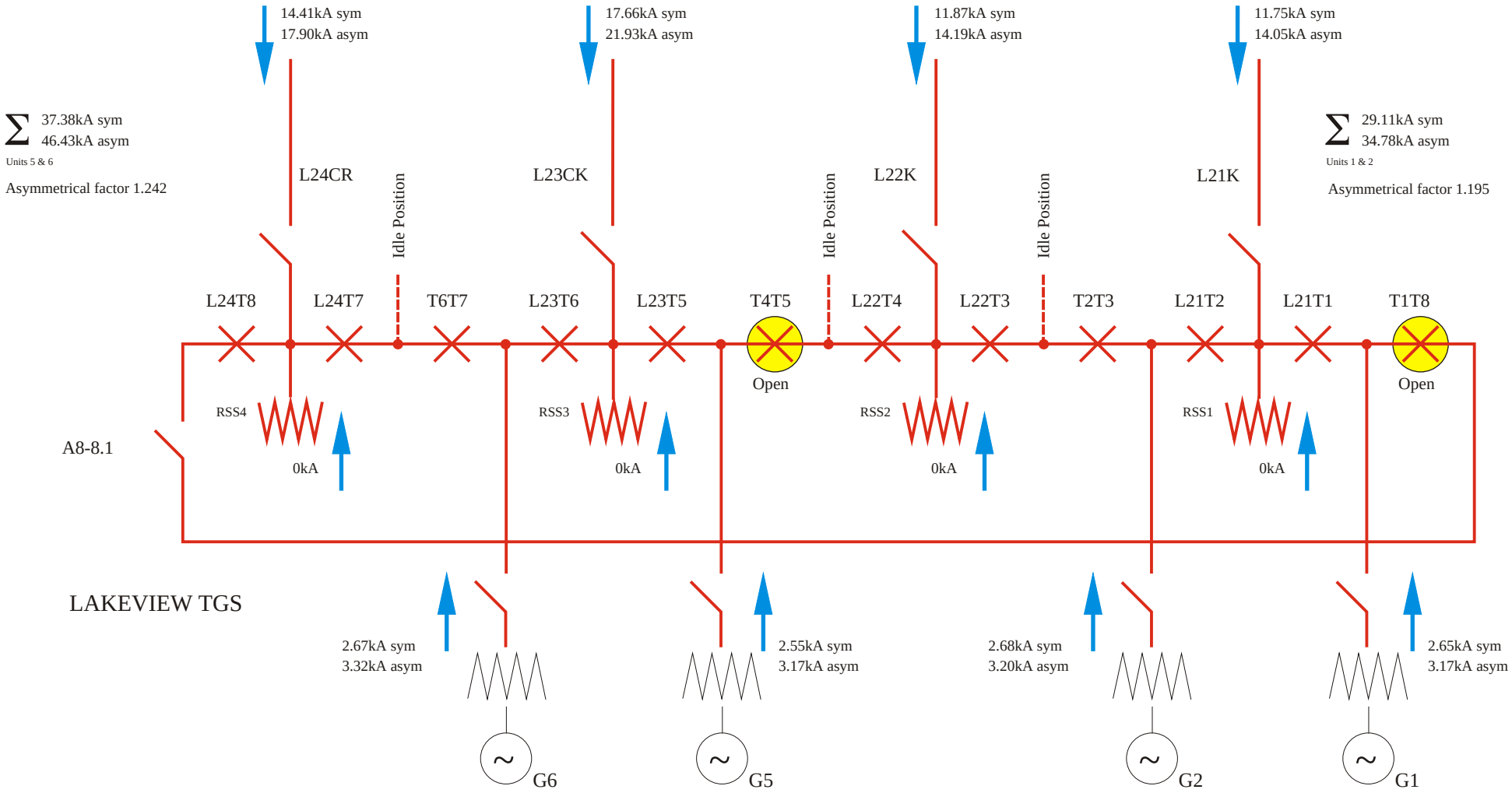
Values for a pre-fault voltage of 250kV
Asymmetrical factor 1.190

Σ 77.86kA sym
92.65kA asym
Total

Single-Line-to Ground Fault Levels
with both Sithe Projects Incorporated
(With series-reactors on the Goreway Project)

DIAGRAM 37

19th February 2001



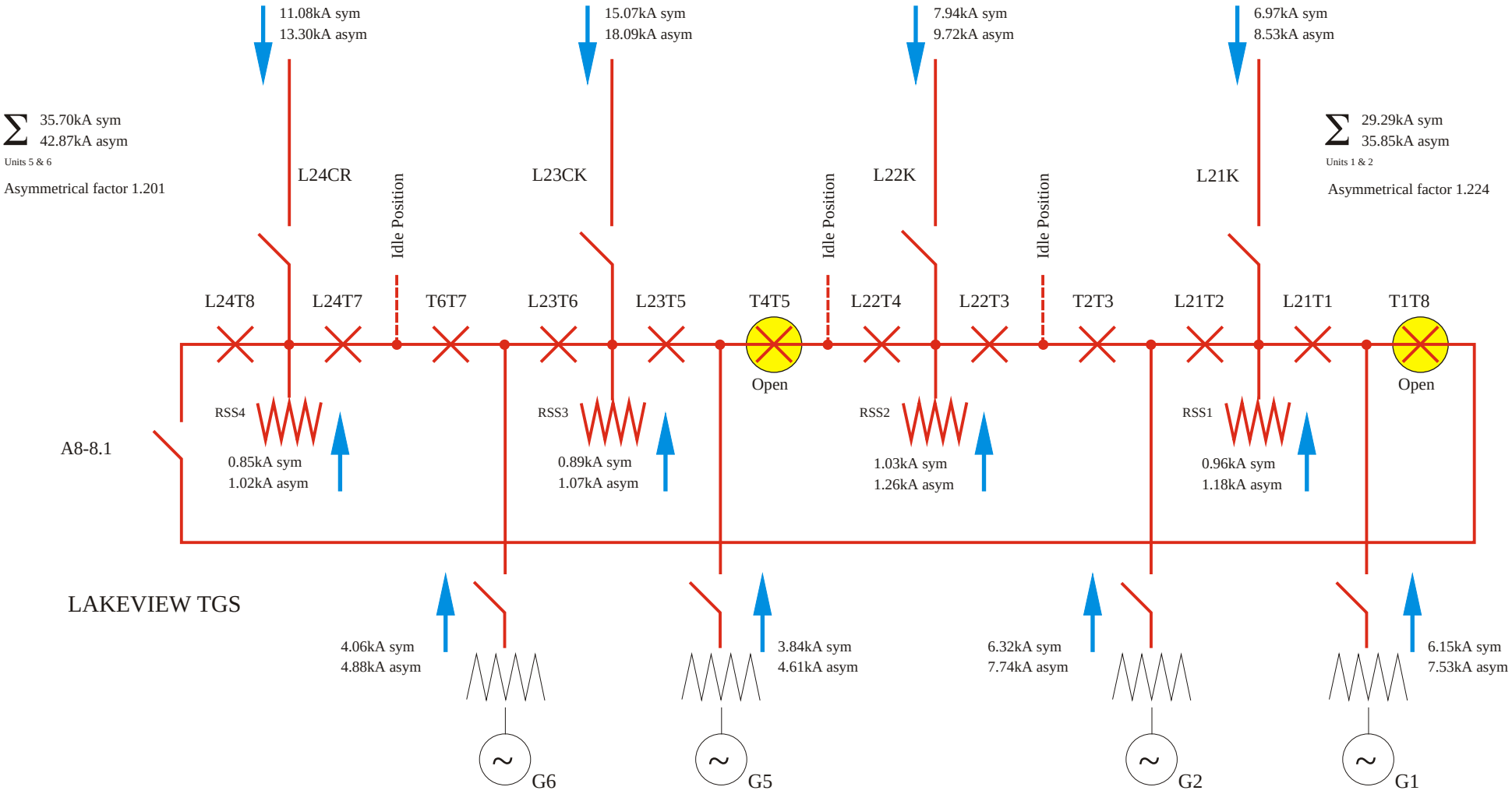
3-Phase Fault Levels with both
Sithe Projects Incorporated

'Horizontal' Split of Lakeview Busbar
(With series-reactors on the Goreway Project)

Values for a pre-fault voltage of 250kV

DIAGRAM 38

19th February 2001



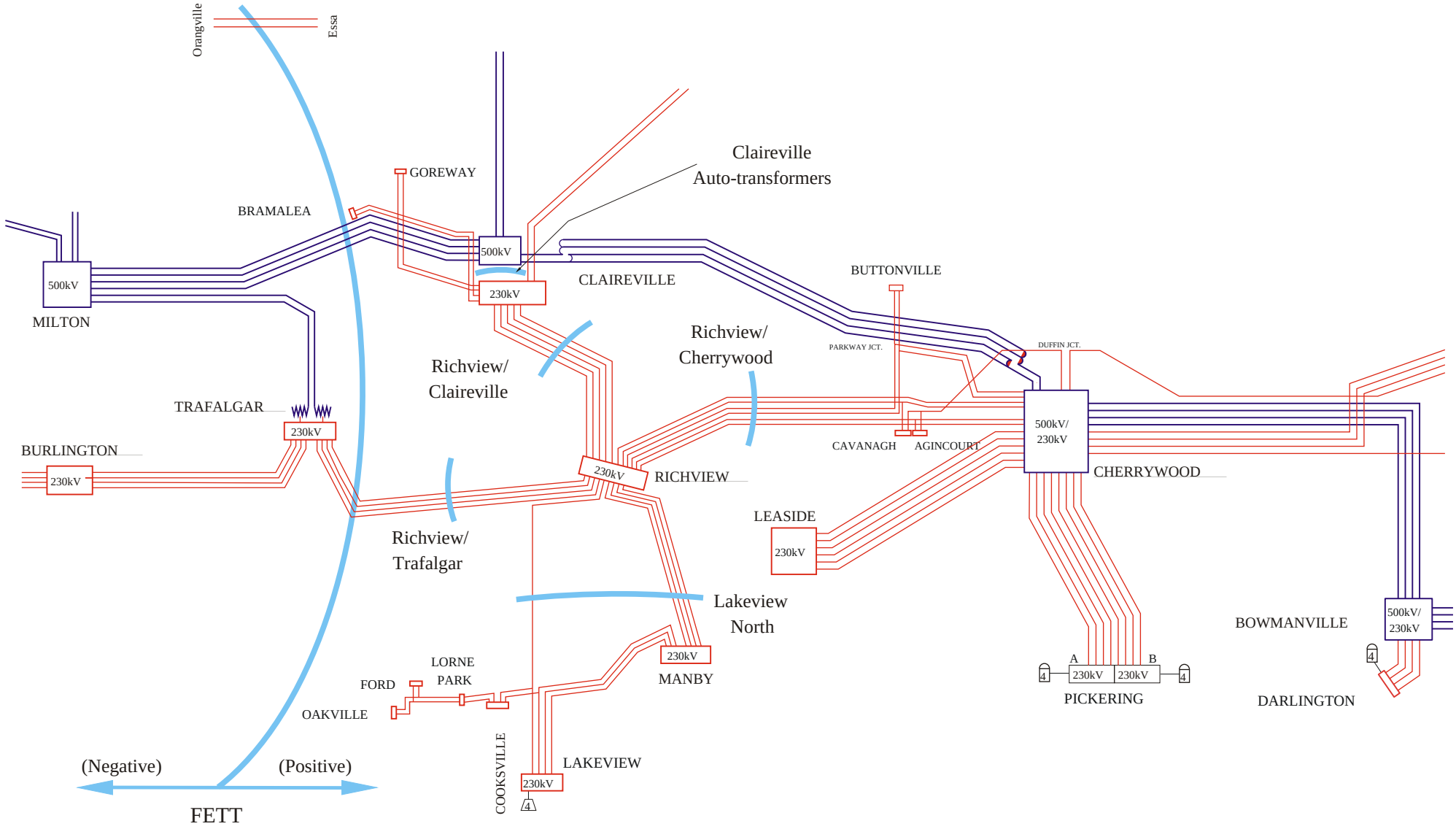
Single Line-to-Ground Fault Levels with
both Sithe Projects Incorporated

'Horizontal' Split of Lakeview Busbar
(With series-reactors on the Goreway Project)

