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CONNECTION ASSESSMENT & APPROVAL PROCESS

System Impact Assessment Report

For Addition of a New Generating Unit (G6) at Kirkland Lake GS by Northland Power Inc.

CAA ID Number 2000-009

Final Report

Long Term Forecasts & Assessments Department

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Station A Box 4474 Toronto On M5W eE5 Canada, Tel. 905.855.6406 fax 905.855.6471 www.theIMO.com

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 whether the connection applicant's proposed connection with the IMO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IMO should issue a notice of approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules. This report has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. 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. 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 system assessment study are based on the information available to Hydro One, at the time of the study, suitable for a system impact assessment of a new interconnection.

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 system impact 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 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 which 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 and Approval process. At more advanced stages 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

Addition of New Generating Unit (G6) at Kirkland Lake GS

Executive Summary

The System Impact Assessment has examined the impact on power system reliability of the proposed Northland Power development at Kirkland Lake.

The Preliminary Assessment for this proposal was omitted because a cursory look at the impact of this project indicated that the main reasons for concern are related to the effect of the new proposal on the system transfer capability. In addition, no other related applications for connections have been received, hence Northland Power was the only candidate in this cluster. For these reasons the IMO initiated a System Impact Assessment which also covered assessment aspects that are normally addressed by the Preliminary Assessment.

Proposed Development

The northeastern Ontario power system covers the area north of Sudbury and east of Wawa stretching all the way to the Quebec border. The northeastern transmission system incorporates many generation resources that are used to supply local demand and demand in southern Ontario. The *main interface* that facilitates the transfer of power from the northeastern Ontario to the south consists of one 500 kV line from Pinard to Porcupine (D501P) and south to Hanmer (P502X) and the 115 kV parallel transmission that connects Hunta to Ansonville TS (A4H and A5H) to Kirkland Lake TS (A8K and A9K) and Dymond TS (D3K). A diagram of the northeastern system is shown in Figure 2.

Northland Power Inc. is planning to increase the capacity of the existing Kirkland Lake GS by 48 MW, through the addition of a sixth generating unit rated at 56.4 MVA to the existing Kirkland Lake GS. Kirkland Lake GS is located in northeastern Ontario near the town of Kirkland Lake and presently consists of five generating units rated between 24 to 29 MVA for a total available capacity of 106 MW. Three of the five units are connected to the 115 kV circuit D3K which connects Kirkland Lake TS to Dymond TS. The remaining two units are connected to the 115 kV line K2. The proposal is to connect the new generating (G6) unit to the 115 kV circuit D3K via a new transformer.

Connection and Data Verification

The new unit (G6) can be connected to the 115 kV circuit from Kirkland Lake to Dymond (D3K) or to the 115 radial connection of Kirkland Lake TS (K2). However, the continuous current carrying capability of K2 is insufficient to accommodate the net increase of 41 MW of power flowing into Kirkland Lake TS.

The IMO requires that the new unit be connected to D3K via the existing 2 km of 115 kV circuit which presently connects the existing G1, G2 and G3. The new unit will be connected via a low voltage breaker, a step-up transformer (13.8 / 138kV) rated at 85 MVA and a high voltage breaker.

At the time of application, the connection applicant did not provide actual data for the generator unit excitation system, stabilizer and governor models. It has been agreed with the applicant that typical data will be used in the System Impact Assessment, with the understanding that all of the required information will be supplied when available.

> The IMO requires that Northland Power Inc. submit models for the actual excitation, stabilizer and governor systems for review and approval as soon as the information becomes available but before installation, because assumed data was used to complete the SIA studies.

The new 56.4 MVA generating unit is to be connected via an 85MVA step-up transformer. The information provided with the application specified that the step-up transformer impedance is 18% on an 85 MVA base, which is equivalent to 12% on the generator rating. The 12% equivalent transformer impedance satisfies the generator's reactive constraints required by the market rules.

> In order to satisfy the generator's reactive constrains required by the market rules, the IMO requires that the generating power capability connected via this particular transformer be kept at 56.4 MVA or lower.

Impact on Fault Levels

The study results show that the incorporation of the sixth generator at Kirkland Lake will result in an increase in the *total* fault currents seen at the neighbouring stations for 3-phase faults and line to ground faults. However, the resulting fault levels are well below the short circuit interrupting capability of the breakers at the respective stations.

Transient Stability

The transient stability study results indicated that with the proposed development incorporated, which amounts to a total station maximum output of 140 MW, and under conditions of flow south (P502X, A8K and A9K) higher than 785 MW (including margin) the D3K relay margin criterion is violated. In the event of loss of P502X this would result in the tripping of the 115 kV circuit D3K and the islanding of the Northeastern system.

> The IMO requires that under conditions of flow south higher than or equal to 785 MW the total output of the Kirkland Lake GS be restricted to 106 MW.

Thermal Loading Considerations

The results of power flow studies conclude that with the sixth unit in service at Kirkland Lake GS under very hot weather conditions D3K could become thermally overloaded in *pre contingency* situations. Also under most situations, for ambient temperature higher than 20^0C D3K will become thermally overloaded in *post contingency* for the loss of P502X.

The IMO requires that Northland Power install generation rejection facilities to be triggered by the loss of P502X to alleviate the post contingency overloading of D3K. The units must be tripped within 250 ms from the detection of the line loss. The design of the G/R scheme must be carried out jointly with the transmitter.

