APPENDIX A CONNECTION ASSESSMENT

Engineering Connection Assessment

P2082 Suncor Base Plant Cogeneration Facility Connection

Suncor Energy Inc.

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NOTE:

The conclusions and recommendations in this report are based on the results presented in *Attachment A: Engineering Connection Assessment: Study Results*, which was prepared by a third party consultant in accordance with the AESO Connection Process.

The AESO has reviewed the *Engineering Connection Assessment: Study Results*, and finds it acceptable for the purpose of assessing the potential impacts of the proposed connection on the performance of the Alberta interconnected electric system.

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Attachment A: Engineering Connection Assessment Results

1 Introduction

This AESO Engineering Connection Assessment describes the engineering studies that were completed to assess the impact of the Project (as defined below) on the performance of the Alberta interconnected electric system (AIES). This report also provides the AESO's conclusions and recommendations based on the results of the engineering studies.

Attached to this Engineering Connection Assessment are the results of the engineering studies (see Attachment A) and the scope and methodology used to perform the studies (see Attachment A1 to Attachment A). These attachments provide details regarding the technical criteria, assumptions, and methods for performing these engineering studies, and the results of the engineering studies.

1.1 Project Overview

Suncor Energy Inc. (Market Participant) has submitted a request for system access service to the Alberta Electric System Operator (AESO) to connect its approved Suncor Base Plant Cogeneration Facility[1] (Facility) to the AIES. The Facility is part of the approved amendment to the Suncor Base Plant Industrial Complex's Industrial System Designation (ISD), referred to from here on as the Suncor ISD.[2]

The Market Participant's request includes a request for a Rate STS, *Supply Transmission Service*, contract capacity increase of 815 MW, from 450 MW to 1265 MW, and a request for transmission development (collectively, the Project).

The scheduled in-service date of the Project is July 1, 2022

[1] The Facility is part of the Suncor ISD

[2] Suncor Energy Inc.'s request to have its Industrial System Designation amended was originally approved by the Commission in Decision 25744-D01-2020 on September 24, 2020.

2 Assessment Scope

2.1 Objectives

The objectives of the AESO Engineering Connection Assessment are as follows:

- Assess the impact of the Project on the performance of the AIES.
- Evaluate Project connection alternatives and identify the AESO's preferred alternative.
- Recommend mitigation measures, if required, to reliably connect the Project to the AIES.
- Identify Project dependencies, including any TFO projects or AESO plans to expand or enhance the transmission system that must be completed prior to connection.

2.2 Existing System

Geographically, the Project is located in the AESO planning area of Fort McMurray (Area 25), which is part of the AESO Northeast planning region. Fort McMurray is surrounded by the planning areas of Athabasca/Lac La Biche (Area 27), Cold Lake (Area 28), Peace River (Area 19) and High Prairie (Area 21). The Fort McMurray area borders High Level (Area 18) but there are no direct transmission paths between the two areas.

From a transmission system perspective, Fort McMurray consists primarily of a 240 kV and 144 kV transmission system. The Fort McMurray West 500 kV transmission line (12L41/12L44) connects the Fort McMurray area to Wabamun (Area 40).

Existing constraints in the Fort McMurray planning region are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule) as well as by the following existing remedial action schemes (RASs) and/or other protection schemes:

- RAS 52 – Joslyn (849S) 9L66 Overvoltage Protection
- RAS 53 – Dover (888S) 9L07 Overvoltage Protection
- RAS 61 – Ruth Lake (848S) 9L990 Overvoltage Protection
- RAS 101 – Suncor (Millennium) islanding scheme

2.3 Study Area

The Study Area consists of the AESO planning areas of Fort McMurray (Area 25) and Athabasca/Lac La Biche (Area 27), including the tie lines connecting these planning areas to the rest of the AIES. All transmission facilities within the Study Area will be studied and monitored for violations of the Reliability Criteria (defined in Section 3.1 of Attachment A1).

3 Connection Alternatives

3.1 Overview

The AESO, in consultation with the TFO in the Study Area and the Market Participant, examined seven transmission alternatives to meet the Market Participant's request for system access service, as detailed in Section 3.2.

3.2 Connection Alternatives Examined

Below is a description of the developments associated with the transmission alternatives that were examined for the Project.

The Market Participant experienced significant downtime due to loss of the Ruth Lake-Millennium corridor during the 2016 Fort McMurray wildfires. To mitigate this risk, the Market Participant requires two separate connections to the AIES from the Suncor ISD such that following the loss of a single point of connection the remaining connection is capable of carrying the full STS of the Suncor ISD (1265 MW). This has been considered when identifying the below transmission alternatives.

For alternatives 1 to 5, the new cogeneration units would be connected within the Suncor's ISD and the connection from the Base Plant to the AIES would be reinforced. For alternatives 6 and 7, the new cogeneration units would be connected directly to the AIES.

Alternative 1 – Connect the existing Voyageur 29EDD-94 substation to the existing Thickwood Hills 951S substation via two 240 kV circuits, and increase the thermal rating of the existing 240 kV transmission lines 29PL9-1 and 29PL9-2

This alternative includes the following developments:

- Add two 240 kV transmission lines, approximately 37 kilometers (km) each in length, between the Voyageur 29EDD-94 and Thickwood Hills 951S substations;
- Modify the Thickwood Hills 951S substation, including adding three 240 kV circuit breakers;
- Upgrade the existing 240 kV transmission lines 29PL9-1 and 29PL9-2, approximately 5 km each in length, between the existing Ruth Lake 848S and Millennium 29EDD-1 substations by replacing the existing 240 kV conductor with a 240 kV conductor of a higher capacity;[3] and
- Add or modify associated equipment as required for the above transmission developments

The proposed connection configuration is shown in Figure 3-1.

As part of this alternative involves increasing the rating of 29PL9-1 and 29PL9-2, requiring outages, the interim configuration prior to the commercial operation date of the generation component of the Project would be to normally open 29PL9-1 and 29PL9-2 and energize the two new 240 kV circuits between Voyageur 29EDD-94 and Thickwood Hills 951S in order to maintain the Market Participant's connection to the AIES. This proposed configuration is shown in Figure 3-2.

[3] This work will primarily be completed with the Suncor ISD.

