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CONNECTION ASSESSMENT & APPROVAL PROCESS

System Impact Assessment Report
Melancthon Grey Wind Farm

Applicant: Canadian Hydro Developers, Inc.

CAA ID *2003-103*

Long Term Forecasts & Assessments Department & Consistent Information Set Department

May 13, 2005

System Impact Assessment Report

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Acknowledgement

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

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 conditional approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules.

Conditional approval of the proposed connection is based on information provided to the IESO by the connection applicant and Hydro One 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 Hydro One at the request of the IESO. Furthermore, the conditional approval is subject to further consideration due to changes to this information, or to additional information that may become available after the conditional approval has been granted.

If the connection applicant has engaged a consultant to perform connection assessment studies, the connection applicant acknowledges that the IESO will be relying on such studies in conducting its assessment and that the IESO assumes no responsibility for the accuracy or completeness of such studies including, without limitation, any changes to IESO base case models made by the consultant. The IESO reserves the right to repeat any or all connection studies performed by the consultant if necessary to meet IESO requirements.

Conditional 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, the conditional 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, the connection applicant must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to the connection applicant. 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 the most recent version of this report is being used.

Hydro One

The results reported in this preliminary feasibility study are based on the information available to Hydro One, at the time of the study, suitable for a preliminary assessment of this transmission system reinforcement 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 facilities on load and generation customers.

In this preliminary feasibility study, short circuit adequacy is assessed only for Hydro One breakers. 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 facilities. These results should not be used in the design and engineering of any new or existing facilities. The necessary data will be provided by Hydro One and discussed with any 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 facilities 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.

SYSTEM IMPACT ASSESSMENT REPORT

For

MELANCTHON GREY WIND FARM

This System Impact Assessment has been conducted to examine the impact of a 240 MW wind power generation facility on the reliability of the IESO-controlled grid. The facility proposes to connect the 230 kV double circuit line B4V and B5V between Bruce A Nuclear Generating Station (NGS) and Orangeville Transformer Station (TS).

Chinodin Enterprises (Chinodin) was the original proponent for this project. In Q2-2004, Canadian Hydro Developers, Inc. (Canadian Hydro) purchased the Melancthon Grey project from Chinodin.

Chinodin retained AMEC Americas Ltd. (AMEC) to conduct the studies required for the System Impact Assessment. AMEC performed these studies under the guidance of the IESO. The studies completed by AMEC had assumed two stages – an initial capacity of 100 MW and an ultimate capacity of 240 MW.

After the studies were completed, the staged configurations of the proposed project were revised. It has now been confirmed the project will be developed with a stage 1 of 75 MW, which will be injected onto circuit B4V only, followed by a stage 2 of 165 MW, such that 120 MW is injected onto both circuits B4V and B5V. Stage 1 was selected by the Ontario Government as part of the 300 MW renewable energy RFP, and is scheduled to be in service by the end of 2005. Based on the revised configurations, additional studies were completed by AMEC.

A Study Report, detailing the initial study results, and an Addendum, detailing study results based on the revised configurations, were prepared by AMEC. Due to the extremely large size of the Study Report and Addendum, they have not been attached as appendices to this Assessment, but can be made available upon request.

PROPOSED CONNECTION ARRANGEMENT

The wind farm facility will be integrated into the 230 kV transmission corridor between Hanover TS and Orangeville TS. The connection point will be approximately 12 km west of Orangeville TS.

Stage1 – 75 MW of Generation

Stage 1 is to develop a 75 MW generating facility consisting of fifty 1.67 MVA, 575 V, GE 1.5 MW, 60 Hz variable speed wind turbines that employ a doubly-fed induction generator with a power converter interfacing the rotor to the grid.

The wind generated power is stepped up from 575 V to 34.5 kV by means of individual transformers located at the base of each wind turbine. The wind turbines are grouped into three 34.5 kV collector systems approximately 5 km long. Two collector systems contain 17 wind turbines each, while the third collector system contains 16 wind turbines.

Each collector system is connected to 34.5 kV feeder approximately 15 km long. Each feeder then connects to a 34.5 kV bus via a breaker. The 34.5 kV bus connects to a 34.5/240 kV step-up transformer which in turn connects to the existing 230 kV circuit B4V through a breaker.

The 34.5/230 kV step-up transformer is to be rated 60/80/100 MVA and connected HV-wye-grounded/LV-delta. The 575 V/34.5 kV step-up transformers associated with the wind turbine units are rated at 1.75 MVA and are connected HV-delta/LV-wye-grounded. For all transformer types, fixed off-load HV taps at ±5%, ±2.5% and 0% are provided.

A 12.75 Mvar shunt capacitor bank is to be connected to the 34.5 kV bus. The IESO understands that a motorized, independent pole operated contactor will be used for routine switching of this capacitor bank.

The proposed connection arrangement for stage 1 does not reduce the level of reliability of existing facilities and is, therefore, acceptable to the IESO.

A single line diagram of stage 1 is provided in Figure 1 on page 24.

Stage 2 – 165 MW of Generation

Stage 2 is to develop an additional 165 MW of generation with one hundred and ten GE wind turbines resulting in an ultimate capacity of 240 MW for the facility. The GE wind turbines employed in this stage would be the same type as those used in stage 1.

With 75 MW connected via stage 1, an additional 45 MW is to be connected to B4V for a total of 120 MW. The additional 45 MW on B4V is to be provided via by an additional connection arrangement consisting of thirty wind turbines that are grouped into two 34.5 kV intermediate collector systems consisting of 15 turbines each, approximately 5 km long. The two collector systems are connected to a 34.5 kV bus that connects to a 34.5/66 KV step-up transformer. A 20 km, 66 kV feeder then connects the 34.5/66 kV transformer to a 66/230 kV step-up transformer. The 66/230 kV transformer connects to B4V utilizing the same 230 kV breaker from stage 1.

A 10 Mvar shunt capacitor bank is to be connected to the B4V associated 66 kV bus. This capacitor will also utilize a motorized, independent pole operated contactor for switching.

For B5V, 120 MW from 80 wind turbines is to be connected using a connection arrangement similar to the additional 45 MW for B4V. The only difference is that wind turbines will grouped into six 34.5 kV intermediate collector systems. The six collector systems are then grouped into pairs, with each pair connecting to a common 66/230 kV transformer via a 20 km, 66 kV feeder and a 34.5/66 kV transformer. Two collector systems will contain 14 turbines each, while four collector systems will contain 13 turbines each.

Two 12.5 Mvar shunt capacitor banks are to be connected to the B5V associated 66 kV bus, each utilizing a motorized, independent pole operated contactor for switching.

The 34.5/66 kV step-up transformers are to be rated 45/60/75 MVA and connected HV-wye-grounded/LV-wye-grounded. The 66/230 kV step-up transformers are to be rated 90/120/150 MVA and connected HV-wye-grounded/LV-delta. The 575 V/34.5 kV step-up transformers are the same type as those used in stage 1. For all transformer types, fixed off-load HV taps at ±5%, ±2.5% and 0% are provided.

No low voltage (LV) transfer capability between B4V and B5V has been identified in the connection arrangement. As a result, an outage to B4V or B5V will limit the generation capability of the facility to maximum of 120 MW.

The proposed connection arrangement for stage 2 is also acceptable to the IESO. Like the stage 1 connection arrangement, it does not reduce the level of reliability of existing facilities.

A single line diagram of the ultimate capacity for the proposed wind facility is provided in Figure 2 on page 25.

Equipment Requirements for Stages 1 and 2

Generators

It is required that each induction generator connecting to the IESO-controlled grid must have the capability to perform the following:

- Supply full active power continuously to the IESO-controlled grid while operating at a generator terminal voltage ranging from 0.95 pu to 1.05 pu of the generator's rated terminal voltage, and
- Supply full active power and supply/absorb reactive power in the range of 0.9 lagging to 0.95 leading power factor for at least one constant 230 kV system voltage at the High Voltage (HV) side of the step-up transformers.

The above two requirements would effectively limit the impedance between the generator terminals and HV side of the 230 kV step-up transformers to a maximum of 0.13 pu based on the MVA rating of the generating facility. These requirements must be satisfied for stage 1 and stage 2 separately. If the above impedance limit is not met, additional reactive power compensation must be provided to compensate for the excessive reactive power losses occurring between the generator terminals and the HV side of the step-up transformer.

The wind turbine generators must also be able to ride through recognized contingencies on the IESO-controlled grid that do not disconnect the generators by configuration. This would mean during a recognized fault external to the connecting transmission circuit(s), no generator should trip. Therefore, each generator should have sufficient low voltage ride through (LVRT) capability to remain connected to the IESO-controlled grid during disturbances. Conversely, faults within the proposed facility must not trip the connecting transmission circuit(s).

Breakers & Disconnects

All 230 kV breakers and disconnects must be suitable for continuous operation at 250 kV to comply with Reference 2 of Appendix 4.1 of the Market Rules. In addition, the Transmission System Code requires that 230 kV equipment have a rated symmetrical short circuit capability of a least 63 kA and that 230 kV breakers have a rated interrupting time of three cycles (50ms) or less.

The power system near Orangeville is normally operated the 250 kV maximum. Some contingencies (e.g. load shedding, open line end) can cause a temporary voltage increase. Equipment connected to the IESO controlled grid is required to be able to withstand this over-voltage during the short period of time it takes to restore a normal voltage profile.

All 230 kV breakers, and any breaker participating in the Bruce Special Protection System (BSPS), must have dual trip coils.

Protection Systems

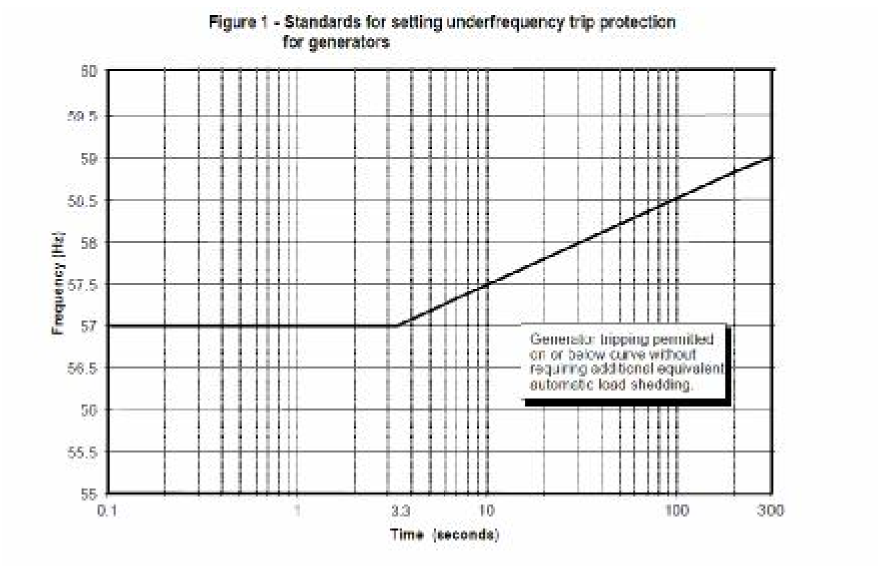
With respect to the protection and telecommunication requirements, Canadian Hydro is required to follow for the proposed generation facility the Transmission System Code technical requirements for a transmitter. This will require that the protection systems associated with the proposed facility be fully duplicated and supplied from separate batteries. In addition, it may be required that some of the existing protection systems be modified, and that the protection systems of the proposed facility be coordinated with these existing systems. Canadian Hydro is also required to follow any additional protection and communication requirements identified by Hydro One for incorporation onto the IESO-controlled grid.