System Enhancements Recommendations

The reliable operation of the Northeastern Ontario transmission system relies heavily on generation and load rejection schemes. Originally, these special protection systems were installed as an interim measure to avoid the bottling of NE generation until the NE transmission reinforcement project could be completed. However, due to decisions made in the late ‘80s this work has been deferred indefinitely.

As part of this SIA the IMO examined briefly options of strengthening the transmission interface between Kirkland Lake TS and Dymond TS.

One alternative would be installing a second 115 kV line in parallel with D3K. Studies showed that an identical parallel line to D3K between Kirkland Lake TS and Dymond TS could eliminate the requirements for limiting the Kirkland Lake output to 106 MW for high flows south and installation of generation rejection scheme for contingency situations.

Another option would be to build a 230 kV line between Dymond TS and Kirkland Lake TS into a 230/115 kV transformer at Kirkland Lake and continue with a 230 kV line into Ansonville TS. This alternative would complete the 230 kV transmission path between Porcupine TS and Hanmer TS thus strengthening this electrical interface.

IMO recommends that Hydro One consider the options for reinforcing the transmission in the Northeastern Ontario.

1.0 Introduction

Northland Power Inc. has submitted a proposal to increase the capacity of the existing Kirkland Lake GS by 48 MW, through the addition of a sixth generating unit rated at 56.4 MVA to the existing Kirkland Lake GS. Kirkland Lake GS is located in northeastern Ontario near the town of Kirkland Lake and presently consists of five generating units rated between 24 to 29 MVA.

The Preliminary Assessment for this proposal was omitted because a cursory look at the impact of this project indicated that the main reasons for concern are related to the effect of the new proposal on the system transfer capability. In addition, no other related applications for connections have been received, hence Northland Power is the only candidate in this cluster. For these reasons the IMO initiated a System Impact Assessment which also covered assessment aspects that are normally addressed by the Preliminary Assessment.

The existing generating station is equipped with five generating units with a maximum capacity of 106 MW. Three of the five units are connected to the 115 kV circuit D3K which connects Kirkland Lake TS to Dymond TS. The remaining two units are connected to the 115 kV line K2. The proposal recommends to connect the new generating (G6) unit to the 115 kV circuit D3K via a new transformer.

The proponent provided information regarding the maximum capacity of each unit for summer and winter as shown in Table 1 below.

Table 1. Kirkland Lake GS Maximum Capacity

Unit #	Type	Summer Maximum (30^0C)	Winter Maximum (-10^0C)
G1	Gas Turbine -01	17.9	23
G2	Gas Turbine - 02	17.9	23
G3	Steam Turbine - 02	14	15
G4	Gas Turbine - 03	17.9	23
G5	Steam Turbine - 01	19	20
G6	Steam Turbine - 03	41.5	41
Station Load		4.6	4.8
Net Station Output		**123.6 MW**	**140.2 MW**

Although G6 is rated at 48 MW Northland Power indicated that the unit will be capable of a maximum output of 41.5 MW only. The proposed in service date for the new generating unit is September 2002.

The connectivity arrangement at Kirkland Lake GS is shown in Figure 1.

The purpose of this study was to investigate any impact that the proposed new generation may have on the power transfer capability of the northeastern transmission system and identify any measures that the proponent must take to mitigate the impact of their new connection. The assessment also briefly addressed the need for northeast transmission system reinforcement.

2.0 Connection Verification

Physically, the new unit (G6) can be connected to the 115 kV circuit from Kirkland Lake to Dymond (D3K) or to the 115 radial connection of Kirkland Lake TS (K2). However, the continuous current carrying capability of K2 is insufficient to accommodate the net increase of 41 MW of power flowing into Kirkland Lake TS.

Thus, it is recommended that the new unit be connected to D3K via the existing 2 km of 115 kV line (shown in Figure 1 between points A and B), which presently connects the existing G1, G2 and G3. The new unit will be connected via a low voltage breaker, a step-up transformer (138-13.8 kV) rated at 85 MVA and a high voltage breaker, which was designated as 52P3 in the single line diagram that was provided by Northland Power (1245XE01). A short tap will be built from the 52P3 breaker to the 2 km line connecting to D3K. This 2 km line is equipped with 477 MCM, ACSR conductor. Hydro One has informed us that the line sag clearance corresponds to an operating temperature of 82^0C. Based on this information the line continuous rating is 110 MVA and 133 MVA for the summer and winter, respectively. The continuous line rating is sufficient to accommodate the maximum output of the four units (G1, G2, G3 and G6).

The Transmission System Code specifies that the standard transformer winding connection is LV delta and HV wye and that any other winding configuration has to be approved by the transmitter. The configuration selected for this project, where the high side of the transformer is delta connected and the low side is grounded wye, is similar to the existing step-up transformers to which the other units are connected. It has been acknowledged by Hydro One that this configuration was requested by Hydro One.

The Market Rules require that any generator facility connected to the IMO controlled grid must have the capability to supply reactive power within the range 90% lagging and 95% leading based on rated active power and that the terminal voltage at full output must be ± 5% of the rated generator voltage. The typical generator capability curves provided with the application meet these Market Rules requirements.

3.0 Data Verification

At the time of application, the connection applicant did not have actual data for the generator unit and excitation system, hence typical data was provided. This data was used in the transient stability studies performed by the IMO. In addition the IMO included with the proponent's generator model a typical speed governing module - IEEE Type 1 governor model- which has not been provided by the proponent.

