IMO_REP_0118

CONNECTION ASSESSMENT & APPROVAL PROCESS

Preliminary Assessment Report
Bruce Wind Park

CAA ID 2002-084

Final Version

Long Term Forecasts & Assessments Department
&
Consistent Information Department

September 19, 2003

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Preliminary Assessment Report

Bruce 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, near the town of Ferndale on the Bruce Peninsula, and its impact on the reliability of the IMO-Controlled Grid (ICG).

Superior Wind Energy Inc., the proponent of the 200 MW Bruce Wind Park project, is considering three incorporation alternatives:

Alternative 1:

200 MW generation is to be incorporated via a new 115 kV line, approximately 70 km in length, connected to the Owen Sound-Hanover circuit S1H near Owen Sound.

Alternative 2:

30-50 MW generation is to be incorporated via two new 44 kV distribution lines, approximately 70 km in length, and the remaining 150-170 MW via the 115 kV system as per Alternative 1.

Alternative 3:

200 MW generation is to be incorporated via a new 230 kV line, approximately 70 km in length, connected to one of the two Bruce-Owen Sound circuits B27S or B28S near Owen Sound.

The proposed developments and in-service dates for the three alternatives are as follows:

	Alternative 1 115 kV Incorporation	Alternative 2 44/115 kV Incorporation	Alternative 3 230 kV Incorporation
Stage 1 : Q4-2003	100 MW	30-50 MW	100 MW
Stage 2 : Q4-2004	100 MW	150-170 MW	100 MW

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.

Superior Wind Energy Inc. is also the proponent of the 200 MW Blue Mountain Wind Park in the Collingwood area. This project is registered in the Connection Assessment and Approval queue ahead of the Bruce Wind Park project.

Conclusions

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

1. The proposed 200 MW Bruce Wind Park Project 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. Incorporation at 115 kV or 44/115 kV as per Alternatives 1 and 2 would require a connectivity-based Special Protection System to reject appropriate amounts of wind turbine generation under certain system contingencies. The special system protection requirement does not apply to the 230 kV incorporation alternative.

2. The proposed 200 MW Bruce Wind Park, if incorporated at 115 kV or 44/115 kV as per Alternatives 1 and 2 and in addition to the 200 MW Blue Mountain Wind Park, would result in overloading the local 115 kV transmission line S2S between the Blue Mountain connection point to Stayner TS with all facilities in service. No overloading would result if the proposed 200 MW Bruce Wind Park were to be incorporated as a stand-alone project (i.e. without the incorporation of the 200 MW Blue Mountain Wind Park project).

3. The proposed 200 MW Bruce Wind Park, if incorporated at 230 kV as per Alternative 3, would not result in overloading of any transmission facilities, with or without the incorporation of the 200 MW Blue Mountain Wind Park.

4. 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 Bruce Wind Park facility are as follows:

1. To incorporate 200 MW of generation at 115 kV or 44/115 kV with all facilities in service, Superior Wind Energy Inc. is required to:

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

        - Loss of the Bruce to Milton/Claireville 500 kV 2-cct line
        - Loss of the Bruce to Longwood 500 kV 2-cct line
        - Loss of the Bruce to Orangeville 230 kV 2-cct line
        - Loss of the Stayner to Essa 115 kV line
        - Loss of one of the two dedicated 44 kV feeders to Owen Sound TS (This applies only to the 44 kV incorporation with a common 44 kV bus)

    - Upgrade the 20 km section of 115 kV line S2S between the Blue Mountain connection point to Stayner TS to accommodate the full output from both the Bruce Wind Park and Blue Mountain Wind Park with all facilities in service.

    - As an alternative to upgrading the 115 kV line S2S, the amount of generation incorporation at Bruce Wind Park is limited to 167 MW and 186 MW for the 115 kV and 44/115 kV incorporation alternatives respectively.

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 consumption on the 44/115 kV or 44/230 kV transformation and the dedicated connection line(s). This can be achieved with combinations of low impedance 44/120/230 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 Bruce 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 and assessment of the cumulative impact of a related project on the IMO-Controlled Grid.

Budgetary Cost Estimates

There is only minor 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.

Superior Wind Energy Inc. is to obtain cost estimates of the following from Hydro One Network Inc., if the proposed 200 MW Bruce Wind Park is to be incorporated at 115 kV or 44/115 kV level.

- Upgrade the 20 km line section of S2S between the Blue Mountain connection point to Stayner TS.

- Provide a connectivity-based Special Protection System to reject appropriate amounts of wind turbine generation under certain system contingencies.

Identification of "Sole Beneficiary"

The facilities that are triggered by and deemed to be for the sole benefit of this project have been identified as follows, if the proposed 200 MW Bruce Wind Park project is to be incorporated at 115 kV or 115/44 kV level.

- Upgrade the 20 km line section of S2S between the Blue Mountain connection point to Stayner TS.

- Provide a connectivity-based Special Protection System to reject appropriate amounts of wind turbine generation under certain system contingencies.

Notification of Approval

This Preliminary Assessment has investigated the impact of the proposed 200 MW Bruce 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

This preliminary assessment has been conducted to examine the proposed 200 MW wind generation facility, near the town of Ferndale on the Bruce Peninsula, and its impact on the reliability of the IMO-Controlled Grid (ICG).

Superior Wind Energy Inc., the proponent of the 200 MW Bruce Wind Park project, is considering three incorporation alternatives:

Alternative 1:

200 MW generation is to be incorporated via a new 115 kV line, approximately 70 km in length, connected to the Owen Sound-Hanover circuit S1H near Owen Sound.

Alternative 2:

30-50 MW generation is to be incorporated via two new 44 kV distribution lines, approximately 70 km in length, and the remaining 150-170 MW via the 115 kV system as per Alternative 1.

Alternative 3:

200 MW generation is to be incorporated via a new 230 kV line, approximately 70 km in length, connected to one of the two Bruce-Owen Sound circuits B27S or B28S near Owen Sound.

The proposed developments and in-service dates for the three alternatives are as follows:

	Alternative 1 115 kV Incorporation	Alternative 2 44/115 kV Incorporation	Alternative 3 230 kV Incorporation
Stage 1 : Q4-2003	100 MW	30-50 MW	100 MW
Stage 2 : Q4-2004	100 MW	150-170 MW	100 MW

Superior Wind Energy Inc. is also the proponent of the 200 MW Blue Mountain Wind Park located in the Collingwood area. This project is registered in the Connection Assessment and Approval queue ahead of the Bruce Wind Park project. Please refer to the companion Preliminary Assessment Report (IMO_REP_0117) on Blue Mountain Wind Park.

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 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.

In Alternative 1, the 44 kV bus is connected via a 44/115 kV transformer bank, a 115 kV breaker, 70 km of 115 kV line tap and a high voltage isolating device onto the 115 kV circuit S1H between Owen Sound TS and Hanover TS. The connection point is assumed to be near Owen Sound.

In Alternative 2, it is assumed a dedicated 44 kV distribution line will be connected to 2 groups of 7 x 1.5 MW (~20 MW), and another 44 kV distribution line will be used to incorporate 3 groups of 7 x 1.5 MW (~30 MW) of wind turbine generation. The remaining generation will be incorporated at 115 kV as per Alternative 1.

In Alternative 3, the 44 kV bus is connected via a 44/230 kV transformer bank, a 230 kV breaker, 70 km of 230 kV line and a high voltage isolating device onto the 230 kV circuit B27S or B28S between Owen Sound TS and Bruce GS. The connection point is assumed to be near Owen Sound.

The unit size and grouping will be adjusted accordingly to accommodate other unit 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. SWEI 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 (e.g. 200 MW Blue Mountain Wind Park), that have been registered prior to December 20, 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

(A) 115 kV Incorporation

LF1 is the base case created to assess the impact on the transfer capability of the BLIP interface loaded at its test level of -1660 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 Bruce Wind Park connected on the 115 kV line S1H and the available resources in southwestern Ontario dispatched to effect the power transfer on the BLIP interface. The 115 kV circuits S1H and S2S would be loaded to 95 MW (434 A) and 215 MW (1,036 A) respectively.

LF2 is the post-fault load flow following the loss of the 500 kV double-circuit line (B560V/B561M) between Bruce GS and Claireville/Milton TS. The results show satisfactory post-fault voltage profile on the ICG. The 115 kV circuits S1H and S2S would be loaded to 88 MW (409 A) and 268 MW (1,376 A) respectively.

LF3 is the post fault load flow following the loss of the 230 kV 2-cct line B4V/B5V between Bruce GS and Orangeville TS. The 115 kV circuits S1H and S2S would be loaded to 74 MW (351 A) and 225 MW (1,112 A) respectively.

LF4 is the post fault load flow following the loss of the proposed 200 MW Bruce Wind Park. The voltage declines at the 115 kV buses nearby are all within 5%. A comparison of LF1 and LF3 shows that 16.5% and 67% of the Bruce generation incorporated at 115 kV would appear on the 115 kV circuit S2S and S1H respectively.

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

Impact on BLIP Transfer Capability

2004 Summer Peak, BLIP = -1,660 MW, Bruce = 6 units, Blue Mountain Wind Park = 200 MW Bruce Wind Park = 200 MW at 115 kV

	Voltage Profile (kV)						
Case	Bruce 500	Longwood 500	Lambton 230	Richview 230	Owen Sound 115	Stayner 115	Remarks

LF1	546.7	545.1	242	236	126.6	120	Base Case
LF2	544	527.7	242	222.2	124.5	112.6	Loss of Bruce-Milton/Claireville 2-cct line

Impact on 115 kV Transmission System

2004 Summer Peak, Bruce = 6 units, Blue Mountain = 200 MW
Bruce Wind Park = 200 MW at 115 kV

Case	Bruce Wind (MW)	Voltage (kV)		Circuit Loading (Amp/MW)		Remarks
		O. Sound	Stayner	S2S at Stayner	S1H at O.Sound	
LF1	200	126.6	120	1036/215	434/95	Base loading of 200 MW S2S exceeds continuous rating
LF2	200	124.5	112.6	1376/268	409/88	Loss of Bruce-Miton/Claireville 2-cct line, S2S exceeds 15 min. LTR
LF3	200	122	117	1112/225	351/74	Loss of Bruce to Orangeville 2-cct line, S2S exceeds 15 min. LTR.
LF4	0	121.4	119.1	914/185	185/39	Loss of Bruce WP, $\Delta V < 5\%$ TDF on S2S = 0.165 TDF on S1H = 0.67

(B) 44/115 kV Incorporation

LF5 is the base case created to assess the impact on the transfer capability of the BLIP interface loaded at its test level of -1663 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 Bruce Wind Park (150 MW connected on the 115 kV line S1H and 50 MW connected on two 44 kV feeders to Owen Sound TS), and the available resources in southwestern Ontario dispatched to effect the power transfer on the BLIP interface. The 115 kV circuits S1H and S2S would be loaded to 59 MW (270 A) and 212 MW (1021 A) respectively.

LF6 is the post-fault load flow following the loss of the 500 kV double-circuit line (B560V/B561M) between Bruce GS and Claireville/Milton TS. The results show satisfactory post-fault voltage profile on the ICG. The 115 kV circuits S1H and S2S would be loaded to 52 MW (270 A) and 212 MW (1,021 A) respectively.

LF7 is the post fault load flow following the loss of the 230 kV 2-cct line B4V/B5V between Bruce GS and Orangeville TS. The 115 kV circuits S1H and S2S would be loaded to 30 MW (142 A) and 220 MW (1,084 A) respectively.

LF8 is the post fault load flow following the sudden loss of the 50 MW of Bruce Wind Park generation that is incorporated via two 44 kV feeders to Owen Sound TS. This is to simulate the condition in which the prevailing wind speed is higher than the shutdown speed limit, resulting in shutdown and disconnection of the wind turbine generation from the ICG. The voltage change (rise) at the Owen Sound 44 kV bus is about 3.5%. This voltage rise is due to the assumed shunt capacitors (about 20 MVAR) that are required to compensate for the reactive consumption on the

two 44 kV feeders. It is further assumed that the reactive power corrective equipment required for the wind turbine generation to produce an equivalent power factor of 90% lagging is disconnected along with the wind turbine generators. A comparison of LF5 and LF8 shows that 6% of the Bruce generation incorporated at 44 kV would appear on the 115 kV circuit S2S and S1H.

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

Impact on BLIP Transfer Capability

2004 Summer Peak, BLIP = -1663 MW, Bruce = 6 units, Blue Mountain Wind Park = 200 MW
Bruce Wind Park = 150 MW at 115 kV and 50 MW at 44 kV

	Voltage Profile (kV)						
Case	Bruce 500	Longwood 500	Lambton 230	Richview 230	Owen Sound 115	Stayner 115	Remarks
LF5	547	545	242	236.7	126.3	120	Base Case
LF6	544.4	527.8	242	222	124.4	112.7	Loss of Bruce-Milton/Claireville 2-cct line

Impact on 115 kV Transmission System

2004 Summer Peak, Bruce = 6 units, Blue Mountain = 200 MW
Bruce Wind Park = 150 MW at 115 kV and 50 MW at 44 kV

Case	Bruce Wind (MW)	Voltage (kV)		Circuit Loading (Amp/MW)		Remarks
		O. Sound 115/44 kV	Stayner	S2S at Stayner	S1H at O.Sound	
LF5	200	126.3/46.4	120	1021/212	270/59	Base loading of 200 MW S2S exceeds continuous rating
LF6	200	124.4/46	112.7	1359/265	242/52	Loss of Bruce-Miton/Claireville 2-cct line, S2S exceeds 15 min. LTR
LF7	200	122.4/46	117.3	1084/220	142/30	Loss of Bruce to Orangeville 2-cct line, S2S exceeds 15 min. LTR.
LF8	150 (loss of 50 MW at 44 kV)	127/48	120.7	1003/209	295/62	Loss of 50 MW of Bruce WP at 44 kV, $\Delta V < 3.5\%$ TDF on S2S = 0.06 TDF on S1H = 0.06

(C) 230 kV Incorporation

LF9 is the base case created to assess the impact on the transfer capability of the BLIP interface loaded at its test level of -1660 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 Bruce Wind Park connected on the 230 kV kV circuit B28S and the available resources in southwestern Ontario dispatched to effect the power transfer on the BLIP interface. The 115 kV circuits S1H and S2S would be loaded to 44 MW (210 A) and 190 MW (931 A) respectively.

