REPORT

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System Impact Assessment Report

Upper Mattagami and Hound Chute Generation Development

CONNECTION ASSESSMENT & APPROVAL PROCESS

CAA ID 2006-241

Applicant: Ontario Power Generation Inc.

Transmission Assessments & Performance
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System Impact Assessment Report

Upper Mattagami and Hound Chute Generation Development Project

Disclaimers

IESO

This report has been prepared solely for the purpose of assessing whether the connection applicant's proposed connection with the IESO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IESO should issue a notice of approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules.

Approval of the proposed connection is based on information provided to the IESO by the connection applicant and the transmitter(s) at the time the assessment was carried out. The IESO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by the transmitter(s) at the request of the IESO. Furthermore, the connection approval is subject to further consideration due to changes to this information, or to additional information that may become available after the approval has been granted. Approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed facility to the IESO-controlled grid. However, connection approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter(s) during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with physical or equipment limitations, or with the Transmission System Code, before connection can be made.

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 IESO in accordance with Chapter 4, section 6 of the Market Rules. The IESO assumes no responsibility to any third party for any use, which it makes of this report. Any liability which the IESO 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 IESO provides a draft of this report to the connection applicant, you must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IESO 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

Special Notes and Limitations of Study Results

The results reported in this 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 available 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 OPG) customers.

In this 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 ratings 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 under the current IESO Connection Assessment and Approval process. Additional facility studies may be necessary to confirm constructability and the time required for construction. Further studies at more advanced stages of the project development may identify additional facilities that need to be provided or that require upgrading.

Table of Contents

UPPER MATTAGAMI AND HOUND CHUTE GENERATION DEVELOPMENT IESO SYSTEM IMPACT ASSESSMENT

SIA Findings

Summary

This System Impact Assessment examined the impact on the IESO-controlled grid by the following Upper Mattagami and Hound Chute generation re-development projects.

Station Name	Total Capacity	River System	GS connected to	Expected I/S date
Sandy Falls	6.25 MVA	Mattagami River	Timmins TS	2009 December
Lower Sturgeon	16 MVA	Mattagami River	LaForest DS	2009 December
Wawaitin	17 MVA	Mattagami River	Timmins TS	2009 December
Hound Chute	11 MVA	Montreal River	Dymond TS	2009 December

Based on the analysis, following conclusions are made.

Conclusions

(1) The proposed projects will not cause an adverse material impact on the reliability of the IESO-controlled grid.

(2) The post-contingency voltage declines occurring in IESO-controlled grid due to the loss of any of the generating stations are within required limits.

(3) The automatic excitation systems meet IESO Market Rule requirement on excitation ceiling and response ratio only if operated at unity or at lead power factor.

(4) The transient analysis showed disturbances can create poorly damped oscillations in the distribution system. But the transient behavior of the generators is acceptable to the IESO based on the fact that those oscillations remain confined to the distribution system and do not propagate to the IESO-controlled grid.

(5) If Lower Sturgeon units are operated at rated terminal voltage, the reactive power drawn from the 115 kV bus at LaForest DS will increase more than present level. This new reactive load appearing on HT system can be reduced to present level if the generator voltage is increased and a capacitor is installed at LaForest DS or the tap of 27/44 kV transformer tap is reduced.

IESO's Requirements for Connection

The *Market Rules* do not specify performance standards for non-market participant embedded generators which are smaller than 10 MVA, unless the facility is comprise of generation units whose net output is greater than 50 MVA. However, where a new facility could negatively impact the IESO-controlled grid, the IESO will request the applicant to meet specific minimum technical requirements, regardless of the size of the facility. The size of each proposal is below the above mentioned thresholds and no negative impact on the IESO-controlled grid was identified. Therefore, IESO has the following minimum requirements for the new generation facilities based on the data and models provided to the IESO and the assumptions listed in Section 4.0:

1. The generator must have the capability to supply at its terminal reactive power within the range between 0.9 lag and 0.95 lead power factor based on rated active power at rated voltage.

2. For the Lower-Sturgeon connection, in order to ensure that the reactive power drawn from the LaForest 115 kV bus is maintained at pre-Lower Sturgeon level, (a) or (b) or (c) or (d) must be done.

	Generator Controls	Additional Requirement
(a)	Power factor at terminal to 1.0	Install a 3 MVAr capacitor at LaForest 27 kV bus
(b)	Power factor at LaForest 44 kV bus to 1.0	Reduce 44 kV tap of 27/44 kV transformer to 0.9 pu
(c)	Terminal voltage to 1.05 pu	Install a 5 MVAr capacitor at LaForest 27 kV bus
(d)	Terminal voltage to 1.05 pu	Reduce 44 kV tap of 27/44 kV transformer to 0.9 pu

The proponent has informed the IESO that (d) will be implemented.

3. Each generator must operate near unity or at lead power factor at terminal. The IESO has been informed that it is the intention of the proponent to operate the units in following manner in order to control the distribution system voltage.
   - Sandy Falls, Wawaitin and Hound Chute generators at unity or leading power factor
   - Lower Sturgeon generators near unity power factor

4. The generator under-frequency settings should be set such that the generators do not trip for frequency variations that are above the curve in Figure 1.

5. The performance of the equipment must meet or exceed the predicted performance observed in simulations done by the IESO based on data supplied by the applicant.

