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CONNECTION ASSESSMENT & APPROVAL PROCESS

Preliminary Assessment Report
Prince Wind Park

Applicant: Superior Wind Energy Inc.

CAA ID 2002-076

Final Report

Long Term Forecasts & Assessments Department & Consistent Information Department

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Preliminary Assessment Report

Prince Wind Park

Acknowledgement

The IMO wished to acknowledge the assistance of Great Lakes Power Limited (GLPL) 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.

Great Lakes Power Limited– Transmission Division

The results reported in this preliminary feasibility study are based on the information available to GLP, at the time of the study, suitable for a preliminary assessment of this transmission system reinforcement proposal.

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

This study does not assess the short circuit or thermal loading impact of the proposed facilities on load and generation customers.

In this preliminary feasibility study, short circuit adequacy is assessed only for GLP breakers. The short circuit results are only for the purpose of assessing the capabilities of existing GLP breakers and identifying upgrades required to incorporate the proposed facilities. These results should not be used in the design and engineering of any new or existing facilities. The necessary data will be provided by GLP and discussed with any connection proponent upon request.

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

The additional facilities or upgrades which are required to incorporate the proposed facilities have been identified to the extent permitted by a preliminary assessment under the current IMO Connection Assessment and Approval process. Additional facility studies may be necessary to confirm constructability and the time required for construction. Further studies at more advanced stages of the project development may identify additional facilities that need to be provided or that require upgrading.

Connection Assessment Report

Executive Summary

Project Description

This preliminary assessment has been conducted to examine the effect on system reliability of the Superior Wind Energy Inc. proposed 200 MW wind turbine generation development in the Sault St. Marie area. The proposed facility is to be developed in two stages of 100 MW each and connected to the 115 kV bus at Third Line TS in the Great Lake Power transmission system via a 5 km line tap.

Originally, the project commissioning was scheduled to commence in Q2-2004 with full commercial operation starting in Q3-2004. A revised in service date was not yet provided by the connection applicant.

This assessment of this project was carried out via the Expedited CAA process, whereby a System Impact Assessment was not required and the Preliminary Assessment covered all the issues associated with the new proposal.

The IMO has completed a connection assessment for the redevelopment and reinforcement of the Great Lakes Power transmission system. This project is of significance for Prince Wind Park development because it involves major modifications and improvements to the transmission system where this development will be connected.

Assessment Conclusions

This Connection Assessment concluded:

1. Subject to meeting all IMO's requirements listed in section 12, the 200 MW Prince Wind Park generation development will not have an adverse impact on the reliability of the IMO-controlled grid.

2. The proposed generation development will likely act as a load displacement resource at Third Line TS and result in a reduction in flow over Third Line TS transformers.

3. For situations of high power flows Eastbound over the EW and Mississagi interfaces the new development could contribute to power congestion over these interfaces.

4. If GLPL transmission reinforcement Option 1 is implemented then the addition of the 200 MW wind turbine development will result in short circuit levels at MacKay TS which exceed the interrupting capability of the existing breakers.

5. If GLPL transmission reinforcement Option 3 is implemented then the increases in fault level, due to the proposed 200 MW generation, will not exceed the interrupting capabilities of the existing breakers and the new breakers that will be incorporated as part of the GLPL transmission reinforcement project.

6. The loss of 100 MW of the wind turbine generation will result in a post-contingency voltage decline of less than 10% thus meeting IMO's voltage decline criteria.

7. The loss of 200 MW the wind turbine generation will result in a post-contingency voltage decline larger than 10%, which exceeds IMO's voltage decline criteria.

8. For GLPL transmission reinforcement Option 1 and conditions of peak load, generation and high flows Eastbound on the EW interface, a contingency associated with Third Line transformer results in unacceptably slow recovery of the 115 kV system voltages.

9. For GLPL transmission reinforcement Option 3 all studied contingencies resulted in stable and well damped system oscillation.

IMO Requirements

The IMO identified the measures required to mitigate the impact on reliability of the 200 MW Prince Wind Park facility as follows:

1. To incorporate 200 MW of generation at 115 kV assuming all other transmission 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 Prince Wind Park for the loss of the double 230 kV circuit A23/24P and other contingencies if so determined by the IMO in future operating studies.

    - Incorporate each 100 MW wind turbine generation group via a dedicated 115 kV line connection into Third Line TS and provide all the necessary station equipment.

2. Should GLPL implement Option 1 for their transmission reinforcement plan, then Superior Wind Energy Inc. is required to initiate, with GLPL, a detailed short circuit studies to determine the impact of their generation project on the existing station breakers. If the studies indicate that the interrupting capability of some of the breakers is exceeded then Superior Wind Energy Inc. is required to replace these breakers.

3. Superior Wind Energy Inc. is required to provide a source of dynamic reactive power at their Prince Wind Park generation development site to meet the Market Rules requirements for induction generators with respect to reactive power capability.

4. Superior Wind Energy Inc. is required to provide adequate reactive power to compensate for the reactive consumption on the 34.5/115 kV and the dedicated connection line(s). This can be achieved with low impedance transformers and provision of reactive power devices, in a combination that is economic and subject to IMO's approval.

5. Meet all the transmitter's requirements with respect to the installation of protection systems and the required reviews and/or modifications of the existing protection systems.

6. Upon deciding on a specific technology for 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.

- If the specific model of wind turbine generators is equipped with ac-dc-ac voltage source converters or equivalent equipment, then Superior Wind Energy Inc. must provide evidence to the IMO that the facility will not have an adverse impact, including sub-synchronous resonance interaction, on the IMO-controlled grid or existing generating facilities. 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.

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

8. Superior Wind Energy Inc. is required to initiate as soon as possible a Customer Impact Assessment (CIA) with the transmitter to determine the impact of new generation connection on existing Transmission Customers. The detailed CIA study will be carried out by GLPL.

9. 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

Superior Wind Energy Inc. is to obtain cost estimates of the following from Great Lakes Power Limited – Transmission Division for the incorporation of the proposed 200 MW Prince Wind Park.

- All the modifications that are require to be made at Third Line TS to accommodate the incorporation of each 100 MW of wind turbine generation.

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

Identification of "Sole Beneficiary"

Section 9.1.3 of the Transmission System Code sates:

"The cost of modifications and upgrades on specific network facilities that are triggered by and for the sole benefit of the generator shall be borne by the generator."

The facilities that are triggered by and deemed to be for the sole benefit of this project have been identified as follows:

- All the modifications that are require to be made at Third Line TS to accommodate the incorporation of each 100 MW of wind turbine generation.

- The two 5 km 115 kV line taps that will connect each 100 MW wind turbine generators group into Third Line TS.

- The connectivity-based Special Protection System to reject the appropriate amount of wind turbine generation under certain system contingencies.

- The breaker replacements required to adequately accommodate the increase in short circuit levels due to the additional generation in case that GLPL decides to implement Option 1 for their transmission reinforcement plan.

Notification of Approval

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

Preliminary Assessment Report

Superior Wind Energy Inc. – Prince Wind Park

1.0 Background

Superior Wind Energy Inc. has submitted a connection application for the development of up to 200 MW wind generation facility in the Sault St. Marie area. The proposed facility is to be developed in two stages of 100 MW each and connected to the 115 kV bus at Third Line TS in the Great Lake Power transmission system via a 5 km line tap. This connection could be achieved via a new line or via one of the existing Sault 115 kV lines.

Originally, the project commissioning was scheduled to commence in Q2-2004 with full commercial operation starting in Q3-2004. A revised in service date was not yet provided by the connection applicant.

This proposed project will undergo an Expedited CAA process, whereby a System Impact Assessment is not required and the Preliminary Assessment will cover all the issues associated with the new proposal.

The IMO has completed a connection assessment for the redevelopment and reinforcement of the Great Lakes Power transmission system. This project is of significance for Prince Wind Park because it involves major modifications and improvements to the transmission system where this development will be connected.

2.0 Data Verification

The connection applicant has been considering different wind turbine manufacturers for the Prince Wind development. The technical specifications for the two technologies are slightly different and will be mentioned throughout the report.

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.

3.0 Connection Arrangement

Wind Park Configuration

Each individual wind turbine is equipped with a 575/34.5 kV (690/34.5 kV) step-up transformer rated for 1.75 MVA (1.85 MVA). The local step-up transformer is to be connected delta on the HV side and wye on the LV side (wye on the HV side and wye on the LV side).

As mentioned above the wind generation will be developed in two stages of 100 MW each. Each stage will constitute of sixty-seven 1.5 MW wind turbines arranged in ten groups of six turbines each and one group of seven turbines. Each of the eleven wind turbine groups is connected via a

34.5 kV breaker to a common 34.5 kV bus. The connection to the 115 kV line is provided via one 115/34.5 kV transformer bank, a 115 kV breaker and a disconnect switch. Figure 1 shows the proposed arrangement for the 100 MW wind park.

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. The main 115/44 kV step up transformer winding configuration will be delta on the LV side and wye on the HV side; this meets the code requirements.

Superior Wind Energy Inc. is advised to seek approval from GLPL with respect to winding configuration and grounding requirements if the proposed connection arrangement is different than the standard.

Thermal Ratings Methodology

The IMO and Hydro One have agreed to use the following criteria for determining the thermal ratings for the transmission facilities to which wind turbine generating projects are connected:

- For transmission facilities within 50 km radius of the wind turbine project the thermal ratings are to be determined using a wind speed of 15 km/hr instead of the normal 4 km/hr value.

  This is intended to recognize that the wind turbine is able to deliver its maximum power for wind speeds higher than or equal to 15 km/hr.

- For those transmission facilities whose loadings are directly affected by the output of the wind turbine project, their continuous ratings will be determined using a maximum conductor operating temperature of 127^0C, or the individual sag temperature if it is lower, instead of the normal value of 93^0C (or its sag temperature, if lower).

  This relaxed criteria is intended to recognize the wide variation in the output of wind turbine projects and the expectation that none of the projects would deliver full output for more than50 hours per year while the temperature is at 30^0C. This criterion is to be applied only the transmission facilities (line tap) that connect the wind turbine project to the system.

GLPL will be consulted to ensure that they are in agreement with these principles.

Wind Park System Incorporation

The proposed connection point of the wind generation to the Great Lakes Power system at Third Line TS is shown in Figure 2. This configuration assumed that the preferred option for transmission reinforcement that was proposed by GLPL and approved by the IMO would be completed by the time the wind generation development is to be commissioned. The wind farm is to be incorporated via a 5 km line tap which is to connect to the Third Line 115 kV switchyard. After the implementation of the GLPL transmission reinforcement the 115 kV switchyard at Third Line will have three spare breaker positions where the new generation could be connected.

It is recommended that the wind generation be connected on the same diameter as the Sault No.3 115 kV circuit. A spare 115 kV breaker (i.e.482) could be used to complete this diameter, which would be equipped with only two breakers upon completion of the transmission reinforcement.

The wind generation could be incorporated via a new 115 kV circuit (Option A) or alternatively via one of the exiting Sault 115 kV circuits (Option B).

Option A

The new circuit could be installed on new tower structures or, with the transmitter's agreement, could be strung on the same structures with Sault No.3 circuit. With respect to the rating on the new line, Superior Wind Energy Inc. has two options:

Option A1

Based on the voltage decline study results (section 9.5) this option has proven to be unacceptable.

The first option is to build, at the same time with the first stage of 100 MW wind generation, transmission facilities with sufficient capability to accommodate also the second 100 MW wind development. In this case the following facilities are required:

- a new 115 kV circuit of about 5 km that could be installed on a new structure or double up with the new Sault No.3 circuit (IMO has no preference) with a thermal continuous capability of 225 MVA at 30C and 15 km/hr wind,
- one 34.5/115 kV, 225 MVA transformer,
- one 115 kV breaker for installation at Third Line 115 kV switchyard

Option A2

The second option is to incorporate each wind generation project stage of 100 MW via dedicated transmission facilities. In this case ***each stage will require the following facilities***:

- a new 115 kV circuit of about 5 km that could be installed on a new structure or double up with the new Sault No.3 circuit (IMO has no preference) with a thermal continuous capability of 112 MVA at 30C and 15 km/hr wind
- one 34.5/115 kV, 112 MVA transformer,
- one 115 kV breaker for installation at Third Line 115 kV switchyard

Option B

The incorporation via one of the existing 115 kV Sault circuits has to be closely coordinated with GLPL. GLPL transmission reinforcement plan includes the complete removal of No.1 Sault and No.2 Sault circuits and structures to make room for the new 230 kV corridor. If Superior Wind Inc. considers this option and comes to an agreement with GLPL then the transmitter will have to factor in their transmission reinforcement plan the preservation of the 115 kV structure and circuit.

The summer thermal rating of the exiting 115 kV circuits is listed in Table B.

Table B. Sault Circuits Summer Ratings

Wind Speed (km/h)	Thermal Rating @ 30^{0}C (A, MVA @ 113 kV)		Maximum Wind Farm Output (MW)	
	No.1 Sault	No.2 Sault	Stage 1	Stage 2
5	*387, 76*	*331, 65*	*9 MW*	*18 MW*
10	*479, 94*	*400, 78*	*79 MW*	*158 MW*
15	*544, 103*	*453, 89*	*100 MW*	*200 MW*

If GLPL and Superior Wind Inc. agree on retaining and use one of the existing 115 kV Sault circuits for the incorporation of the Prince Wind Park development then:

- No.1 Sault 115 kV circuit must be retained because it is the higher rated circuit and will accommodate the full output of the first stage of the wind turbine generation project and
- Superior Wind Inc. will have to construct a separate 115 kV circuit for the incorporation of the second stage of the generation project.

4.0 Market Rules Requirements for Generation Facilities

Appendix 4.2 of the Market Rules lists all the requirements that the generation facilities must meet for connecting to the IMO–controlled grid.

With respect to the reactive capability "induction generation facilities shall be supported by power corrective equipment designed to raise the equivalent power factor of the unit to 90% lagging at rated output."

With respect to voltage variations "generation facilities shall be capable to operated continuously at full output within $\pm$5% of the generating facility's rated terminal voltage."
With respect to frequency variations "generation facilities shall be capable to operate continuously at full power in the range between 60.6 to 59.4 Hz."

The wind turbine generators and the associated equipment must remain connected to the IMO-controlled grid for system disturbances or contingencies other than the transmission to which they are connected. This capability will be verified in the transient stability studies.

5.0 On-line Monitoring

The *Market Rules* (Appendix 4.15 and Appendix 4.19) list the IMO requirements with respect to the information that has to be monitored and available to the IMO on a continual basis from all generators connected to the IMO-controlled grid.

It is required that Superior Wind Energy Inc. install all the equipment needed to monitor the information required by the IMO on a continuous basis.

6.0 Protection Systems

With respect to the protection and telecommunication requirements, Superior Wind Energy Inc. will have to follow the Transmission System Code technical requirements for generating stations connecting to the IMO-controlled grid. It may be required that some of the existing protection settings be modified, and the new generator protections will have to be coordinated with the exiting schemes.

7.0 Fault Level Assessment

Great Lakes Power T&D, as part of their transmission redevelopment work performed short circuit studies to identify the impact of each transmission reinforcement option on the short circuit currents in the area.

The results of the short circuit studies are summarized in Table 1.

Option 1

The short circuit studies for *O*ption 1 were performed for a system with all existing elements in service without any assumed future developments. The results, tabulated in the first half of the table, show that some the line-to-ground short circuit levels at MacKay TS approach the interrupting capability of some of the breakers. It is expected that the addition of 200 Mw generation at Third Line TS will result in short circuit currents, which exceed these breakers interrupting capability. Since GLPL transmission reinforcement Option 1 is unlikely to be pursued, studies were not performed to identify the exact impact of the new wind turbine generation of the short circuit levels at MacKay TS.

10. Should GLPL implement Option 1 for their transmission reinforcement plan, then Superior Wind Energy Inc. is required to initiate, with GLPL, a detailed short circuit studies to determine the impact of their generation project on the existing station breakers. If the studies indicate that the interrupting capability of some of the breakers is exceeded then Superior Wind Energy Inc. is required to take on the replacement of these breakers.

Option 3

Since Option 3 involving significant transmission facilities was expected to provide opportunities for incorporation of future resources, additional short circuit studies were performed to assess the fault levels for an ultimate GLPL system configuration. The main purpose of this study was to ensure that the new 115 kV and 230 kV breakers selected for installation at Anjigami, MacKay and Third Line will be adequately rated for the *ultimate system* expansions. The *ultimate system* model used in this study included:

- All the Northwest system generation and transmission in service,
- All the Great Lakes Power generation in service, including the new High Falls GS
- Lake Superior Power GS in service,
- New 230 kV line between Wawa TS and Third Line TS, tapped at MacKay TS,
- Two 230/115 kV auto-transformers at MacKay TS,

- New 200 MW generation connected at MacKay 115 kV switchyard,
- Three 230/115 kV auto-transformers at Third Line TS,
- New 200 MW generation connected at Third Line 115 kV switchyard,
- New 300 MW generation connected at Third Line 230 kV switchyard,
- Third 230 kV line between Third Line TS and Mississagi TS,
- Third 230 kV line between Wawa TS and Marathon TS and
- One large fictitious generator connected at Mississagi TS.

