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CONNECTION ASSESSMENT & APPROVAL PROCESS

Preliminary Assessment Report
Blue Mountain Wind Park

CAA ID 2002-077

Final Version

Long Term Forecasts & Assessments Department
&
Consistent Information Department

September 19, 2003

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Preliminary Assessment Report

Blue Mountain Wind Park

Acknowledgement

The IMO wished to acknowledge the assistance of Hydro One Networks Inc. (HONI) in completing this assessment.

Disclaimers

IMO

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

Approval of the proposed connection is based on information provided to the IMO by the connection applicant and the transmitter(s) at the time the assessment was carried out. The IMO 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 IMO. 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 IMO-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 IMO in accordance with Chapter 4, section 6 of the Market Rules. The IMO assumes no responsibility to any third party for any use, which it makes of this report. Any liability which the IMO may have to the connection applicant in respect of this report is governed by Chapter 1, section 13 of the Market Rules. In the event that the IMO provides a draft of this report to the connection applicant, you must be aware that the IMO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IMO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that it is using the most recent version of this report.

Hydro One Networks Inc.

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

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

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

In this preliminary feasibility study, short circuit adequacy is assessed only for HONI breakers and does not include other HONI facilities. The short circuit results are only for the purpose of assessing the capabilities of the existing HONI 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 HONI and discussed with the connection proponent(s) upon request.

The ampacity rating of HONI facilities are established based on assumptions used in HONI for power system planning studies. The actual ampacity ratings during operations may be determined in real-time and are based on actual system conditions, including ambient temperature, wind speed and facility loading, and may be higher or lower than those stated in this study.

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

Connection Assessment Report

Executive Summary

Project Description

This preliminary assessment has been conducted to examine the proposed 200 MW wind generation facility in the Blue Mountain area, near Collingwood and its impact on the reliability of the IMO-Controlled Grid (ICG).

Superior Wind Energy Inc. is the proponent of the 200 MW wind park project in the Blue Mountain area. The proposed facility is to be incorporated at 115 kV via a new line tap (5 to 10 km) onto the section of circuit S2S between Stayner TS and Meaford TS. Circuit S2S (67.3 km) and circuit S2E (26.8 km) between Stayner TS and Essa TS form a 115 kV connection between the 230/115 kV transformer stations at Owen Sound and Essa.

Since Superior Wind Energy Inc. is in the process of evaluating suppliers and various models of wind turbine generators, they requested the IMO to conduct the assessment using typical wind turbine generator data in the 1.5 MW - 2 MW range. Superior Wind Energy Inc. understands that before connection can be made, the wind turbine generators and the associated connection facilities shall meet all applicable Market Rule requirements and their performance and characteristics will be equivalent to or better than those assumed by the IMO using typical data.

Commissioning of the project is scheduled to commence in Q2-2004, with full commercial operation starting in Q3-2004.

Conclusions

Based on the results of this assessment, it is concluded that:

1. The proposed 200 MW Blue Mountain Wind Park Project with a connectivity-based Special Protection System will not have an adverse impact on the stability performance of the IMO-Controlled Grid and transfer capabilities of major 500/230 kV transmission interfaces.

2. The proposed generation would result in overloading the local 115 kV transmission line section of S2S between the Blue Mountain connection point to Stayner TS, following the loss of the Bruce to Milton-Claireville 500 kV 2-cct line.

3. The increases in fault level, due to the proposed 200 MW generation, will not exceed the interrupting capabilities of the existing breakers.

IMO Requirements

The IMO requirements that have been identified during this Connection Assessment for the proposed incorporation of the 200 MW Blue Mountain Wind Park facility are as follows:

1. To incorporate 200 MW of generation, Superior Wind Energy Inc. is required to:

- Provide a connectivity-based Special Protection System to reject appropriate amounts of generation at the Blue Mountain Wind Park for the following two contingencies:

  - Loss of the Bruce to Milton/Claireville 500 kV 2-cct line,
  - Loss of the 115 kV circuit from Stayner TS to Essa TS.

- Alternatively, the amount of generation incorporation is limited to 120 MW to respect the rating of S2S and the 115 kV voltage decline post-contingency.

2. Upon its decision on a specific model of wind turbine generators for installation in this project, Superior Wind Energy Inc. is required to:

- Provide evidence and documentation to demonstrate that the proposed wind turbine generators are in compliance with the Market Rule requirements as stated in Chapter 4 Appendix 4.2, including ride-through capabilities during system disturbances.

- Provide the modeling suitable for use in load flow and transient stability studies in PTI - PSS/E format and evidence to support the modeling of the proposed wind turbine generators. It is preferred that the evidence be based on recorded dynamic responses of similar wind turbine generators, including terminal voltages, active and reactive power injections into the grid, obtained during commissioning tests or from existing installations which had experienced system disturbances.

- Provide adequate reactive power to compensate for the reactive power consumption on the 44/115 kV transformer and the dedicated transmission line. This can be achieved with combinations of low impedance 44/120 kV transformer and provision of reactive power, whichever combination is more economic and subject to IMO's approval.

- If the specific model of wind turbine generators is equipped with ac-dc-ac voltage source converters or equivalent equipment, engage the service of an expert consultant with experience in modeling the dynamic behavior of that model of wind turbine generators and power systems to assess the potential of adverse interactions (e.g. sub-synchronous resonance) with the IMO-Controlled Grid and its existing generators. The results are subject to IMO's review and acceptance. If an adverse interaction is identified, the applicant is responsible for providing the appropriate mitigation measures subject to IMO's approval.

- If the specific model of wind turbine generators is not with equipped ac-dc-ac voltage source converters or equivalent equipment, provide an expert statement from the wind turbine generator supplier that the dynamic behavior of the units is no different than that of a conventional induction generator.

3. Superior Wind Energy Inc. must complete the IMO facility registration process including meter registration before placing the proposed 200 MW Blue Mountain Wind Park generation in service.

4. A Customer Impact Assessment (CIA) is required to determine the impact of new generation connection on Transmission Customers and a detailed CIA study will be carried out by Hydro One.

Superior Wind Energy Inc. has elected to postpone this phase of the process. Therefore, this Report has been finalized but should any issues be raised when the Customer Impact Assessment is subsequently undertaken, then they will be addressed through an Addendum to the PA Report.

5. A separate System Impact Assessment is not required since this Preliminary Assessment has included transient stability analysis of the IMO-Controlled Grid.

Budgetary Cost Estimates

There is only minor work associated with review and verification of protection schemes and final equipment data, and witness verification during commissioning. No budgetary cost estimate is provided for that purpose.

If required to make its economic decision to enable incorporation of 200 MW of generation, Superior Wind Energy Inc. is to obtain cost estimates on the connectivity-based Special Protection System from Hydro One Network Inc.

Identification of "Sole Beneficiary"

The facility that is triggered by and deemed to be for the sole benefit of this project has been identified as the following mitigation solution to enable incorporation 200 MW of generation:

- Connectivity-based Special Protection System

Notification of Approval

This Preliminary Assessment has investigated the impact of the proposed 200 MW Blue Mountain Wind Park on the reliability of the IMO-Controlled Grid and has identified IMO's requirements for connection to ensure that the project has no adverse impact on the reliability of the IMO-Controlled Grid.

It is recommended that a Notification of Approval be granted, subject to the implementation of the requirements stipulated in this report.

1.0 Proposal Description

Superior Wind Energy Inc. is the proponent of the 200 MW wind park project in the Blue Mountain area, near Collingwood. The proposed facility is to be incorporated at 115 kV via a new line tap (5 to 10 km) onto the section of circuit S2S between Stayner TS and Meaford TS. Circuit S2S (67.3 km) and circuit S2E (26.8 km) between Stayner TS and Essa TS form a 115 kV connection between the 230/115 kV transformer stations at Owen Sound and Essa.

Commissioning of the project is scheduled to commence in Q2-2004, with full commercial operation starting in Q3-2004.

2.0 Data Verification

Superior Wind Energy Inc. is considering installation of wind turbine generators in the range of 1.5 MW to 2 MW per unit.

Since Superior Wind Energy Inc. is in the process of evaluating suppliers and various models of wind turbine generators, they requested the IMO to conduct the assessment using typical wind turbine generator data in the 1.5 MW - 2 MW range. Superior Wind Energy Inc. understands that before connection can be made, the wind turbine generators and the associated connection facilities shall meet all applicable Market Rule requirements and their performance and characteristics will be equivalent to or better than those assumed by the IMO using typical data.

2.1 Connection Arrangement

The proposed facility is to be incorporated at 115 kV via a new line tap (5 to 10 km) onto the 38 km section of circuit S2S between Stayner TS and Meaford TS. Circuit S2S (67.3 km) and circuit S2E (26.8 km) form a 115 kV connection between the 230/115 kV transformer stations at Owen Sound and Essa. The connection point is assumed to be mid way between Meaford TS and Stayner TS.

The 500/230 kV transmission system in southwestern Ontario and the portion of the 115 kV transmission system with the proposed generation incorporation are shown in Figure 1.

The proposed 200 MW wind park project, assuming a unit size of 1.5 MW, comprises 21 groups of 6 x 1.5 MW wind turbines and 1 group of 7 x 1.5 MW wind turbines. Each of the 22 wind turbine groups is connected via a 44 kV breaker to a common 44 kV bus. The 44 kV bus is connected via a 44/115 kV transformer bank, a 115 kV breaker, 5 to 10 km of 115 kV line tap and a high voltage isolating device onto the section (38 km) of the circuit S2S between Meaford TS and Stayner TS.

The unit size and grouping will be adjusted accordingly to accommodate other units sizes.

The Transmission System Code specifies that the standard transformer winding connection is LV delta and HV wye and that any other configuration has to be approved by the transmitter. Superior Wind Energy Inc. is advised to seek approval from Hydro One with respect to winding configuration and grounding requirements if the proposed connection arrangement is different than the standard.

2.2 Generating Facility Requirements

Market Rule Chapter 4 Appendix 4.2 contains the generating facility requirements for generator connection to the IMO-Controlled Grid.