6. The registration of the new facilities will need to be completed through the IESO's Market Entry process before any part of the facility can be placed in-service.

7. Presently, it was decided that real-time monitoring is not required from these facilities as they are embedded, minor (< 20 MVA), intermittent, self-scheduling, and further the facilities do not affect the reliability of the IESO-controlled grid. However, in future, if IESO determines real-time monitoring is required, the proponent must provide it.

Notification of Conditional Approval

From the information provided, our review concludes that the proposed changes will not result in a material adverse effect on the reliability of the IESO-controlled grid. It is recommended that a Notification of Conditional Approval be issued for installation of new generators in upper Mattagami generation project subject to the IESO receiving written acknowledgement that the requirements listed in this report will be implemented.

1. Project Description

Ontario Power Generation Inc is proposing to redevelop three hydroelectric generating stations on the Upper Mattagami River. This redevelopment will take place on the sites of the existing end-of-life 25 Hz generating stations at Wawaitin, Sandy Falls and Lower Sturgeon. The Wawaitin and Sandy Falls generating stations are located within the City of Timmins and the Lower Sturgeon generating station is located north of Timmins.

When completed, the combined capacity of the three new generating facilities will be approximately 35 MW. This is an increase of 45 percent capacity of existing 25 Hz stations and will produce electricity at 60 Hz which can be injected directly into the local distribution system.

- The Sandy Falls GS will consist of a single 6.25 MVA generator with maximum unit capacity of 5.5 MW. It will be connected to the 27 kV feeder M7 of Timmins TS, approximately 16 km away from the TS via a 6 MVA 4.16/27 kV transformer.

- The Wawaitin GS will consist of two 8.5 MVA generators with maximum unit capacity of 7.5 MW. They will be connected to the 27 kV feeder M8 of Timmins TS, approximately 24 km away from the TS via a 15 MVA 4.16/27 kV transformer.

- The Lower Sturgeon GS will consist of two 8 MVA generators with maximum unit capacity of 7 MW. They will be connected to a 15 MVA 4.16/44 kV transformer which will be connected to a 44/27 kV transformer located at LaForest DS using a 37 km long circuit. The 44/27 kV transformer is connected to the 27 kV feeder F1 of LaForest DS.

In addition to above upper Mattagami redevelopment, Ontario Power Generation Inc. is also proposing to redevelop the Hound Chute generating station located on the Lower Montreal River, east of the Town of Latchford on the site of the existing generating station. The proposed undertaking will replace the existing facility and when complete will provide an expected capacity of 10 MW to the local 44 kV distribution system. This is an increase from the existing 4 MW capacity.

- The Hound Chute GS will consist of two 5.5 MVA generators with maximum unit capacity of 4.8 MW. They will be connected to the 44 kV feeder M3 of Dymond TS, approximately 27 km away from the TS via a 10 MVA 4.16/44 kV transformer.

– End of Section –

2. General Requirements

Models & Data

The Connection Applicant must complete the IESO Facility Registration process before IESO final approval for connection is granted.

Generators

The generators must have the dynamic reactive power capabilities to supply reactive power continuously at all active power outputs in the range of 0.9 lag to 0.95 lead power factor based on rated active power at its generator terminals.

Protection Systems

Hydro One will have to follow the *Distribution System Code* technical requirements for protection of the respective transformer stations.

Under-frequency Tripping

Appendix 4.2 of the *Market Rul*es requires that generating facilities be capable of operating continuously at full power for a system frequency range between 59.4 to 60.6 Hz. For under-frequency system conditions, generators shall not trip for frequency variations that are above the curve shown in Figure 1.

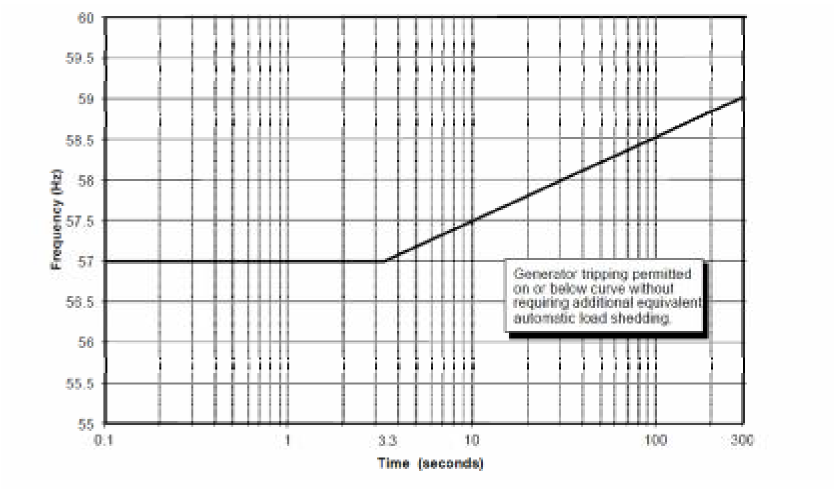

Figure 1: Standards for Setting Under-frequency Trip Protection for Generators

– End of Section –

3. Data Verification

(a) Generator

Following are the data for the GENSAL models provided by the proponent. The saturation parameters S(1.0) and S(1.2) were calculated by the IESO based on the saturation curves provided.

