REPORT

Power to Ontario.
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System Impact Assessment Report (Addendum)

McLean's Mountain Wind Farm

CONNECTION ASSESSMENT & APPROVAL PROCESS

CAA ID 2010-386

Final Report

Applicant: McLean's Mountain Wind Farm L.P.

Market Facilitation Department

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System Impact Assessment Report

McLean's Mountain Wind Farm Addendum

Acknowledgement

The IESO wishes to acknowledge the assistance of Hydro One in completing this assessment.

<u>Disclaimers</u>

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.

<u>HYDRO ONE</u>

<u>Special Notes and Limitations of Study Results</u>

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.

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MCLEAN'S MOUNTAIN WIND FARM
IESO SYSTEM IMPACT ASSESSMENT (ADDENDUM)

Introduction

This addendum updates the System Impact Assessment, "McLean's Mountain Wind Farm (CAA ID 2010-386)" originally issued on October 27, 2010 for the connection of a new wind power generation farm in Manitoulin Island, Ontario named McLean's Mountain Wind Farm. This project, proposed by McLean's Mountain L.P., is to connect to the provincial grid via the 115 kV circuit S2B. The original assessment evaluated the impact of 59.4 MW of injection from 33 x 1.8 MW Vestas V90 VCUS 60 Hz wind turbine generators at the McLean's Mountain facility.

Recently, McLean's Mountain L.P. has notified the IESO that they will adopt a different technology for their generators, namely the GE-103 2.5MW full conversion wind turbine generator system. The development will now consist of 24 x2.5 MW wind turbines, with a total maximum output of 60 MW. McLean's Moutain L.P has also updated their commercial in-service date to October 2012.
This addendum examines the impact of the change in generator technology.

Findings

The following is a list of updated conclusions for the incorporation of McLean's Mountain and they supersede those presented in the original SIA.

(1) The proposed wind farm, accounting for the change in turbine technology, does not have a material adverse impact on the reliability of the IESO-controlled grid.

(2) The increase in fault levels, due to the proposed McLean's Mountain, will not exceed the interrupting capabilities of the existing breakers on the IESO-controlled grid.

Under normal S2B operating conditions, the asymmetrical fault level at Martindale 115 kV for a LG fault is 96% of the interrupting capability and under conditions where S2B is supplied entirely by Martindale 115 kV, the asymmetrical fault level at Martindale 115 kV for a LG fault is 99% of the interrupting capability.

(3) As the amount of load is typically greater than the amount of generation on the 115 kV circuit S2B, the loss of the McLean's wind farm will result in increased flows on S2B. Under high loads along S2B and under conditions where McLean's wind farm and Manitoulin TS are transferred to Algoma 115 kV, the loss of McLean's wind farm may result in S2B line section flows being near or at long term emergency ratings.

(4) Without the McLean's Mountain wind farm in-service, the pre-contingency voltage at Manitoulin can be as low as 110 kV under 2013 peak load conditions when Manitoulin TS is supplied from Algoma 115 kV and 112 kV under 2013 peak load conditions when Manitoulin TS is supplied from Martindale. In both cases, this voltage is below the minimum acceptable pre-contingency voltage of

113 kV as per the IESO Transmission Assessment Criteria. It was determined that a 7 MX capacitor installed at Manitoulin TS would help increase voltages to above 113 kV.

(5) Under normal S2B operating conditions, for all contingency cases tested with the proposed McLean's Mountain wind farm, all voltage declines are within the 10% pre and post-ULTC action limit.

Under conditions in which McLean's Mountain and Manitoulin are transferred to Algoma 115 kV supply, the loss of McLean's wind farm, could exceed 10% at McLean's Mountain 115 kV, Manitoulin 44 kV and Manitoulin 115 kV buses under peak system conditions and maximum wind farm active power injection. Under this configuration the pre-contingency reactive injection at the 115 kV point of connection may need to be limited to about 4.7 Mvar to ensure voltage declines are within 10% for the loss of the wind farm.

Sensitivity studies show that under the same system conditions, with a 7 Mvar capacitor at Manitoulin in-service, the wind farm reactive injection at the point of connection must be limited to about 4.5 Mvar in order for voltage declines for the loss of McLean's Mountain to be within IESO criteria.

(6) None of the recognized contingencies cause any material adverse impact to the transient performance of the IESO-controlled grid.

(7) The new wind farm is not required to be part of any special protection scheme.

(8) Based on the information provided by the applicant, the fault ride through capability of the wind turbines is adequate.

(9) The new generating facility will result in the need for protection and settings revision at Martindale TS and Algoma TS and addition of new telecommunication links between McLean's Mountain and the terminal stations of circuit S2B.

Zone 1 coverage on S2B at Martindale and Algoma will be slightly decreased as a result of the incorporation of McLean's Mountain. Studies show that there is no adverse impact with this reduction.

(10) The applicant has indicated it will implement a voltage control process whereby all WTGs control the PCC voltage to a reference value, reactive power compensation devices are automatically controlled/switched to regulate the overall WTGs' reactive power generation to around zero output, while the WF main transformer is to be automatically adjusted to regulate the collector bus voltage such that it is within normal range.

(11) The applicant has indicated that an inertia emulation control function, WindINERTIA, will be part of its wind farm Management system.

(12) While the facility is capable of injecting/withdrawing up to 33% of its rated active power at all levels of active power at a fixed transformer tap position of 125 kV, a closer examination shows that the wind turbine generator terminal bus voltages would range between 0.88 pu to 1.10 pu. This is outside of the normal generator terminal bus operating range of 0.9 pu to 1.1 pu which would result in turbine tripping under certain conditions. Acceptable voltages at the generator terminal buses and collector system were found with the use of a 115/34.5 kV under load tap changer transformer under automatic adjustment.

Other Findings

(1) During the assessment of McLean's Mountain, it has been identified that a 7 MX capacitor at the Manitoulin LV bus may be needed to ensure that pre-contingency voltages at Manitoulin TS are within continuous voltage requirements when McLean's wind farm is out of service. A mitigation plan to address potential voltage issues should be implemented as soon as possible. Accordingly, Hydro One should assess and submit a mitigation plan and schedule as soon as practical. Connection to the grid of McLean's wind farm is not dependent on the in-service of this capacitor.

IESO Requirements for Connection

The following is a list of updated IESO requirements for the incorporation of McLean's Mountain and they supersede those presented in the original SIA.

Transmitter Requirements

The following requirements are applicable to Hydro One for the incorporation of McLean's Wind Farm:

(1) The transmitter changes the relay settings of S2B terminal stations to account for the effect of the wind farm.

Modifications to protection relays after this SIA is finalized must be submitted to IESO as soon as possible or at least six (6) months before any modifications are to be implemented. If those modifications result in adverse impacts, the connection applicant and the transmitter must develop mitigation solutions.

Connection Applicant Requirements

Specific Requirements: The following *specific* requirements are applicable to the applicant for the incorporation of McLean's Mountain Wind Farm. Specific requirements pertain to the level of reactive compensation required, operation restrictions, Special Protection System requirements, upgrading of equipment and any items not covered in the *general* requirements:

(1) The wind farm is required to have the capability to inject or withdraw reactive power continuously (i.e. dynamically) at a connection point up to 33% of its rated active power at all levels of active power output:

- Based on the equivalent parameters for the WF provided by the connection application, a static compensation device of 8 Mvar installed at the collector bus would satisfy the reactive power requirement. The capacitor bank will need to be auto-switched via the Wind Farm Management Scheme. The capacitor bank is required to have two steps of 4 Mvar each in order to observe the system voltage change requirements on shunt switching.

The connection applicant has the obligation to ensure that the WF has the capability to meet the Market Rule requirement at the connection point and be able to confirm this capability during the commission tests.

(2) The applicant is required to provide a copy of the functionalities of the Wind Farm Management System (WFMS) to the IESO.

(3) The wind farm is required to have a 115/34.5 kV transformer with under load tap changers to be automatically adjusted.

General Requirements: The proposed connection must comply with all the applicable requirements from the Transmission System Code (TSC), IESO Market Rules and standards and criteria. The most relevant requirements are summarized below and presented in more detail in Section 2 of the original SIA report.

(1) The new generator must satisfy the Generator Facility Requirements in Appendix 4.2 of the Market Rules.

(2) As this facility is in northern Ontario, all new 115 kV equipment must have a maximum continuous voltage rating and the ability to interrupt fault current at a voltage of at least 132 kV.

(3) Any revenue metering equipment that is installed must comply with Chapter 6 of the Market Rules.

(4) Equipment must sustain increase fault levels due to future system enhancements. Should future system enhancements result in fault levels exceeding equipment capability, the applicant is required to replace equipment at its own expense with higher rated equipment, up to 50 kA as per the Transmission System Code for 115 kV systems.

(5) The 115 kV breakers must meet the required interrupting time of less than or equal to 5 cycles as per the Transmission System Code.

(6) The connection equipment must be designed such that adverse effects due to failure are mitigated on the IESO controlled grid.

(7) The connection equipment must be designed for full operability in all reasonably foreseeable ambient temperature conditions.

(8) The facility must satisfy telemetry requirements as per Appendices 4.15 and 4.19 of the Market Rules. The determination of telemetry quantities and telemetry testing will be conducted during the IESO Facility Registration/Market entry process.

(9) Protection systems must satisfy requirements of the Transmission system code and specific requirements from the transmitter. New protection systems must be coordinated with existing protection systems.

(10) Protective relaying must be configured to ensure transmission equipment remains in service for voltages between 94% of minimum continuous and 105% of maximum continuous values as per Market Rules, Appendix 4.1.

(11) Although the SIA has found that a Special Protection Scheme (SPS) is not required for McLean's Mountain, provisions must be made in the design of the protections and controls at the facility to allow for the installation of Special Protection Scheme equipment and participation, if an SPS will be required in the future.

(12) Protection systems within the generation facility must only trip appropriate equipment required to isolate the fault.

(13) The autoreclosure of the new 115 kV breaker(s) at the connection point must be blocked. Upon its opening for a contingency, it must be closed only after IESO approval is granted. The IESO will require reduction of power generation prior to the closure of the breaker(s) followed by gradual increase of power to avoid a power surge.

(14) The generator must operate in voltage control mode. The generation facility shall regulate automatically voltage at a point whose impedance (based on rated apparent power and rated voltage) is not more than 13% from the highest voltage terminal based within ±0.5% of any set point within ±5% of rated voltage. If the AVR target voltage is a function of reactive output, the slope $\Delta V / \Delta Q_{max}$ shall be adjustable to 0.5%.

(15) A disturbance monitoring device must be installed. The applicant is required to provide disturbance data to the IESO upon request.

(16) During the commissioning period, a set of IESO specified tests must be performed. The commissioning report must be submitted to the IESO within 30 days of the conclusion of commissioning. Field test results should be verifiable using the PSS/E models used for this SIA.

(17) The registration of the new facilities will need to be completed through the IESO's Market Entry process before IESO's final approval for connection is granted and any part of facility can be placed into service. During the IESO Market Entry process, the connection applicant will be required to demonstrate to the IESO that all requirements identified in this SIA report have been satisfied.

(18) The proposed facility must be compliant with applicable reliability standards set by the North American Electric Reliability Corporation (NERC) and the North East Power Coordinating Council (NPCC) prior to energization to the IESO controlled grid.

(19) The connection applicant may meet the restoration participant criteria as per the NERC standard EOP-005. Further details can be found in section 3 of Market Manual 7.8 (Ontario Power System Restoration Plan).

(20) Mathematical models and data, including any controls that would be operational, must be provided to the IESO through the IESO Facility Registration/Market Entry process at least seven months before energization from the IESO-controlled grid. That includes both PSS/E and DSA software compatible mathematical models representing the new equipment for further IESO, NPCC and NERC analytical studies. The connection applicant may need to contact the software manufacturers directly, in order to have the models included in their packages. If the data or assumptions supplied for the registration of the facilities materially differ from those that were used for the assessment, then some of the analysis might need to be repeated.

Notification of Conditional Approval

From the information provided, our review concludes that the proposed changes at McLean's Mountain Wind Farm, subject to the requirements specified in this report, 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 for Connection* be issued for McLean's Mountain Wind Farm subject to the implementation of the requirements listed in this report.

1. Review of Connection Proposal

1.1 Proposed Connection Arrangement

McLean's Mountain Wind L.P. has proposed to develop a 60 MW wind farm located in Manitoulin, Ontario, known as McLean's Mountain Wind Farm which has been awarded a Power Purchase Agreement under the Feed-In Tariff (FIT) program with Ontario Power Authority. Since the original SIA was issued, the expected commercial operation has been updated to November 1, 2011.