The wind turbine generators and the associated equipment must be capable of remaining connected to the IMO-Controlled Grid for system disturbances or contingencies that are external to the transmission line(s) to which they are connected.

3.0 Impact on the IMO-Controlled Grid

Power system studies have been conducted to assess the incorporation of the proposed facility and its impact on the IMO-Controlled Grid.

3.1 Power System Study Assumptions and Results

3.1.1 Assumptions

The forecast 2004 summer peak load conditions form the basis of the assessment. Consistent with the queue principles of the Connection Assessment and Approval process, all of the relevant projects, that have been registered prior to November 29, 2002, the CAA registration date of this proposal, have been included in the power system studies.

As requested by Superior Wind Energy Inc., the modeling of wind turbine generators in the load flow and transient stability studies is assumed to be that of a generic wind turbine generator with characteristics equivalent to an induction generator with unit size in the 1.5 MW to 2 MW range. Superior Wind Energy Inc. understands that before connection can be made, the wind turbine generators and the associated connection facilities shall meet all applicable Market Rule requirements and their performance and characteristics will be equivalent to or better than the assumed units using typical data.

3.1.2 Load Flow Study Results

Load flow studies have been carried out to assess the impact of the proposed facility on the ICG in the area of:

- Impact on the transfer capability of the critical interface (Bruce Longwood Input)
- Impact on the local 115 kV transmission
    - Voltage performance for loss of the 200 MW generation
    - Possible overload on the local 115 kV transmission facilities

LF1 is the base case created to assess the impact on the transfer capability of the BLIP interface loaded at its test level of -1,670 MW (-1,500 MW + 10% margin). This base case assumes all 6 units at the Bruce Complex at their respective maximum output, the proposed 200 MW Blue Mountain Wind Park and the available resources in southwestern Ontario dispatched to effect the desired eastbound power transfer on the BLIP interface. The 115 kV circuit S2S would be loaded to 185 MW (915A).

LF2 is the post-fault load flow following the loss of the 500 kV double-circuit line (B560V/B561M) between Bruce GS and Claireville TS and Milton TS. The results show satisfactory post-fault voltage profile on the ICG. The 115 kV circuit S2S would be loaded to 237 MW (1240 A).

LF3 is the post fault load flow following the loss of the proposed 200 MW Blue Mountain Wind Park. The voltage declines at the 115 kV buses in the vicinity are all within 1%. A comparison of LF1 and LF2 shows that 54% of the Blue Mountain generation would appear on the 115 kV circuit S2S.

The salient parameters of the load flow results are summarized below:

Impact on BLIP Transfer Capability

2004 Summer Peak, BLIP = -1,670 MW, Bruce = 6 units, Blue Mountain = 200 MW

	Voltage Profile (kV)						
Case	Bruce 500	Longwood 500	Lambton 230	Richview 230	Owen Sound 115	Stayner 115	Remarks
LF1	548	531	242	237	120.9	118.4	Base Case
LF2	545	523	242	225	119.2	112.2	Loss of Bruce-Milton/Claireville 2-cct line.

Impact on 115 kV Transmission System

2004 Summer Peak, Bruce = 6 units, Blue Mountain = 200 MW

Case	Blue Mt. (MW)	Voltage (kV)		Circuit Loading (MW/Amp)		Remarks
		O. Sound	Stayner	S2S at Stayner	S1H at O.Sound	
LF1	200	120.9	118.4	184MW/ 915 A	38 MW/190 A	Base loading of 200 MW
LF2	200	119.2	112.2	237MW/1240 A	43 MW/210 A	Loss of Bruce-Milton/Claireville 2-cct line, S2S exceeds 15 min. LTR of 1030 A.
LF3	0	120	117.6	76 MW/ 375 A	11 MW/65 A	Loss of Blue Mt., $\Delta V < 1\%$ TDF on S2S = 0.54

3.1.3 Transient Stability Study Results

Transient stability simulations have been carried out using the following recognized critical contingencies to assess the impact of the proposed 200 MW generation on the ICG for contingencies external to the transmission line to which these units are connected. The initial system conditions prior to the simulated disturbances are based on LF1.

Contingency 1: 3-phase fault at Stayner, loss of 115 kV cct S2E between Stayner and Essa
Contingency 2: 2-cct llg fault at Willow Creek Junction, loss of two 500 kV ccts B562L/B563L
Contingency 3: 2-cct llg fault at Willow Creek Junction, loss of two 500 kV ccts B560V/B561M

The results of the transient stability simulations for the 0-1second period are summarized in the table below.

Transient Stability Case	Contingency	Voltage Plots	System Responses
TS1	1 (S2E)	Figure 2	Stable, positive damping

TS2	2 (BxL)	Figure 3	"
TS3	3 (BxM/C)	Figure 4	"

Longer Term Voltage Responses

The results of the same transient stability simulations extended to 10 seconds are summarized in the table below.

Transient Stability Case	Contingency	Voltage Plots	System Responses	Acceptable Voltage Declines at		
				500/230 kV	Stayner 115 kV	Blue Mt Wind Park
TS1	1 (S2E)	Figure 5	Stable, positive damping	Yes	No	No
TS2	2 (BxL)	Figure 6	"	Yes	Yes	Yes
TS3	3 (BxM/C)	Figure 7	"	Yes	No	No

From the overall system stability perspective, the incorporation of the proposed 200 MW generation facility would not have an adverse impact on the ICG since the simulation results display stable and positively damped system responses on the 500/230 kV system voltages.

However, the voltages at Stayner TS and the Blue Mountain Wind Park would drop to below 0.9 pu in a few seconds and continue their declines to below 0.6 pu within 10 seconds following the loss of S2E as shown in Figure 5. Similar unacceptable voltage decline phenomenon also results from the loss of the Bruce to Milton/Claireville 500 kV line as shown in Figure 7.

Satisfactory voltages at Stayner TS and Blue Mountain Wind Park can be maintained by rejecting 20 MW and 50 MW of generation at the proposed site for contingencies 1 and 3 respectively. The voltage plots for the two transient stability tests are shown in Figures 8 and 9.

It should be noted that the generation rejection levels shown are illustrative levels to demonstrate the need for a connectivity-based Special Protection System as part of the connection requirements. During day-to-day operations, the amounts of generation rejection may be higher or lower than these illustrative levels and will be dependent on the system conditions, the prevailing ambient conditions (for thermal overload consideration), the final equipment parameters of the wind park generation facilities. These include the wind turbine generators, unit transformers, 44/115 kV transformers, switched shunt capacitors, transmission line(s), switching arrangements and real and reactive power control of the wind turbine generation.

3.2 Impact on Major Transmission Interface BLIP

The proposed generation facility would have a direct impact on the power flows on Bruce Longwood Input interface, a critical interface in southwestern Ontario.

The Bruce Longwood Input (BLIP) interface consists of three 500 kV circuits (B562L, B563L and N582L) and five 230 kV circuits (D4W, D5W, M31W, M32W and M33W). This interface facilitates westbound power transfers to supply the loads west of London and exports to the US markets via the Ontario-Michigan interconnections. If the available generation in the Sarnia/Lamton/Windsor area and imports from Michigan exceed the area load, the BLIP interface would facilitate an eastbound transfer of surplus generation to the rest of the ICG.

An eastbound flow on the BLIP interface at its maximum test level (maximum operating level + 10% margin) with all units at Bruce at their respective maximum output represent a critical system condition in which the ICG is stressed. It is selected to assess whether the proposed generation at Bruce Wind Park would have an adverse impact on the stability performance of the ICG.

Load flow and transient stability studies show that the proposed 200 MW Blue Mountain Wind Park incorporated with a connectivity-based Special Protection System, would not have an adverse impact on the stability performance of IMO-Controlled Grid.

3.3 Impact on Local 115 kV System

The proposed 200 MW generation facility would be connected to the local 115 kV transmission system, supplying the Owen Sound-Stayner-Barrie area. The impact on this 115 kV system, which is an integral part of the ICG, is as follows:

3.3.1 Voltage Decline for Loss of 200 MW Generation Facility

In the event of a sudden loss of the entire 200 MW generation, the voltage decline measured at Owen Sound-Stayner area is less than 1%.

The proposed incorporation arrangement via a single line tap with a 115 kV breaker and a 115/44 kV transformer is acceptable.

3.3.2 Loading on 115 kV Transmission

The proposed 200 MW generation would significantly increase the power flows on the 115 kV circuit S2S between Owen Sound TS and Stayner TS. This could overload the line section between the proposed connection point to Stayner TS under the criteria ambient condition of 30^{o} C and a wind speed of 4 km/hr and a maximum conductor temperature of 93^{o} C. It is noted that the criteria ambient conditions are used in Connection Assessment for conventional generation whose output is not dependent on the prevailing wind speed.

Recognizing that the maximum output of wind turbine generators cannot be achieved and sustained with wind speed lower than 15 m/s (54 km/hr), Hydro One and IMO have agreed to increase the criteria wind speed to 15 km/hr and the maximum operating temperature of 127^{o} C in assessing the impact on the transmission lines that are within a 50 km radius of the proposed wind park.

Based on the assumed 2004 summer peak system conditions, the proposed 200 MW generation would increase the loading on the line section from the connection point to Stayner TS to about 184 MW (915 A). This is within the continuous rating of the 115 kV S2S of 1,010 A under the increased criteria ambient condition of 15 km/hr wind and a maximum operating temperature of 127^{o} C used in assessing wind turbine generation.

Following the loss of the 500 kV 2-cct line from Bruce GS to the Toronto area, the loading on the 115 kV circuit S2S would increase by 53 MW to 237 MW (1,240 A). This would exceed the 15-minute limited time rating (1030 A) of the circuit, based on a wind speed of 15 km/hr and a maximum operating temperature of 127^{o} C.

To avoid overloading the 115 kV circuit S2S, the following three alternatives are considered acceptable:

1. Limit the amount of generation incorporation at the Blue Mountain Wind Park to 120 MW.

2. Provide a connectivity-based Special Protection System that will reject an appropriate amount of generation at the 200 MW Blue Mountain Wind Park, following the loss of the Bruce to Milton/Claireville 500 kV 2-cct line.