The short circuit study results indicate that with the new 200 MW generation development at Third Line, the system short circuit currents are within the interrupting capability of the proposed new breakers and the existing breakers that are to be retained.

Table 1. Short Circuit Study Results

BUS kV	TOTAL FAULT CURRENT Symmetrical (kA)		Breaker Ratings (kA)
	3-phase fault	L-G	Symm.
OPTION 1			
Anjigami 115	*8.32*	*10.01*	**40 kA** (834,844,854,864) **7.5 kA** (814, 824)
MacKay 115 kV	*6.66*	*7.03*	**40 kA** (615,635,665) **10.5 kA** (638,648,658) **7.5 kA** (618,668,612,622,632,662)
Third Line 115 kV	*9.64*	*11.83*	**25 kA (All Existing)**
Third Line 230 kV	*4.08*	*4.68*	**31.5 kA** (510)
OPTION 3			
Anjigami 115	*7.54*	*9.26*	**40 kA** (834,844,854,864)
MacKay 115 kV	*5.93*	*6.58*	**40 kA** (615,635,665) **10.5 kA** (638) **7.5 kA** (618,668,632,662)
Third Line 115 kV	*9.44*	*11.81*	**25 kA (All Existing)**
Third Line 230 kV	*5.36*	*5.29*	**40 kA (All New)**
OPTION 3 –Ultimate System Configuration			
Anjigami 115	*8.38*	*10.1*	**40 kA**(834,844,854,864)
MacKay 115 kV	***12.45***	***11.02***	**40 kA** (615,635,665) **10.5 kA** (638) **7.5 kA** (618,668,632,662)
Third Line 115 kV	*20.12*	***25.11***	**25 kA (All Existing)**
Third Line 230 kV	*13.29*	*14.43*	**40 kA (All New)**

8.0 Assessment of Local Impact

The GLP system peak load is about 380 MW and the off peak load is about 300 MW. Most of this load is being supplied from Third Line 115 switchyard. Also, connected to Third Line TS are two generating stations with a total maximum capability of 175 MW.

Maximum Generation and Peak Load Conditions

With the new wind turbine generation at maximum, the total on-line generation connected to Third Line could be up to 375 MW, which would be sufficient to supply a peak load of 310 MW at Third Line. It is expected that 30 MW will be flowing over each Third Line transformer T1 and T2 towards the 230 kV switchyard.

Minimum Generation and Peak Load Conditions

Assuming that the wind turbine generation is on-line and the other two generators at Third Line are off, the supply of peak load at Third Line will result in a flow of about 55 MW over each Third Line transformer T1 and T2 towards the 115 kV system.

It can be concluded that the incorporation of the new wind turbine generation Third Line TS will not have an adverse impact on the local transmission system and during periods significant output will reduce the power flow over the Third Line autotransformers.

9.0 Assessment of Impact on System Reliability

This section covers a detailed analysis of the results of the power flows studies and transient stability studies that were performed to determine the impact that the proposed generation will have on the reliability of the IMO-controlled grid.

9.1 Study Assumptions

Based on the queue principles of the Connection Assessment and Approval process the impact of Prince Wind Park was assessed for a system which incorporates all existing facilities and all the connection projects that are ahead of the subject application in the queue. Hence, the system model used in this assessment included the Hydro One's two new shunt capacitors at Wawa TS and GLPL's transmission reinforcement plan (option 3). It is expected that by 2006 the transmission system between Wawa TS and Mississagi TS will include:

- Two 38.9 Mvar shunt capacitors,
- One new 230 kV circuit from Wawa to MacKay to Third Line, that will be connected to MacKay TS via one 115/230 kV auto-transformer,
- One additional 230 kV breaker at Wawa,
- A new 230 kV four breaker ring bus at MacKay TS,
- Upgraded No.3 Sault 115 kV circuit to 90 MVA,
- A new 230 kV switchyard at Third Line,

as it is shown in Figure 2.

The thermal rating of the new equipment and the equipment that will be affected by the proposed wind turbine generation is listed in Table 2.

Table 2. Thermal Ratings

Equipment/ Terminals	*Conductor (ACSR)*	*Continuous Rating* A/MVA*	*15 Minute LTR A/MVA*
230 kV P21G Third Line to Mississagi	864 kcmil	535 A 204 MVA	718 A 274 MVA
230 kV P22G Third Line to Mississagi	864 kcmil	940 A 374 MVA	940 A 374 MVA (assumed)
New 230 kV circuit Wawa to Mackay	1272 kcmil	940 A 374 MVA	1090 A 415 MVA (assumed)
New 230 kV circuit Mackay to Third Line	1272 kcmil	940 A 374 MVA	1090 A 415 MVA (assumed)
No.3 Sault Mackay to Third Line	266.8 kcmil	450 A 90 MVA	1090 A 415 MVA (assumed)
Third Line T1/T2	-	150/200/250	350 MVA (assumed)

*Ratings calculated on 115 kV and 220 kV respectively

IMO's proposed "Transmission Assessment Criteria" for evaluating the effect of new developments on the system reliability and establishing the need to reinforce the transmission system define the "design criteria contingencies" as follows:

- Single transmission element contingency,
- Double-circuit line contingency (presently applicable in the Northwest region for adverse weather conditions),
- Stuck breaker condition (presently not applicable everywhere in the Northwest region).

The proposed general guidelines specify that with all transmission elements in service in pre-contingency:

- the power flows over the transmission elements must be within their continuous thermal ratings.
- following any design-criteria contingency the power flows must not exceed the limited time ratings of the equipment.
- the steady state voltages must be within the ranges required by the *Market Rules*.
- the post-contingency decline in voltage cannot exceed 10%,
- the system shall remain stable during and after the most severe contingency,

The load was modelled as constant MVA in pre-contingency with a 0.92 power factor. In post contingency situations, before and after tap changer action, the loads were modeled as variable active and reactive power as follows:

- 50% of the active power was proportional to the square of the voltage and 50% to the voltage
- 100% of reactive power load is proportional to the square of the voltage.

9.2 Study Scenarios and Simulated Contingencies

The system operating scenarios selected for this assessment represent stressed system conditions where the power flows over the affected interfaces are at acceptable maximum levels. Two system operating scenarios were selected for this study as shown in Table 3.

Table 3. Study Scenarios- Generation, Load, Flows on Main Interfaces Flows

Scenario/ Contingencies	GLPL Load (MW)	GLPL Generation (MW)	Aubrey Falls/Wells GS (MW)	East-West Transfer (MW)	OMTR/MPF	Miss Flow (MW)
Scenario A	350	418	80/0	326 E	297 E /75 S	472 East
Scenario B	300	35	0/0	350 W	300 W/75 S	609 West

9.3 Linear Load Flow Analysis

For each scenario described in Table 2, linear load flow analysis was performed to determine the distribution of the additional 200 MW of generation over the 230 kV and 115 kV transmission between Wawa TS and Algoma TS. Table 4 below summarizes the system Transmission Distribution Factors for situations when the new 200 MW of generation displaces either generation to the East or to the West

Table 4. Transmission Distribution Factors

Circuit # /Section	Monitored Line		Generation Displacement: FROM Generation Third Line, TO West	TO East
	From	To		
	230 kV Lines			
W21M	Marathon	Wawa	0.22	-0.06
W22M	Marathon	Wawa	0.22	-0.06
EW Tie@Wawa			***44%***	***-12%***
P25W/West	Wawa	Aubrey	0.07	0.04
P26W/West	Wawa	Aubrey	0.07	0.04
P25W/East	Aubrey	Mississagi	0.07	0.04
P26W/East	Aubrey	Mississagi	0.07	0.04
NewCr./North	Wawa	MacKay	0.3	-0.20
New Cr./South	MacKay	Third Line	0.20	-0.12
P21G	Third Line	Mississagi	-0.35	0.40
P22G	Third Line	Mississagi	-0.35	0.40
PxG Flow @ThirdL			***-70%***	***80%***
A23P	Mississagi	Algoma	-0.18	0.28
A24P	Mississagi	Algoma	-0.18	0.28
X74P	Mississagi	Hanmer	-0.2	0.32

Circuit # /Section	Monitored Line		Generation Displacement FROM Generation / TO	Third Line West	Third Line East
Miss Fl				*-56%*	*88%*
	Transformers				
Wawa T1	115 kV	230 kV		0	0
Wawa T2	115 kV	230 kV		0	0
MacKay TS	115 kV	230 kV		0.1	0.08
Third Line T1	115 kV	230 kV		0.45	0.46
Third Line T2	115 kV	230 kV		0.45	0.46
	115 kV Lines				
No.3 Sault	MacKay	Third Line		0.1	-0.08

These results indicate that the additional 200 MW wind turbine generation connected at Third Line will distribute over the major interfaces in the following way:

- For high flows East into Wawa and the new generation displacing generation installed to the east of Mississagi:
  - The EW flow East will be reduced by about 12% of the wind generation output,
  - The Mississagi flow East will increase by about 88% of the wind generation output,
  - Flow south on the New 230 kV line at Wawa will reduce by about 20 % of the wind generation output.

- For high flows West into Wawa and the new generation displacing generation installed West of Wawa:
  - The EW flow West will increase by about 44%% of the wind generation output,
  - The Mississagi flow Wast will decrease by about 56% of the wind generation output,
  - Flow North on the New 230 kV line at Wawa will increase by about 30 % of the wind generation output.

From the linear analysis it can be concluded that for high flows east the new wind turbine generation will slightly reduce the EW flow east but will substantially increase the Mississagi Flow East.

Conversely, for high flows West the new wind turbine generation will slightly reduce Mississagi Flow West but will substantially increase the EW flow West.

In general, in can be concluded that for situations of high power flows over the EW and Mississagi interfaces the new development could contribute to power congestion over these interfaces. Given the unpredictable nature of the wind generation the dispatching of the Northwest system including the GLP internal generation, while respecting the system security limits could become a difficult task. On the other hand, the wind turbine generation could become a much needed source of electricity during periods when the hydraulic generation in the Northwest is scarce and the Northwest system has to rely on imports.

Presently, different operating limits are used in the NW Ontario for fair weather conditions, when the critical contingency is considered to be the loss of a single circuit, and for adverse weather conditions, when the critical contingency is considered to be the loss a double circuit line. Currently, there is no restriction on the Mississagi flow east or west for fair weather condition. For adverse weather, the power flow over the Mississagi circuits could be as high as 560 MW eastbound and 500 MW westbound if the local generation (Aubrey GS, Wells GS, Lake Superior Power GS) is in service and armed for rejection for the loss of A23P and A24P.

These limits however will change drastically when the new GLPL transmission reinforcement is complete. It is expected that an increase of up to 50 MW in the Mississagi Flow East will be achieved with the new transmission. The IMO will carry out detailed studies to establish the new system operating limits before the new transmission comes in service.
Judging by the present system operating limits, and the improvement in Mississagi Flow East attributed to the new GLPL transmission can be concluded that the new wind turbine development will be required to participate at least in the generation rejection scheme that in presently available for maximizing the Mississagi flow east during adverse weather conditions.

Superior Wind Energy Inc. will be required to install a contingency based generation rejection scheme, which must at least be able to reject part or all of the generation in the event of a double contingency associated with A24/24P.

The IMO will determine if generation rejection is required for any other system contingencies as part of the studies that will be initiated to establish the system operating limits for the new GLPL transmission development.

9.4 Reactive Power Requirements

The generator reactive power or reactive compensation requirements originate from three sources.

(1) As required by the Market Rules, (appendix 4.2, reference 1), induction generation facilities shall be supported by power corrective equipment designed to raise the equivalent power factor of the unit to 90% lagging at rated output.

This requirement translates into the capability to produce, whenever needed, 48 Mvar's for each 100 MW of active power.

(2) As required by the Market Rules, (appendix 4.2, reference 2), generation facilities shall be capable to operate continuously at full output within $\pm$5% of the generating facility's rated terminal voltage. In order to meet this requirement the step-up transformer impedance should not exceed about 13% based on the generator MVA rating.

The connection to the IMO-controlled grid of the wind turbine generators is provided via a two-stage voltage transformation. Every wind turbine is equipped with 575 V (690 kV) to 34.5 kV unit transformer and collectively through a 34.5k V to 115 kV transformer. Based on the information provided by Superior Wind Energy Inc. the effective impedance of both transformers could total approximately 17 %, when considering 10% impedance for the 34.5/115 kV transformer and 6.8% for each of the individual wind turbines transformers.

(3) Additional reactive power is also required to compensated for the reactive power losses over the 5 km line tap that is used exclusively by the wind turbine generators to connect to the IMO-controlled grid.

Superior Wind Energy Inc. will be required to:

- Provide evidence and documentation to demonstrate that the proposed wind turbine generators are provided with dynamic reactive power control, in compliance with the Market Rule requirements for generator power factor,
- Use either a combination of low impedance 575 V/34.5 kV/115 kV transformers whose total impedance does not exceed 13% on the generation MVA base, OR
- Provide additional reactive support to compensate for the 4% excess in transformer impedance (200/0.9*.04=9 Mvar), which totals about 9 Mvar, AND
- Provide additional reactive support to compensate for the reactive losses over the 5 km line connecting the wind turbine generator to the IMO-controlled grid.

Table 5 provides an estimate of the dynamic reactive capability requirements and reactive power consumption over the transformers and the dedicated connection line for the incorporation of the proposed wind turbine generation, based on typical transformer and line impedances.

Table 5. Reactive Compensation Estimates

Stage	Dynamic Reactive Capability @ Unit Terminals (575 V) (1)	Reactive Requirement due to Transformer Impedances (2)	Reactive Requirement due to Line Reactive Losses (3)	Total Reactive Support Requirements (Dynamic, Static)
100 MW (111 MVA)	48 Mvar	4.5 Mvar	1.5 Mvar	**48 + 6**
200 MW (222 MVA)	96 Mvar	2 X 4.5 Mvar	2 x 1.5 Mvar	**96 +12**

Assumptions:

- Operating voltages: 575 V, 34.5 kV, 120 kV,
- Conductors: 477 kcmil for 115 kV transmission (Xl=0.353 ohms/km).
- 5 km line length
- Each 100 MW development is incorporated via a dedicated transmission connection into Third Line TS.
- 10% impedance on 100 MVA base for the 34.5/115 kV transformer

Superior Wind Energy Inc. is required to provide the reactive power summarized in table 5, regardless of the transmission reinforcement option that will be selected by GLPL for the redevelopment of their transmission system.

9.5 Voltage Decline Analysis

Voltage decline studies were performed for scenario B only since it simulates stressed system conditions, which are expected to yield considerable post-contingency voltage decline.

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The effect on post-contingency voltages was studied for GLPL transmission reinforcement options 1 and 3. Table 6 summarizes the results of this analysis.

Table 6. Voltage Study Results

GLPL Transmission Reinforcement OPTION 1 (5 x 115 kV circuits refurbished)						
Stage		**Third Line 115 kV (kV)**	**Third Line 230 kV (kV)**	**Anjigami 115 kV (kV)**	**Wawa 230 kV (kV)**	**Mississagi 230 kV (kV)**
100 MW	Pre	***121***	***237***	***119.6***	***233***	***236.9***
	Imm. Post	***118 (-2.5%)***	***231.3 (-4.09%)***	***119.1 (-0.4%)***	***232.1 (-0.4%)***	***232.5 (-1.86%)***
	Post ULTC	***116 (-4.1%)***	***227.3 (-4.1%)***	***116.3 (-2.8%)***	***226.4 (-2.9%)***	***228.7 (-3.5%)***
200 MW	Pre	***121***	***237***	***119.6***	***233***	***236.9***
	Imm. Post	***112 (-7.4%)***	***220 (-7.2%)***	***116.9 (-2.51)***	***227.1 (-2.6)***	***223.3 (-0.4%)***
	Post ULTC	***In Excess of 15%***				
GLPL Transmission Reinforcement OPTION 3 (New 230 kV transmission)						
Stage		**Third Line 115 kV (kV)**	**Third Line 230 kV (kV)**	**Anjigami 115 kV (kV)**	**Wawa 230 kV (kV)**	**Mississagi 230 kV (kV)**
100 MW	Pre	***120.9***	***240.1***	***120***	***240.6***	***240.3***
	Imm. Post	***118.1 (-2.3%)***	***235.1 (-2.1%)***	***119.1 (-.8%)***	***238.7 (-.8%)***	***236 (-2.1%)***
	Post ULTC	***116.5 (-3.6%)***	***232 (-3.4%)***	***117 (-2.5%)***	***234.5 (-2.5%)***	***233.3 (-2.9%)***
200 MW	Pre	***120.9***	***240.1***	***120***	***240.6***	***240.3***
	Imm. Post	***113.2 (-6.4%)***	***226.5 (-5.6%)***	***117.1 (-2.4%)***	***234.7 (-2.55)***	***229.1 (-4.7%)***
	Post ULTC	***103.7 (-14.2%)***	***208.7 (-13.1%)***	***107.4 (-10.5%)***	***215.4 (-10.5%)***	***213.7 (-11.75)***

The results of the post-contingency voltage decline study can be summarized as follows:

- The loss of 100 MW of the wind turbine generation will result in a post-contingency voltage decline of less than 10% thus meeting IMO's voltage decline criteria, BUT
- The loss of 200 MW the wind turbine generation will result in a post-contingency voltage decline larger than 10%, which exceeds IMO's voltage decline criteria.