It has been agreed with the applicant that typical data will be used in the System Impact Assessment, with the understanding that all of the required information will be supplied when available. Then, the IMO will perform the necessary analysis for ensuring that the actual proposed development meets the Market Rules requirements.

The information submitted with the assessment package indicates that an 85MVA step-up transformer will be installed to connect the 56.4 MVA generating unit. The transformer impedance is 18% on 85 MVA base, which is equivalent to 12% on the generator rating. The 12% equivalent transformer impedance satisfies the generator's reactive constraints required by the market rules. However, any future increase in the capability of generating power behind this particular transformer will be considered to increase the transformer apparent impedance beyond an acceptable value.

4.0 Fault Levels Analysis

A study was performed to determine if the addition of G6 at Kirkland Lake GS would have an effect on the fault currents at the neighboring transformer and switching stations. The results of the short circuit studies are presented in Table 2 below.

Table 2. Fault Levels Calculations

Fault Location	Breaker Rating (kA)	G6 Status	Prefault Voltage	Symmetrical Total Fault (kA)		Asymmetrical Total Fault (kA)	
				3-phase	LG	3-phase	LG
Kirkland Lake 115 kV	10.5 sym	O/S	127	5.3	4.49	5.8	5.16
	11.4 asym	I/S	127	6.3	4.92	7	5.66
Kirkland Lake 44 kV	12.6 sym	O/S	48.3	5.7	7.25	6.6	8.37
		I/S	48.3	6.0	7.64	7.1	8.95
Dymond 115 kV	40 sym	O/S	127	8.4	9.24	10	10.66
	47.5 asym	I/S	127	8.6	9.41	10.1	10.68
Ansonville 115 kV	40 sym	O/S	127	5.4	6.46	5.7	6.99
	47.5 asym	I/S	127	5.5	6.59	5.9	7.1

The study results show that the incorporation of the sixth generator at Kirkland Lake will result in an increase in the *total* fault currents seen at the neighbouring stations for 3-phase faults and line to ground faults. However, the resulting fault levels are well below the short circuit interrupting capability of the breakers at the respective stations. The fault current (marked in yellow in Table 2) that is closest to the breaker capability is at 61% of the breaker current rating.

5.0 Existing System and Transfer Capability

The northeastern Ontario power system covers the area north of Sudbury and east of Wawa stretching all the way to the Quebec border. The northeastern transmission system incorporates many generation resources that are used to supply local demand and demand in southern Ontario. The *main interface* that facilitates the transfer of power from the northeastern Ontario to the south consists of one 500 kV line from Pinard to Porcupine (D501P) and south to Hanmer (P502X) and the 115 kV parallel transmission that connects Hunta to Ansonville TS (A4H and A5H) to Kirkland Lake TS (A8K and A9K) and Dymond TS (D3K). A diagram of the northeastern system is shown in Figure 2.

Currently, with all transmission elements in service the excess generation in the northeastern Ontario can be directed to the south via the *main interface.* On a typical day, as the generators follows their economic schedule and the loads follow their daily and seasonal changes, the balance of the generation and load will flow on the P502X/AnsonvilleXKirkland Lake interface. Typically, in the daytime the flow south across this interface could reach close to 900 MW. At night, the flow reverses direction and typically ranges from 200 to 450 MW flow north.

A high flow south on the *main interface* is possible providing that sufficient generation is armed to be rejected for the loss of P502X to ensure that the post-fault flow on the remaining 115 kV lines (A8K and A9K) does not exceed 40 MW. At all times the generation armed for rejection is as close as possible to, but not less then the sum of flows on P502X at Porcupine and A9K and

A8K at Ansonville less 40 MW. In reality however, the post contingency flow on A8K and A9K is not exactly 40 MW because some load might be lost when rejecting the generation.

If the corrective actions described in the above paragraph are not met, a contingency on the 500 kV circuit would result in cascade tripping of the 115 kV interface due to the tripping of D3K. The area north of this interface will therefore become an electrical island and will most probably collapse.

Presently, the output of Kirkland Lake GS is limited to 106 MW at all time to ensure that the synchronism between the two systems is maintained after the loss of P502X.

Historical information obtained for year 2000 indicates that about 4% (Figure 5.2) of the time the flow on P502X was above 785 MW and that occurred between May and July as shown in the figures below.