3. Upgrade the 20 km section of the 115 kV circuit S2S from the Blue Mountain Jct to Stayner TS. *(This alternative which does not address the voltage declines as discussed in Section 3.1.3 is not considered further.)*

3.3.3 Voltage Changes due to Start-up

The in-rush current during starting is assumed to be limited to less than 8 kA. This is acceptable since the voltage change in the local 115 kV due to start-up of one unit is less than 4%.

After its selection on a specific model, Superior Wind Energy Inc. will provide the in-rush current, the start-up/shut down characteristics of the wind turbine generators to the IMO to ensure there will be no adverse impact on the ICG.

Voltage Flicker

Depending on the prevailing wind, wind turbine generators are expected to go through start-up's and shut-down's during the day-to-day operation and would result in voltage fluctuations (voltage flicker) affecting the supply voltages in the local area. It is noted that the voltage flicker standard is a part of the Transmission System and Connection Point Performance Standards (Appendix 2) in the Transmission System Code which is not under IMO's jurisdiction.

It is provided below as a reference to the proponent to ensure that the start-up/shutdown control of the wind turbine units is in compliance with the Transmission System Code.

Magnitude (%)	Limit
0.5	3 per second
1.0	20 per minute
2.0	45 per hour
3.0	4 per day
A higher flicker may be acceptable for infrequent starts	

3.4 Reactive Power Compensation

The wind turbine generators due to their characteristics have a two-stage voltage transformation to deliver power to the ICG, first through a 345 V to 34.5 kV (44 kV) unit transformer and collectively through a 34.5k V (44 kV) to 115 kV transformation to the ICG.

The two-stage transformation is equivalent to that of a unit transformer of conventional generator which is stipulated by the Market Rules to provide adequate voltage control and reactive support to the ICG. This is usually achieved by limiting the impedance of the unit transformer to less than

12.5% on the generator base rating while meeting the power factor requirements of the synchronous or induction generators.

To meet the market rule requirements, the wind turbine generators may choose an economic combination of low impedance 44 kV/120 kV transformer and provision of reactive power, subject to IMO's approval.

Additional reactive compensation is also required for the line tap and the 44/115 kV transformer which are owned and used exclusively by the wind turbine generators.

An estimate of the reactive power consumption on the 44/115 kV transformer and 10 km of 115 kV line as a result of the 200 MW generation facility is provided below.

Reactive Power Consumption on 10 km of 115 kV line = 11 MVar
Reactive Power Consumption on 44/115 kV transformer = 35 MVar

Assumptions:

- 477 kcmil conductor for 115 kV line
- 8.5% impedance on 100 MVA base for 44/115 kV 250 MVA transformer
- 46 kV and 125 kV operating voltages

3.5 Ride-Through Capability under System Disturbances

The wind turbine generators and the associated equipment must be capable of remaining connected to the IMO-Controlled Grid for system disturbances or contingencies that are external to the transmission line(s) to which they are connected. This is for compliance with the Market Rule, Chapter 4 Appendix 4.2 Item 7, which states:

> *"Protection systems shall be constructed and maintained in accordance with all applicable reliability standards."*

3.6 Possible Adverse Interactions with the ICG

Certain models of wind turbine generators are equipped with solid state voltage source-converter AC excitation systems (ac-dc-ac converters) with a dynamic behavior significantly different than that of the conventional synchronous or induction generators. The proponent is required to engage the service of an expert consultant to investigate the potential of such wind turbine generators having adverse interactions with the IMO-Controlled Grid and the existing generating units, including sub-synchronous resonance. If an adverse interaction is identified, the applicant will be responsible for providing the appropriate mitigation measures subject to IMO's approval.

If the specific model of wind turbine generators is not equipped with ac-dc-ac voltage source converters or equivalent equipment, the proponent is to provide an expert statement from the wind turbine generator supplier stating that the dynamic behavior of the units is no different than that of a conventional induction generator. No special system study is required.

3.7 Fault Level Analysis

Fault level analysis was conducted to determine the impact of the proposed wind park project on the existing transmission facilities. The base condition for the study assumes all projects, that are ahead of the Blue Mountain Wind Park Project in the CAA Queue, are in service.

The study results show that the increases in fault levels due to the proposed Blue Mountain Wind Park, using either supplier's units would not exceed the interrupting capabilities of the existing circuit breakers.

4.0 Conclusions

Based on the results of this assessment, it is concluded that:

1. The proposed 200 MW Blue Mountain Wind Park Project with a connectivity-based Special Protection system will not have an adverse impact on the stability performance of the IMO-Controlled Grid and transfer capabilities of major 500/230 kV transmission interfaces.

2. The proposed generation would result in overloading the local 115 kV transmission line section of S2S between the Blue Mountain connection point to Stayner TS, following the loss of the Bruce to Milton-Claireville 500 kV 2-cct line.

3. The increases in fault level, due to the proposed 200 MW generation, will not exceed the interrupting capabilities of the existing breakers.

5.0 IMO Requirements

The IMO requirements that have been identified during this Connection Assessment for the proposed incorporation of the 200 MW Blue Mountain Wind Park facility are as follows:

1. To incorporate 200 MW of generation, Superior Wind Energy Inc. is required to:

   - Provide a connectivity-based Special Protection System to reject appropriate amounts of generation at the Blue Mountain Wind Park for the following two contingencies:

     - Loss of the Bruce to Milton/Claireville 500 kV 2-cct line,
     - Loss of the 115 kV circuit from Stayner TS to Essa TS.

   - Alternatively, the amount of generation incorporation is limited to 120 MW to respect the rating of S2S and the 115 kV voltage decline post-contingency.

2. Upon its decision on a specific model of wind turbine generators for installation in this project, Superior Wind Energy Inc. is required to:

   - Provide evidence and documentation to demonstrate that the proposed wind turbine generators are in compliance with the Market Rule requirements as stated in Chapter 4 Appendix 4.2, including ride-through capabilities during system disturbances.

   - Provide the modeling suitable for use in load flow and transient stability studies in PTI - PSS/E format and evidence to support the modeling of the proposed wind turbine generators. It is preferred that the evidence be based on recorded dynamic responses of similar wind turbine generators, including terminal voltages, active and reactive power injections into the grid, obtained during commissioning tests or from existing installations which had experienced system disturbances.

- Provide adequate reactive power to compensate for the reactive power consumption on the 44/115 kV transformer and the dedicated transmission line. This can be achieved with combinations of low impedance 44/120 kV transformer and provision of reactive power, whichever combination is more economic and subject to IMO's approval.

- If the specific model of wind turbine generators is equipped with ac-dc-ac voltage source converters or equivalent equipment, engage the service of an expert consultant with experience in modeling the dynamic behavior of that model of wind turbine generators and power systems to assess the potential of adverse interactions (e.g. sub-synchronous resonance) with the IMO-Controlled Grid and its existing generators. The results are subject to IMO's review and acceptance. If an adverse interaction is identified, the applicant is responsible for providing the appropriate mitigation measures subject to IMO's approval.

- If the specific model of wind turbine generators is not equipped with ac-dc-ac voltage source converters or equivalent equipment, provide an expert statement from the wind turbine generator supplier that the dynamic behavior of the units is no different than that of a conventional induction generator.

3. Superior Wind Energy Inc. must complete the IMO facility registration process including meter registration before placing the proposed 200 MW Blue Mountain Wind Park generation in service.

4. A Customer Impact Assessment (CIA) is required to determine the impact of new generation connection on Transmission Customers and a detailed CIA study will be carried out by Hydro One.

   Superior Wind Energy Inc. has elected to postpone this phase of the process. Therefore, this Report has been finalized but should any issues be raised when the Customer Impact Assessment is subsequently undertaken, then they will be addressed through an Addendum to the PA Report.

5. A separate System Impact Assessment is not required since this Preliminary Assessment has included transient stability analysis of the IMO-Controlled Grid.

6.0 Budgetary Cost Estimates

There is only minor IMO work associated with review of protection schemes and final equipment data, and witness verification during commissioning. No budgetary cost estimate is provided for that purpose.

If required to make its economic decision to enable incorporation of 200 MW of generation, Superior Wind Energy Inc. is to obtain cost estimates on the connectivity-based Special Protection System from Hydro One Network Inc.

7.0 Identification of "Sole Beneficiary"

The facility that is triggered by and deemed to be for the sole benefit of this project has been identified as the following mitigation solutions to enable incorporation of 200 MW of generation:

- Connectivity-based Special Protection System.

8.0 Notification of Approval

This Preliminary Assessment has investigated the impact of the proposed 200 MW Blue Mountain Wind Park on the reliability of the IMO-Controlled Grid. It has also identified IMO's requirements for connection to ensure that the project has no adverse impact on the reliability of the IMO-Controlled Grid.

It is recommended that a Notification of Approval be granted, subject to the implementation of the requirements stipulated in this report.