With the exception of the number of generators connected to each feeder, the connection arrangement remains the same as what was evaluated in the original SIA assessment. The development will consist of a total of 24 GE-103 12.5 60 Hz wind turbine generators with a rated power output of 2.5 MW each. Each generator is connected to a power converter system and is connected to one of three collector circuits C1, C2 and C3 via a 0.69/34.5 kV (0.06 pu reactance on 2.8 MVA) transformer. The facility will be tapped to the IESO controlled grid via the 115 kV circuit S2B.

Each collector circuit will have the following number of generators:

GE-103 2.5 (2.8 MVA, 2.5 MW each)				
Circuit ID	C1	C2	C3	Total
Number of generators	8	8	8	24
Maximum MW	20	20	20	60
Maximum Mvar	9.6	9.6	9.6	28.8
Minimum. Mvar	-9.6	-9.6	-9.6	-28.8

The proposed connection arrangement is shown in **Figure 1.**

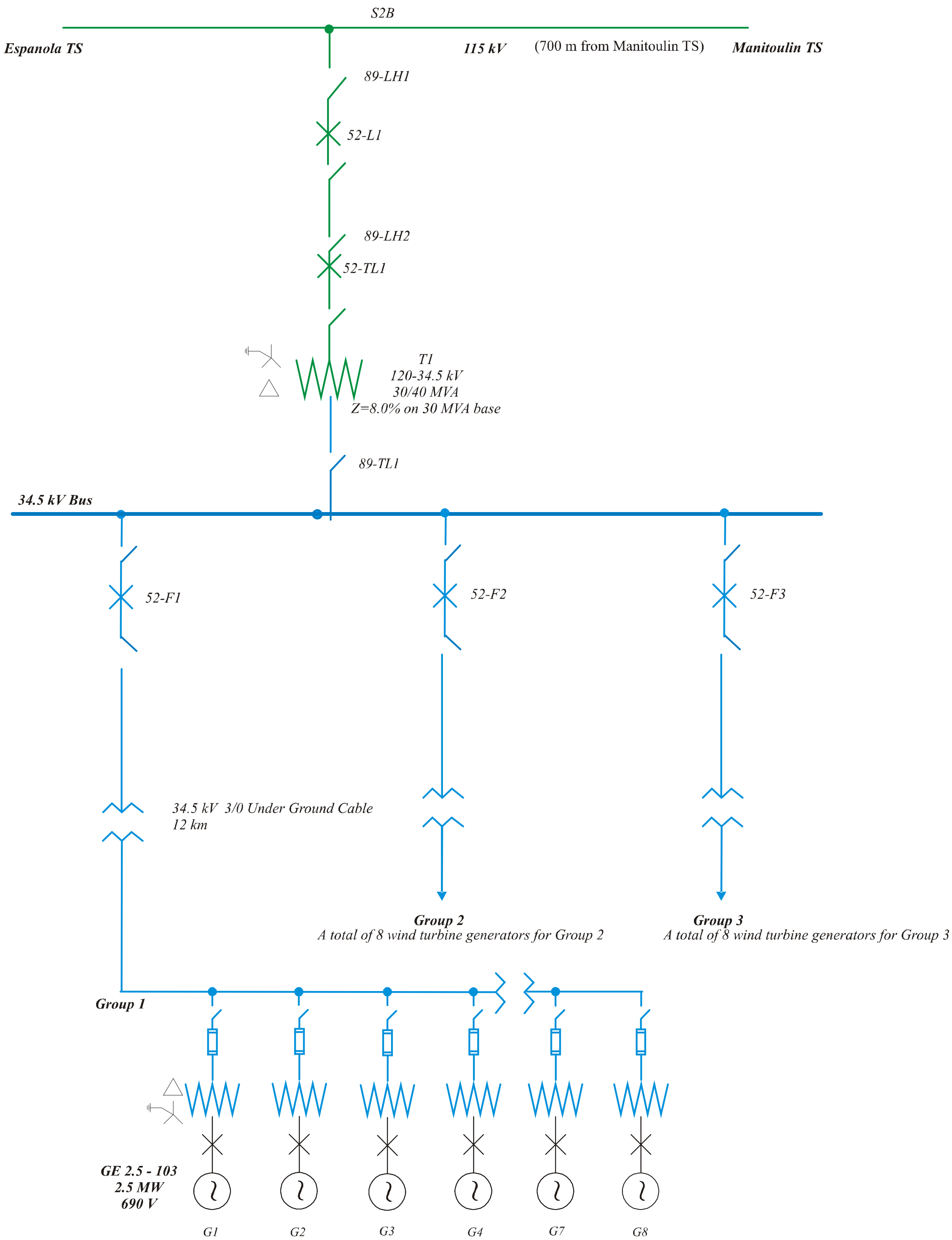


Figure 1: Proposed Connection Arrangement

2. Data Verification

The proponent has confirmed that other than the change in generator technology, data specifications relating to the 115 kV tap line, 34.5/125 kV step up transformer data, circuit breaker and switches and collector system presented in the original SIA have not been modified.

2.1 Generator

GE -103 2.5MW three bladed, variable pitch, variable speed, full conversion wind turbine generator system

Maximum Continuous Rating	2.5 MW
Transformation	0.69/34.5 kV
Rating	1.9 MVA
Impedance	0.078 on a base of 1.9 MVA
Configuration	3 phase, high side: delta, low side: wye grounded

2.2 Dynamic Models

The following are dynamic models used for the full conversion wind turbine generator system. Parameters and their associated values are also outlined below.

GEWTG1 – Wind Turbine Generator/Converter Model

CONs	Value	Description
J	2.5	Prate, Rated power of the original unit, MW
J+1	99999	Xeq, Equivalent reactance for current injection, pu on Mbase
J+2	0.575	VLVPL1, LVPL voltage 1
J+3	0.9	VLVPL2, LVPL voltage 2
J+4	1.11	GLVPL2, LVPL gain
J+5	1.2	VHVRCR2, HVRCR voltage2
J+6	2	CURHVRCR2, max reactive current at VHVRCR2
J+7	0.4	VLVACR1, Low voltage active current regulation logic, voltage 1
J+8	0.8	VLVACR2, LVACR logic, voltage 2
J+9	10	Rip_LVPL, Rate of LVACR active current change
J+10	$0.2x10^{-1}$	T_LVPL, voltage sensor for LVACR time constants
ICONs	Value	Description
M	0	Memory
M+1	8	A number of original WTs lumped up to the model equivalent

GEWTT – Two Mass Shaft Model

CONs	Value	Description
J	4.18	H
J+1	0.0	DAMP
J+2	0.0	Htfrac
J+3	1.45	Freq1
J+4	1.5	DSHAFT

GEWTE1 – GE Wind Turbine Electrical Control Model

CONS	Value	Description	CONs	Value	Description
J	0.15	Tfv	J+32	0.95	PFRb
J+1	18	Kpv	J+33	0.95	PFRc
J+2	5	Kiv	J+34	0.4	PFRd
J+3	0	Rc	J+35	1.0	PFRmax
J+4	0	Xc	J+36	0.2	PFRmin
J+5	$0.5 x 10^{-1}$	Tfp	J+37	1.0	Tw
J+6	0.3	Kpp	J+38	0.25	T_LVPL
J+7	0.1	Kip	J+39	-1.0	V_LVPL
J+8	1.12	Pmax	J+40	14.0	SPDW1
J+9	0.0	Pmin	J+41	25.0	SPDWMX
J+10	0.4	Qmx	J+42	3.0	SPDWMN
J+11	-0.4	Qmn	J+43	-0.9	SPD_LOW
J+12	1.1	IPmax	J+44	8.0	WTTHRES
J+13	$0.2 x 10^{-1}$	Trv	J+45	0.2	EBST
J+14	0.45	RPMX	J+46	10.0	KDBR
J+15	-0.45	RPMN	J+47	1.0	Pdbr_MAX
J+16	60	Tpower	J+48	1.7	ImaxTD
J+17	0.1	KQi	J+49	**1.11**	Iphl
J+18	0.9	Vmincl	J+50	1.25	Iqhl
J+19	1.1	Vmaxcl	J+51	5.0	TIpqd
J+20	120	KVi	J+52	0.0	Kqd
J+21	0.5	XIQmin	J+53	0.0	Xqd
J+22	1.45	XIQmax	J+54	0.0	Kwi
J+23	$0.5 x 10^{-1}$	Tv	J+55	$0.25 x 10^{-2}$	Dbwi
J+24	$0.5 x 10^{-1}$	Tp	J+56	1.0	TIpwi
J+25	1.0	Fn	J+57	5.5	Twowi
J+26	0.15	Tpav	J+58	0.1	urIwi
J+27	0.96	FRa	J+59	-1.0	drIwi
J+28	0.996	FRb	J+60	0.1	Pmxwi
J+29	1.004	FRc	J+61	0.0	Pmnwi
J+30	1.04	FRd			
J+31	1.0	PFRa			
ICONs	**Value**	**Description**	**ICONs**	**Value**	**Description**
M		Remote bus # for voltage control	M+5	0	FRFLG
M+1	0	Memory	M+6	0	PQFLAG
M+2	0	PFAFLG	M+7	0	Q-droop branch From Bus
M+3	1	VARFLG	M+8	0	Q-droop branch To Bus
M+4	0	APCFLG	M+9	0	Q-droop branch circuit ID

WGUSTC - Wind Gust and Ramp Model

CONS	Value	Description	CONs	Value	Description
J	9999	T1g	J+3	9999.0	T1r
J+1	5.0	Tg	J+4	9999.0	T2r
J+2	30.0	MAXG	J+5	30.0	MAXR
ICONS	Value	Description	ICONS	Value	Description
M		Generator bus #	M+2	0	Flag to mark the end of ramp
M+1	1	Generator ID			

GEWTA – Wind Turbine Aerodynamics Model

CONs	Value	Description	CONs	Value	Description
J	20.0	λmax	J+5	1.225	ρ
J+1	0.0	λmin	J+6	50.0	Radius
J+2	27.0	PITCHmax	J+7	91.3	GB_ratio
J+3	-4.0	PITCHmin	J+8	1200	Synchr
J+4	0.0	Ta			
ICONs	Value	Description	ICONs	Value	Description
M		Machine Bus #	M+2	0	Memory
M+1	1	Machine ID			

GEWTP - Pitch Control Model

CONs	Value	Description	CONs	Value	Description
J	0.30	Tp	J+5	-4.0	min
J+1	150.00	Kppt	J+6	27.0	max
J+2	25.0	Kipt	J+7	-10.0	d/dt min
J+3	3.0	Kpc	J+8	10.0	d/dt max
J+4	30.0	Kic	J+9	1.0	Pref
ICONs	Value	Description	ICONs	Value	Description
M		Machine Bus #	M+2	0	Memory
M+1	1	Machine ID			

GEWTPT – Plotting Output Variables as VARs Model

ICONs	Value	Description	ICONs	Value	Description
M		Machine Bus #	M+1		Machine ID

VTGDCA – Under Voltage Generator Bus Disconnection Relay Model (for voltage < 0.15 pu)

CONs	Value	Description	CONs	Value	Description
J	0.15	VL	J+2	0.02	TP
J+1	5.0	VU	J+3	$0.8x10^{-1}$	TB
ICONs	Value	Description	ICONs	Value	Description
M		Bus number where voltage is monitored	M+3	0	Delay flag
M+1		Bus number of generator bus where relay is located	M+4	0	Time-out flag
M+2	1	Generator ID	M+5	0	Timer status

VTGDCA – Under Voltage Generator Bus Disconnection Relay Model (for 0.15 pu<voltage < 0.3pu)

CONs	Value	Description	CONs	Value	Description
J	0.3	VL	J+2	0.7	TP
J+1	5.0	VU	J+3	$0.8x10^{-1}$	TB
ICONs	Value	Description	ICONs	Value	Description
M		Bus number where voltage is monitored	M+3	0	Delay flag
M+1		Bus number of generator bus where relay is located	M+4	0	Time-out flag
M+2	1	Generator ID	M+5	0	Timer status

VTGDCA – Under Voltage Generator Bus Disconnection Relay Model (for 0.3 pu<voltage < 0.5pu)

CONs	Value	Description	CONs	Value	Description
J	0.5	VL	J+2	1.1	TP
J+1	5.0	VU	J+3	$0.8x10^{-1}$	TB
ICONs	Value	Description	ICONs	Value	Description
M		Bus number where voltage is monitored	M+3	0	Delay flag
M+1		Bus number of generator bus where relay is located	M+4	0	Time-out flag
M+2	1	Generator ID	M+5	0	Timer status