LF10 is the post-fault load flow following the loss of the 500 kV double-circuit line (B560V/B561M) between Bruce GS and Milton/Claireville TS. The results show satisfactory post-fault voltage profile on the ICG. The 115 kV circuits S1H and S2S would be loaded to 54 MW (246 A) and 253 MW (1290 A) respectively.

LF11 is the post fault load flow following the loss of the proposed 200 MW Bruce Wind Park. The voltage changes at the 115 kV buses nearby are less than 1%. A comparison of LF9 and LF11 shows that 3% and 2.5% of the Bruce Wind Park generation would appear on the 115 kV circuits S2S and S1H respectively.

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

Impact on BLIP Transfer Capability

2004 Summer Peak, BLIP = -1660 MW, Bruce = 6 units, Blue Mountain Wind Park = 200 MW
Bruce Wind Park = 200 MW at 230 kV

	Voltage Profile (kV)						
Case	Bruce 500	Longwood 500	Lambton 230	Richview 230	Owen Sound 115	Stayner 115	Remarks
LF9	549	546	242	237	121	118	Base Case
LF10	545	527	242	222.8	126.7	113.4	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	Bruce Wind (MW)	Voltage (kV)		Circuit Loading (Amp/MW)		Remarks
		O. Sound	Stayner	S2S at Stayner	S1H at O.Sound	
LF9	200	121	118	931/190	210/44	Base loading of 200 MW
LF10	200	126.7	113.4	1,290/253	246/54	Loss of Bruce-Miton/Claireville 2-cct line, Exceeds 15 min. LTR on S2S.
LF11	0	121.2	118.5	902/184	186/39	Loss of Bruce, $\Delta V < 1\%$ TDF on S2S = 0.03 TDF on S1H = 0.025

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, LF5 and LF9 for the 115 kV incorporation, 44/115 kV incorporation and 230 kV incorporation respectively.

Contingency 1: 3-phase fault at O. Sound, l/o of 115 kV cct S2S between O. Sound and Stayner
Contingency 2: 3-phase fault at Stayner, l/o of 115 kV cct S2E between Stayner and Essa
Contingency 3: 2-cct llg fault at Willow Creek Junction, loss of two 500 kV ccts B562L/B563L

Contingency 4: 2-cct llg fault at Willow Creek Junction, loss of two 500 kV ccts B560V/B561M
Contingency 5: 3-phase fault at O. Sound, l/o 230 kV cct B27S between Bruce and O. Sound
Contingency 6: 2-cct llg at Bruce, loss of two 230 kV ccts B4V/B5V
Contingency 7: 3-phase fault at Bruce Wind Park, l/o 44 kV feeder to Owen Sound.

Similar to the Blue Mountain Wind Park connection assessment, the incorporation of 200 MW of wind generation at the Bruce Wind Park would also require generation rejection to maintain acceptable post-contingency voltages in the Owen Sound-Stayner area for the 115 kV and 44/115 kV incorporation alternatives.

The results of the transient stability tests for the three incorporation alternatives are summarized below with various amounts of generation rejected for different contingencies for the assumed study conditions. These are illustrative generation rejection levels to demonstrate the need for a connectivity-based Special Protection System as part of the connection requirements.

It should be noted that the generation rejection requirements during day-to-day operations 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, 44/115/230 kV transformers, switched shunt capacitors, transmission line(s), switching arrangements and real and reactive power control of the wind turbine generation.

(A) 115 kV Incorporation

Transient Stability Case	Contingency	Voltage Plots	System Responses	Amount of Generation Rejection Assumed at Bruce and Blue Mt Wind Parks			
				Bruce 115 kV	Bruce 44 kV	Bruce 230 kV	Blue Mt 115 kV
TS1/LF1	1 (S2S)	Fig. 2	Stable, +ve damping	50	-	-	0
TS2/LF1	2 (S2E)	Fig. 3	"	50	-	-	20
TS3/LF1	3 (BxL)	Fig. 4	"	50	-	-	0
TS4/LF1	4 (BxM/C)	Fig. 5	"	50	-	-	50
TS5/LF1	6 (B4/5V)	Fig. 6	"	50	-	-	0

(B) 44/115 kV Incorporation

Transient Stability Case	Contingency	Voltage Plots	System Responses	Amount of Generation Rejection Assumed at Bruce and Blue Mt Wind Parks			
				Bruce 115 kV	Bruce 44 kV	Bruce 230 kV	Blue Mt 115 kV
TS6/LF5	1 (S2S)	Fig. 7	Stable, +ve damping	0	0	-	0
TS7/LF5	2 (S2E)	Fig. 8	"	30	30	-	20
TS8/LF5	3 (BxL)	Fig. 9	"	30	30	-	0
TS9/LF5	4 (BxM/C)	Fig. 10	"	30	30	-	50
TS10/LF5	6 (B4/5V)	Fig. 11	"	30	20	-	0
TS11/LF5	7*	Fig. 12	"	0	20	-	0
* Loss of one of 2 feeders to Owen Sound TS with a common bus for 50 MW of wind generation.							

(C) 230 kV Incorporation

Transient Stability Case	Contingency	Voltage Plots	System Responses	Amount of Generation Rejection Assumed at Bruce and Blue Mt Wind Parks			
				Bruce 115 kV	Bruce 44 kV	Bruce 230 kV	Blue Mt 115 kV
TS12/LF9	5 (B27S)	Fig. 13	Stable, +ve damping	-	-	0	0
TS13/LF9	3 (BxL)	Fig. 14	"	-	-	0	0
TS14/LF9	4 (BxM/C)	Fig. 15	"	-	-	0	50

While the study results, based on typical wind turbine generator data, show that the 230 kV incorporation alternative does not require generation rejection for the 200 MW Bruce Wind Park generation, the proponent is advised to submit the final equipment data for confirmation prior to deciding on the 230 kV incorporation alternative.

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 represents 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 generation on the Bruce Peninsula with a connectivity-based Special Protection System would not have an adverse impact on the stability performance of IMO-Controlled Grid. This special protection system requirement does not apply to the 230 kV incorporation.

3.3 Impact on Local 115 kV System

The proposed 200 MW generation facility would be connected to the local 115/230 kV transmission system, supplying the Owen Sound-Stayner-Barrie area. The impact on this 115/230 kV system, which is an integral part of the ICG, is discussed below.

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 changes measured at 115 and 230 kV bus at Owen Sound TS are less than 1%.

All three proposed incorporation arrangements are acceptable from the IMO-Controlled Grid viewpoint. For Alternative 2 involving incorporation of 30-50 MW of wind turbine generation at Owen Sound 44 kV, the voltage changes and customer impacts are subject to Hydro One's Customer Impact Assessment and acceptance.

3.3.2 Loading on 115 kV Transmission

The proposed 200 MW generation would increase the power flows on the 115 kV circuit S1H between Owen Sound TS and Hanover TS and 115 kV circuit S2S between Owen Sound TS and Stayner TS.

Criteria Ambient Conditions used in determining circuit ratings in Connection Assessment:

- Conventional Generation: 30^{o} C and 4 km/hr wind
- Wind Turbine Generation:
  Within 50 km radius from wind park: 30^{o} C and 15 km/hr wind
  Outside the 50 km radius: 30^{o} C and 4 km/hr wind

(a) 115 kV Circuit S1H

The Bruce Wind Park connection point on the 115 kV circuit S1H is about 70 km from the proposed wind park site. For circuit rating consideration, the criteria ambient conditions of 30^{o} C and 4 km/hr wind are used.

Based on the assumed 2004 summer peak system conditions, the proposed 200 MW Bruce Wind Park generation would increase the loading on S1H, but within the continuous rating of the 115 kV circuit S1H of 620 A. This applies to all three incorporation alternatives.

(b) 115 kV Circuit S2S

The incorporation of the 200 MW Bruce Wind Park and the 200 MW Blue Mountain Wind Park would increase the loading on the 115 kV circuit S2S between Owen Sound TS and Stayner TS. The transfer distribution factors of the two wind parks on S2S are 16.5% and 54% respectively. This means that the impact due to Blue Mountain Wind Park on S2S is more than three times that of Bruce Wind Park. It follows that to relieve overload on S2S, it would require more than 3 MW reduction at Bruce Wind Park to achieve the same effect as 1 MW reduction at Blue Mountain Wind Park.

If the 200 MW Bruce Wind Park were to be incorporated without the 200 MW Blue Mountain Wind Park, the loading on S2S would be within its ampacity limit under the 4 km/hr wind speed. This applies to all three incorporation alternatives.

As shown in Sections 3.1.2 (A) and (B), the loadings on S2S due to the incorporation of the 200 MW Bruce Wind Park at 115 kV or 44/115 kV and the 200 MW Blue Mountain Wind Park would be about 1,036 A and 1,021 A respectively. This would marginally exceed the 1010 A continuous rating of S2S under the ambient conditions of 30^{o} C and 15 km/hr wind and a maximum operating temperature of 127^{o} C. This criteria ambient condition is used for the cumulative impact of both wind parks recognizing while Bruce Wind Park is located more than 50 km from S2S, the contributing impact of Blue Mountain Wind Park is more than three times that of Bruce Wind Park.

Since both wind parks are from the same proponents who may consider optimizing the two projects together. The following tables provide the amounts of generation reduction from the two wind parks to respect the continuous rating of S2S under the criteria conditions of 30° C and 15 km/hr wind. It should be noted that the amounts of reduction would be further reduced during actual operation if the prevailing ambient conditions are more restrictive than the criteria conditions used in this Preliminary Assessment report. Experience has shown that it is not unusual that the ambient temperature is significantly higher than 30° C.

115 kV Incorporation
Generation Reduction at Ambient Conditions of 30° C and 15 km/hr wind.

Bruce Wind Park		Blue Mt Wind Park
33 MW	Or	10 MW

44/115 kV Incorporation
Generation Reduction at Ambient Conditions of 30° C and 15 km/hr wind.

Bruce Wind Park		Blue Mt Wind Park
14 MW	Or	4.5 MW

The 230 kV incorporation alternative would not result in overloading the 115 kV circuits in the Owen Sound-Essa area.

3.3.3 Loading on 230 kV Transmission System

The increased loadings on the 230 kV circuits B27S or B28S between Bruce GS and Owen Sound TS or on the 115/230 kV auto-transformer at Owen Sound TS are within their respective ratings.

Therefore, from the IMO-Controlled Grid perspective, both connections are acceptable.

The 230 kV connection to circuit B28S is preferred over circuit B27S. This is because circuit B28S is currently connected to only one element (T3 at Owen Sound TS), while circuit B27S is connected to T4 and the 230/115 kV autotransformer at Owen Sound TS. The 70 km incorporation line would slightly increase the outage exposure of the 230/115 kV autotransformer at Owen Sound TS.

Connection to 230 kV circuit B28S, however, will result in a large unbalance in the loadings of the two 230 kV DESN transformers T3 and T4 at Owen Sound TS. Its acceptance is subject to Hydro One's concurrence.

3.3.4 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-ups and shut-down's during the day-to-day operation and would result in voltage fluctuation (voltage flicker0 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/shut-down 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 115/230 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% while meeting the power factor requirements of the synchronous or induction generators.

Additional reactive compensation is also required for the line tap and the 44/115/230 kV transformer which are owned and used exclusively by the wind turbine generators.

To meet the market rule requirements, the wind turbine generators may choose combinations of low impedance 44/120/230 kV transformer and provision of reactive power, whichever combination is more economic and subject to IMO's approval.

The following table provides an estimate of the reactive power consumption in the transformer and the dedicated connection lines for the incorporation alternatives, based on typical transformer and line impedances. It is noted that the estimated values only serve the purpose of a high level comparison of reactive power consumption for the three incorporation alternatives and is not intended for use by the proponent to make its investment decisions.

	Estimated Reactive Power Consumption (MVAR)				
Incorporation Alternative	2, 44 kV feeders	115 kV Transmission	230 kV Transmission	44/115/230 kV 250 MVA Transformer	Total
(1) 200 MW at 115 kV	-	80	-	35	115
(2) 50 MW/44 kV, 150 MW/115 kV	20	47	-	20	87
(3) 200 MW at 230 kV	-	-	11	35	46

Assumptions:
- Operating voltages: 46/125/240 kV
- Conductors: 477 kcmil for 44 kV and 115 kV transmission and 795 kcmil for 230 kV transmission.
- 70 km line length
- 8.5% impedance on 100 MVA base for 44/115/230 kV 250 MVA transformer

3.5 Real Power Losses

Similar to reactive power consumption (MVAR losses) on the transmission facilities, the three alternatives would result in different levels of real power (MW) losses. The estimated values in the table serves the purpose of a high level comparison of MW losses using typical line and transformer parameters. The estimated values are not intended for use by the proponent in making its investment decision.

	Estimated Transmission Losses (MW)				
Incorporation Alternative	2, 44 kV feeders	115 kV Transmission	230 kV Transmission	44/115/230 kV 250 MVA Transformer	Total
(1) 200 MW at 115 kV	-	24	-	4	28
(2) 50 MW/44 kV, 150 MW/115 kV	6	14	-	2.3	22.3
(3) 200 MW at 230 kV	-	-	4	4	8

Assumptions:
- Operating voltages: 46/125/240 kV
- Conductors: 477 kcmil for 44 kV and 115 kV transmission and 795 kcmil for 230 kV transmission.
- 70 km line length
- Transformer losses: 2% at 200 MW

3.6 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."*

3.7 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 the 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.

3.8 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 Bruce 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 the GE or Vestas 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 Bruce Wind Park Project 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. Incorporation at 115 kV or 44/115 kV as per Alternatives 1 and 2 would require a connectivity-based Special Protection System to reject appropriate amounts of wind turbine generation under certain system contingencies. The special system protection requirement does not apply to the 230 kV incorporation alternative.

2. The proposed 200 MW Bruce Wind Park, if incorporated at 115 kV or 44/115 kV as per Alternatives 1 and 2 and in addition to the 200 MW Blue Mountain Wind Park, would result in overloading the local 115 kV transmission line S2S between the Blue Mountain connection point and Stayner TS with all facilities in service. No overloading would result if the proposed 200 MW Bruce Wind Park were to be incorporated as a stand-alone project (i.e. without the incorporation of the 200 MW Blue Mountain Wind Park project).

3. The proposed 200 MW Bruce Wind Park, if incorporated at 230 kV as per Alternative 3, would not result in overloading of any transmission facilities, with or without the incorporation of the 200 MW Blue Mountain Wind Park.