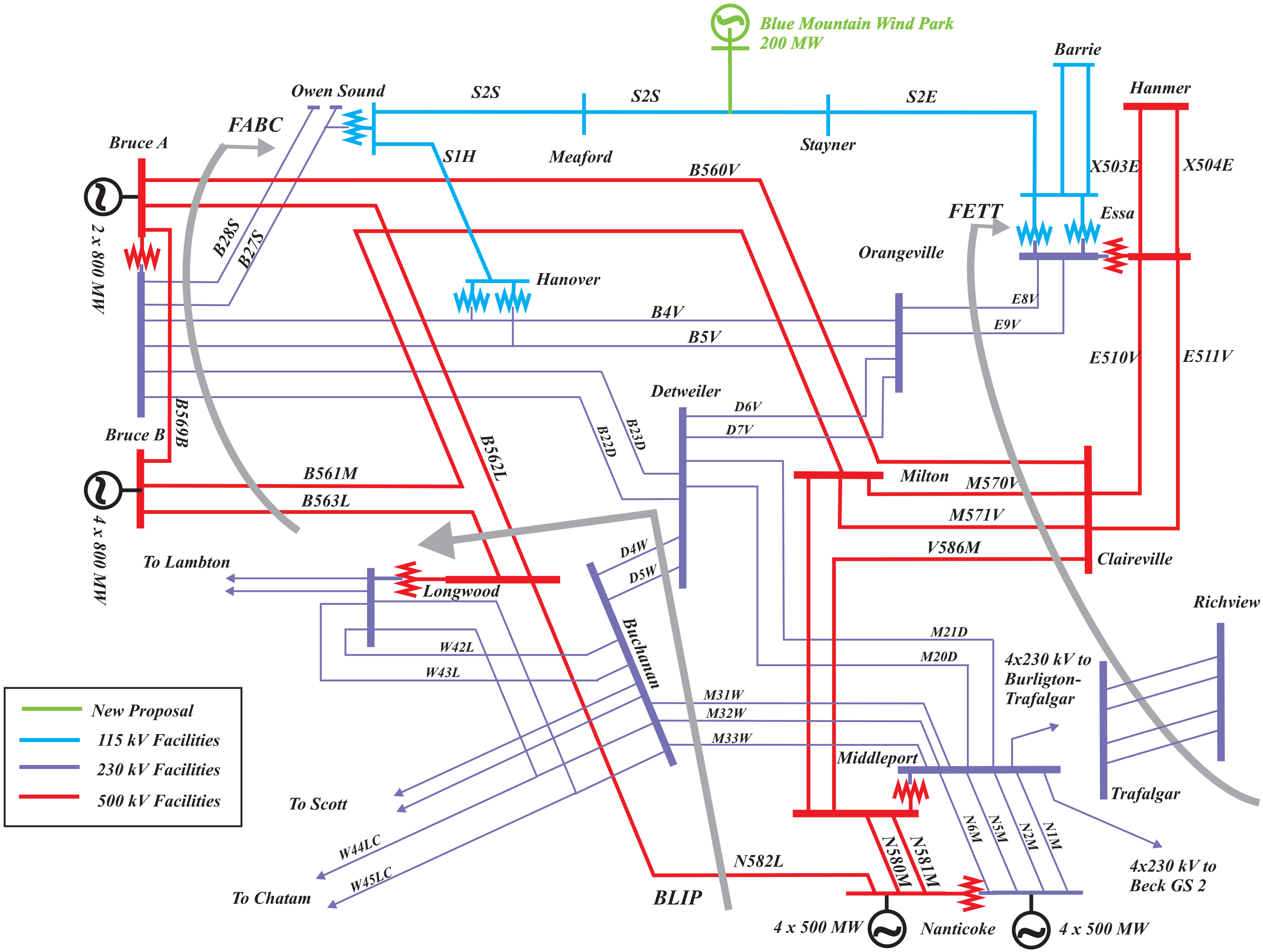

Figure 1. Southwestern Ontario Transmission System - Proposed Wind Park Generation