Values for a pre-fault voltage of 250kV

DIAGRAM 39

19th February 2001

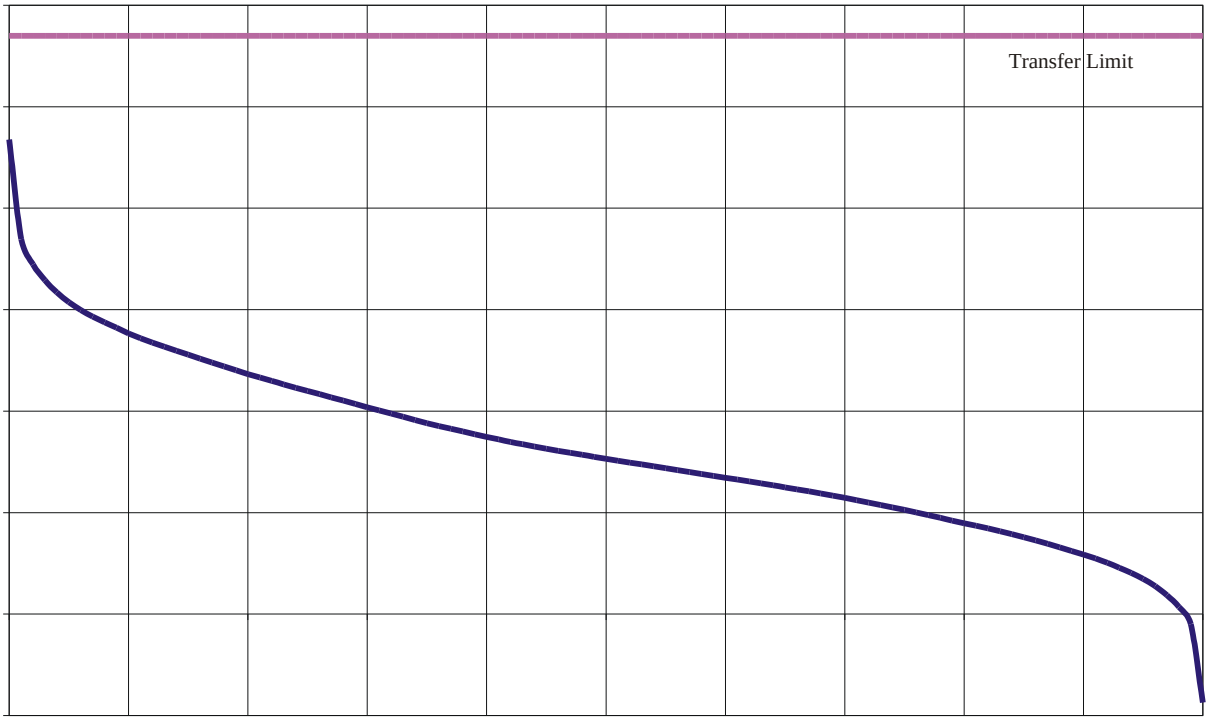


Principal Interfaces for the Sithe Assessment

DIAGRAM 40

27th February 2001

FETT Transfers for 1999



FETT Transfers for 2000

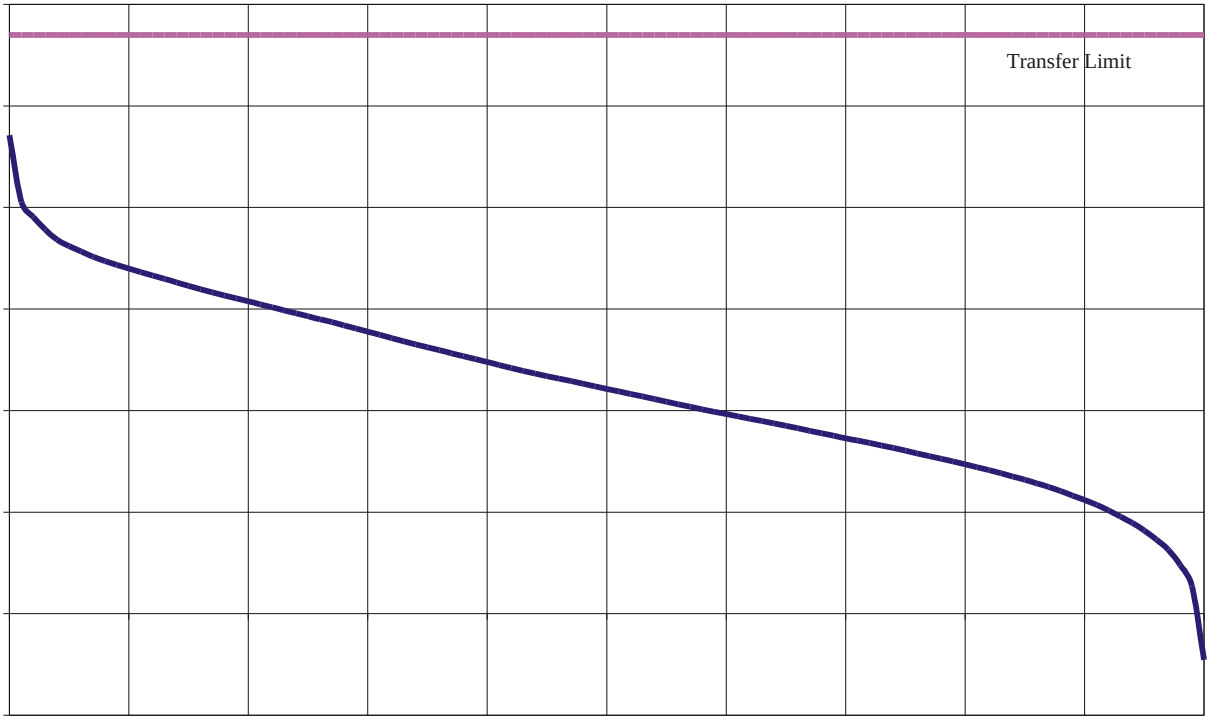
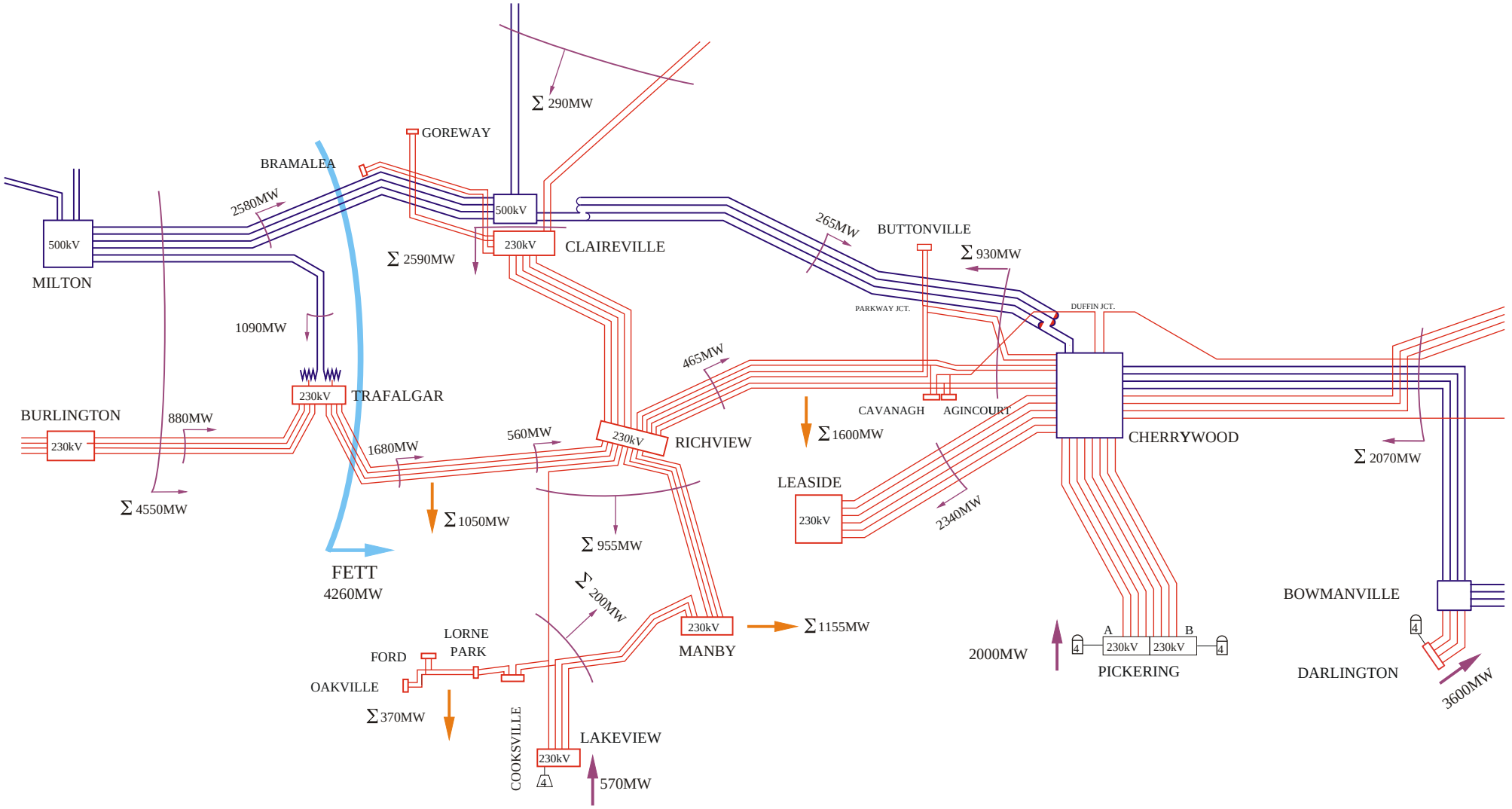


DIAGRAM 41

19th February 2001

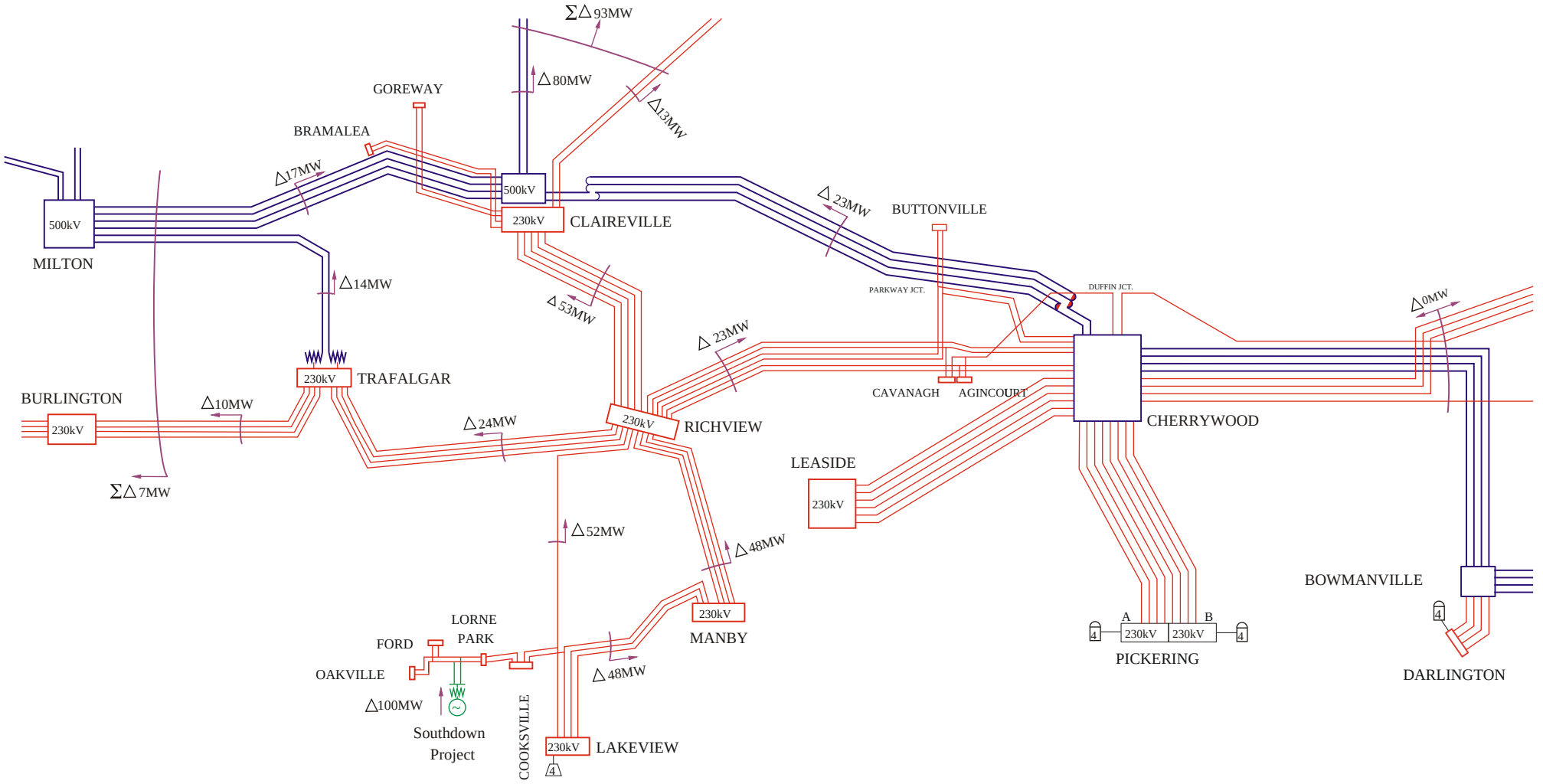


Flow Distribution for High FETT (Flow East To Toronto) Case

With No Sithe Projects In-service

DIAGRAM 42

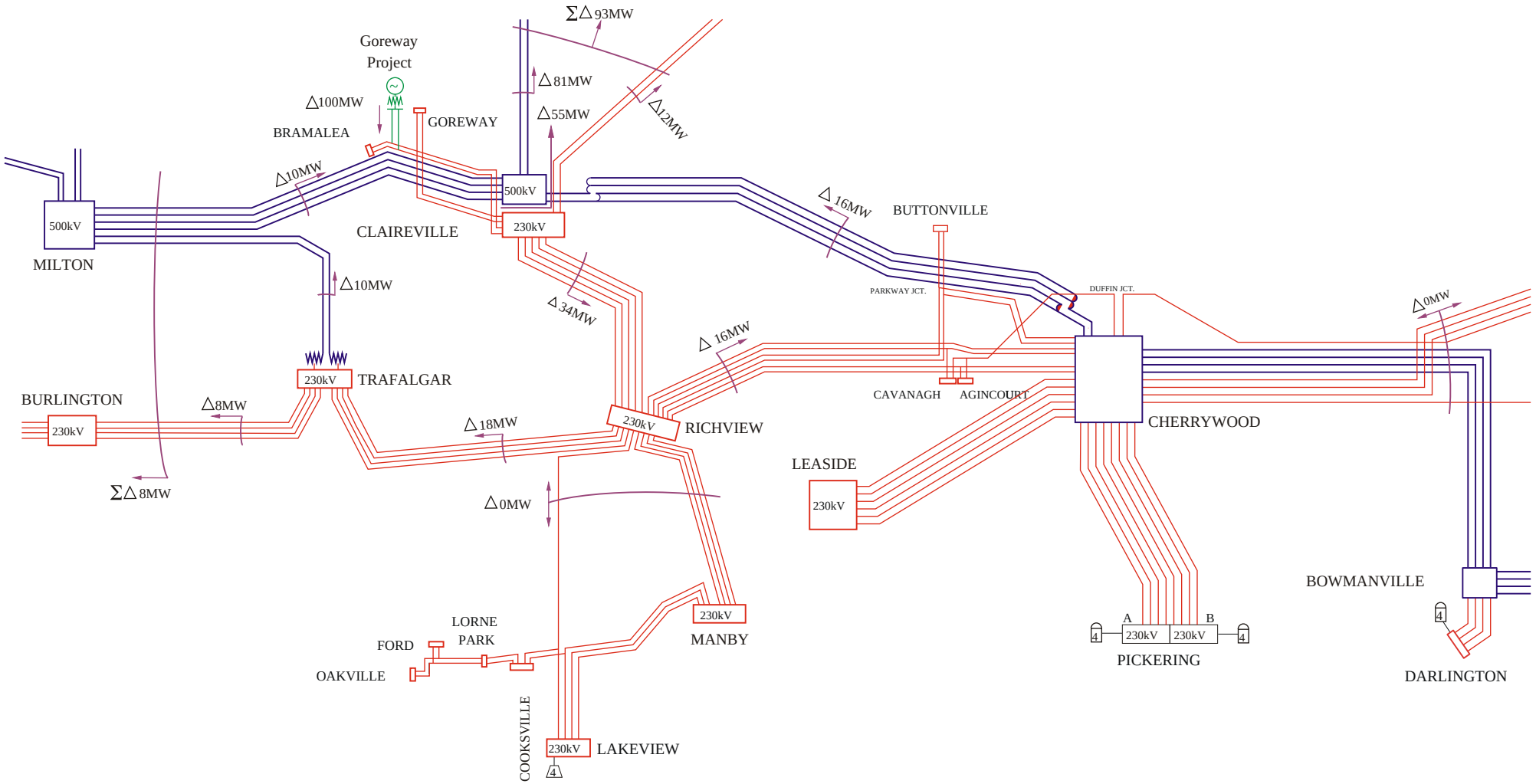
25th February 2001



Incremental Changes in Flow Distribution for each
100MW output from the Sithe - Southdown Project

DIAGRAM 43

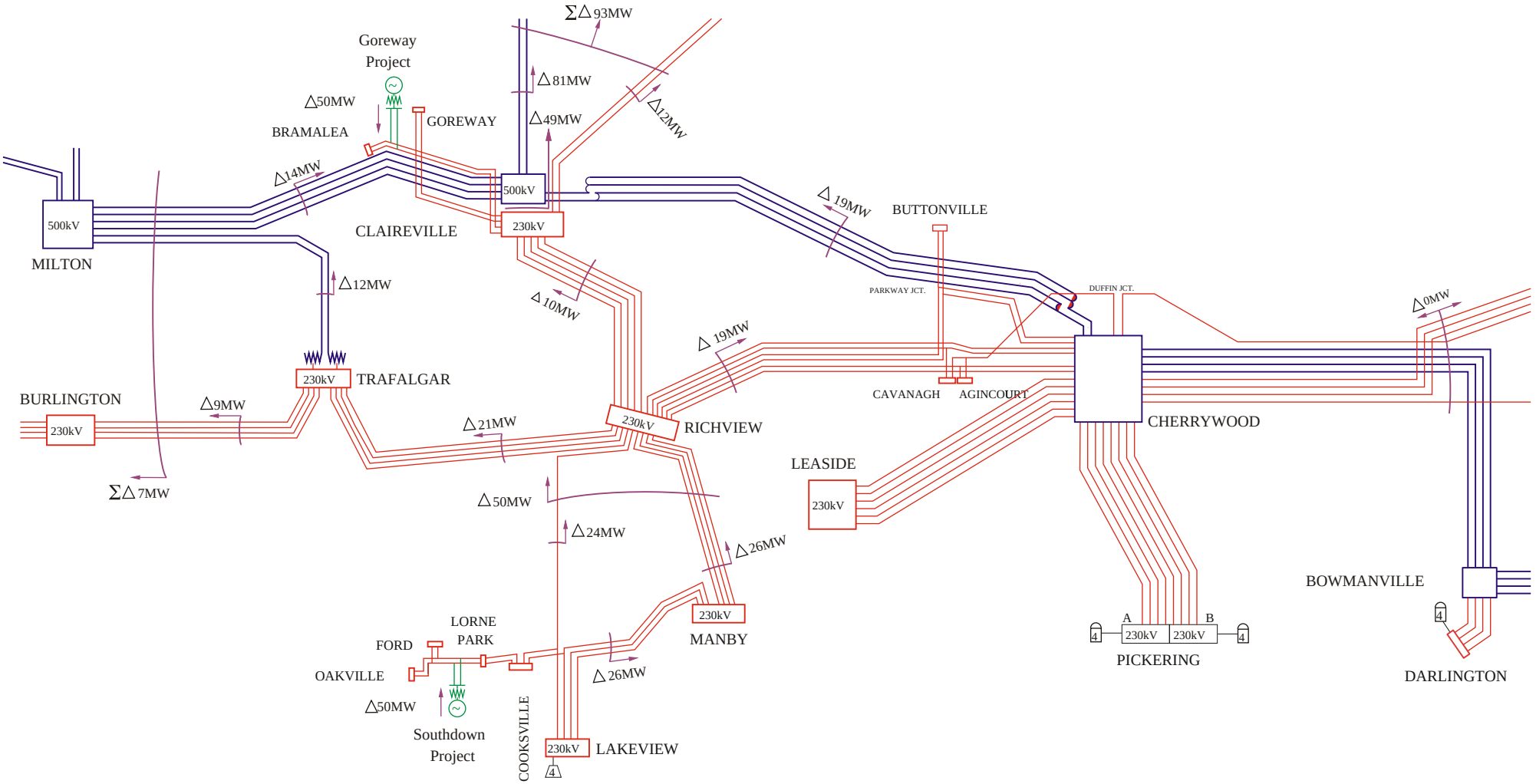
25th February 2001



Incremental Changes in Flow Distribution for each
100MW output from the Sithe - Goreway Project