It is thus required that Superior Wind Energy Inc. incorporate each 100 MW wind turbine generation group via a dedicated 115 kV connection into Third Line TS, as shown in Figure 3. The connection of the second 100 MW wind turbine generation into Third Line 115 kV switchyard shall use one of the spare positions available on the diameters where T1 or T2 are connected.

It is thus required that Superior Wind Energy Inc. incorporate each 100 MW wind turbine generation group via a dedicated 115 kV connection into Third Line TS, as shown in Figure 3. The connection of the second 100 MW wind turbine generation into Third Line 115 kV switchyard shall use either spare positions available on the diameters where T1 or T2 are connected.

9.6 Transient Analysis Study

The transient stability assessment was carried out for system scenarios listed in Table 2 and additional system scenarios that represent adverse weather stressed system conditions over the Mississagi East transmission interface. Transient stability simulations were carried out for the most critical contingencies as listed in Table 7, starting with a system with all transmission elements in service. The 200 MW wind turbine generation development was modeled as two separate block of 100 MW, each connected to the 115 kV system via a dedicated transmission connection.

A detailed induction generator model was used to model the wind turbine generators in the transient stability studies, since Superior Wind Energy Inc. has not yet selected a wind turbine manufacturer and a specific dynamic model is not available.

Upon selecting a particular technology for the Prince Wind Park development, Superior Wind Energy Inc. is required to provide the detailed machine model and data to the IMO for review and additional studies, if necessary.

Table 7. Result of Transient Stability Studies

Transient Stability Results (Appendix A) ***Figure #***						
GLP Transmission Reinforcement OPTION 1 (Upgrade all five 115 kV circuits)						
System Scenario (GLP Load, Gen)	**Loss of P22G @ Miss**	**Loss of Third Line T1[1]**	**LLG on W22M @ Wawa**	**LLG on P26W @ Wawa**	**LLG on New 230 @ Third Line**	**LLG on A23/24P @ Miss**
Case A (350MW, 452MW) MissFL E=692 MW	**N/A[2]**	**Unacceptable Figure O1-A1**	**Stable Figure O1-A2**	**Stable Figure O1-A3**	**-**	**N/A**
Case B (300 MW, 75 MW) MissFL E=-402 MW	**N/A**	**Stable Figure O1-B1**	**Stable Figure O1-B2**	**Stable Figure O1-B3**	**-**	**N/A**
Case C (350 MW, 326 MW) MissFL E=477 MW	**N/A**	**N/A**	**N/A**	**N/A**	**-**	**Stable Figure O1-C1**
GLP Transmission Reinforcement OPTION 3 (New 230 kV line Wawa/MacKay/Third Line)						
System Scenario	**Loss of P22G @ Miss**	**Loss of Third Line T1[1]**	**LLG on W22M @ Wawa**	**LLG on P26W @ Wawa**	**LLG on New 230 @ Third Line**	**LLG on A23/24P @ Miss**
Case A (350MW, 452MW) MissFL E=703 MW	**Stable Figure O3-A1**	**Stable Figure O3-A2**	**Stable Figure O3-A3**	**Stable Figure O3-A4**	**Stable Figure O3-A5**	**N/A**
Case B (300 MW, 75 MW) MissFL E=-402 MW	**Stable Figure O3-B1**	**Stable Figure O3-B2**	**Stable Figure O3-B3**	**Stable Figure O3-B4**	**Stable Figure O3-B5**	**N/A**
Case D (350 MW, 381 MW) MissFL E=582 MW	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**Stable Figure O3-C1**

Upon examining the results of transient stability studies it was concluded that:

- For GLPL transmission reinforcement Option 1 and conditions of peak load, generation and high flows Eastbound on the EW interface, a contingency associated with Third Line transformer results in unacceptably slow recovery of the 115 kV system voltages.

[1] For GLPL Option 1, P21G, T27P and Wells G2 are also lost by configuration
[2] Not Available- Contingency not studied because it is not critical

- For GLPL transmission reinforcement Option 3 all studied contingencies resulted in stable and well damped system oscillation.

- The local conventional generators appear to be compensating the inability of the induction generators that were used to model the wind turbine development, to produce dynamic reactive power.

The results of the transient stability studies confirmed that Superior Wind Energy Inc. is required to provide a source of dynamic reactive power at their Prince Wind Park generation development As required by the Market Rules (Appendix 4.2).

10.0 Customer Impact Assessment

Great Lakes Power Inc. has informed the IMO that Customer Impact Assessment will be required to determine whether the proposed facilities could have an adverse impact on the existing connected customers.

Superior Wind Energy Inc. has not yet initiated this phase of the process. This Report has therefore 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.

11.0 Assessment Conclusions

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

1. Subject to meeting all IMO's requirements listed in section 12, the 200 MW Prince Wind Park generation development will not have an adverse impact on the reliability of the IMO-controlled grid.

2. The proposed generation development will likely act as a load displacement resource at Third Line TS and result in a reduction in flow over Third Line TS transformers.

3. For situations of high power flows over the EW and Mississagi interfaces the new development could contribute to power congestion over these interfaces.

4. If GLPL transmission reinforcement Option 1 is implemented then the addition of the 200 MW wind turbine development will result in short circuit levels at MacKay TS which exceed the interrupting capability of the existing breakers.

5. If GLPL transmission reinforcement Option 3 is implemented then the increases in fault level, due to the proposed 200 MW generation, will not exceed the interrupting capabilities of the existing breakers and the new breakers that will be incorporated as part of the GLPL transmission reinforcement project.

6. The loss of 100 MW of the wind turbine generation will result in a post-contingency voltage decline of less than 10% thus meeting IMO's voltage decline criteria.

7. The loss of 200 MW the wind turbine generation will result in a post-contingency voltage decline larger than 10%, which exceeds IMO's voltage decline criteria.

8. For GLPL transmission reinforcement Option 1 and conditions of peak load, generation and high flows Eastbound on the EW interface, a contingency associated with Third Line transformer results in unacceptably slow recovery of the 115 kV system voltages.

9. For GLPL transmission reinforcement Option 3 all studied contingencies resulted in stable and well damped system oscillation.

12.0 IMO Requirements

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

1. To incorporate 200 MW of generation at 115 kV assuming all other transmission 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 Prince Wind Park for the loss of the double 230 kV circuit A23/24P and other contingencies if so determined by the IMO in future operating studies.

    - Incorporate each 100 MW wind turbine generation group via a dedicated 115 kV line connection into Third Line TS and provide all the necessary station equipment.

2. Should GLPL implement Option 1 for their transmission reinforcement plan, then Superior Wind Energy Inc. is required to initiate, with GLPL, a detailed short circuit studies to determine the impact of their generation project on the existing station breakers. If the studies indicate that the interrupting capability of some of the breakers is exceeded then Superior Wind Energy Inc. is required to take on the replacement of these breakers.

3. Superior Wind Energy Inc. is required to provide a source of dynamic reactive power at their Prince Wind Park generation development site to meet the Market Rules requirements for induction generators with respect to reactive power capability.

4. Superior Wind Energy Inc. is required to provide adequate reactive power to compensate for the reactive consumption on the 34.5/115 kV and the dedicated connection line(s). This can be achieved with combinations of low impedance transformers and provision of reactive power devices, whichever combination is more economic and subject to IMO's approval.

5. Meet all the transmitter's requirements with respect to the installation of protection systems and the required reviews and/or modifications of the existing protection systems.

6. Upon deciding on a specific technology for 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.

- If the specific model of wind turbine generators is equipped with ac-dc-ac voltage source converters or equivalent equipment, then Superior Wind Energy Inc. must provide evidence to the IMO that the facility will not have an adverse impact, including sub-synchronous resonance interaction, on the IMO-controlled grid or existing generating facilities. 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.

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

8. Superior Wind Energy Inc. is required to initiate as soon as possible a Customer Impact Assessment (CIA) to determine the impact of new generation connection on existing Transmission Customers. The detailed CIA study will be carried out by GLPL.

9. 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.

13. Budgetary Cost Estimates

Superior Wind Energy Inc. is to obtain cost estimates of the following from Great Lakes Power Limited – Transmission Division for the incorporation of the proposed 200 MW Prince Wind Park.

- All the modifications that are require to be made at Third Line TS to accommodate the incorporation of each 100 MW of wind turbine generation.

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

14. Identification of "Sole Beneficiary"

Section 9.1.3 of the Transmission System Code sates:

"The cost of modifications and upgrades on specific network facilities that are triggered by and for the sole benefit of the generator shall be borne by the generator."

The facilities that are triggered by and deemed to be for the sole benefit of this project have been identified as follows:

- All the modifications that are require to be made at Third Line TS to accommodate the incorporation of each 100 MW of wind turbine generation.
- The two 5 km 115 kV line taps that will connect each 100 MW wind turbine generators group into Third Line TS.
- The connectivity-based Special Protection System to reject the appropriate amount of wind turbine generation under certain system contingencies.
- The breaker replacements required to adequately accommodate the increase in short circuit levels due to the additional generation in case that GLPL decides to implement Option 1 for their transmission reinforcement plan.

15. Notification of Approval

This Preliminary Assessment has investigated the impact of the proposed 200 MW Prince 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 completion of the CIA studies and the implementation of the IMO's requirements as detailed in the PA Report.

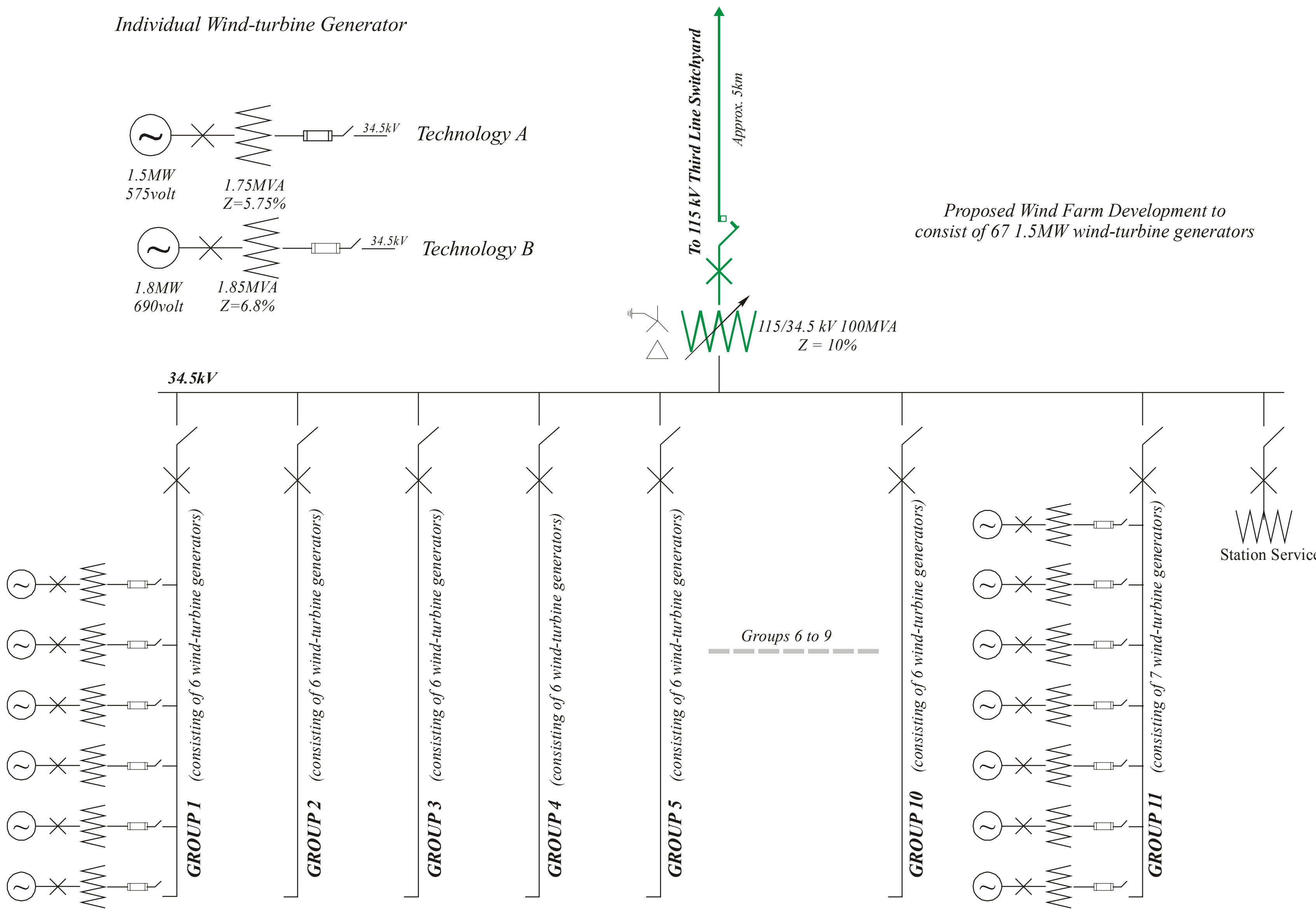


Figure 1. Proposed Configuration of the 100MW Prince Wind Park Project

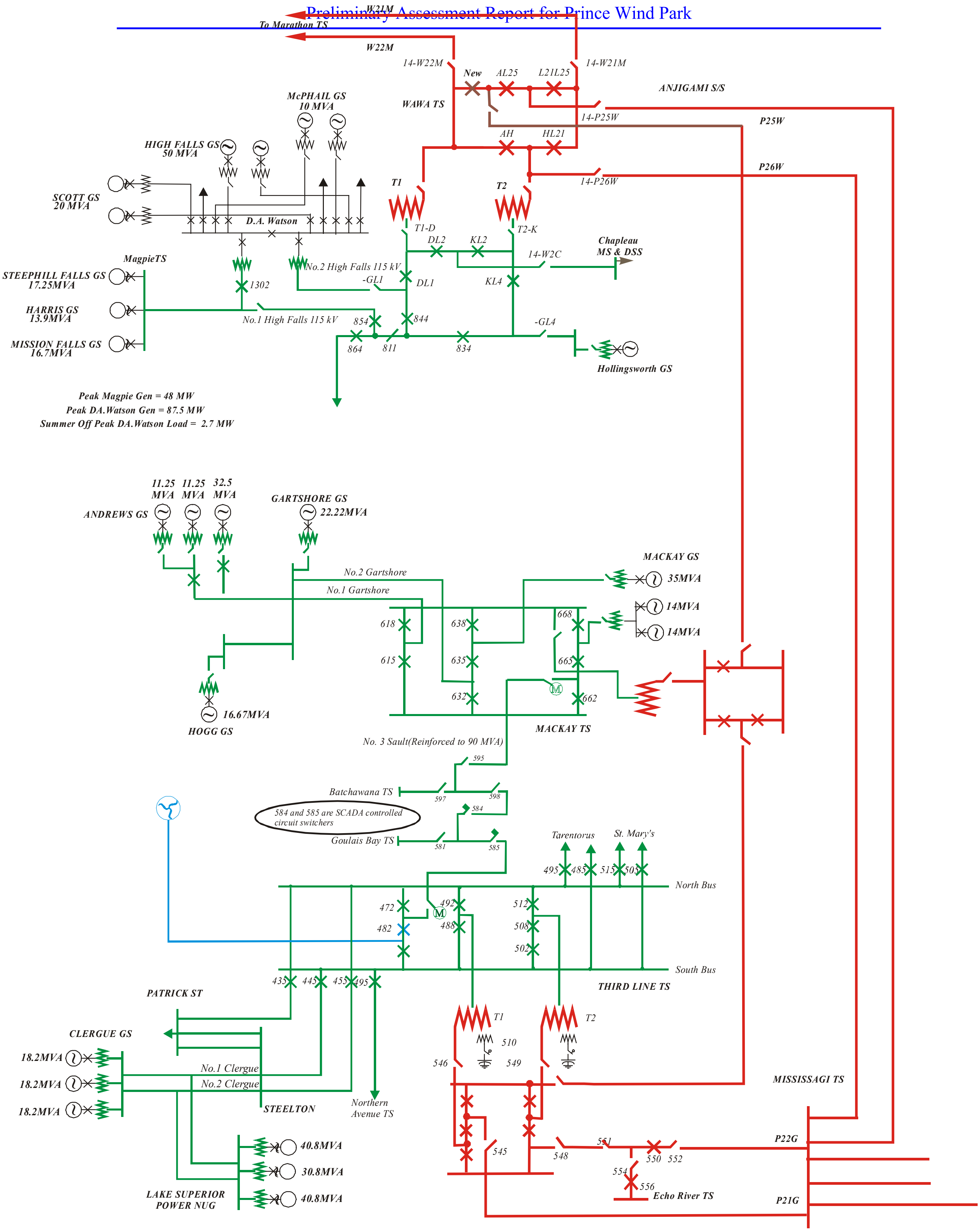


Figure 2. GLP Transmission System - 2006
(GLPL Transmission Reinforcement in service)