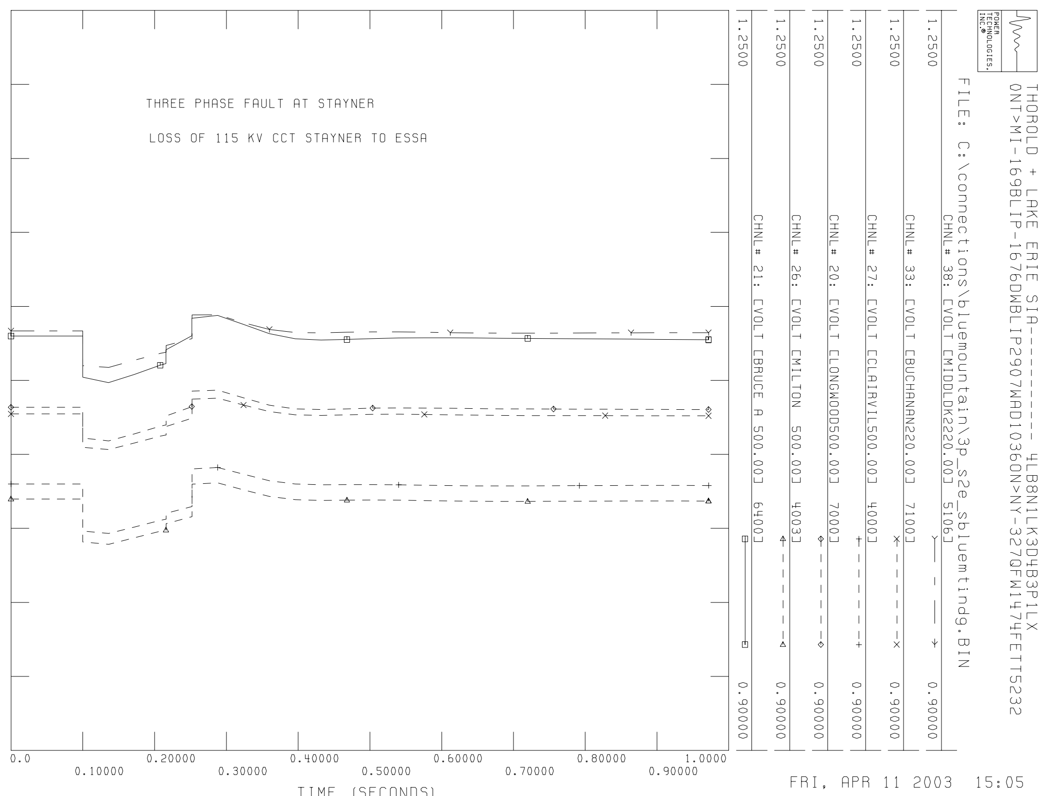

FIG 2A: VOLTAGE PROFILE

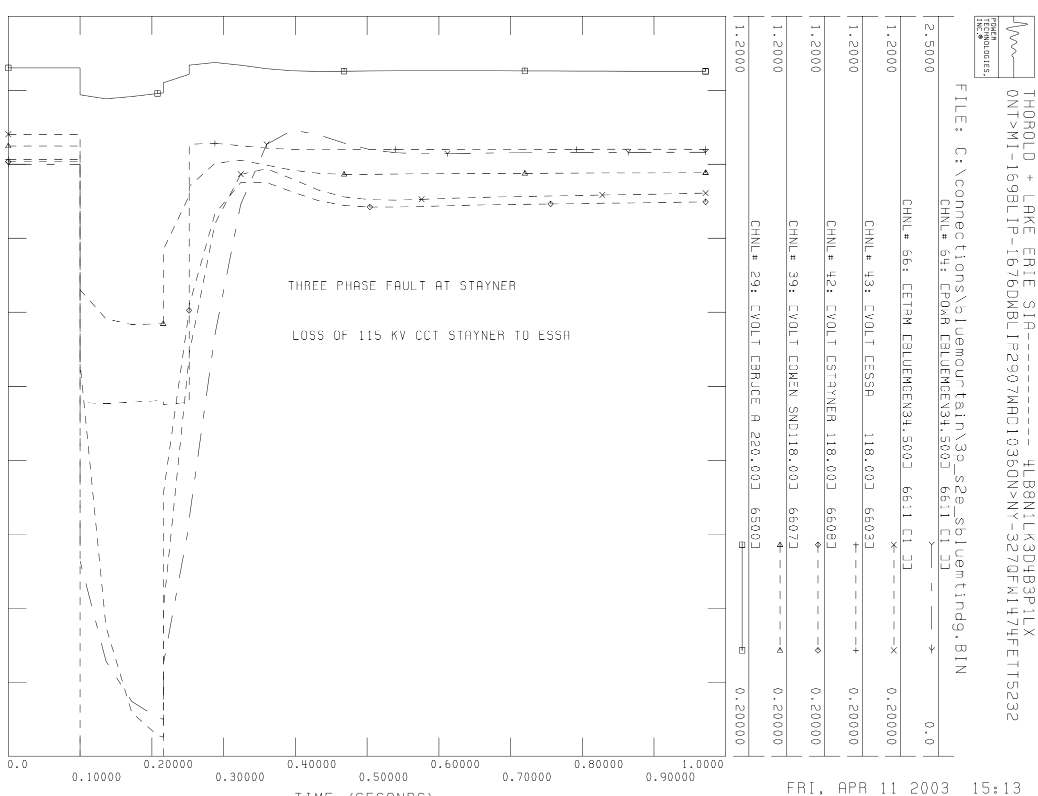

FIG 2B: 115KV VOLTAGES

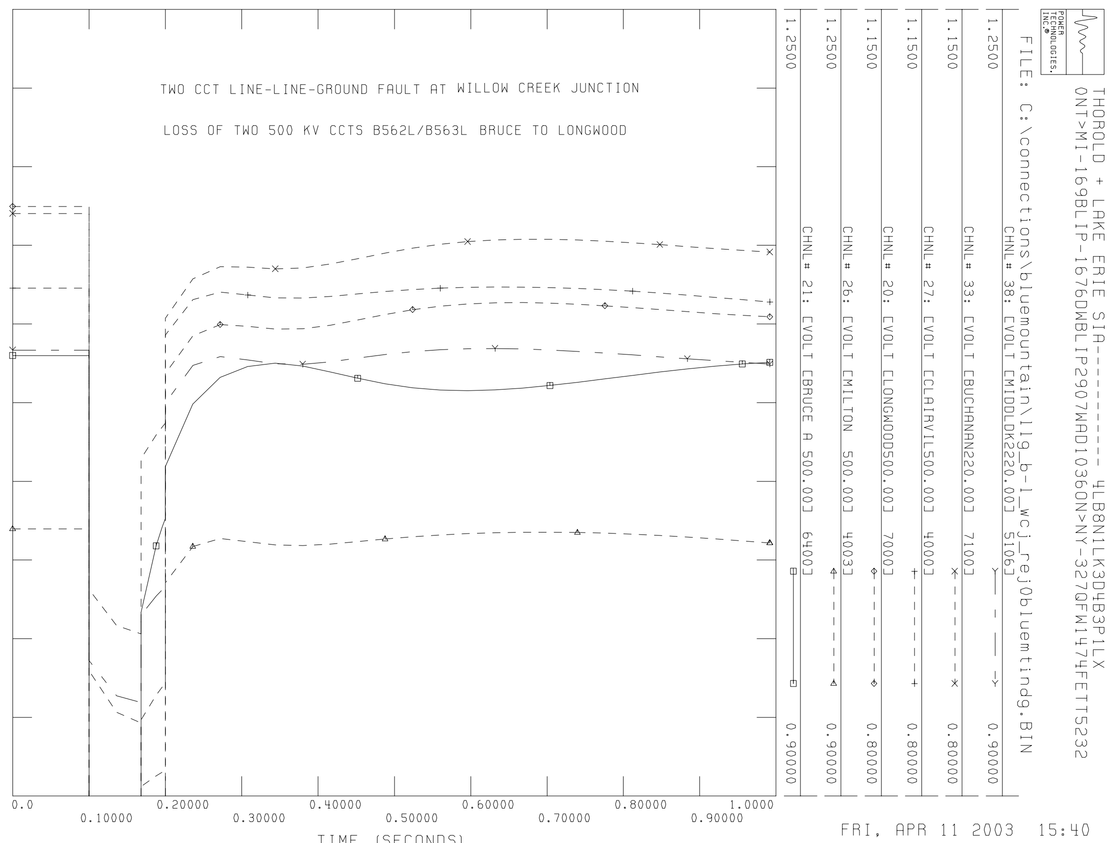

FIG 3A:VOLTAGE PROFILE

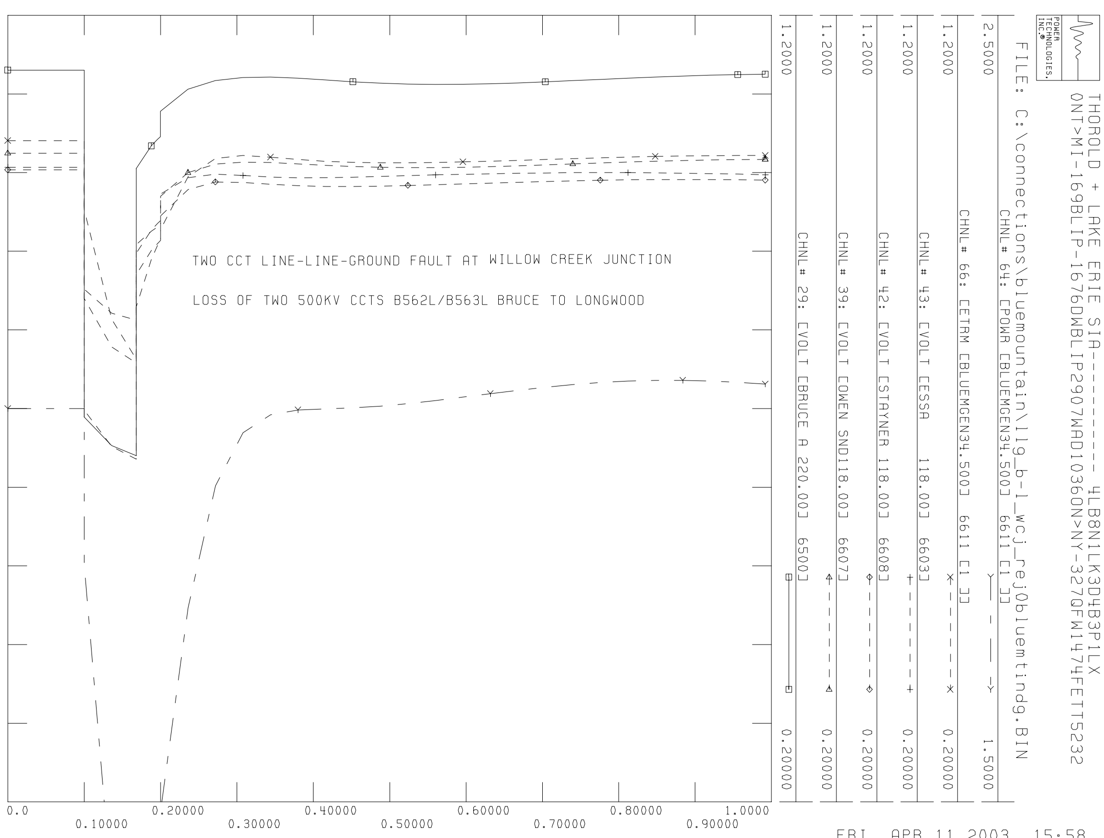

FIG 3B: 115KV VOLTAGES