Sandy Falls G1

$T'_{do} = 2.01$	$T''_{do} = 0.02$	$T''_{qo} = 0.08$	H = 1.02	D = 0.0	$X_d = 1.17$
$X_q = 0.70$	$X'_d = 0.342$	$X''_d = 0.28$	$X_l = 0.15$	S(1.0) = 0.0185	S(1.2) = 0.1958

Wawaitin G1, G2

$T'_{do} = 2.86$	$T''_{do} = 0.02$	$T''_{qo} = 0.08$	H = 1.24	D = 0.0	$X_d = 1.23$
$X_q = 0.72$	$X'_d = 0.29$	$X''_d = 0.22$	$X_l = 0.11$	S(1.0) = 0.0442	S(1.2) = 0.3110

Lower Sturgeon G1, G2

$T'_{do} = 2.04$	$T''_{do} = 0.02$	$T''_{qo} = 0.08$	H = 1.01	D = 0.0	$X_d = 1.22$
$X_q = 0.74$	$X'_d = 0.36$	$X''_d = 0.29$	$X_l = 0.15$	S(1.0) = 0.0163	S(1.2) = 0.1733

Hound Chute G1, G2

$T'_{do} = 1.95$	$T''_{do} = 0.02$	$T''_{qo} = 0.06$	H = 1.01	D = 0.0	$X_d = 1.05$
$X_q = 0.64$	$X'_d = 0.31$	$X''_d = 0.25$	$X_l = 0.14$	S(1.0) = 0.018	S(1.2) = 0.1366

(b) Automatic Excitation System

Following are the data for the ESAC8B models provided by the proponent.

Sandy Falls G1

$T_R = 0.005$	$K_P = 207$	$K_I = 343$	$K_D = 36.0$	$T_D = 0.01$	$K_A = 1.0$
$T_A = 0.0$	$T_E = 0.8$	$K_E = 1.0$	E_1, E2 = 1.5, 1.1		
$V_{RMAX} = 2.4$		$V_{RMIN} = 0.0$	S(E1) = 0.1, S(E2) = 0.05		

Wawaitin G1, G2

$T_R = 0.005$	$K_P = 140$	$K_I = 80$	$K_D = 30.0$	$T_D = 0.01$	$K_A = 1.0$
$T_A = 0.0$	$T_E = 0.6$	$K_E = 1.0$	E_1, E2 = 1.5, 1.1		
$V_{RMAX} = 2.4$		$V_{RMIN} = 0.0$	S(E1) = 0.1, S(E2) = 0.05		

Lower Sturgeon G1, G2

$T_R = 0.005$	$K_P = 207$	$K_I = 343$	$K_D = 36.0$	$T_D = 0.01$	$K_A = 1.0$
$T_A = 0.0$	$T_E = 0.8$	$K_E = 1.0$	E_1, E2 = 1.5, 1.1		
$V_{RMAX} = 2.4$		$V_{RMIN} = 0.0$	S(E1) = 0.1, S(E2) = 0.05		

Hound Chute G1, G2

$T_R = 0.005$	$K_P = 208$	$K_I = 349$	$K_D = 35.0$	$T_D = 0.01$	$K_A = 1.0$
$T_A = 0.0$	$T_E = 0.8$	$K_E = 1.0$	E_1, E2 = 1.5, 1.1		
$V_{RMAX} = 2.4$		$V_{RMIN} = 0.0$	S(E1) = 0.1, S(E2) = 0.05		

(c) Governors

No data for governors were available at the time of the analysis.

(d) Feeder Impedances

Following are the impedance of the LV line between the existing load feeder and the new generating station. The impedances in ohm were provided by the Hydro One. The per unit values were calculated by the IESO on 100 MVA base. The charging of the LV load feeders or new LV lines are not available.

Station	Connection configuration	Impedance (ohm)	Impedance (pu)
Sandy Falls	27.6 kV (16 km) to M7 at Timmins TS	3.77 + j 6.89	0.4949 + j 0.9045
Lower Sturgeon	44 kV (37 km) to F1 of LaForest DS	12.76 + j 17.47	0.6593 + j 0.9028
Wawaitin	27.6 kV (24 km) to M8 of Timmins TS	4.79 + j 10.32	0.6288 + j 1.3547
Hound Chute	44 kV (27 km) to M3 of Dymond TS	4.97 + j 11.39	0.2567 + j 0.5883

– End of Section –

4. System Impact Studies

4.1 Assumptions

The following are the default assumptions unless specified.

(1) All transmission elements are in service.
(2) The governors of Sandy Falls, Wawaitin, Lower Sturgeon and Hound Chute generators are out of service. Therefore, the generators have a constant mechanical power input from turbines.
(3) The line charging of LV feeders and LV lines are neglected.
(4) It is assumed that the feeder impedance given in Section 3(d) is between the new generating station and the existing LV busbar. The LV load feeders are not individually modelled. The total P, Q load with a 0.9 lag power factor is withdrawn directly from the LV busbar.
(5) It is assumed 27.6 kV and 44 kV breakers are 8 cycle breakers. That means during the transient simulation in section 4.2, a fault in HV system would open LV breakers 191 ms after the occurrence of the fault.
(6) Following are the assumed impedances for new transformers.