Figure 3-1: Connection Alternative 1

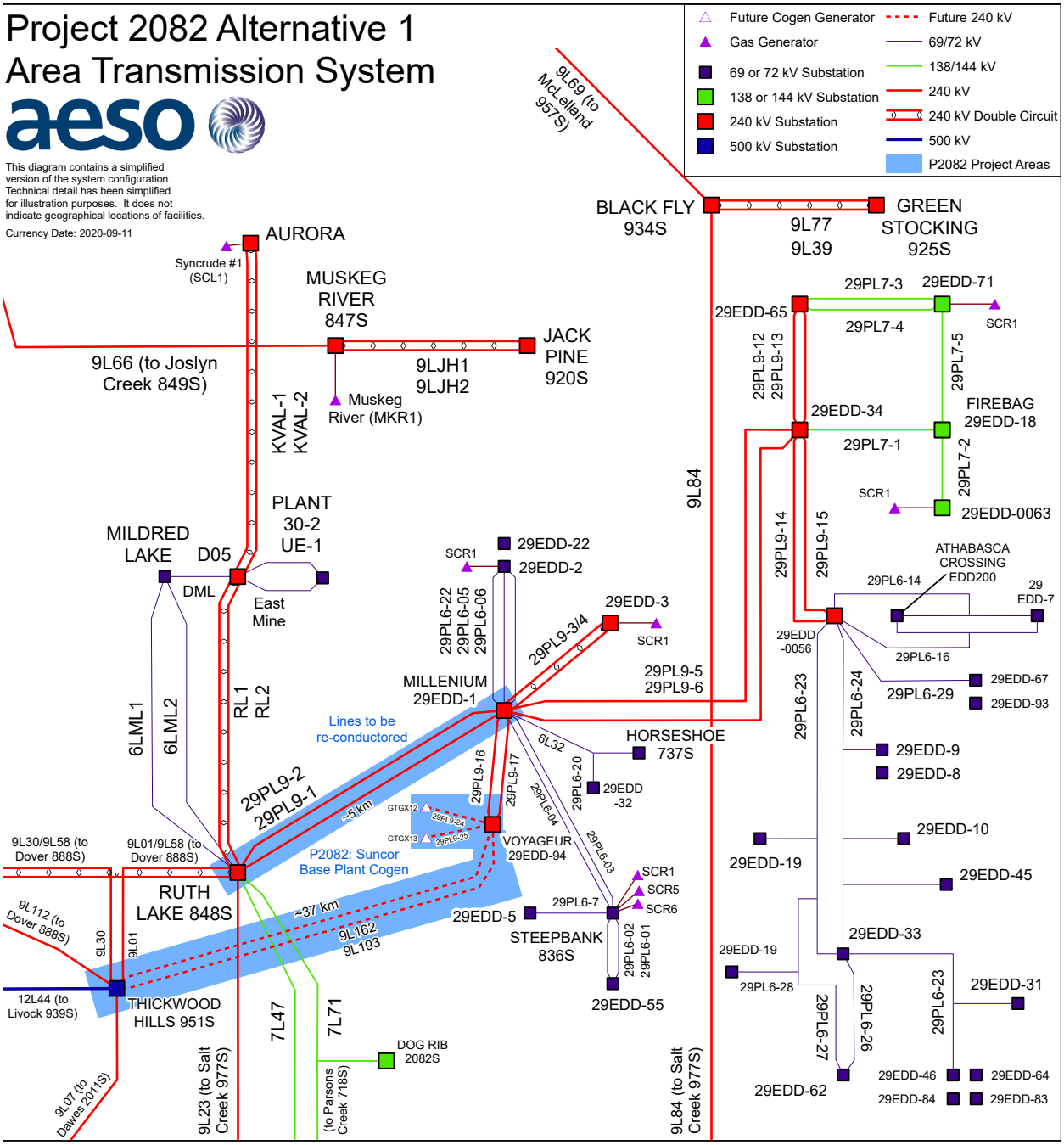
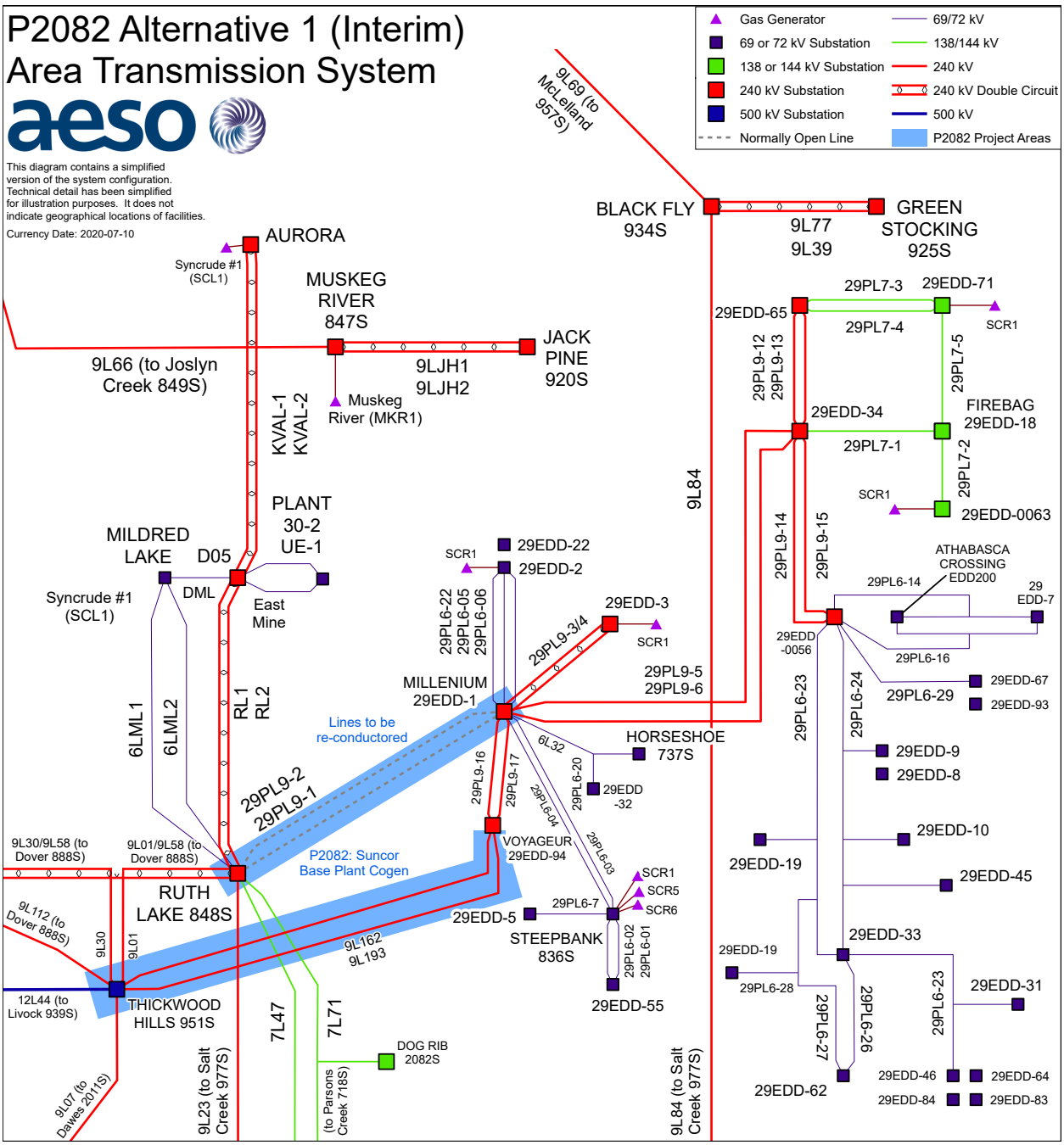