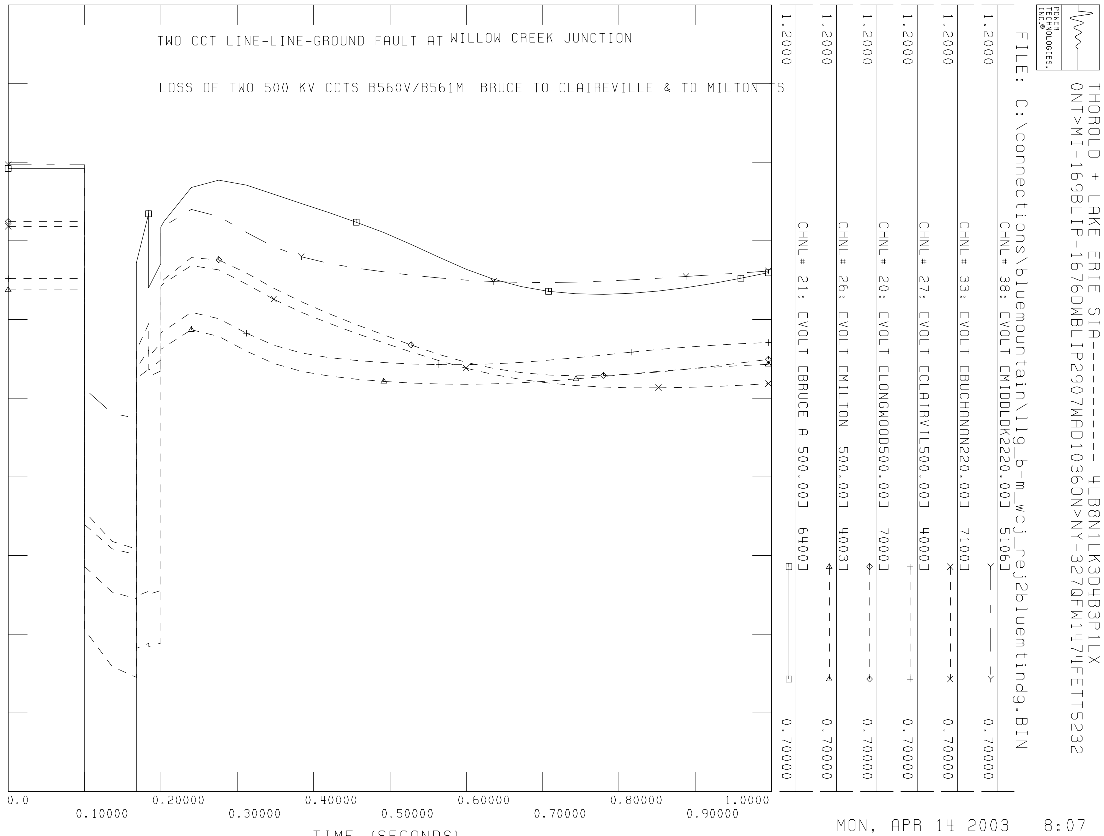

FIG 4A: VOLTAGE PROFILE

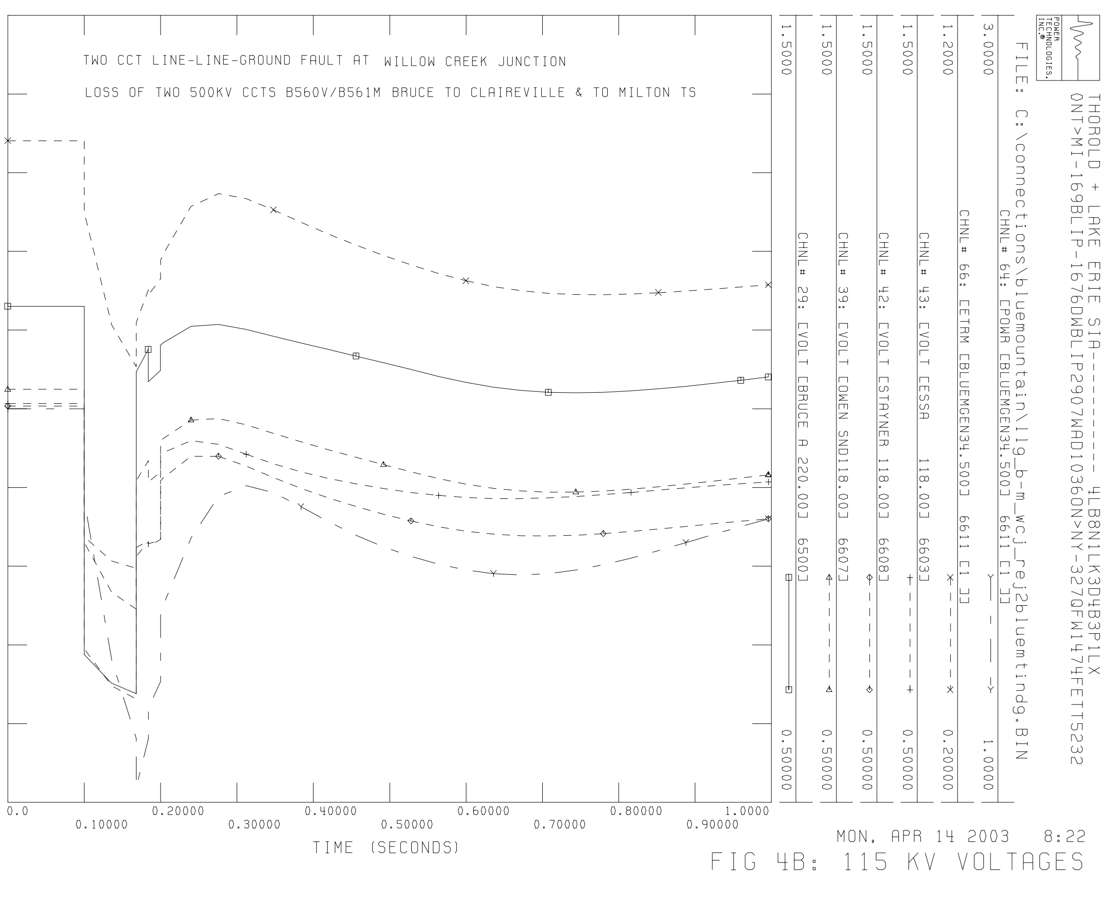

FIG 4B: 115 KV VOLTAGES

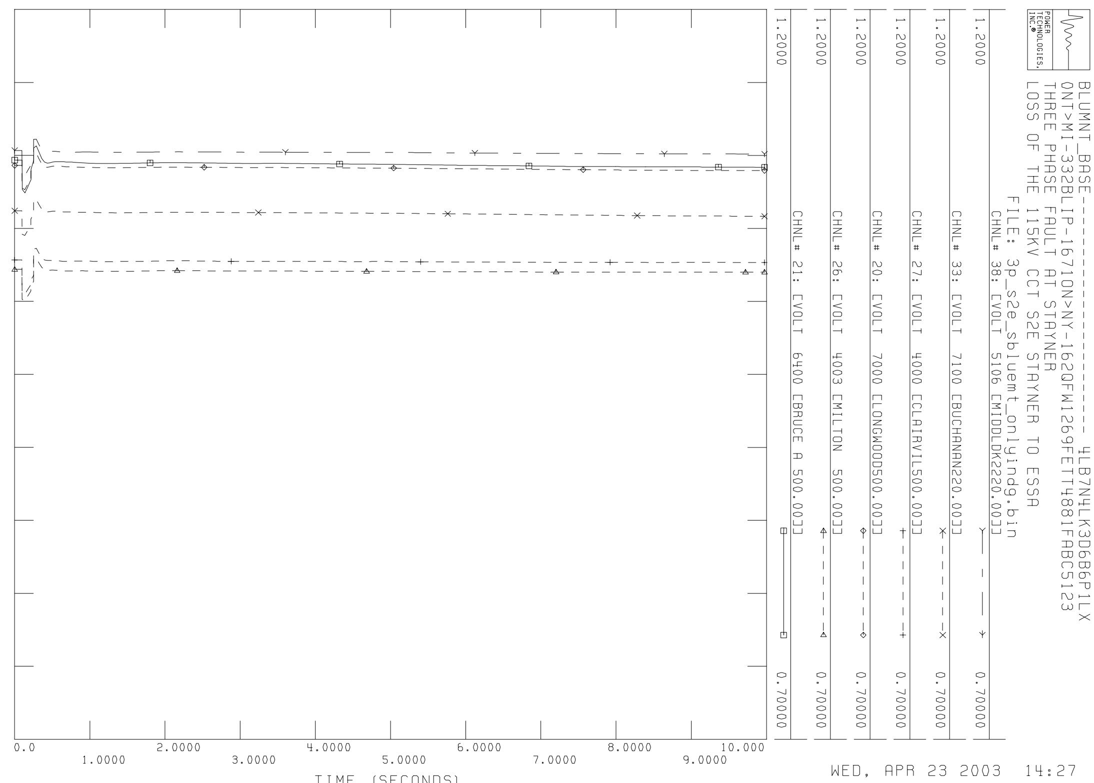

FIG 5A: VOLTAGE PROFILE

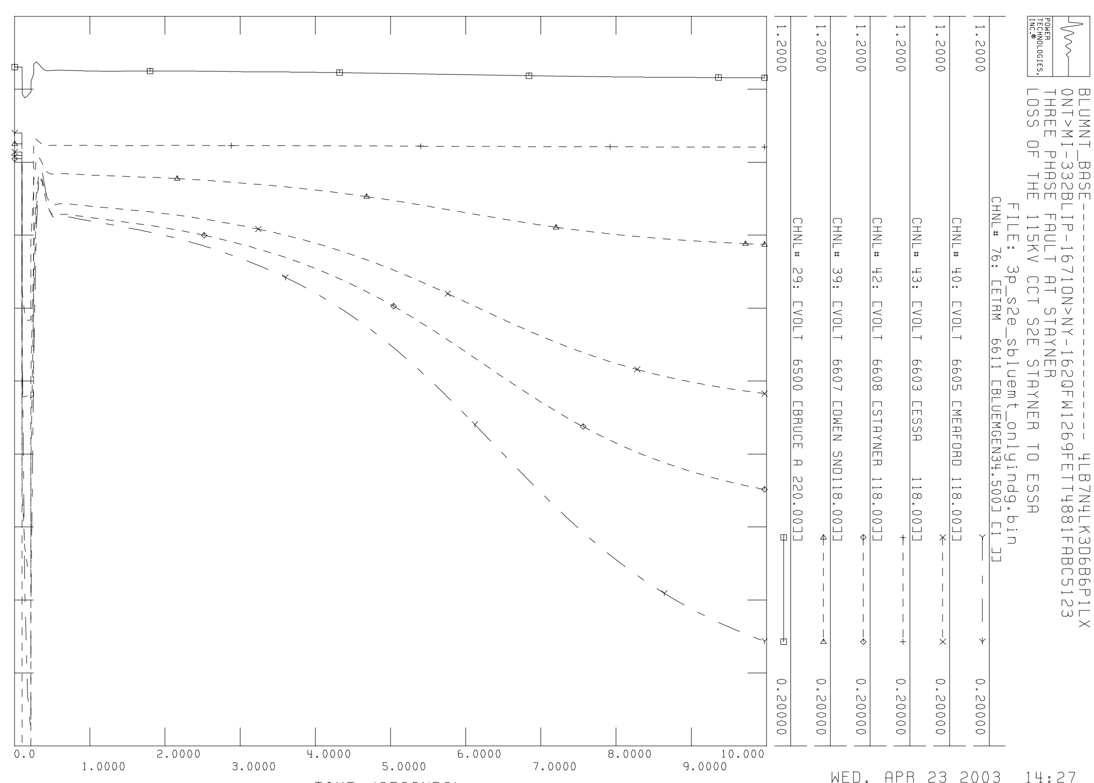

FIG 5B: 115KV VOLTAGES