Figure 5.1 Flow on P502X for Year 2000

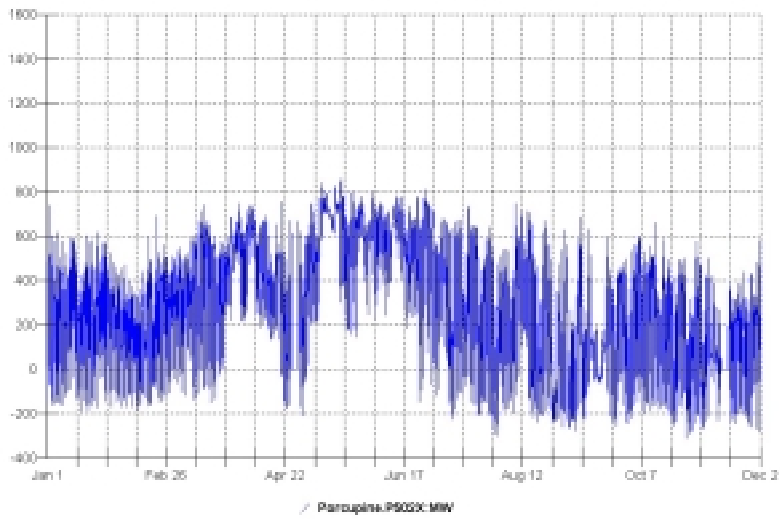
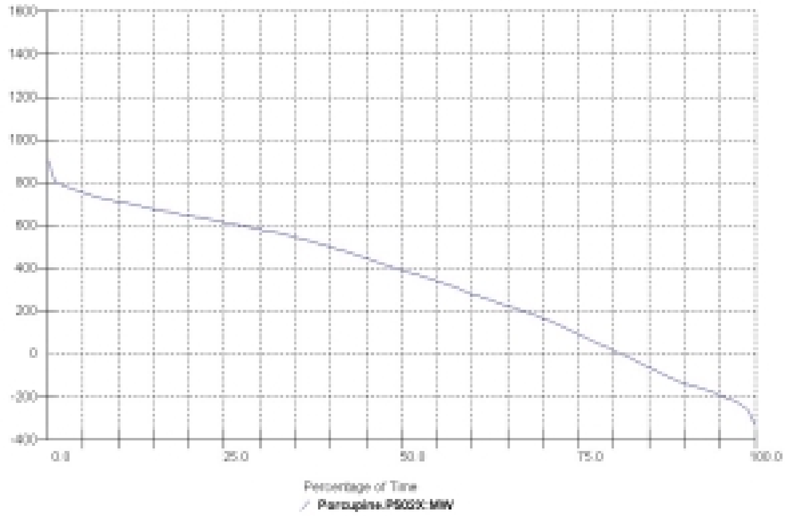


Figure 5.2. Distribution of P502X Flow



6.0 SIA Study

The scope of the SIA study was to find the impact that the new connection proposal will have on the transmission system capability and the operating security limits. The main focus of the studies was to determine the conditions that must be met in order to ensure that in the event of loss on the 500 kV line P502X, the cascading tripping of the 115 kV line D3K does not occur.

All analysis was performed with the existing system configuration, since no other new facilities have been committed in the area, under summer peak load and generation conditions. The studies were performed for a system with all elements in service under conditions of high flow south on the *main interface*. Six units were assumed to be in service at Kirkland Lake GS (G6 connected to D3K) with a total output of 123.6 MW. In some scenarios, the particular generation schedule was selected with the purpose of creating the onerous post fault system conditions.

6.1 Transient Stability Assessment

Transient stability studies simulated normally cleared phase to phase to ground faults on P502X at Pinard and the triggering of sufficient generation rejection in the northeast to ensure that the post fault flow on A8K and A9K does not exceed 40 MW. Simulations attempted to replicate real system operating procedure as described in section 5 above and to identify if the addition of G6 at Kirkland Lake would have a negative impact on the present limits.

To achieve levels of maximum power flow south most of the generation in the northeastern Ontario was simulated at full output.

Under conditions of very high flow south the studies looked at the possibility of accommodating the full output of Kirkland Lake GS provided that two units are rejected in the post fault (units G2 (GT-02)and G4 (GT-03) were selected as indicated by Northland Power).

The results of the transient stability studies are tabulated below in Table 3.

Table 3. Results of Transient Studies.

Case	Pre contingency Flow (MW)	Gen. Rej. @ KL	Transient Results	D3K Relay Margin % @K
	P502X+A8K +A9K			
Existing system	**890**		Stable	13%
With G6 at Kirkland Lake In Service				
A	896 - 4 = **892**	none	Stable	-31.09
B	857-10= **847**	none	Stable	1.0
C	814+11= **803**	none	Stable	37.35
With G/R at Kirkland Lake G2&G4				
D	896 - 4 = **892**	250 ms	Unstable	-
E	896 - 4 = **892**	180 ms	Stable	27.26
F	896 - 4 = **892**	180 ms for all NUG's	Stable	47.52

For present system configuration, the results of post contingency studies which simulated the loss of P502X and generation rejection showed that for transfers of about 890 MW across the 'P502X +A9K+A8K' interface the system remains stable and the D3K relay margin meets the system stability criteria.

The results shown in A, B and C in table 3 are for cases with G6 at Kirkland Lake incorporated and no post contingency generation rejection at Kirkland Lake. The studies indicate (case A) that with G6 unit in service and with transfers of approximately 890 MW, the relay margin for D3K would be violated in event of the loss of P502K. The interface flow was then reduced to approximately 850 MW and the studies were repeated (case B). The results indicate that immediately after the loss of P502X, it is not possible to maintain the D3K relay margin criterion of 10%. With the interface transfers reduced further to approximately 800 MW (case C), the studies showed that for a fault on P502X the D3K relay margin criterion is respected. Assuming that a linear relationship exists between flow and relay margin and extrapolating between cases B and C, it could be calculated that at about 830 MW flow on the interface the D3K relay margin criterion is respected. Consequently, from the perspective of relay margin and transient stability, the full output summer output of 123.6 MW could be incorporated for certain levels of flow across the 'P502X +A9K+A8K' interface.

Due to inaccuracies in telemetered flow values, G/R timing and load losses, the IMO has included a margin of 5% in the northeastern region operating limits. Hence, although the study results presented in the first half of Table 3 would indicate that the sixth unit at Kirkland Lake could be accommodated for flows lower than 830 MW, in practice the proposed development can be accommodated for flows south on the *main interface less than or equal to 785 MW*, allowing for a margin of about 5%.