VTGDCA – Under Voltage Generator Bus Disconnection Relay Model (for 0.5 pu<voltage < 0.75pu)

CONs	Value	Description	CONs	Value	Description
J	0.75	VL	J+2	1.7	TP
J+1	5.0	VU	J+3	$0.8x10^{-1}$	TB
ICONs	Value	Description	ICONs	Value	Description
M		Bus number where voltage is monitored	M+3	0	Delay flag
M+1		Bus number of generator bus where relay is located	M+4	0	Time-out flag
M+2	1	Generator ID	M+5	0	Timer status

VTGDCA – Over Voltage Generator Bus Disconnection Relay Model (for 1.1 pu<voltage < 1.15pu)

CONs	Value	Description	CONs	Value	Description
J	0.0000	VL	J+2	1.0	TP
J+1	1.1000	VU	J+3	$0.8x10^{-1}$	TB
ICONs	Value	Description	ICONs	Value	Description
M		Bus number where voltage is monitored	M+3	0	Delay flag
M+1		Bus number of generator bus where relay is located	M+4	0	Time-out flag
M+2	1	Generator ID	M+5	0	Timer status

VTGDCA – Over Voltage Generator Bus Disconnection Relay Model (for voltage > 1.15pu)

CONs	Value	Description	CONs	Value	Description
J	0.0000	VL	J+2	0.1	TP
J+1	1.1500	VU	J+3	$0.8x10^{-1}$	TB
ICONs	**Value**	**Description**	**ICONs**	**Value**	**Description**
M		Bus number where voltage is monitored	M+3	0	Delay flag
M+1		Bus number of generator bus where relay is located	M+4	0	Time-out flag
M+2	1	Generator ID	M+5	0	Timer status

3. Fault Level Assessment

Fault level studies were completed by Hydro One to re-examine the effects of the change in McLean's Mountain generator technology on fault levels at existing facilities in the area. Details of the study assumptions can be found in the original McLean's Mountain SIA.

The following table summarizes the symmetric and asymmetrical fault levels near McLean's Mountain and corresponding breaker ratings under normal operating conditions. Under normal operating conditions, Manitoulin load and McLean's Mountain wind farm would be supplied from Martindale.

Short Circuit Levels: Normal S2B Operating Conditions										
Bus	Wind Farm O/S				Wind Farm I/S				Breaker Ratings	
	Total Fault Current (kA)				Total Fault Current (kA)					
	Symm		Asymm		Symm		Asymm		Symm (kA)	Asymm (kA)
	3-ph fault	L-G fault	3-ph fault	L-G fault	3-ph fault	L-G fault	3-ph fault	L-G fault		
Martindale 115 kV	14.306	17.462	16.679	21.430	14.639	17.881	17.033	21.901	19.20	22.70
Martindale 230 kV	17.552	18.993	20.399	23.032	17.762	19.546	20.624	23.658	41.10	46.20
Algoma 115 kV	10.127	11.876	11.275	13.862	10.112	11.870	11.256	13.852	39.30	45.50
Algoma 230 kV	8.140	7.394	9.320	9.180	8.117	7.402	9.292	9.183	39.40	46.20
Domtar Espanola 115 kV	2.482	1.229	2.787	1.233	2.476	1.191	2.781	1.195	7.3	7.9
McLean's Mountain 115 kV	N/A	N/A	N/A	N/A	1.578	1.680	1.663	1.841	unknown	unknown

The results show that the fault levels in the surrounding area of the McLean's Mountain wind farm area are within the symmetrical and asymmetrical breaker ratings. It should be noted that the asymmetrical current for an L-G fault is marginally within the asymmetrical breaker capability at Martindale 115 kV (21.901/22.70=0.96). The following study was performed to determine the short circuit levels at Martindale 115 kV for the condition in which S2B is supplied entirely by Martindale (i) with McLean's out of service and (ii) with McLean's in-service.

Short Circuit Levels: S2B supplied entirely Martindale 115 kV										
Bus	Wind Farm O/S				Wind Farm I/S				Breaker Ratings	
	Total Fault Current (kA)				Total Fault Current (kA)					
	Symm		Asymm		Symm		Asymm		Symm (kA)	Asymm (kA)
	3-ph fault	L-G fault	3-ph fault	L-G fault	3-ph fault	L-G fault	3-ph fault	L-G fault		
Martindale 115 kV	14.949	18.095	17.357	22.119	15.127	18.363	17.530	22.401	19.20	22.70

As shown from the results, if S2B is supplied by Martindale and with the McLean's wind farm in-service, the fault levels at Martindale are still within the interrupting capabilities of the Martindale 115 kV breakers (22.401/22.70=0.99). Therefore, it can be concluded that the increases in fault levels due to the proposed change in McLean's Mountain wind farm generator technology will not exceed the interrupting capabilities of the existing breakers on the IESO-controlled grid.

6. System Impact Studies

6.1 Protection Impact Assessment

Hydro One has confirmed that the proposed change in turbine technology will not change the findings or conclusions presented in the original Protection Impact Assessment. The revised Protection Impact Assessment can be found in **Appendix B**.

6.2 Reactive Power Compensation

Market Rules require that generators inject or withdraw reactive power continuously (i.e. dynamically) at a connection point up to 33% of its rated active power at all levels of active power output except where a lesser continually available capability is permitted by the IESO.

The Market Rules accepts that a generating unit with a power factor range of 0.90 lagging and 0.95 leading at rated active power connected via a main output transformer impedance not greater than 13% based on generator rated apparent power provides the required range of dynamic power at the connection point.

Typically, the impedance between the WTG and the connection point is larger than 13%. However, provided the WTG has the capability to provide a reactive power range of 0.90 lagging power factor and 0.95 leading power factor at rated active power, the IESO accepts the WF to compensate for the full reactive power requirement range at the connection point with switchable shunt admittances (e.g. capacitors and reactors). Where the WTG technology has no capability to supply the full dynamic reactive power range at its terminal, the shortfall has to be compensated with dynamic reactive power devices (e.g. SVC).

This section of the SIA indicates how McLean's Mountain can meet the Market Rule requirements regarding reactive power capability, but the applicant is free to deploy any other solutions which result in its compliance with the Market Rule.

It is the applicant's responsibility to ensure that the WF has the capability to meet the Market Rule requirement at the connection point and be able to confirm this capability during the commission tests.

6.2.1 Dynamic Reactive Power Compensation

The following summarizes the IESO required level of dynamic reactive power and the available capability of the GE 2.5-103 from the GE document "Technical Documentation Wind Turbine Generator Systems GE 2.5 Electrical Grid Data"

	Rated Voltage	Rated Active Power	Reactive Power Capability/Turbine
IESO Required	690 V	2.5 MW	Q_{gen}= Sqrt[$(2.5/0.9)^2$-$(2.5)^2$]= 1.21 Mvar
			Q_{abs}= Sqrt [$(2.5/0.95)^2$ –$(2.5)^2$]=0.822 Mvar
GE 2.5-103 Capability	690 V	2.5 MW	Q_{gen} = 1.21 Mvar
			Q_{abs} = 1.21 Mvar

The GE 2.5-103 generators can deliver the IESO required dynamic reactive power to the generator terminal at rated power and at rated voltage. Thus, the IESO has determined that there is no need to install any additional dynamic reactive power compensation device.

6.2.2 Static Reactive Power Compensation

In addition to the dynamic reactive power requirement identified above, the WF has to compensate for the reactive power losses within the facility to ensure that it has the capability to inject or withdraw reactive power up to 33% of its rated active power at the connection point. In the case of McLean's Mountain, the facility will need to have the capability to inject or withdraw 19.8 Mvar (60 x 0.33) at the connection point. As mentioned above, the IESO accepts this compensation to be made with switchable shunt admittances.

Load flow studies were performed to calculate the need for static reactive compensation, based on the equivalent parameters for the WF provided by the connection applicant.

Load flow studies were performed to evaluate the reactive power capability in lagging p.f. of the generation facility under the following assumptions:

- typical voltage of 123 kV at the connection point;
- maximum active power output from the equivalent WTG;
- maximum reactive power output (lagging power factor) from the equivalent WTG, unless limited by the maximum acceptable WTG terminal voltage;
- maximum acceptable WTG voltage is 1.1 pu;
- the main step-up transformer ULTC is available to adjust the LV voltage as close as possible to 1 pu voltage.

The following table shows the capacitor requirement for McLean's Mountain (i) assuming that the ULTC can operate automatically within the range of 114 kV to 136 kV (ii) assuming that the ULTC operates at a fixed tap of 125 kV and (iii) assuming that the ULTC operates at a fixed tap of 123.6 kV.

Operation	Collector Bus Voltage (kV,pu)	Generator Terminal Voltage (pu)	Static Compensation (Mvar)	115/34.5 kV Tap Position (kV)	PCC Reactive Power injection (Mvar)	PCC Voltage (kV)
ULTC	34.3 kV (0.994 pu)	1.04 pu	8 Mvar	134.6 kV	20.2 Mvar	123 kV
Fixed tap	36.5 kV (1.06 pu)	1.10 pu	8 Mvar	125 kV	19.9 Mvar	
	36.9 kV (1.07 pu)	1.11 pu	8 Mvar	123.6 kV	20.1 Mvar	

As shown, in all three cases a static capacitor of 8 Mvar is required to obtain the required reactive power injection at the PCC. However, it should be noted that operation at a fixed tap position of 123.6 kV would require the generator terminal voltage to be at 1.11 pu, which outside its normal operating range of 0.9 pu to 1.10 pu. Based on the GE 2.5-103 steady state voltage tolerances, if the terminal voltage is sustained between 1.10 and 1.15 pu for at least 1 second, the turbines would trip. Therefore, the facility will not be capable of injecting reactive power at 33% of its active rated power value at a fixed tap position of 123.6 kV.

Load flow studies were performed to evaluate the reactive power capability in leading p.f. of the generation facility under the following assumptions:

- typical voltage of 123 kV at the connection point;
- minimum (zero) active power output from the equivalent WTG;
- maximum reactive power consumption (leading power factor) from the equivalent WTG, unless limited by the minimum acceptable WTG terminal voltage;
- minimum acceptable WTG voltage is 0.9 pu;
- the main step-up transformer ULTC is available to adjust the LV voltage as close as possible to 1 pu voltage.

The following table shows the reactor requirement for McLean's Mountain (i) assuming that the ULTC can operate with the range of 114 kV to 136 kV (ii) assuming that the ULTC operates at a fixed tap of 125 kV and (iii) assuming that the ULTC operates at a fixed tap of 123.6 kV.

Operation	Collector Bus Voltage (kV, pu)	Generator Terminal Voltage (pu)	Static Compensation (Mvar)	115/34.5 kV Tap Position (kV)	PCC Reactive Power injection (Mvar)	PCC Voltage (kV)
ULTC	34 kV (0.986 pu)	0.95 pu	0 Mvar	114 kV	-30.6 Mvar	123 kV
Fixed tap	31.4 kV (0.911pu)	0.88 pu	0 Mvar	125 kV	-21.7 Mvar	
	32.0 kV (0.928 pu)	0.9 pu	0 Mvar	123.6 kV	-19.8 Mvar	

As shown, in all three cases no static compensation is required to obtain the required reactive power withdrawal at the PCC. It should be noted that operation at a fixed tap position of 125 kV would require the generator terminal voltage to be at 0.88 pu, which is outside the normal operating range of 0.9 pu to 1.10 pu. Based on the GE 2.5-103 steady state voltage tolerances, if the terminal voltage is sustained between 0.9 pu to 0.85 pu for at least 10 minutes, the turbines would trip. Therefore, the facility will not be capable of withdrawing reactive power at 33% of its active rated power value at a fixed tap position of 125 kV.

Therefore, to ensure that collector bus voltages are close to nominal values and to ensure that generator terminal voltages are within continuous operating ranges under the entire reactive power operating range, McLean's Mountain will need to employ the ULTC capabilities of its 115/34.5 kV transformer such that its full tap range can be achieved.

The IESO's reactive power calculation used the equivalent electrical model for the WTG and collector feeders as provided by the connection applicant. It is very important that the WF has a proper internal design to ensure that the WTG are not limited in their capability to produce active and reactive power due to terminal voltage limits or other facility's internal limitations. For example, it is expected that the transformation ratio of the WTG step up transformers will be set in such a way that it will offset the voltage profile along the collector, and all the WTG would be able to contribute to the reactive power production of the WF in a shared amount.

Based on the equivalent parameters for the WF provided by the connection applicant, an amount of +8 Mvar of static reactive power compensation is required to be installed at the WF collector bus to meet the reactive power requirements at the connection point.