Station	Base voltages	Z in pu
Sandy Falls	4.16/27.6 kV	0.005 + j 0.11 on 6 MVA_{base}
Lower Sturgeon	4.16/44 kV	0.005 + j 0.09 on 15 MVA_{base}
Lower Sturgeon	44/27.6 kV	0.005 + j 0.03 on 20 MVA_{base}
Wawaitin	4.16/27.6 kV	0.005 + j 0.11 on 15 MVA_{base}
Hound Chute	4.16/44 kV	0.005 + j 0.11 on 10 MVA_{base}

(7) The generators have the capability to operate from 0.9 lag to 0.95 lead power factor. The generator reactive power capability limits are calculated based on above power factors.

Station	Qmax in MVAr	Qmin in MVAr
Sandy Falls G1	2.68	1.94
Lower Sturgeon G1 and G2	3.44	2.48
Wawaitin G1 and G2	3.65	2.63
Hound Chute G1 and G2	2.36	1.70

(8) Following are the coincidental peaks for loads in the vicinity of Sandy Falls, Wawaitin, Lower Sturgeon and Hound Chute stations for 2009 under extreme weather conditions obtained from IESO load forecast. The rest of the loads in the province remain at 2007 summer peak conditions.

Weston Lake	Shiningtree	La Forest	Timmins	Dome Gold Mine
3.6 MW	3.4 MW	13 MW	69 MW	18 MW
Hoyle	Kinross	Kidd Creek Mine	Dymond	Kirkland Lake
4.2 MW	13.3 MW	29 MW	33 MW	23 MW

4.2 Transient Analysis

4.2.1 With Constant Excitation

When the Automatic Voltage Regulators (AVR) are out of service, the generators have constant excitation. Then, they provide no voltage control during disturbances. This simulates a scenario, a recovery from a disturbance in IESO-controlled grid that is not assisted by generators which are in distribution system.

Figure 2A shows the variation of rotor angles and electrical power output of Sandy Falls, Wawaitin, Hound Chute and Lower Sturgeon generators and the 115 kV voltages in the IESO-controlled grid in the vicinity of those stations for a LLG fault on P15T at Timmins. The breaker opening times are 116 ms for the 115 kV breakers at Timmins, 141 ms for 115 kV breakers at Porcupine and 191 ms for LV breakers at Timmins and P7G after the occurrence of the fault. The removal of a fault on P15T also disconnects T61S and P7G which includes several loads in the area such as Weston Lake, Shiningtree, Dome mine, Hoyle and Kinross reducing the damping effect on the generator oscillations.