The Melancthon Grey facility will be required to participate in the BSPS. This means that facilities will be required at Melancthon Grey to accept G/R signals from Bruce B and trip the wind turbine generators. The IESO also requires the incorporation of selection switches to allow local blocking or receiving of the G/R signals. The BSPS facilities at Melancthon Grey must also comply with the Northeast Power Coordinating Council (NPCC) Special Protection System Criteria (Document A-11) for type 1 special protection systems.

Reference #3 of Appendix 4.2 of the Market Rules requires that generating facilities be capable of operating continuously at full power for a system frequency range between 59.4 Hz to 60.6 Hz. For under-frequency system conditions, generators shall not trip for frequency variations that are above the curve shown below. 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 under-frequency load shedding in the area.

For under frequency system conditions the generators shall not trip for frequency variations that are above the curve shown in Figure 3.

Figure 3 – Under-frequency Trip Protection Settings



On-Line Monitoring

The Market Rules (Appendix 4.15 and Appendix 4.19) list the requirements with respect to the information that has to be monitored and the performance standards that have to be achieved on a continual basis by all generators.

In accordance with the requirements for a *major generation facility*, Melancthon Grey must ensure that all the equipment needed to monitor and meet the performance standards will be installed.

The IESO requires at a minimum the following items to be monitored for stage 1 of the proposed facility:

- Four quadrant, net 230 kV B4V active and reactive power flows at the facility
- 230 kV B4V voltages at the facility
- 34.5 kV bus A1 voltages
- Status of 230 kV line disconnect B4VP1-B4V
- Status of 230 kV breaker B4VP1
- Status of 34.5 kV breakers BA1FA11, BA1FA12 and BA1FA13
- Status of capacitor bank CA11
- Status of Bruce Special Protection System selection switches

The IESO requires at a minimum the following items to be monitored for stage 2 of the proposed facility:

- Four quadrant, net 230 kV B5V active and reactive power flows at the facility
- 230 kV B5V voltages at the facility
- 66 kV bus A2 & bus B1 voltages
- 34.5 kV bus A2A, bus B1A, bus B1B & bus B1C voltages
- Status of 230 kV line disconnect B5VQ1-B5V
- Status of 230 kV breaker B5VQ1
- Status of 34.5 kV breakers A21F1, A21F2, B11F1, B11F2, B12F1, B12F2, B13F1 & B13F2
- Status of capacitor banks CA21, CB11 & CB21
- Status of Bruce Special Protection System selection switches

The IESO will finalize items to be monitored during the IESO Facility Registration Process.

DATA AND MODEL VERIFICATION

The GE wind turbine generator are doubly-fed (wound rotor) induction type units with AC–DC–AC conversion at rotor circuit that enables control of the rotor current to permit operation at varying speeds. The GE 1.5 wind turbines proposed for this project will be capable of operating at power factors ranging from 0.9 lagging to 0.9 leading.

For the initial studies, AMEC used the GE 1.5 Wind Turbine Generator (WTG) PTI/PSSE model version 1.4 for the load flow simulations. Subsequent to the initial studies, AMEC completed further studies with the GE 1.5 WTG PTI/PSSE model beta version 3.2.

The remaining connection facilities (transformers, feeders & collector systems) were modeled based on equipment to be purchased by Canadian Hydro.

For the 240 MW configuration of Melancthon Grey, the modeling data for the GE 1.5 WTG and connection facilities are provided in Appendix A of this Assessment.

It must be emphasized that IESO has observed performance deficiencies in the GE 1.5 WTG model beta version 3.2 and has reservations on the accuracy of the transient simulation results. Consequently, the IESO assumes no responsibility for the completeness or the dependability on the conclusions drawn from the transient simulations.

Before final approval for connection is granted, Canadian Hydro is required to provide a final complete model of the wind generation facility, including any controls that would be operational. To allow the IESO to perform the necessary tests and verify if the performance of the complete model meets the applicable Market Rules, this information should be submitted to the IESO at least three months before connection for stage 1 and at least seven months before connection for stage 2.

Canadian Hydro is responsible for ensuring that the performance of the generation facility eventually connected to the IESO-controlled grid meets or exceeds the predicted performance observed in the study studies. If the facility either does not meet the predicted performance standards when installed, or is subsequently determined not to meet those performance standards, IESO connection approval may be withdrawn until the specified performance standards, or their equivalent, can be demonstrated.

Canadian Hydro is also required to provide to the IESO evidence that demonstrates the wind generation facility model is valid. This evidence shall be either type tests done in a controlled environment or commissioning tests done on-site. In either case, the testing must be done in accordance with widely recognized standards.

SHORT CIRCUIT STUDIES

Hydro One, performed short circuit studies to identify the impact of the proposed wind farm on the short circuit currents in the local area of connection. The short circuit assessment was performed for stage 1. Table 1 summarizes the results.

Table 1 – Short Circuit Study Results

BUS kV	TOTAL FAULT CURRENT Symmetrical (kA)		Breaker Lowest Ratings Symmetrical (kA)
	3-phase fault	L-G fault	
Existing System + All Other Projects in the Queue (NO Melancthon Grey Wind Farm)			
Essa 220 kV	24.46	28.30	46 kA
Essa 118 kV	13.07	15.31	22 kA
Orangeville 220 kV	16.09	13.61	46.2 kA
Hanover 118 kV	11.14	12.24	40 kA
Bruce 220 kV	31.49	40.28	63 kA
Detweiler 220 kV	21.03	18.32	40 kA
Detweiler 118 kV	20.27	23.71	45 kA
Existing System + All Other Projects in the Queue with Melancthon Grey Wind Farm (75 MW)			
Essa 220 kV	24.62	28.46	46 kA
Essa 118 kV	13.09	15.33	22 kA
Orangeville 220 kV	16.54	15.06	46.2 kA
Hanover 118 kV	11.18	12.32	40 kA
Bruce 220 kV	31.60	40.39	63 kA
Detweiler 220 kV	21.17	18.41	40 kA
Detweiler 118 kV	20.34	23.78	45 kA

In particular, the short circuit study results indicate that the system short circuit currents increase by up 1.45 kA at Orangeville TS, but remain within the interrupting capability of the existing station breakers.

Hydro One will also complete a short circuit study for stage 2. Given the margins shown in Table 1, the IESO expects that the resulting short circuit currents will also not exceed the existing breaker interrupting capabilities.

REACTIVE POWER CAPABILITY

The reactive power consumptions of the connection facilities between the generator terminals and the HV side of the facility for stages 1 and 2 are provided below. The facility MVA base is 83.5 MVA (50 units x 1.67 MVA) for stage 1 and 50.1 MVA (30x1.67) for B4V and 133.6 MVA (80x1.67) for B5V in stage 2.

Stage 1

B4V – incorporate 83.5 MVA (50 WTGs)

- Reactive power consumed by WTG 36.0 kV/575 V step-up transformers (50 in total) on facility MVA base: approximately (~) 5 Mvar
- Reactive power consumed by 5 km collector systems (3 in total) on facility MVA base: ~ 3 Mvar
- Reactive power consumed by 15 km feeders (3 in total) on facility MVA base: ~ 10 Mvar

- Reactive power consumed by 34.5/240 kV step-up transformer on facility MVA base: ~ 6 Mvar
- Total power consumed by stage 1 = 5+3+10+6 = 24 Mvar
- 13% maximum reactive power consumption between generator terminal buses and HV side of 230 kV transformer, based a generator terminal voltage range of 0.95 pu to 1.05 pu = ~ 11 Mvar
- Additional reactive power compensation required = 24-11 = ~ 13 Mvar

Stage 2

a) B4V – incorporate an additional 50.1 MVA (30 WTGs)

- Reactive power consumed by WTG 36.0 kV/575 V step-up transformers (30 in total) on facility MVA base: ~ 3 Mvar
- Reactive power consumed by 34.5 kV, 5 km collector systems (2 in total) on facility MVA base: ~ 2 Mvar
- Reactive power consumed by 34.5/66 kV step-up transformer on facility MVA base: ~ 2 Mvar
- Reactive power consumed by 66 kV, 20 km feeder on facility MVA base: ~ 4 Mvar
- Reactive power consumed by 66/240 kV step-up transformer on facility MVA base: ~ 2 Mvar
- Total power consumed by B4V stage 2 = 3+2+2+4+2 = 13 Mvar
- 13% maximum reactive power consumption between generator terminal buses and HV side of 230 kV transformer, based a generator terminal voltage range of 0.95 pu to 1.05 pu = ~ 7 Mvar
- Additional reactive power compensation required for B4V = 13-7 = ~ 6 Mvar

b) B5V – incorporate 133.6 MVA (80 WTGs)

- Reactive power consumed by WTG 36.0 kV/575 V step-up transformers (80 in total) on facility MVA base: ~ 7 Mvar
- Reactive power consumed by 34.5 kV, 5 km collector systems (6 in total) on facility MVA base: ~ 4 Mvar
- Reactive power consumed by 34.5/66 kV step-up transformers (3 in total) on facility MVA base: ~ 5 Mvar
- Reactive power consumed by 66 kV, 20 km feeders (3 in total) on facility MVA base: ~ 9 Mvar
- Reactive power consumed by 66/240 kV step-up transformer on facility MVA base: ~ 13 Mvar
- Total power consumed by B5V stage 2 = 7+4+5+9+13 = 38 Mvar
- 13% maximum reactive power consumption between generator terminal buses and HV side of 230 kV transformer, based a generator terminal voltage range of 0.95 pu to 1.05 pu = ~ 17 Mvar
- Additional reactive power compensation required for B5V = 38-17 = ~ 21 Mvar

The above calculations were performed using the transformer and line impedances provided for stage 1 and stage 2.

The results show that facility's total reactive power support requirements are not met by the reactive power capability of the wind-turbine generators alone. Additional reactive power corrective equipment is required for the facility.

Shunt capacitors banks are to be installed at the Melancthon Grey wind farm to meet the IESO Market Rules for reactive power capability. A 12.75 Mvar capacitor is to be installed at the 34.5 kV collector bus for stage 1, and a 10 Mvar capacitor (B4V) and two 12.5 Mvar capacitors (B5V) are to be installed at the 66 kV feeder buses for stage 2. With these sized capacitor banks, the Melancthon Grey facility for stage 1 and stage 2 will provide the equivalent reactive power of a synchronous machine with a terminal voltage range of 0.95 pu to 1.05 pu. This satisfies the Market Rules requirements for reactive power capability.

The shunt capacitor banks must have control facilities, under-voltage and over-voltage, to allow automatic switching of the banks.

The IESO understands that Canadian Hydro intents to operate the facility with the capacitor banks always in-service. The reactive power injected to or absorbed from the IESO-controlled grid would then be completely regulated via automatic reactive power control features. These control features would maintain voltage control on the 34.5 kV bus A1 (stage 1), the 66 kV bus A2 (B4V – stage 2) and the 66 kV bus B1 (B5V – stage 2) by varying the amount reactive power produced or absorbed by the WTGs.