The connection applicant has the obligation to ensure that the WF design and the reactive power compensation system takes into account the real electrical parameters and real limitations within the WF facility.

It is necessary to supply the static reactive compensation in small enough steps to have operational flexibility over the entire range of active power output from the wind turbines. The amount of static reactive power compensation should be shared between at least two switchable shunt capacitors.

6.2.3 Static Reactive Power Switching

A switching study was carried out to investigate the effect of the new LV shunt capacitor banks / reactor on the voltage changes. It was assumed that the largest capacitor step size is 4 Mvar. To reflect the reasonable restrictive system conditions, the voltage change study assumed that the Martindale T22 transformer was out of service pre-switching.

Capacitor at LV kV bus	LV bus voltage	ICG connection point
Pre-switching	33.4 kV	119.8 kV
Post-switching	34.7 kV	122.6 kV
ΔV	3.89%	2.34%

The IESO requires the voltage change on a single capacitor switching to be no more than 4 % at the any point in the ICG. The results show that switching a single capacitor of 4 Mvar produces less than 4 % voltage change at the connection point. A subsequent study with the switching of an 8 Mvar capacitor shows that the ICG connection point voltage would reach 125.6 kV, which translates to a 4.8% voltage change. Hence, the capacitor bank is required to have two steps of 4 Mvar each in order to observe the system voltage change requirements on shunt switching.

6.3 Wind Farm Management System

If the generation facility connects to the IESO-controlled grid, the IESO requires that the facility assists maintaining voltage in the high voltage system. It is expected that the wind farm controls the voltage at a point as close as possible to the connection point to values specified by the IESO. This requires that wind farms possess the ability to supply sufficient dynamic reactive power to the high voltage system during voltage declines.

The generation facility shall regulate automatically voltage at a point whose impedance (based on rated apparent power and rated voltage) is not more than 13% from the highest voltage terminal based within ±0.5% of any set point within ±5% of rated voltage. If the AVR target voltage is a function of reactive output, the slope $\Delta V / \Delta Q_{max}$ shall be adjustable to 0.5%.

The Wind Farm Management System (WFMS) must coordinate the voltage control process. The IESO recommends the following two voltage control schemes:

Recommendation #1

(1) All WTGs control the PCC voltage to a reference value. A control slope is applied for reactive power sharing among the WTGs as well as with adjacent generators.
(2) Capacitor banks are automatically switched in/out to regulate the overall WTGs' reactive generation to around zero output.
(3) WF main transformer ULTC is adjusted to regulate the collector bus voltage (LT bus voltage) such that it is within normal range;

Recommendation #2

(1) The capacitor banks are automatically switched in/out according to the WF active power output. A sample capacitor switching scheme is shown in the following table.

P - overall WF active power output	Capacitor banks to be switched on
$0 < P < P_1$	(No capacitor)
$P_1 < P < P_2$	C_1
$P_2 < P < P_3$	C_1+C_2
……	……
$P_N < P < P_{MAX}$	$C_1+C_2+\ldots+C_N$

(2) All WTGs control the PCC voltage to a reference value. A control slope is applied for reactive power sharing among the WTGs as well as with adjacent generators.
(3) WF main transformer ULTC is adjusted to regulate the collector bus voltage (LT bus voltage) such that it is within normal range;

The proponent has indicated to the IESO that they will implement a voltage control scheme consistent with "Recommendation 1."

Prior to McLean's Mountain's in-service date, the proponent must submit a "Voltage Control Document" describing the functionalities of the Wind Farm Management System, including the coordination between the automatic capacitor switching and generator reactive power production to control the voltage at a desired point. This document must also contain the settings of the automatic capacitor switching scheme. If the Wind Farm Management System is unavailable, the IESO requires each generator to control its own terminal voltage.

The proponent must also demonstrate in this document that the functionalities of the Wind Farm Management System will be in line with the "Recommendation 1" control scheme described above.

6.4 Thermal Analysis

The thermal analysis from the original analysis was repeated with the new GE machines. For each scenario, the pre-contingency active power output of McLean's Mountain facility was at 60 MW and the reactive power output of the facility ranged from 5 Mvar to 7.2 Mvar depending on the scenario. Study results showed there were no significant changes in results or conclusions.

6.5 Voltage Analysis

The voltage analysis from the original analysis was repeated with the new GE machines. For each scenario, the pre-contingency active power output of McLean's Mountain facility was at 60 MW and the reactive power output of the facility ranged from 5 Mvar to 7.2 Mvar depending on the scenario. Study results showed there were no significant changes in results or conclusions.

6.6 Transient Analysis

The transient stability analysis that was conducted along with the original SIA was repeated using the GE 2.5-103 model provided the applicant. Seven contingencies were studied under the normally operated condition where Manitoulin and McLean's Wind Farm are supplied by Martindale 115 kV and four contingencies were studied under the configuration where Manitoulin and McLean's Wind Farm are transferred to Algoma. In all eleven cases, minimum S2B load was assumed. For more details on these configurations, please refer to the original SIA report.

ID	Contingency	Voltage (kV)	Location	LLG Fault MVA	Fault Clearing Time (ms)[1]	
					Near	Remote
Normally operated S2B configuration at minimum S2B load Maclean's Mountain Pre-contingency Output: Pgen = 60 MW Qgen=2.1 Mvar Maclean's Mountain PCC voltage controlled at 121 kV						
SC1	LLG fault on L1S	115 kV	Martindale	655-j8700 MVA	200 ms	616 ms
SC2	LLG fault on S5M	115 kV	Martindale	655-j8700 MVA	200 ms	200 ms
SC3	3phase fault on X503E	500 kV	Hanmer	N/A	166 ms	191 ms
SC4	LLG fault on X74P	230 kV	Hanmer	1769-j22618 MVA	183 ms	216 ms
SC5	LLG fault on X27A	230 kV	Hanmer	1769-j22617 MVA	183ms	249 ms
SC6	LLG fault on S22A	230 kV	Martindale	2206 -j14215 MVA	200 ms	216 ms
SC7	LLG fault on L1S	115 kV	Crystal Falls	60.57-345.96 MVA	216 ms	600 ms
Manitoulin and McLean's Wind Farm transferred to S2B Algoma supply at minimum S2B load Maclean's Mountain Pre-contingency Output: Pgen= 60 MW Qgen= -6.3 Mvar Mclean's Mountain PCC voltage controlled at 121 kV						
SC8	3phase fault on X503E	500 kV	Hanmer	N/A	166 ms	191 ms
SC9	LLG fault on X74P	230 kV	Mississagi	781-j6952 MVA	183 ms	216 ms
SC10	LLG fault on X27A	230 kV	Algoma	611-j4983 MVA	216 ms	216 ms
SC11	LLG fault on S22A	230 kV	Algoma	611-j4983 MVA	183 ms	233 ms

The transient responses can be found in **Appendix A** of the report. It can be concluded from the results that, with McLean's Mountain Wind Farm in-service, none of the simulated contingencies caused transient instability or undamped oscillations.

6.7 Low Voltage Ride Through Capability

The following table shows the LVRT II protection settings obtained from the GE 2.5-103 PSS/E Model (Reference: GE Document “Modeling of GE Wind Turbine-Generators for Grid Studies Version 4.5”). These setting points are plotted in **Figure 2** to yield the LVRT under voltage protection limit curve.

Voltage Range (pu of base voltage)	Fault Ride Through Duration Time (s)
V < 0.15 pu	0.02
0.15 pu <V< 0.30 pu	0.7
0.30 pu <V< 0.5 pu	1.1
0.5 pu <V< 0.75 pu	1.7

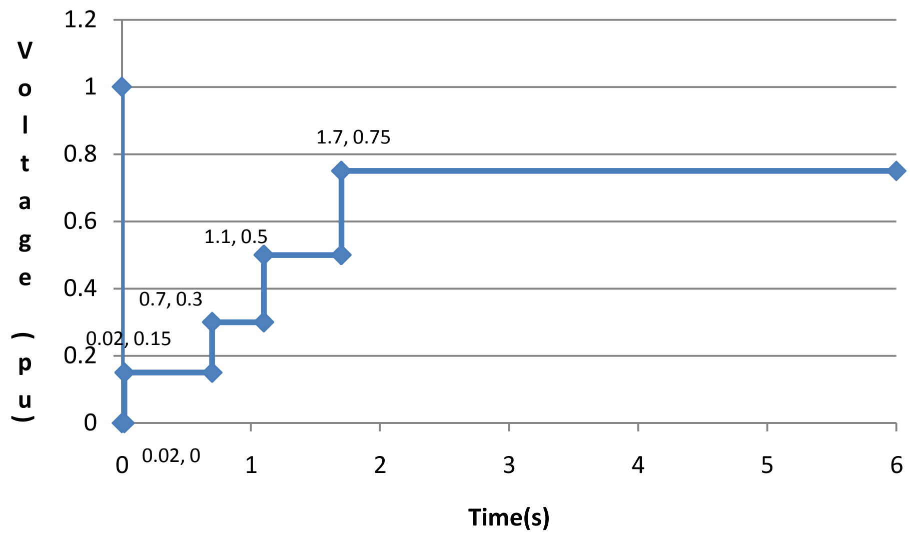


Figure 2: GE 2.5-103 LVRT II Model Settings

During low voltage ride through, as long as the generator terminal voltage is above the curve shown in **Figure 2**, the turbine will remain connected.

It is expected that no change to the above LVRT settings are required for the implementation of McLean’s Mountain.

In order to examine the need for low voltage ride through (LVRT) capability, the terminal voltage of the wind generator was monitored for all eleven contingencies. The variation of the terminal voltage of the new generation facility is plotted in **Figure 3** below for the SC1 to SC7 contingencies and **Figure 4** below for the SC7 to SC11 against the LVRT protection curve. Note, as the fault was applied at t=0.1s, each timeout setting was shifted by 0.1s. It can be seen that the voltage response is well above the LVRT protection curve. Therefore, fault ride through capability of the proposed wind turbines is adequate.

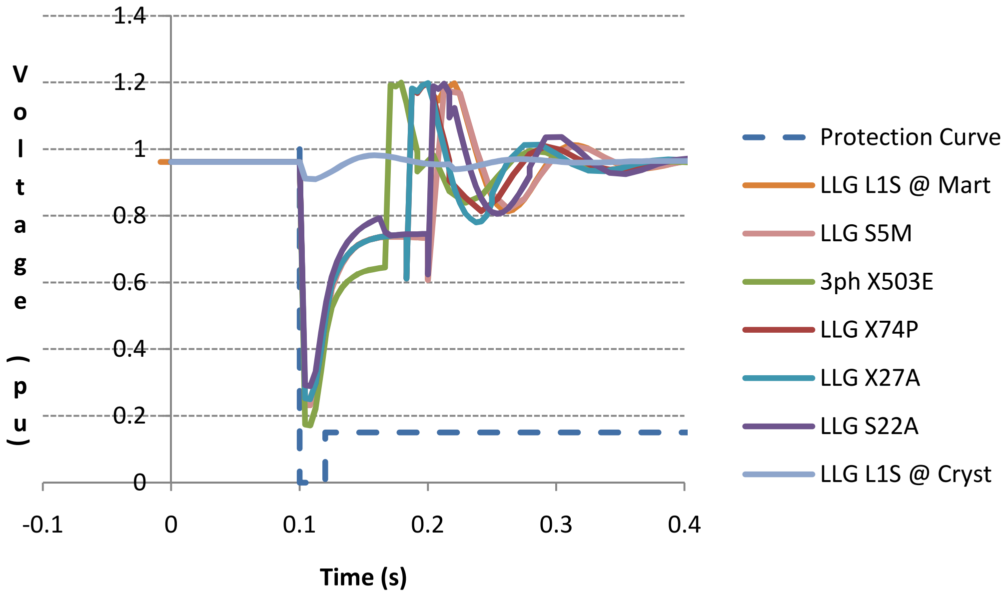


Figure 3 – McLean's Wind Farm Terminal Voltage Vs LVRT Protection Curve (SC1 to SC7)