Figure 3-2: Connection Alternative 1 (interim configuration)



Alternative 2 – Connect the Voyageur 29EDD-94 substation and the Thickwood Hills 951S substation with two 240 kV circuits, add a third circuit between Ruth Lake 848S and Millennium 29EDD-1 substations

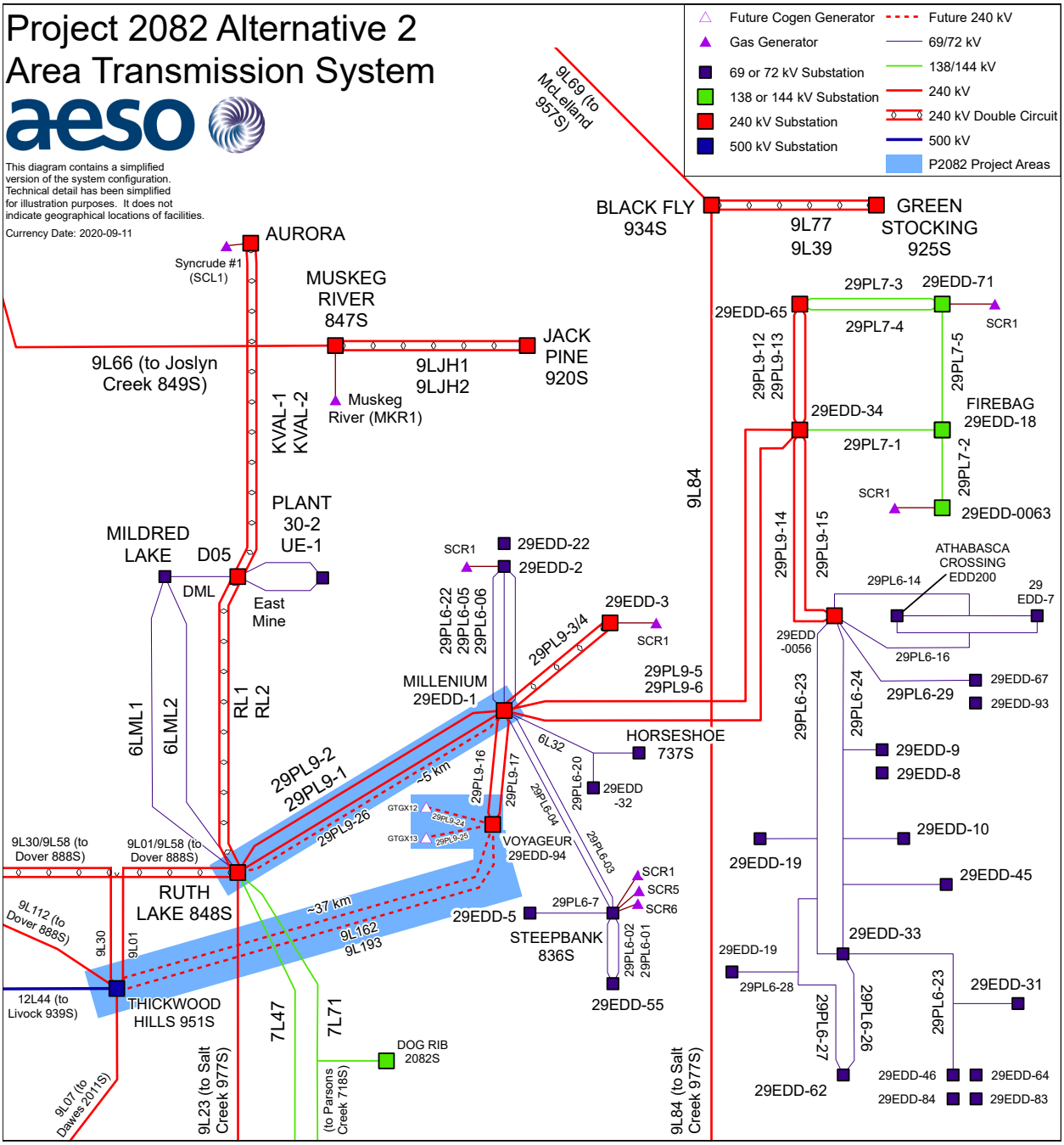
This alternative includes the following developments:

- Add two 240 kV transmission lines, approximately 37 km each in length, between the existing Voyageur 29EDD-94 substation and the Thickwood Hills 951S substation;

- Add one 240 kV transmission line, approximately 5 km in length, between the existing Ruth Lake 848S substation and the existing Millennium 29EDD-1 substation;
- Modify the Thickwood Hills 951S substation, including adding three 240 kV circuit breakers;
- Modify the Ruth Lake 848S substation, including adding one 240 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-3.