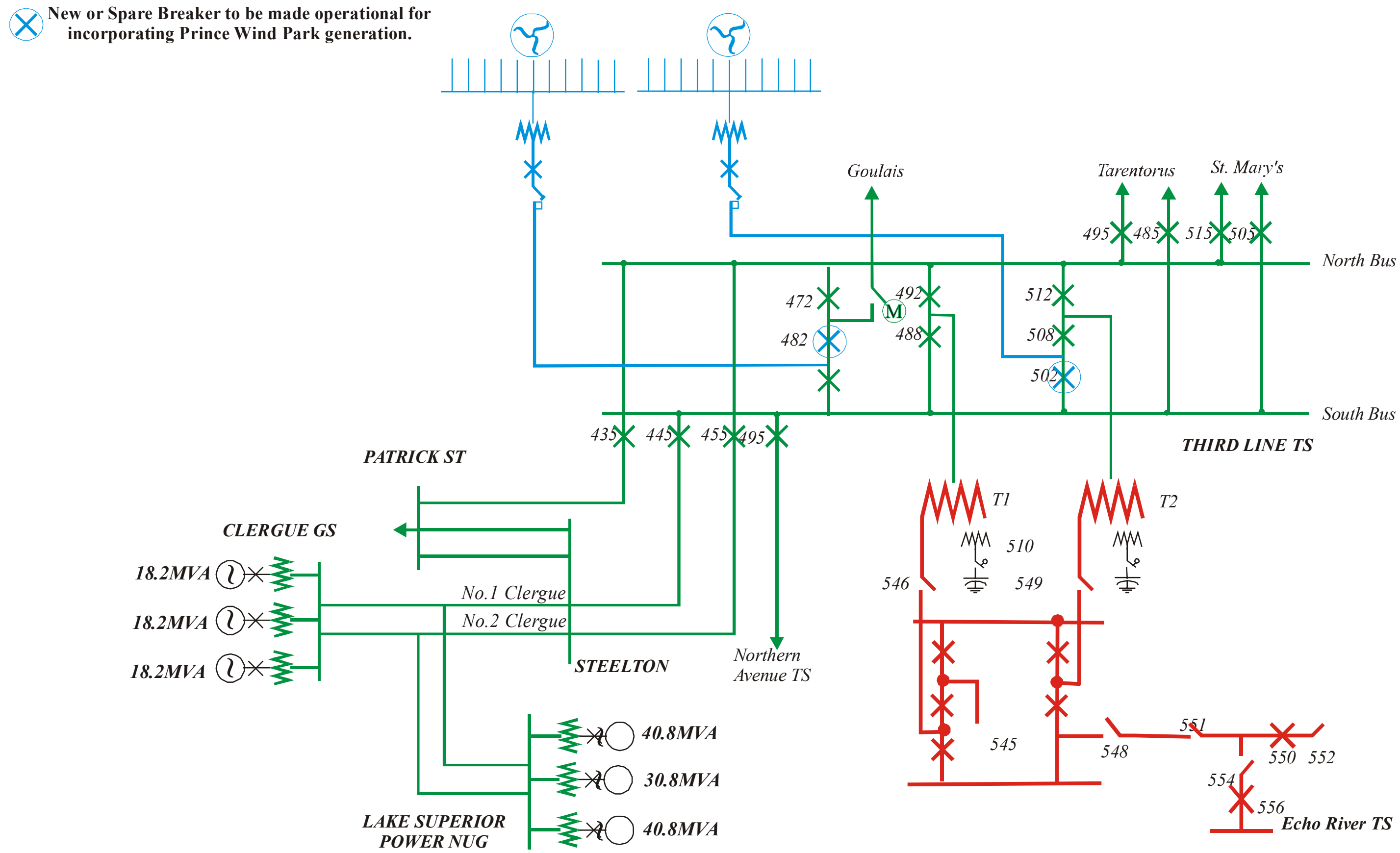


Figure 3. Required Configuration for the Incorporation of 200MW Wind Turbine Generation