However, for conditions of high 230 kV system voltages and low Melancthon Grey generated power, the automatic reactive power control features may not be able to regulate the amount of reactive power injected into the IESO-controlled grid. For these conditions, the IESO may require the Melancthon Grey capacitor banks to be switched out of service. If the proposed switching contactors are not able to perform this function when instructed by the IESO, the IESO will then require the Melancthon Grey 230 kV breakers to be opened, interrupting any power being generated by the WTGs.

LOAD FLOW STUDIES

The initial load flow studies were performed by AMEC. The system models for these studies were provided by the IESO in accordance through a non-disclosure agreement.

Due to the subsequent revised configurations of the project, additional studies were completed by AMEC.

The IESO also provided the Study Scope with study assumptions, and advice and guidance when necessary during the execution of studies.

A brief summary of the Study Scope is provided in items 1 and 2 below.

1. Three system scenarios were formulated by the IESO for the assessment:
   A. 2006 summer peak load and generation at 25,630 MW with power flows on NBLIP transmission interface at approximately 1,500 MW and FETT transmission interface at approximately 5,700 MW,
   B. 2006 summer peak load and generation at 25,630 MW with power flow on BLIP transmission interface at approximately 3,000 MW, and
   C. 2006 summer off-peak load and generation at 13,500 MW.

2. For the initial studies, the above system scenarios were studied with the proposed generation facility at 240 MW, 100 MW and 0 MW, representing nine different study scenarios. For the subsequent studies, only system scenario A was studied with the proposed generation facility at 240 MW, 75 MW and 0 MW. The various studies included the investigation of following areas:

- Linear load flow studies to determine 500 kV and 230 kV power flows on transmission circuits near the proposed facility when Melancthon Grey generation displaces an equivalent amount of generation at Nanticoke Thermal Generating Station (TGS) or Pickering Nuclear Generating Station (NGS).
- Steady state load flow studies, both pre-contingency and post-contingency, to determine if the continuous thermal rating of specific circuits is exceeded and if all local 115 kV, 230 kV and 500 kV voltages are within acceptable system limits.
- Transient stability response studies for specific system disturbances to determine if the proposed facility affects system stability and to identify the low voltage ride-through capability requirements for the proposed facility.

The initial load flow study results were provided to the IESO in a Study Report. The additional load flow study results based on the revised configurations were provided to the IESO in an Addendum.

Since the initial study results showed that the system scenario A is more stressful to the IESO-controlled grid than system scenarios B & C, the following subsections summarize only the AMEC Addendum study results except for the 'Stage 1 – Reduction in Transfer Capability' heading. The analysis detailed under this heading was completed by the IESO.

Linear Load Flow Results

Table 2 summarizes the transfer distribution factors on the specific transmission circuits when Melancthon Grey displaces generation at Nanticoke or Pickering.

Table 2 – Transfer Distribution Factors

Circuit / Interface	Section	Distribution Factor (%) when Melancthon Displaces:			
		Stage 1: 75MW		Stage 2: 240MW	
		Nanticoke	Pickering	Nanticoke	Pickering
B4V	Melancthon tap to Orangeville	79%	79%	35%	35%
	Melancthon tap to Hanover	21%	21%	15%	15%
	Hanover to Bruce	17%	17%	13%	13%
B5V	Melancthon tap to Orangeville	-	-	35%	35%
	Melancthon tap to Hanover	-	-	15%	15%
	Hanover to Orangeville	-9%	-9%	-	-
	Hanover to Bruce	10%	10%	13%	13%
D6V	Orangeville to Fergus	17%	15%	17%	15%
D7V	Orangeville to Fergus	17%	15%	17%	15%
E8V	Orangeville to Alliston	18%	20%	18%	20%
E9V	Orangeville to Alliston	18%	20%	18%	20%
BLIP		1%	2%	1%	2%
FETT		1%	97%	1%	97%

For stage 1 of the proposed facility, 79% of the active power from Melancthon Grey flows to Orangeville TS when generation at Nanticoke or Pickering is displaced. For stage 2, 70% of the active power from Melancthon Grey flows to Orangeville TS.

The results also show that approximately 97% of the Melancthon Grey generation shows up on the FETT transmission interface when Pickering generation is displaced.

Stage 1 – Reduction in Transfer Capability

The addition of stage 1 causes an imbalance in the flow on circuits B4V and B5V. This reduces the transfer capability of B4V and B5V into Orangeville TS by about 100 MW. As Melancthon Grey is only expected to be generating when there is appreciable wind, this reduction will not cause a material adverse effect on the reliability of the IESO-controlled grid.

Steady State Load Flow Results

For system scenario A and Melancthon Grey generation at 0 MW, 75 MW and 240 MW, pre-contingency power flows and bus voltages are within limits for the monitored transmission elements.

Post-contingency studies to examine thermal overloading concerns and voltage declines (pre-ULTC & post-ULTC) were completed for the following contingencies:

- Loss of 500 kV double circuit line B560V & B561M
- Loss of 230 kV circuit B5V
- Loss of Melancthon Grey Wind Farm (Stage 1: 75 MW; Stage 2: 240 MW)
- Loss of Melancthon Grey shunt capacitor bank(s) (Stage 1: CA11; Stage 2: CB11 & CB21)

For the above contingencies, no thermal overload concerns were identified for the monitored transmission circuits in the study scenarios. All power flows on the monitored circuits were observed to be within the continuous ratings of the circuits.

In addition, for the four contingencies studied, most of the voltage declines on the monitored buses were also within the IESO 10% maximum voltage decline criterion. In particular, the largest voltage declines were observed for the loss of the 500 kV double circuit line B650V/B561M. A 10.1% voltage decline, post-tapchanger operation (post-ULTC), was observed at the Orangeville 230 kV bus with the Melancthon Grey generation at 0 MW. However, the voltage decline at the Orangeville bus falls below 10% when the Melancthon Grey facility is at either 75 MW or 240 MW and is providing its full reactive power capability from the WTGs and shunt capacitor(s).

The voltage declines at the Orangeville, Alliston, and Hanover low voltage buses for all study scenarios are all well within the maximum voltage decline criterion.

Since the studies reveal that the loss of the reactive power support from Melancthon Grey in both stages does not reduce the IESO-controlled grid voltages by greater than 10%, there is no requirement to provide any additional reactive compensation on the IESO-controlled grid to maintain post-contingency voltages.

Table 3 lists the pre-contingency voltages and post-contingency voltages (pre-ULTC & post-ULTC) of the monitored buses for the 500 kV double circuit line B560V and B561M contingency with Melancthon Grey at 0 MW, 75 MW and 240 MW.

Table 3 – Loss of 500 kV double circuit line B560V & B561M: Pre- and Post- Contingency Voltages

Bus Name	Bus #	B560V/B561M Melancthon Grey 0 MW					B560V/B561M Melancthon Grey 75 MW					B560V/B561M Melancthon Grey 240 MW				
		Base kV	Pre-ULTC kV	Pre-ULTC % Decline	Post-ULTC kV	Post-ULTC % Decline	Base kV	Pre-ULTC kV	Pre-ULTC % Decline	Post-ULTC kV	Post-ULTC % Decline	Base kV	Pre-ULTC kV	Pre-ULTC % Decline	Post-ULTC kV	Post-ULTC % Decline
ORANGVIL 220	80251	237.5	216.5	8.8%	213.6	10.1%	238.7	217.8	8.8%	215.6	9.7%	239.8	219.5	8.5%	217.8	9.2%
ORANG BY44.0	80380	46.7	42.6	8.8%	46.1	1.3%	47	42.8	8.9%	46.5	1.1%	46.6	42.7	8.4%	46.4	0.4%
ORANG JQ44.0	80382	46.7	42.6	8.8%	45.8	1.9%	47	42.8	8.9%	46.3	1.5%	46.4	42.5	8.4%	46.1	0.6%
ORANG EZ27.6	80383	29.1	26.5	8.9%	29.0	0.3%	29.3	26.7	8.9%	28.9	1.4%	29.4	26.9	8.5%	29.2	0.7%
ALLISTE9 220	80202	244.8	229.2	6.4%	225.7	7.8%	245.4	229.7	6.4%	226.8	7.6%	244.5	228.9	6.4%	226.4	7.4%
ALLISTBY44.0	80336	46.4	43.4	6.5%	46.5	-0.2%	46.6	43.5	6.7%	46.2	0.9%	46.4	43.4	6.5%	46.1	0.6%
BUCHANAN 220	82550	235.9	222.5	5.7%	222.2	5.8%	236.2	222.8	5.7%	222.9	5.6%	236.5	223	5.7%	223.7	5.4%
BUCHANAN 118	82720	118.2	111.4	5.8%	111	6.1%	118.4	111.6	5.7%	111.3	6.0%	118.5	111.7	5.7%	111.8	5.7%
HANOVRB4 220	80227	240.1	220.5	8.2%	222.1	7.5%	241.1	221.9	8.0%	223.9	7.1%	242.1	223.7	7.6%	226.1	6.6%
HANOVRB5 220	80226	239.9	220.3	8.2%	222	7.5%	240.7	221.4	8.0%	223.4	7.2%	241.9	223.6	7.6%	225.9	6.6%
HANOVER 118	80306	120.9	111.4	7.9%	112	7.4%	121.4	112	7.7%	112.8	7.1%	121.9	112.9	7.4%	113.9	6.6%
HANOVER 44.0	80356	46.4	42.8	7.8%	44.8	3.4%	46.6	43	7.7%	45.1	3.2%	46.8	43.3	7.5%	45.6	2.6%
ESSA 500	80046	524.7	507.2	3.3%	500.9	4.5%	525.2	507.8	3.3%	502.4	4.3%	526.8	509.5	3.3%	504.9	4.2%
ESSA 220	80221	247.9	234.3	5.5%	230.9	6.9%	248.3	234.6	5.5%	231.7	6.7%	247	233.4	5.5%	230.9	6.5%
DETWEILE 118	81705	118.4	108.5	8.4%	107.1	9.5%	118.7	108.9	8.3%	107.8	9.2%	119	109.3	8.2%	108.5	8.8%
DETWEILE 220	81570	234	215.7	7.8%	212.7	9.1%	234.7	216.4	7.8%	214.1	8.8%	235.3	217.2	7.7%	215.4	8.5%
BRUCE A 220	80211	245.9	238	3.2%	243.2	1.1%	246.1	238.4	3.1%	243.8	0.9%	246.4	239	3.0%	244.5	0.8%
BRUCE A 500	80002	543.9	541.8	0.4%	542.7	0.2%	544	541.8	0.4%	542.8	0.2%	544	541.9	0.4%	543	0.2%
BRUCE B 500	80001	545	545	0.0%	545	0.0%	545	545	0.0%	545	0.0%	545	545	0.0%	545	0.0%

Dynamic Response Results

It must be strongly emphasized again that the dynamic simulation results presented in this Assessment are suspect due to IESO observed performance deficiencies in the GE 1.5 WTG model beta version 3.2. Therefore, conclusions drawn from these results are not necessarily accurate or dependable. Before final approval for connection is granted, the dynamic simulations will need to be re-done with a model verified by the IESO. These simulations may result in different performance standards than those presently identified in this Assessment.