Figure 3-3: Connection Alternative 2



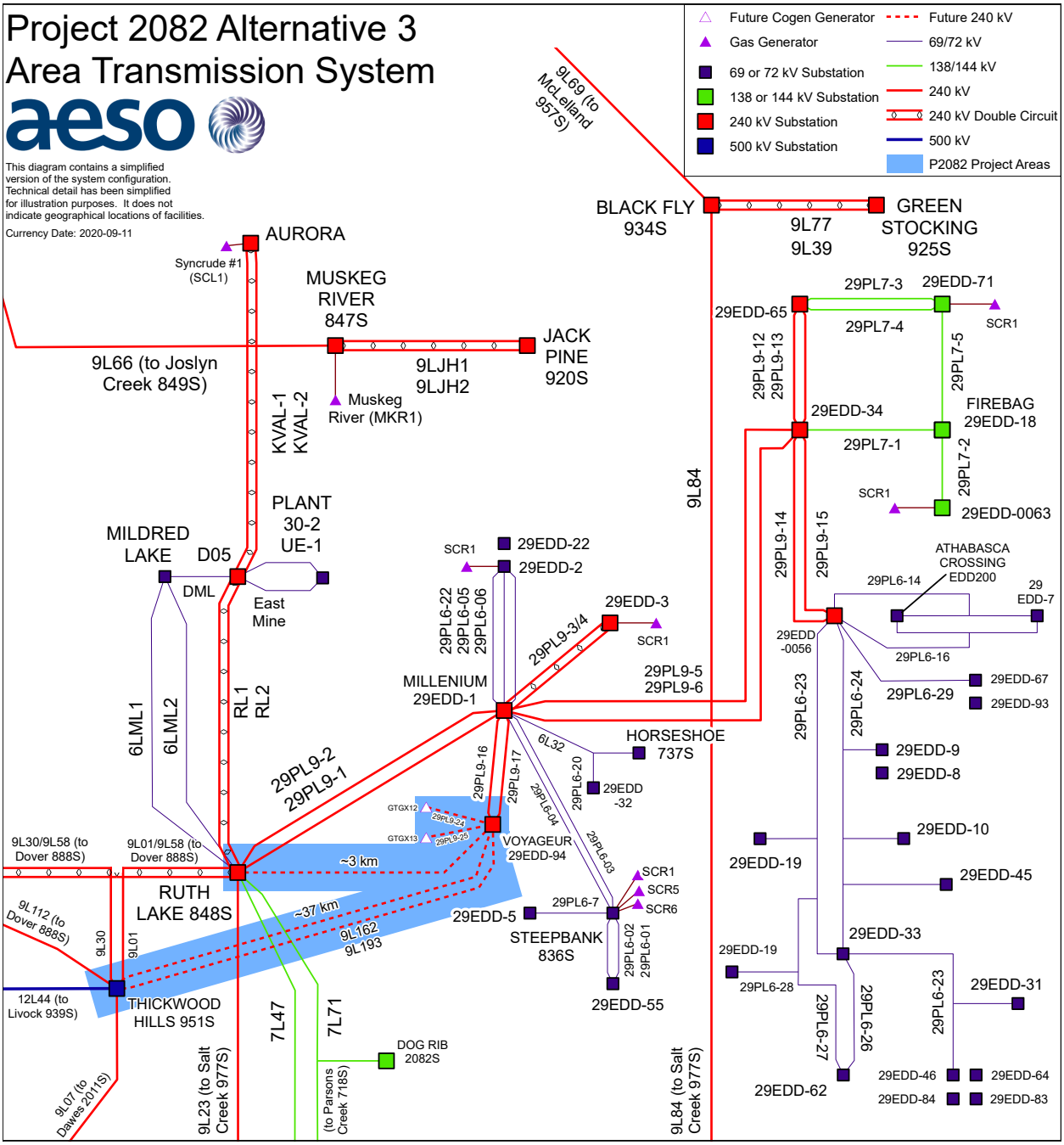
Alternative 3 – Connect the Voyageur 29EDD-94 substation and the Thickwood Hills 951S substation with two 240 kV circuits, add a third circuit between Ruth Lake 848S and Voyageur 29EDD-94 substations

This alternative includes the following developments:

- Add two 240 kV transmission lines, approximately 37 km each in length, between the Voyageur 29EDD-94 substation and the Thickwood Hills 951S substation;
- Add one 240 kV transmission line, approximately 3 km in length, between the Ruth Lake 848S and Voyageur 29EDD-94 substations;
- Modify the Thickwood Hills 951S substation, including adding three 240 kV circuit breakers; and
- Add or modify associated equipment as required for the above transmission developments

The proposed connection configuration is shown in Figure 3-4.

Figure 3-4: Connection Alternative 3



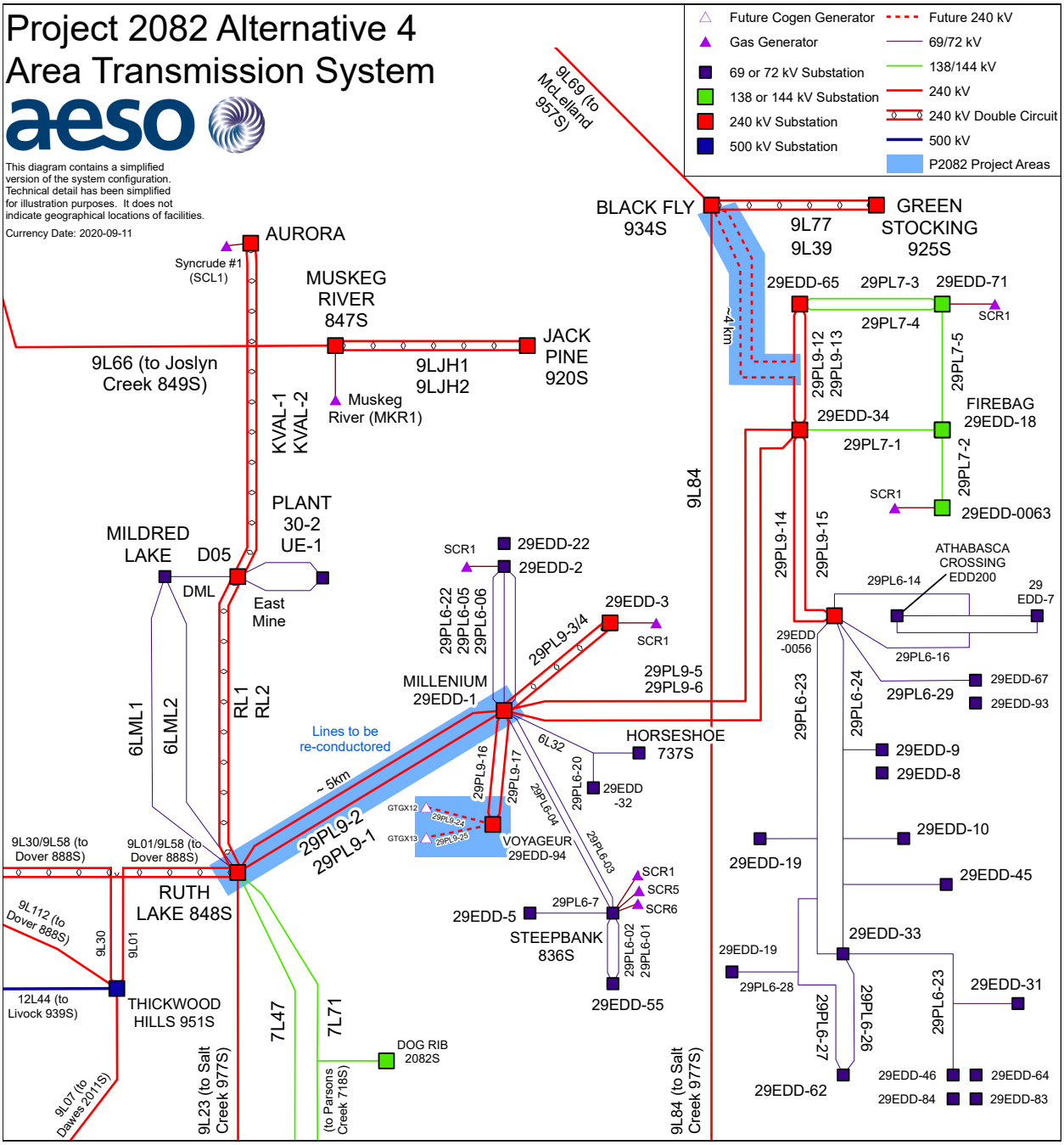
Alternative 4 – Connect the Black Fly 934S substation to the 240 kV transmission line 29PL9-12 via an in and out configuration

