Independent
Electricity
Market Operator

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CONNECTION ASSESSMENT & APPROVAL PROCESS

Preliminary Assessment Report For Richmond Hill MTS #2

CAA ID 2000-020

Final Report

Long Term Forecasts & Assessments Department
May 16, 2001

Preliminary Assessment Report

Richmond Hill MTS #2

Acknowledgement

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

Disclaimers

IMO

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

Hydro One

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

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

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

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

The ampacity rating of Hydro One facilities are established based on assumptions used in Hydro One for power system planning studies. The actual ampacity ratings during operations may be

determined in real-time and are based on actual system conditions, including ambient temperature, wind speed and facility loading, and may be higher or lower than those stated in this study.

The additional facilities or upgrades which are required to incorporate the proposed connection have been identified to the extent permitted by a preliminary assessment. Additional facility studies may be necessary to confirm constructability and the time required for construction. System impact or further studies at more advanced stages of the project development may identify additional facilities that need to be provided or that require upgrading.

Executive Summary

This Preliminary Assessment has examined the impact of the Richmond Hill Municipal Transformer Station #2 on the reliability of the IMO-controlled grid. This project was subject to an expedited Connection Assessment process and it is not required to undergo a System Impact Assessment.

Proposed Project

Richmond Hill Hydro Inc. has started construction of the Municipal Transformer Station #2 at a location that is adjacent to the existing Richmond Hill MTS#1 located on the 230 kV transmission right-of-way between Claireville TS and Richmond Hill. The new station will be connected to the 230 kV circuitsV71R and V75R.

The in service date for the proposed project is June 2001.

Impact on System Reliability

The studies performed as part of the Preliminary Assessment indicated that the new MTS has no adverse impact on the transfer capability of the surrounding transmission facilities.

The studies showed that the power transfers over the 230 kV lines V71R and V75R, to which the new Richmond Hill MTS#2 is connected, with all elements in service and under post contingency situations are within the line ratings agreed upon by Hydro One.

The studies concluded that the addition of the new supply point does not have an effect on the short circuit current at Claireville TS.

Conclusions

It is recommended that Richmond Hill Hydro Inc provide the IMO with the following information as soon as it becomes available:

1. A confirmation that a underfrequency load shedding relay, which will have the capability of tripping up to 35% of the station load is to be installed. Appropriate settings for the relay will be provided by the IMO prior to commissioning.
2. A confirmation that voltage reduction facilities will be provided, with the capability of reducing the distribution voltage by 3% to 5%.
3. A confirmation that transfer trip communication will be provided as required by the Transmission System Code.
4. Inform the IMO when the plans for installing the LV shunt capacitors are initiated.

It is required that Richmond Hill Hydro install all the equipment needed to monitor the information required by the IMO on a continuous basis as described in Chapter 4 section 7.5 and Appendix 4.17 of the Market Rules.

It is recommended that approval be granted and Notification of Approval be issued subject to the acceptance by the proponent of the IMO requirements.

1.0 Project Description

Richmond Hill Hydro Inc. has started construction of the Municipal Transformer Station #2 located at a site on Highway #7 about half way between Yonge St. and Bayview Avenue. The new site will be adjacent to the existing Richmond Hill MTS#1 located on the 230 kV transmission right-of-way between Claireville TS and Richmond Hill. The new station will be connected to the 230 kV circuitsV71R and V75R.

The in service date for the proposed project is June 2001.

It is projected that initially, in the summer of 2001, the station will supply about 37 MW of residential and commercial load. The ultimate forecast indicates that the station will supply about 90 MW by 2010.

A schematic representation of the electrical connectivity for the proposed Richmond Hill MTS#2 is shown in Figure 1.

2.0 Review of Connection Arrangement

The proposed municipal transformer station is equipped with two 215.5/28 kV transformers rated at 50/67/83 MVA each, which are supplied from two separate transmission circuits (V71R and V75R) that share the same right of way. The transformers are both identical and configured with a solidly grounded wye winding on the high side and reactor grounded zigzag single winding on the low side.