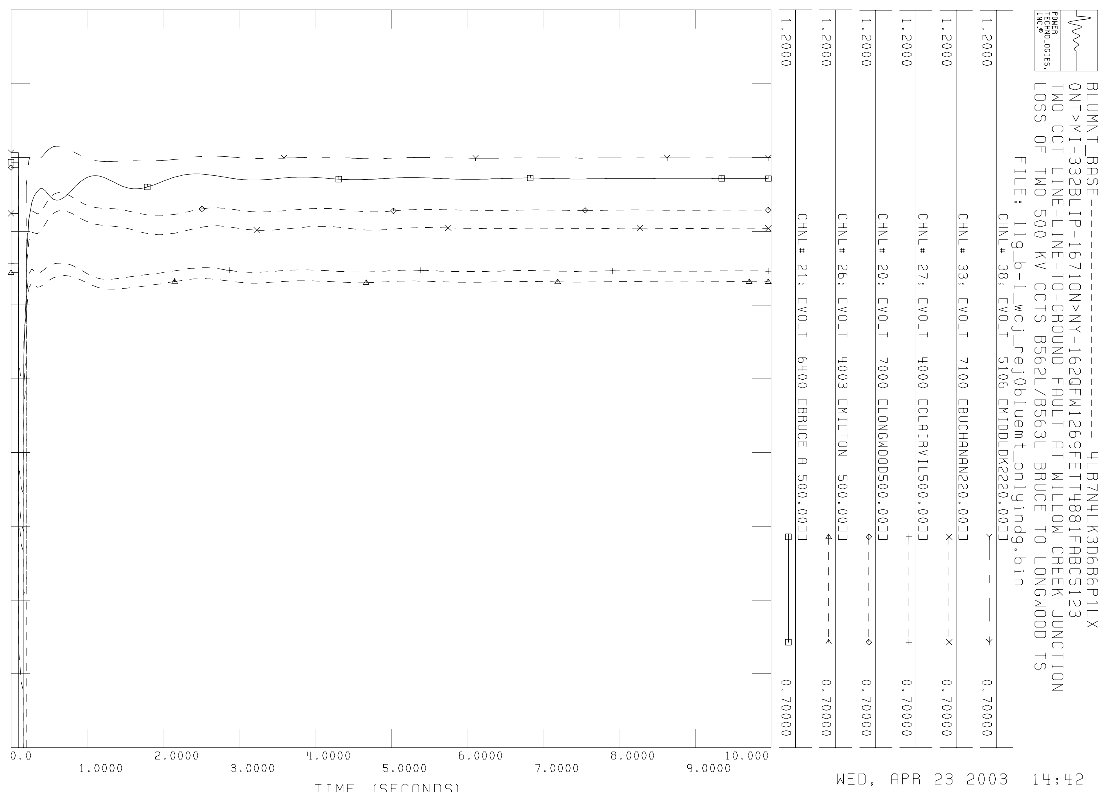

FIG 6A: VOLTAGE PROFILE

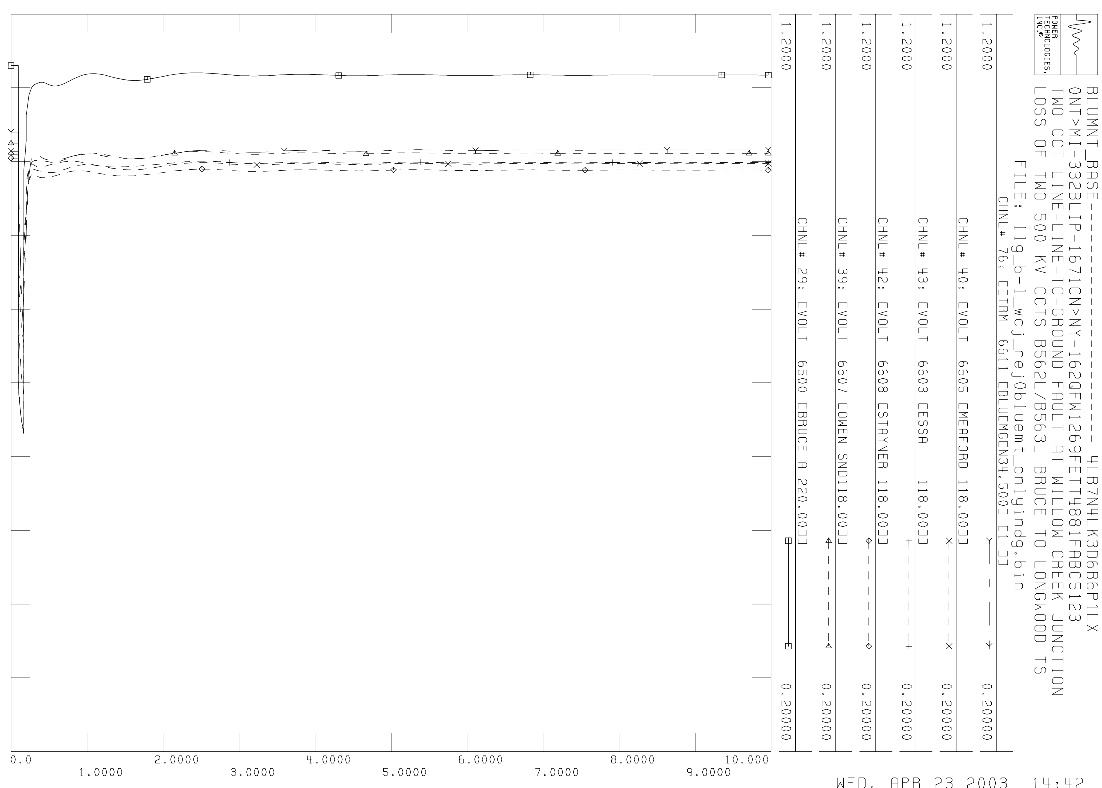

FIG 6B: 115KV VOLTAGES

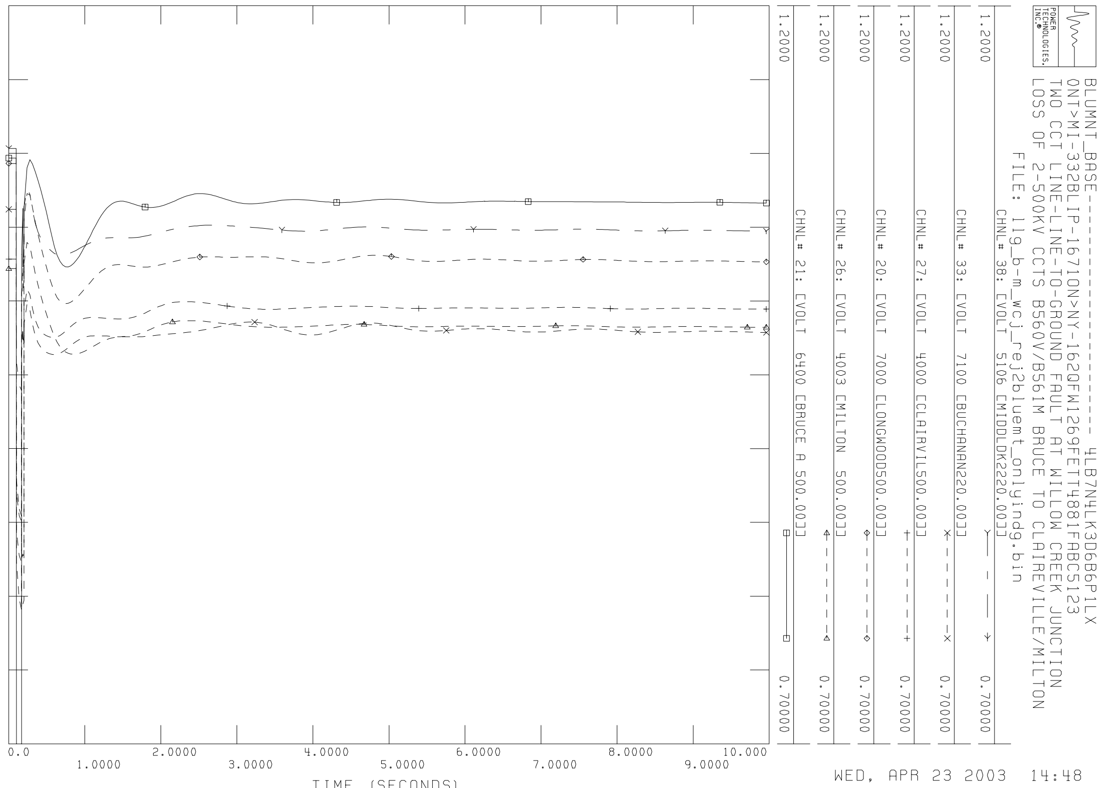

FIG 7A: VOLTAGE PROFILE

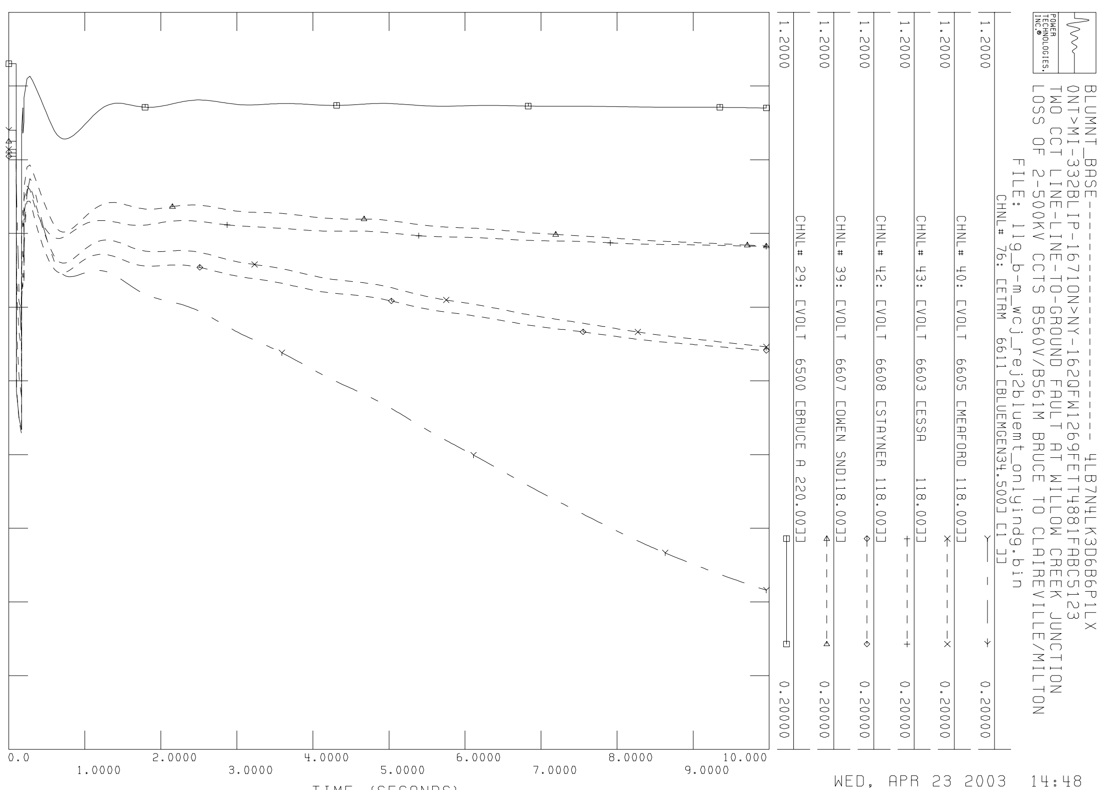

FIG 7B: 115KV VOLTAGES