This alternative includes the following developments:

- connecting the existing Black Fly 934S substation to the existing 240 kV transmission line 29PL9-12 in an in-and-out configuration, by adding two 240 kV circuits approximately 4 km each in length.
- Modify the Black Fly 934S substation, including adding two 240 kV circuit breakers;
- Upgrade the existing 240 kV transmission lines 29PL9-1 and 29PL9-2, approximately 5 km each in length, between the existing Ruth Lake 848S and Millennium 29EDD-1 substations by replacing the existing 240 kV conductor with a 240 kV conductor of a higher capacity; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-5.

Figure 3-5: Connection Alternative 4



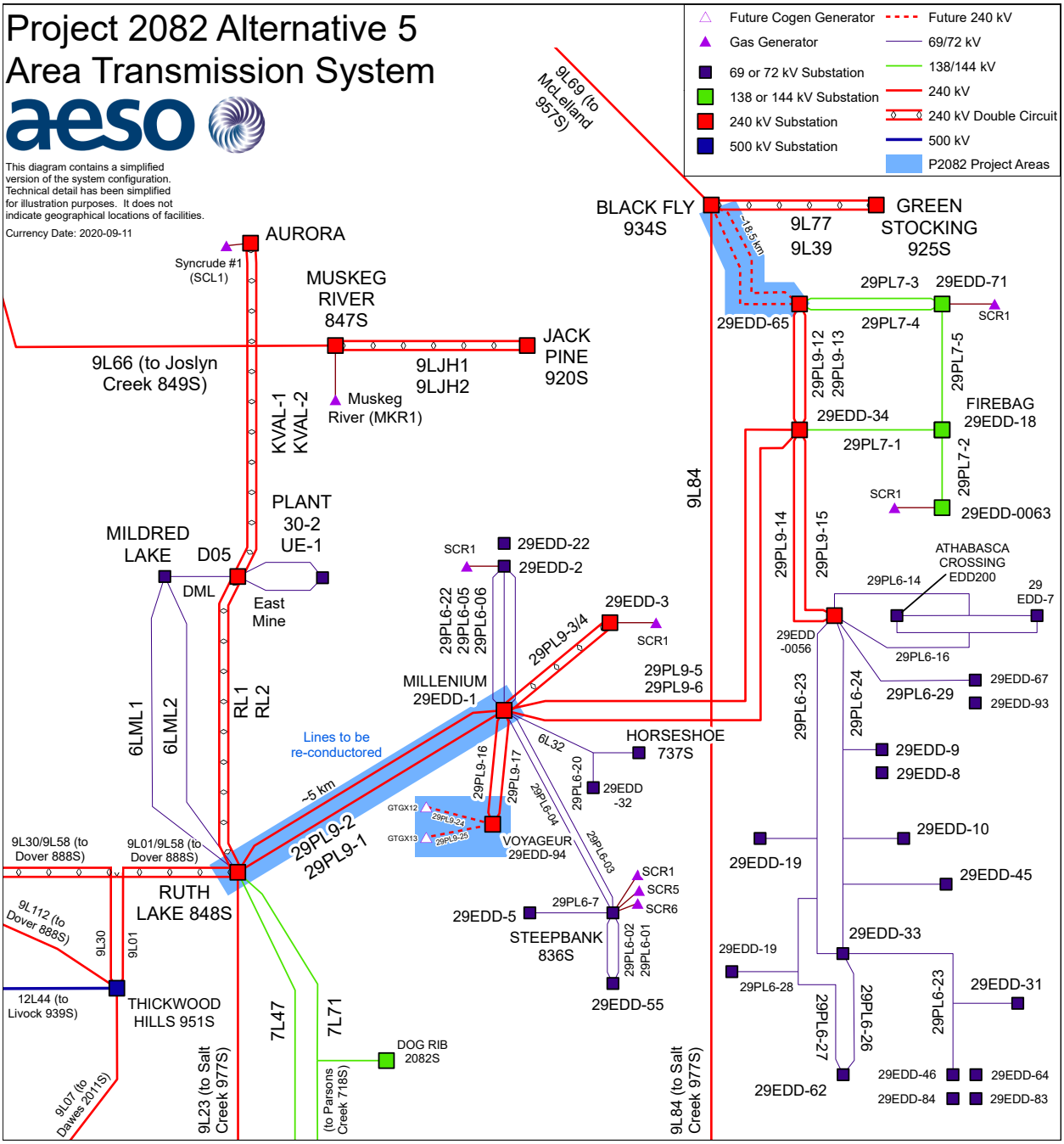
Alternative 5 – Connect the 29EDD-65 substation and the Black Fly 934S substation with two 240 kV circuits

This alternative includes the following developments:

- Add two 240 kV transmission lines, approximately 18.5 km each in length, between the existing 29EDD-65 substation and the existing Black Fly 934S substation;
- Modify the Black Fly 934S substation, including adding two 240 kV circuit breakers;
- Upgrade the existing 240 kV transmission lines 29PL9-1 and 29PL9-2, approximately 5 km each in length, between the existing Ruth Lake 848S and Millennium 29EDD-1 substations by replacing the existing 240 kV conductor with a 240 kV conductor of a higher capacity; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-6.