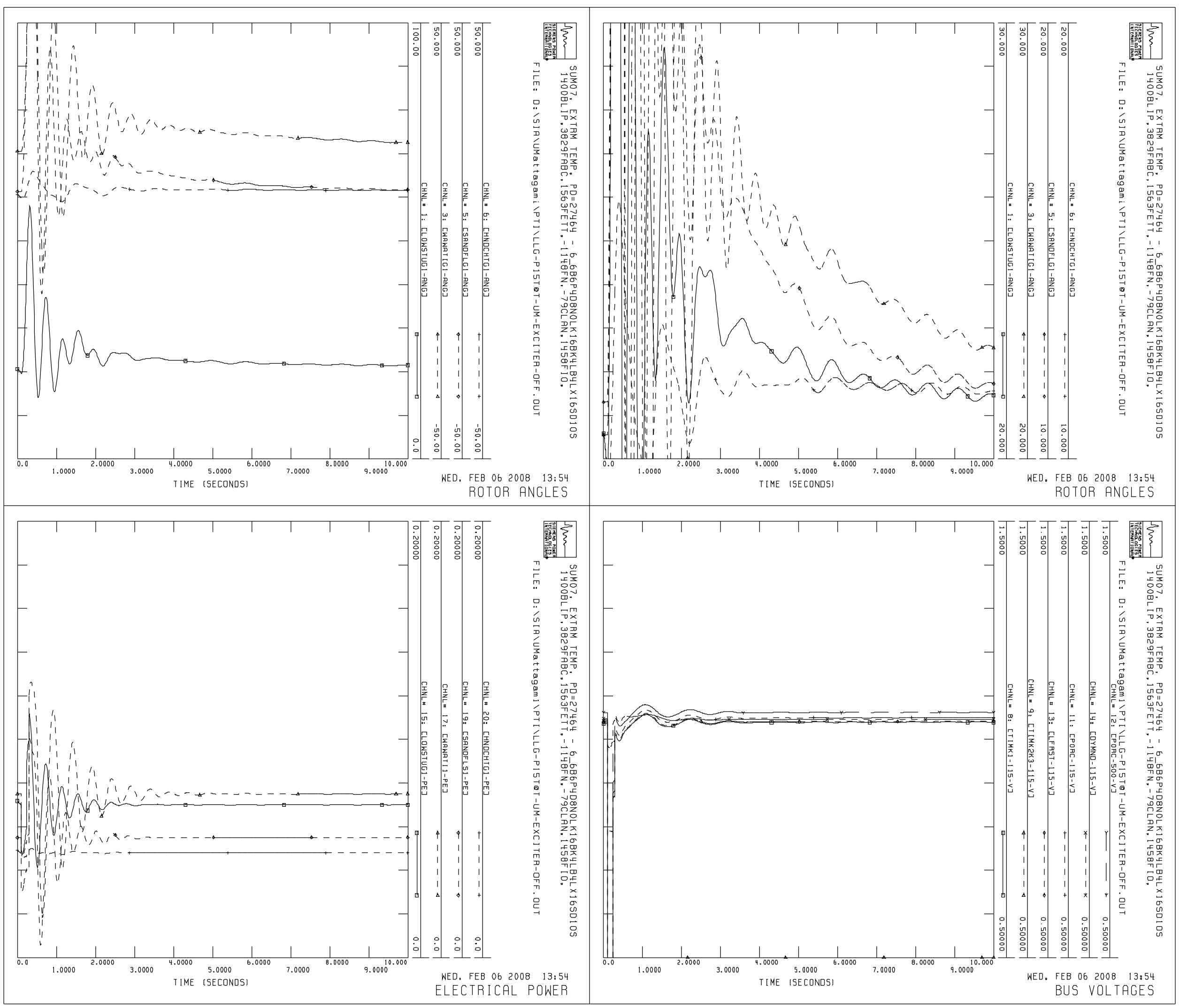

FIGURE 2A – WITH AVR O/S

The rotor angles show low-amplitude oscillations, but the plots of 115 kV voltages show those oscillations have no significantly adverse impact on 115 kV voltages, i.e. the IESO-controlled grid.

4.2.2 With Automatic Excitation

Figure 2B shows the variation of same variables for the same fault as (a), but with AVR of Sandy Falls, Wawaitin, Hound Chute and Lower Sturgeon generators in service.

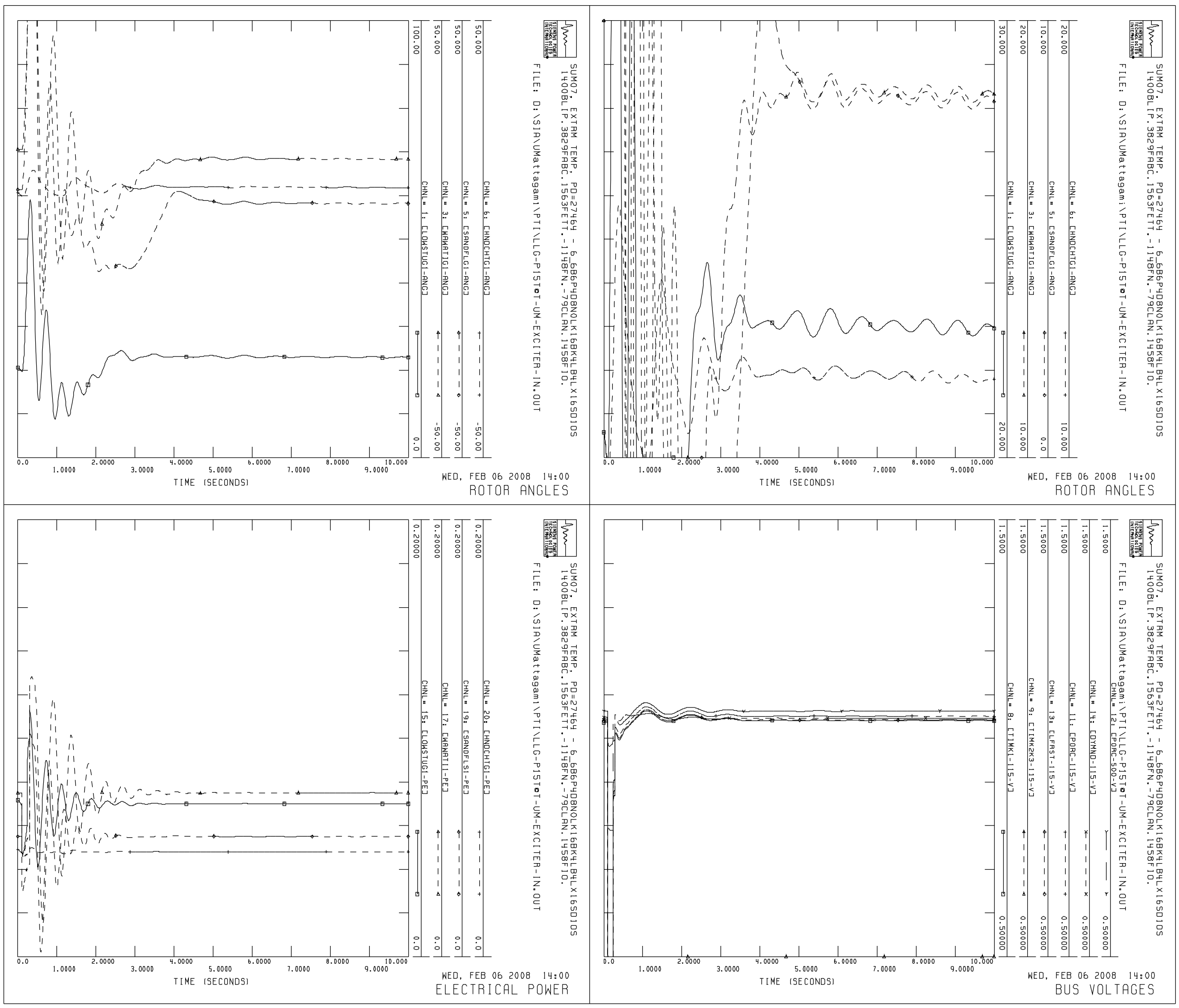

FIGURE 2B – WITH AVR I/S

The rotor angles show low-amplitude oscillations, but the plots of 115 kV voltages show those oscillations have no significantly adverse impact on 115 kV voltages, i.e. the IESO-controlled grid.