Additional studies were performed to determine whether or not rejecting some of the Kirkland units for the loss of P502X would help the situation. The results are listed in the second half of Table 3 (cases D to F).

As a start, a typical rejection time of 250 ms was selected for G2&G4 at Kirkland Lake GS. This represents an estimate of the actual generation rejection times for all the existing generators in the Northeastern Ontario that employ leased communication facilities.

Case D indicates that for an interface transfer of about 890 MW, with the units at Kirkland Lake rejected in 250 ms the system becomes unstable after the loss of P502X.

Case E shows the results for the same conditions, but with units G2&G4 rejected in 180 ms. The generation rejection time of 180 ms represents the speed of the Moose River generation rejection facilities (the scheme is equipped with PLC and dedicated fiber-optics communication channels). For this situation the system remains stable and the relay margin criterion on circuit D3K is respected.

Case F indicates that if all the generation in the Northeastern Ontario would by equipped with 180 ms generation rejection facilities then after the loss of P502X the system would continue to remain stable and the "system apparent impedance" at Kirkland Lake would be even further away from the D3K relay characteristic.

From cases A and D it could be concluded that the addition of the proposed development may lower the existing system transfer capability under conditions of high flow south and that slow generation rejection does not represent a viable solution for the incorporation of the proposed development. However, it seams that by speeding up the generation rejection scheme to 180 ms (case E) the system remains stable and the relay margin on D3K is respected. These results would seam to indicate that by installing a *fast G/R scheme* at Kirkland Lake, G6 could be incorporated without any restriction.

However, in order to reduce the rejection time from 250 ms to 180 ms the communication link between Porcupine, from where the G/R signal originates, and Kirkland Lake GS would need to be enhanced. This would likely require the installation of a fibre-optics connection between Ansonville and Kirkland Lake GS. It has been assumed that the cost of this option would be prohibitive, and has therefore not been pursued.

In addition, these results would indicate that the balance between keeping the system together and running into system instability depends on a 70 ms difference in the generation rejection times. This represents a very small margin of reliance for system stability assurance, especially since in practice it would be very difficult to take an exact measurement of generation rejection times.

It is important to note that these results were obtained for system conditions with all available generation in the Northeast in service and all transmission elements in service. For different generation dispatch or various transmission outage conditions study results may indicate that more stringent operating limitations must be imposed.

Additional studies will have to be performed by the IMO to determine if a new operating limit based on transient stability must be developed for this area (the transient limit is to be set at a power transfer which is 10% below the system transient break point). These studies have not been performed as part of this project because it was felt that they are outside that scope of this work.

6.2 System Voltage Requirements

Kirkland Lake TS is equipped with one 12 MX automatically switchable capacitor, SC11, that can be used for steady state voltage control or selected either to switch in during an undervoltage condition or to switch out during an overvoltage condition. The undervoltage and overvoltage capacitor's switching are set at 111 kV and 132 kV, respectively. The normal operating voltage at Kirkland Lake is around 122 kV and it is expected that the addition of the proposed development at Kirkland Lake will help maintain the voltage in the area in steady state situation and improve the voltage decline situation during various contingencies.

6.3 Thermal Loading Considerations

As identified in section 6.1 the 115 kV line D3K constitutes the weak link in the subject transmission interface. In addition to relay margin concerns expressed above, this circuit could also become thermally overloaded under particular system conditions. The 115 kV circuit is equipped with 477 MCM, ACSR conductor with a thermal loading capability as shown in Table 4 below.

Table 4. Thermal Rating for 115 kV Circuit D3K

Summer Rating (MVA)*			Winter Rating(MVA)*		
Ambient T	Continuous	15 min LTR	Ambient T	Continuous	15 min LTR
20^0C	121	131	-10^0C	151	167
30^0C	109	117	0^0C	140	155
35^0C	100	110			

* Calculations are based on 115 kV voltage.

The thermal ratings calculations show that during the summer, for temperatures higher than 20^0C the 15 minute limited time rating is below 131 MVA (111 MW).

In order to assess the contribution of the proposed generation to the line loading, studies were performed to obtain transfer distribution factors (TDF) for the generation connected directly to D3K. The results show that, with all elements in service in steady state 54% of power is distributed towards Kirkland Lake and 46% towards Dymond TS. Hence, G6 would contribute about 19 MW to the flow south on D3K.

A cursory calculation of pre contingency flows on D3K shows that under hot weather conditions (35^0C) power flows on D3K could be above the continuous rating of the line. Hence, *the addition of the sixth generator at Kirkland Lake GS may create congestion on D3K under certain operating scenarios.* However the competitive electricity market has been designed to resolve transmission congestion issues through the re-dispatch of most expense generation and not attribute congestion to the mast recently connected projects. Hence the burden of congestion on D3K will be shared by all Northeastern generators.

A calculation of generation and load balance in post fault conditions at Kirkland Lake indicates the following:

(a) D3K post fault flow$_{(summer)}$ = 124 $_{(generation)}$ +40 $_{(A8K+A9K)}$ – 30$_{(Kirkland\ Load)}$ = 134 MW

(b) D3K post fault flow$_{(winter)}$ = 140 $_{(generation)}$ +40 $_{(A8K+A9K)}$ – 30$_{(Kirkland\ Load)}$ = 150 MW

The results of power flow studies shown on Table 5 confirm the calculations discussed above and conclude that with the sixth unit in service at Kirkland Lake GS;

- Under very hot weather conditions D3K could become thermally overloaded in pre contingency situations, and
- under most situations, for ambient temperature higher than 20^{0}C D3K will become thermally overloaded in post contingency for the loss of P502X. The post fault thermal overloading is above the 15 minute limited time rating.