APPENDIX A

Transient Stability Plots

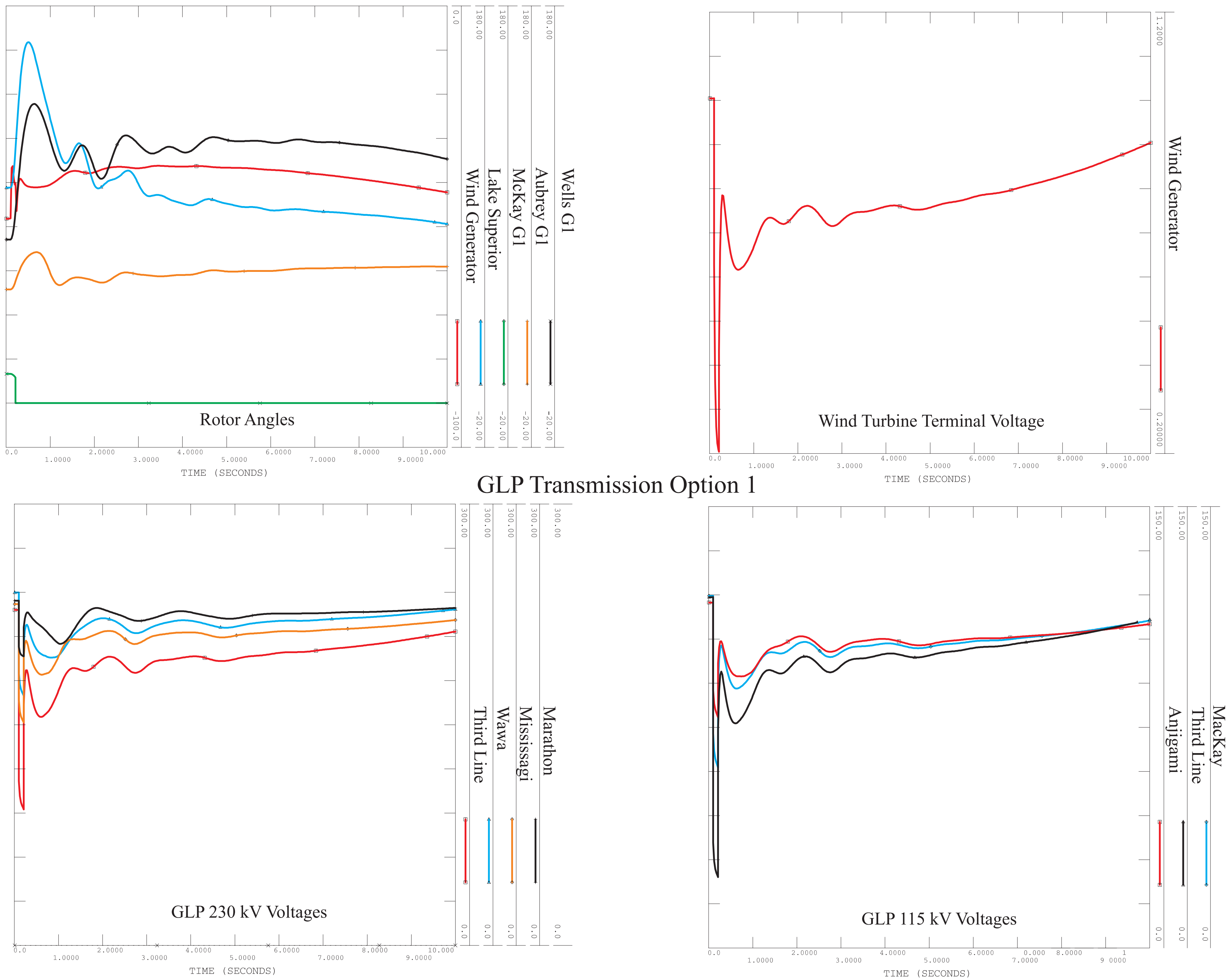


Figure O1-A1.Loss of Third Line TS -T1 Transformer

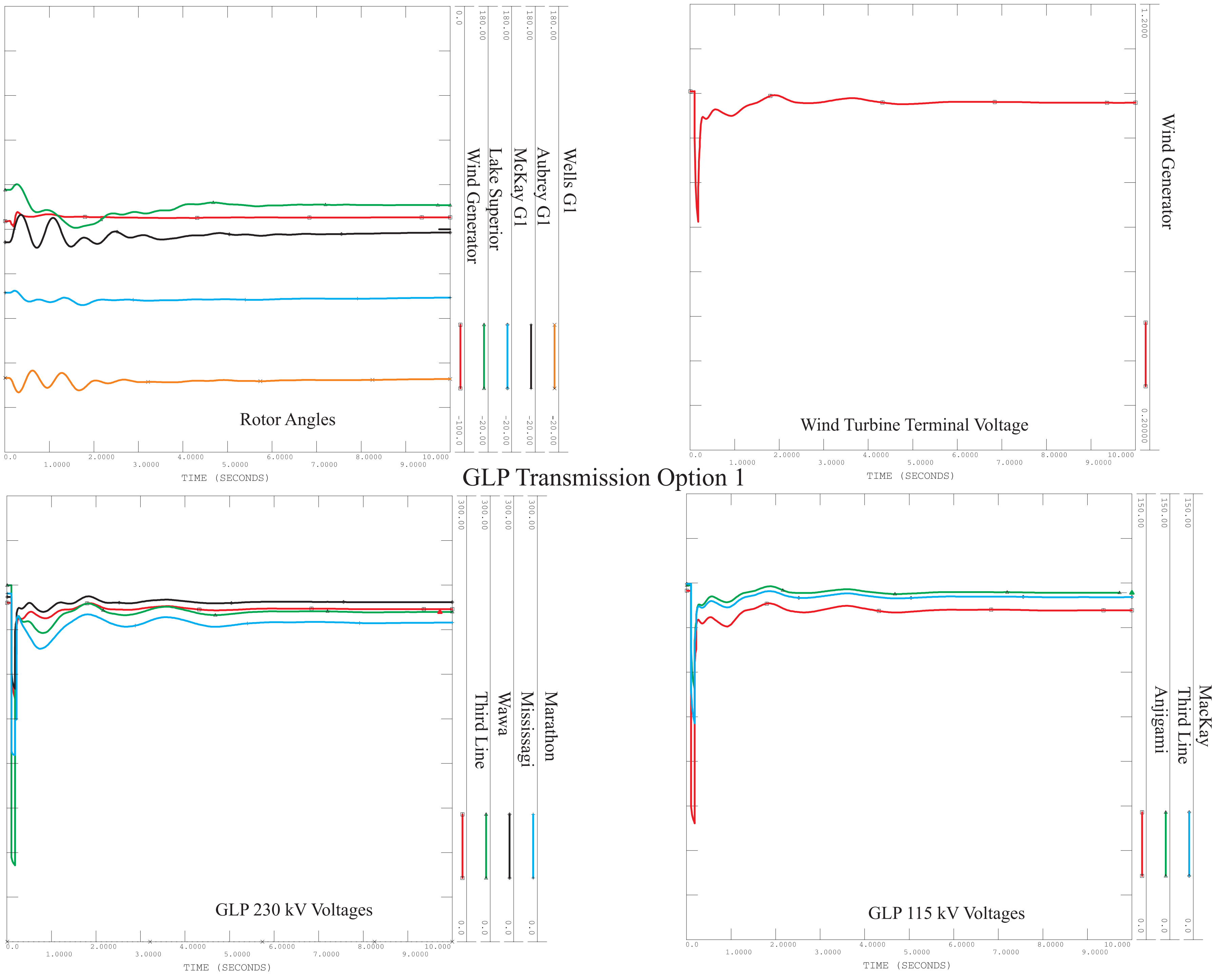


Figure O1-A2.LLG of W22M at Wawa

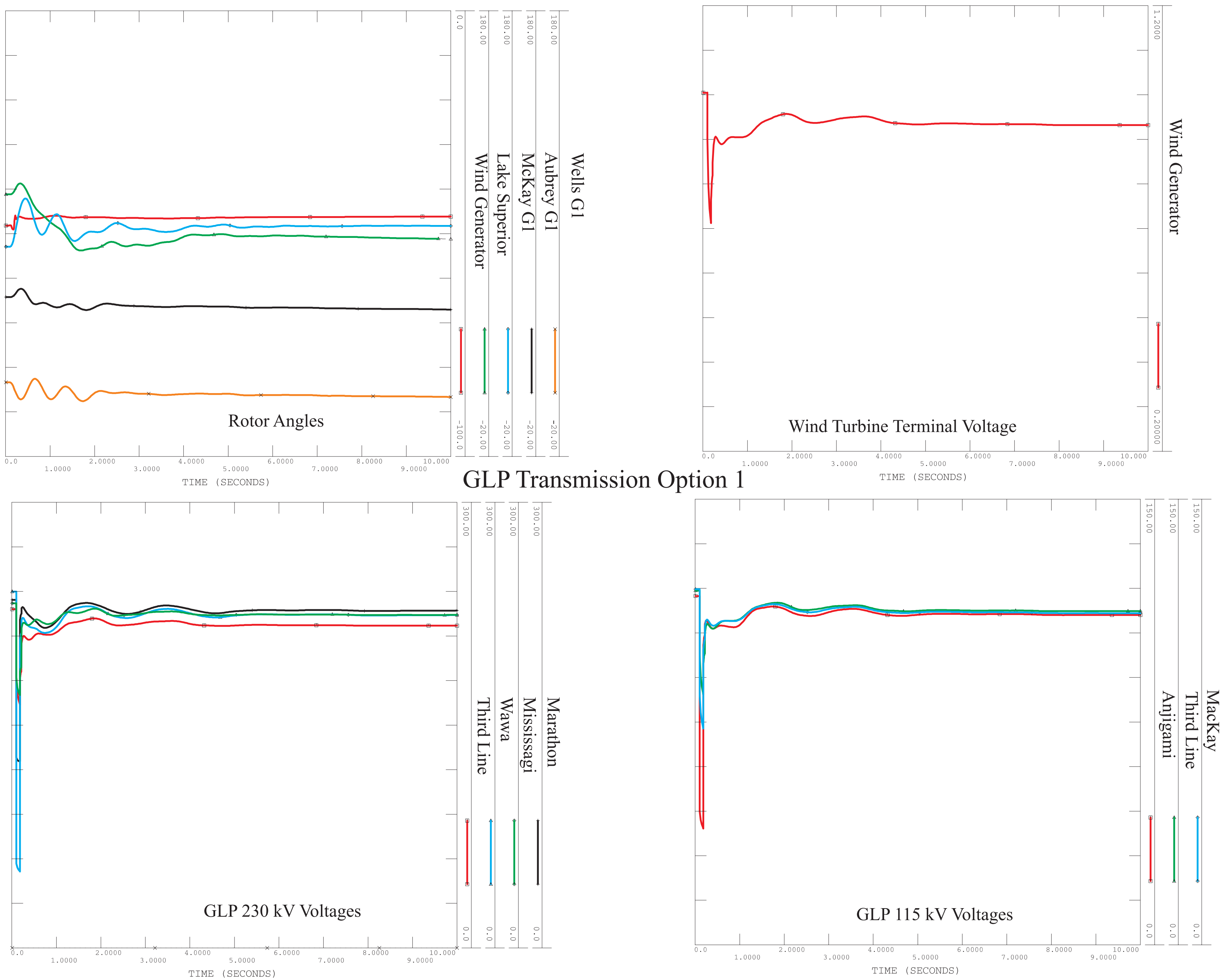


Figure O1-A3.LLG on P26W at Wawa

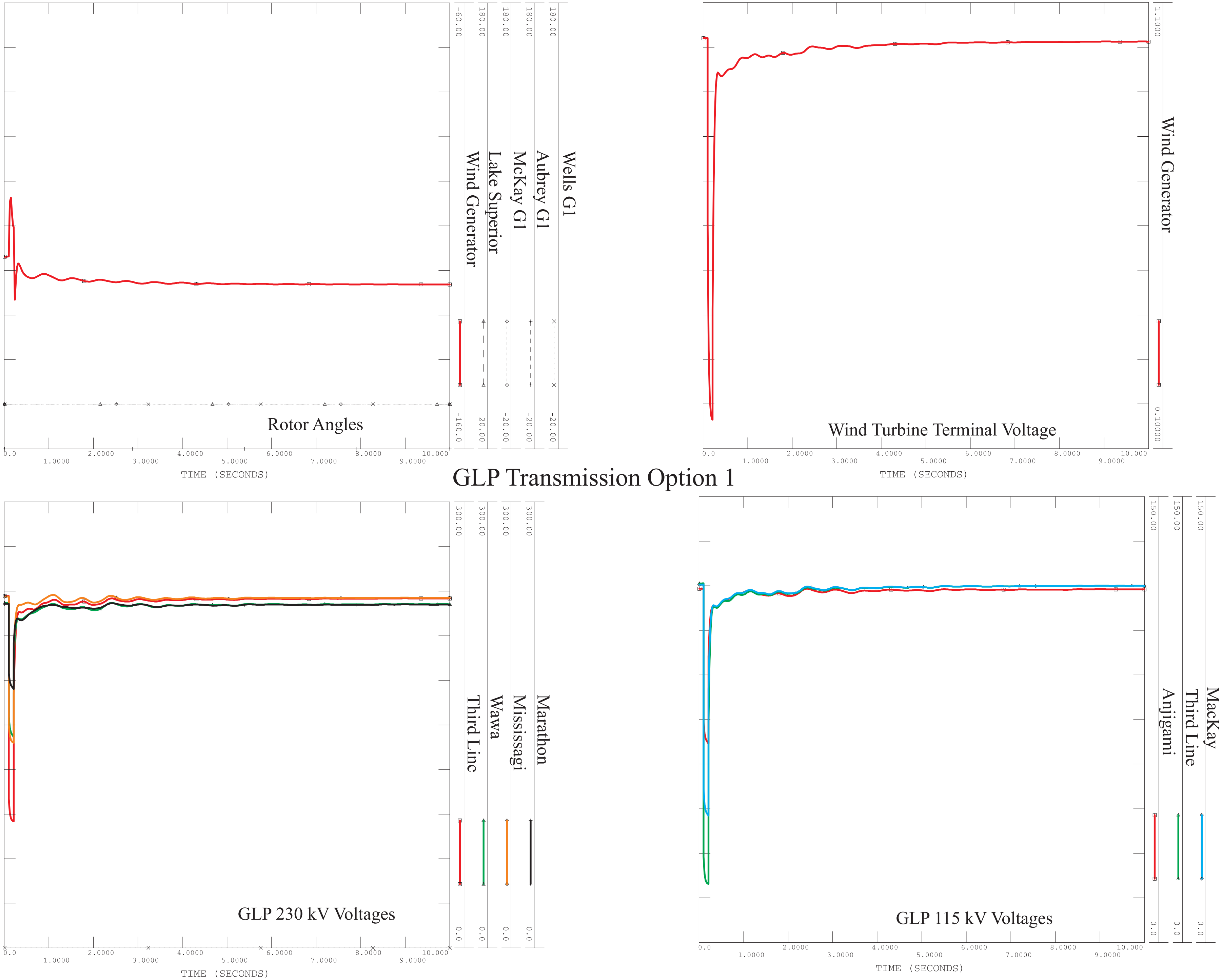


Figure O1-B1. Loss of Third Line T1

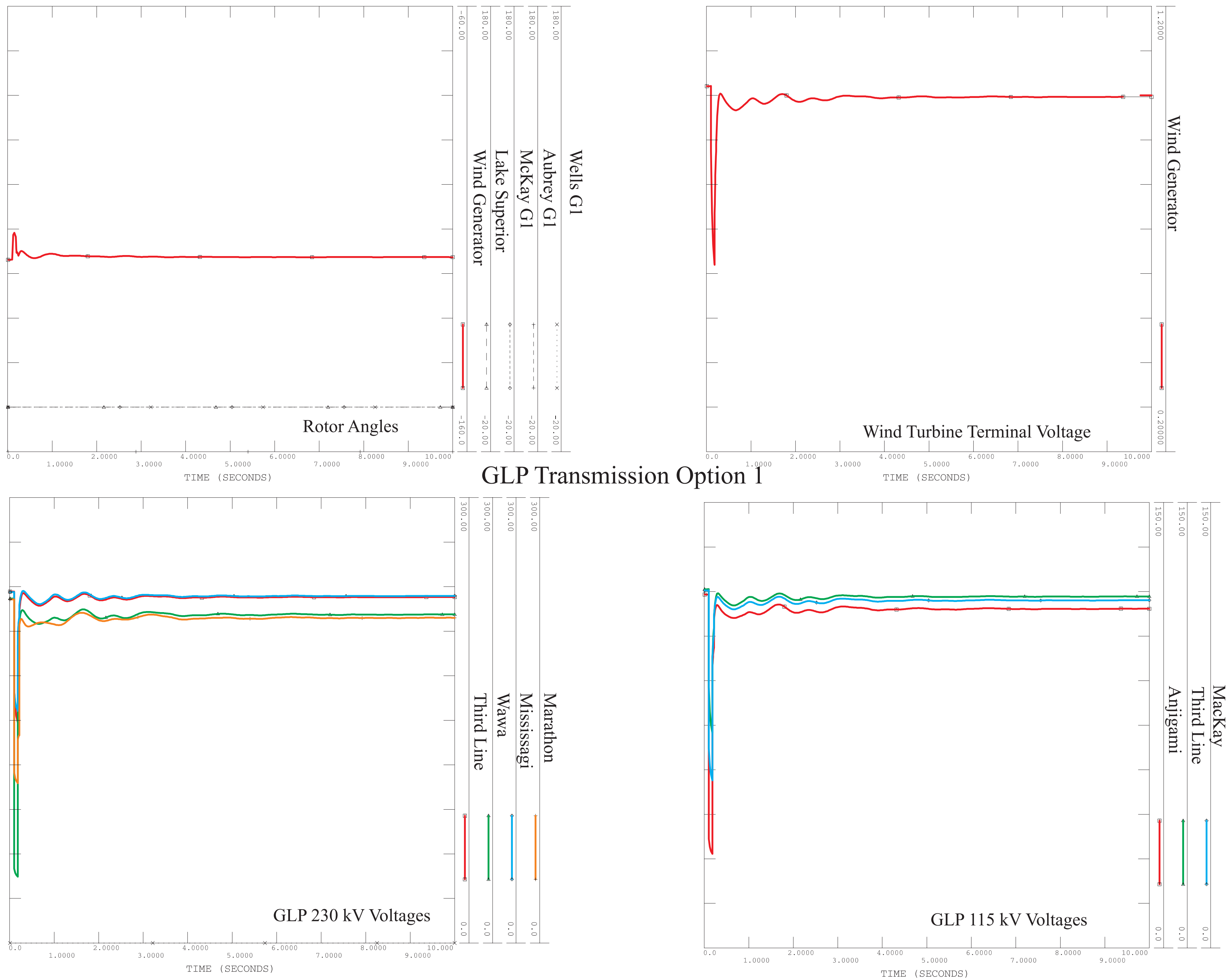


Figure O1-B2. LLG on W22M at Wawa

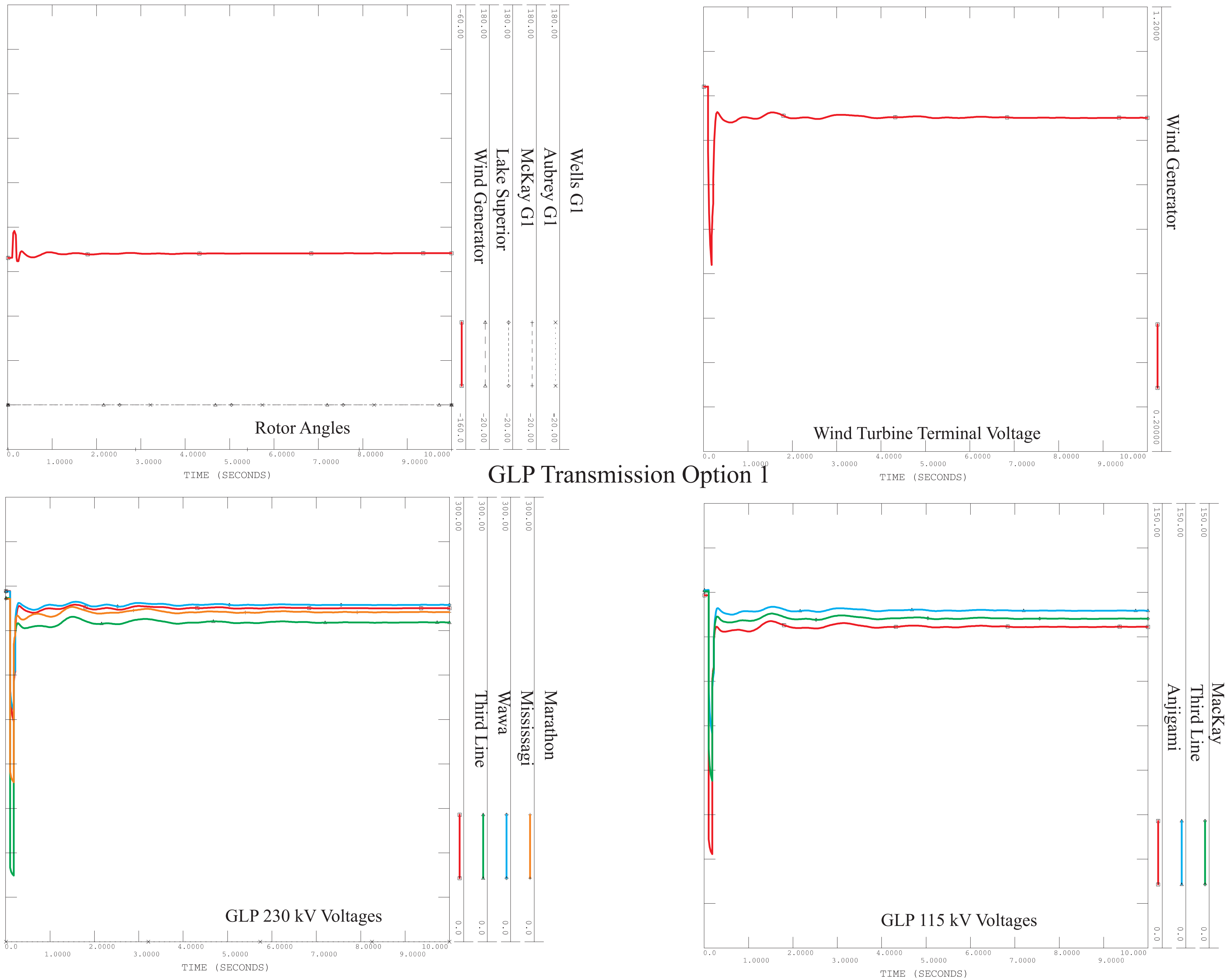
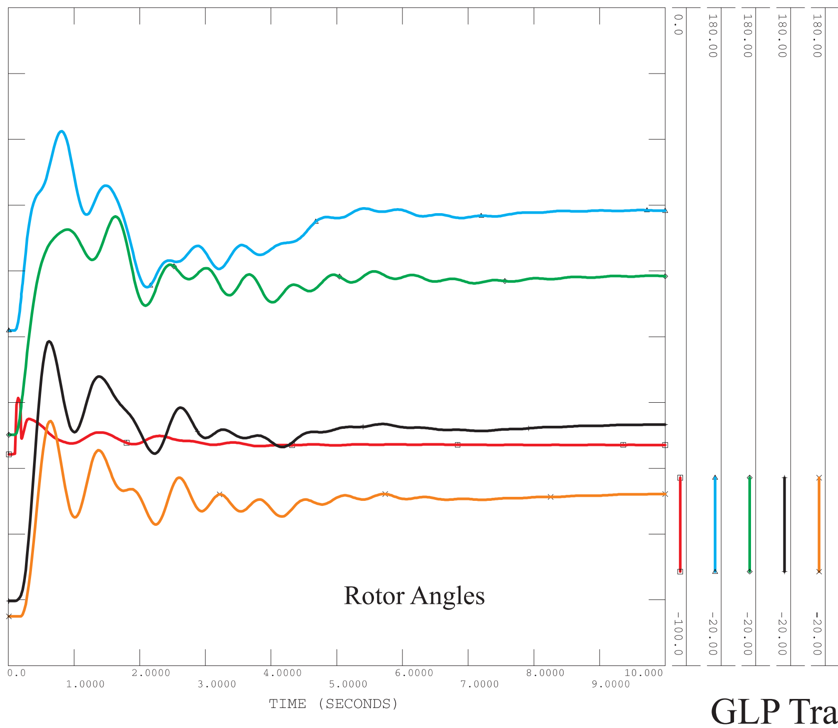
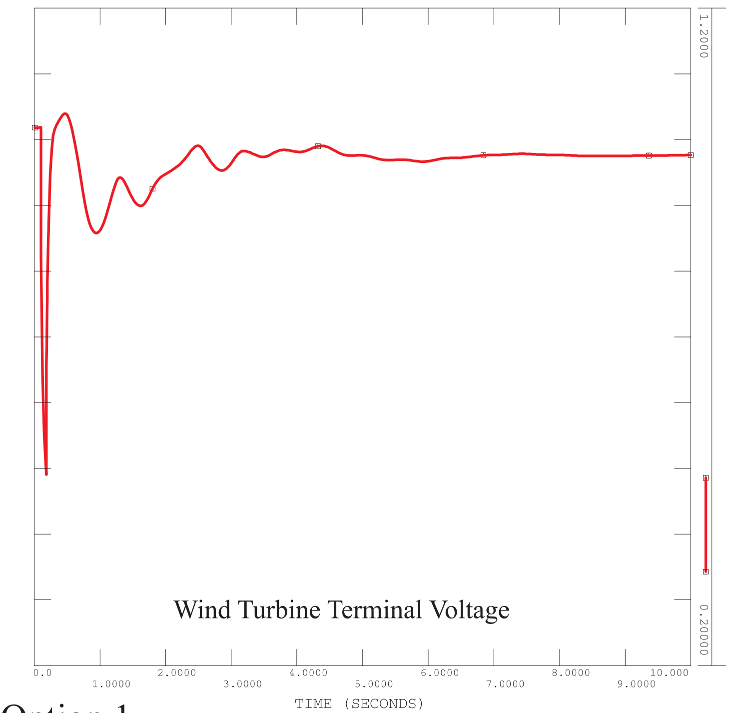
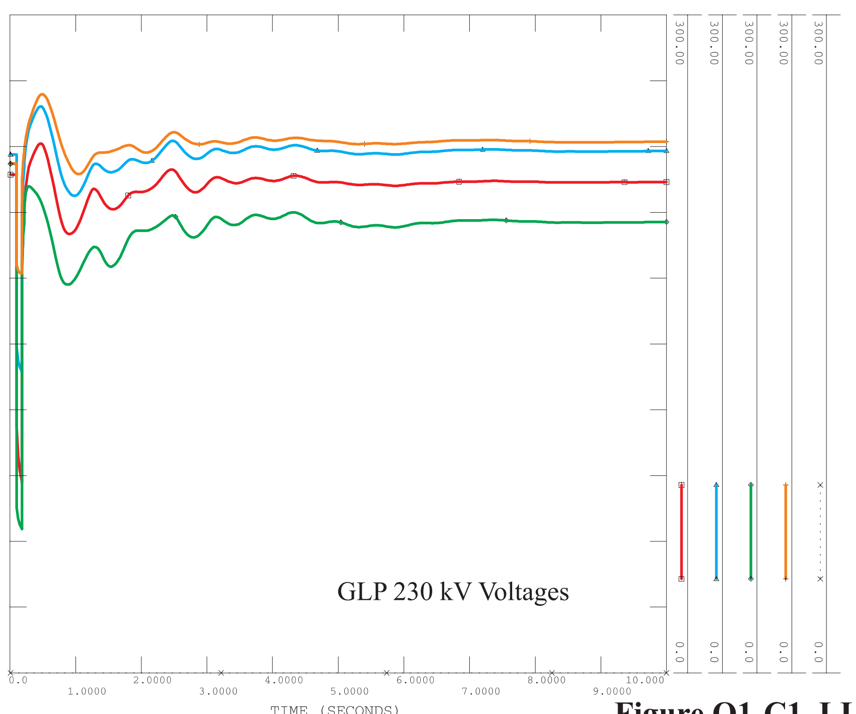