4.3 Voltage Control

When a generator is connected to the power system using a relatively long radial line particularly in a distribution network that is connected to voltage-wise strong area in the HT system, there is a potential that the reactive power will flow in to the new connection. Consequently, the voltage in the feeder will rise and in order to maintain voltage, the generators may need to be operated at a leading power factor absorbing reactive power. This will in turn draw more reactive power from the HT system and may appear like a new reactive load on the transmission system.

This scenario is particularly a concern in Lower Sturgeon which is connected using a 43 km long radial line compared to 16 km in Sandy Falls, 24 km in Wawaitin and 27 km in Hound Chute. Therefore, it is necessary to examine the voltages and reactive power flows for the Lower Sturgeon connection.

4.3.1 Lower Sturgeon Voltage Control

The Lower Sturgeon GS will have two generators of maximum unit capacity of 7 MW and will be connected to a 44 kV feeder which is 37 km long and then to 27.6 kV F1 feeder of LaForest DS using 44/27.6 kV transformer. In order to maintain the 27.6 kV voltages within maximum 6 % limit (29.25 kV), the generators will have to be operated at a leading power factor. Then, the distribution network will draw more reactive power from the 115 kV system than existing level which must be mitigated.

The Figure 3 shows the LaForest load for the period of Jan 1 – Aug 1, 2007. This was obtained by summing the power injection into H6T at Hunta and Timmins, thus the losses in H6T have been omitted.

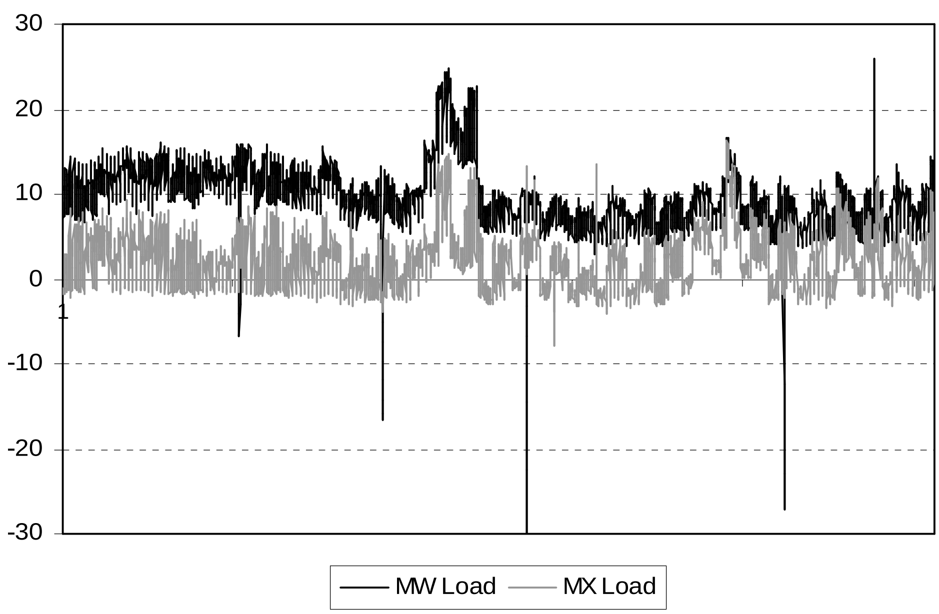

FIGURE 3 – LAFOREST DS LOAD

Mostly the present reactive power load on LaForest 115 kV bus is less than 8 MVAr. Thus, after the Lower Sturgeon is connected, the reactive power load on LaForest 115 kV bus must not exceed this level.

The Figure 4 shows the H6T voltage at Timmins for the period of Jan 1 – Aug 1, 2007. the Timmins voltage seems to be mostly about 129 - 130 kV.

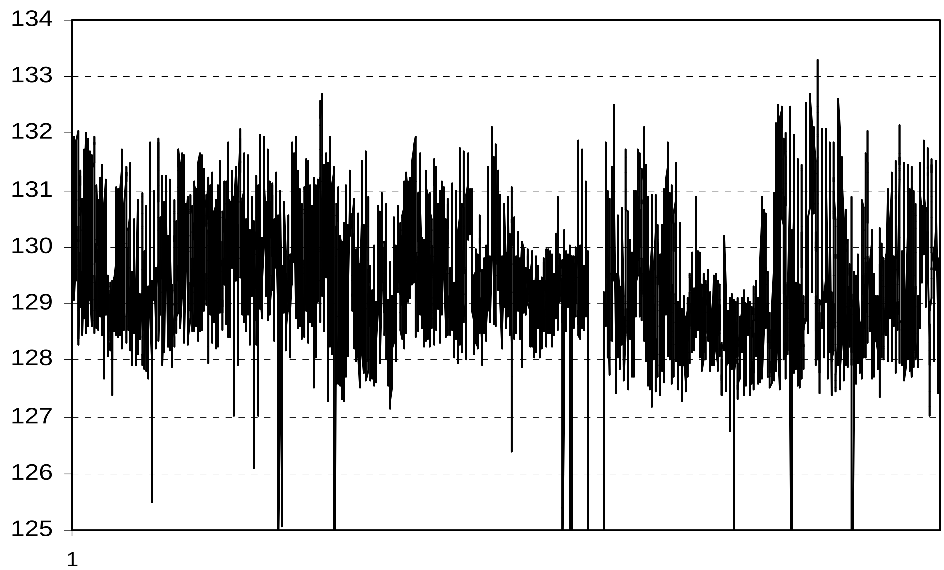

FIGURE 4 – TIMMINS VOLTAGE

(a) Use of capacitor at LaForest

Following Table shows the voltages and reactive power flow in various busbars for,

(a) Pre-Lower Sturgeon
(b) With Sturgeon generators operating at power factor = 1 at terminals
(c) With Lower Sturgeon generators controlling terminal voltage = 1.0 pu
(d) With Lower Sturgeon generators controlling terminal voltage = 1.05 pu

The *Q load* has been defined as the MVAr leaving the bus towards the Lower Sturgeon units.