Table 5. D3K Thermal Loading

Pre Contingency Flow P502X+A8K+A9K	Pre Contingency Flow D3K	Post Contingency Flow A8K+A9K	Post Contingency Flow D3K
896 - 4 = **892**	92	27	117[1]
857 - 10 = **847**	85	25	118
814 – 11 = **803**	86	35	128[2]
728 - 22= **706**	72	39	130

6.4 SIA Study Conclusions

Based on the results of the SIA study, it is concluded that addition of the proposed new generator at Kirkland Lake GS will result in a reduction of the existing system transfer capability under conditions of high flow south. One option has been identified which will mitigate the above adverse reliability impacts. This alternative is described below.

Apply the following measures for mitigating the impact on reliability:

(A) For flows south of 785 MW or higher as measured on circuits P502X, A8K and A9K, limit the total output of Kirkland Lake GS to 106 MW in order to prevent tripping of circuit D3K by its relay at the Kirkland Lake terminal following the loss of P502X; and,

(B) For flows south less than 785 MW as measured on P502X, A8K and A9K at Kirkland Lake, implement up to 41 MW of generation rejection triggered by the loss of P502X (to limit the post-contingency station output to 106 MW). As Northland Power indicated, the units selected for rejection should be G2 and G4. The units must be tripped within 250 ms from the detection of the line loss.

[1] Tunis GS and Northland Power Cochrane GS were rejected.
[2] Tunis GS and Northland Power Cochrane GS were not rejected.

During this assessment it became evident that a more permanent solution must be found to alleviate the weakness of the northeastern portion of the IMO-controlled grid. It would be advantageous for the proponent and the IMO to avoid the requirement for operating restrictions, although they are valid and achievable. The special protection systems (G/R and L/R) in the Northeastern Ontario system were originally installed as a temporary measure until the transmission reinforcement plan implementation. The reinforcement plan did not materialize and in the meantime more generation was added to the region which required increased reliance on the SPS's to a point where it is felt that the reliability of the system could be jeopardized.

The IMO also examined the alternative of strengthening the transmission path between Kirkland Lake TS and Dymond TS. One alternative would be installing a second 115 kV line in parallel with D3K. Studies showed that an identical parallel line to D3K between Kirkland Lake TS and Dymond TS could eliminate the requirements for limiting the Kirkland Lake output to 106 MW for high flows south and installation of generation rejection scheme for contingency situations.

Another option would be to build a 230 kV line between Dymond TS and Kirkland Lake TS into a 230/115 kV transformer at Kirkland Lake.

7.0 Generator Underfrequency Tripping Requirements

The Market Rules require that generating facilities be able to operate continuously at full power for a system frequency range between 59.4 to 60.6 Hz. For underfrequency system conditions the generators shall not trip for frequency variations that are above the curve shown in Figure 3. However, if this cannot be achieved then automatic load shedding equivalent to the amount of generation to be tripped must be provided in the area. This criterion is required to ensure the maintenance of the stability of an island, if formed, and to avoid major underfrequnecy load shedding in the area.

8.0 IMO Connection Requirements

8.1 The IMO requires that the proponent respect conditions (A) and (B) described in section 6.4 as a requirement for connection to the IMO-controlled grid.

8.2 The IMO requires the proponent to:

- Connect the new unit to D3K via the existing 2 km of 115 kV line that presently connects G1,G2 and G3;
- Provide to the IMO the actual generator data as soon as it is available; and
- Meet the generator underfrequency tripping requirements described in Section 7 of this report.

9.0 Sole Beneficiary

The generation rejection scheme required by the IMO is triggered by and is for the sole benefit of the proponent.

10.0 Cost Estimates

The IMO has requested Hydro One to provide a cost estimate for the installation of a generation rejection scheme for two units at Kirkland Lake GS. Hydro One provided budgetary purpose estimates only and indicated that accurate estimates require a detailed scope of work. The generation rejection facilities for Kirkland Lake GS could cost about $400,000 plus an additional monthly costs for leasing the communication channels of $15,000 a month. These cost estimates are for G/R facilities that are similar to those that are presently associated with the other non-utility generators in the Northeastern Ontario (G/R occurs in approximately 250 ms).