Transient Stability Simulations

Transient stability simulations were completed to determine if the power system and the proposed facility remain stable and well damped for a severe system contingency. A LLG fault on the 500 kV double circuit line B561V and B560M was investigated with Melancthon Grey generation dispatched at 240 MW and 75 MW.

With the Superior Wind Energy Bruce and Collingwood wind proposals assumed dispatched in the study assumptions, the results show that even with Melancthon Grey at 0 MW generation rejection of the Bruce and Collingwood proposals is required to avoid slowly decaying voltages, as shown in Figures 3 and 4.

With Melancthon Grey generation at 75 MW and 240 MW, generation rejection of the Melancthon Grey and the Bruce and Collingwood proposals is also required for the system voltages to remain stable and well damped. Figures 5 and 6 show the transient simulation results with Melancthon Grey at 75 MW and 240 MW, respectively.

The Melancthon Grey wind farm will be required to participate in the Bruce Special Protection System (BSPS).

Low Voltage Ride Through (LVRT) Capability

For system contingencies, the IESO requires that the wind turbine generators and associated equipment remain connected to the IESO-controlled grid unless the generators are removed from service by configuration. This requirement is commonly referred to as the ‘low voltage ride-through’ (LVRT) capability. To determine the LVRT requirements for this project, transient simulations of the contingency expected to be most onerous on ride-through are required. The results of these simulations are used to determine sag of the WTG terminal voltages during the fault period before the fault is cleared.

For the proposed stage 1 and stage 2 connection arrangements of Melancthon Grey, a 3-phase fault at the Orangeville 230 kV bus is considered the worst-case condition for LVRT. This fault type and fault location would have the greatest impact on the WTG terminal voltages at Melancthon Grey. As show in Figures 7 and 8, it can be concluded that the WTGs will be required to have a ride-through capability of at least 100 ms with transient system voltages below 0.45 pu.

Figure 4 – LLG fault on B560V/B561M with Melancthon Grey at 0 MW and no generation rejection (G/R)

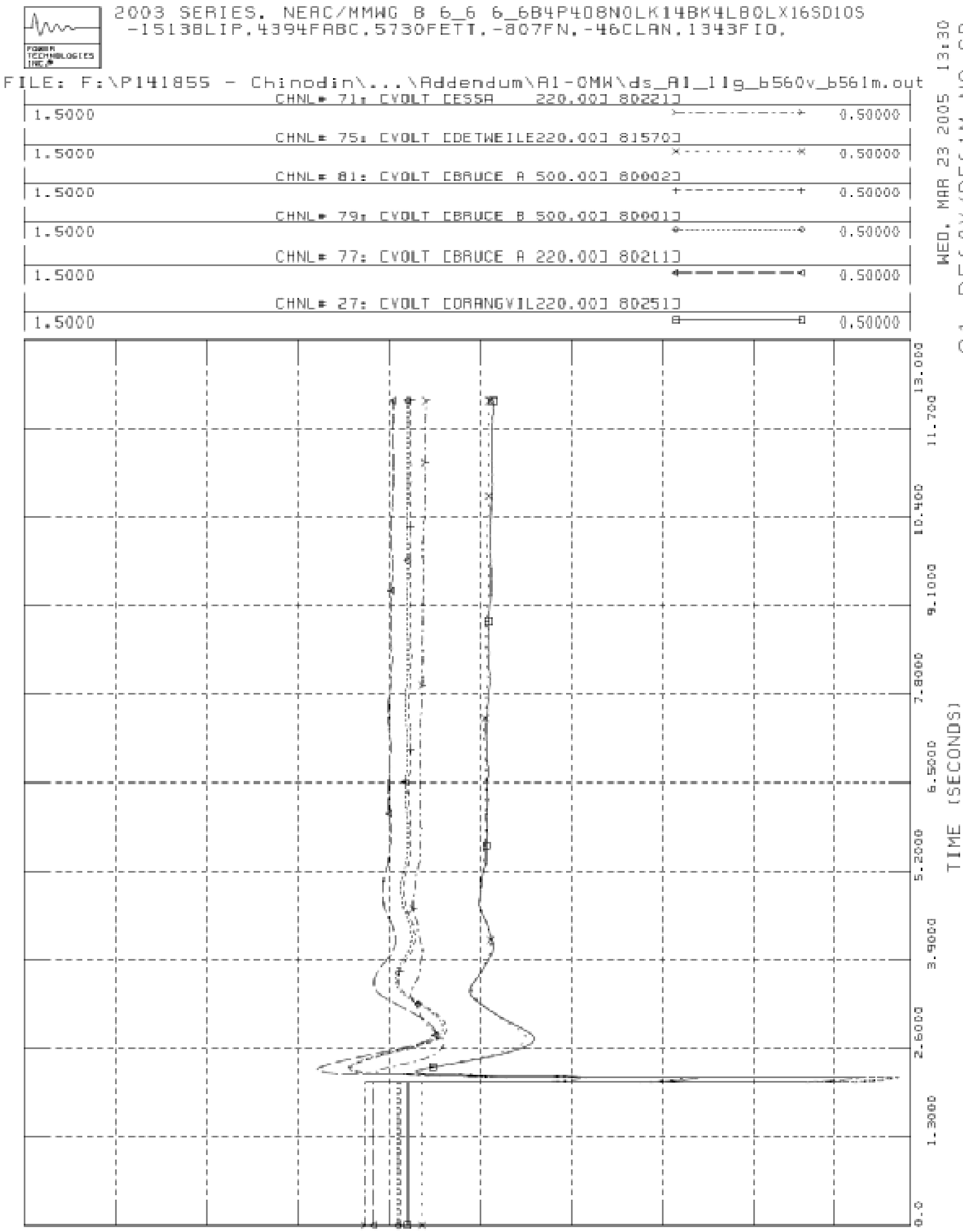


Figure 5 – LLG fault on B560V/B561M with Melancthon Grey at 0 MW and generation rejection (G/R)

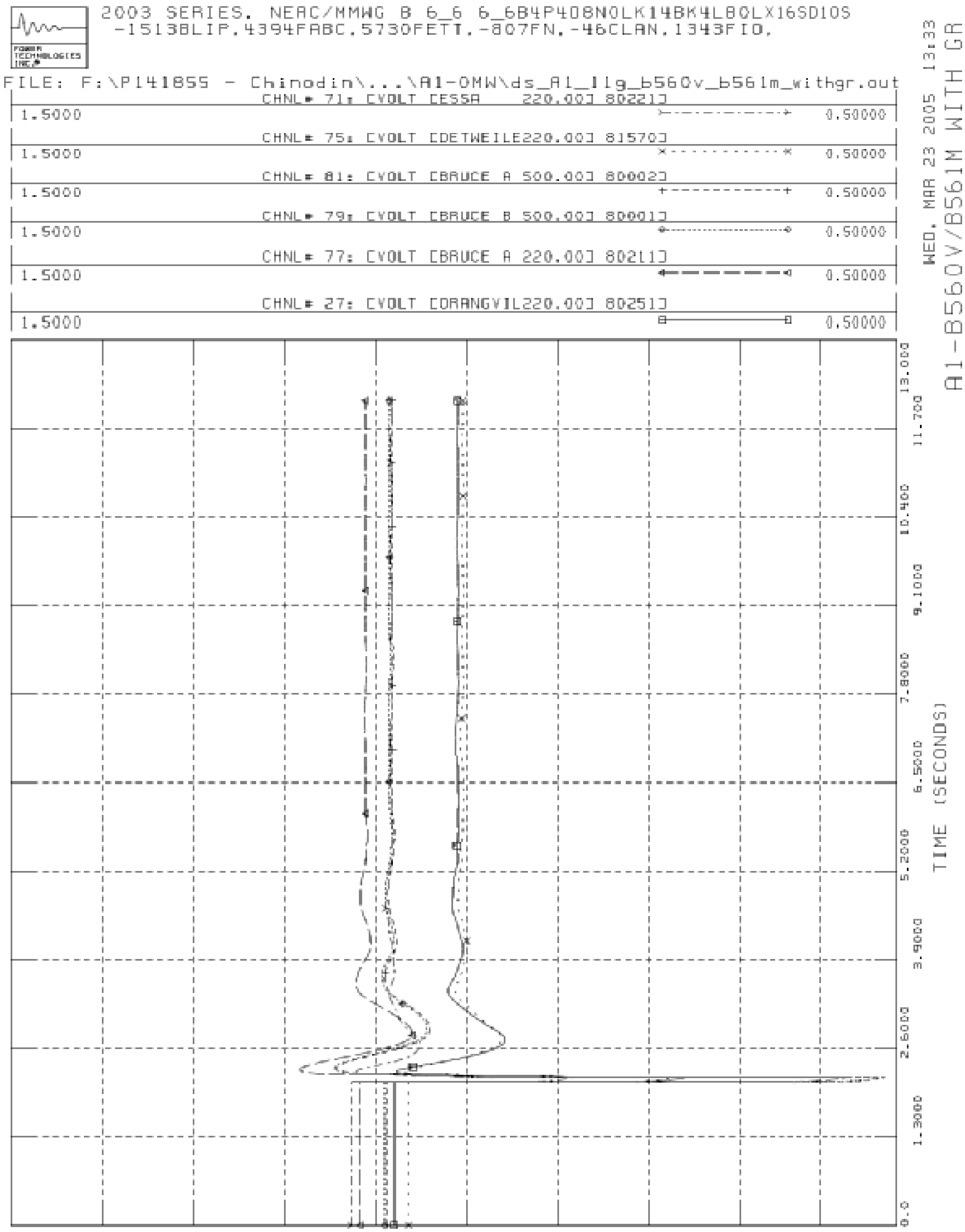


Figure 6 – LLG fault on B560V/B561M with Melancthon Grey at 75 MW and generation rejection (G/R)