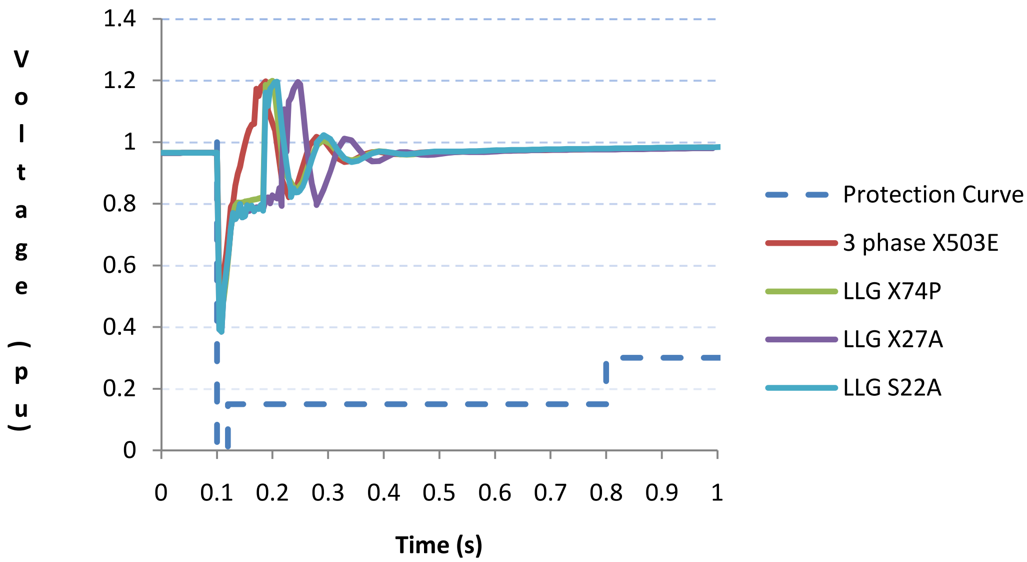
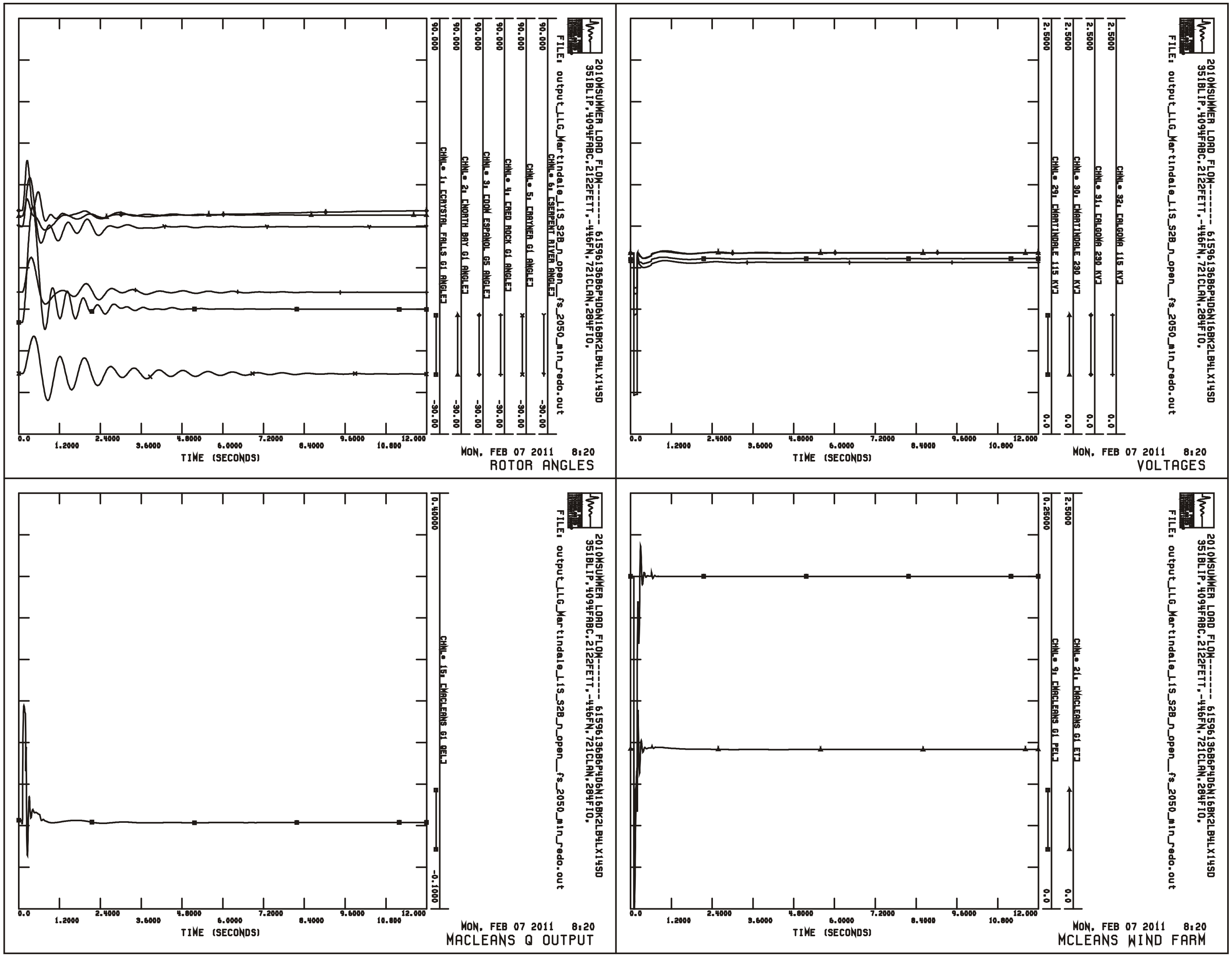


Figure 4 – McLean's Wind Farm Terminal Voltage vs LVRT Protection Curve (SC8 to SC11)

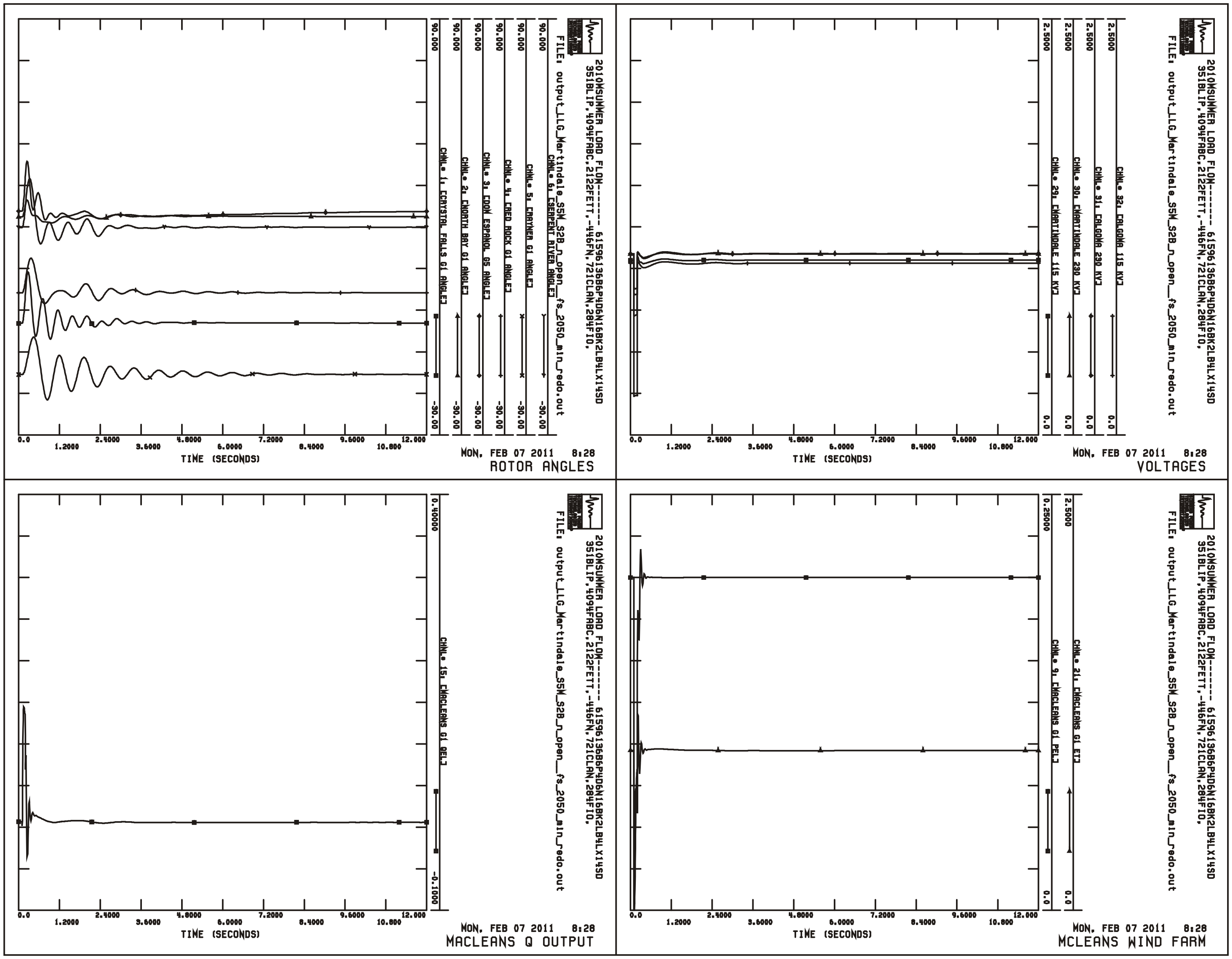
The LVRT capability must be demonstrated during commissioning by monitoring several variables under a set of IESO specified field tests and the results should be verifiable using the PSS/E model.

The new generating facility is required to ride-through routine switching events and design criteria contingencies assuming standard fault detection, auxiliary relaying, communication, and rated breaker interrupting times, unless disconnected by configuration.

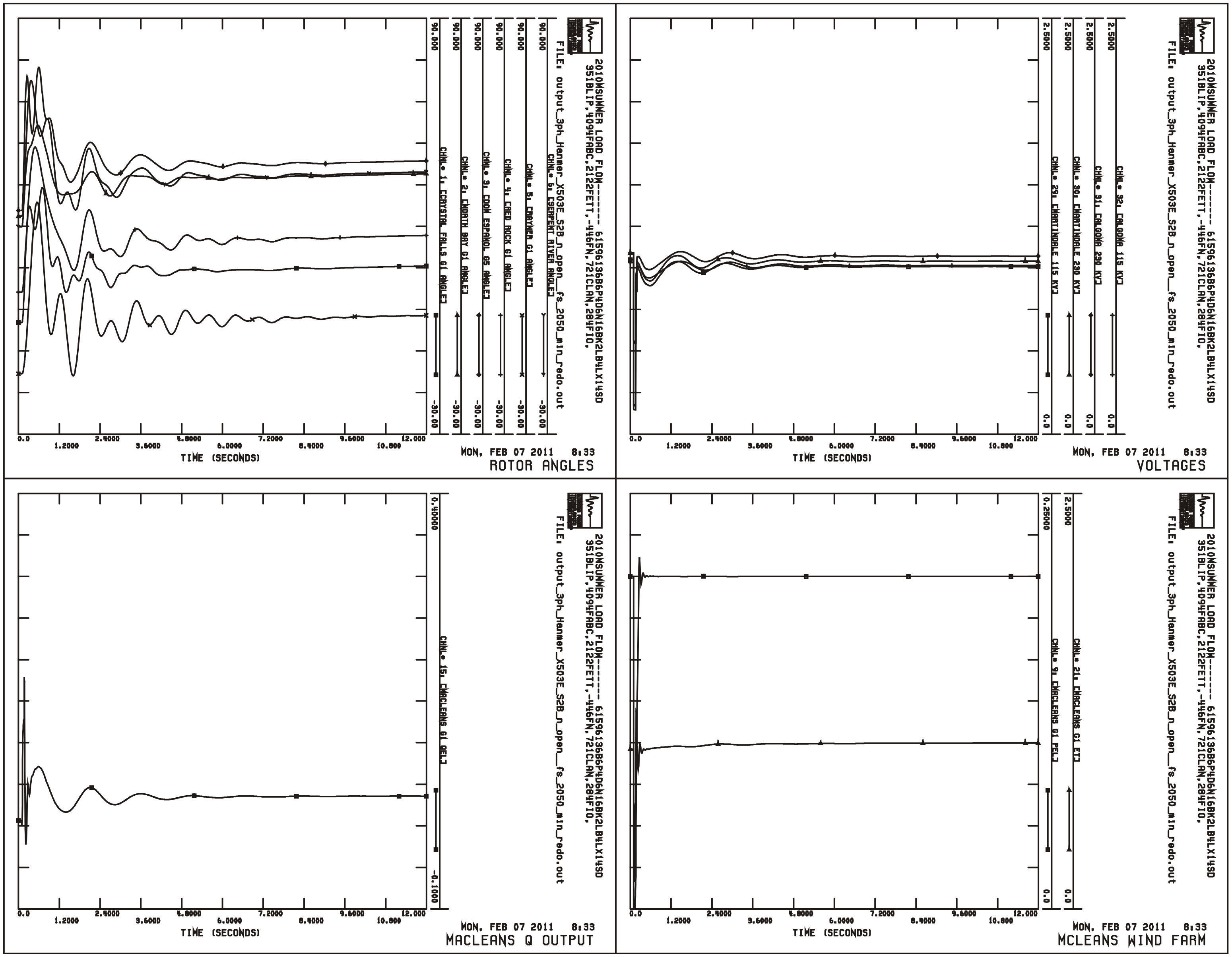
Appendix A: Diagrams for Transient Simulation Results