Figure 3-6: Connection Alternative 5



Alternative 6 – Connect the Facility to Thickwood Hills 951S substation with two 240 kV circuits

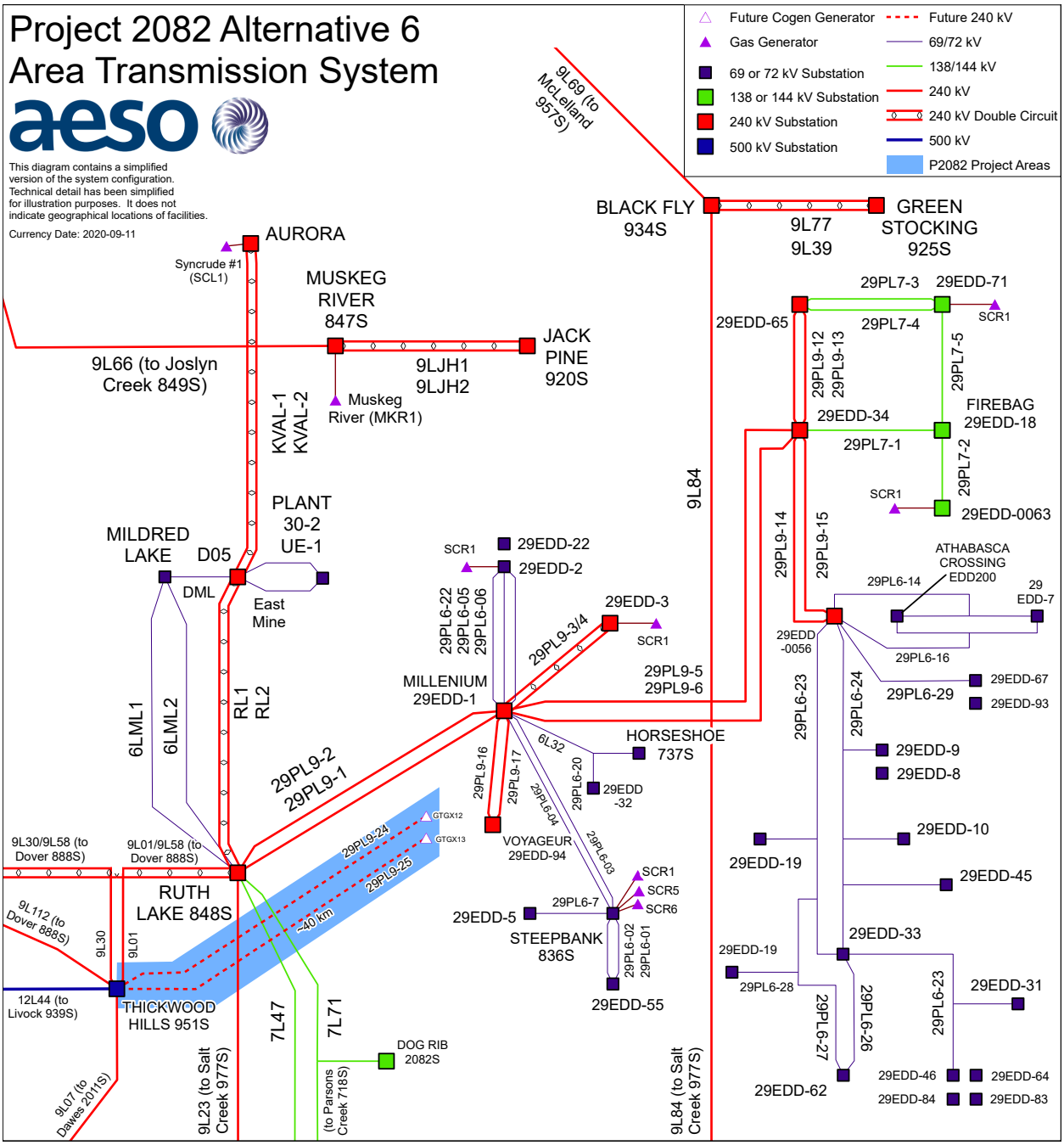
This alternative includes the following developments:

- Add two 240 kV transmission lines, approximately 40 km each in length, to connect the Facility to the Thickwood Hills 951S substation;

- Modify the Thickwood Hills 951S substation, including adding three 240 kV circuit breakers; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-7.