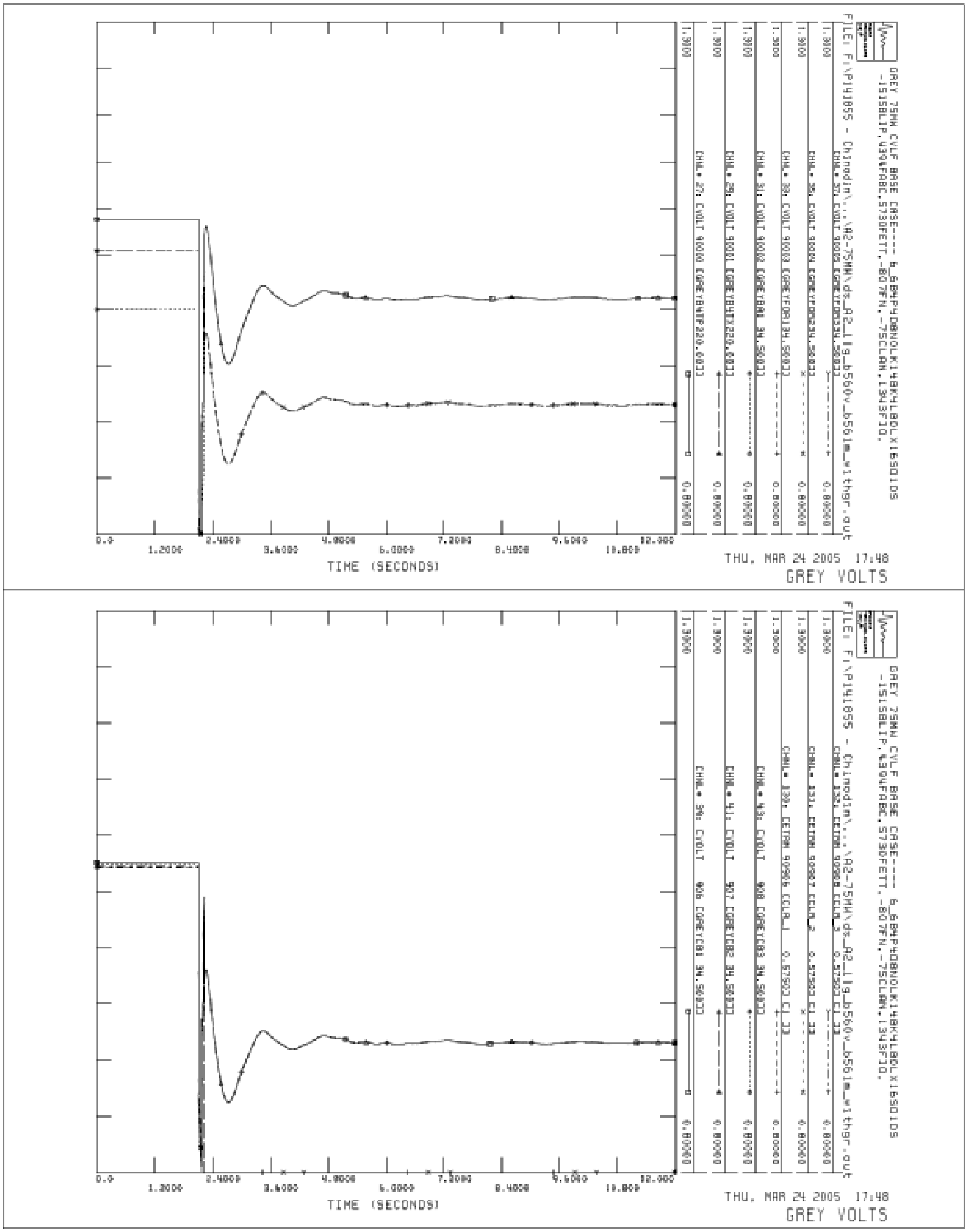


Figure 7 – LLG fault on B560V/B561M with Melancthon Grey at 240 MW and generation rejection (G/R)

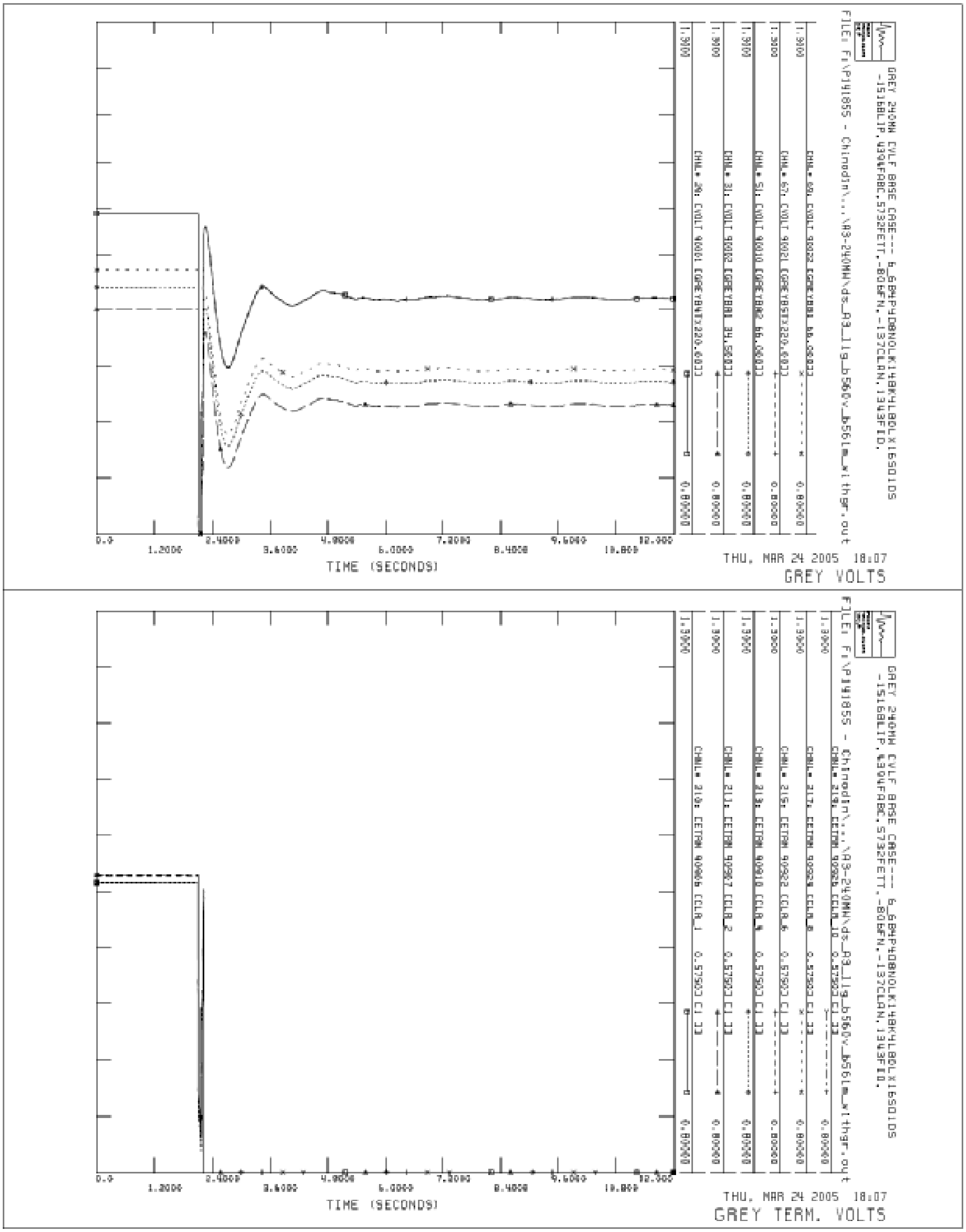


Figure 8 – Melancthon Grey 75 MW (Stage 1): LVRT Requirements – 3-phase at Orangeville TS

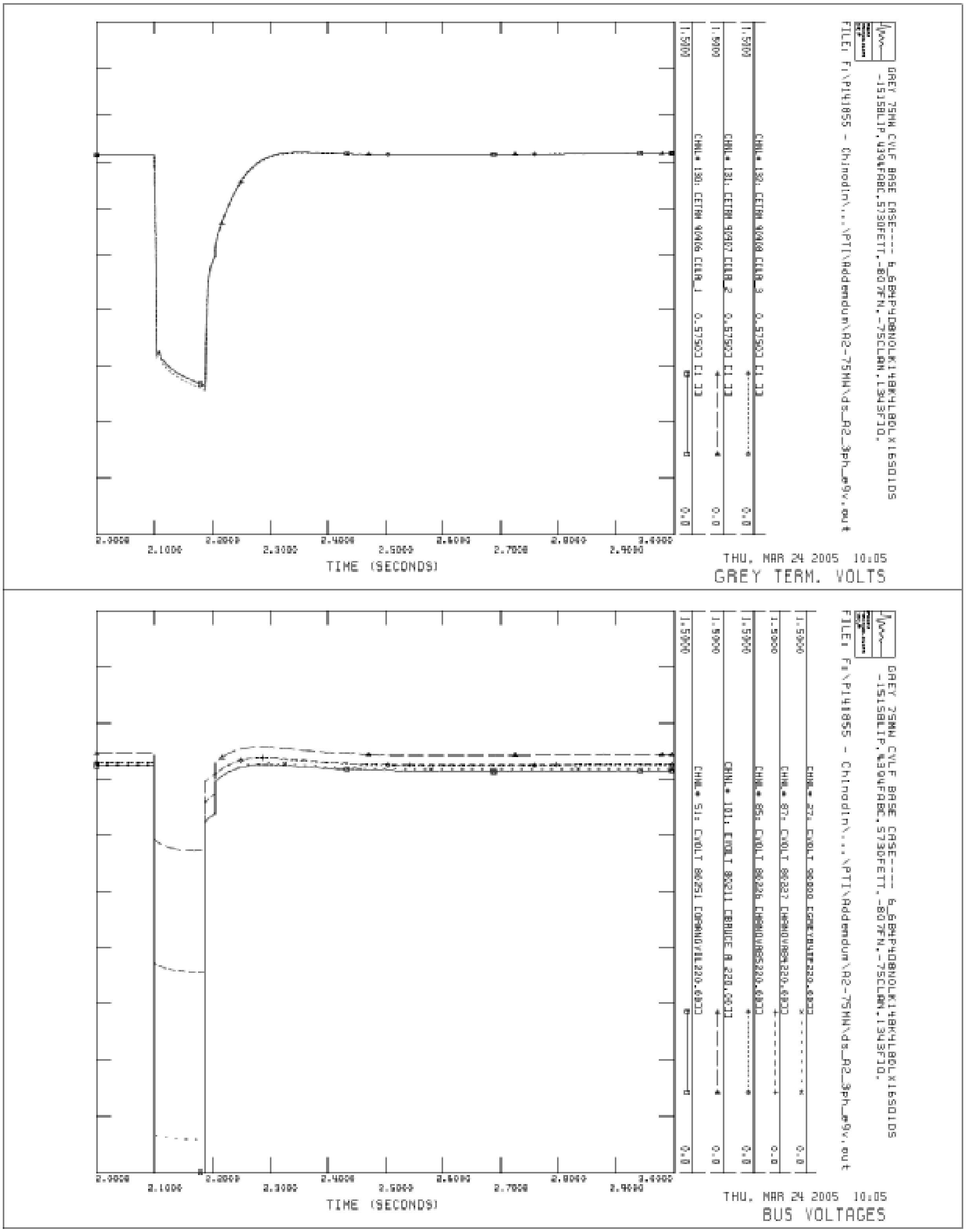
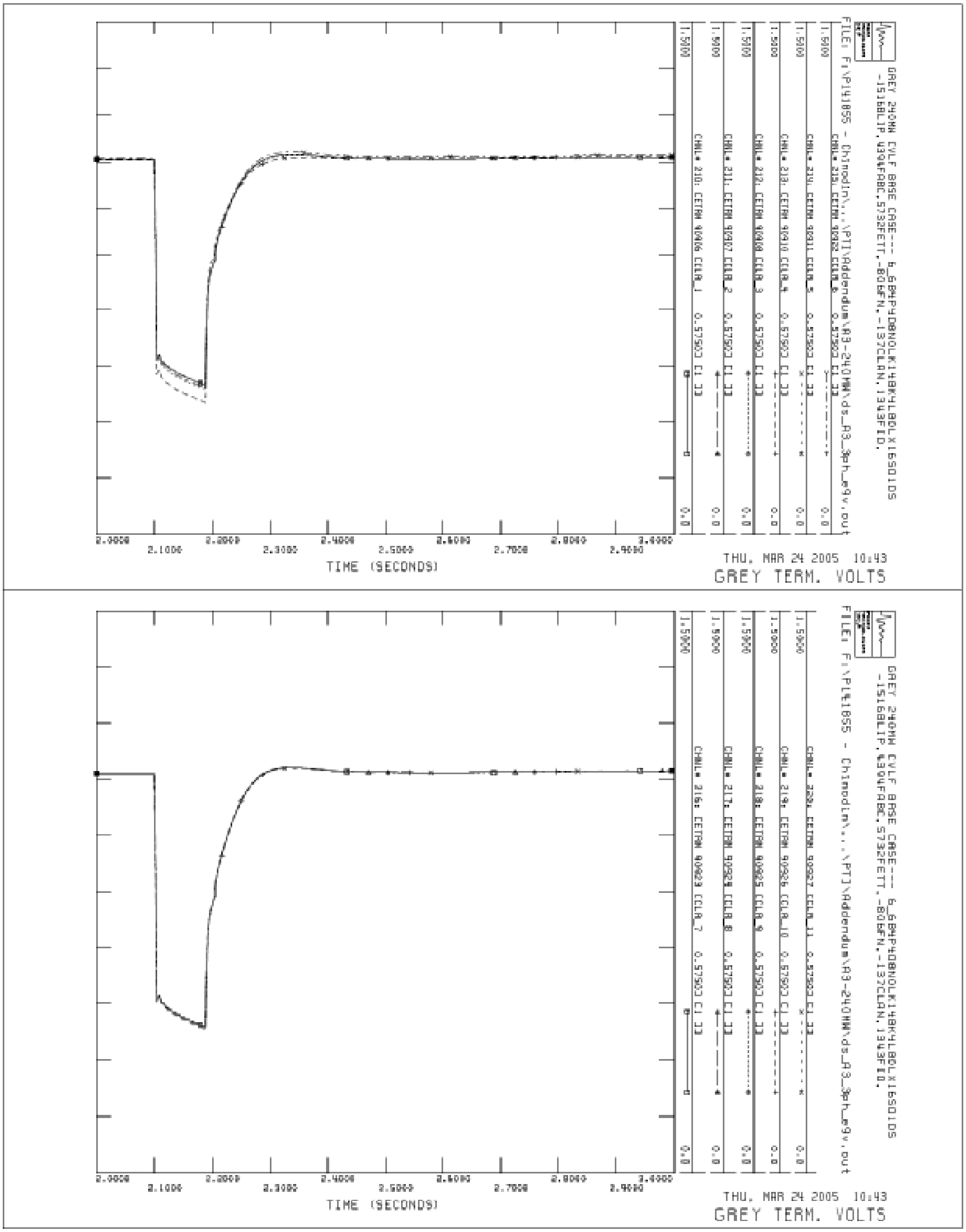