The transformer station documents were reviewed by HON for compliance with the Transmission System Code. Based on the single line diagram 112718-D-60-001 provided by Richmond Hill Hydro Inc., each transformer is separated from the transmission system via a motorized disconnection switch. For this particular arrangement the Transmission System Code requires that transfer trip of the Transmitter's breakers at the terminal stations be provided for transformer faults and for a condition of failure to operate of the LT breakers (T4D, T3C). For these faults, in the case of Richmond Hill MTS#2, which is connected at the end of radial lines transfer trip must be sent to the following breakers:

- For faults on T4 or T4D failure to operate, trip T16L75 and HL75 at Claireville 230 kV station.
- For faults on T3 or T3C failure to operate, trip KL71 and T14L71 at Claireville 230 kV station, and L24l71 and H1L71 at Richview 230 kV transformer station.

It is also required that the protection system initiate simultaneously both signals for transfer trip and the opening of the disconnect switch. Full opening of the disconnect switch shall then block the sending of the transfer trip signal.

Voltage control will be provided via on-load tap changers located on the high voltage winding of the transformer. The tap changer range for the step-down transformer is 34.5 kV to –34.5 kV (from 250 kV to 181 kV) and it is to be achieved in 32 steps.

At the time of coming in service of this station, Richmond Hill Hydro Inc. does not plan to install low voltage shunt capacitors because the there is no requirement for power factor correction in the initial stage. However, Richmond Hill Hydro Inc. has confirmed that provisions have been

made for future installation of shunt capacitors to ensure that the load power factor requirements (90%) of the Market Rules are met.

Underfrequency Load Shedding Requirements

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

Voltage Reduction Facilities Requirements

The Market Rules (Chapter 4 Appendix 4.3) are being revised by the IMO to include a requirement of the distributors and wholesale customers to install facilities to reduce, when instructed by the IMO, the distribution voltage by 3% to 5%. Although this obligation is not currently in the Market Rules it will be included in the next revision. Consequently, this condition is being included in the list of requirements for this project.

On-line Monitoring

The Market Rules (Chapter 4 section 7.5) require that each distributor and connected wholesale customer shall provide the IMO on a continual basis with on-line monitored quantities as specified in Appendix 4.17. It is required that Richmond Hill Hydro install all the equipment required to monitor the information required by the IMO on a continuous basis.

3.0 Data Verification

The information provided by the proponent as part of the application for preliminary assessment was incomplete in some areas and this information must be provided as soon as it becomes available.

The current rating of the transformer low voltage neutral 1.5 ohms grounding reactor was not initially specified. The industry standards require that the grounding reactor have a continuous rating of 1000A and 15 s current rating of 6000A. It has been since confirmed by Richmond Hill that the grounding reactor rating conforms to the industry standard.

The rating of the remaining station equipment was found to meet all applicable standards.

4.0 Fault Level Assessment

In general, radial loads do not have a large impact on the system fault levels.

Hydro One has carried out a study to identify the impact of the Richmond Hill MTS#2 on the short circuit currents in the area. The results indicated that the proposed development does not contribute to the single-line-to-ground fault or three phase fault currents.

5.0 Impact on System Reliability

The assessment of the impact of incorporating the proposed project has assumed in service all the projects that have already been approved for connection in the electrical vicinity of Claireville

TS. Explicitly, the baseline assumptions include Vaughan MTS#3 connected between Kleinburg TS and Woodbridge TS, Sithe Goreway and Southdown generation developments in service.

5.1 Sithe Project - Impact on Load Meeting Capability

A System Impact Assessment for Sithe-Goreway generation project was completed and the recommendations are listed in the SIA report that is posted at www.theimo.com. In summary the report stipulates that a number of staged modification are required to the connectivity of the VxR circuit at Claireville to ensure that the fault interrupting capability of the existing breakers at Claireville is not exceeded. In the initial stage it is required that the Claireville x Richview sections of circuit V72R be reconnected to V75R. Alternatively, in the event that the equipment installed for the Sithe project results in higher fault levels than those studied then two options are considered;

- Installing supplementary series-connected reactors at the Sithe-Goreway site or,
- Permanently split the 230 kV bus at Claireville TS.