Lower Sturgeon GS	(a) Pre-LS		(b) PF = 1.0		(c) V_T = 1.0		(d) V_T = 1.05	
	Voltage	Q load	Voltage	Q load	Voltage	Q load	Voltage	Q load
4.16 kV at Low. Sturg.	-	-	4.5 kV	0.0	4.16 kV	4.3	4.3 kV	2.2
44 kV bus at Low. Sturg.	-	-	48.1 kV	1.2	45.4 kV	5.9	46.9 kV	3.5
44 kV bus at LaForest	-	-	45.2 kV	2.7	44.3 kV	7.8	44.8 kV	5.1
27 kV bus at LaForest	28.5 kV	-	28.4 kV	2.9	28.0 kV	8.1	28.2 kV	5.3
115 kV bus at LaForest	123.2 kV	7.3	123.1 kV	10.1	122.6 kV	15.5	122.8 kV	12.5

Since Timmins area voltages are strong, when the new facility is connected, the generators will start absorbing reactive power.

(1) Generators operate at power factor control (controlling the power factor to unity) would increase the terminal voltage to 4.5 kV and increase the reactive power drawn from the LaForest 115 kV bus to 10 MVAr. Thus, a 3 MVAr capacitor is required.
(2) Generators operate at voltage control (controlling the terminal voltage to 1.05 pu) would increase terminal voltage to 4.3 kV and increase the reactive power drawn from the LaForest 115 kV bus to 12.5 MVAr. Thus, a 5 MVAr capacitor will be required.

In essence, the increased reactive withdrawal from IESO-controlled grid can be reduced by using a capacitor and operating the generators at an increased voltage. For example, the generator voltages can be increased up to 1.05 pu and a 5 MVAr capacitor can be installed at LaForest 27 kV bus. Then, the reactive withdrawal from 115 kV LaForest bus can be limited to about present 8 MVAr level. Still the LaForest 27.6 kV bus voltage will remain within maximum 1.06 × 27.6 kV = 29.26 kV limit.

(b) Change 27/44 kV transformer tap

The Hydro One has informed the IESO that the OLTC taps will be available at 44 kV side. Following Table shows the voltages and reactive power flow in various busbars for,

(a) Pre-Lower Sturgeon
(b) With Lower Sturgeon generators controlling terminal voltage = 1.05 pu and 44 kV tap at 1.0 pu
(c) With Lower Sturgeon generators controlling terminal voltage = 1.05 pu and 44 kV tap at 0.9 pu

Lower Sturgeon GS	(a) Pre-LS		(b) V_T = 1.05, Tap = 1.0 pu		(c) V_T = 1.05, Tap = 0.9 pu	
	Voltage	Q load	Voltage	Q load	Voltage	Q load
4.16 kV at Low. Sturg.	-	-	4.3 kV	2.2	4.3 kV	-2.8
44 kV bus at Low. Sturg.	-	-	46.9 kV	3.5	45.3 kV	- 1.7
44 kV bus at LaForest	-	-	44.8 kV	5.1	41.0 kV	0.0
27 kV bus at LaForest	28.5 kV	-	28.2 kV	5.3	28.5 kV	-0.2
115 kV bus at LaForest	123.2 kV	7.3	122.8 kV	12.5	123.3 kV	7.3

If the 27/44 kV transformer tap is maintained at 0.9 pu lowering 44 kV voltage, the generator controlling the terminal voltage to 1.05 pu will have the same effect as generator controls the power factor to unity at LaForest 44 kV bus. Both will maintain the reactive power flow from HT system to current level.

4.4 Voltage Decline

The IESO allows a voltage change ΔV of 10 % in the IESO-controlled grid in the period immediately after a contingency. If the Wawaitin, Sandy Falls or Lower Sturgeon GS is lost, following are the voltage declines. All the generators are made to operate at a maximum reactive power before they are lost so that the ΔV is maximum.

Loss of	Pre-contingency 115 kV voltage	ΔV on 115 kV bus
Wawaitin GS	124 kV @ Timmins TS	0.5 % @ Timmins TS
Hound Chute	123 kV @ Timmins TS	0.2 % @ Timmins TS
Lower Sturgeon GS	124 kV @ LaForest DS	0.4 % @ LaForest DS

4.5 Reverse Power Flow

In each of these stations, the MW flow can be towards the 115 kV transmission system reversing the role of a conventional load serving station if the generation is more than the load which could occur especially under light load conditions. The Figure 5 shows the sum of flows into Timmins 115/27 kV and Dymond 115/44 kV transformers from the grid for the period of Jan 1 – Aug 1, 2007. Thus, the Figures show the net load, i.e. (load – generation) if there is embedded generation already. Figure 3 shows for LaForest DS.