Figure 9 – Melancthon Grey 240 MW (Stage 2): LVRT Requirements – 3-phase at Orangeville TS



The simulation results suggest that the WTGs must be equipped with GE level II LVRT capability. The key requirement is the wind turbine generators and associated equipment must be capable of remaining connected to the IESO-controlled grid for system disturbances or contingencies unless the transmission facilities connecting the generators are removed from service.

When the facility is incorporated into the IESO-controlled grid, if the WTGs trip for contingencies for which they are not removed by configuration, the IESO will require more enhanced LVRT to be installed by Canadian Hydro to prevent such tripping.

CONCLUSIONS AND REQUIREMENTS

Conclusions

The proposed stage 1 and 2 connection arrangements for the Melancthon Grey wind farm are acceptable to the IESO.

The Melancthon Grey facility will be required to participate in the Bruce Special Protection System (BSPS).

The short circuit study results indicate that fault currents at the specified buses do not materially change with the addition of the Melancthon Grey facility.

To meet the Market Rules requirements for reactive power capability of a synchronous machine with a generator terminal voltage range of 0.95 pu to 1.05 pu, additional reactive power devices are required for stage 1 and stage 2.

The Melancthon Grey facility will not have any adverse effects on the reliability of the IESO-controlled grid.

Enhanced LVRT capability is required to allow the wind turbine generators to remain connected to the IESO-controlled grid for system disturbances or contingencies, unless the facility is removed from service by configuration.

IESO Requirements

IESO approval of this project is depend on implementation of the following requirements and the implementation of any additional requirements specified in the Customer Impact Assessment for this project performed by Hydro One.

The following requirements have been identified by the IESO for the proposed stage 1 (75 MW) and stage 2 (additional 165 MW) incorporation of Melancthon Grey:

1. Since the Assessment of this project has been based on results of studies conducted using a beta PTI/PSSE model of the GE 1.5 WTG, additional dynamic simulation studies will need to be completed with a model verified by the IESO before final approval for connection is granted.

   The new study results may result in different performance standards than those presently identified in this Assessment.
2. The voltage ratings of the 230 kV breakers and disconnects must be suitable for continuous operation at 250 kV. The 230 kV breakers must also have a rated interrupting time of 3 cycles or less, and a short circuit symmetrical duty of at least 63 kA.

   Some contingencies can cause a temporary voltage increase greater than 250 kV. Equipment connected to the IESO controlled grid is required to be able to withstand this over-voltage during the short period of time it takes to restore a normal voltage profile.
3. The facility shall be capable of operating continuously at full active power within ± 5 % of the generators' rated terminal voltage.
4. The facility shall be capable operating continuously at full active power for system frequencies in the range between 60.6 Hz to 59.4 Hz. It is required that for under frequency system conditions the generators not trip for frequency variations that are above the curve shown in Figure 1 of this Assessment.
5. The wind turbine generators must be able to ride through recognized contingencies on the IESO-controlled grid that do not disconnect the facility by configuration. Faults within the facility must not trip 230 kV circuit B4V for the stage 1 and 230 kV circuits B4V and B5V for the stage 2.
6. The shunt capacitor banks must have control facilities, under-voltage and over-voltage, to allow automatic switching of the banks.
   The facility must also have an automatic reactive power control features that operates in voltage control.
7. The wind turbine generators must minimize any adverse effects on the IESO-controlled grid during the connection and disconnection of the generation facility to the system.
8. Canadian Hydro must provide to the IESO a complete model for the wind generation facility, including any controls that would be operational before final approval for connection is granted. To allow the IESO to perform the necessary tests and verify if the performance of the complete model meets the applicable Market Rules, this information should be submitted to the IESO at least three months before connection for stage 1 and at least seven months before connection for stage 2.
9. Canadian Hydro is required to provide to the IESO evidence that demonstrates facility performance standards obtained with the wind generation facility model are valid. This evidence shall be either type tests done in a controlled environment or commissioning tests done on-site. In either case, the testing must be done in accordance with widely recognized standards.

If the facility either does not meet the predicted performance standards when installed, or is subsequently determined not to meet those performance standards, IESO connection approval may be withdrawn until the specified performance standards, or their equivalent, can be demonstrated.

10. Canadian Hydro is required to follow for the facility the Transmission System Code technical requirements and/or any requirements identified by Hydro One for protection and telecommunication facilities.

    The BSPS facilities at Melancthon Grey must also comply with the Northeast Power Coordinating Council (NPCC) Special Protection System Criteria (Document A-11) for type 1 special protection systems.

11. In accordance with the requirements for a *major generation facility,* the IESO will require on-line monitoring in accordance with Appendices 4.15 and 4.19 of the Market Rules.

    At a minimum, the IESO requires the following items to be monitored:

    <u>Stage 1</u>

    - Four quadrant, net 230 kV B4V active and reactive power flows at the facility
    - 230 kV B4V voltages at the facility
    - 34.5 kV bus A1 voltages
    - Status of 230 kV line disconnect B4VP1-B4V
    - Status of 230 kV breaker B4VP1
    - Status of 34.5 kV breakers BA1FA11, BA1FA12 and BA1FA13
    - Status of capacitor bank CA11
    - Status of Bruce Special Protection System selection switches

    <u>Stage 2</u>

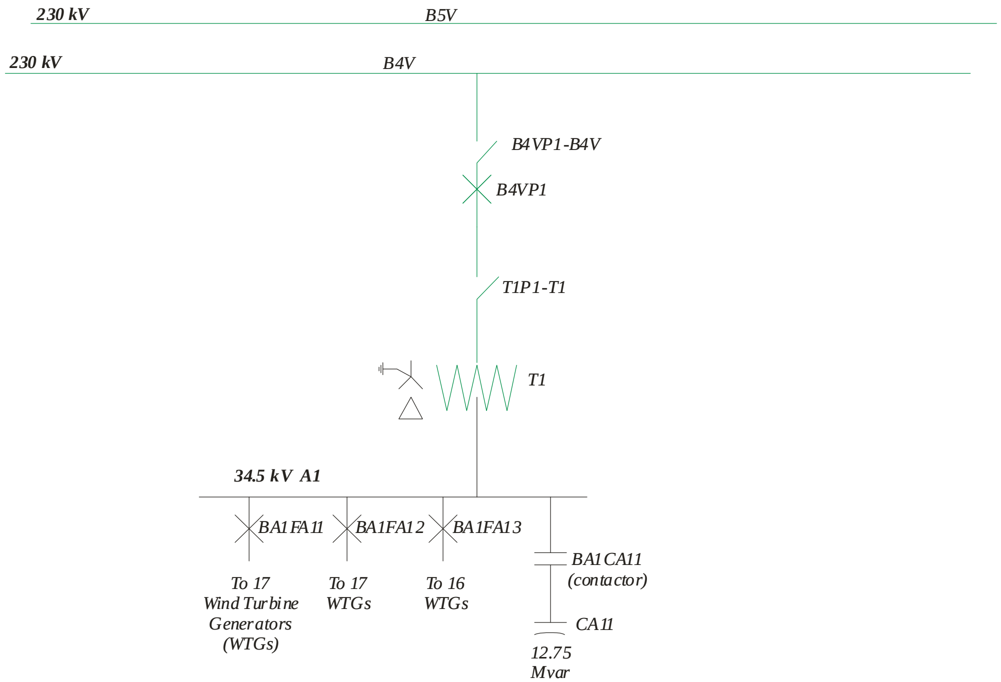
    - Four quadrant, net 230 kV B5V active and reactive power flows at the facility
    - 230 kV B5V voltages at the facility
    - 66 kV bus A2 & bus B1 voltages
    - 34.5 kV bus A2A, bus B1A, bus B1B & bus B1C voltages
    - Status of 230 kV line disconnect B5VQ1-B5V
    - Status of 230 kV breaker B5VQ1
    - Status of 34.5 kV breakers A21F1, A21F2, B11F1, B11F2, B12F1, B12F2, B13F1 & B13F2
    - Status of capacitor banks CA21, CB11 & CB21
    - Status of Bruce Special Protection System selection switches

    The IESO will finalize items to be monitored during the IESO Facility Registration Process.

12. Canadian Hydro is required to install a disturbance recording device that meets technical specifications provided by Hydro One.