4. 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 Bruce Wind Park facility are as follows:

1. To incorporate 200 MW of generation at 115 kV or 44/115 kV with all facilities in service, Superior Wind Energy Inc. is required to:

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

        - Loss of the Bruce to Milton/Claireville 500 kV 2-cct line

- Loss of the Bruce to Longwood 500 kV 2-cct line
- Loss of the Bruce to Orangeville 230 kV 2-cct line
- Loss of the Stayner to Essa 115 kV line
- Loss of one of the two dedicated 44 kV feeders to Owen Sound TS (This applies only to the 44 kV incorporation with a common 44 kV bus)

- Upgrade the 20 km section of 115 kV line S2S between the Blue Mountain connection point to Stayner TS to accommodate the full output from both the Bruce Wind Park and Blue Mountain Wind Park with all facilities in service.

- As an alternative to upgrading the 115 kV line S2S, the amount of generation incorporation at Bruce Wind Park is limited to 167 MW and 186 MW for the 115 kV and 44/115 kV incorporation alternatives respectively.

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 consumption on the 44/115 kV or 44/230 kV transformation and the dedicated connection line(s). This can be achieved with combinations of low impedance 44/120/230 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 Bruce 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 and assessment of the cumulative impact of a related project on 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.

Superior Wind Energy Inc. is to obtain cost estimates of the following from Hydro One Network Inc., if the proposed 200 MW Bruce Wind Park is to be incorporated at 115 kV or 44/115 kV level.

- Upgrade the 20 km line section of S2S between the Blue Mountain connection point to Stayner TS.

- Provide a connectivity-based Special Protection System to reject appropriate amounts of wind turbine generation under certain system contingencies.

7.0 Identification of "Sole Beneficiary"

The facilities that are triggered by and deemed to be for the sole benefit of this project have been identified as follows, if the proposed 200 MW Bruce Wind Park is to be incorporated at 115 kV or 115/44 kV level.

- Upgrade the 20 km line section of S2S between the Blue Mountain connection point to Stayner TS.

- Provide a connectivity-based Special Protection System to reject appropriate amounts of wind turbine generation under certain system contingencies.

8.0 Notification of Approval

This Preliminary Assessment has investigated the impact of the proposed 200 MW Bruce 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.

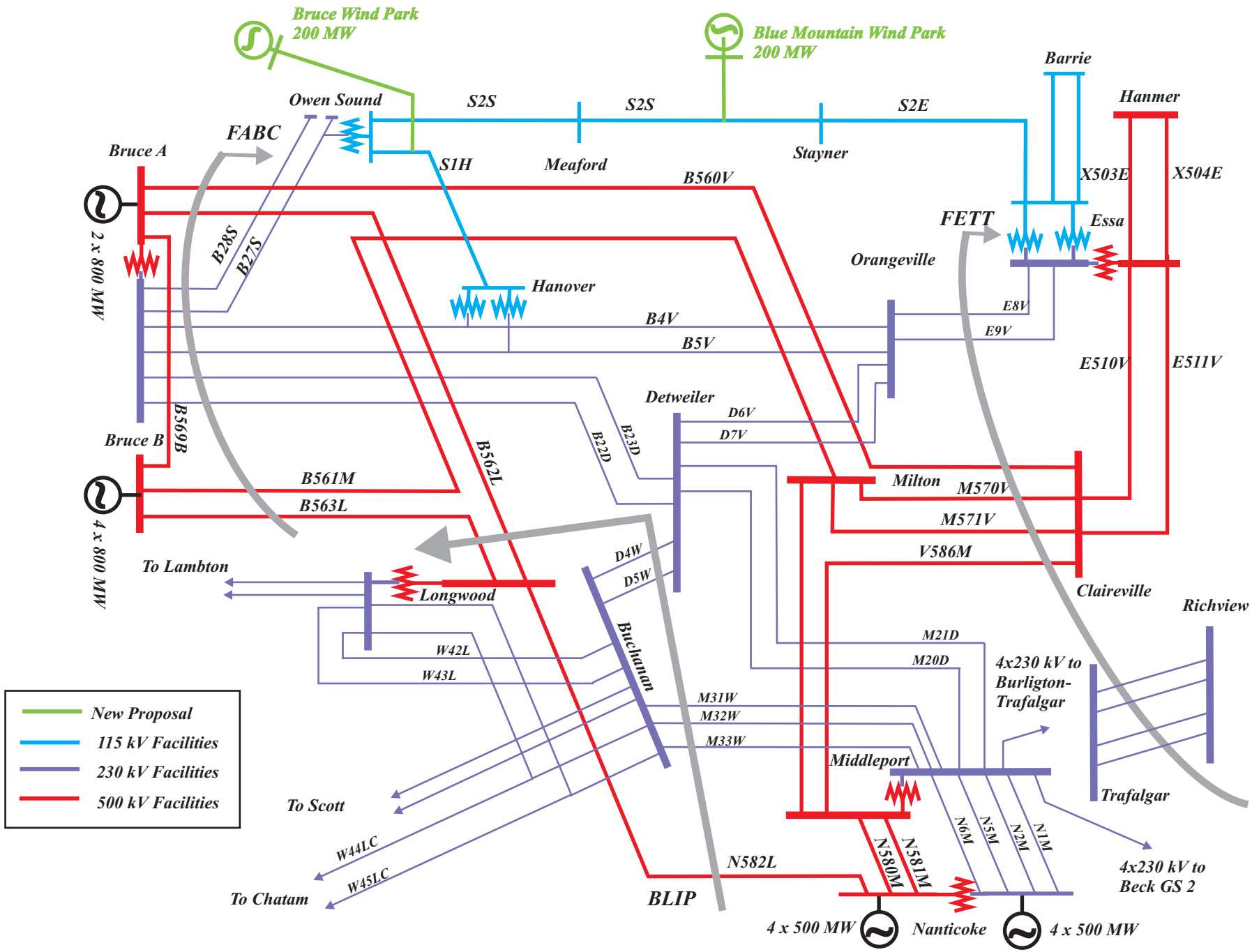

Figure 1. Southwestern Ontario Transmission System- Proposed Wind Park Generation