DIAGRAM 44

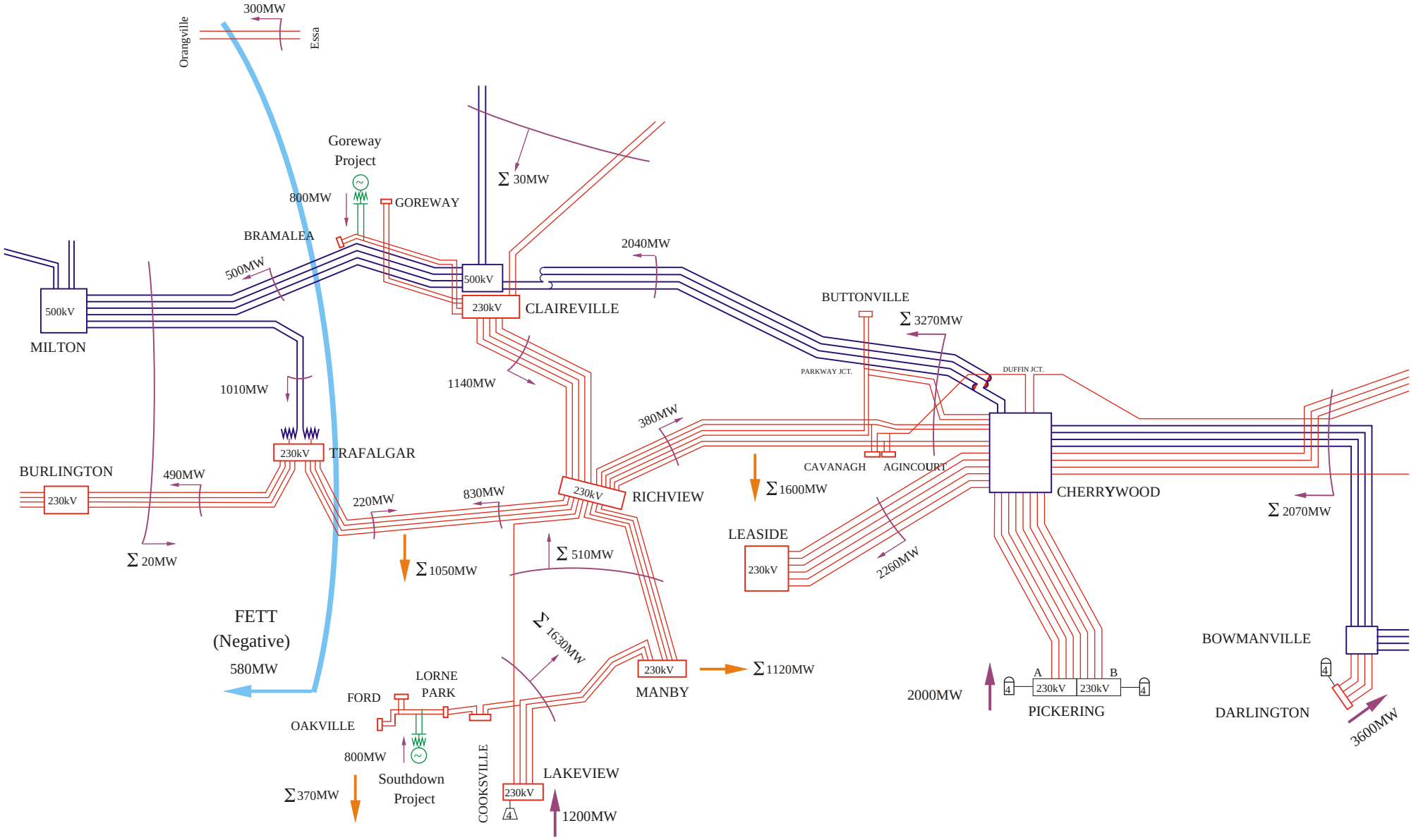
25th February 2001



Incremental Changes in Flow Distribution for each
100MW of combined output from the two Sithe Projects
(50MW from each Project)