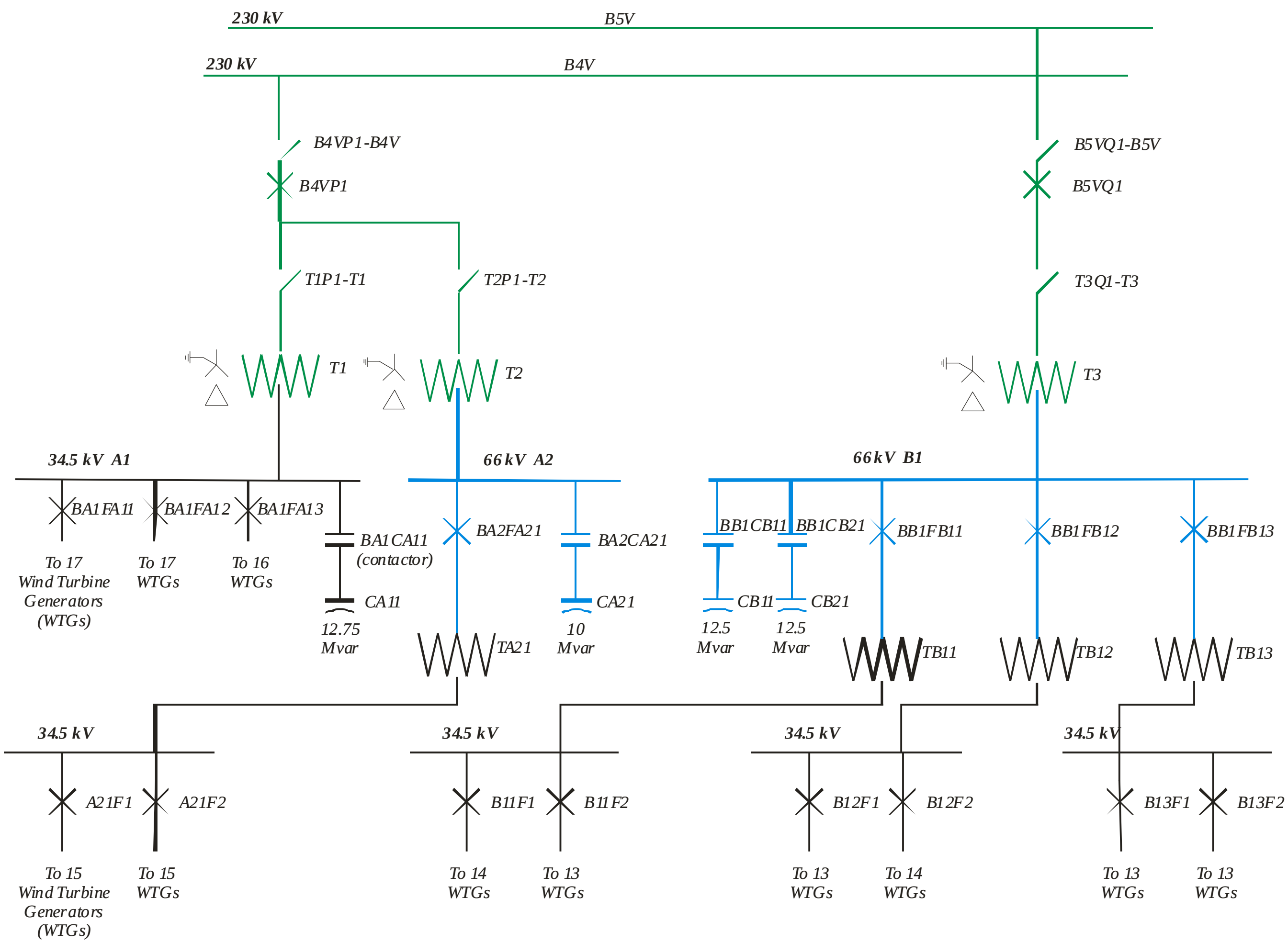
NOTIFICATION OF APPROVAL

It is recommended that a *Notification of Conditional Approval for Connection* be issued for this project subject to implementation of the requirements described above under the heading “IESO Requirements”.



Melancthon Grey Wind Farm - Stage 1
75 MW

FIGURE 1



Melancthon Grey Wind Farm - Stage 2
240 MW

FIGURE 2

APPENDIX A

PTI PSS/E Modeling Data

PSS/E LOAD FLOW DATA – 240MW

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90025,90026, 0,'T1',1,1,1, 0.00060, 0.00217,2,' ',1, 1,1.0000 0.00444, 0.08890, 100.00
1.02500, 0.000, 0.000, 45.00, 60.00, 75.00, 0, 0, 1.10000, 0.90000, 1.10000, 0.90000, 33, 0, 0.00000, 0.000001.01450, 0.000
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0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN SWITCHED SHUNT DATA
90002,0,1.05000,1.00000, 0,' ', 12.75, 1, 12.75
90010,0,1.05000,1.00000, 0,' ', 10.00, 1, 10.00
90022,0,1.05000,1.00000, 0,' ', 25.00, 1, 25.00
0 / END OF SWITCHED SHUNT DATA, BEGIN IMPEDANCE CORRECTION DATA

PSS/E DYNAMIC DATA – 240MW DYRE FILE

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90906 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90907 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90908 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90910 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90911 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90922 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90923 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90924 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90925 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90926 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90927 'USRMDL' 1 'DFIGEI' 1 1 1 13 5 22 0 0.8 0.1714 2.904 0.005 0.1563 0.62 0.0 0.2 0.02 0.02 -30.0 0.1 -0.1 /
90906 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90002 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90907 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90002 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90908 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90002 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90910 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90010 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90911 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90010 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90922 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90022 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90923 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90022 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90924 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90022 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90925 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90022 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90926 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90022 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
90927 'USRMDL' 1 'CGECNB' 4 0 4 26 10 10 90022 0  0 1 0.15 18.0 5.0 0.0 0.0 0.05 3.0 0.6 1.12 0.1 0.436 -0.436 1.11 0.05 0.45 -0.45 5.0 0.1 0.9 1.1 40.0 -0.5 0.4 0.05 0.05 1.0/
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90906 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90907 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90908 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90910 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90911 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90922 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90923 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90924 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90925 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90926 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TWIND1' 8 0 2 7 0 3 90927 '1' 12.0 9999.0 5.0 30.0 9999.0 9999.0 30.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90906 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90907 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90908 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90910 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90911 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90922 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90923 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90924 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90925 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90926 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'TSHAFT' 8 0 3 5 2 3 90927 '1' 0   1.5 1.11 8.66 3 72.0 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90906 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90907 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90908 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90910 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90911 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90922 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
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0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90923 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90924 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90925 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90926 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'GEAERO' 8 0 3 12 1 4 90927 '1' 0  12.0 20.0 0.0 27.0 -4.0 0.0 1.225 35.25 72.0 1200.0 1500.0 1.667 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90906 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90907 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90908 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90910 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90911 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90922 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90923 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90924 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90925 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90926 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'TGPTCH' 8 0 3 10 3 3 90927 '1' 0   0.3 150.0 25.0 3.0 30.0 -4.0 27.0 -10.0 10.0 0.91 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90906 90906 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90906 90906 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90906 90906 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90906 90906 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90906 90906 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90906 90906 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90906 90906 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90906 90906 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90907 90907 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90907 90907 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90907 90907 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90907 90907 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90907 90907 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90907 90907 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90907 90907 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90907 90907 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90908 90908 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90908 90908 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90908 90908 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90908 90908 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90908 90908 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90908 90908 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90908 90908 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90908 90908 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90910 90910 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90910 90910 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90910 90910 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90910 90910 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90910 90910 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90910 90910 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90910 90910 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90910 90910 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90911 90911 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90911 90911 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90911 90911 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90911 90911 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90911 90911 0 0 0 0.90 5.0 600.0 0.15 /
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0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90911 90911 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90911 90911 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90911 90911 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90922 90922 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90922 90922 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90922 90922 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90922 90922 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90922 90922 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90922 90922 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90922 90922 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90922 90922 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90923 90923 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90923 90923 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90923 90923 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90923 90923 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90923 90923 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90923 90923 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90923 90923 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90923 90923 0 0 0 0.0 1.3 0.02 0.15 /
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0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90924 90924 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90924 90924 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90924 90924 0 0 0 0.85 5.0 10.0 0.15 /
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0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90924 90924 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90924 90924 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90924 90924 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90925 90925 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90925 90925 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90925 90925 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90925 90925 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90925 90925 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90925 90925 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90925 90925 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90925 90925 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90926 90926 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90926 90926 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90926 90926 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90926 90926 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90926 90926 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90926 90926 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90926 90926 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90926 90926 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90927 90927 0 0 0 0.15 5.0 0.02 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90927 90927 0 0 0 0.7 5.0 0.560 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90927 90927 0 0 0 0.75 5.0 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90927 90927 0 0 0 0.85 5.0 10.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90927 90927 0 0 0 0.90 5.0 600.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90927 90927 0 0 0 0.0 1.1 1.0 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90927 90927 0 0 0 0.0 1.15 0.1 0.15 /
0 'USRMDL' 0 'VTGTRP' 0 2 5 4 0 1 90927 90927 0 0 0 0.0 1.3 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90906 90906  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90906 90906  '1'  0 0 0 57.5 70.0 10.0 0.15 /
```