Figure O1-B3. LLG on P26W at Wawa





GLP Transmission Option 1



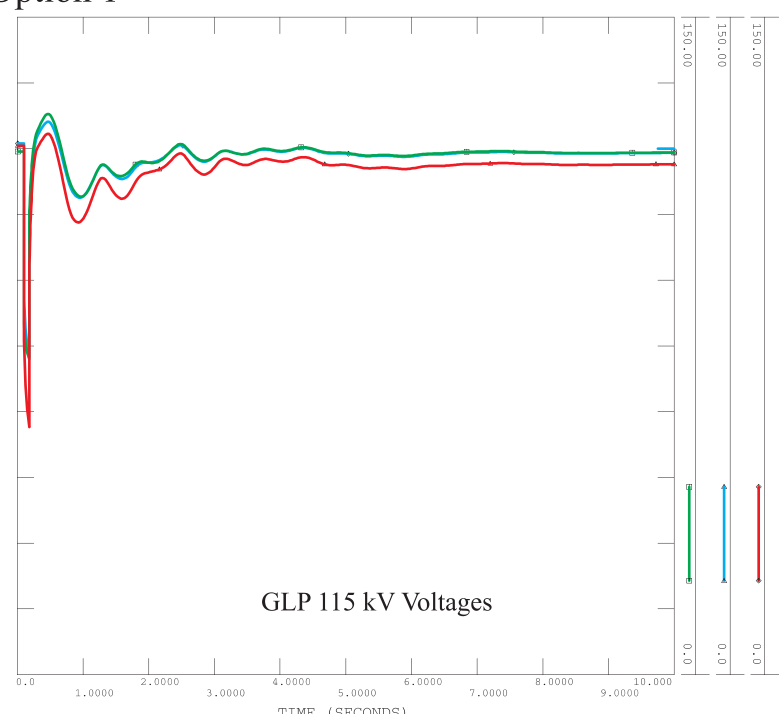


Figure O1-C1. LLG on A23P/A24P at Mississagi

GLP Transmission Option 3

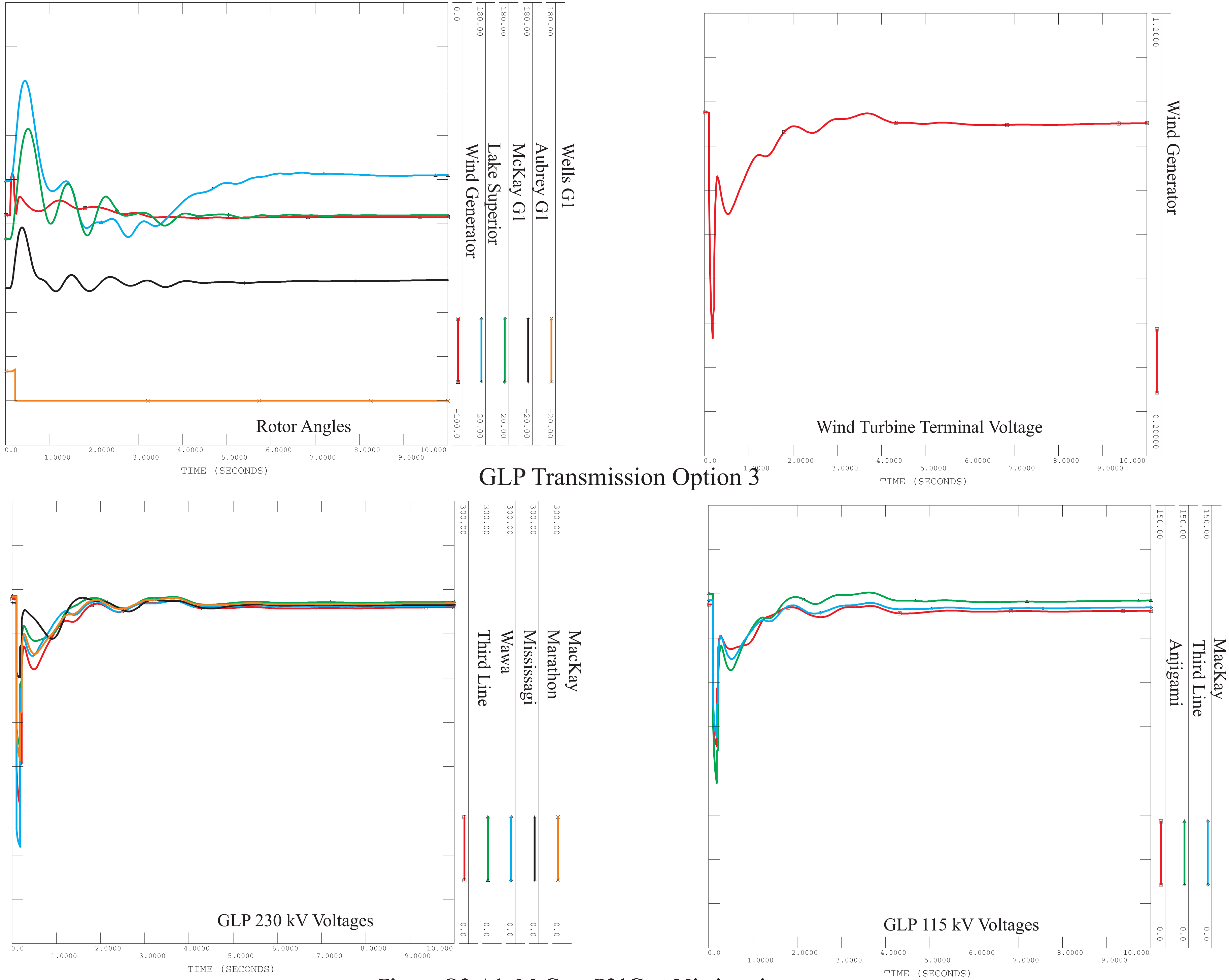


Figure O3-A1. LLG on P21G at Mississagi

GLP Transmission Option 3

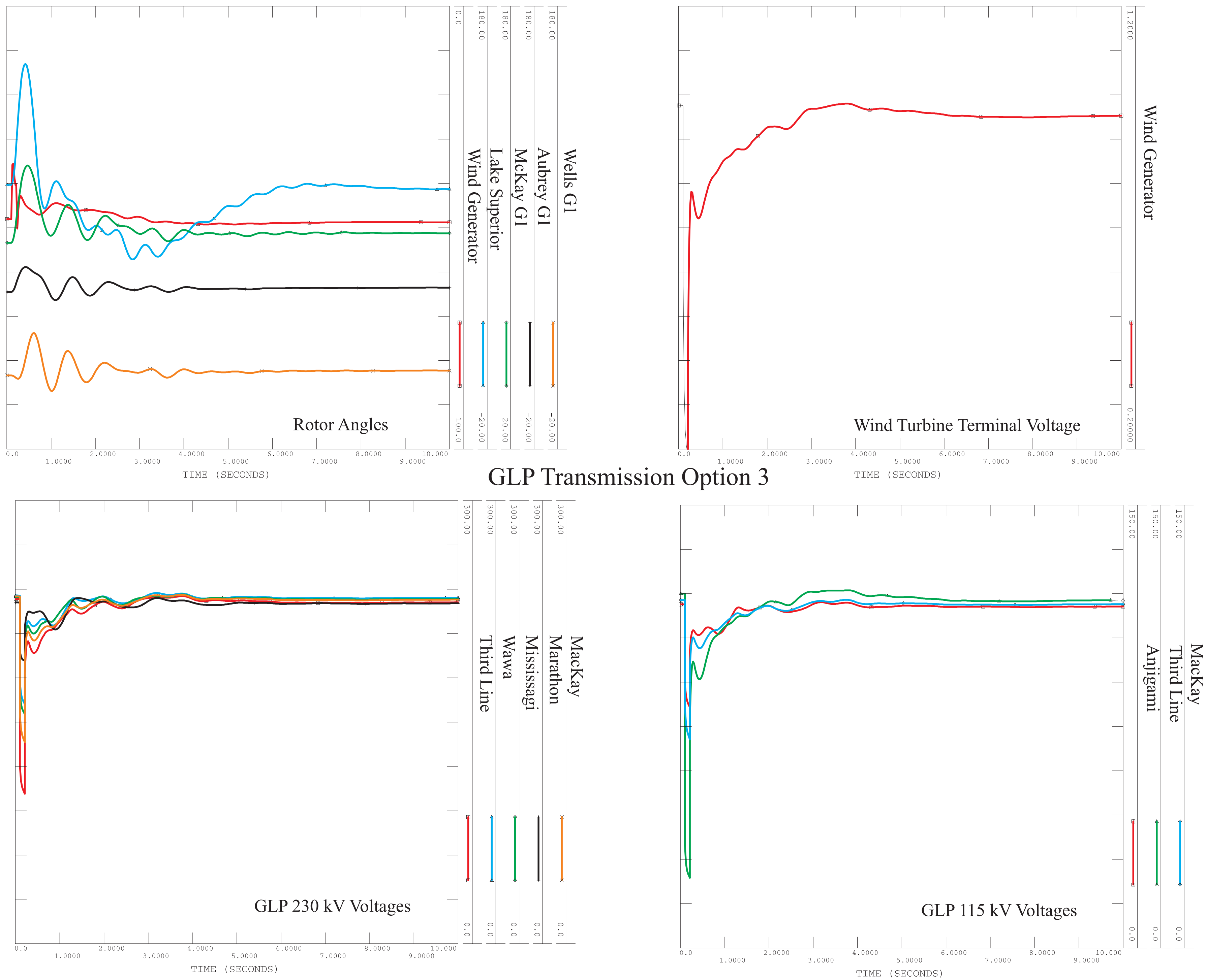
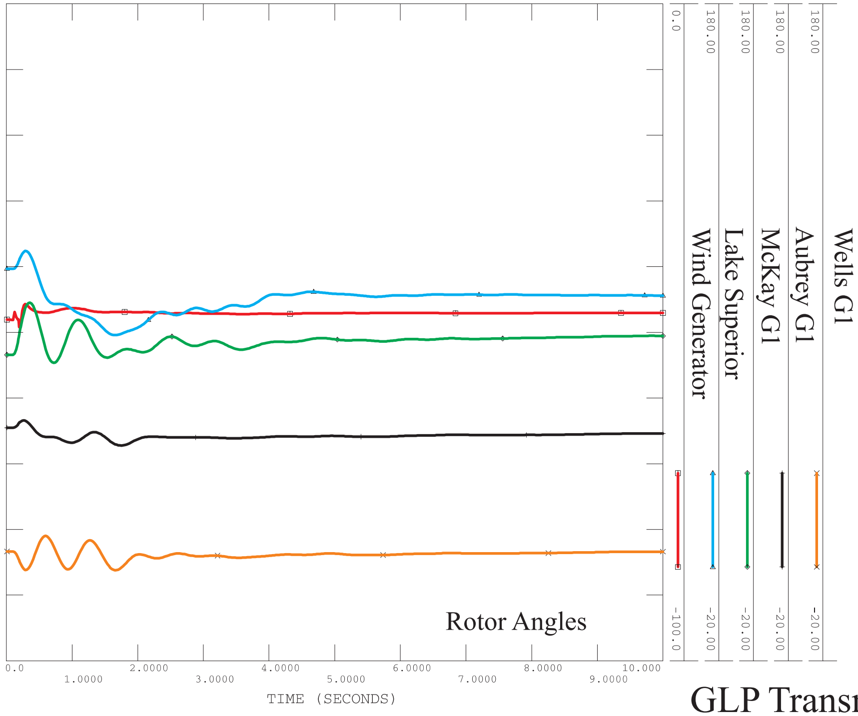
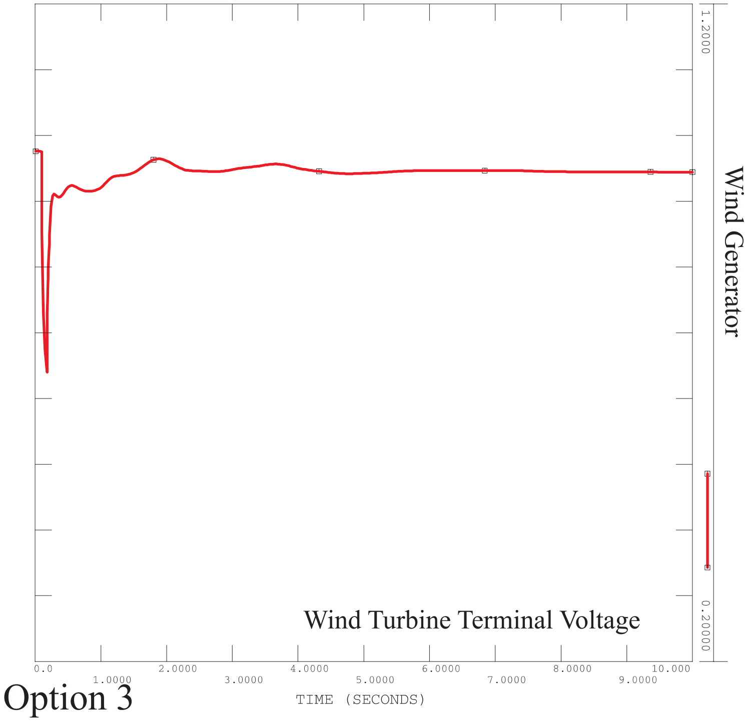
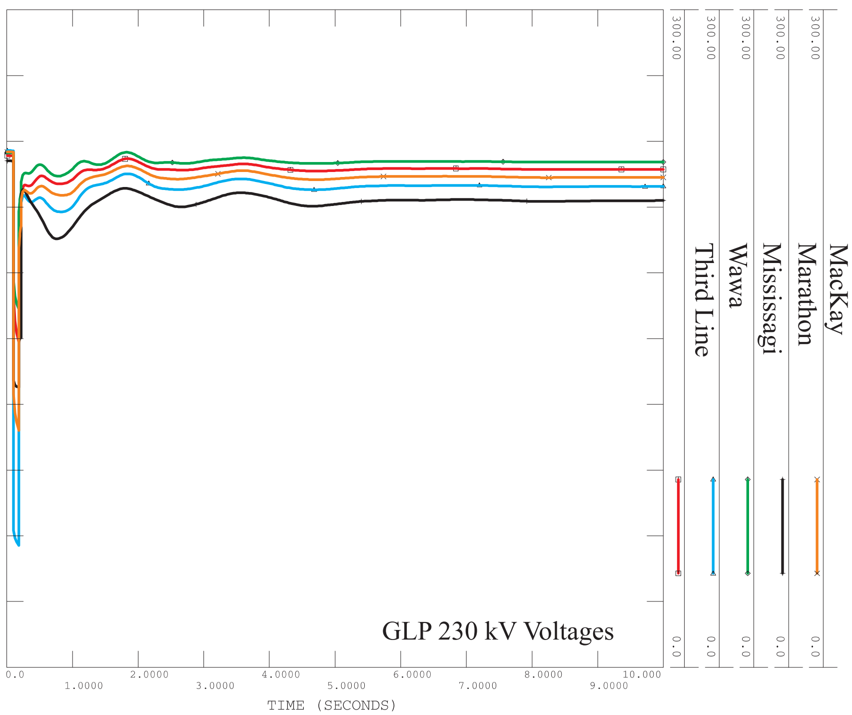