DIAGRAM 45

25th February 2001

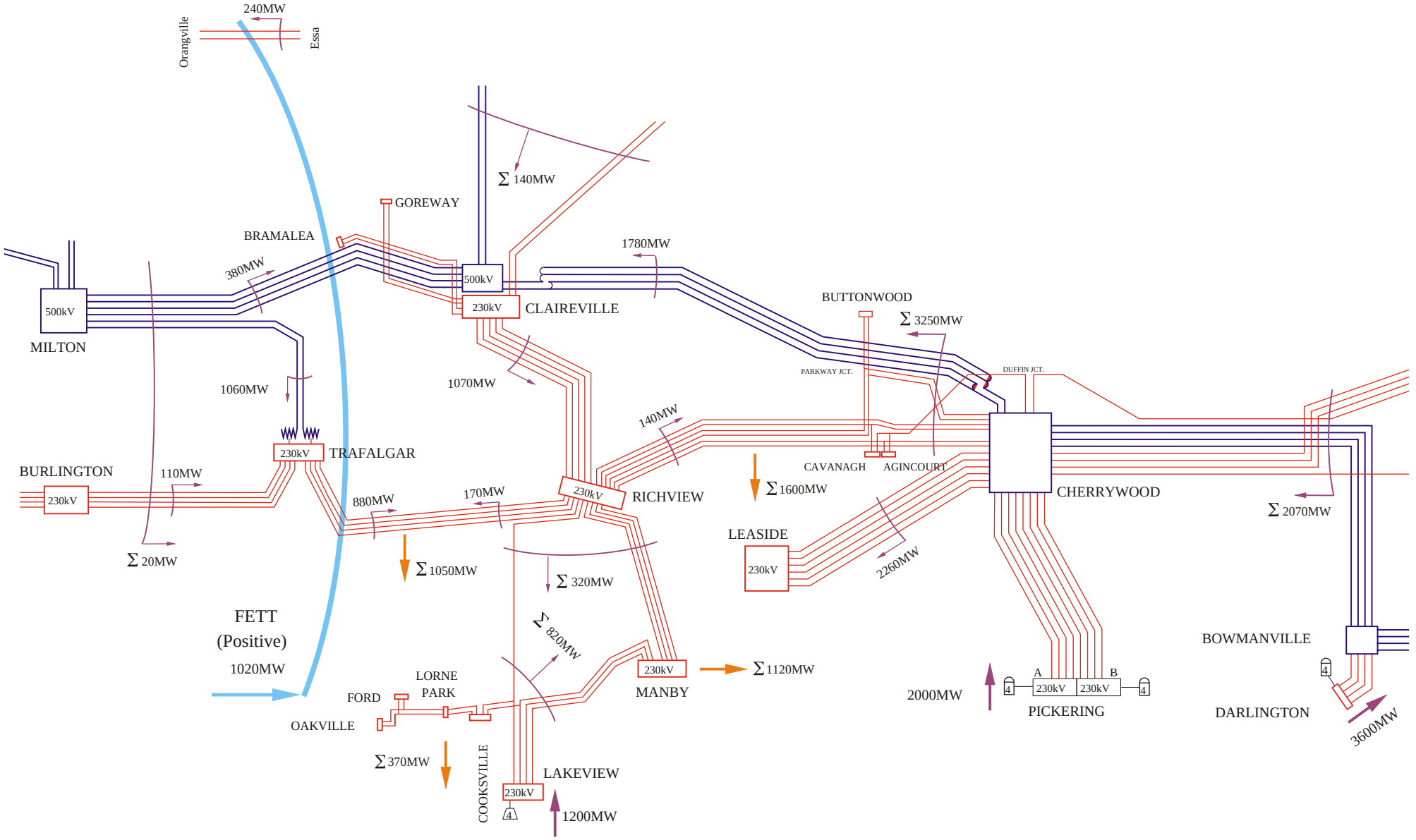


Flow Distribution for Negative FETT (Flow East To Toronto) Case

With Both Sithe Projects In-service

DIAGRAM 46

25th February 2001



Flow Distribution for Negative FETT (Flow East To Toronto) Case

With No Sithe Projects In-service

DIAGRAM 47

25th February 2001

SITHE: Southdown Project

Transfer Capability on the Lakeview North Interface

With a Horizontal 'Split' of the Lakeview 230kV Busbar

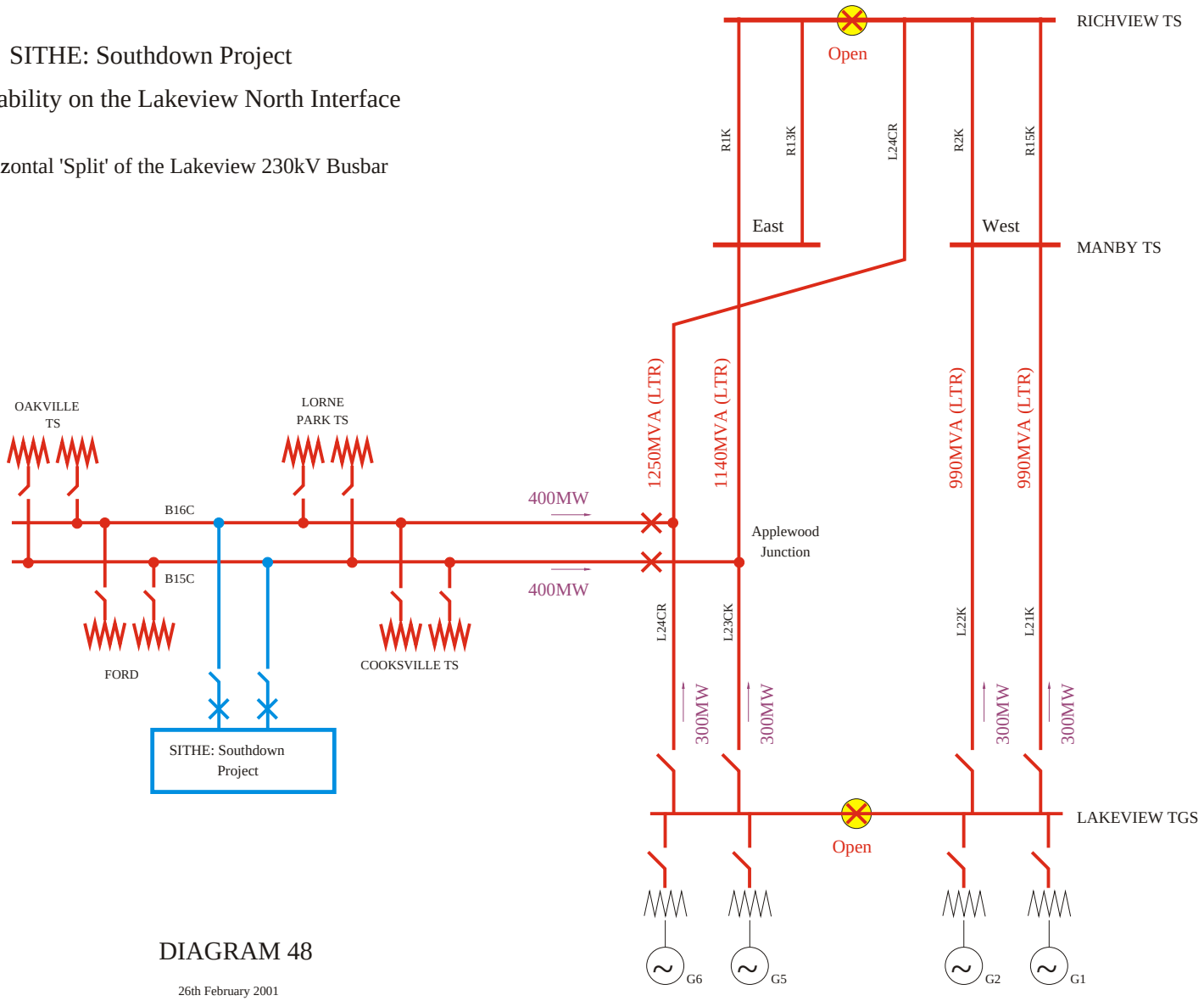


DIAGRAM 48

26th February 2001

SITHE: Southdown Project

Transfer Capability on the Lakeview North Interface

With a Vertical 'Split' of the Lakeview 230kV Busbar

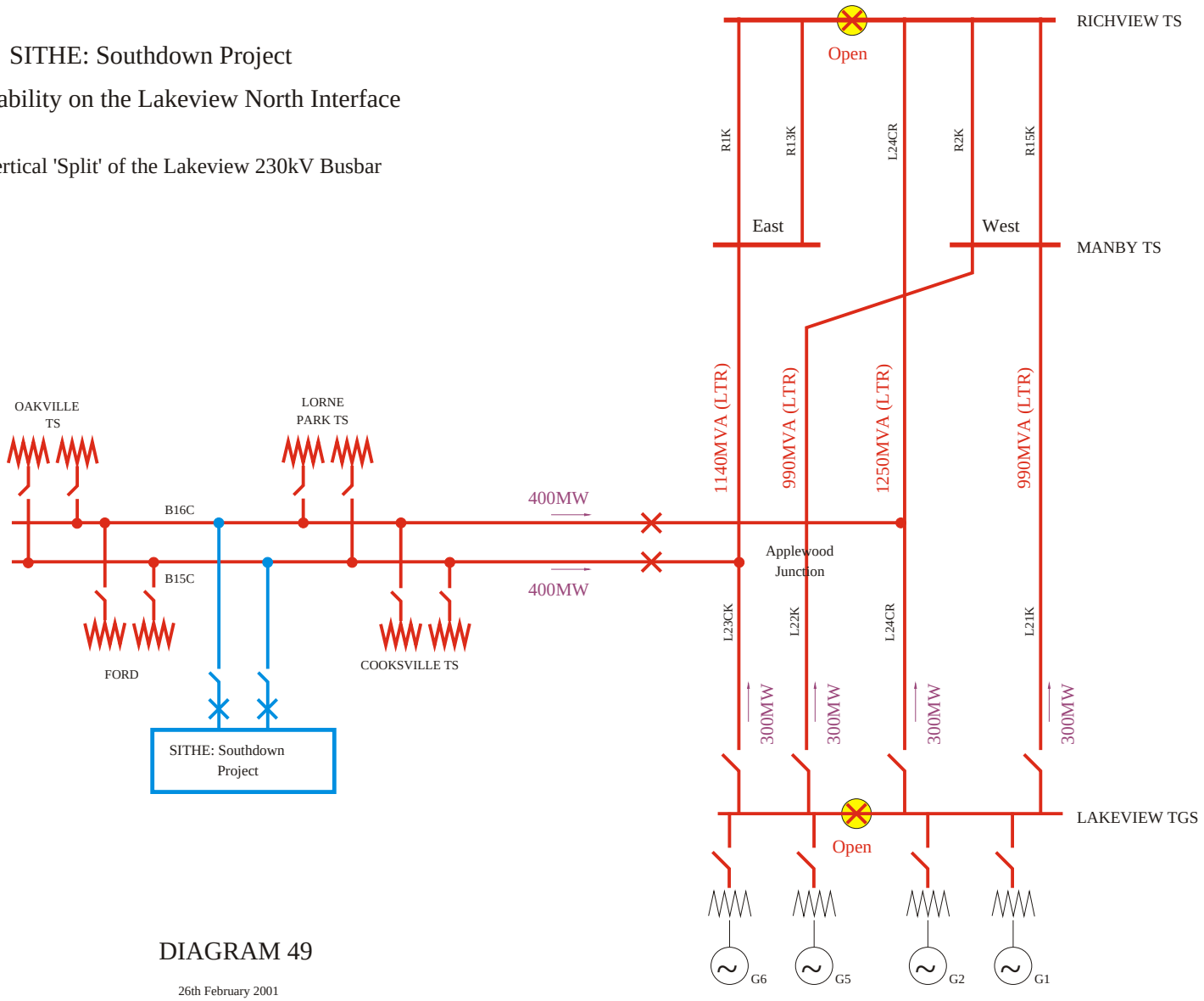
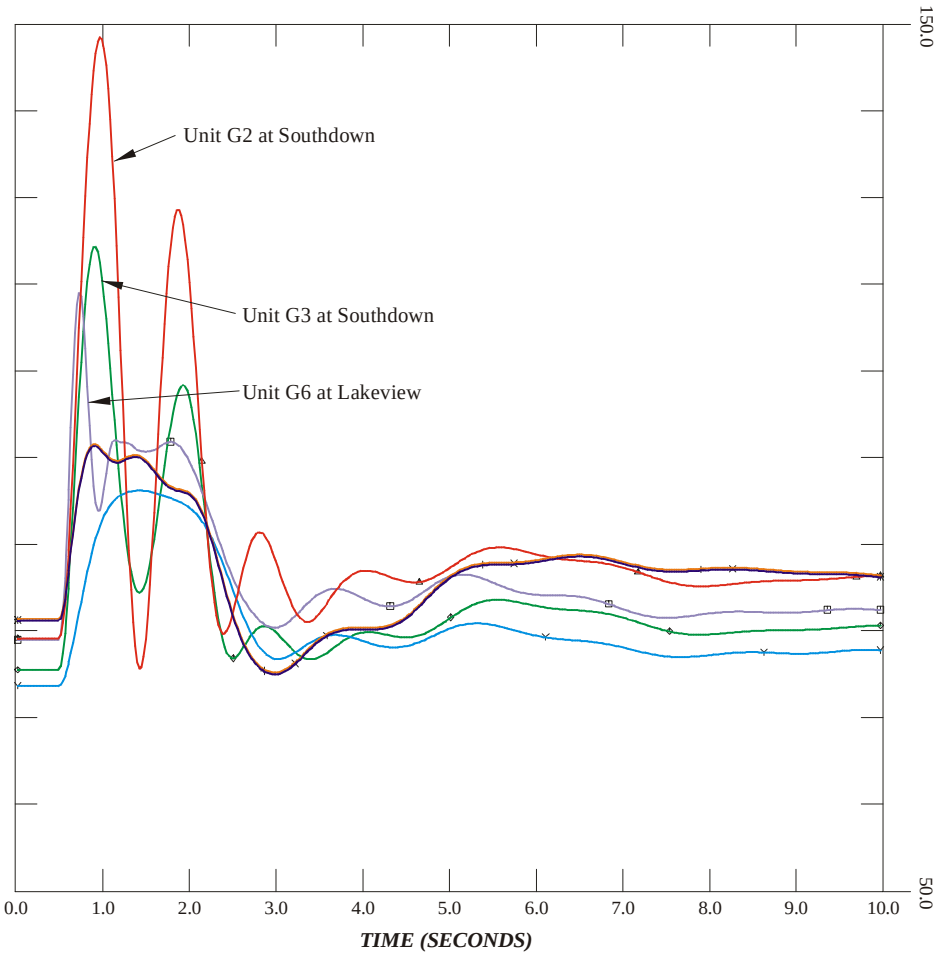


DIAGRAM 49

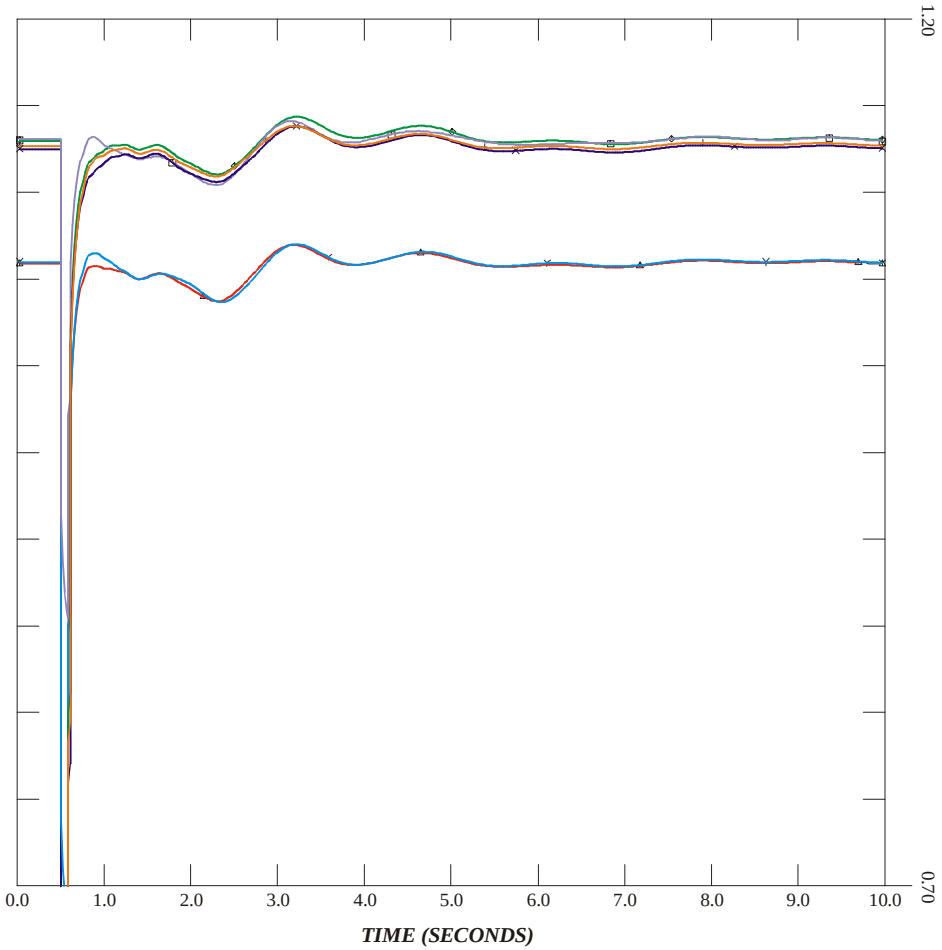
26th February 2001

THREE-PHASE FAULT ON CIRCUIT L23CK AT MANBY TS - Cleared Normally:
No Generation Rejection at the Sithe-Southdown facility



GENERATOR ANGLES - degrees

- BRUCE 'B' G8
- SITHE GOREWAY G4
- SITHE GOREWAY G3
- SITHE SOUTHDOWN G3
- SITHE SOUTHDOWN G2
- LAKEVIEW G6



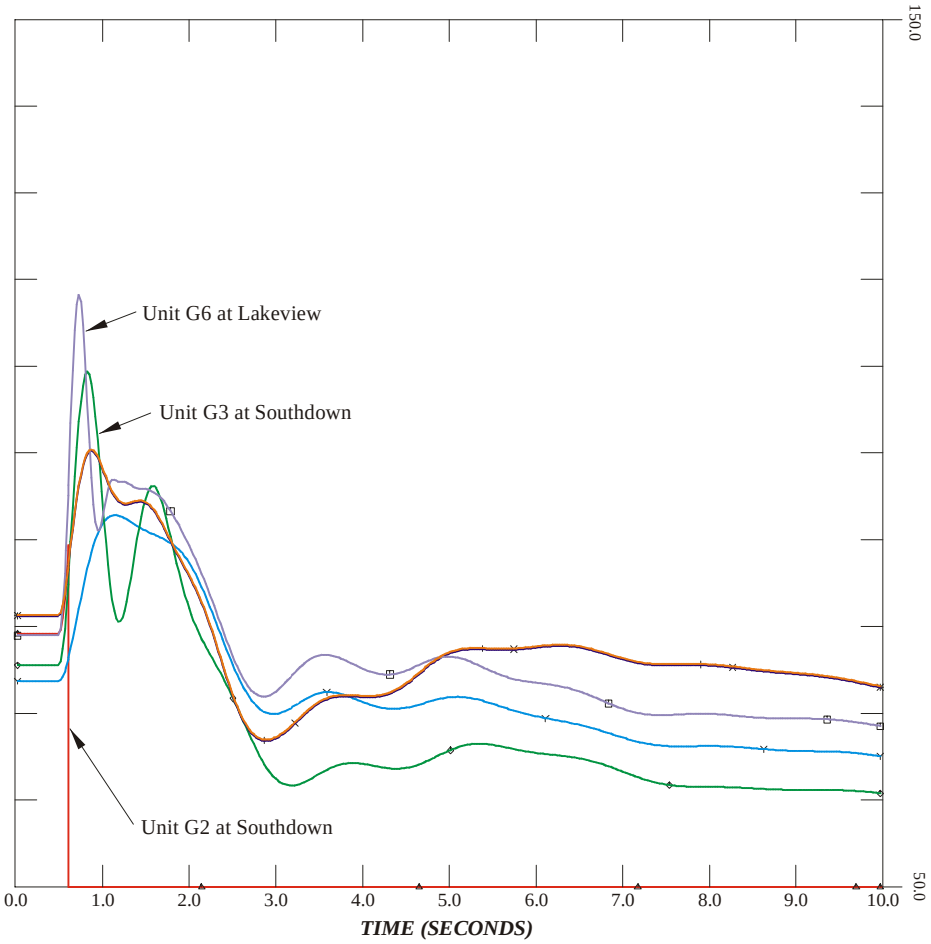
BUS VOLTAGES - p.u.

- CHERRYWOOD 500kV
- RICHVIEW 230kV
- LAKEVIEW CR12 230kV
- CLAIREVILLE 230kV
- MILTON 500kV
- BRUCE A 230kV

DIAGRAM 50

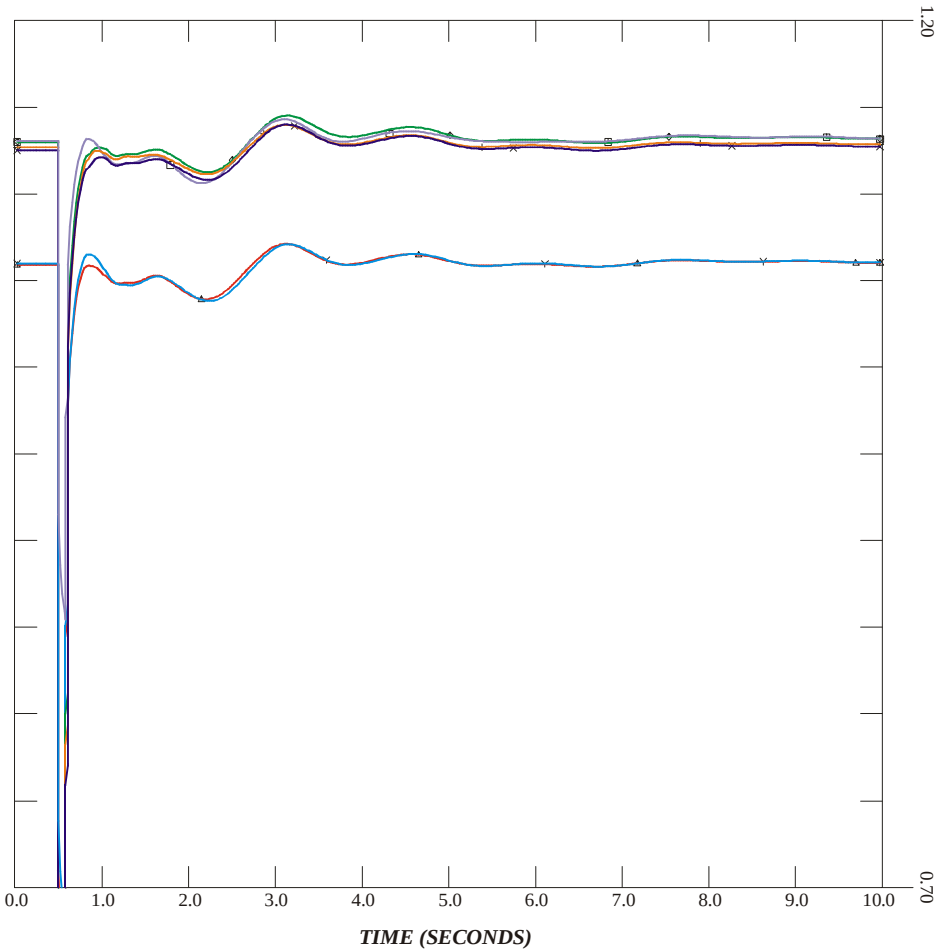
23rd February 2001

THREE-PHASE FAULT ON CIRCUIT L23CK AT MANBY TS - Cleared Normally:
With Unit G2 At Sithe-Southdown Rejected



GENERATOR ANGLES - degrees

- BRUCE 'B' G8
- SITHE GOREWAY G4
- SITHE GOREWAY G3
- SITHE SOUTHDOWN G3
- SITHE SOUTHDOWN G2
- LAKEVIEW G6



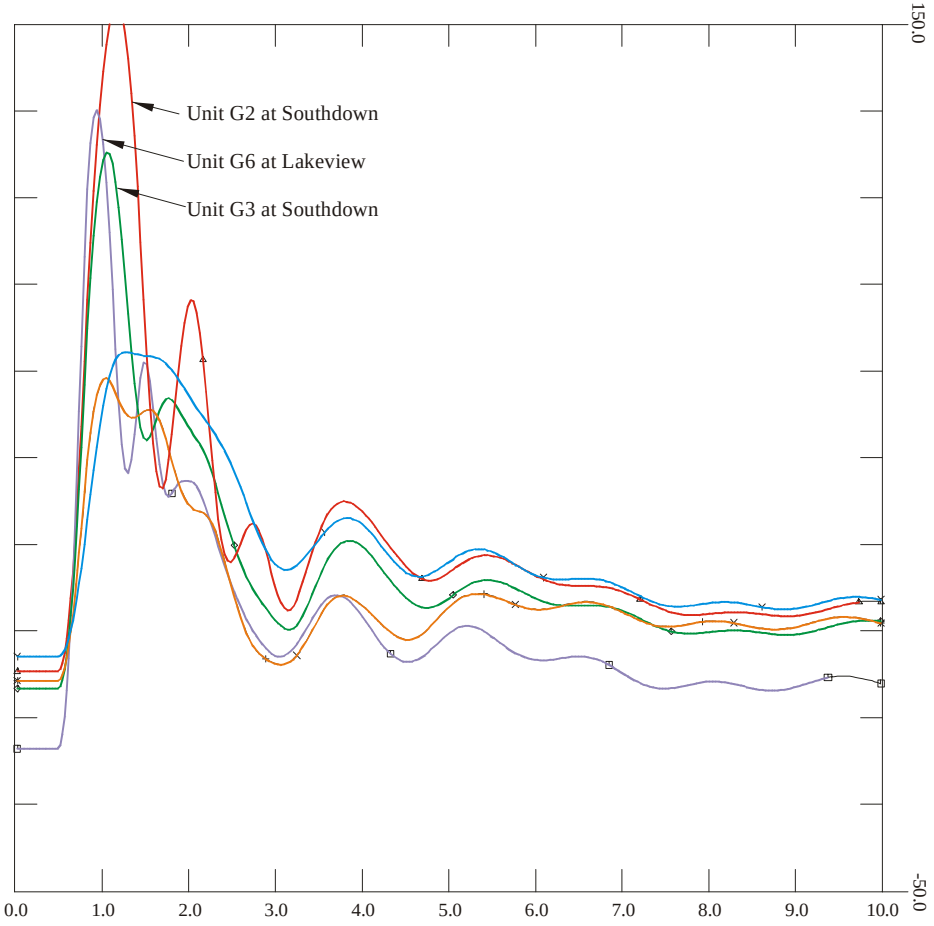
BUS VOLTAGES - p.u.