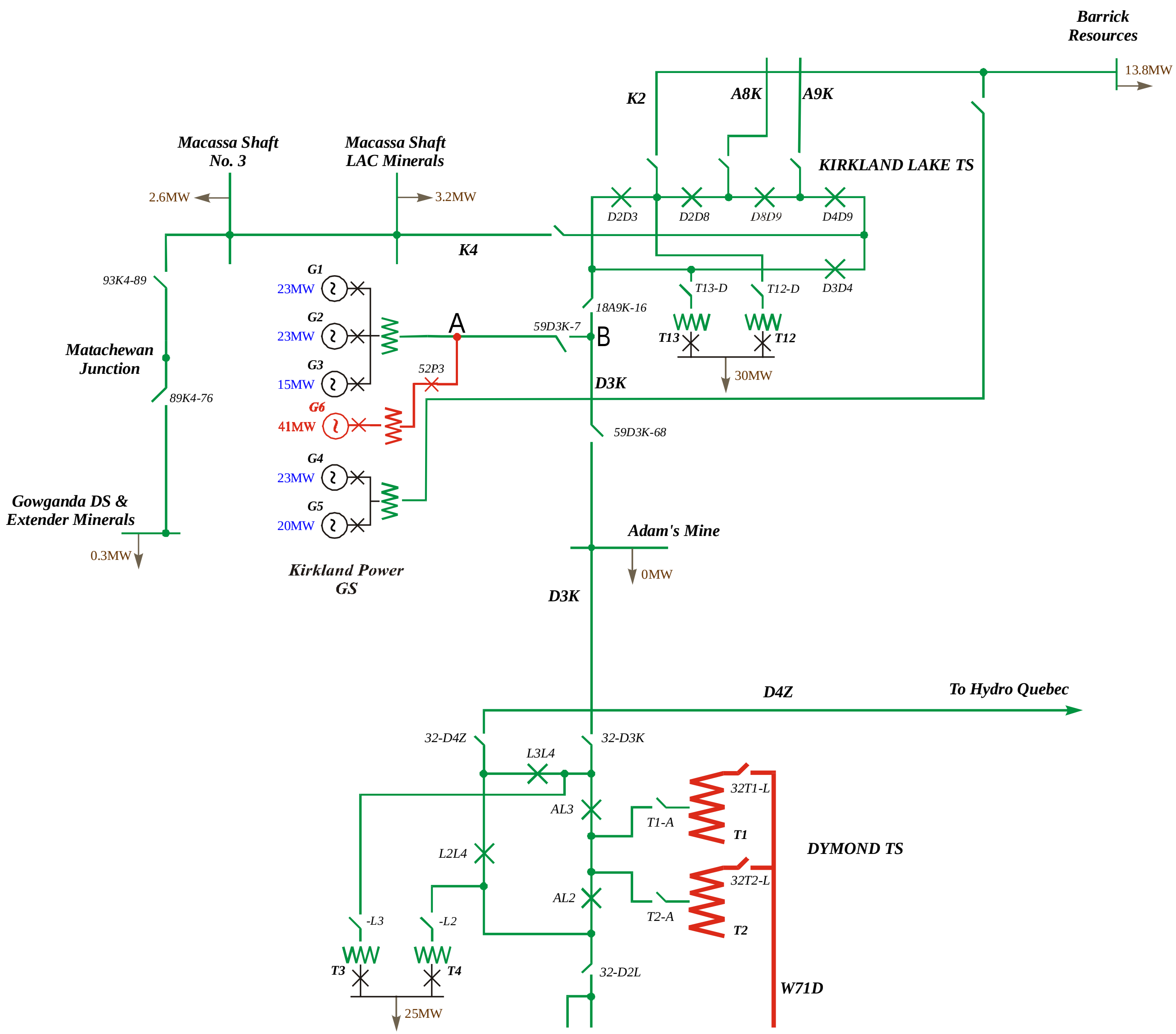


Figure 1. Kirland Lake Area Transmission

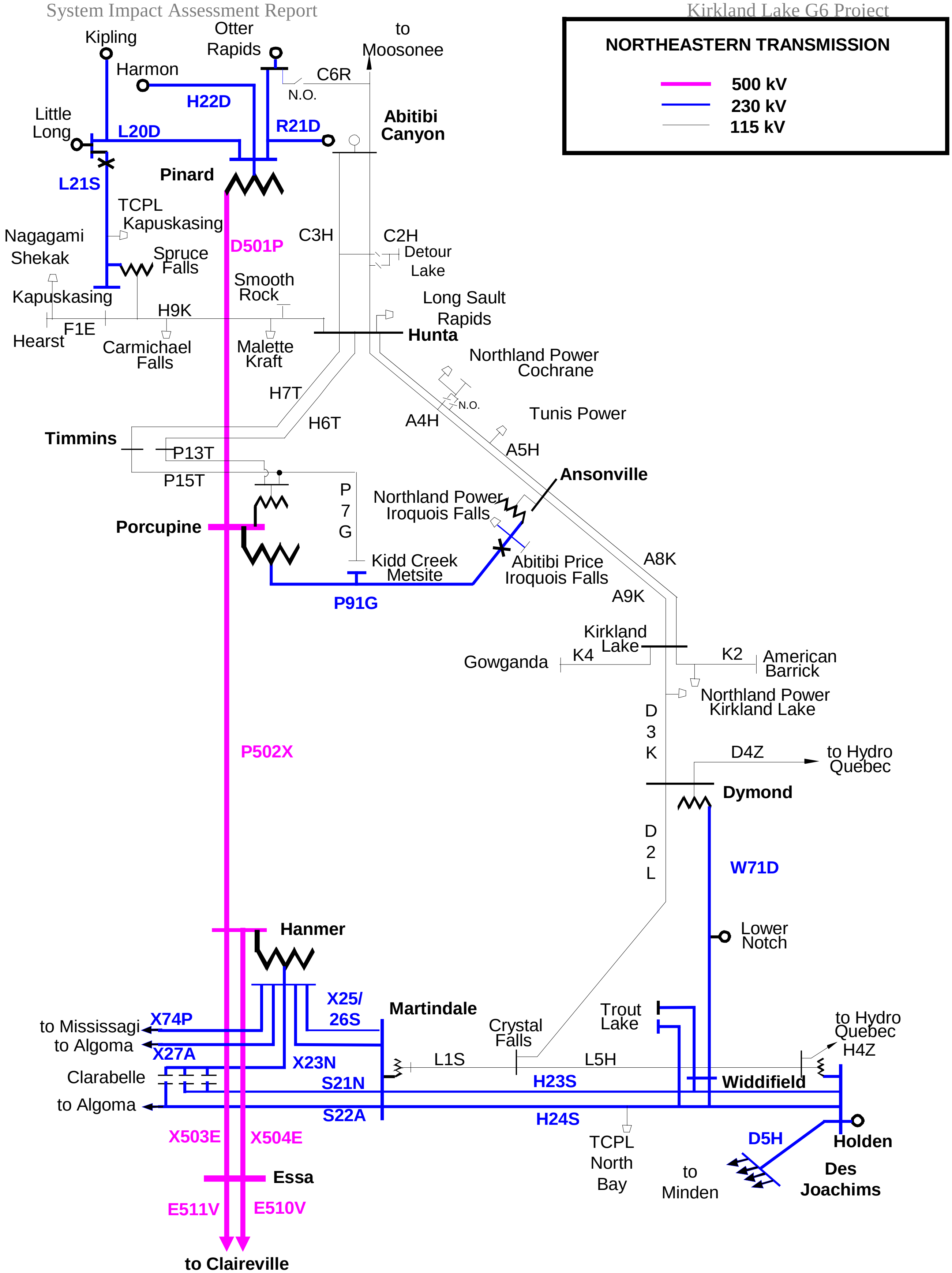