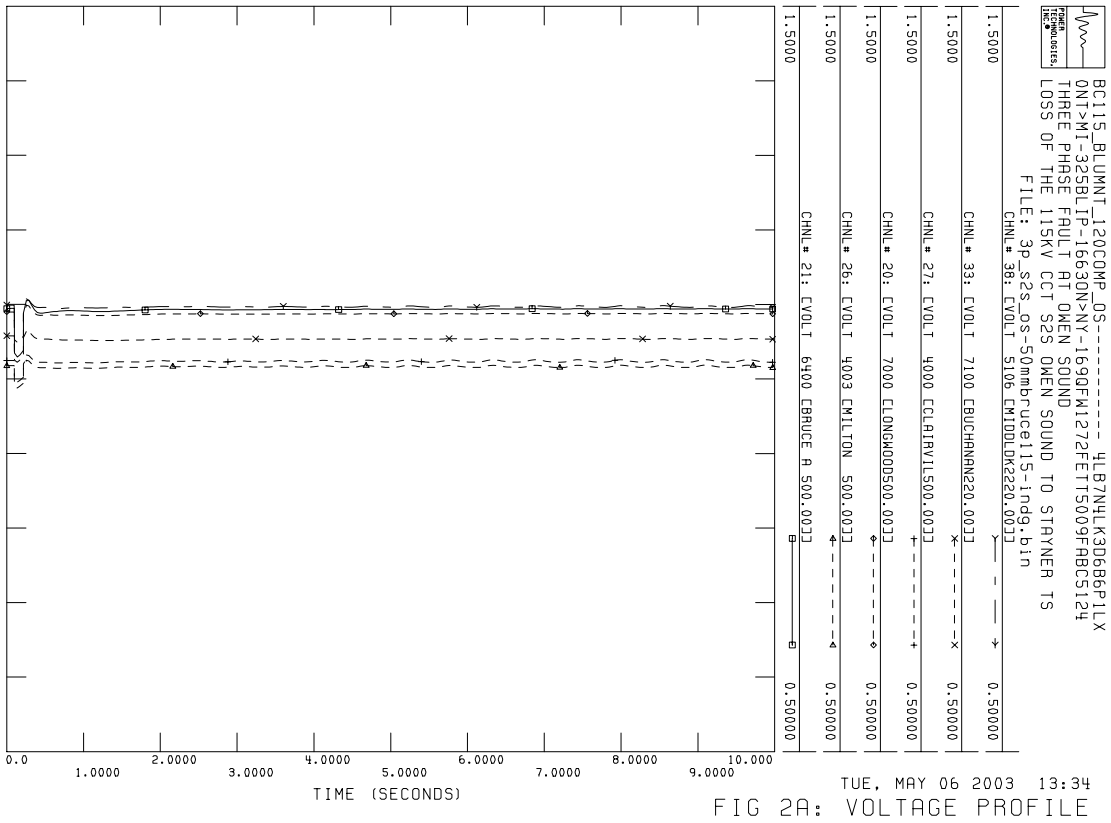

FIG 2A: VOLTAGE PROFILE

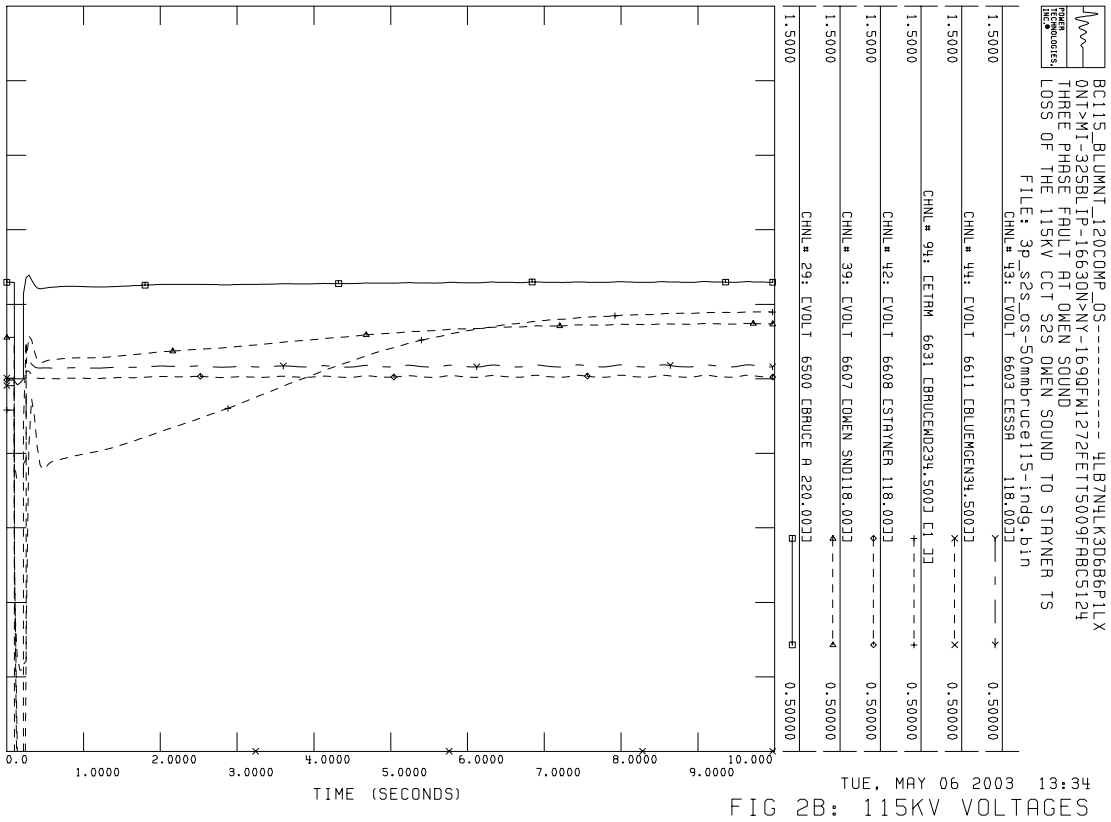

FIG 2B: 115KV VOLTAGES

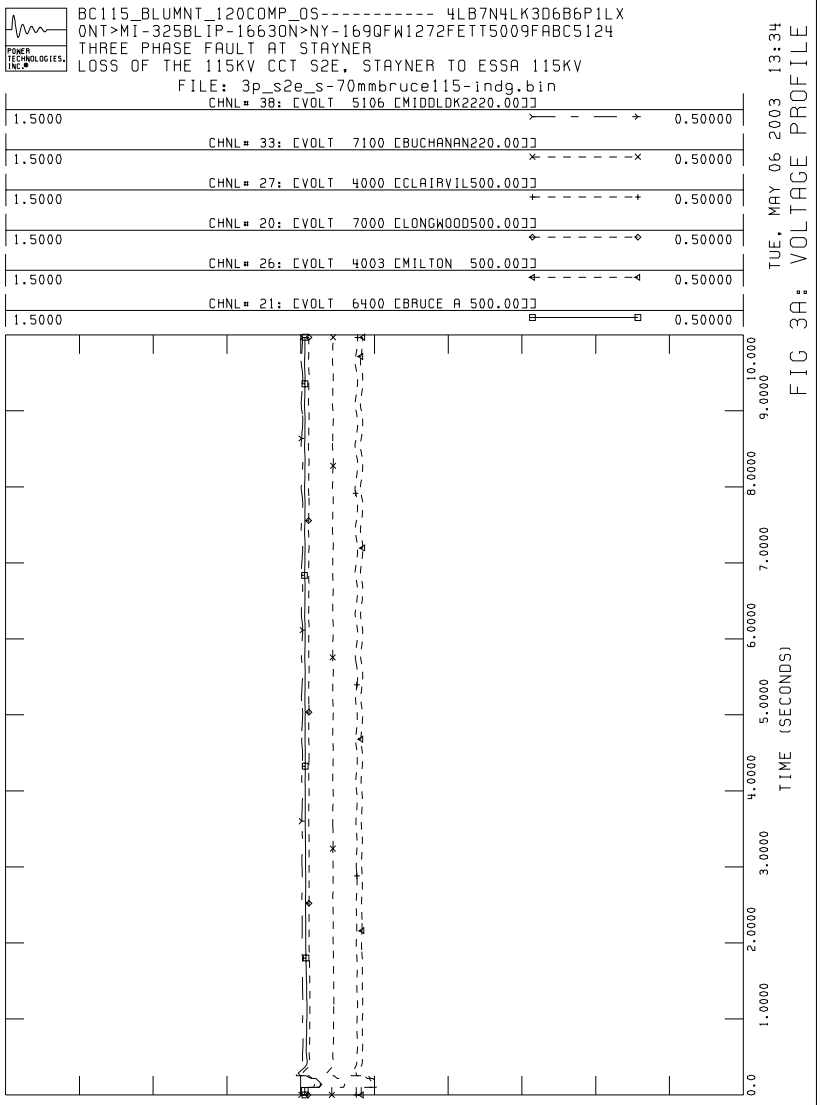
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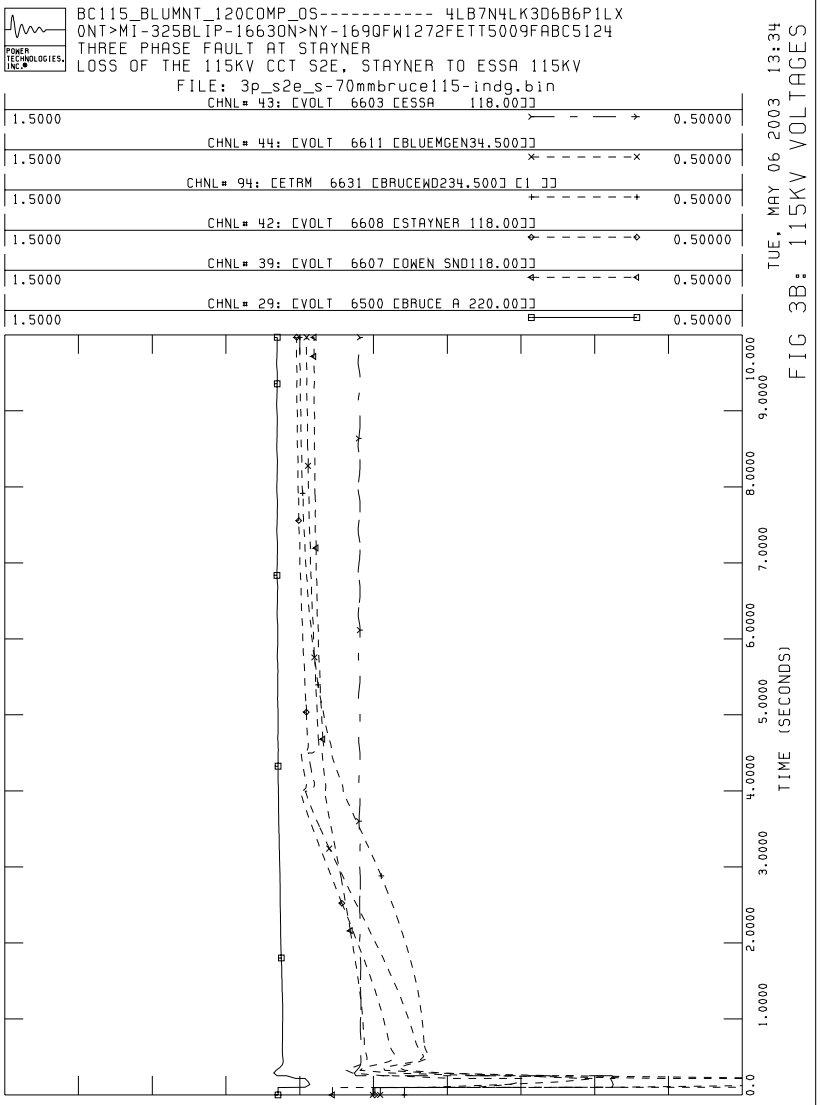
FIG 3A: VOLTAGE PROFILE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LOSS OF THE 115KV CCT S2E, STAYNER TO ESSA 115KV
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FIG 3B: 115KV VOLTAGES

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TWO CCT LINE-LINE-TO-GROUND FAULT AT WILLOW CREEK JUNCTION
LOSS OF TWO 500 KV CCTS B562L/B563L BRUCE TO LONGWOOD TS
FILE: llg_b-l_wcj_rej0-50bruce115-indg.bin

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CHNL# 33: [VOLT 7100 [BUCHANAN220.00]]
CHNL# 27: [VOLT 4000 [CLAIRVIL500.00]]
CHNL# 20: [VOLT 7000 [LONGWOOD500.00]]
CHNL# 26: [VOLT 4003 [MILTON 500.00]]
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FIG 4A: VOLTAGE PROFILE

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LOSS OF TWO 500 KV CCTS B562L/B563L BRUCE TO LONGWOOD TS
FILE: llg_b-l_wcj_rej0-50bruce115-indg.bin

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FIG 4B: 115KV VOLTAGES

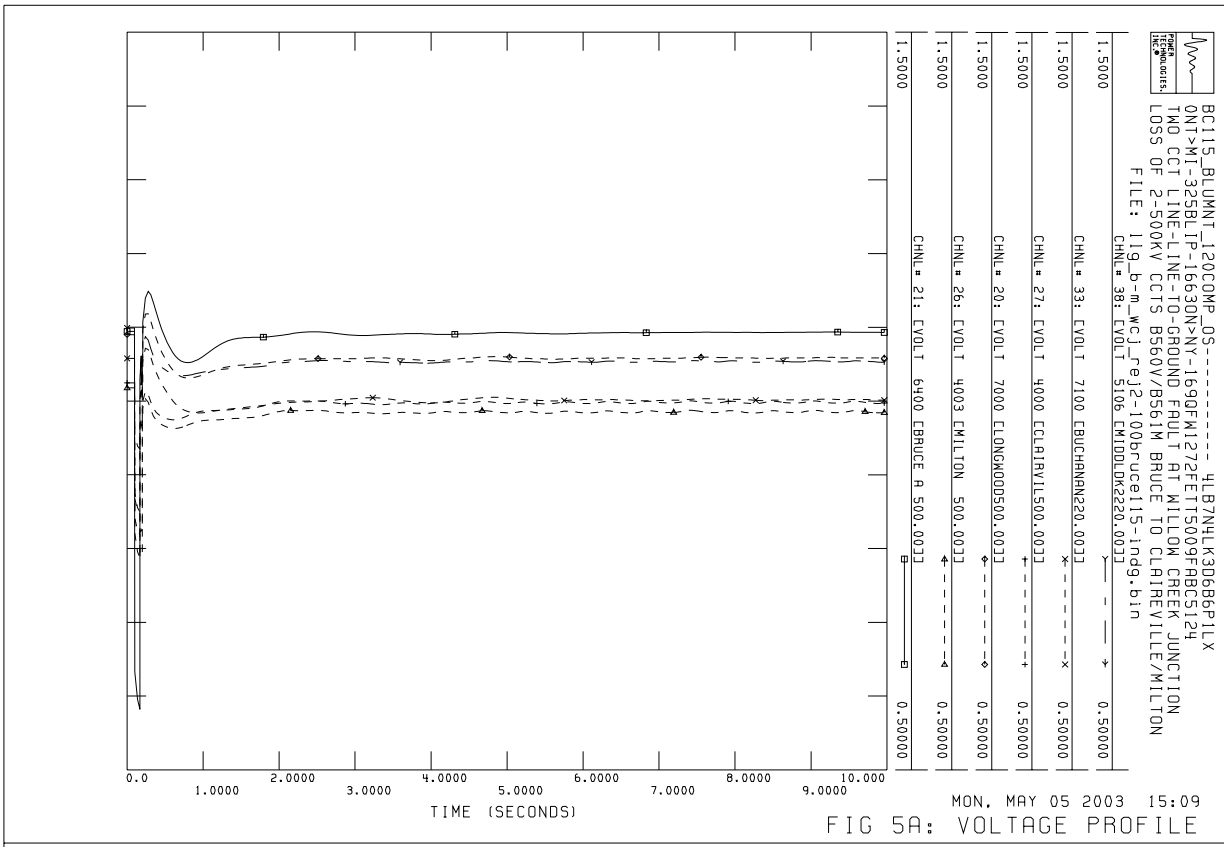

FIG 5A: VOLTAGE PROFILE

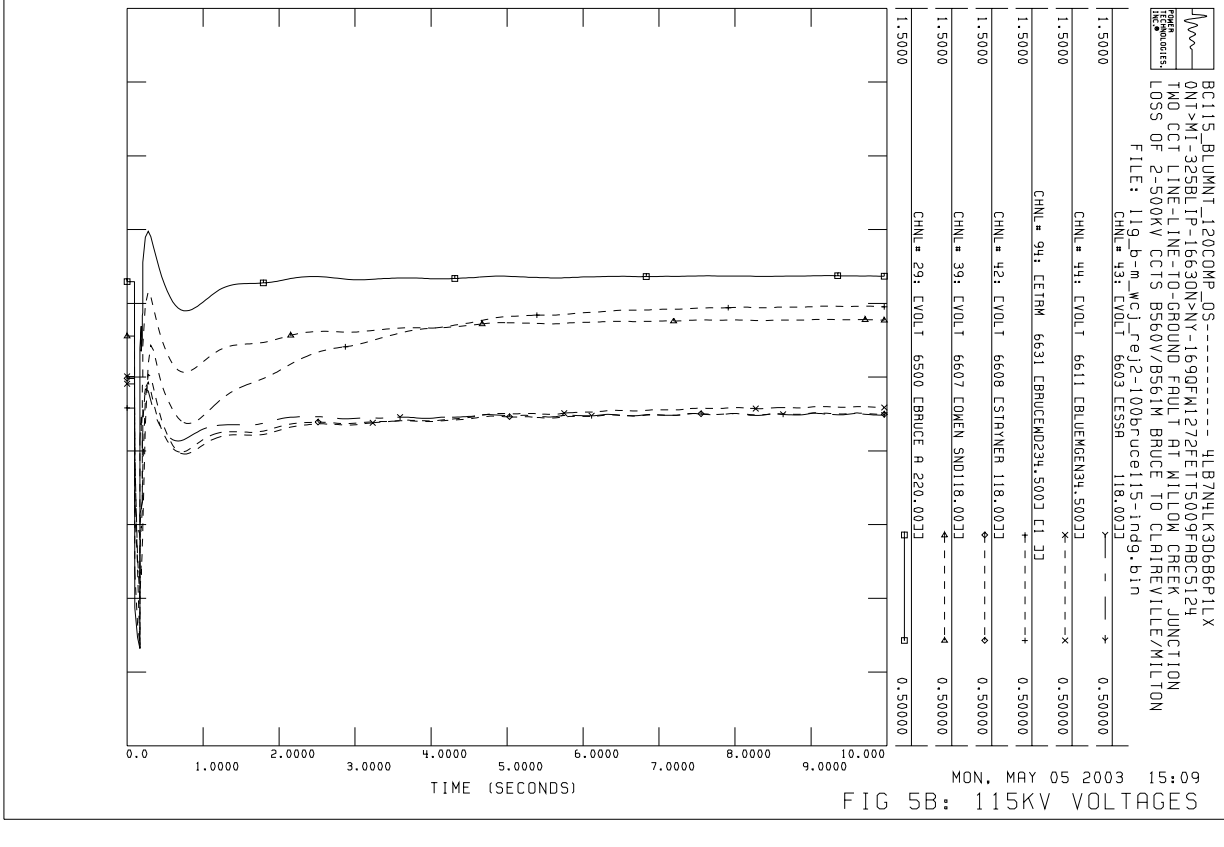

FIG 5B: 115KV VOLTAGES

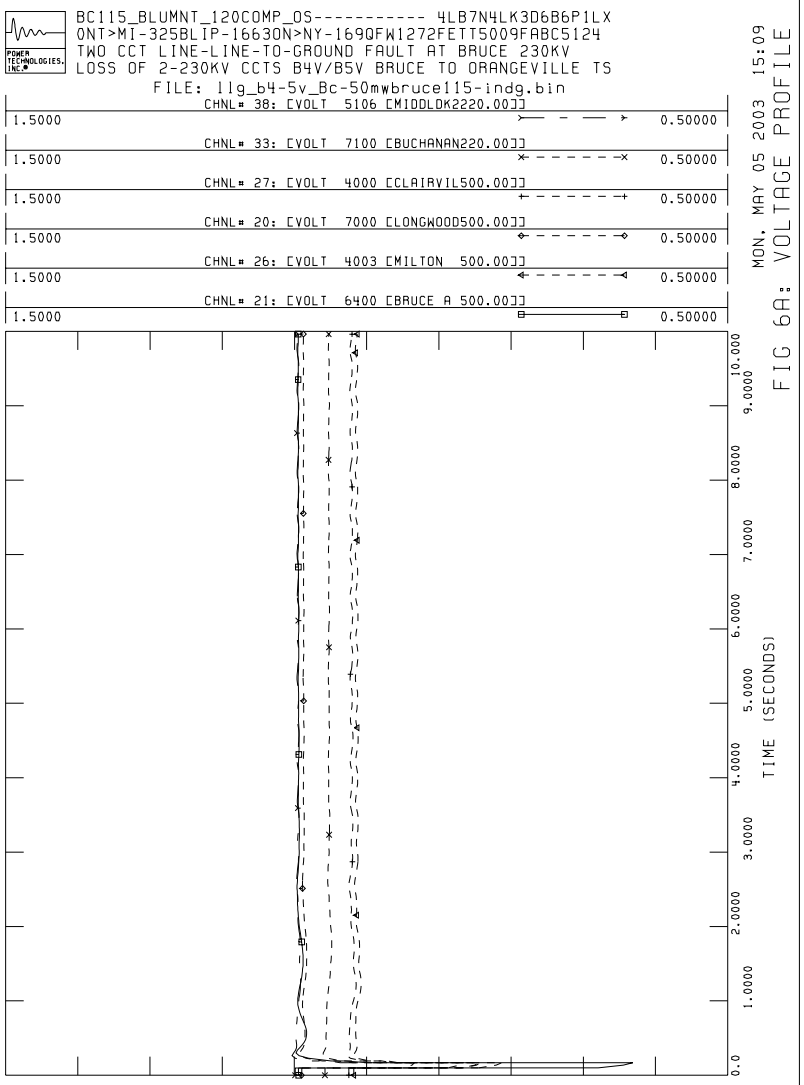
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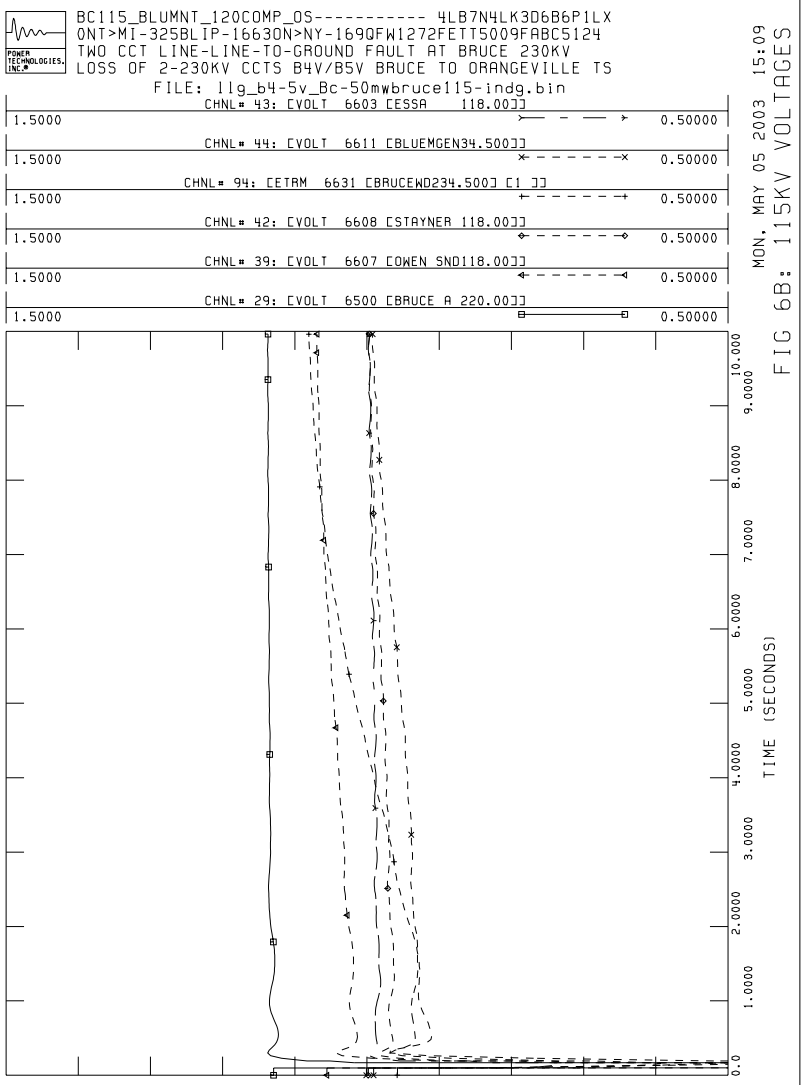
FIG 6A: VOLTAGE PROFILE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LOSS OF 2-230KV CCTS B4V/B5V BRUCE TO ORANGEVILLE TS
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MON, MAY 05 2003 15:09
FIG 6B: 115KV VOLTAGES