- CHERRYWOOD 500kV
- RICHVIEW 230kV
- LAKEVIEW CR12 230kV
- CLAIREVILLE 230kV
- MILTON 500kV
- BRUCE A 230kV

DIAGRAM 51

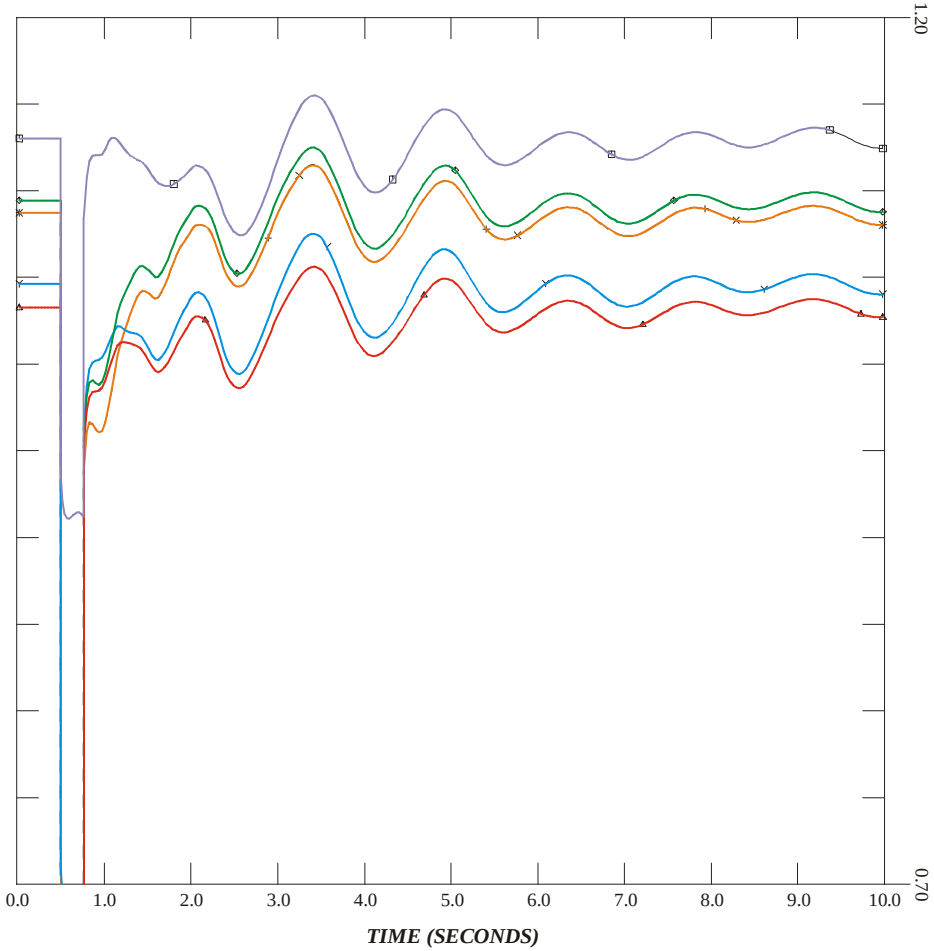
23rd February 2001

THREE-PHASE FAULT ON THE H2 BUSBAR AT MANBY EAST TS - Cleared Normally
With circuit breaker L21L23 out-of-service under Light Load Conditions -
Results in an LEO condition on circuit L23CK at Manby TS



GENERATOR ANGLES - degrees

BRUCE 'B' G8
SITHE GOREWAY G4
SITHE GOREWAY G4
SITHE SOUTHDOWN G3
SITHE SOUTHDOWN G2
LAKEVIEW G6



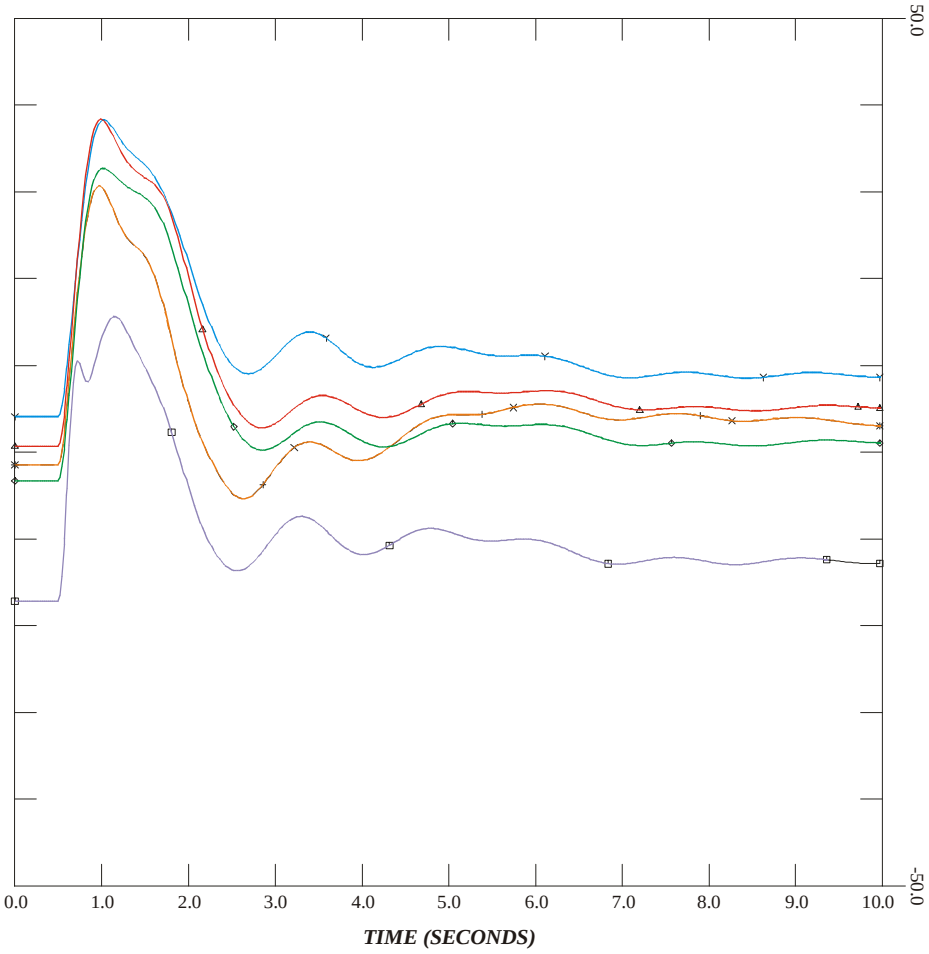
BUS VOLTAGES - p.u.

CHERRYWOOD 500kV
RICHVIEW 230
LAKEVIEW CR12 230kV
CLAIREVILLE 230kV
MILTON 500kV
BRUCE A 230kV

DIAGRAM 52

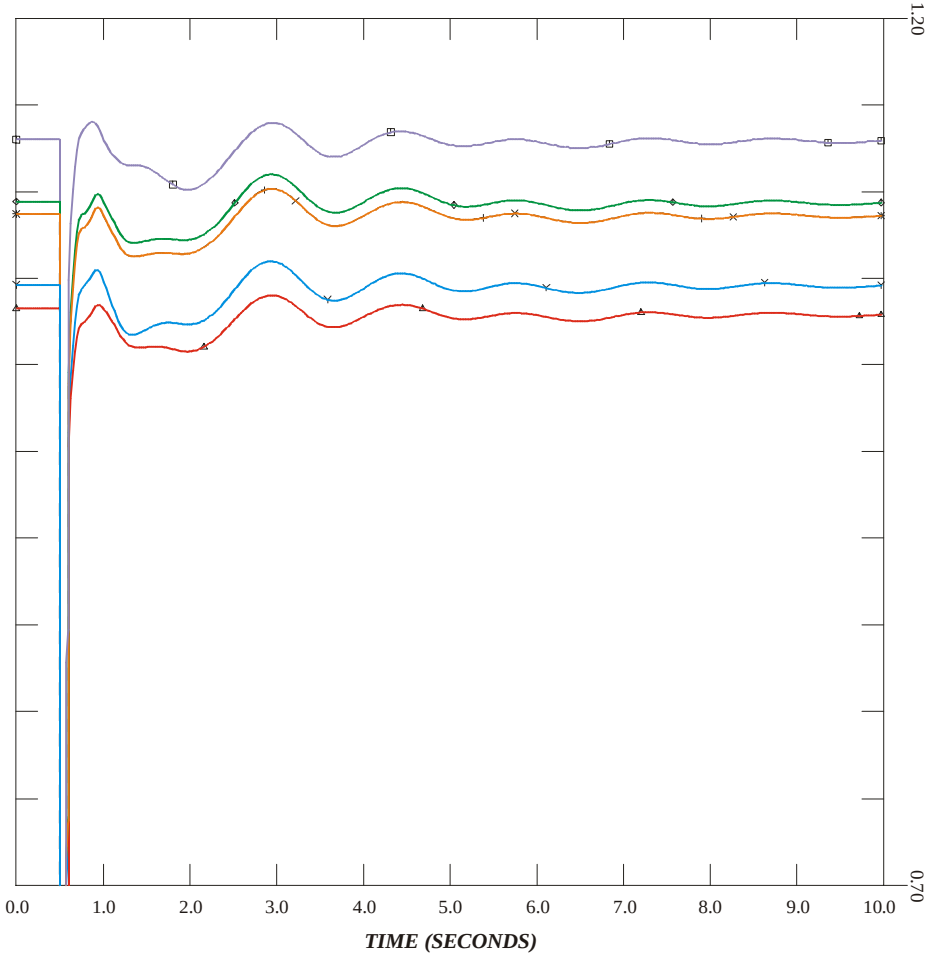
23rd February 2001

THREE-PHASE FAULT ON 500kV CIRCUIT M570V AT CLAIREVILLE TS - Cleared Normally:
4000MW FETT Case (IMPORT)



GENERATOR ANGLES - degrees

- BRUCE 'B' G8
- SITHE GOREWAY G4
- SITHE GOREWAY G3
- SITHE SOUTHDOWN G3
- SITHE SOUTHDOWN G2
- LAKEVIEW G6



BUSBAR VOLTAGES - p.u.

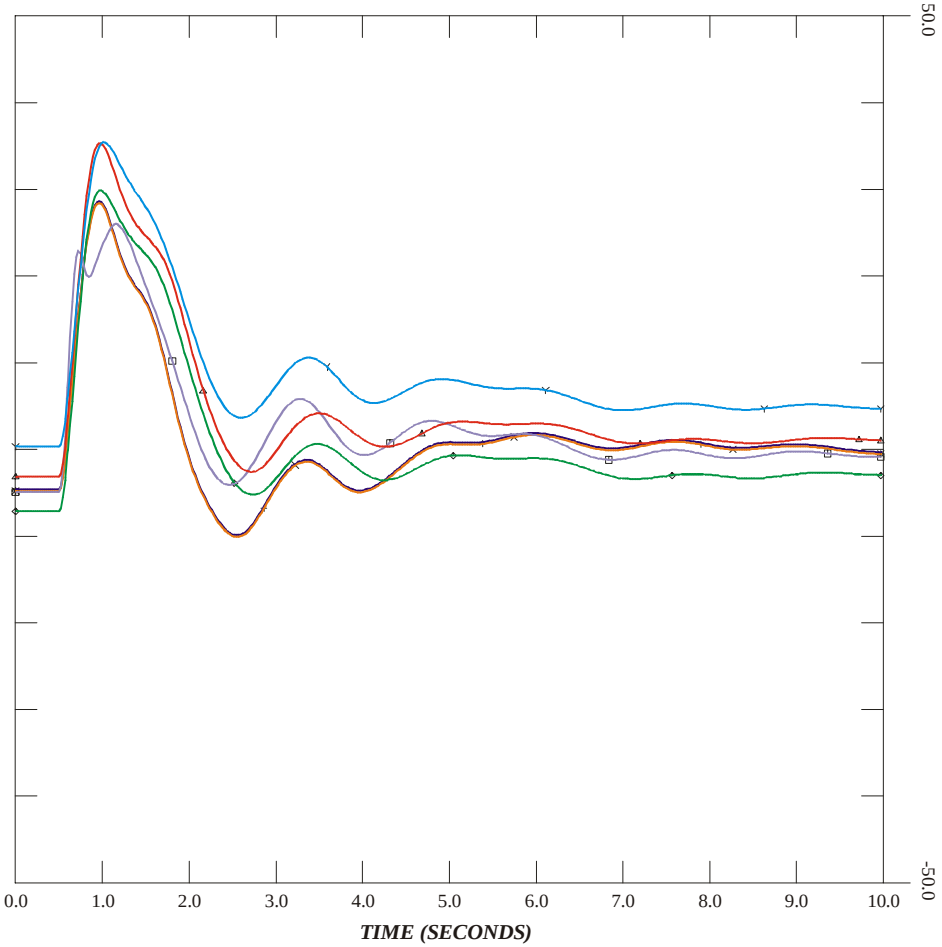
- CHERRYWOOD 500kV
- RICHVIEW 230kV
- LAKEVIEW CR12 230kV
- CLAIREVILLE 230kV
- MILTON 500kV
- BRUCE 'A' 230kV

DIAGRAM 53

23rd February 2001

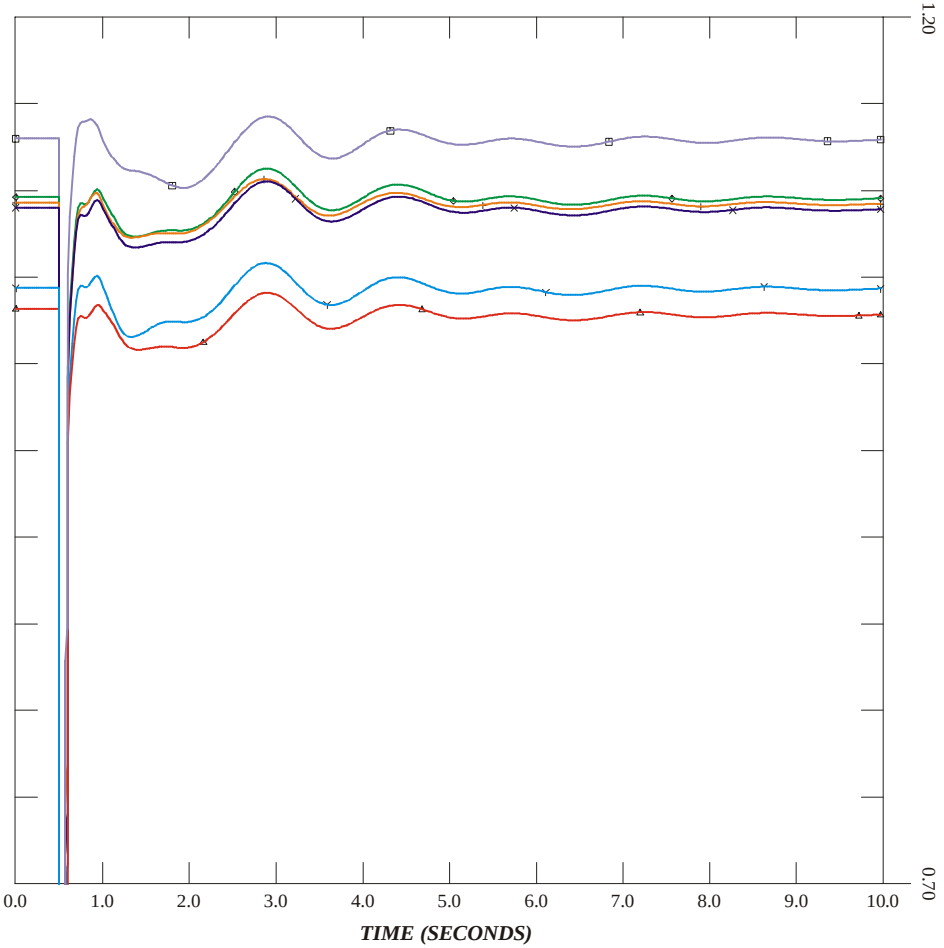
THREE-PHASE FAULT ON 500kV CIRCUIT M570V AT CLAIREVILLE TS - Cleared Normally:

Sensitivity test with FETT Increased to 4330MW (Import Case)



GENERATOR ANGLES - degrees

- BRUCE 'B' G8
- SITHE GOREWAY G4
- SITHE GOREWAY G3
- SITHE SOUTHDOWN G3
- SITHE SOUTHDOWN G2
- LAKEVIEW G6



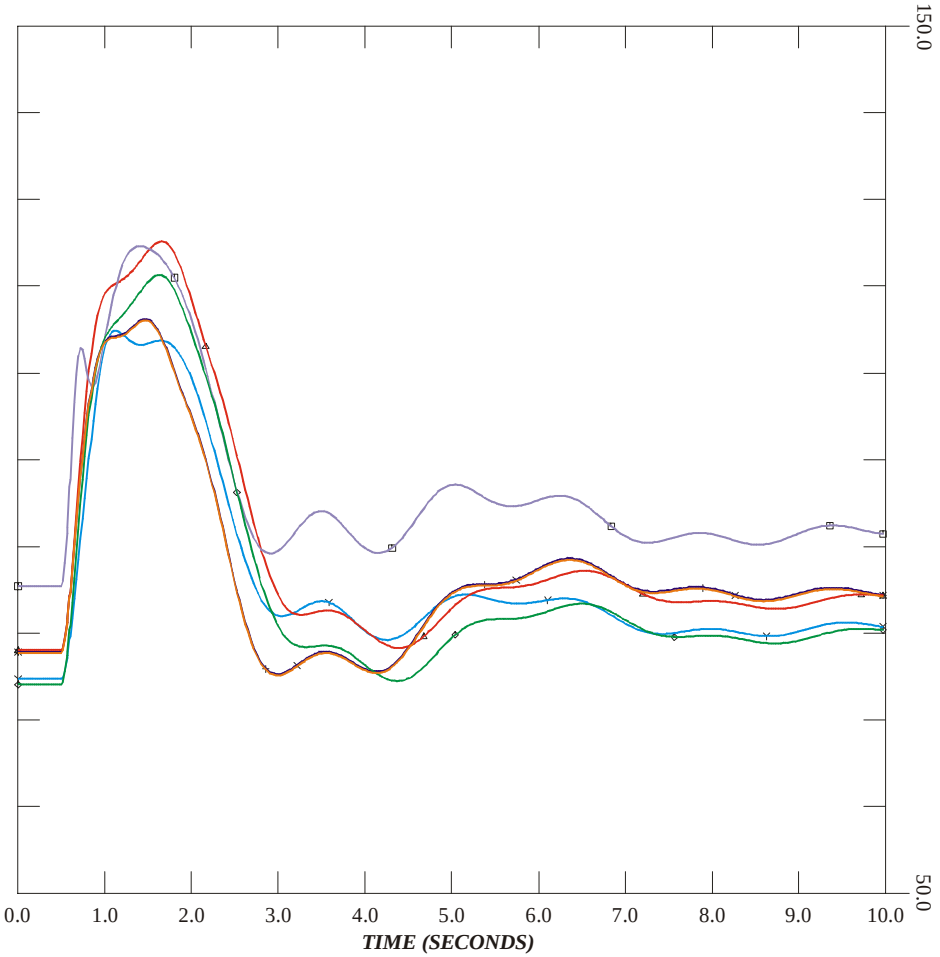
BUS VOLTAGES - p.u.

- CHERRYWOOD 500kV
- RICHVIEW 230kV
- LAKEVIEW CR12 230kV
- CLAIREVILLE 230kV
- MILTON 500kV
- BRUCE A 230kV

DIAGRAM 54

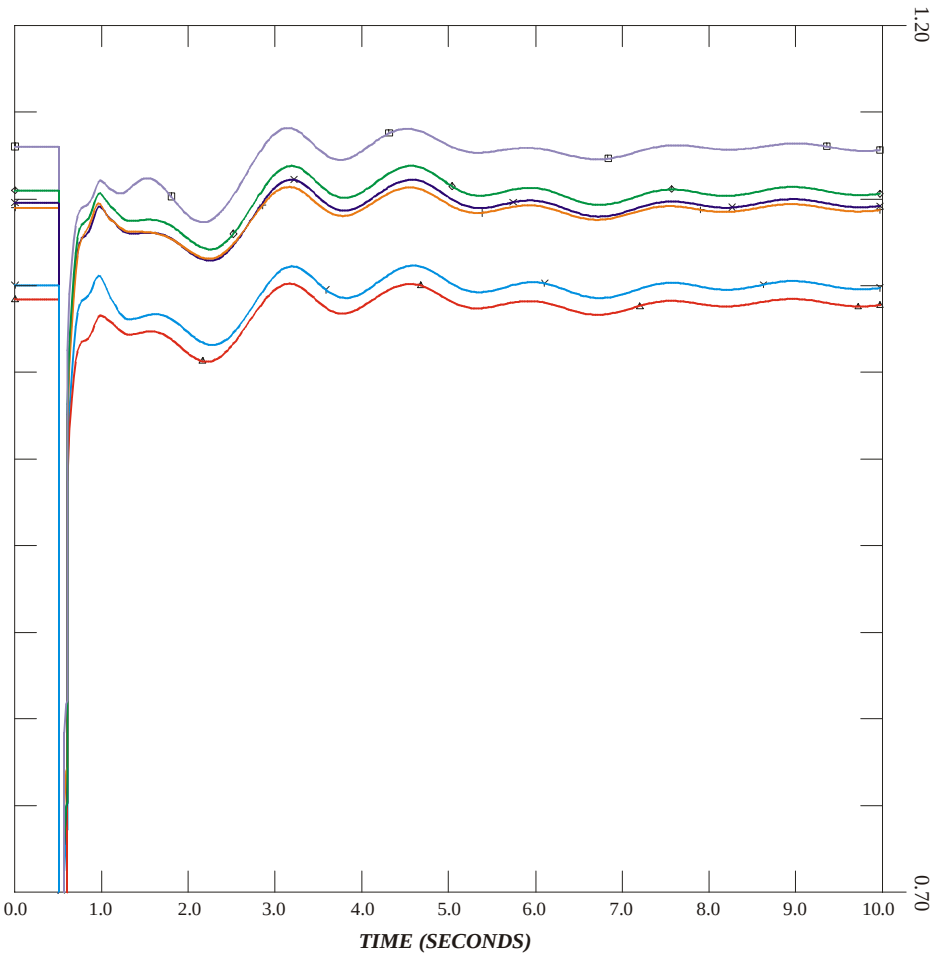
23rd February 2001

THREE-PHASE FAULT ON 500kV CIRCUIT M570V AT CLAIREVILLE TS - Cleared Normally:
Negative FETT Transfer of 600MW (High Export to Michigan Case)



GENERATOR ANGLES - degrees

BRUCE B G8
SITHE GOREWAY G4
SITHE GOREWAY G3
SITHE SOUTHDOWN G3
SITHE SOUTHDOWN G2
LAKEVIEW G6



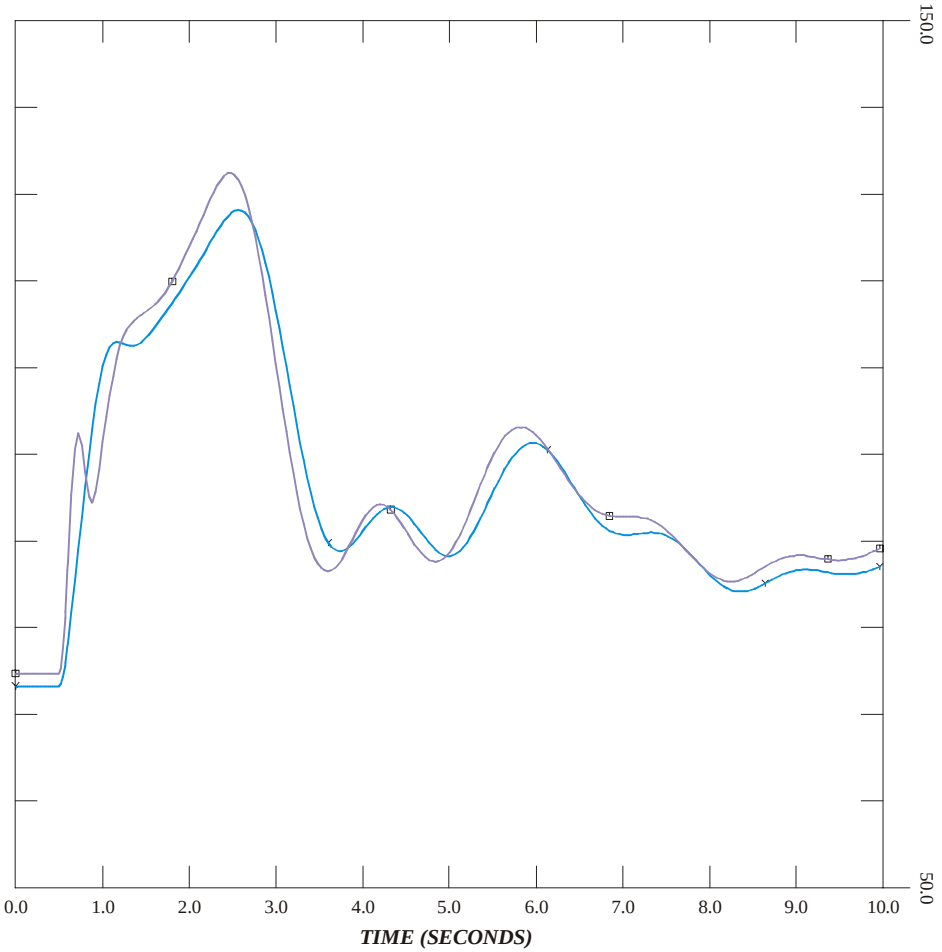
BUS VOLTAGES - p.u.

CHERRYWOOD 500kV
RICHVIEW 230kV
LAKEVIEWCR12 230kV
CLAIREVILLE 230kV
MILTON 500kV
BRUCE A 230kV

DIAGRAM 55

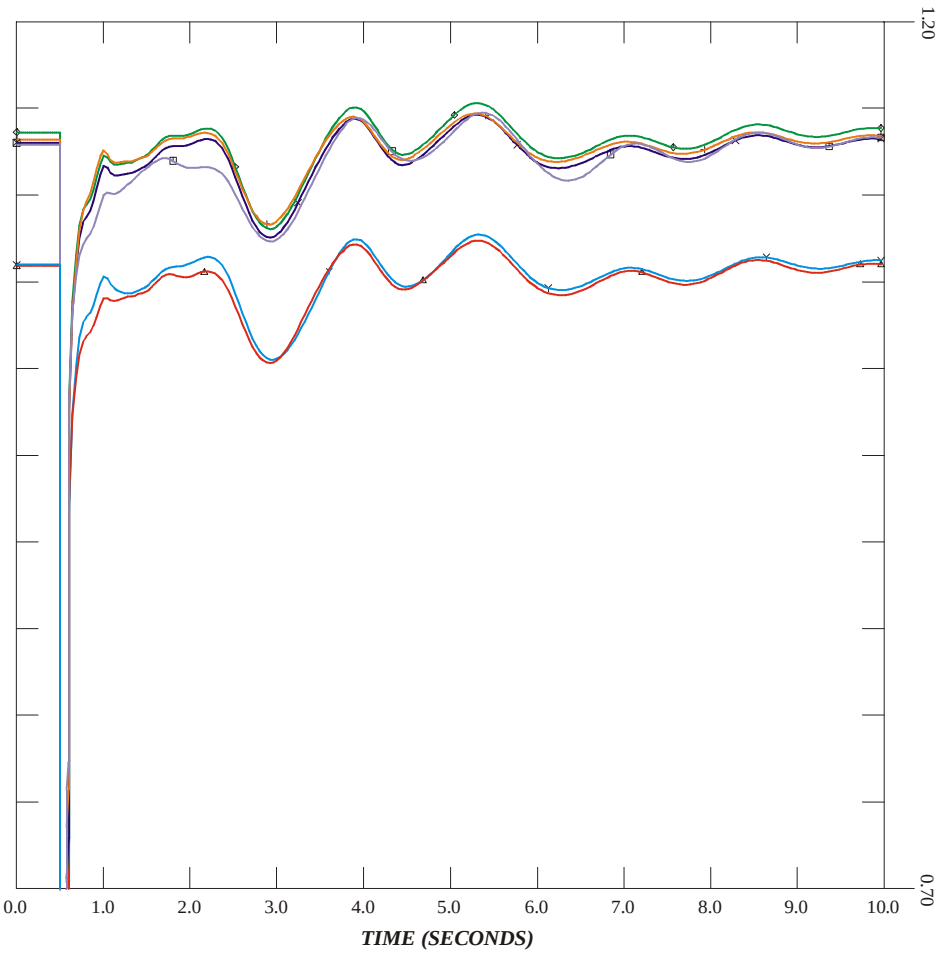
23rd February 2001

THREE-PHASE FAULT ON 500kV CIRCUIT M570V AT CLAIREVILLE TS - Cleared Normally:
Accentuated *Negative FETT Transfer of 1460MW. Heavy eastward flow through New York. Pickering increased to 7 units from 4.*
PRESENT SYSTEM, WITHOUT THE SITHE PROJECTS



GENERATOR ANGLES - degrees

BRUCE 'B' G8
LAKEVIEW G6



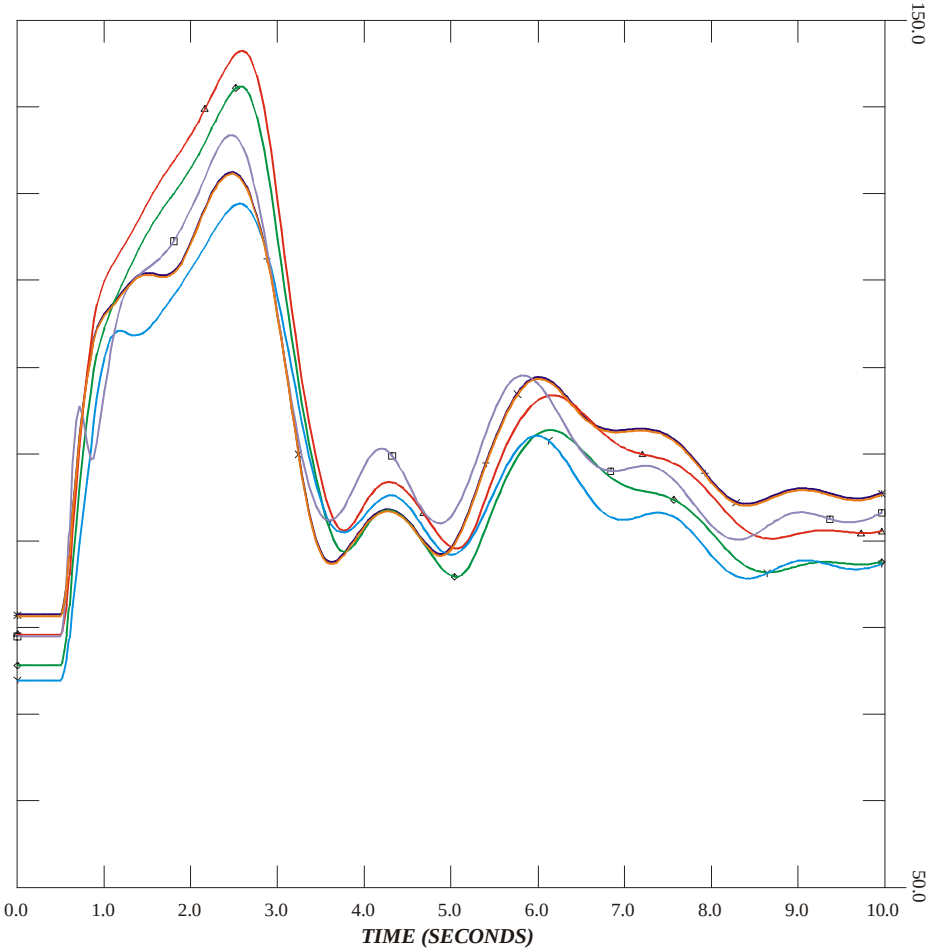
BUS VOLTAGES - p.u.