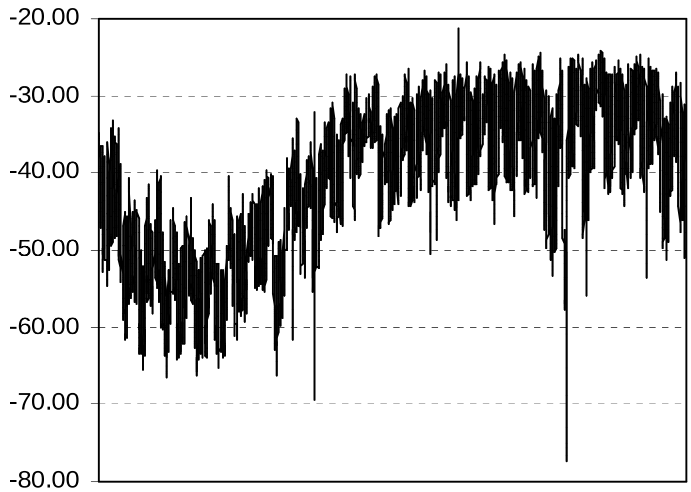

FIGURE 5 – TIMMINS TS LOAD

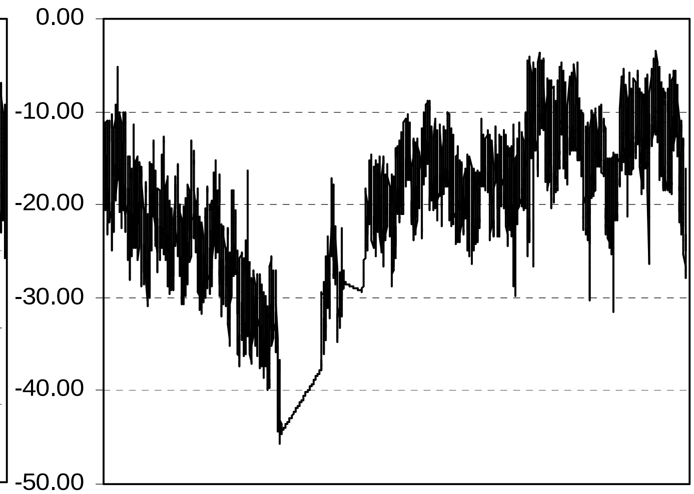

FIGURE 5 – DYMOND TS LOAD

Generation	Maximum Generation	Light load	Potential Reverse Flow
Wawaitin + Sandy Falls	20.5 MW to Timmins	25 MW at Timmins TS	-
Lower Sturgeon GS	14 MW to LaForest	5 MW at LaForest DS	9 MW
Hound Chute	9.6 MW to Dymond	5 MW at Dymond TS	4.6 MW

Therefore, at Lower Sturgeon and Hound Chute, the potential exists for reverse flow by about 9 MW and 5 MW under rare conditions of light load and maximum generation. Under these conditions, issues such as UFLS operation, ULTC operation, bi-directional monitoring, bi-directional protection, generator voltage control etc may be further investigated.

4.6 Excitation System Performance

The dynamic performance of the generator excitation system was simulated to check the compliance of the automatic excitation system behavior in terms of the ceiling and the speed of response to IESO standards.

- *Response Ratio Test*

This test demonstrates the behavior of the exciter during *large signal disturbances*. The disturbance simulated is a rapid increase of exciter reference voltage to a large value. This drives the excitation voltage to its ceiling as rapidly as possible, allowing us to estimate the exciter positive ceiling when generator is working at full output and connected to the actual system as well as how fast the exciter responds.

Following are the Response Ratio and Excitation Ceiling level if operate at 0.95 lag or unity power factor.

Station	Power Factor	(a) Initial Excitation	(b) Excitation Ceiling	(b)/(a)	Response Ratio
Sandy Falls	0.95 lag	1.859	2.344	1.26	0.2645
	1.0	1.517	2.344	1.54	0.5517
Lower Sturgeon	0.95 lag	1.896	2.344	1.23	0.2399
	1.0	1.547	2.344	1.51	0.5204
Wawaitin	0.95 lag	1.925	2.348	1.22	0.2852
	1.0	1.559	2.348	1.50	0.6556
Hound Chute	0.95 lag	1.713	2.344	1.37	0.3731
	1.0	1.420	2.344	1.65	0.6574

The IESO standard is to have an excitation ceiling, 1.5 times of rated excitation and to have 0.5 of response ratio. If operated at 0.95 lag power factor at terminals, neither the excitation ceiling nor the response ratio meets the IESO standard.

The proponent has informed the IESO that the generators at Lower Sturgeon will be operated near unity power factor and Sandy Falls, Wawaitin and Hound Chute will be operated at lead power factor in order to control distribution voltage.

4.7 Real Time Monitoring

The proponent has informed the IESO that all four generating stations will be operating as *Intermittent Generation* which would indicates the OPG does not produce an energy schedule which is to be followed or OPG will not offer units for dispatch.

The Sandy Falls, Wawaitin, Lower Sturgeon and Hound Chute facilities are less than 20 MVA each and no single generator is equal or greater than 20 MVA. The IESO *Market Rules* defines such a station as a ***minor generating facility***. The proponent is expected to comply with Market Rules (Chapter 4 section 7.3) on real-time monitoring requirements applicable for embedded, minor, intermittent, self-scheduling generating facilities.