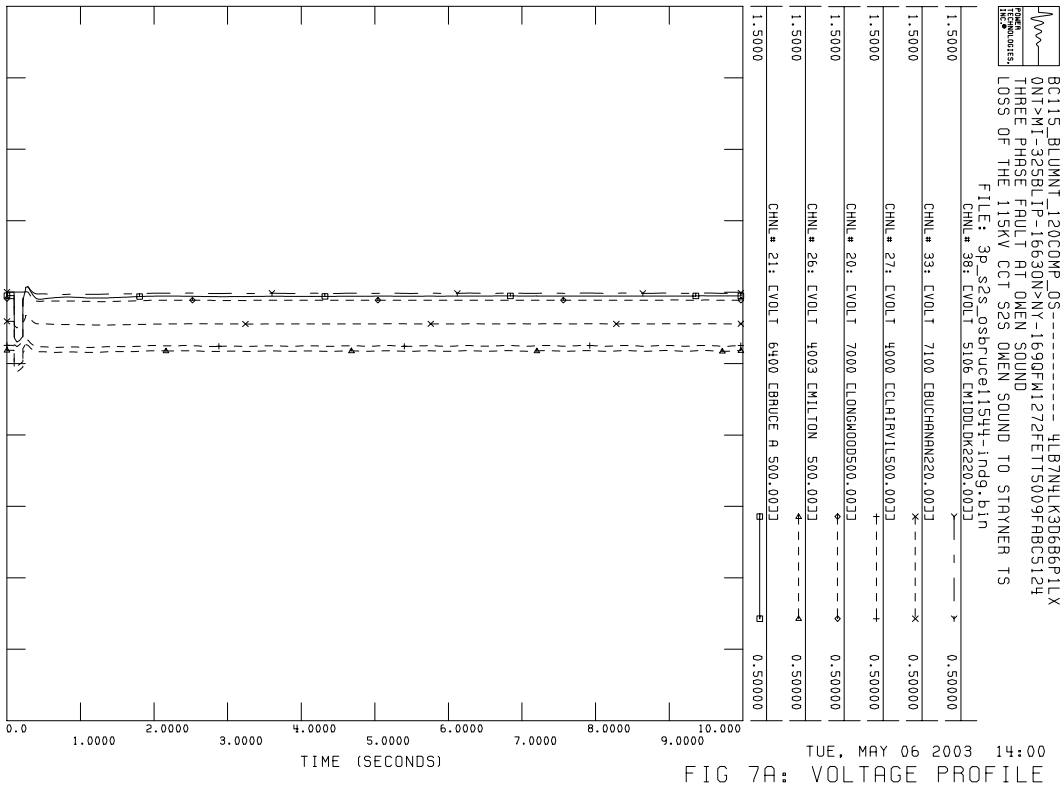


FIG 7A: VOLTAGE PROFILE

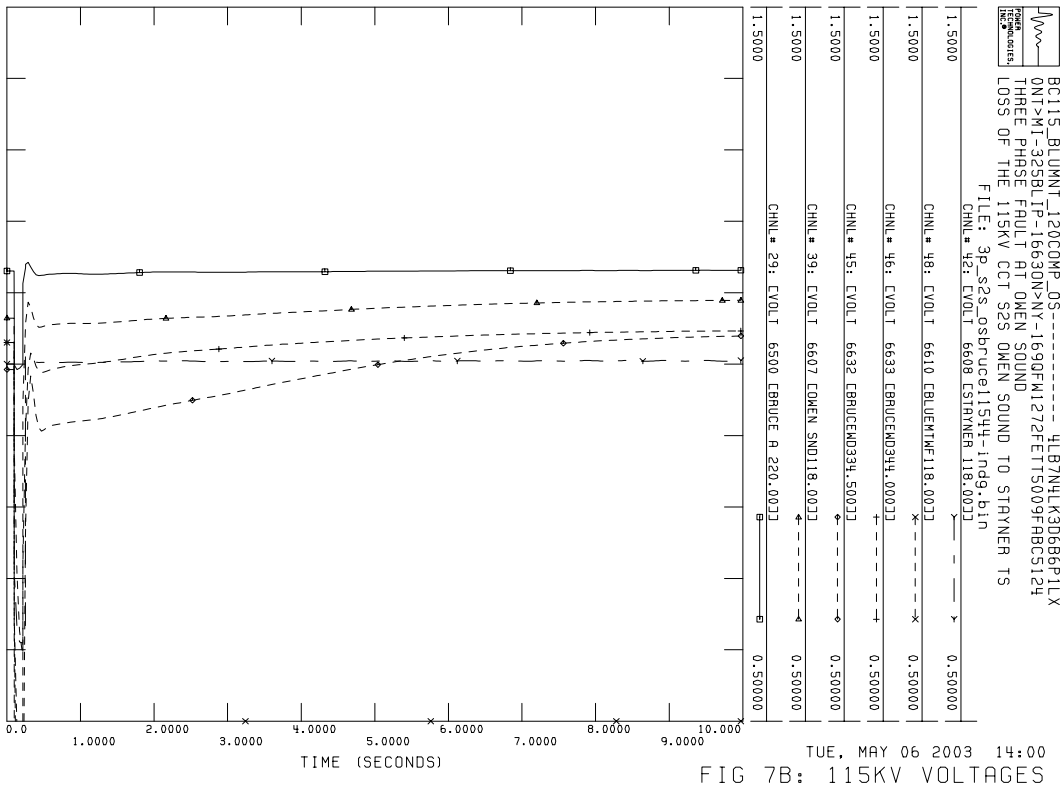
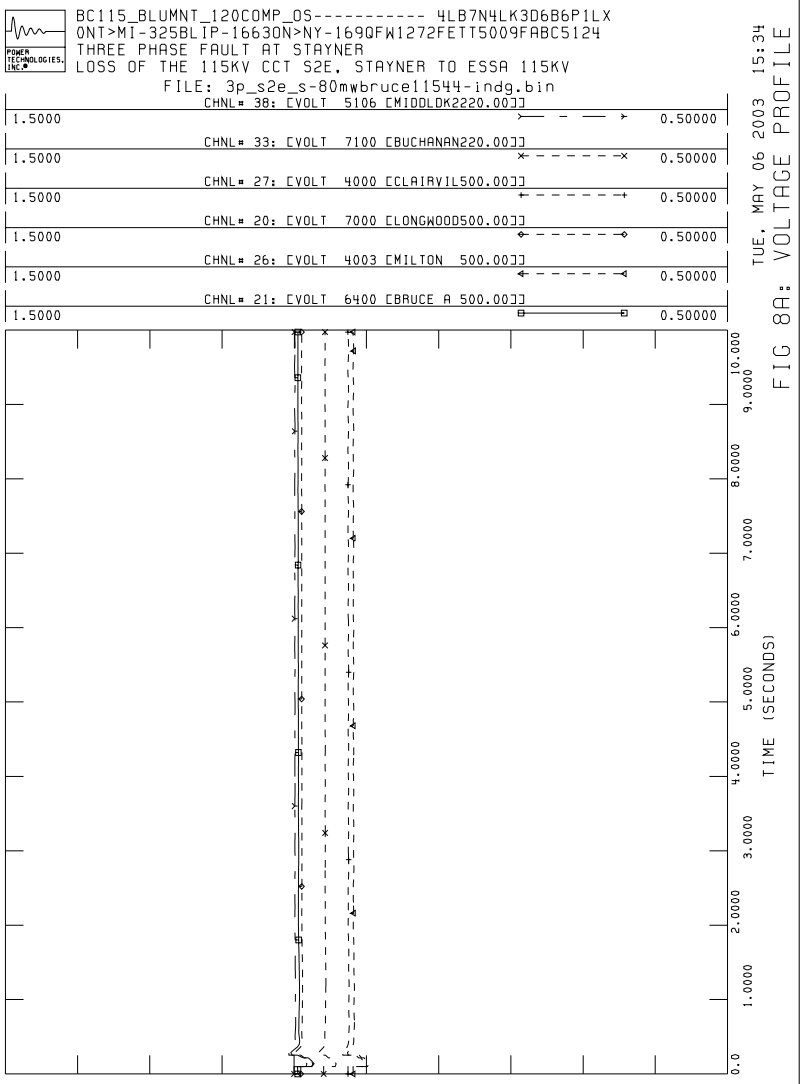
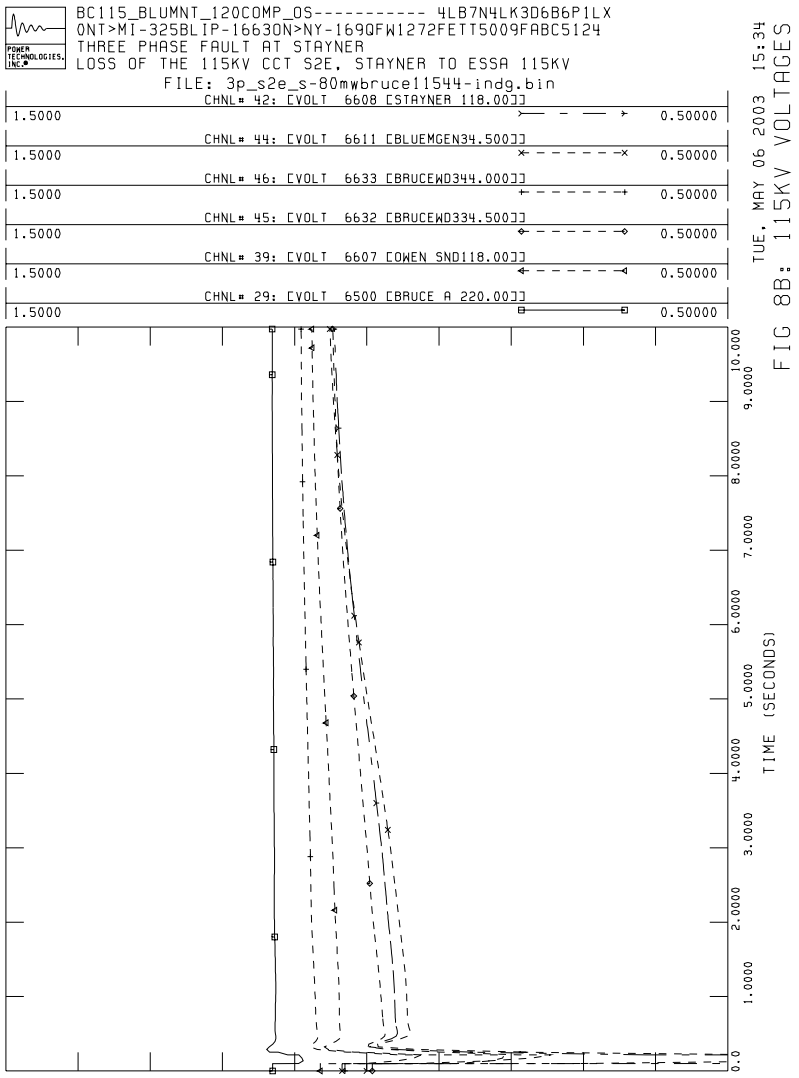


FIG 7B: 115KV VOLTAGES


BC115_BLUMNT_120COMP_OS---------- 4LB7N4LK3D6B6P1LX
ONT>MI-325BLIP-16630N>NY-169QFW1272FETT5009FABC5124
THREE PHASE FAULT AT STAYNER
LOSS OF THE 115KV CCT S2E, STAYNER TO ESSA 115KV
FILE: 3p_s2e_s-80mwbruce11544-indg.bin
CHNL# 38: CVOLT 5106 CMIDDLDK2220.00]]
CHNL# 33: CVOLT 7100 CBUCHANAN220.00]]
CHNL# 27: CVOLT 4000 CCLAIRVIL500.00]]
CHNL# 20: CVOLT 7000 CLONGWOOD500.00]]
CHNL# 26: CVOLT 4003 CMILTON 500.00]]
CHNL# 21: CVOLT 6400 CBRUCE A 500.00]]
1.5000
0.50000
0.0
1.0000
2.0000
3.0000
4.0000
5.0000
6.0000
7.0000
8.0000
9.0000
10.000
TIME (SECONDS)
TUE, MAY 06 2003 15:34
FIG 8A: VOLTAGE PROFILE