```
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90906 90906  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90906 90906  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90907 90907  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90907 90907  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90907 90907  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90907 90907  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90908 90908  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90908 90908  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90908 90908  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90908 90908  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90910 90910  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90910 90910  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90910 90910  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90910 90910  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90911 90911  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90911 90911  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90911 90911  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90911 90911  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90922 90922  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90922 90922  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90922 90922  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90922 90922  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90923 90923  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90923 90923  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90923 90923  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90923 90923  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90924 90924  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90924 90924  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90924 90924  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90924 90924  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90925 90925  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90925 90925  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90925 90925  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90925 90925  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90926 90926  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90926 90926  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90926 90926  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90926 90926  '1'  0 0 0 50.0 62.5 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90927 90927  '1'  0 0 0 56.5 70.0 0.02 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90927 90927  '1'  0 0 0 57.5 70.0 10.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90927 90927  '1'  0 0 0 50.0 61.5 30.0 0.15 /
0 'USRMDL' 0 'FRQTRP' 0 2 6 4 0 1 90927 90927  '1'  0 0 0 50.0 62.5 0.02 0.15 /
```

PSS/E DYNAMIC DATA - BUS 90906

THE DFIGPQ11.FOR MODEL, RELEASE # 06, WAS UPDATED ON JANUARY 03, 2005

** DFIGPQ **	BUS X-- NAME --X BASEKV MC	C O N S	S T A T E S	VAR	ICON
90906	CLR_1 0.5750 1	222008-222020	82724-82728	15377-15398	6744

XEQ	LA	LM	R1	L1	H	DAMP
0.8000	0.1714	2.9040	0.0050	0.1563	0.6200	0.0000

-SLIP	TIpcmd	TEqcmd
0.2000	0.0200	0.0200

Kpll	PLLMX	PLLMN
-30.0000	0.1000	-0.1000

THE CGECN10.FOR MODEL, RELEASE # 06, WAS UPDATED ON JANUARY 05, 2005

** CGECNB for DFIGPQ **	BUS X-- NAME --X BASEKV MC	C O N S	S T A T E S	VAR	ICON
90906	CLR_1 0.5750 1	222151-222176	82779-82788	15619-15628	6755-6758

TFV	KPV	KIV	RC	XC	TFP	KPP
0.1500	18.0000	5.0000	0.0000	0.0000	0.0500	3.0000

KIP	PMX	PMN	QMX	QMN	IPMAX	TRV
0.6000	1.1200	0.1000	0.4360	-0.4360	1.1100	0.0500

RPMX	RPMN	T_POWER
0.4500	-0.4500	5.0000

KQi	VMINCL	VMAXCL	KVi	XIQmin	XIQmax
0.1000	0.9000	1.1000	40.0000	-0.5000	0.4000

Tv	Tp	Fn
0.0500	0.0500	1.0000

THE TWIND1.FOR MODEL, RELEASE # 03, WAS UPDATED ON JANUARY 03, 2005

** TWIND1 **	BUS X-- NAME --X BASEKV MC	C O N S	V A R S	ICONS
90906	CLR_1 0.5750 1	222437-222443	15729-15731	6799-6800

VWB T1G TG MAXG T1R T2R MAXR
12.0009999.000 5.000 30.0009999.0009999.000 30.000

Wind generator Bus # 90906
Wind Generator ID 1

THE TSHAFT2.FOR MODEL, RELEASE # 03, WAS UPDATED ON JANUARY 03, 2005

** TSHAFT for a machine **	BUS X-- NAME --X BASEKV MC	C O N S	STATE	VAR	ICON
90906	CLR_1 0.5750 1	222514-222518	82889-82890	15762-15764	6821-6823

D12	K12	Ta1	p	Rq
1.5000	1.1100	8.6600	3.0000	72.0000

Wind Generator Bus # 90906
Wind Generator ID 1

THE GEAERO1.FOR MODEL, RELEASE # 02, WAS UPDATED ON JANUARY 03, 2005

** GEAERO for DFIGPQ **	BUS X-- NAME --X BASEKV MC	C O N S	STATE	VAR	ICON
90906	CLR_1 0.5750 1	222569-222580	82911-82911	15795-15798	6854-6856

VWinit	Lambda_Max	Lambda_Min	PITCH_MAX	PITCH_MIN	Ta
12.0000	20.0000	0.0000	27.0000	-4.0000	0.0000

RHO	Radius	GB_RATIO	SYNCHR	Power_Rate	MBASE1
1.2250	35.2500	72.0000	1200.0	1500.0	1.6670

Wind Generator Bus # 90906
Wind Generator ID 1

THE TGPTCH1.FOR MODEL, RELEASE # 03, WAS UPDATED ON JANUARY 03, 2005

** TGPTCH for DFIGPQ ** BUS	X-- NAME --X	BASEKV	MC	C O N S	STATE	VAR	ICON
90906	CLR_1	0.5750	1	222701-222710	82922-82924	15839-15841	6887-6889

Tp	Kpp	Kip	Kpc	Kic
0.3000	150.0000	25.0000	3.0000	30.0000
TetaMin	TetaMax	RTetaMin	RTetaMax	PMX
-4.0000	27.0000	-10.0000	10.0000	0.9100

Wind Generator Bus # 90906
Wind Generator ID 1

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(6920,222811, 0, 15872) ***

BUS	NAME	BSKV	GENR BUS	NAME	BSKV
90906	CLR_1	.575	90906	CLR_1	.575

I C O N S	C O N S	V A R
6920-6924	222811-222814	15872

VLO	VUP	PICKUP	TB
0.150	5.000	0.020	0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(6925,222815, 0, 15873) ***

BUS	NAME	BSKV	GENR BUS	NAME	BSKV
90906	CLR_1	.575	90906	CLR_1	.575

I C O N S	C O N S	V A R
6925-6929	222815-222818	15873

VLO	VUP	PICKUP	TB
0.700	5.000	0.560	0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(6930,222819, 0, 15874) ***

BUS	NAME	BSKV	GENR BUS	NAME	BSKV
90906	CLR_1	.575	90906	CLR_1	.575

I C O N S	C O N S	V A R
6930-6934	222819-222822	15874

VLO	VUP	PICKUP	TB
0.750	5.000	1.000	0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(6935,222823, 0, 15875) ***

BUS	NAME	BSKV	GENR BUS	NAME	BSKV
90906	CLR_1	.575	90906	CLR_1	.575

I C O N S	C O N S	V A R
6935-6939	222823-222826	15875

VLO	VUP	PICKUP	TB
0.850	5.000	10.000	0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(6940,222827, 0, 15876) ***

BUS	NAME	BSKV	GENR BUS	NAME	BSKV
90906	CLR_1	.575	90906	CLR_1	.575

I C O N S	C O N S	V A R
6940-6944	222827-222830	15876

VLO	VUP	PICKUP	TB
0.900	5.000	600.000	0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(6945,222831, 0, 15877) ***

BUS	NAME	BSKV	GENR BUS	NAME	BSKV
90906	CLR_1	.575	90906	CLR_1	.575

I C O N S	C O N S	V A R
6945-6949	222831-222834	15877

VLO	VUP	PICKUP	TB
0.000	1.100	1.000	0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(6950,222835, 0, 15878) ***

BUS	NAME	BSKV	GENR BUS	NAME	BSKV
90906	CLR_1	.575	90906	CLR_1	.575

I C O N S	C O N S	V A R
6950-6954	222835-222838	15878

VLO	VUP	PICKUP	TB
0.000	1.150	0.100	0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(6955,222839, 0, 15879) ***

BUS	NAME	BSKV	GENR BUS	NAME	BSKV
90906	CLR_1	.575	90906	CLR_1	.575

I C O N S	C O N S	V A R
6955-6959	222839-222842	15879

VLO	VUP	PICKUP	TB
0.000	1.300	0.020	0.150

THE FRQTRP1.FLX MODEL, RELEASE # 03, WAS UPDATED ON FEBRUARY 25, 2004

```
*** CALL FRQTRP(  7360,223163,     0, 15960) ***

 BUS    NAME    BSKV     GEN BUS    NAME    BSKV   ID
90906  CLR_1    .575      90906  CLR_1    .575    1

  I C O N S     C O N S      V A R
  7360-7365   223163-223166   15960

   FLO      FUP     PICKUP    TB
  56.500    70.000     0.020    0.150
```

THE FRQTRP1.FLX MODEL, RELEASE # 03, WAS UPDATED ON FEBRUARY 25, 2004

```
*** CALL FRQTRP(  7366,223167,     0, 15961) ***

 BUS    NAME    BSKV     GEN BUS    NAME    BSKV   ID
90906  CLR_1    .575      90906  CLR_1    .575    1

  I C O N S     C O N S      V A R
  7366-7371   223167-223170   15961

   FLO      FUP     PICKUP    TB
  57.500    70.000    10.000    0.150
```

THE FRQTRP1.FLX MODEL, RELEASE # 03, WAS UPDATED ON FEBRUARY 25, 2004

```
*** CALL FRQTRP(  7372,223171,     0, 15962) ***

 BUS    NAME    BSKV     GEN BUS    NAME    BSKV   ID
90906  CLR_1    .575      90906  CLR_1    .575    1

  I C O N S     C O N S      V A R
  7372-7377   223171-223174   15962

   FLO      FUP     PICKUP    TB
  50.000    61.500    30.000    0.150
```

THE FRQTRP1.FLX MODEL, RELEASE # 03, WAS UPDATED ON FEBRUARY 25, 2004

```
*** CALL FRQTRP(  7378,223175,     0, 15963) ***

 BUS    NAME    BSKV     GEN BUS    NAME    BSKV   ID
90906  CLR_1    .575      90906  CLR_1    .575    1

  I C O N S     C O N S      V A R
  7378-7383   223175-223178   15963

   FLO      FUP     PICKUP    TB
  50.000    62.500     0.020    0.150
```

PSS/E Dynamic Simulation Command File – "ds_A3_3ph_E9V.idv"

```
TEXT  Save convergence monitor output
pdev
2
ds_A3_3ph_e9v_cm.dat

rstr A3.snp
TEXT
TEXT
TEXT     PURPOSE: Melancthon Grey Wind low voltage ride through
TEXT
TEXT             Test case: 3-phase fault
TEXT
TEXT
TEXT             USES splt_orangville.idv, ds_A3_3ph_e9v.idv
TEXT             END
TEXT
TEXT  DISTURBANCE: 3-phase fault on E9V at Orangeville TS
TEXT
lofl
case  A3_cvlf.sav
TEXT
@input splt_orangevil_e9v.idv
TEXT
TEXT this splits Orangeville 230kV bus for a 3-ph fault on E9V at Orangeville
TEXT
rtrn
psas


convergence monitor on
start output='ds_A3_3ph_e9v.out'
passthru
text,
text, run no fault to 2.100
text, 3-phase fault on E9V at Orangeville
text, loses E9V
text, local fault clearing time at Orangeville is 0.086s after fault occurs
text, remote fault clearing time at Essa is 0.104s after fault occurs
text,
fin
run to 2.100 seconds print=0 plot=1 crtplt=0
apply fault at bus 9999 admittance 0 -2E9 mva
run to 2.186 seconds print=0 plot=1 crtplt=0
trip line from bus 80251 to bus 9999 ckt 1
run to 2.204 seconds print=0 plot=1 crtplt=0
clear fault
disconnect bus 80204
disconnect bus 9999
run to 5.0 seconds print=0 plot=1 crtplt=0
run to 12.1 seconds print=0 plot=9 crtplt=0
end
stop, delete
```

PSS/E Dynamic Simulation Command File – "splt_orangville.idv"

```
MENU,OFF     /* FORCE MENU TO CORRECT STATUS
splt
80251
9999
1
e9vfalt
0
0
0
1
-1

echo
@END
```

PSS/E Dynamic Simulation Command File – "ds_A3_LLG_B560V_B561M_withgr.idv"

```
MENU,OFF      /* FORCE MENU TO CORRECT STATUS
rtrn
pdev
2
ds_A3_llg_b560v_b561m_withgr_cm.dat

TEXT *** LLG fault on B560V/B561M ***
rstr
A3.snp
lofl
case A3_cvlf.sav
ordr
fact
rtrn
strt,cm
ds_A3_llg_b560v_b561m_withgr.out

run, cm
2.1 0 1
altr

1
0
1
80047
1
,1539. -10769.
0
-1
80048
1
,1006. -9509.
0
-1
-1
run, cm
2.168 0 1
altr

1

3
80002 80047 1
1
0


80001 80048 1
1
0




run, cm
2.2 0 1
altr
6
```

```
0
lofl
dscn
80047
80007
80048

ordr
fact
rtrn
run, cm
2.228 0 1
altr

1

9
80347
1
0,,,0
0
80346
1
0,,,0
0
80348
1
0,,,0
0
82786
1
0,,,0
0
82787
1
0,,,0
0
82785
1
0,,,0
0
82789
1
0,,,0
0
82788
1
0,,,0
0
-1
TEXT *** REJECT BRUCE WIND GEN. AND BLUE MTN. WP AND MELANCTHON GEN.
altr

1
0
2
80320
```

1
0

-1
80310

1
0

-1
90906

1
0

-1
90907

1
0

-1
90908

1
0

-1
90910

1
0

-1
90911

1
0

-1
90922

1
0

-1
90923

1
0

-1
90924

```
1
0

-1
90925


1
0

-1
90926


1
0

-1
90927


1
0

-1
-1
run, cm
7.1 0 1
run, cm
12.1 0 9

snap A3_llg_b560v_b561m_withgr_post.snp

lofl
save A3_llg_b560v_b561m_withgr_post.sav
echo
@END
```