The Sithe SIA report identifies that the proposed fault level mitigating measures would not have an adverse impact on the load meeting capability in the area.

It is considered that the arrangement proposed in the initial stage of the Sithe project will not materially affect the load meeting capability of the existing V75R circuit.

5.2 Description of Transmission Facilities

The new Richmond Hill MTS#2 will have a dual supply from the 230 kV double-circuit lineV71R/V75R. Figure 1 shows a schematic representation of the IMO-controlled Grid in the area surrounding Claireville TS. The circuit designated as V71R is a radial circuit out of Claireville TS which branches into two sections, one going to Richview and the other one going to Richmond Hill MTS#2. The circuit designated as V75R also branches into two sections one terminating at Kleinburg TS and the other one at Richmond Hill MTS#2.

After the incorporation of the proposed development, four municipal transformer stations will be supplied via these two circuits, namely Vaughan #1, Vaughan #2, Richmond Hill MTS#1 and Richmond Hill MTS#2.

5.3 Area Load Considerations

The impact of the proposed MTS on the local area transmission was studied for the summer of 2005 under conditions of peak demand in Ontario. A moderate average load growth of 2% per year was assumed between year 2000 and 2005 for the existing Kleinburg and Woodbridge stations, which resulted in a total of 10% load growth per station by year 2005. In addition, 165 MW of load was considered to be connected to Vaughan MTS#3.

Two different load scenarios were considered for existing municipal stations that are being supplies via V71R and V75R (Vaughan MTS#1, Vaughan MTS#2, Richmond Hill #1).

Scenario A

One scenario (A) was based on coincident summer peak loads obtained from 1999 historical data. The IMO historical information indicated that in the summer of 1999 the peak loads at the

Vaughan MTS#1 and MTS #2 stations were well above the 10 day limited time rating of these stations. Based on the information available to the IMO the 10 day LTR for these stations is about 170 MVA. However, the 1999 peak loads were 217 MVA, 187 MVA and 141 MVA respectively. In addition, the new Richmond Hill MTS#2 with an ultimate load projection of 90 MW at 92% power factor, as indicated by the applicant, was incorporated in this scenario.

Scenario B

The second scenario (B) assumed that the load would eventually be distributed such that the coincident peak will not exceed the 10 day limited time ratings of these MTS's. Hence, the maximum load at each of the three existing municipal stations is 170 MVA and the new Richmond Hill MTS#2 is 112 MVA.

It is believed that the two selected scenarios result in a realistic representation of the possible maximum load that may be experienced in this area in the next two to five years.
These scenarios are summarized in Table 1 below.

Table 1: Load Scenarios

Station Name	**SCENARIO A** Actual 1999 Summer Load (coincident with system peak)				**SCENARIO B** Summer Load Equivalent to the 10day Station LTRs			
	MW	MVAR	pf	MVA	MW	MVAR	pf	MVA
Vaughan MTS#1	206	63	95%	217	156	66	92%	170
Vaughan MTS#2	172	75	92%	187	156	66	92%	170
Richmond Hill MTS#1	130	57	92%	141	156	66	92%	170
Richmond Hill MTS#2(new)	90	38	92%	98	103	44	92%	112
Total Load	**598**	**233**		**643**	**571**	**242**		**622**

The impact on the new Richmond Hill MTS#2 on the area transmission capability was studied for the two scenarios shown above.

5.4 Assessment of Transmission Thermal Loading

This assessment was performed to identify if there is a significant impact on the thermal line loading under conditions of summer peak load with all transmission elements in service, and after the loss of one critical transmission element. The possible overloading of these circuits represent a concern during the summer months when the load is generally high and the line operating ratings are lower. Table 2 and Table 3 below list the results of the study.

Two summer continuous ratings are quoted in the tables; they were calculated based on a continuous operating temperature of 93^0C and 127^0C respectively and an average operating voltage of 240 kV. Hydro One recommended using 240 kV for the calculation of MVA circuit thermal rating because the system lower voltages are experienced during the hot summer days and are coincident with the peak demand. The historical records of voltages at Claireville 230 kV TS are shown in Figure 2.