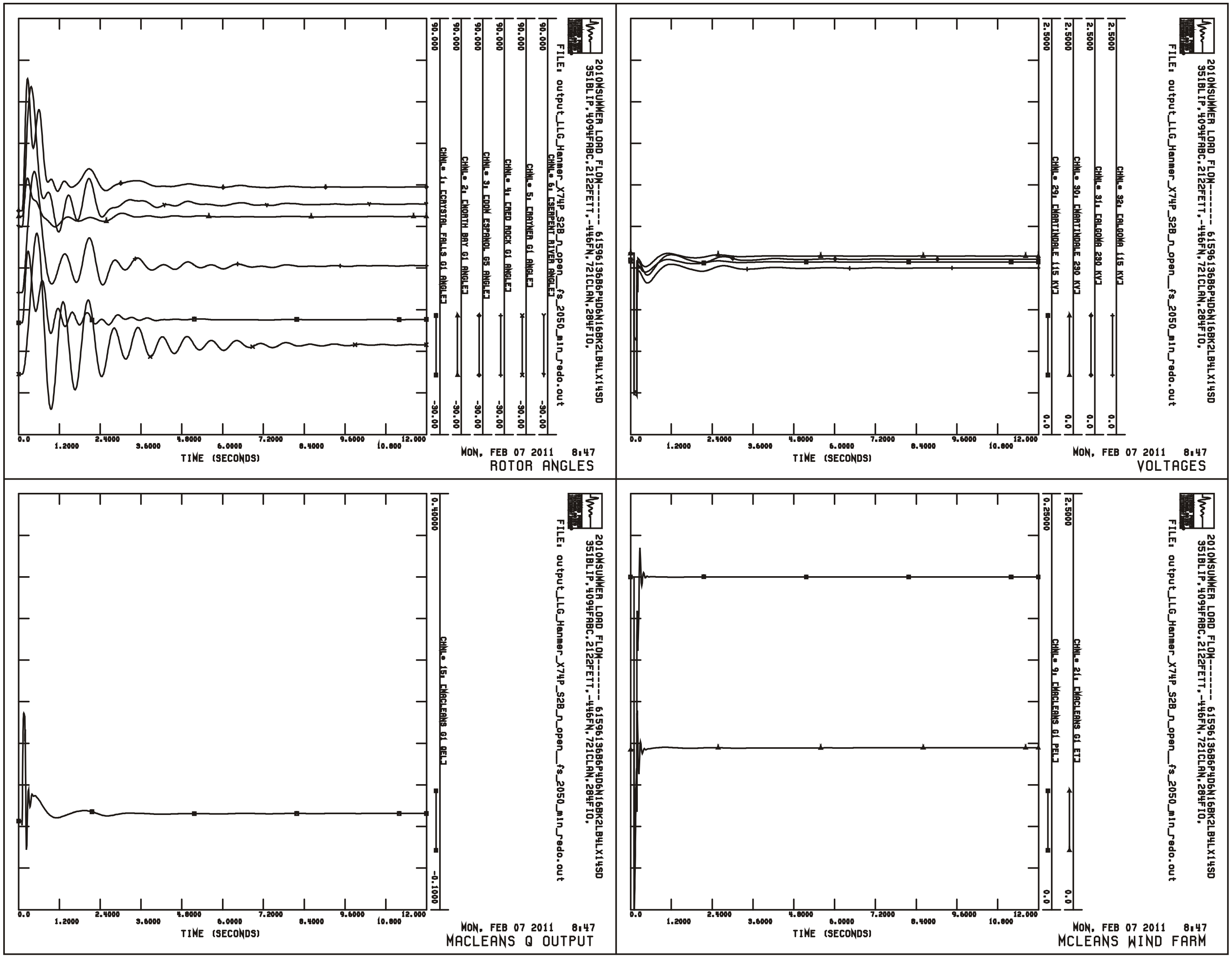
SC1 – McLean's and Manitoulin on Martindale Supply: LLG Fault on L1S at Martindale 115 kV



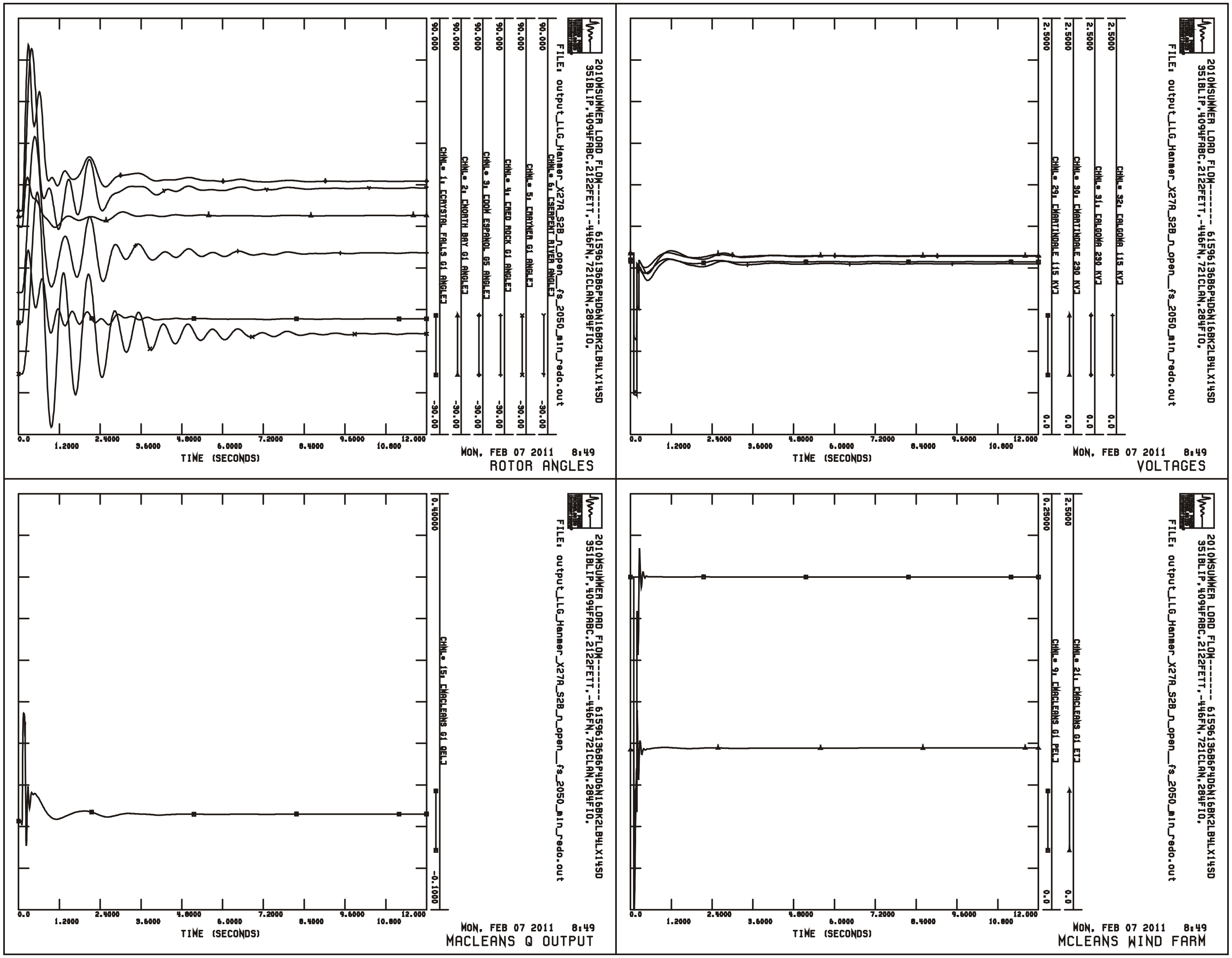
SC2 - McLean's and Manitoulin on Martindale Supply: LLG Fault on S5M at Martindale 115 kV



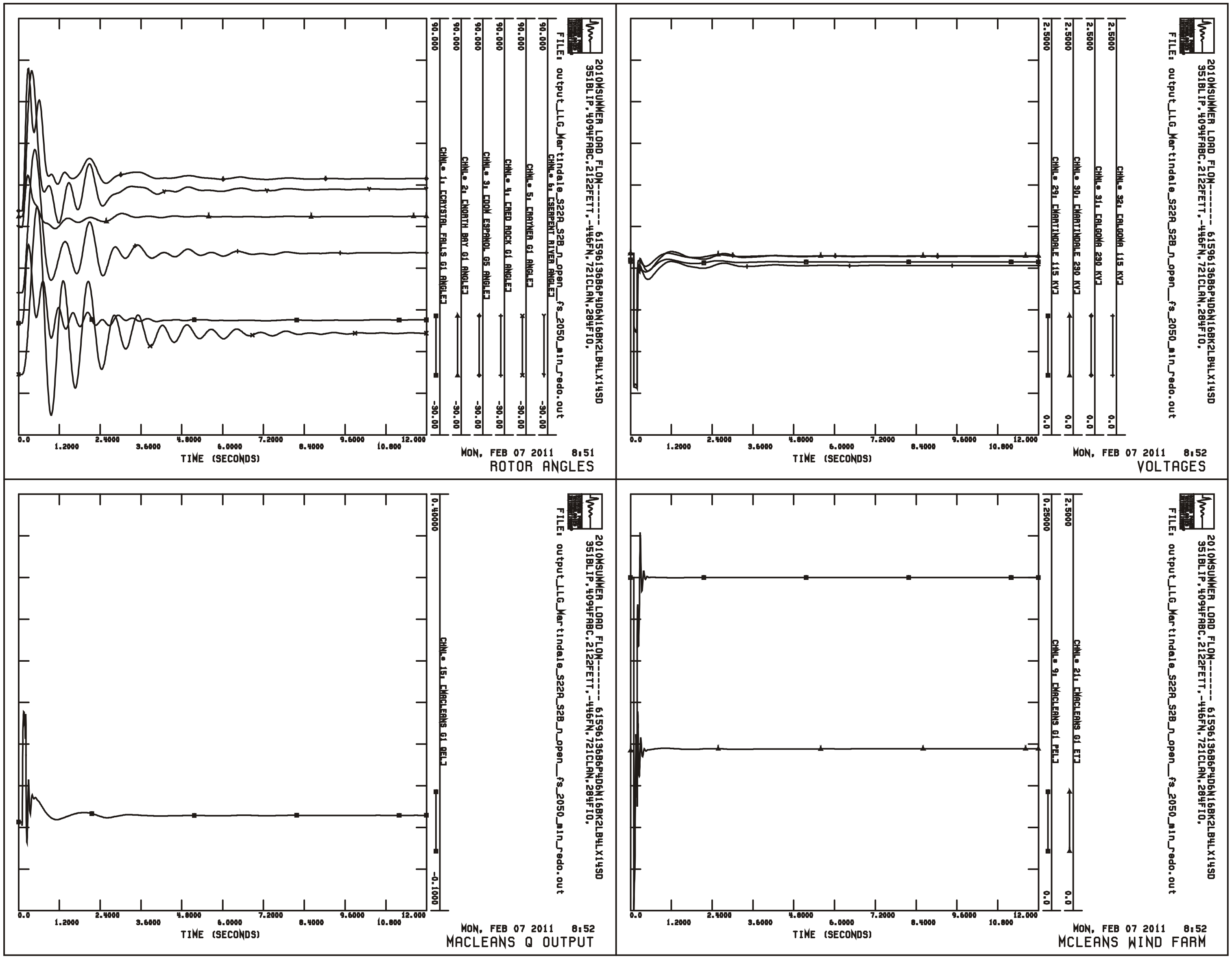
S3 - McLean's and Manitoulin on Martindale Supply: 3 phase Fault on X503E at Hanmer 500 kV