BC115_BLUMNT_120COMP_OS---------- 4LB7N4LK3D6B6P1LX
ONT>MI-325BLIP-16630N>NY-169QFW1272FETT5009FABC5124
THREE PHASE FAULT AT STAYNER
LOSS OF THE 115KV CCT S2E, STAYNER TO ESSA 115KV
FILE: 3p_s2e_s-80mwbruce11544-indg.bin
CHNL# 42: CVOLT 6608 CSTAYNER 118.00]]
CHNL# 44: CVOLT 6611 CBLUEMGEN34.500]]
CHNL# 46: CVOLT 6633 CBRUCEWD344.000]]
CHNL# 45: CVOLT 6632 CBRUCEWD334.500]]
CHNL# 39: CVOLT 6607 COWEN SND118.00]]
CHNL# 29: CVOLT 6500 CBRUCE A 220.00]]
1.5000
0.50000
0.0
1.0000
2.0000
3.0000
4.0000
5.0000
6.0000
7.0000
8.0000
9.0000
10.000
TIME (SECONDS)
TUE, MAY 06 2003 15:34
FIG 8B: 115KV VOLTAGES

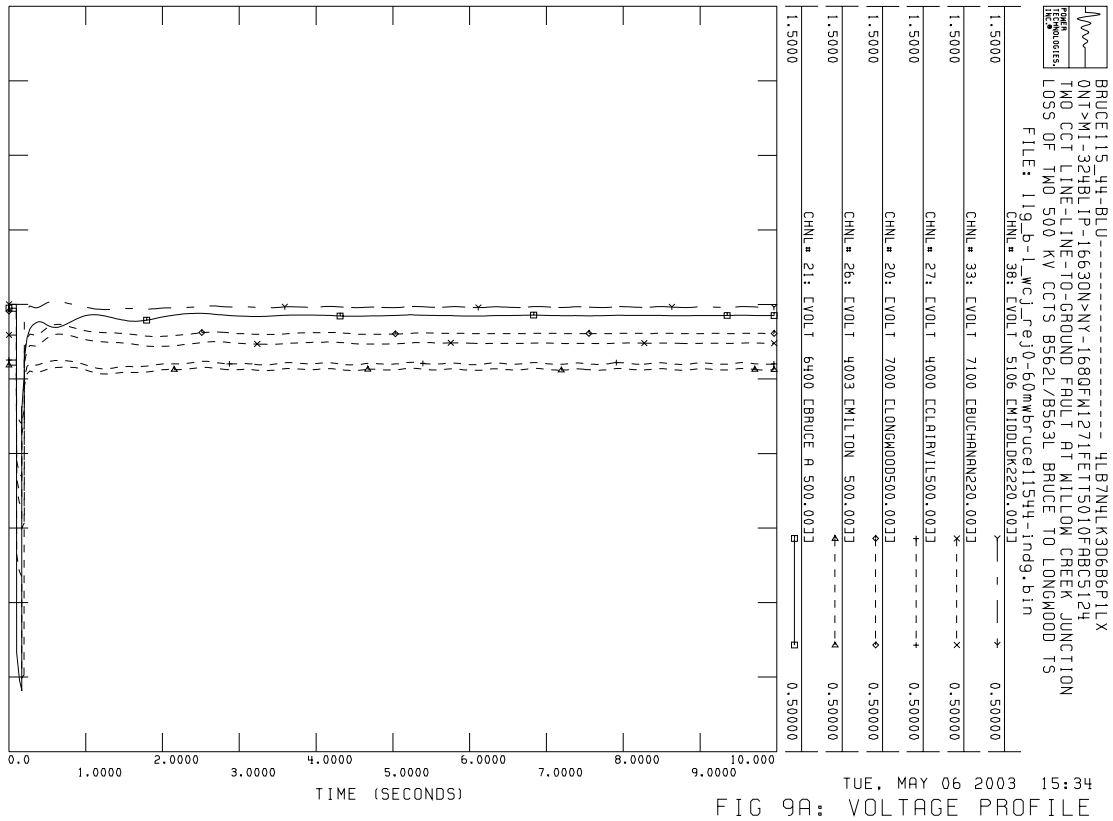


FIG 9A: VOLTAGE PROFILE

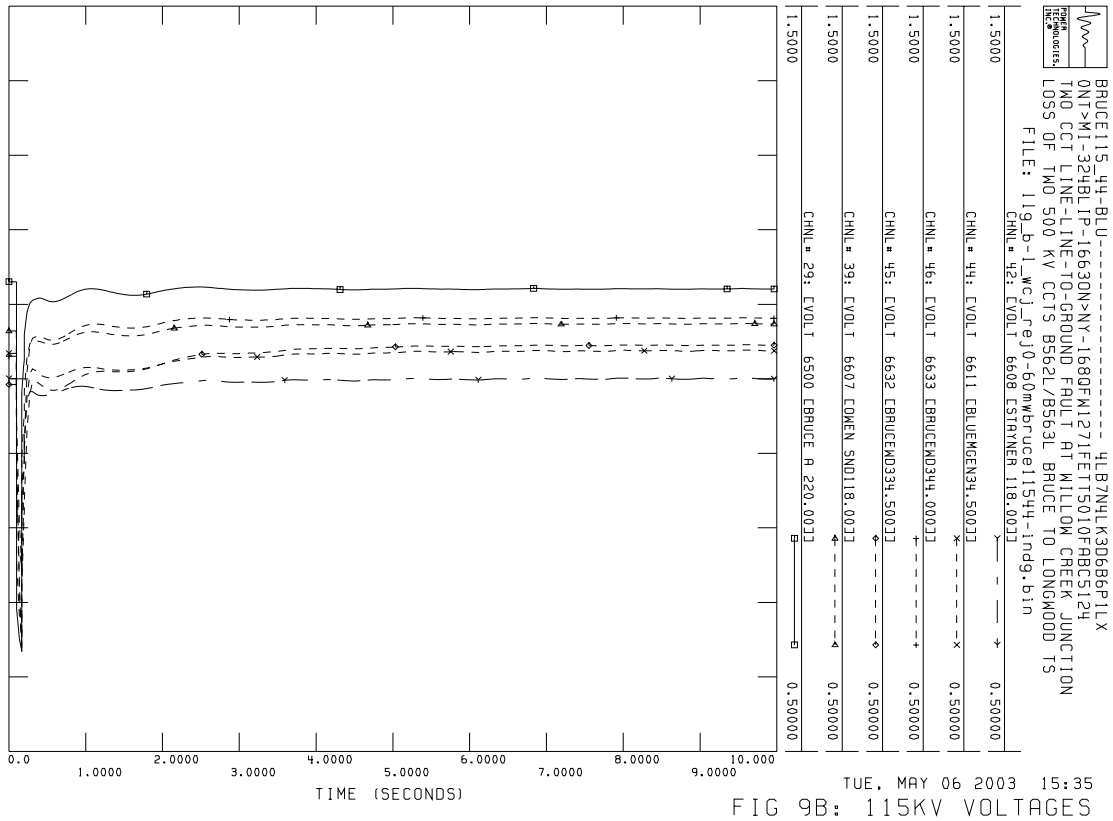


FIG 9B: 115KV VOLTAGES

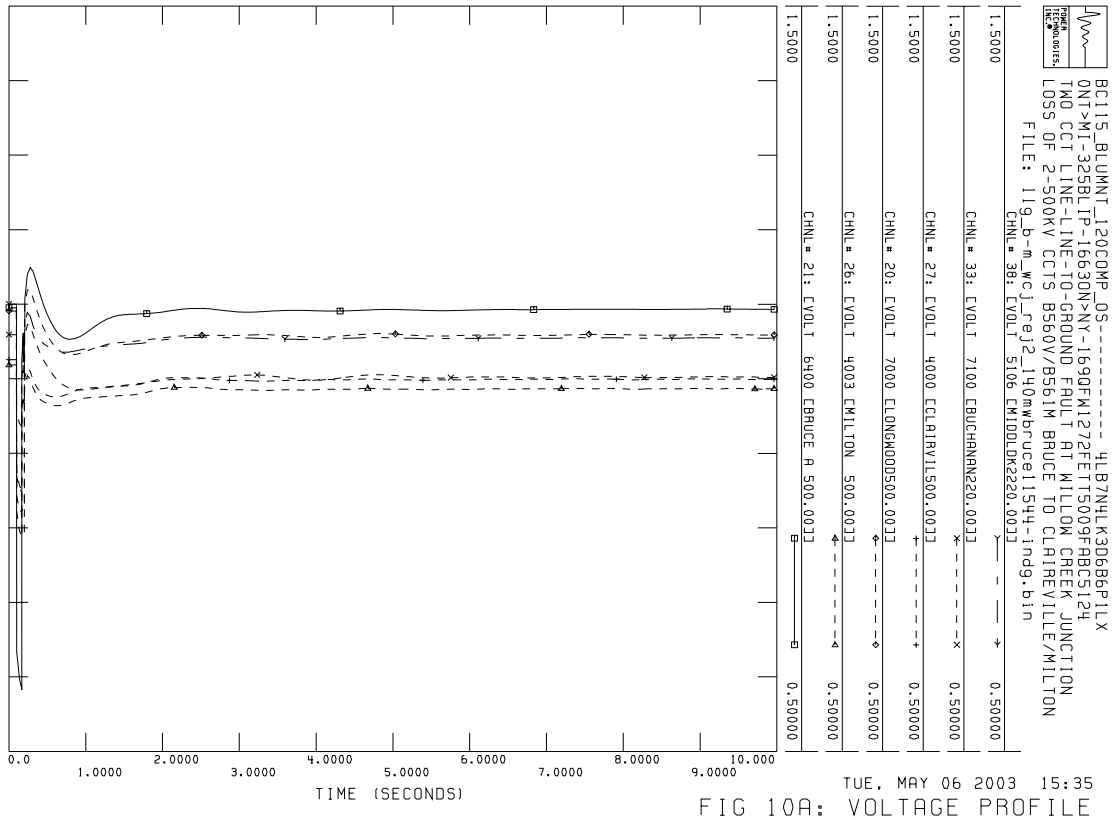


FIG 10A: VOLTAGE PROFILE

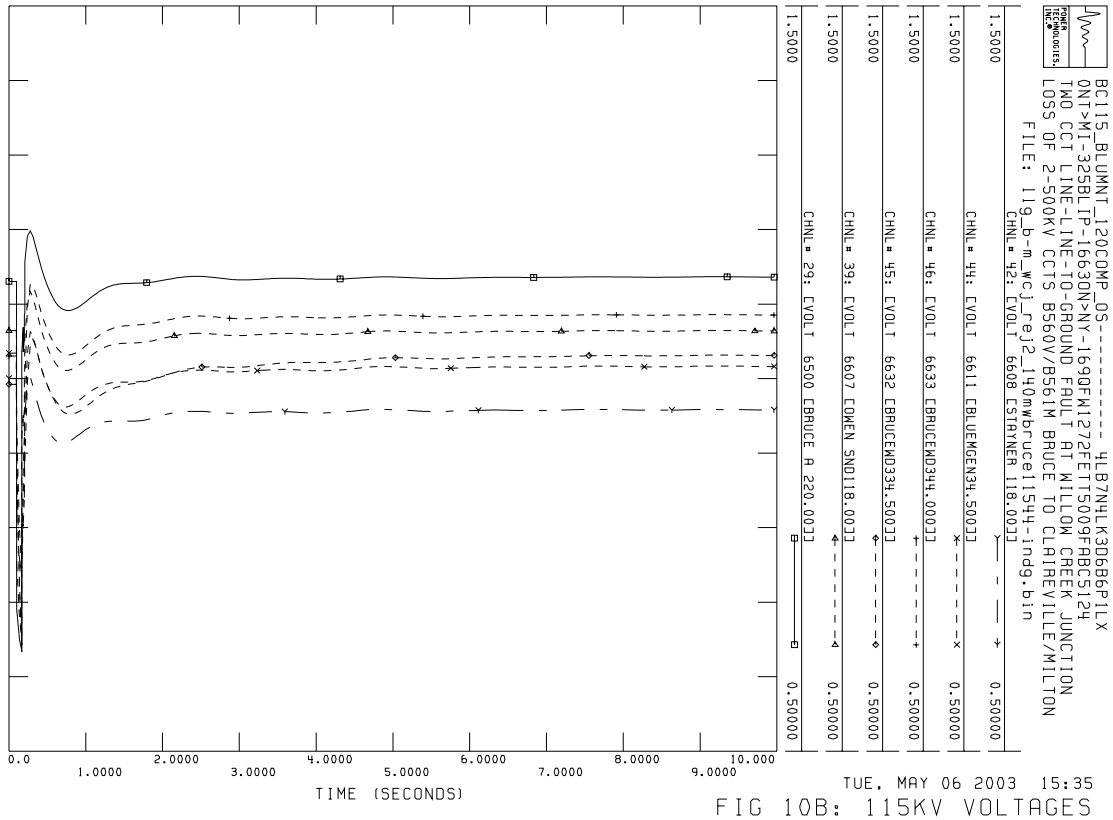


FIG 10B: 115KV VOLTAGES

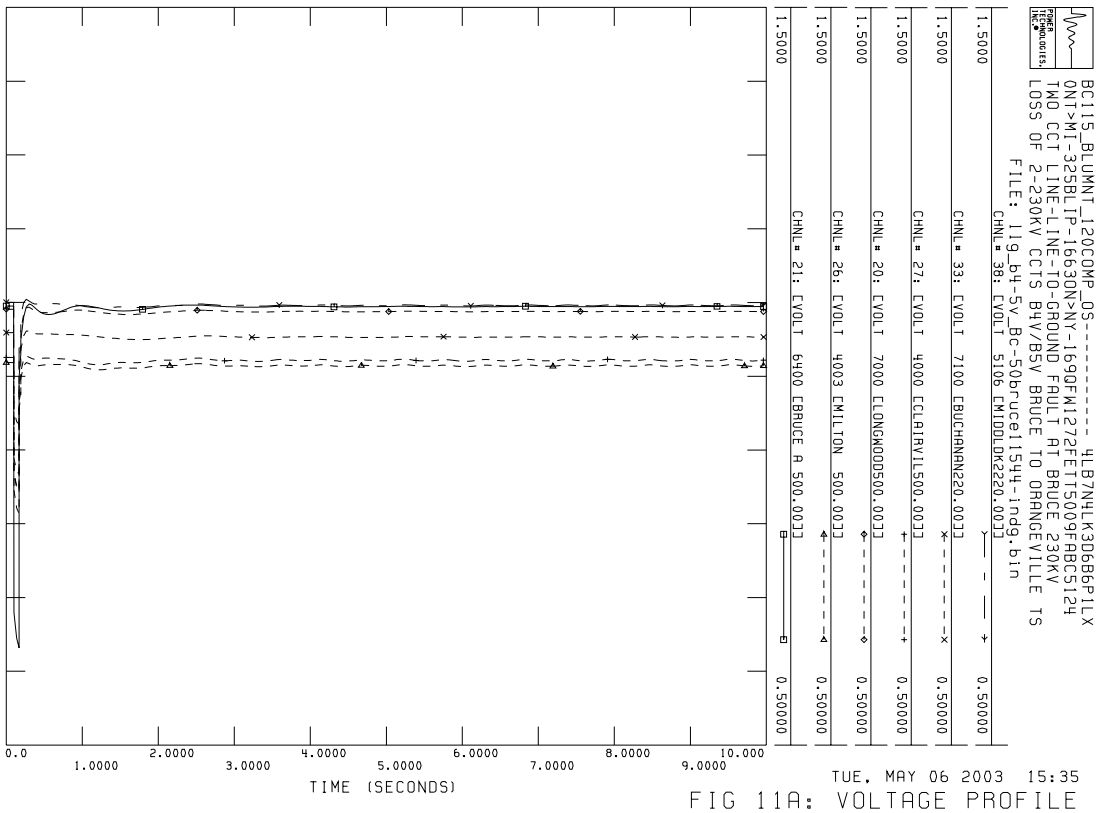


FIG 11A: VOLTAGE PROFILE

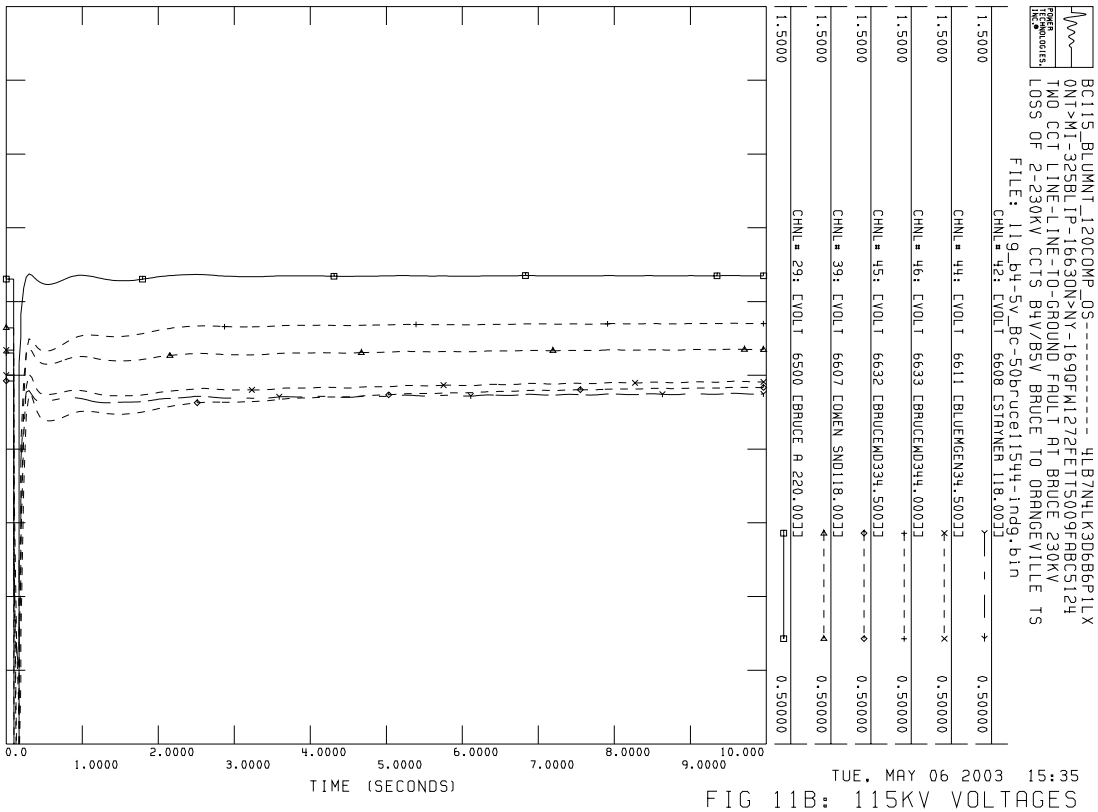


FIG 11B: 115KV VOLTAGES

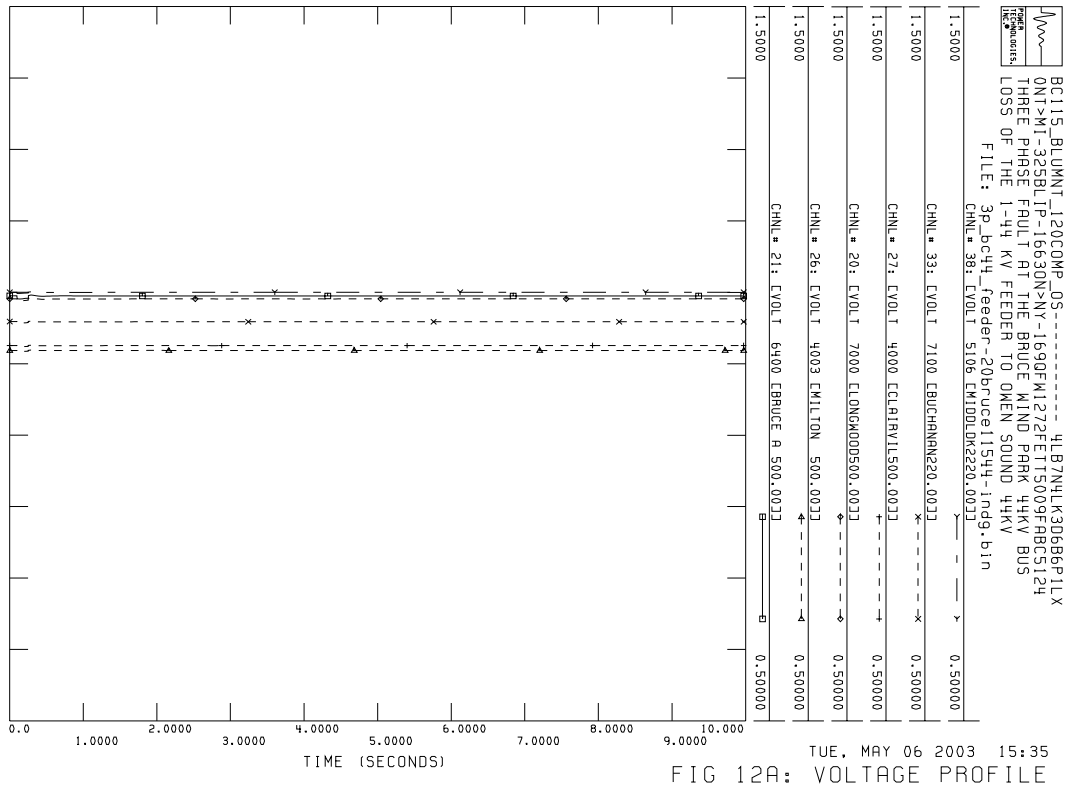