Figure 3-7: Connection Alternative 6



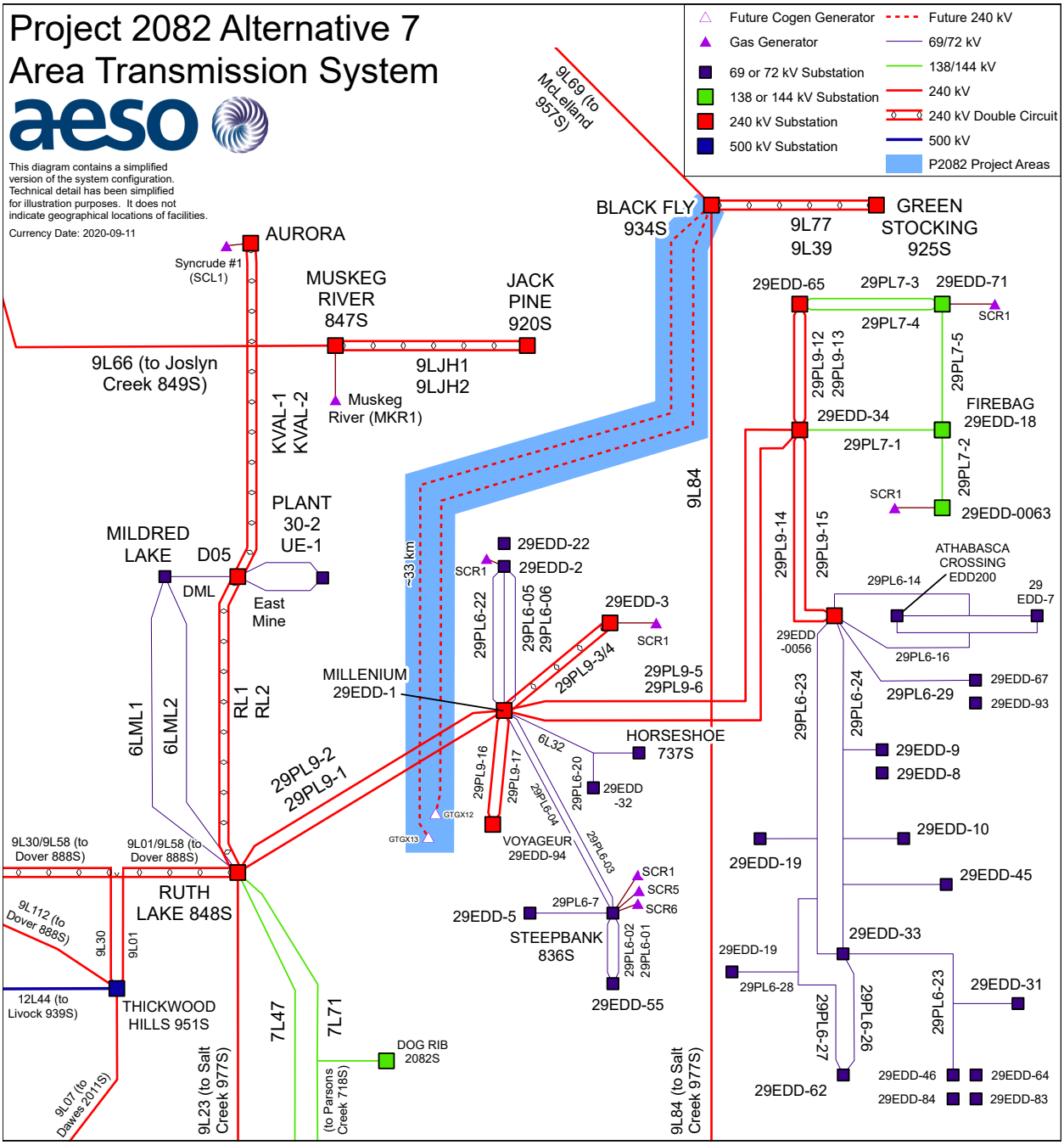
Alternative 7 – Connect the Facility to Black Fly 934S substation with two 240 kV circuits

This alternative includes the following developments:

- Add two 240 kV transmission lines, approximately 33 km each in length, to connect the Facility to the existing Black Fly 934S substation;
- Modify the Black Fly 951S substation, including adding two 240 kV circuit breakers; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-8.

Figure 3-8: Connection Alternative 7



3.3 Connection Alternatives Selected for Further Study

Alternative 1 is considered technically feasible and was selected for further study.

3.4 Connection Alternatives Not Selected for Further Study

Alternative 2 is ruled out as the Market Participant provided information supporting that adding a third line between Ruth Lake 848S and Millennium 29EDD-1 substations involves increased transmission development and hence increased cost compared to reconductoring the existing transmission lines 29PL9-1 and 29PL9-2.

Alternative 3 is ruled out as the TFO and Market Participant determined that the line between Voyageur 29EDD-94 and Ruth Lake 848S substations is not constructible due to existing structures (transmission lines, pipeline corridors, other easements) occupying the corridor.

Alternative 4 and 5 are ruled out as the Market Participant determined that the lines to and around 29EDD-65 and Black Fly 934S substations are not constructible due to routing/right-of-way issues within its ISD. In addition, the Market Participant performed a preliminary study of its ISD and found that certain ISD-internal facilities could become lightly loaded as a result of the new path to Black Fly 934S substation, which could create operational issues.

The Market Participant plans to use the new cogeneration units to first serve on-site load at its Base Plant. Alternative 6 and alternative 7 are ruled out as they would require electricity produced by the new cogeneration units to flow through the AIES before serving the Base Plant load.

4 Assessment Approach

4.1 Standards, Criteria and Assumptions

A detailed description of the standards, criteria, and assumptions that were used for the connection assessment is provided in Attachment A (see Attachment A1).

4.2 Studies Performed

The scheduled in-service date for the Project is July 1, 2022. At the time of study, the targeted generator commercial operation date was Q3 2023. Therefore, studies were performed using scenarios for 2023 SP, SL, and WP to model the expected commercial operation date of the generation.

Short-circuit studies were performed using the 2023WP and 2029WP scenarios.

After completion of the studies, the commercial operation date was delayed to 2024. The AESO determined that this would have no material impact on the studies as the studies show a more conservative case due to lower forecasted load in 2023 compared to 2024 and thus higher net export from the region.

Table 4-1 lists the study scenarios. Post-Project scenarios reflect the requested Rate STS contract capacity increase of 815 MW for the Market Participant's ISD, measured at Ruth Lake 848S and Thickwood 951S substations.

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Generation (MW)	Suncor Net-to-Grid Generation (MW)
Pre-Project					
1	2023 SP	High Northeast Generation	2023 SP Pre-Project	0	450
2	2023 SL		2023 SL Pre-Project	0	450
3	2023 WP		2023 WP Pre-Project	0	450
Post-Project					
4	2023 SP	High Northeast Generation	2023 SP Post-Project	815	1265
5	2023 SL		2023 SL Post-Project	815	1265
6	2023 WP		2023 WP Post -Project	815	1265
7	2029 WP	All study area generation in service	2029 WP Post-Project	815	1265

The AESO Northeast Planning Region load forecasts used for the connection studies were based on the *2019 Long-term Outlook* (2019LTO).

4.2.1 Power Flow Studies

The purpose of the power flow studies is to identify and quantify any thermal and voltage criteria violations in the Study Area.

In addition, power flow studies are also used to identify point of delivery (POD) low voltage bus voltage deviations beyond the limits listed in Table 3-1 of Attachment A1.[4]

Power flow studies were performed for the 2023 SP, SL and WP pre-Project and post-Project scenarios.

4.2.2 Transient Stability Studies

The purpose of the transient stability studies is to assess the post-Project stability of the transmission system after three-phase to ground faults are applied on select transmission lines in the Study Area.

Transient stability studies were performed for the 2023 SP, SL and WP post-Project scenarios.