Hydro One operating practice has been to use 93^0 C thermal rating for overhead circuits with conductors of high aluminum content. In exceptional cases, a thermal rating of 127^0C has been permissible as long as the loading was restricted to less than 0.6% of time or 50 hours in one year. Hydro One has continued to support this practice for the time being, or until a revision of the technical directive pertaining to the circuit's operating rating is completed. Consequently, for less than 50 hours a year V71R and V75R could be operated at 764 MVA.

However, it should be noted that for dual radial supply of load, the common practice is to use the continuous rating of the conductor in calculating the post contingency loading of the remaining line, since no operating measures are normally implemented to lower the loading of the remaining single supply.

Load Scenario A – Table 2

The studies results concluded that with all elements in service and for different operating temperatures the 230 kV circuits V71R and V75R which supply the four municipal stations will be equally loaded at 57% and 44% of the circuits' summer continuous capability respectively.

Under contingency situation, for the loss of V71R or V75R the four loads will be supplied via the remaining 230 kVcircuit. The flow on the remaining transmission line will be at about 125% of the 93^0C continuous rating of the line and 96% of the 127^0C continuous rating of the line.

Table 2: Pre-contingency and Post-contingency Line Loadings –Scenario A

Circuit	Rating(MVA)[1]		Pre-contingency	Post-contingency	
	Summer Cont.	Summer LTR(15min)	MVA, % of Cont. Rating	Loss of V71R, MVA, % Cont. Rating	Loss of V75R, MVA, % Cont. Rating
V71R					
At 93^0C	588	641	336 or 57%	-	736 or 125%
At 127^0C	764	827	336 or 44%	-	735 or 96%
V75R					
At 93^0C	588	641	336 or 57%	736 or 125%	-
At 127^0C	764	827	336 or 44%	736 or 96%	-

Load Scenario B- Table 3

The studies results concluded that with all elements and for different operating temperatures the 230 kV circuits V71R and V75R which supply the four municipal stations will be equally loaded at 55% and 43% of the circuits' summer continuous capability, respectively.

Under contingency situation, for the loss of V71R or V75R the four loads will be supplied via the remaining 230 kV circuit. The flow on the remaining transmission line will be at about 120% of the 93^0C continuous rating and 93% of the 127^0C continuous rating of the line.

[1] MVA rating calculated based on 240 kV voltage

Table 3: Pre-contingency and Post-contingency Line Loading –Scenario B

Circuit	Rating(MVA)		Pre-contingency	Post-contingency (MVA)	
	Summer Cont.	Summer LTR(15min)	MVA, % of Cont. Rating	Loss of V71R, MVA, % Cont. Rating	Loss of V75R, MVA, % Cont. Rating
V71R					
At 93^0C	588	641	325 or 55%	-	709 or 120%
At 127^0C	764	827	325 or 43%	-	709 or 93%
V75R					
At 93^0C	588	641	325 or 55%	709 or 120%	-
At 127^0C	764	827	325 or 43%	709 or 93%	-

In should also be noted that in both scenarios due to the heavy line loading the reactive line losses have increased considerably in post contingency situation.

The results indicate that if one of the lines that supply the four stations is out of service the remaining line may become thermally loaded over its 93^0C continuous summer rating. However, the post-contingency loading is below the 127^0C continuous summer rating.

The results on the post contingency line loading for scenarios A and B raise the question of what would be the duration of individual outages to these circuits during a typical year. If it is found that the outage duration in one year is longer than 50 hours then, the post-contingency line overloading represents a valid concern, since operating at the higher rating is allowed for only 50 hours a year.

5.5 Line Thermal Loading Projections

Additional analysis was performed to address the concern expressed in the paragraph above with respect to the likelihood of line thermal overloading. The analysis looked at two aspects related to this concern.

Firstly, we estimated the percent of time in a year when V71R and V75R would be loaded over their 93^0C summer continuous rating. The analysis started with the actual '20 minute averaged' load distribution for the summer of 1999. Then, an estimate of the Richmond Hill MTS#2 summer load distribution was produced based on the new station maximum capacity and the actual 1999 load distribution curve. The result of this calculation was a '20 minute averaged' peak of 658 MVA. The total power flow distribution calculations indicate that the flow on V71R and V75R would exceed the continuous rating of 588 MVA for about 47 hours in one year.