Figure O3-A2. Loss of Third Line Transformer





GLP Transmission Option 3



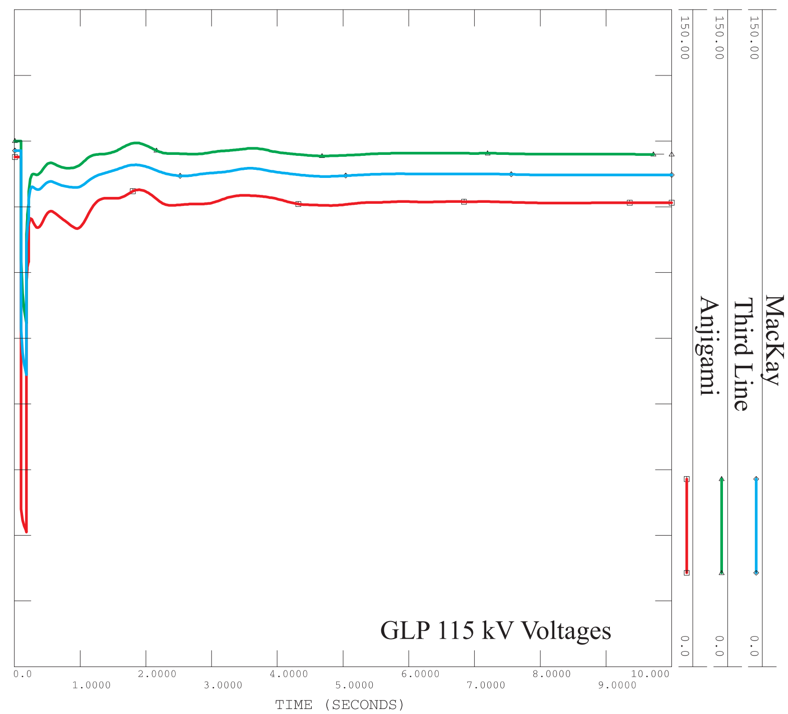


Figure O3-A3. LLG on W22M at WawaTS

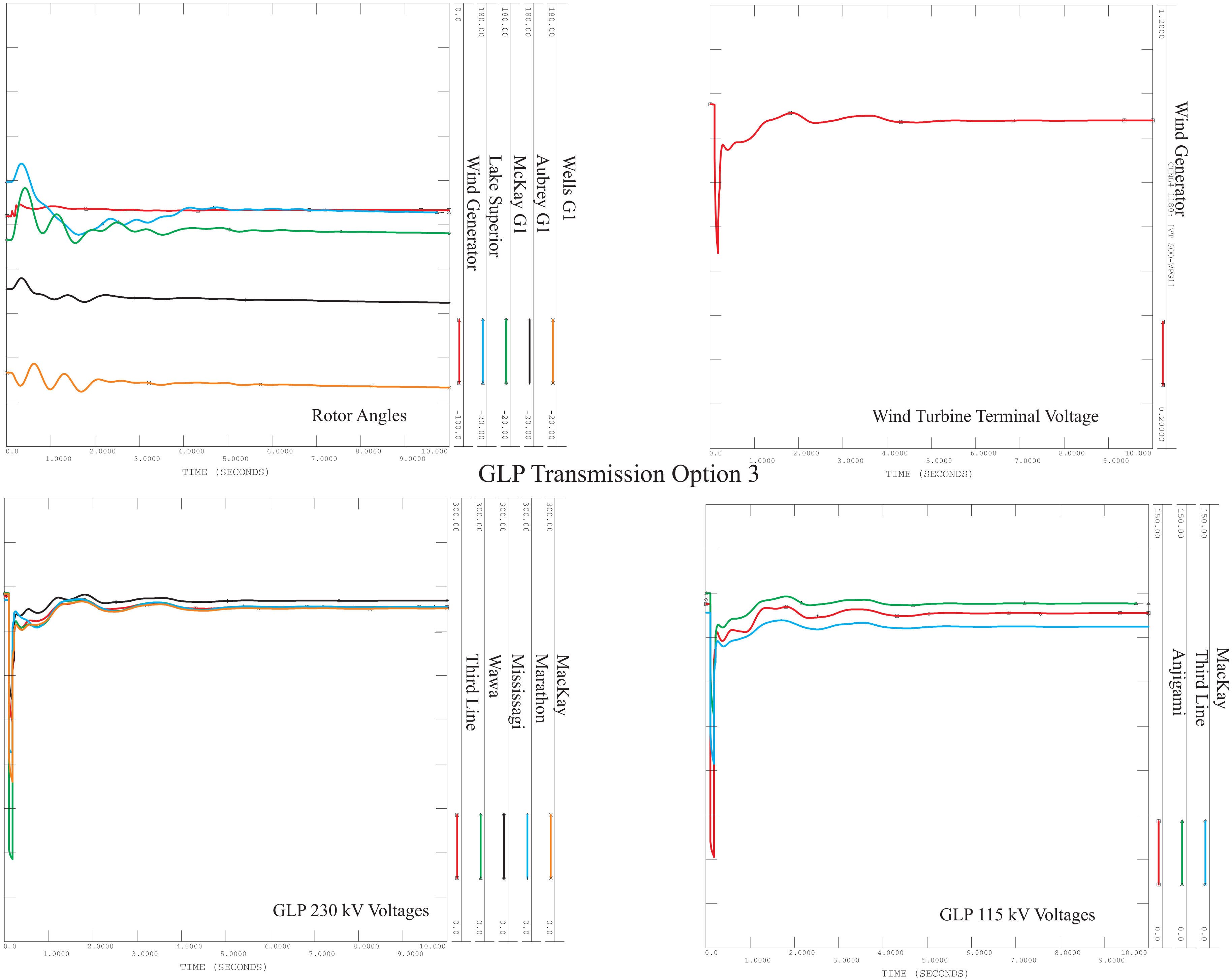


Figure O3-A4. LLG on P26W at Wawa

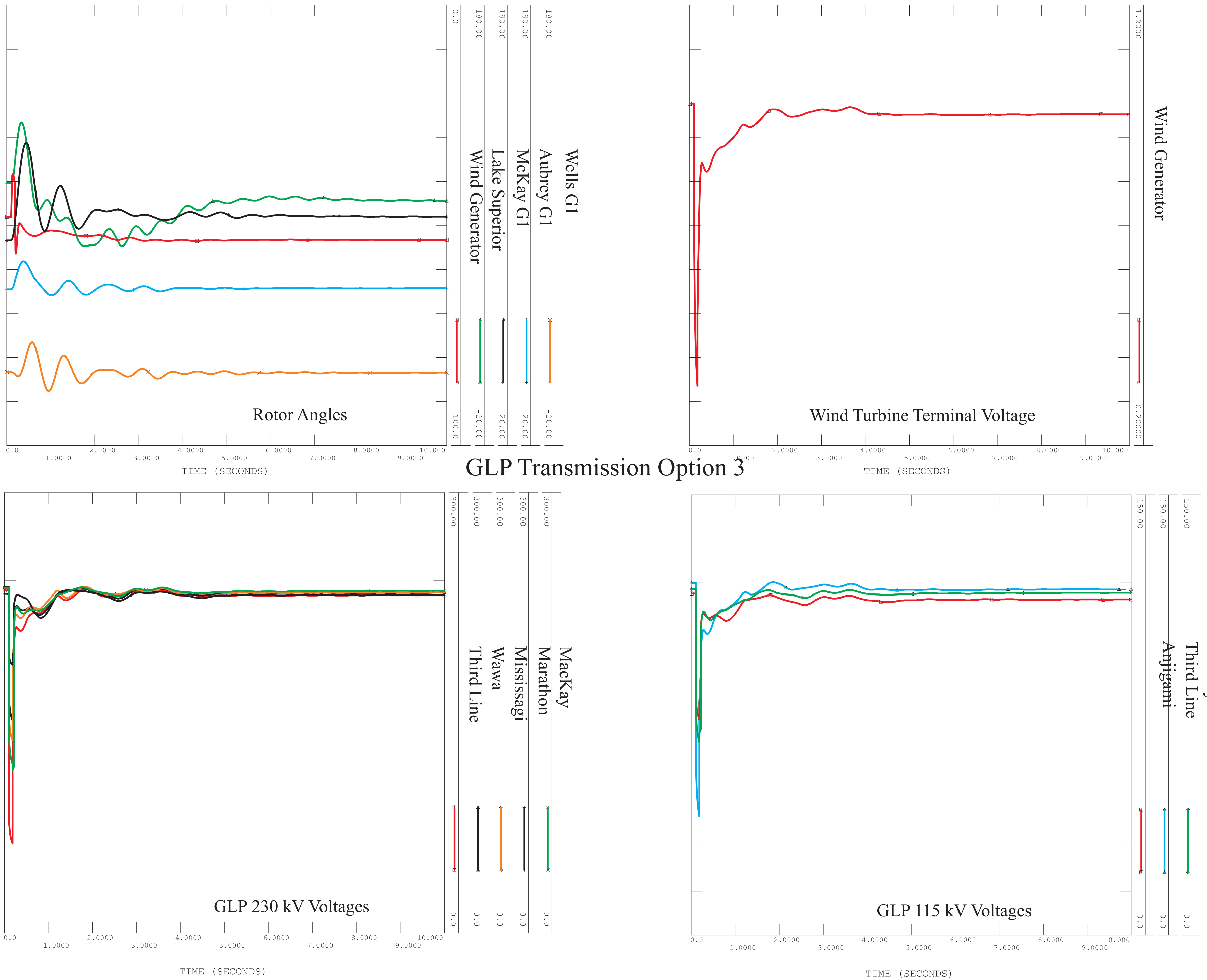


Figure O3-A5. LLG on New 230 kV at Third Line

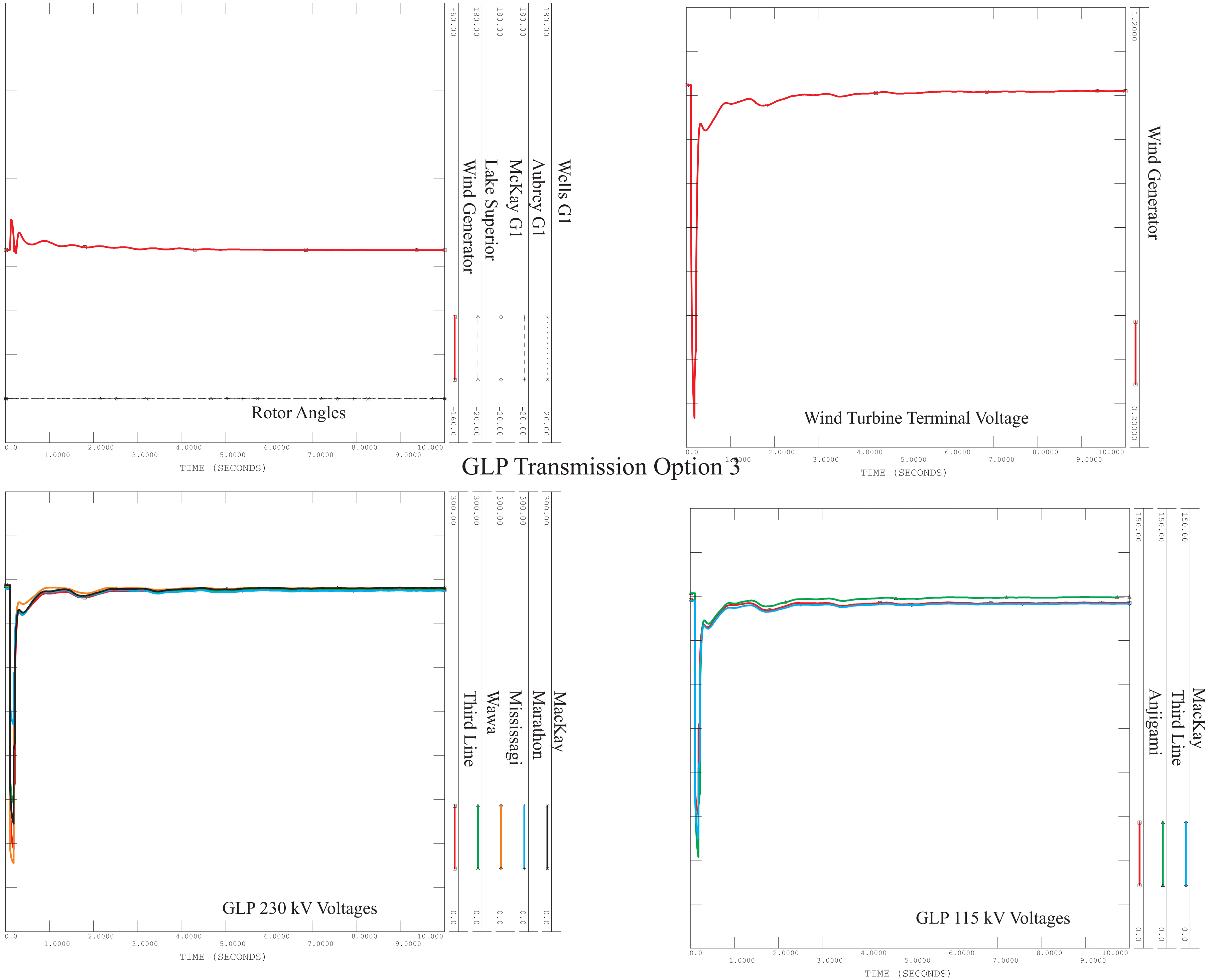


Figure O3-B1. LLG of P21G at Mississagi

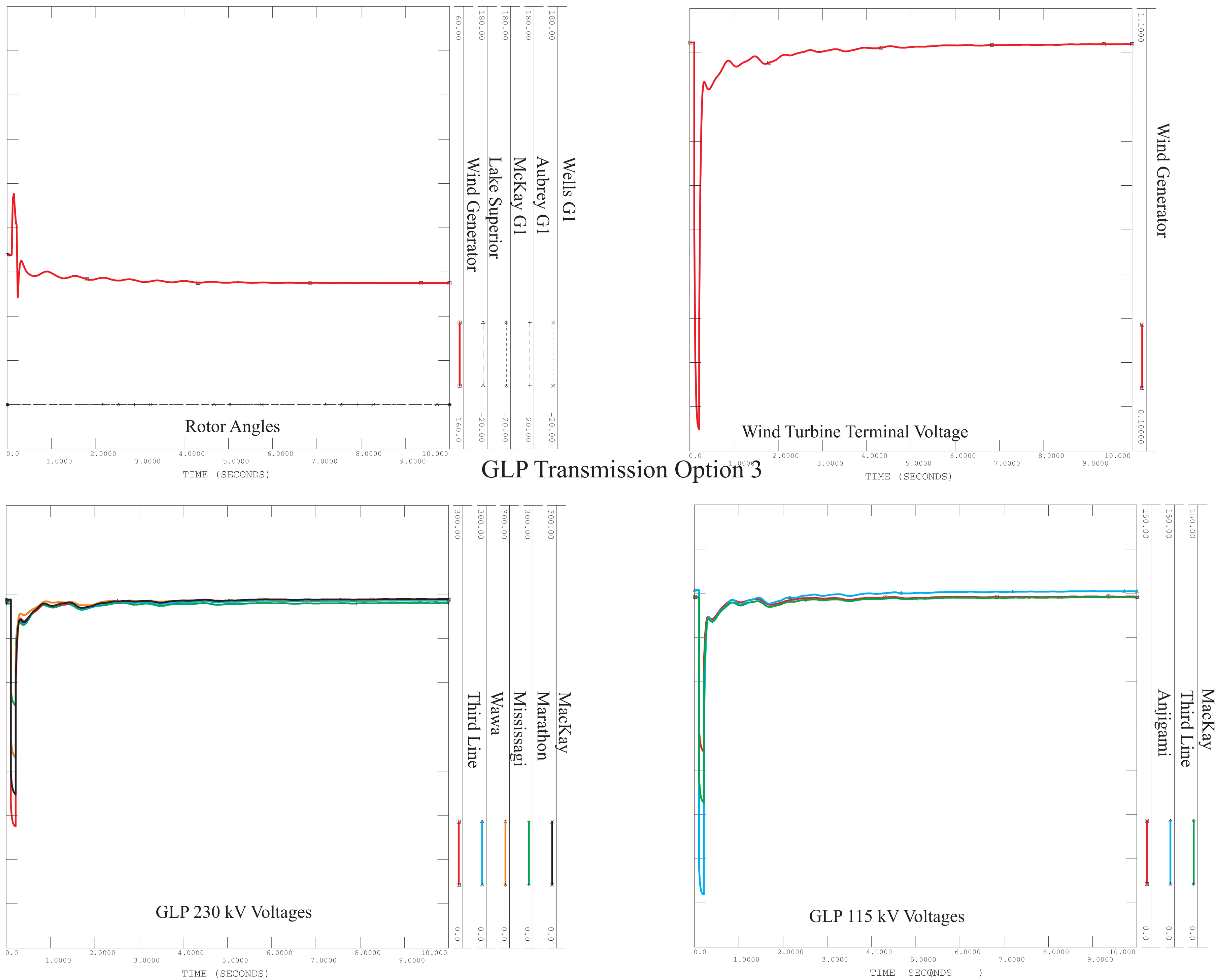


Figure O3-B2. Loss of Third Line T1