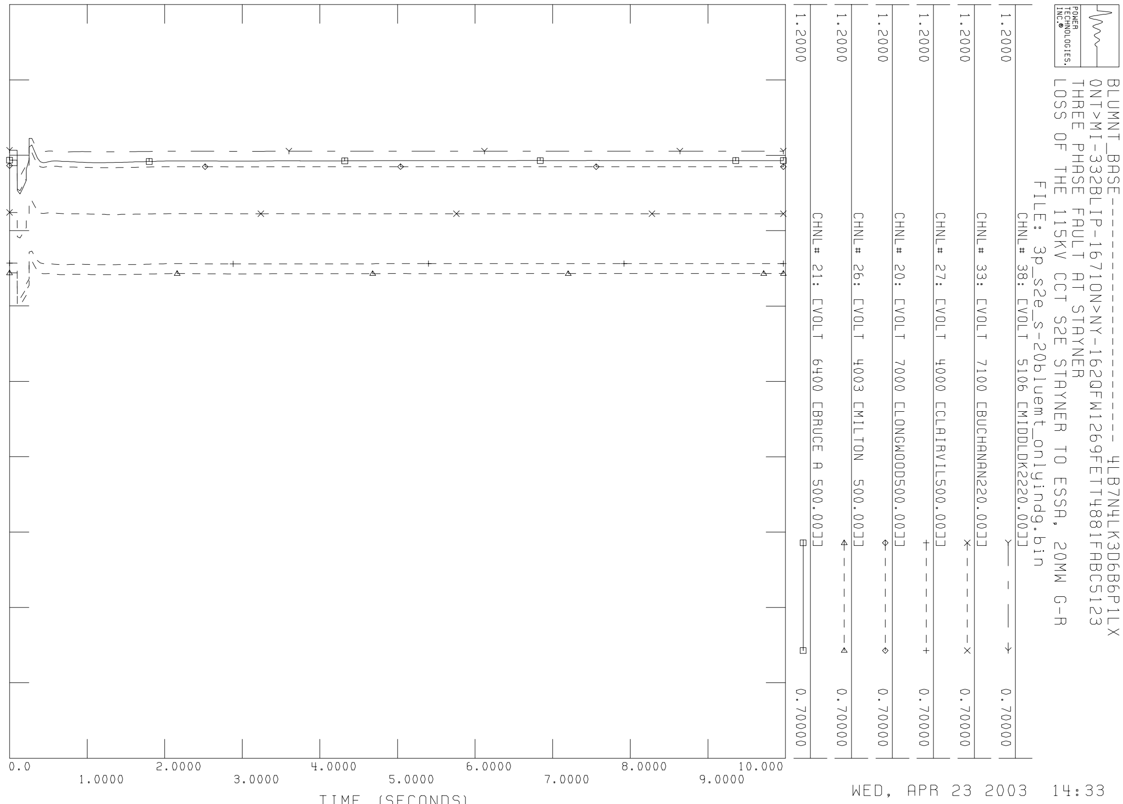

FIG 8A: VOLTAGE PROFILE

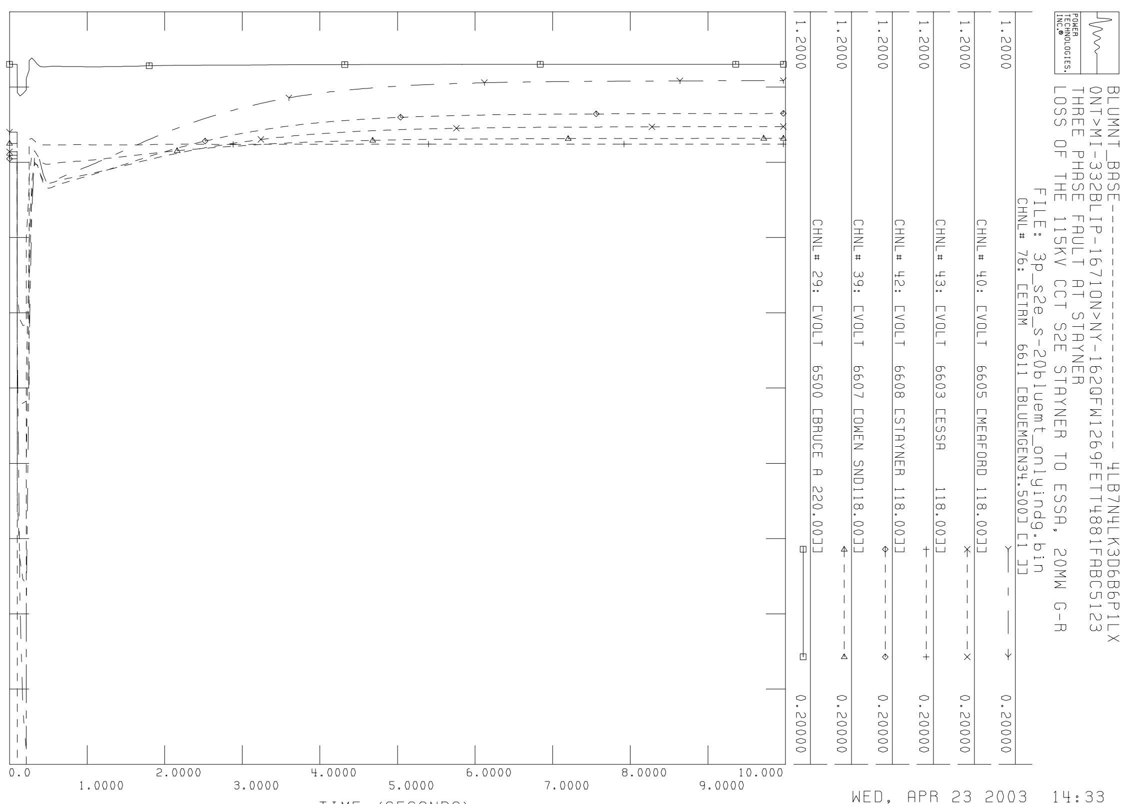

FIG 8B: 115KV VOLTAGES

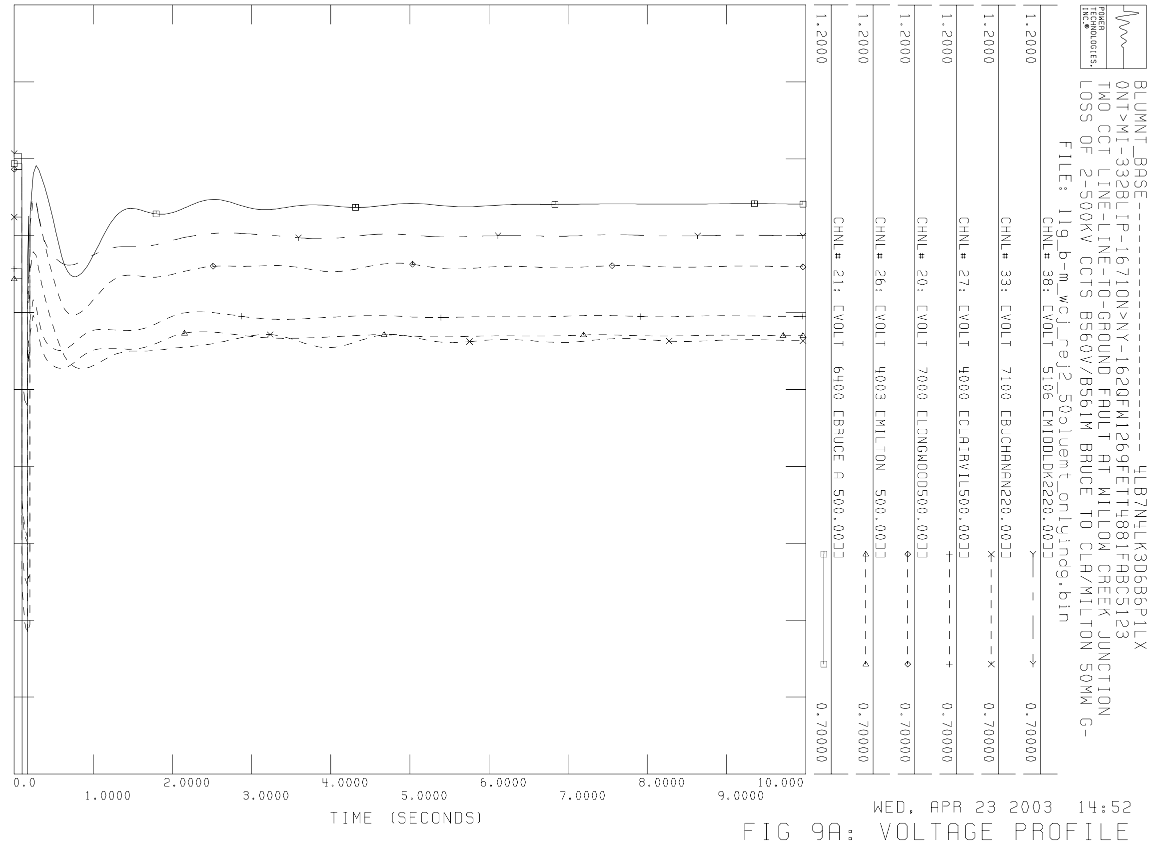

FIG 9A: VOLTAGE PROFILE

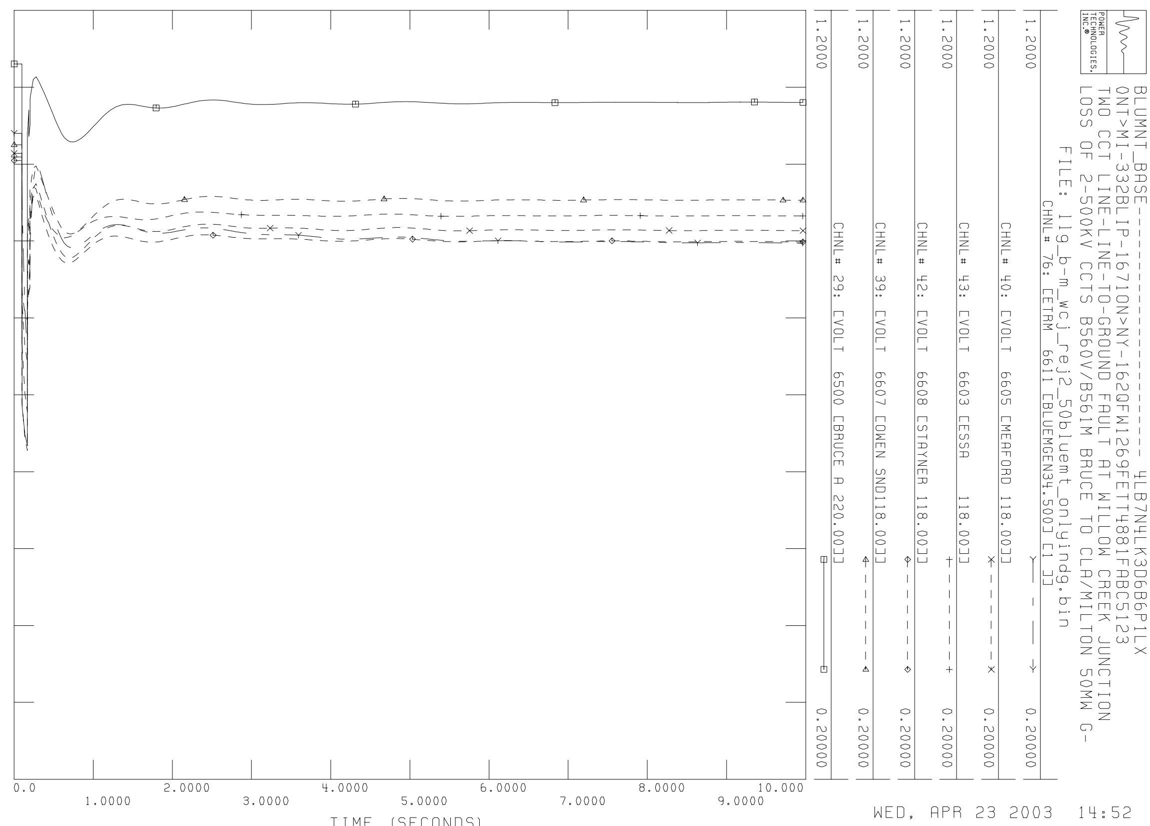

FIG 9B: 115KV VOLTAGES