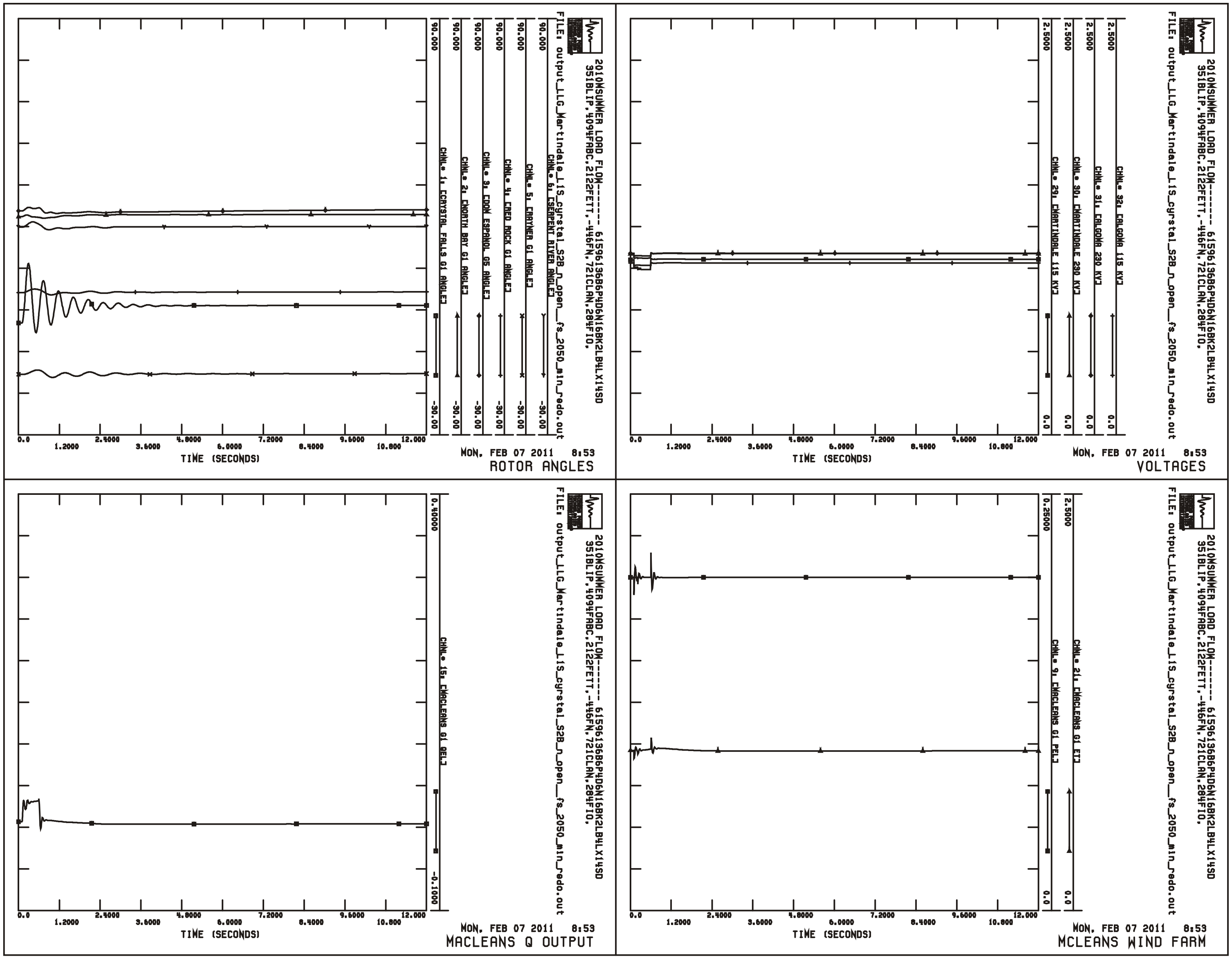
S4 - McLean's and Manitoulin on Martindale Supply: LLG Fault on X74P at Hanmer 230 kV



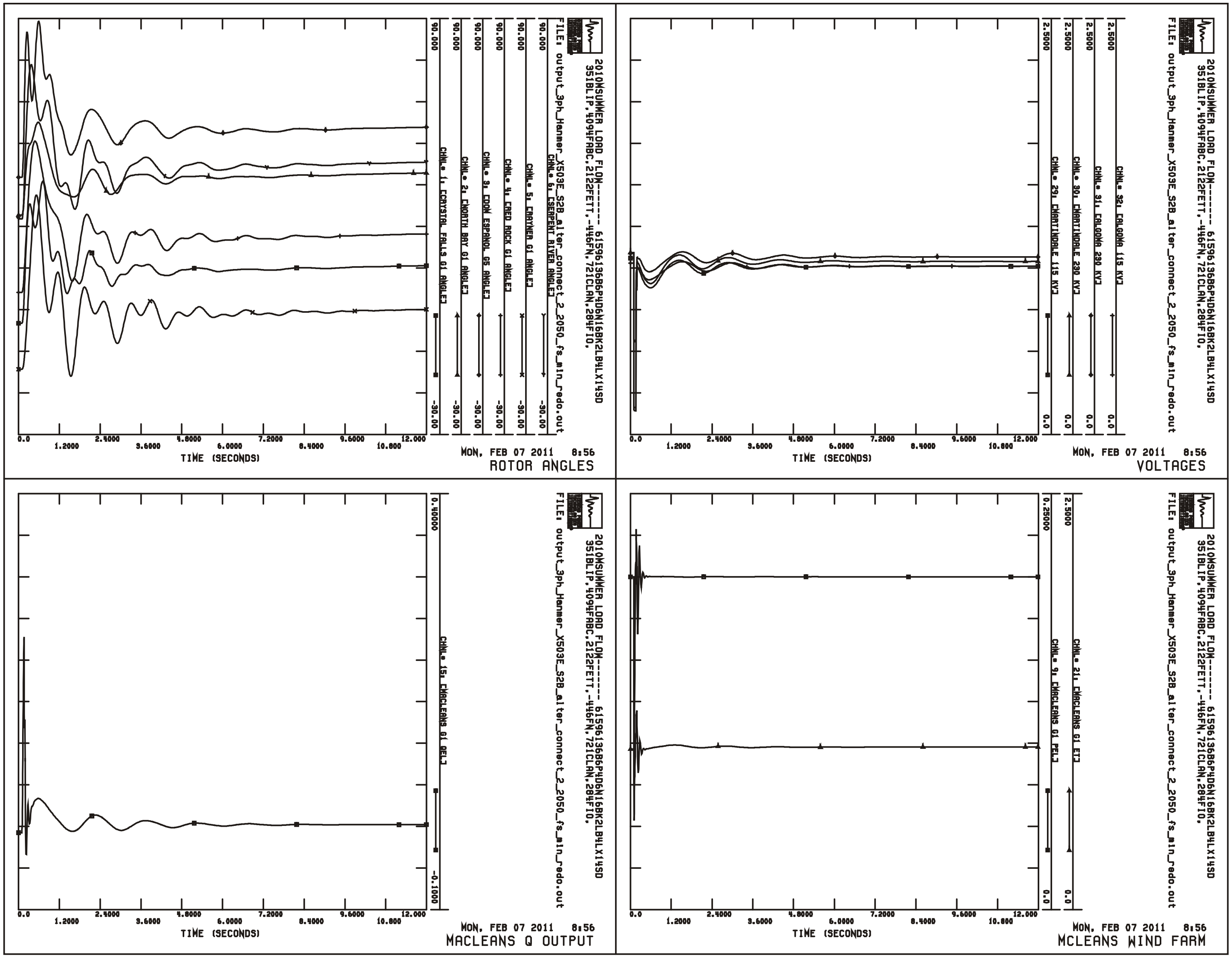
S5 - McLean's and Manitoulin on Martindale Supply: LLG Fault on X27A at Hanmer 230 kV



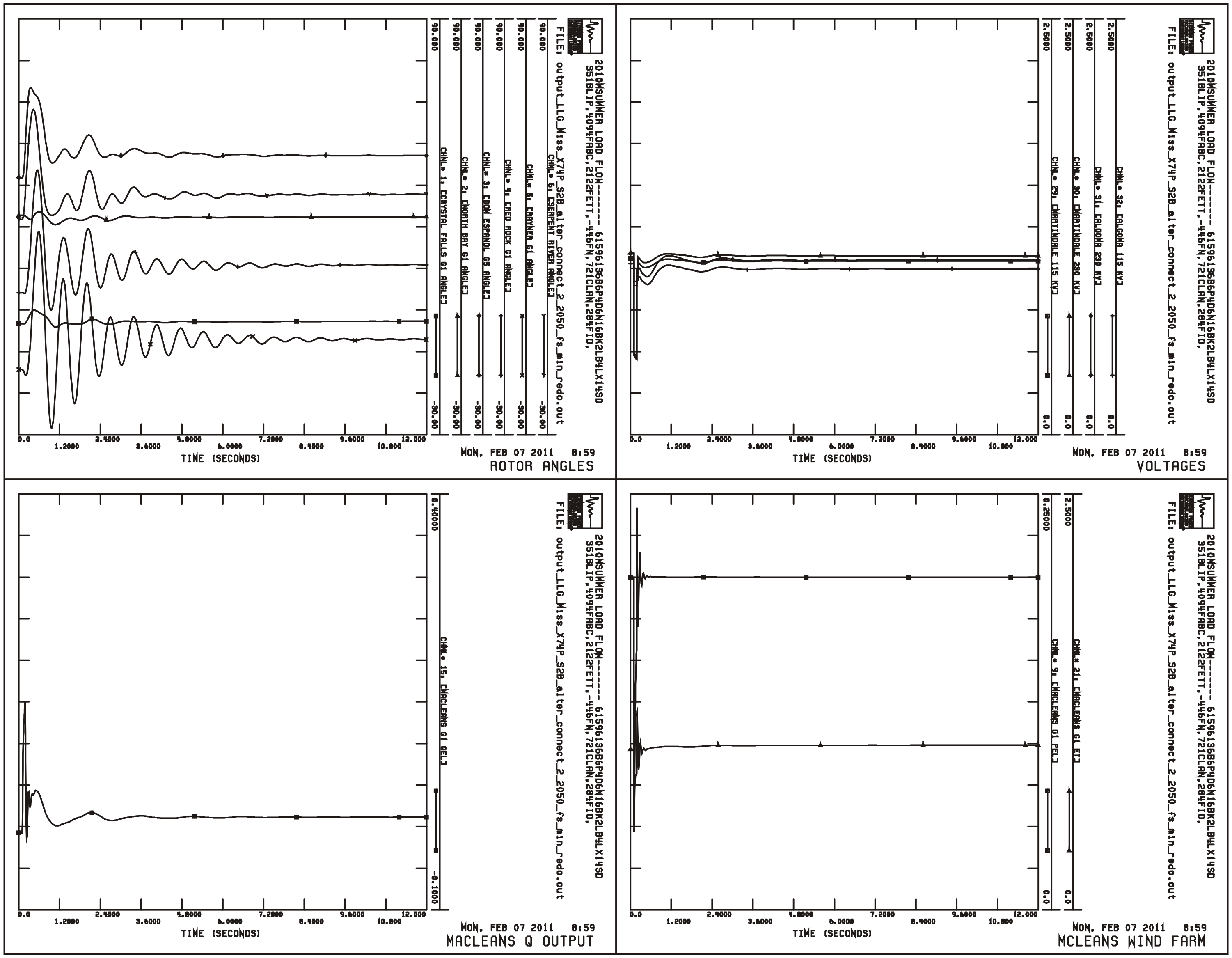
S6 - McLean's and Manitoulin on Martindale Supply: LLG S22A at Martindale 230 kV