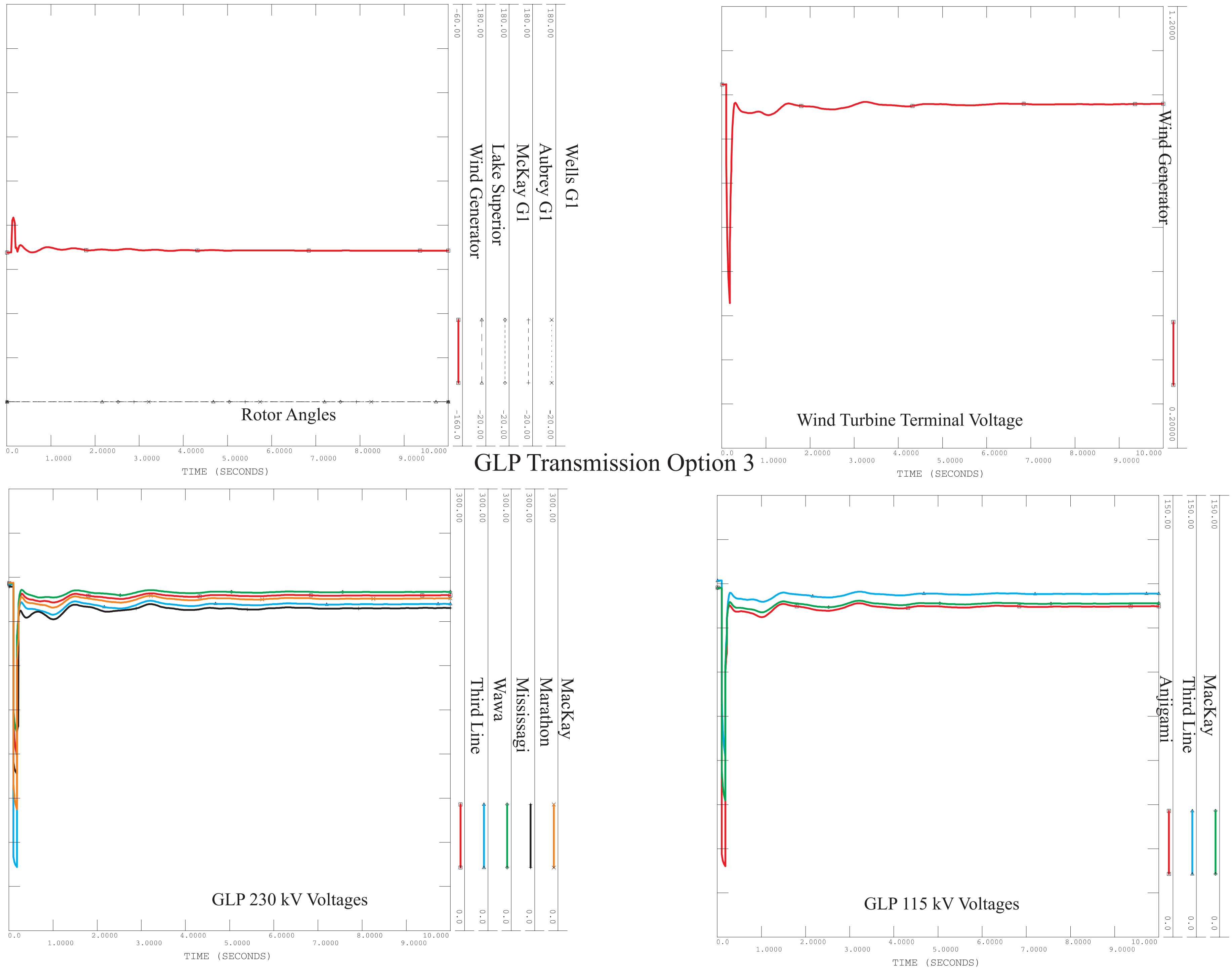


Figure O3-B3. LLG on W22M at Wawa

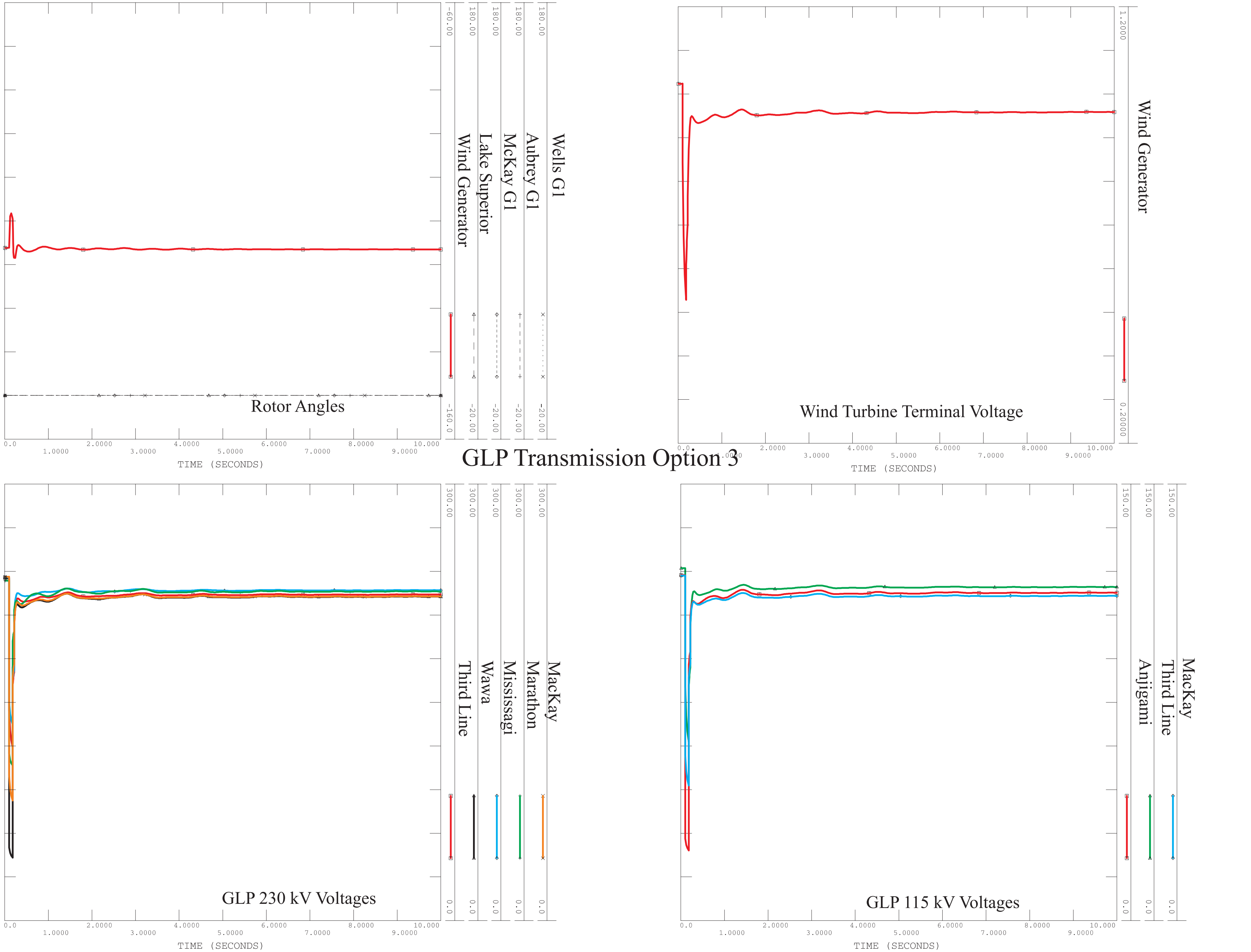


Figure O3-B4. LLG on P26W at Wawa

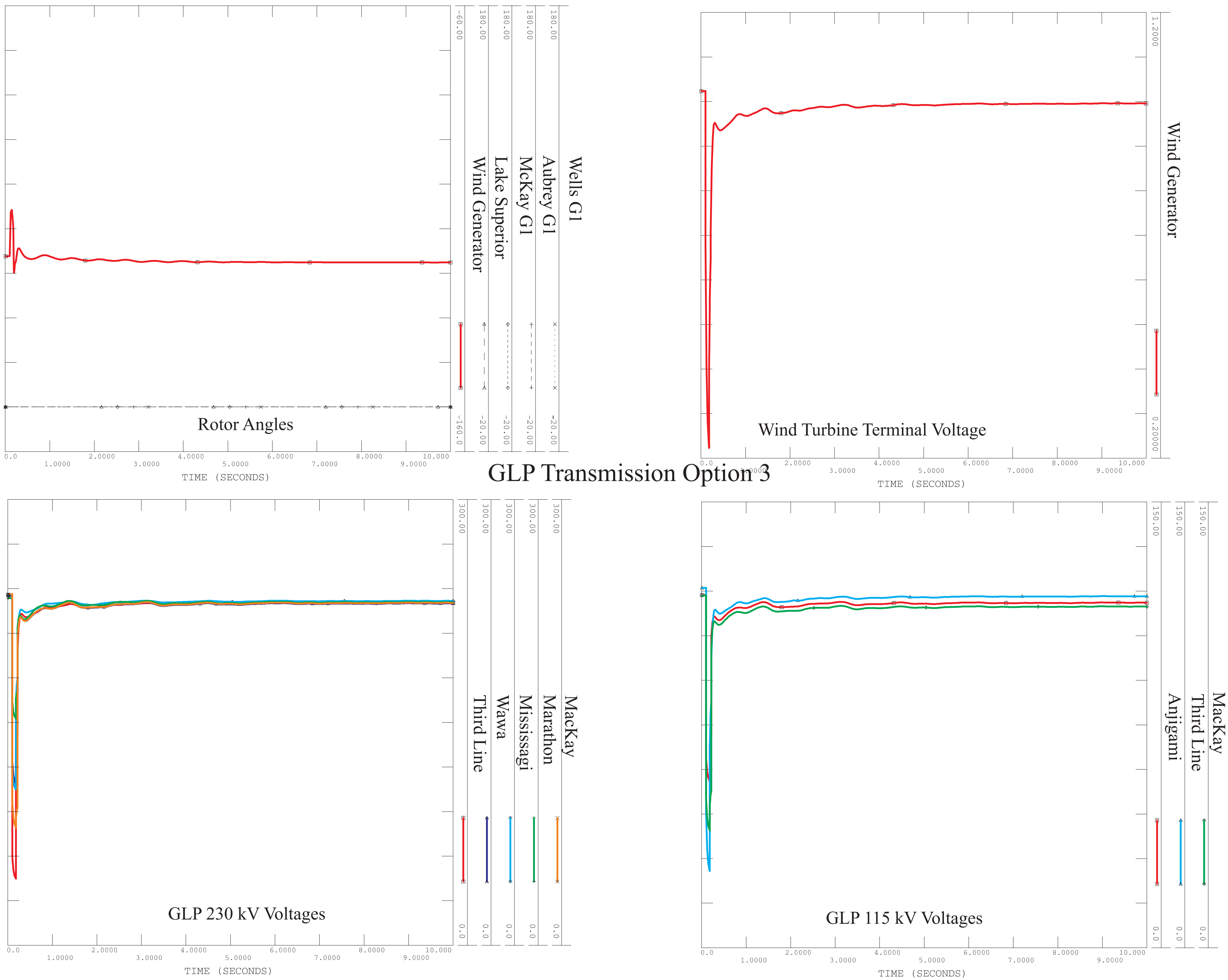
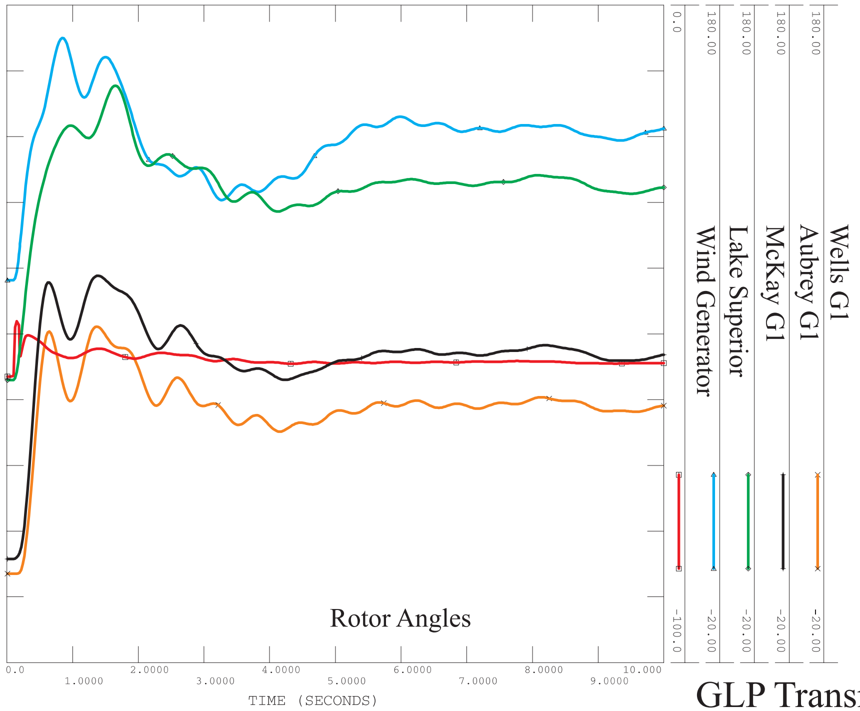
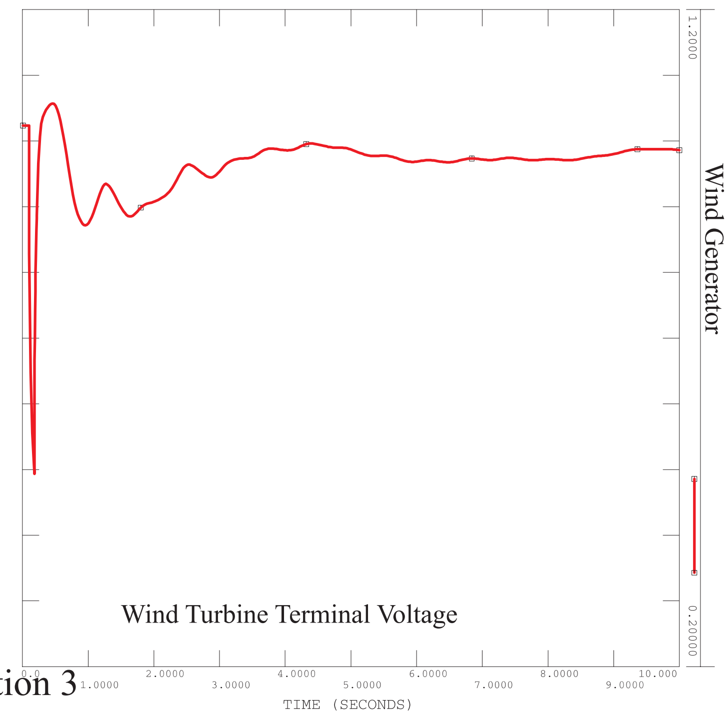
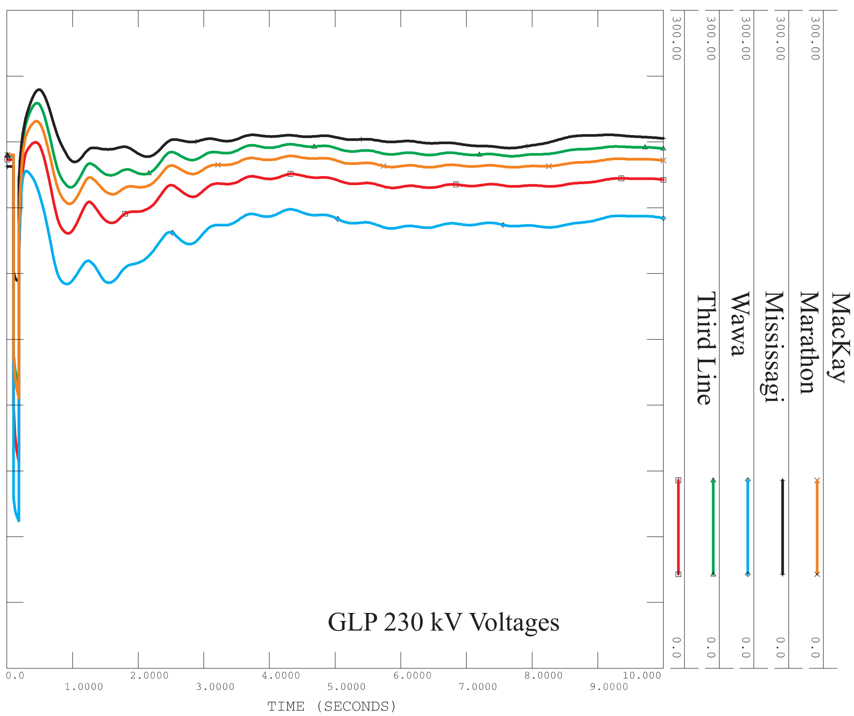


Figure O3-B5. LLG on New 230 kV line at MacKay





GLP Transmission Option 3



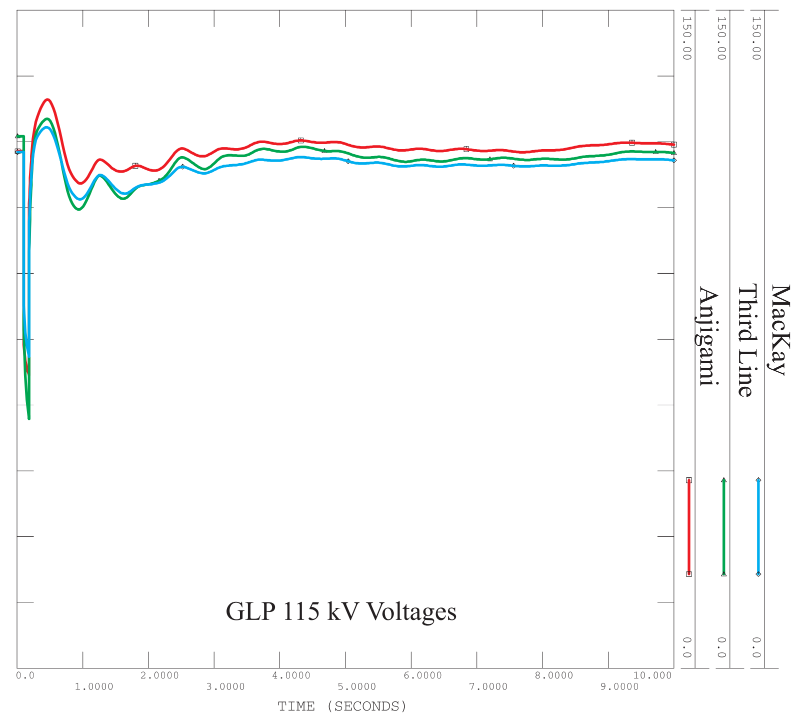


Figure O3-C1. LLG on A23P/A24P at Mississagi