CHERRYWOOD 500kV
RICHVIEW 230kV
LAKEVIEW CR12 230kV
CLAIREVILLE 230kV
MILTON 500kV
BRUCE A 230kV

DIAGRAM 56

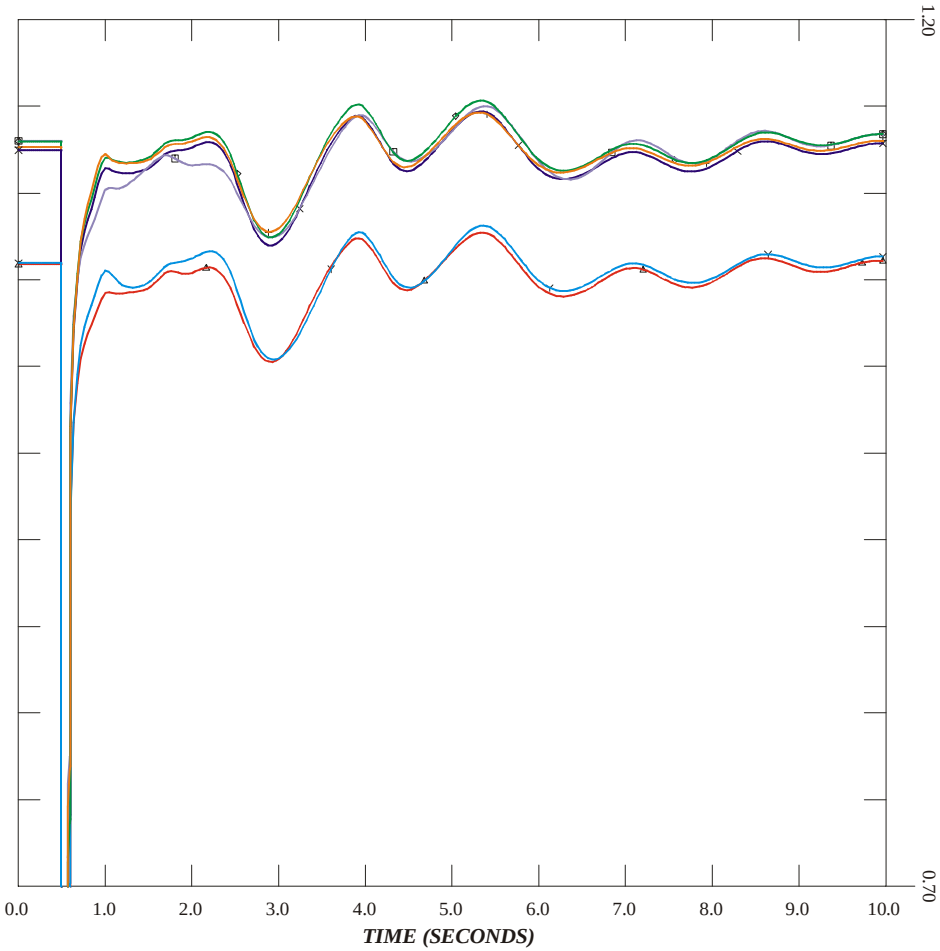
23rd February 2001

THREE-PHASE FAULT ON 500kV CIRCUIT M570V AT CLAIREVILLE TS - Cleared Normally:
Accentuated *Negative FETT Transfer of 1460MW. Heavy eastward flow through New York. Pickering increased to 7 units from 4.*
WITH BOTH SITHE PROJECTS IN-SERVICE



GENERATOR ANGLES - degrees

- BRUCE B G8
- SITHE GOREWAY G2
- SITHE GOREWAY G1
- SITHE SOUTHDOWN G2
- SITHE SOUTHDOWN G1
- LAKEVIEW G6



BUS VOLTAGES - p.u.

- CHERRYWOOD 500kV
- RICHVIEW 230kV
- LAKEVIEW CR12 230kV
- CLAIREVILLE 230kV
- MILTON 500kV
- BRUCE A 230kV

DIAGRAM 57

23rd February 2001

CONNECTION ASSESSMENT & APPROVAL PROCESS

SYSTEM IMPACT ASSESSMENT REPORT

For the two Sithe Projects in the Greater Toronto Area

Addendum:

Alternative Termination Arrangement for the 230kV circuits between Claireville TS and Richview TS

CAA ID Numbers 2000-007 & 2000-008

Long Term Forecasts & Assessments Department

Date: 27th April 2001

Station A Box 4474 Toronto ON M5W 4E5 Canada **tel** 905.855.6100 **fax** 905.855.6372 **www.theIMO.com**

Addendum to the System Impact Assessment Report for the two Sithe Projects in the GTA

Alternative Termination Arrangement for the 230kV circuits between Claireville TS and Richview TS

Introduction

The 230kV facilities at Claireville TS comprise SF_6 gas-insulated switchgear (GIS). This means that all the connections between the line terminations and the actual disconnects and circuit breakers are enclosed in steel pipework, insulated with SF_6 gas. Any revisions to the connection arrangement that directly entail modifying the GIS pipework can therefore be quite difficult and expensive, with the added complication that long outages can be required to undertake the work.

Since the SIA Report was issued, the IMO has worked closely with Hydro One to develop an arrangement which would minimise any work that would involve the GIS facilities, while at the same time meeting all of the IMO's requirements for the connection of the two Sithe Projects.

This addendum provides details of the revised termination arrangement at Claireville TS, as well as the reconfiguration of the 230kV circuits on the Claireville TS to Richview TS right-of-way.

This revised arrangement is to be used as the reference for the future changes that it is planned to implement for the incorporation of the two Sithe Projects into the IMO-controlled grid, and supersedes that given in the SIA Report.

Conclusions from the Sithe System Impact Assessment

The conclusions from the System Impact Assessment, that would have a direct impact on the 230kV busbar at Claireville TS and on the configuration of the 230kV circuits to Richview TS, were as follows:

i. That the section of circuit V72R between Richview TS and Claireville TS should be reterminated on to the same position on the Claireville 230kV busbar as is currently occupied by the sections of circuit V75R to Richmond Hill TS and Kleinburg TS.

   That, subject to further review by Hydro One, the present connection from circuit V72R to the Richview DESN should be moved to another circuit.

ii. That if the test results for the equipment that is eventually supplied for the two Sithe Projects, should indicate that fault levels will be higher than those obtained from the SIA studies, Sithe would have the option of installing supplementary, series-connected reactors in the connections from the Sithe Goreway Project to circuits V72R & V73R.

iii. That if the measures detailed in i. & ii. above are insufficient to maintain the projected fault levels at Claireville TS within the ratings of the existing equipment, then it would be necessary to reterminate some of the 230kV circuits to allow the 230kV busbar at Claireville TS to be operated permanently 'split'.

   Diagrams 28 & 29 from the SIA Report (copies of which are attached) show the arrangement of the various circuits following retermination.

   Diagram 27, a copy of which is also attached, shows the existing arrangement.

It should be noted that the section of circuit V72R between Richview TS and Claireville TS would need to be restored to its original position as part of the retermination work that would need to be completed to allow the 230kV busbar at Claireville TS to be operated 'split'.

Consequently, the retermination of circuit V72R, as detailed in i. above, would only be required for the interim period until such time as the 230kV busbar at Claireville TS would need to be operated 'split', in response to increasing fault levels.

Revised Termination Arrangement

Diagrams 28-1 and 29-1 show the revised configuration of the 230kV circuits on the Richview TS x Claireville TS right-of-way, and the revised termination arrangement at Claireville TS, respectively, that will now be required to be implemented to allow the 230kV busbar at Claireville TS to be operated 'split'.

The work that will be required will be as Follows:

1. Reterminate the section of circuit V72R between Richview TS and Claireville TS on to the same position as is currently occupied by the radial sections of circuit V75R to Richmond Hill TS and Kleinburg TS.

   This work is planned to be completed under i. above, and will remain as a permanent change.

2. Terminate the idle section of circuit V75R between Richview TS and Claireville TS on to a new position on a new diameter that is to be established on the eastern half of the 230kV busbar at Claireville TS.

   Reterminate the radial section of circuit V72R to Bramalea TS on to the same position as the section of V75R to Richview TS.

   The idle section of circuit V75R between Richview TS and Claireville TS is also to be terminated on to a new position on the eastern half of the 230kV busbar at Richview TS.

3. Interchange circuits V73R and V74R on the Richview TS to Claireville TS right-of-way, as close as possible to the circuit terminations into Claireville TS and into Richview TS.

   This will ensure that the circuits alternate across the right-of-way with respect to the relevant halves of the Richview TS & Claireville TS busbars on to which they are terminated.

4. Relocate the following radial sections:

   - The supply to the Richview DESN:

     change the existing connection from circuit V72R to circuit V73R (which will become circuit V74R when the interchange of the circuits as detailed in 3. above is complete.

   - The supply to Rexdale TS:

     change the existing connection from circuit V76R to circuit V75R (when the idle section of this circuit between Richview TS and Claireville TS is terminated and placed in-service, as detailed in 2. above.

   - The supply to Goreway TS:

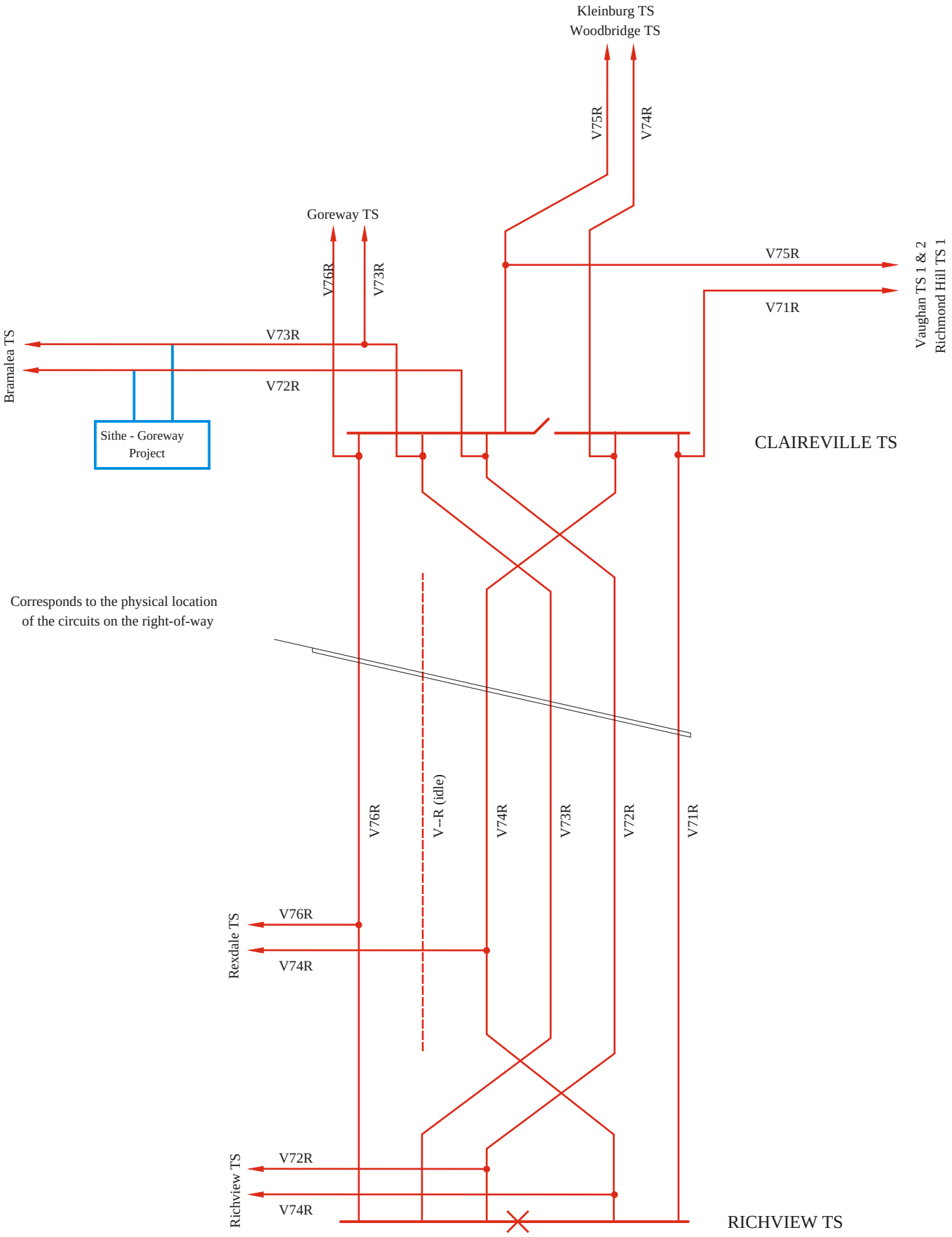
     change the existing connection from circuit V73R to circuit V72R (which is expected to be re-designated as circuit V75R when the radial section of circuit V72R is terminated on to the same position as circuit V75, as detailed in 2. above.

   These changes are intended to ensure that Goreway TS, Rexdale TS and the Richview DESN are each connected to the two halves of the 'split' busbars at Claireville TS and Richview TS. Not only will this improve supply security, but it will also help to balance the load on the 500/230kV auto-transformers connected to the respective halves of the Claireville 230kV busbar.

IMO Requirements

The IMO's revised requirements for operating with the 230kV busbar at Claireville TS permanently 'split' are now shown in Diagrams 28-1 & 29-1. These supersede those shown in Diagrams 28 & 29 in the SIA Report for the two Sithe Projects in the Greater Toronto Area.