Figure 2. Northeast Transmission System

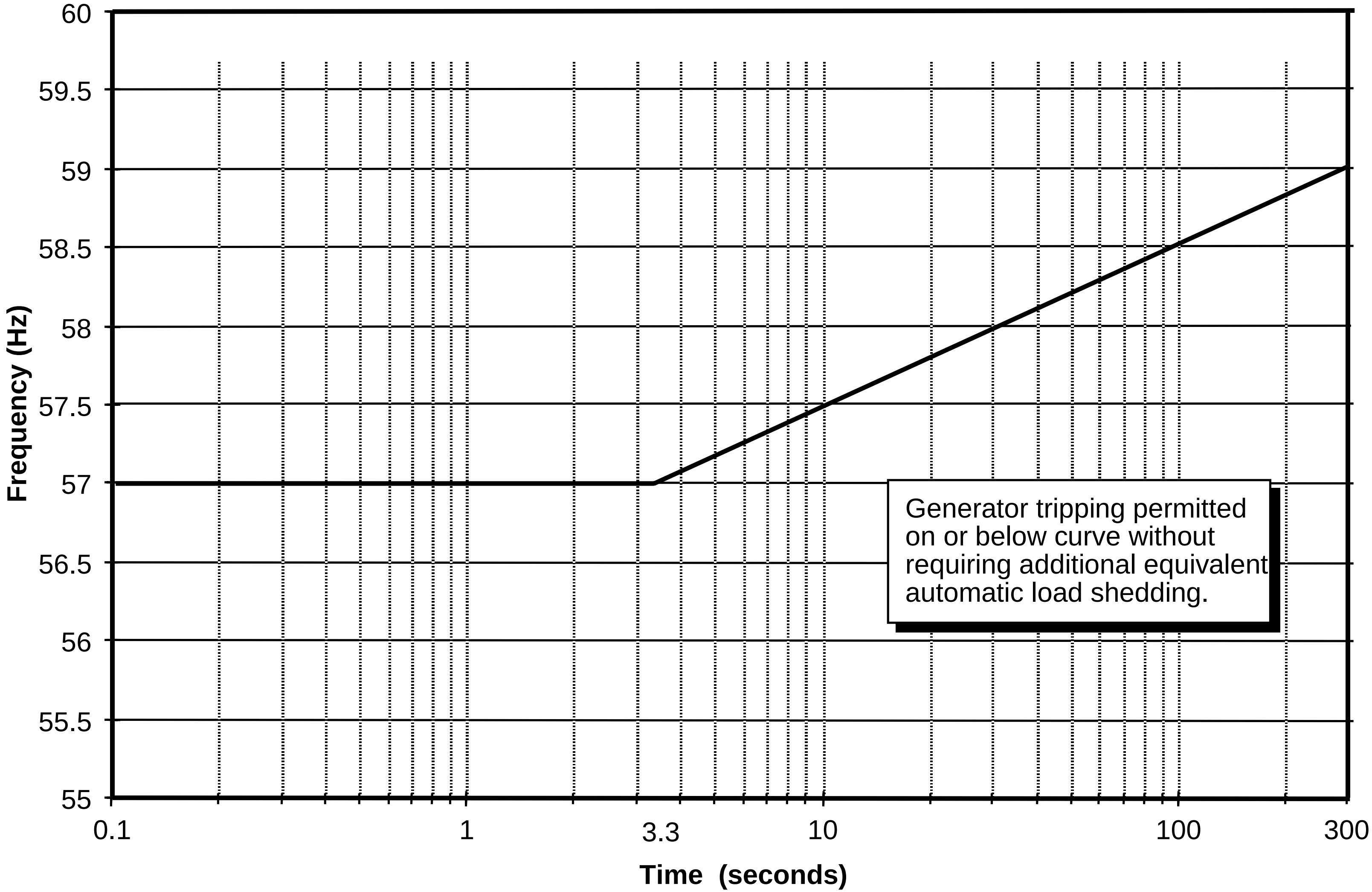


Figure 3. Underfrequency Generator Tripping