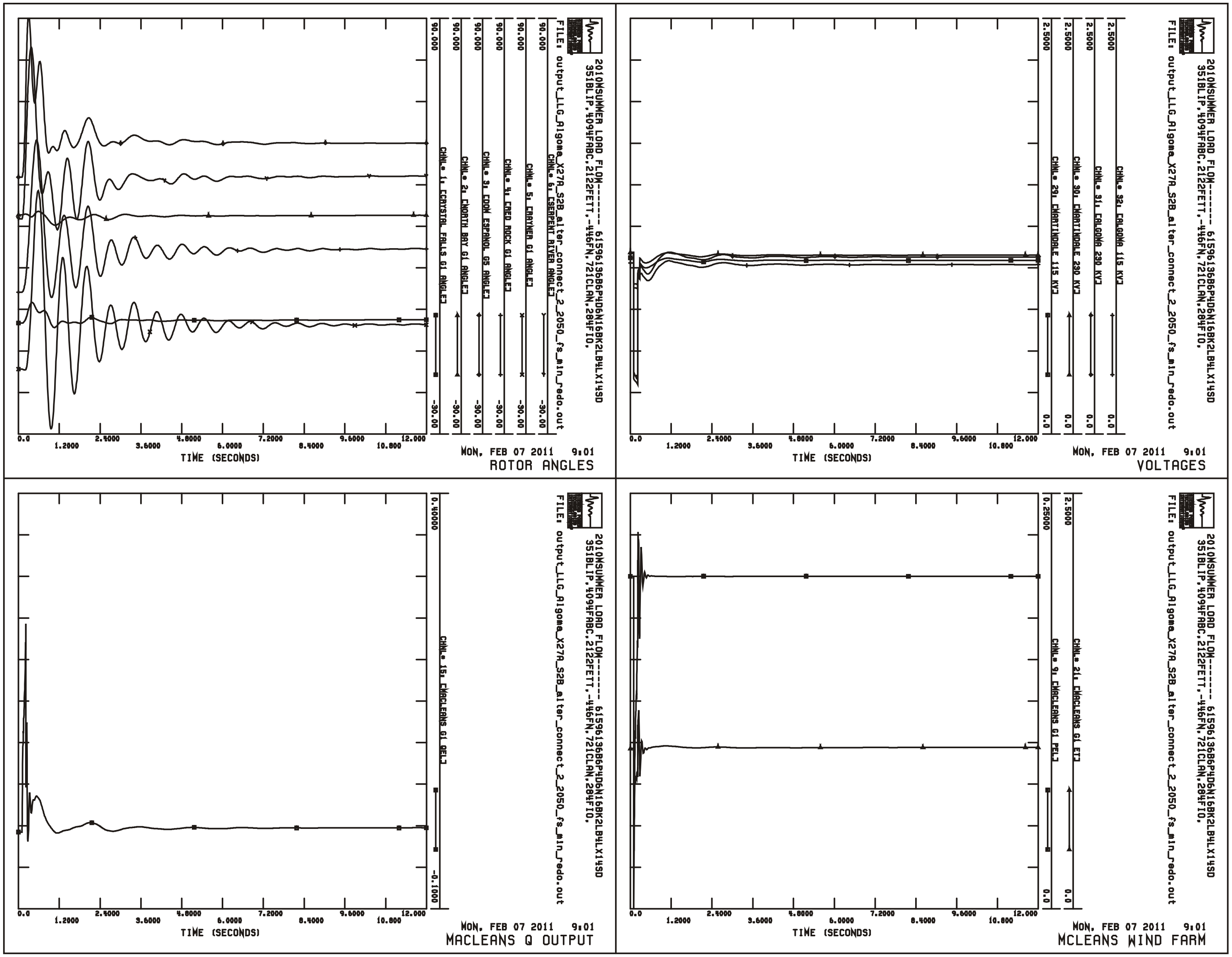
S7 - McLean's and Manitoulin on Martindale Supply: LLG L1S at Crystal Falls 115 kV



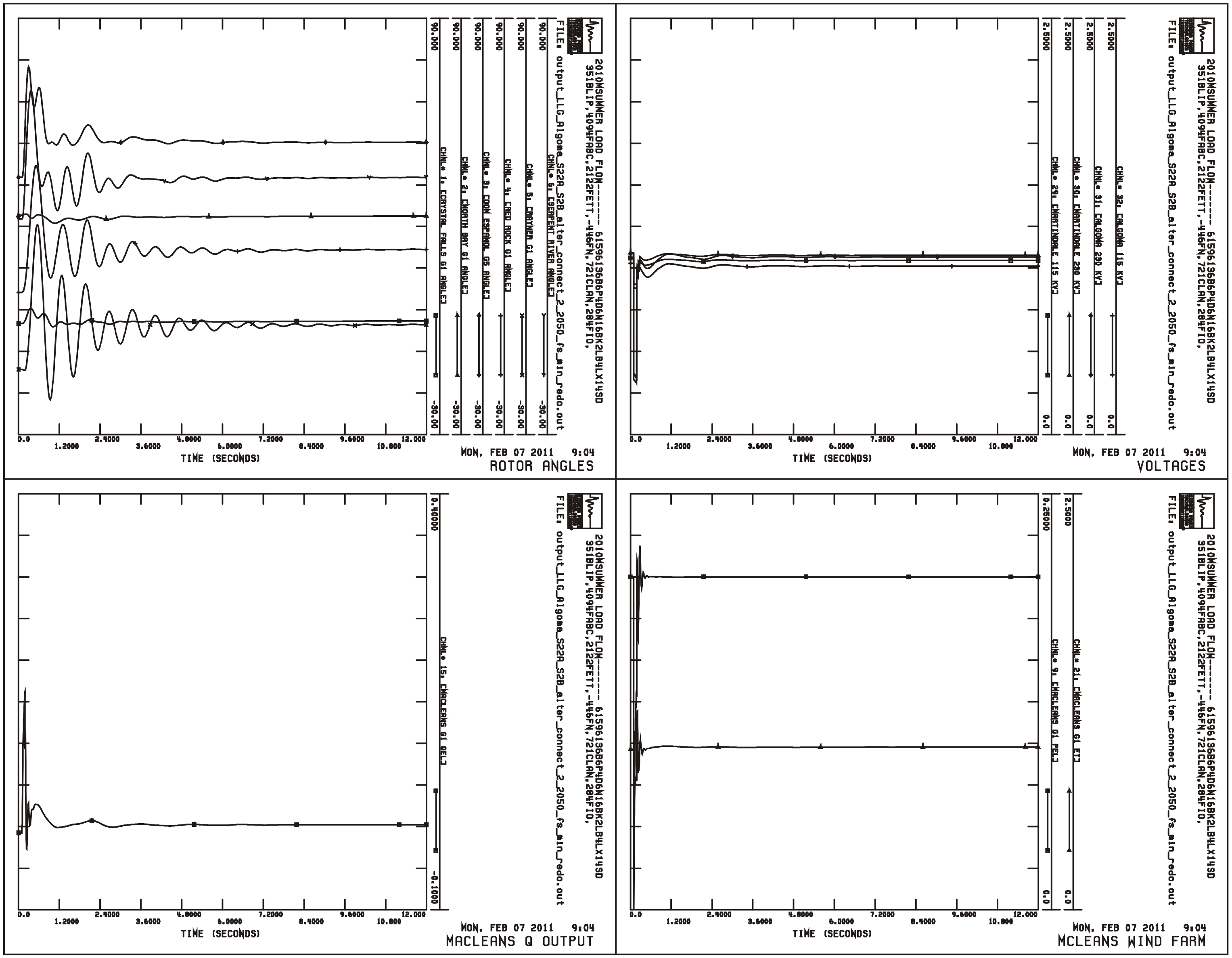
S8 - McLean's and Manitoulin on Algoma Supply: 3 Phase Fault on X503E at Hanmer 500 kV



S9 - McLean's and Manitoulin on Algoma Supply: LLG fault on X74P at Mississagi 230 kV



S10 - McLean's and Manitoulin on Algoma Supply: LLG Fault on X27A at Algoma 230 kV



S11 - McLean’s and Manitoulin on Algoma Supply: Scenario S4: LLG Fault on S22A at Algoma 230 kV

Appendix B: Protection Impact Assessment

Hydro One Networks Inc.
483 Bay Street
Toronto, Ontario
M5G 2P5

Protection Impact Assessment

Maclean's Mountain Windfarm

60 MW Wind

Generation Connection

Date: February 10, 2011 R4
P&C Planning Group Project # PCT-113

Prepared by:

Hydro One Networks Inc.

Disclaimer

This Protection Impact Assessment has been prepared solely for the IESO for the purpose of assisting the IESO in preparing the System Impact Assessment for the proposed connection of the proposed generation facility to the IESO–controlled grid. This report has not been prepared for any other purpose and should not be used or relied upon by any person, including the connection applicant, for any other purpose.

This Protection Impact Assessment was prepared based on information provided to the IESO and Hydro One by the connection applicant in the application to request a connection assessment at the time the assessment was carried out. It is intended to highlight significant impacts, if any, to affected transmission protections early in the project development process. The results of this Protection Impact Assessment are also subject to change to accommodate the requirements of the IESO and other regulatory or legal requirements. In addition, further issues or concerns may be identified by Hydro One during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with the Transmission System Code legal requirements, and any applicable reliability standards, or to accommodate any changes to the IESO-controlled grid that may have occurred in the meantime.

Hydro One shall not be liable to any third party, including the connection applicant, which uses the results of the Protection Impact Assessment under any circumstances, whether any of the said liability, loss or damages arises in contract, tort or otherwise.

Revision History

Revision	Date	Change
R0	July 1, 2010	Draft
R1	July 14, 2010	Added Section 2.2.4
R2	Aug 4, 2010	Revised Section 2.2
R3	Sept 3, 2010	Revised executive summary
R4	Feb 10, 2011	Change of Wind Generators and respective settings

EXECUTIVE SUMMARY

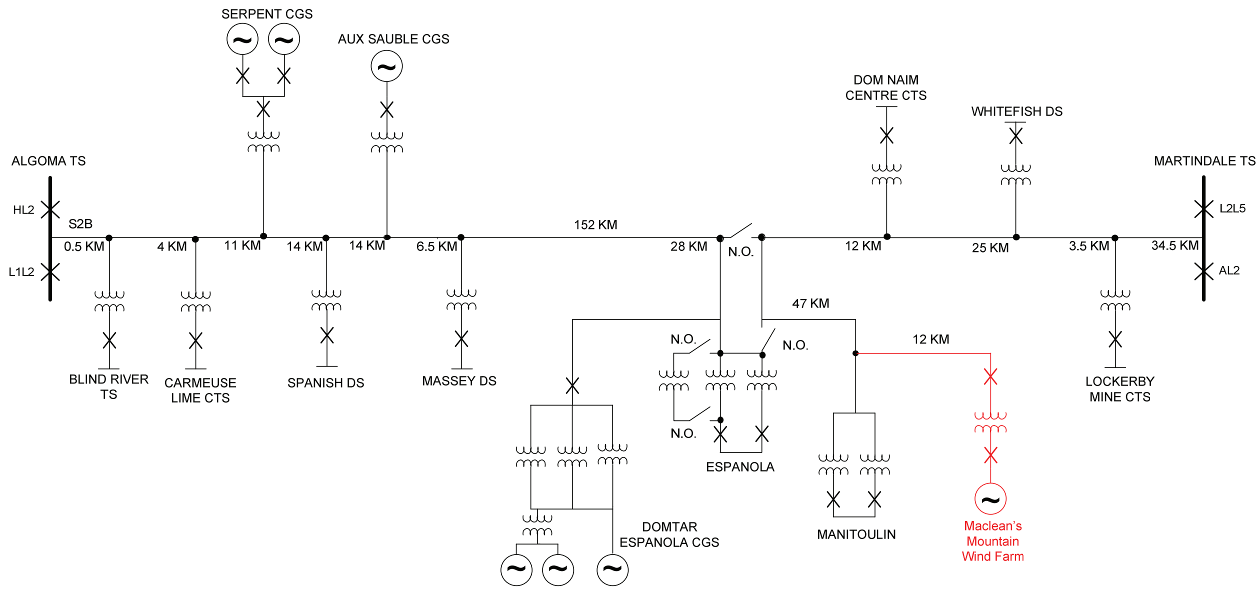


Figure 1: MacLean's Mountain Windfarm Connection to HONI Transmission System

It is feasible for MacLean's Mountain Windfarm to connect the proposed 60 MW generation at the location in Figure 1 as long as the proposed changes are made:

PROTECTION HARDWARE

- Due to connection of the new MacLean's Mountain Windfarm generating facility, the electromechanical relays at Martindale and Algoma TS must be replaced with microprocessor based relays having multiple setting groups. Multiple setting groups are required to accommodate several operating conditions: namely, with the line sectionalizer at Espanola TS open/closed and the S2B circuit connected to Martindale TS or Algoma TS.

PROTECTION SETTING

- The updated protections will function as the existing ones in a Direct Underreaching Scheme for Zone 1 and Direct Overreaching Scheme for Zones 2 and 3. The existing Zone 2 and Zone 3 reaches will be extended to cover the maximum apparent impedance due to the connection of the MacLean's Mountain Windfarm. Time delay settings will need to be reviewed to ensure proper coordination.

TELECOMMUNICATIONS

- New communications will be required between MacLean’s Mountain Windfarm and Martindale TS (normal supply terminal) for transfer trip and GEO signals. When the entire circuit is supplied from Algoma TS only, the MacLean’s Mountain Windfarm will need to be taken offline. If MacLean’s Wind Farm requires to be connected under this operating condition, communications (transfer trip and GEO) must be established to Algoma TS.