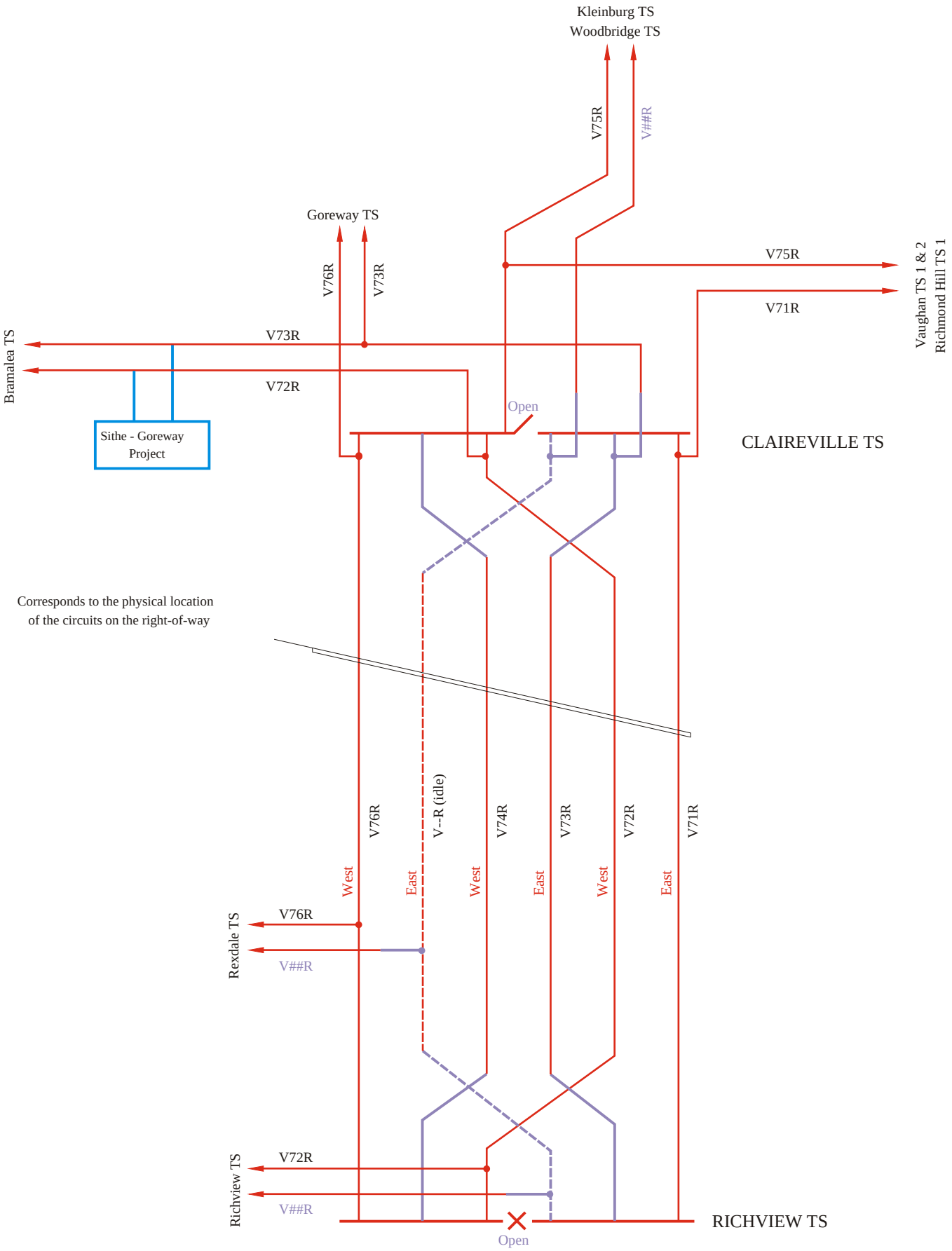
The proposed retermination of circuit V72R on to the same position that is currently used for the termination of the radial sections of circuit V75R, and the change in the connection to the Richview DESN should comply with this revised arrangement.



Existing Arrangement of the 230kV Circuits on the Richview TS to Claireville TS right-of-way

DIAGRAM 27

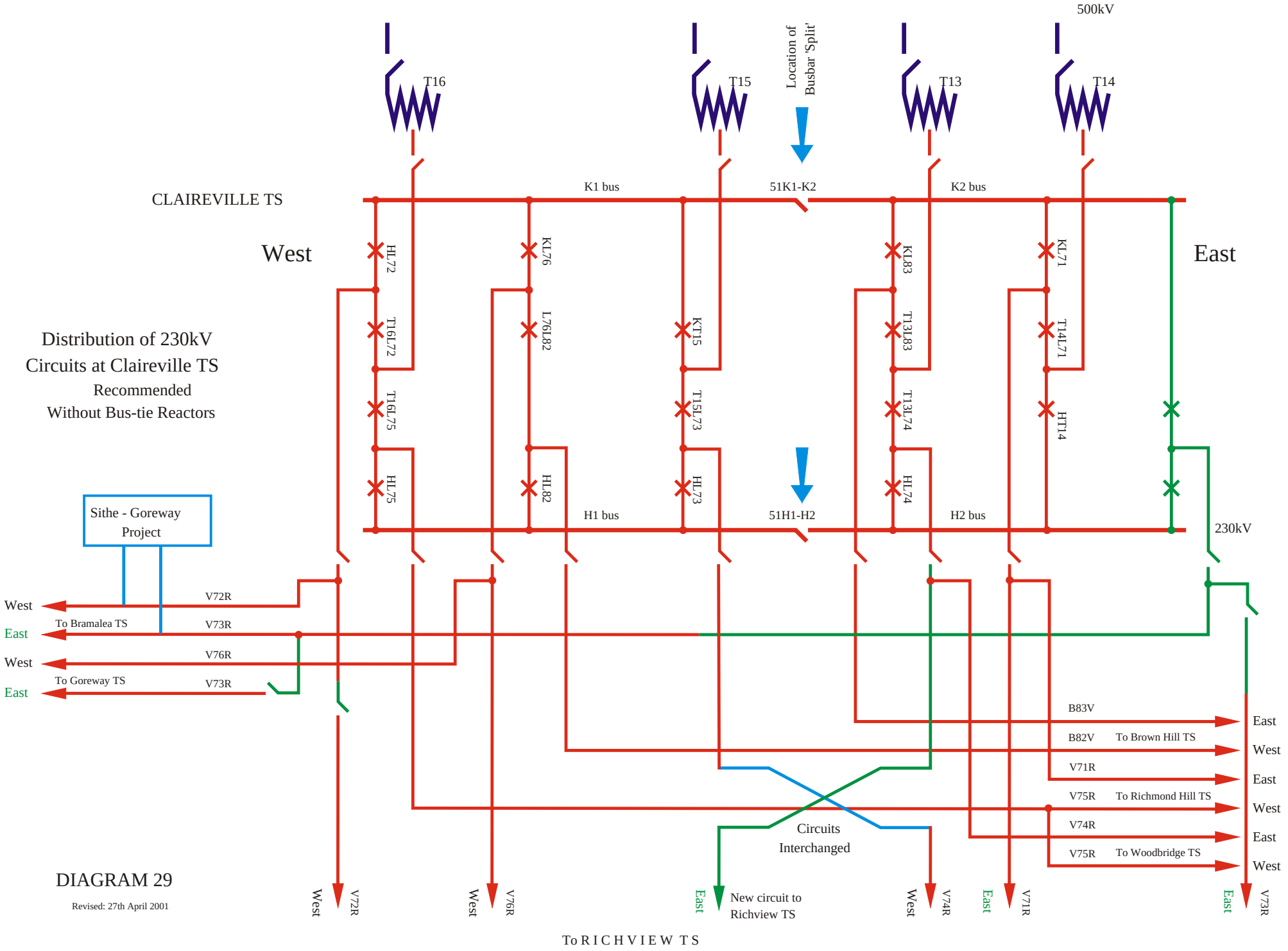
19th February 2001



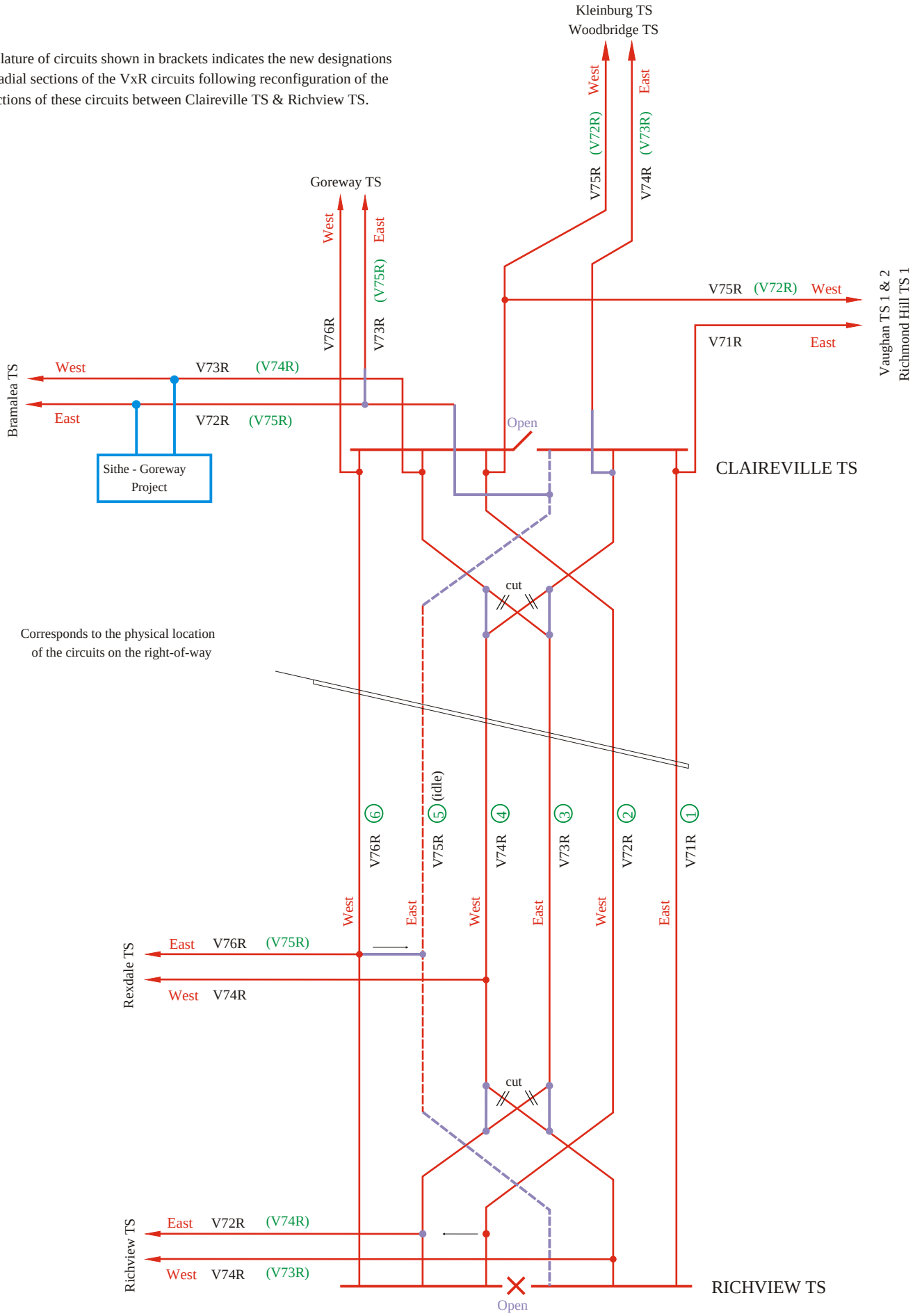
Proposed retermination of the
Richview TS to Claireville TS 230kV Circuits

DIAGRAM 28

19th February 2001


500kV
T16
T15
Location of
Busbar 'Split'
T13
T14
CLAIREVILLE TS
K1 bus
51K1-K2
K2 bus
West
East
HL72
KL76
KL83
KL71
T16L72
L76L82
KT15
T13L83
T14L71
T16L75
T15L73
T13L74
HT14
HL75
HL82
HL73
HL74
Distribution of 230kV
Circuits at Claireville TS
Recommended
Without Bus-tie Reactors
Sithe - Goreway
Project
H1 bus
51H1-H2
H2 bus
230kV
West
V72R
To Bramalea TS
East
V73R
West
V76R
To Goreway TS
East
V73R
B83V
East
B82V
To Brown Hill TS
West
V71R
East
V75R
To Richmond Hill TS
West
V74R
East
V75R
To Woodbridge TS
West
Circuits
Interchanged
DIAGRAM 29
Revised: 27th April 2001
West
V72R
West
V76R
East
New circuit to
Richview TS
West
V74R
East
V71R
East
V73R
To R I C H V I E W T S

Note: Nomenclature of circuits shown in brackets indicates the new designations for the radial sections of the VxR circuits following reconfiguration of the main sections of these circuits between Claireville TS & Richview TS.



Alternative Retermination Arrangement of the Richview TS to Claireville TS 230kV Circuits

DIAGRAM 28-1

27th April 2001

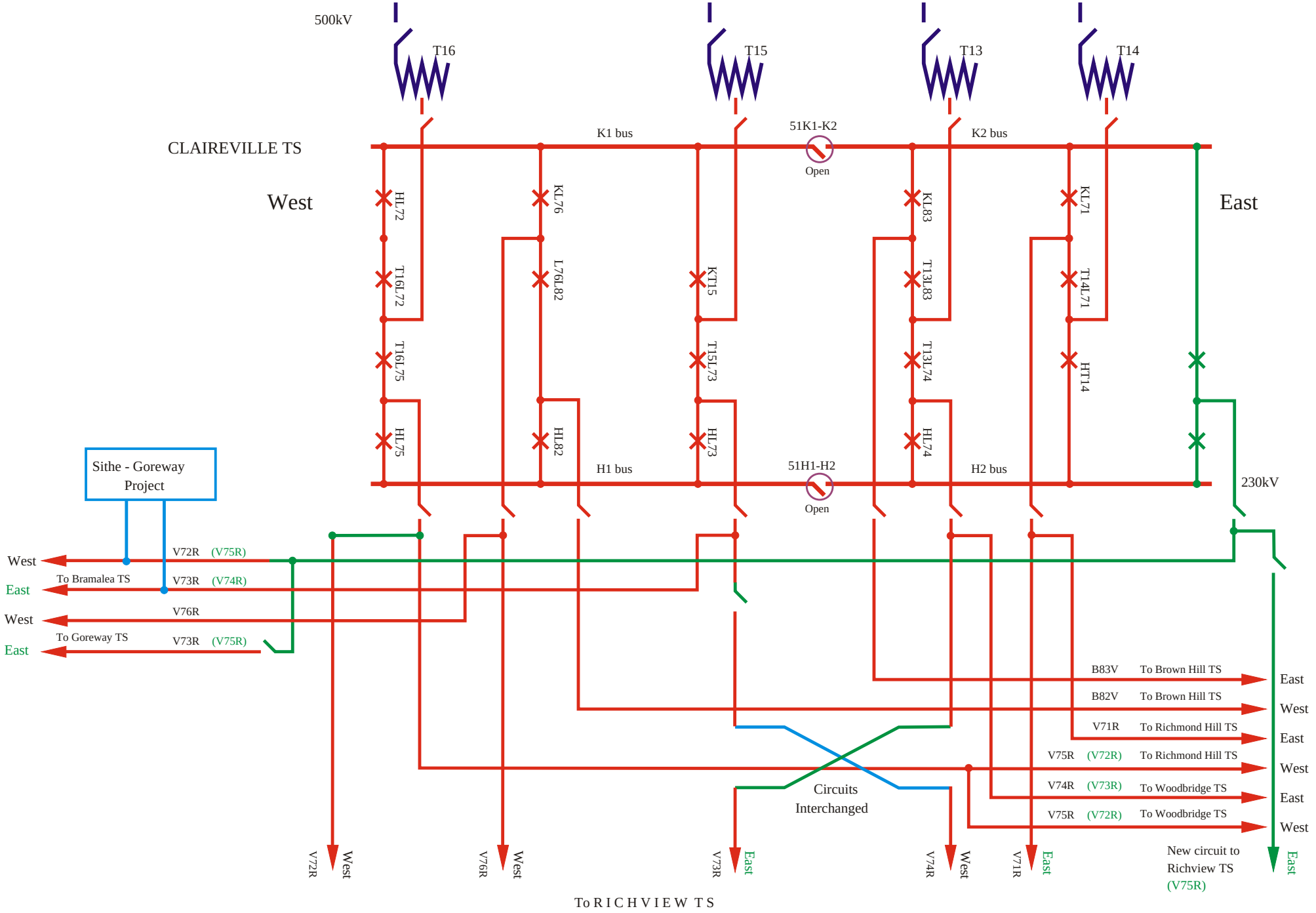


DIAGRAM 29-1

Revised: 27th April 2001

Required Configuration of the 230kV circuits at Claireville TS