FIG 12A: VOLTAGE PROFILE

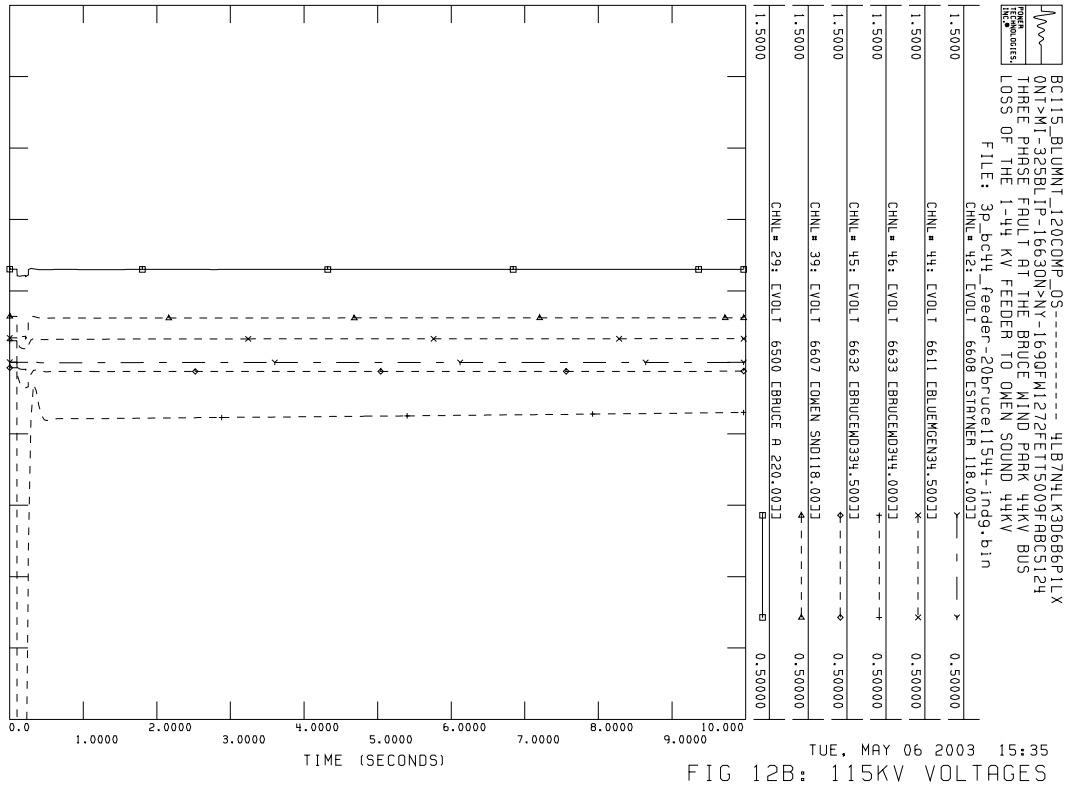


FIG 12B: 115KV VOLTAGES

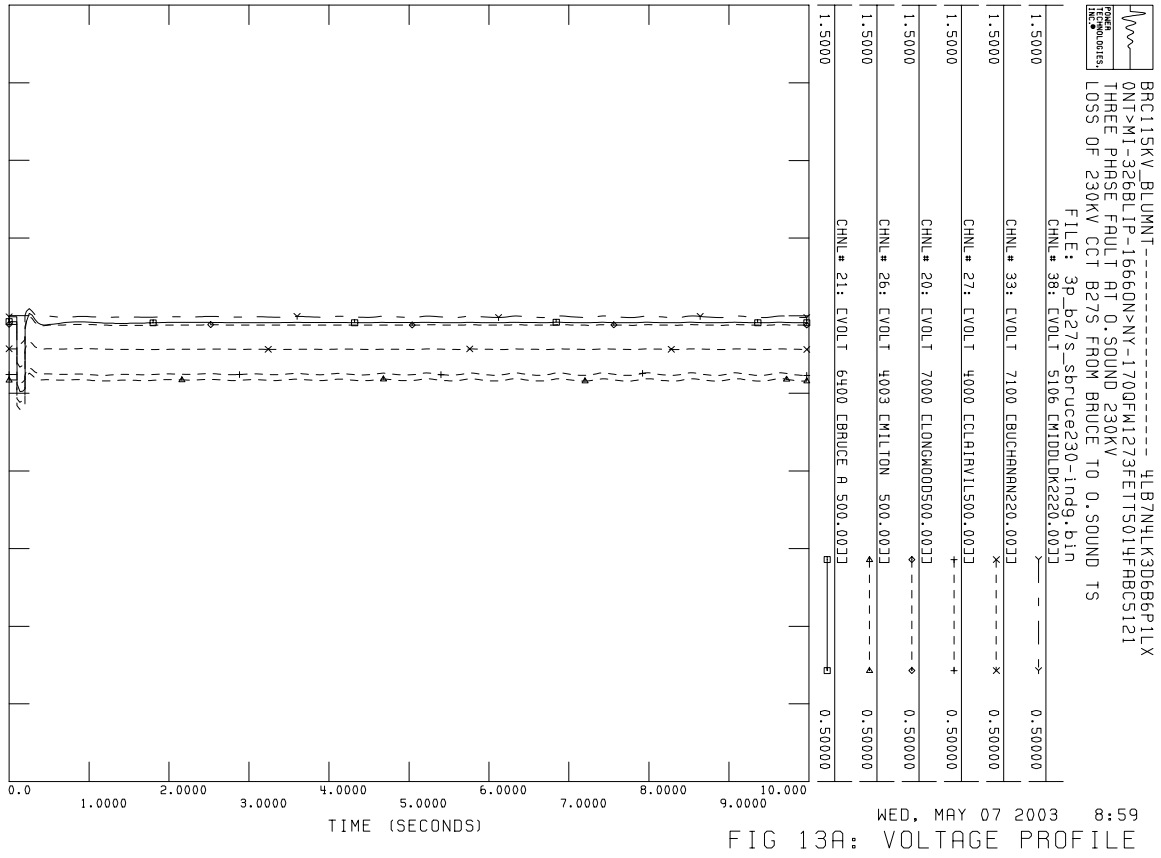


FIG 13A: VOLTAGE PROFILE

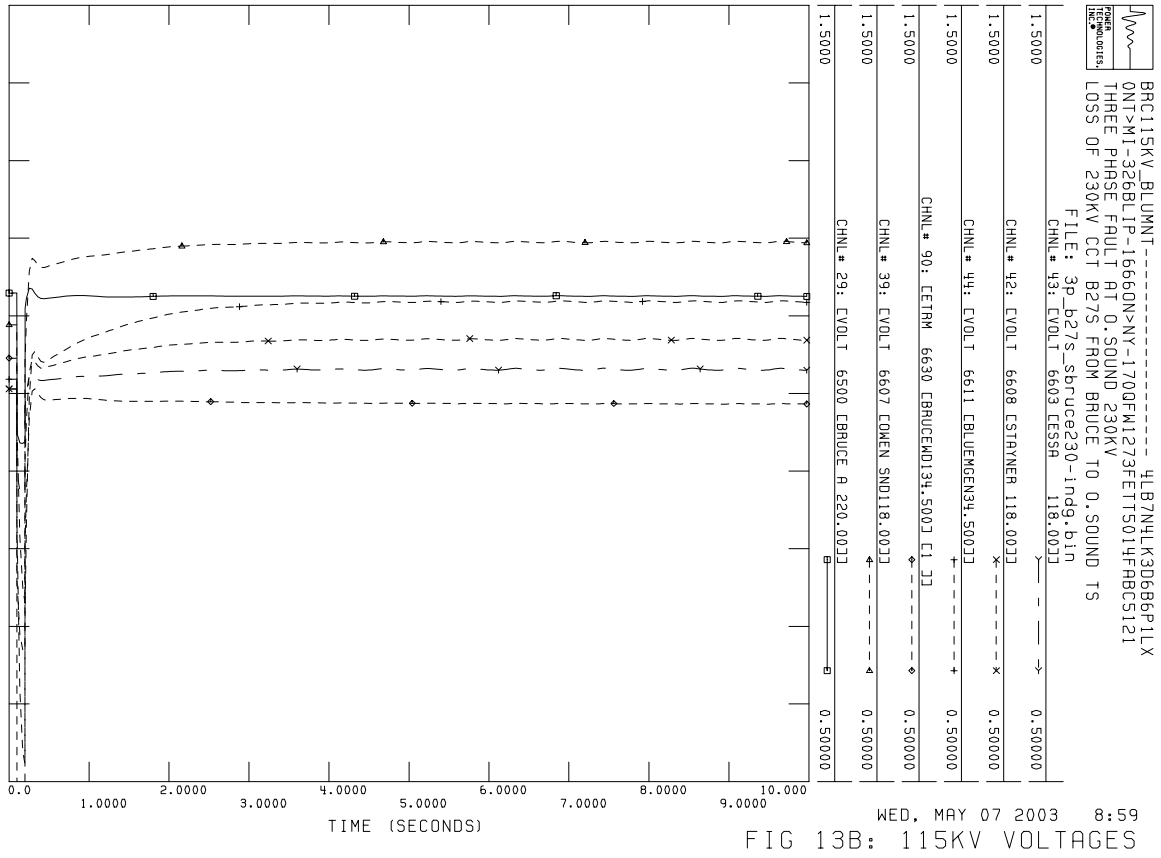


FIG 13B: 115KV VOLTAGES

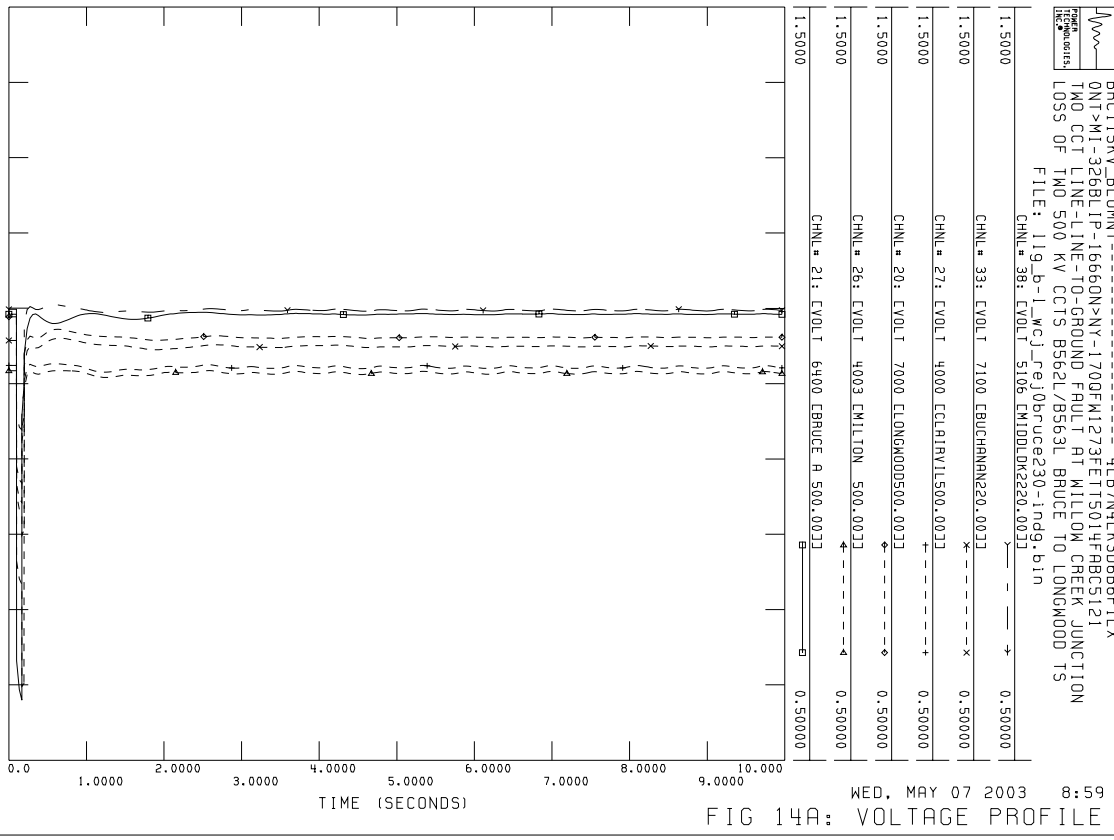


FIG 14A: VOLTAGE PROFILE

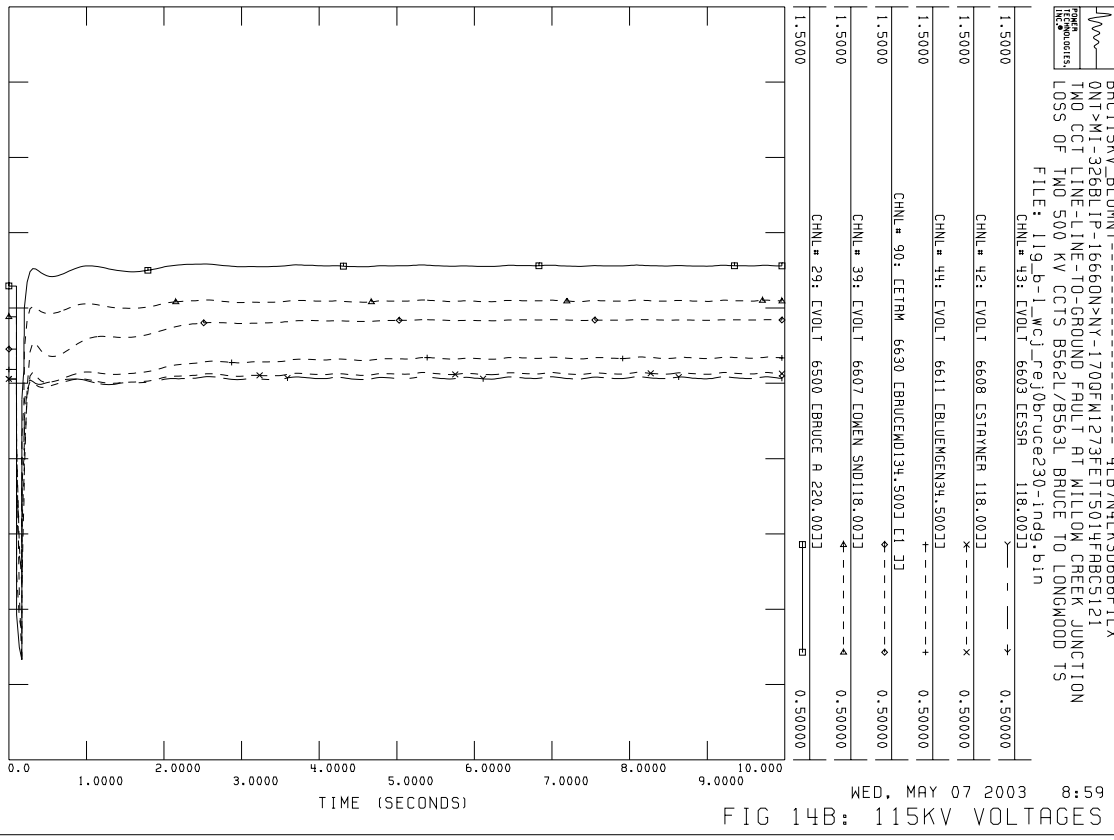


FIG 14B: 115KV VOLTAGES

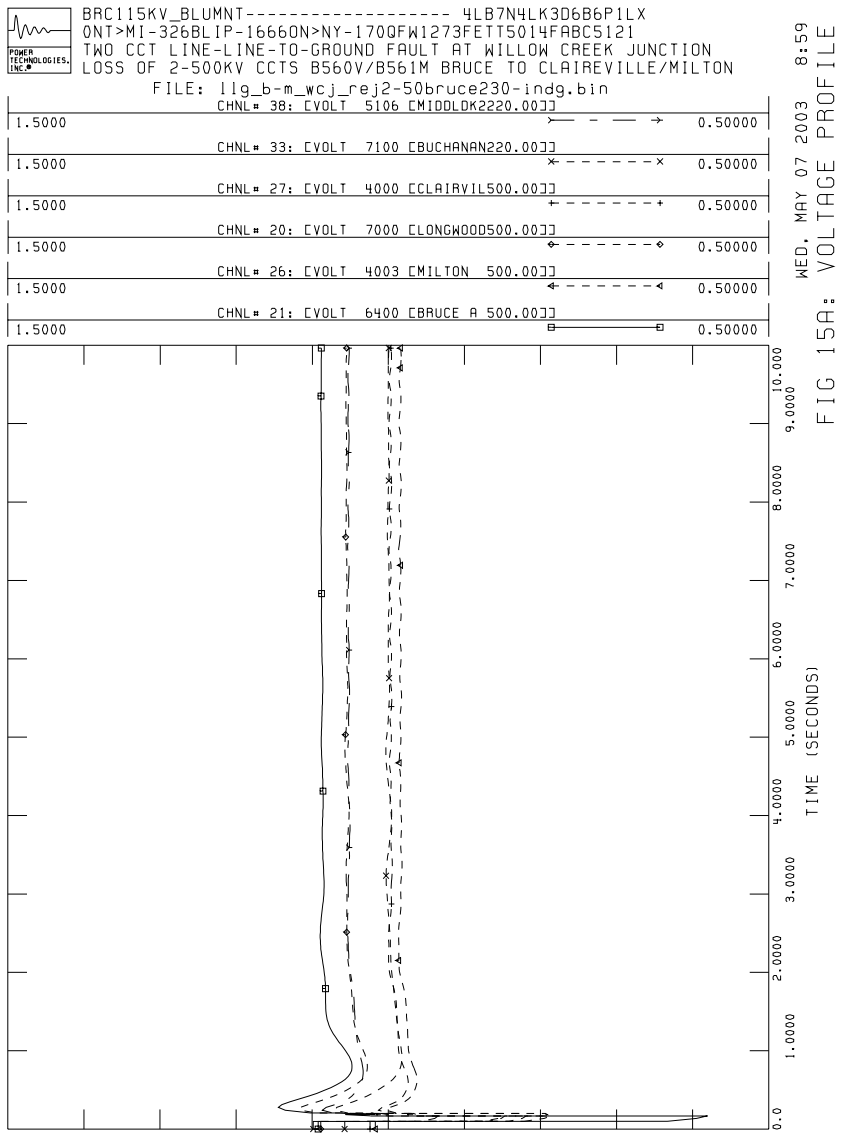


FIG 15A: VOLTAGE PROFILE

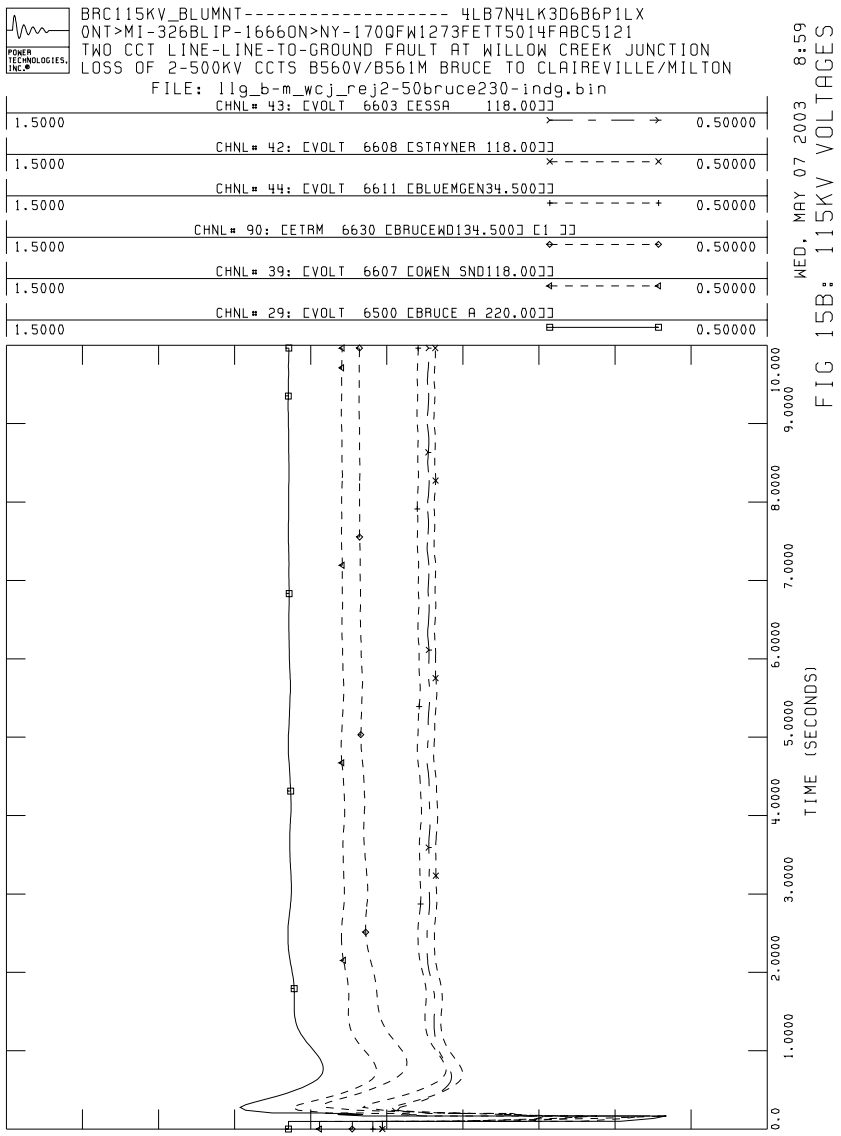


FIG 15B: 115KV VOLTAGES