Secondly, Hydro One provided information on frequency duration and unavailability of V71R and V75 R for the past five years. The forced outage statistics data show that V71R and V75R were unavailable on an average of 1.133 hours and 8.574 hours per year, respectively. The maintenance outage data was not included in the analysis because it is assumed that maintenance would be carried out during periods of off peak load conditions.

The results of this analysis indicated that:

- the load is likely to exceed the continuous rating of *one line for less than 50 hour a year,* hence it is safe to use the 127^0C circuit rating and, additionally
- in the last 5 year, single circuit forced outage occurred for an average of *8.6 hour per year*, (considerably less than 50 hours per year).

Based on these results it could be concluded that for load levels not exceeding those in the study the thermal overloading of the two 230 kV circuits V71R and V75R will not occur.

5.6 Voltage Assessment

A preliminary analysis of the IMO-controlled grid voltage at the point of connection of Richmond Hill MTS#2 indicated that the system voltage will be similar in magnitude to the voltages observed at Richmond Hill MTS#1.

The preliminary assessment also examined the effect of a single circuit outage (V71R or V75R), a double circuit outage (V71R and V75R) and the Richview capacitor (a 420 MVAR capacitor bank is connected at Richview 230 kV) switching on the voltage at the new Richmond Hill station and at Clareville TS. The results of the study are shown in Table 4.

Table 4. Voltage Variations

Monitored Location	Event		Pre-event Voltage (kV)	Post-event Steady state Voltage (kV)	% change
Richmond Hill 230 kV	Loss of V71R or V75R		243.6	237.6	-2.5%
Richmond Hill 28 kV	Loss of V71R or V75R		29.5	27.3	-7.5%
Richmond Hill 28 kV	Switching of Richview Capacitor		29.5	29.9	1%
Claireville 230 kV	Loss of V71R and V75R	No Sithe	241.0	245	1.6%
		With Sithe	248	250	1%

The results of the voltage variations studies show that:

- the effect of the Richview capacitor switching on the Richmond Hill MTS#2 voltage is within the 4% margin allowed by the Market Rule,
- the line switching events create voltage excursions that are under the 10% margin allowed by the Market Rules, and
- the loss of the double circuit V71R/V75R, which would be equivalent to loss of about 650 MVA of load, results in a marginal rise in the Claireville voltage.

6.0 Conclusions and Recommendations

This Preliminary Assessment has examined the impact of connecting Richmond Hill MTS#2 to the 230 kV lines V71R and V75R, on the reliability of the IMO-controlled grid. The studies concluded:

1. The addition of the new supply point does not have an effect on the short circuit current at Claireville TS.

2. The power transfers over the 230 kV lines V71R and V75R, to which the new Richmond Hill MTS#2 is connected, with all elements in service and under post contingency situations are within the continuous ratings of one line calculated for an operating temperature of 127^0C.

It is recommended that Richmond Hill Hydro Inc provide the IMO with the following information as soon as it becomes available:

3. A confirmation that a underfrequency load shedding relay, which will have the capability of tripping up to 35% of the station load (12% at 59.3 Hz and additional 23% at 58.8 Hz) is to be installed. Appropriate settings for the relay will be provided by the IMO prior to commissioning.
4. A confirmation that voltage reduction facilities will be provided, with the capability of reducing the distribution voltage by 3% to 5%.
5. A confirmation that transfer trip communication will be provided as required by the Transmission System Code.
6. Inform the IMO when the plans for installing the LV shunt capacitors are initiated.

It is required that Richmond Hill Hydro install all the equipment needed to monitor the information required by the IMO on a continuous basis as described in Chapter 4 section 7.5 and Appendix 4.17 of the Market Rules.

7.0 Notification of Approval

Section 6.0 of the Preliminary Assessment Report lists all the requirements identified by the IMO for the incorporation of the proposed Richmond Hill Municipal Transformer Station #2. It is recommended that approval be granted and Notification of Approval be issued subject to the acceptance by the proponent of the IMO requirements.

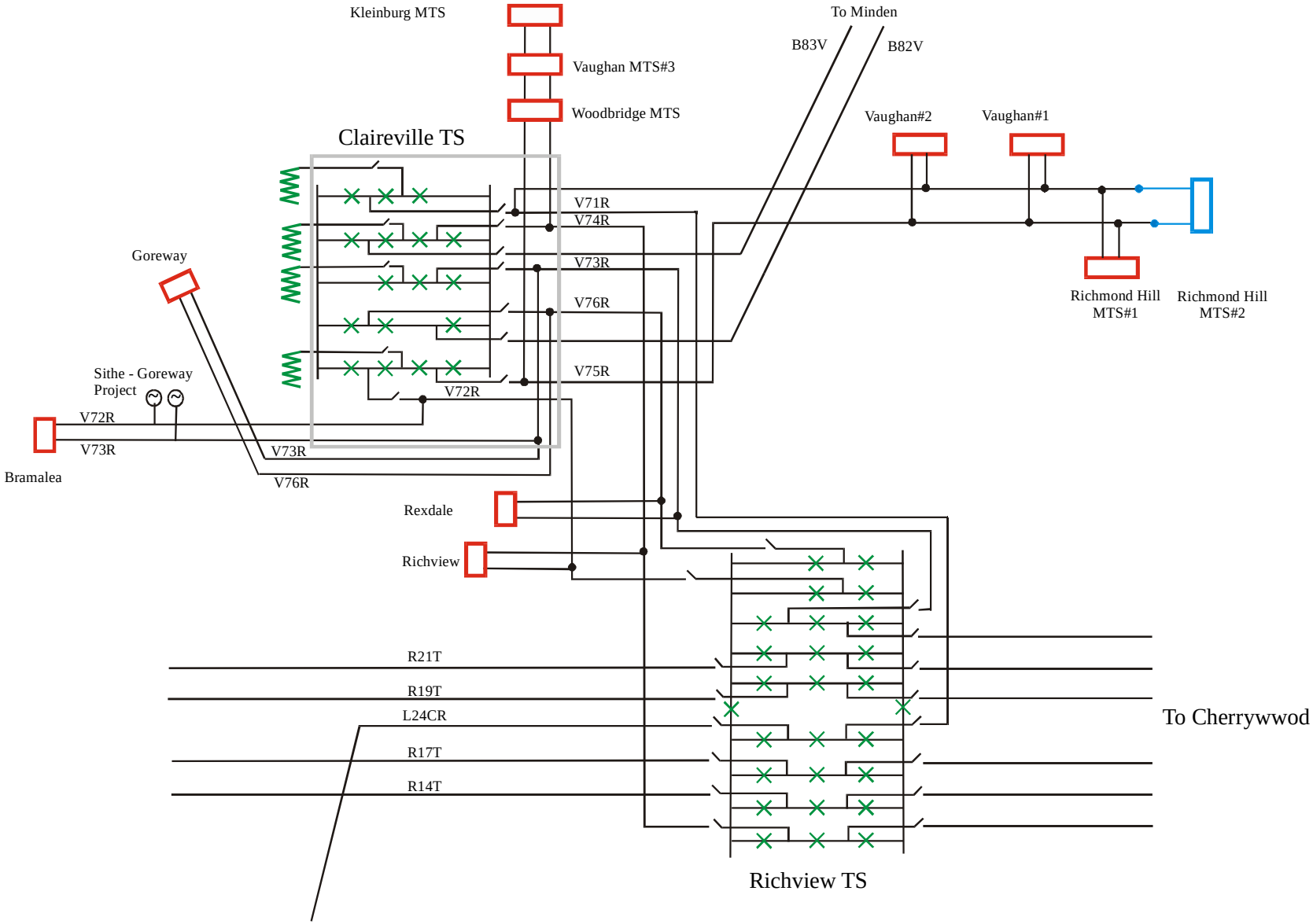

Figure 1. Claireville Area Transmission Layout

FIGURE 2
Claireville TS 230kV Voltage - Year 2000