4.2.3 Short-Circuit Current Level Studies

The purpose of short-circuit current level studies is to determine the expected system short-circuit current levels in the vicinity of the Project.

Short circuit studies were performed for the 2023 WP pre-Project and 2023/2029 WP post-Project scenarios.

4.3 Mitigation Measure Development and Evaluation

As explained in Section 6 of Attachment A1, mitigation measures were developed to address system performance issues that were identified in the post-Project scenarios. Studies performed to assess the effectiveness of mitigation measures are briefly outlined below.

4.3.1 Post-Mitigation Studies

Power flow studies were performed to assess the impact of the Project on the performance of the AIES following implementation of the AESO's proposed mitigation measures.

4.3.2 Constraint Effective Factor Studies

Constraint effective factor studies were used to determine the generator and load constraint effective factors and to identify the most effective generators or loads to manage thermal criteria violations that were observed under Category B conditions.

[4] The AESO's desired post-contingency voltage deviations for low voltage busses represent guidelines rather than criteria. A POD bus voltage deviation that exceeds the desired limits shown in Table 3-1 of Attachment A1 does not represent a Reliability Criteria violation. Mitigation measures would not be developed to specifically address POD bus voltage deviations that exceed the desired values in Table 3-1 of Attachment A1.

5 Interpretation of Results

5.1 Results Overview

This section provides an assessment of the impact of the Project on the performance of the AIES. The Reliability Criteria violations observed during the connection assessment studies, and the proposed mitigation measures are summarized in Table 5-1.

- Section 5.2 includes an overview of the pre-Project studies results.
- Section 5.3 includes an overview of the post-Project studies results.
- Section 5.4 includes a description of the proposed mitigation measures to address observed Reliability Criteria violations.
- Section 5.5 includes an overview of the post-mitigation studies results.

Detailed study results are provided in Attachment A.

Table 5-1: Summary of Reliability Criteria Violations, Project Impact and Mitigation Measures

Scenario	Type of Reliability Criteria Violation		Contingency (System Element Lost)	Details of Violation	Project Impact	Pre-Project Mitigation Measures	Post-Project Mitigation Measures
	Pre-Project	Post-Project					
2023 SL	None	Thermal - above emergency rating	12L41 (Sunnybrook 510S - Livock 939S)	9L74 (Dover 888S - Birchwood Creek 960S)	New thermal criteria violation	N/A	New RAS - FMM Outflow Line Overload Mitigation Scheme
	None	Thermal - above normal rating	12L41 (Sunnybrook 510S - Livock 939S)	9L57 (Livock 939S - Birchwood Creek 960S)	New thermal criteria violation	N/A	New RAS - FMM Outflow Line Overload Mitigation Scheme
	None	Thermal - above emergency rating	951S1201T (Thickwood Hills 951S Transformer 1201T)	9L74 (Dover 888S - Birchwood Creek 960S)	New thermal criteria violation	N/A	New RAS - FMM Outflow Line Overload Mitigation Scheme
	None	Thermal - above normal rating	951S1201T (Thickwood Hills 951S Transformer 1201T)	9L57 (Livock 939S - Birchwood Creek 960S)	New thermal criteria violation	N/A	New RAS - FMM Outflow Line Overload Mitigation Scheme
	None	Thermal - above emergency rating	12L44 (Thickwood Hills 951S - Livock 939S)	9L74 (Dover 888S - Birchwood Creek 960S)	New thermal criteria violation	N/A	New RAS - FMM Outflow Line Overload Mitigation Scheme
	None	Thermal - above normal rating	12L44 (Thickwood Hills 951S - Livock 939S)	9L57 (Livock 939S - Birchwood Creek 960S)	New thermal criteria violation	N/A	New RAS - FMM Outflow Line Overload Mitigation Scheme

5.2 Pre-Project Study Results

5.2.1 Category A Conditions

No Reliability Criteria violations were observed under the Category A conditions (i.e., all elements in service) for any of the pre-Project scenarios. The short-circuit fault levels were found to be within the typical capabilities of the nearby facilities.

5.2.2 Category B Conditions

No reliability criteria violations were observed under Category B conditions.

No voltage deviations were observed that were beyond the limits listed in Table 3-1 of Attachment A1 (hereafter referred to as point of delivery (POD) bus voltage deviations) under Category B conditions.

5.3 Post-Project Study Results

5.3.1 Category A Conditions

No Reliability Criteria violations were observed under Category A conditions for any post-Project scenarios following adjustment of the Livock 939S phase-shifting transformer. Post-Project short-circuit fault levels were not significantly higher than pre-Project levels.

The long-term short circuit levels were found to be within the designed capabilities of the nearby facilities.

5.3.2 Category B Conditions

Post-Project power flow studies identified several system performance issues under Category B conditions, namely: thermal criteria violations.

Results did not indicate any transient stability concerns, and the system showed acceptable dynamic response to all Category B conditions studied.

5.4 Mitigation Measures

This section discusses the AESO's proposed mitigation measures to address the system performance issues that were identified in the pre-Project and post-Project scenarios.

5.4.1 Pre-Project

Prior to connection of the Project, all of the observed thermal criteria violations can be managed by using real-time operational practices.

5.4.2 Post-Project

After the Project is connected, the use of real-time operational practices and a new RAS is required to mitigate observed Reliability Criteria violations under certain Category B conditions. Based on the study results, there are thermal criteria violations observed after a contingency is observed on any portion of the Fort McMurray 500 kV West path, including the Thickwood Hills 951S substation 240/500 kV transformer. These criteria violations can be mitigated by a new RAS, referred to as the "FMM Outflow Line Overload

Mitigation Scheme," which monitors Fort McMurray outflow and the status of the Fort McMurray 500 kV West path.

5.4.3 Post-Project Mitigation Study Results

Under Category B conditions, all of the observed Reliability Criteria violations resulting from a contingency on the Fort McMurray 500 kV West path were mitigated following simulated action of the proposed FMM Outflow Line Overload Mitigation Scheme.

6 Project Dependencies

The Project does not require the completion of any other AESO plans to expand or enhance the transmission system prior to connection

7 Conclusions and Recommendations

Based on the study results, Alternative 1 is technically viable. The connection assessment identified several post-Project system performance issues.

These issues can be mitigated through the use of the new proposed RAS and adjusting the Livock 939S phase-shifting transformer. With implementation of these mitigation measures, connecting the project with the preferred alternative does not adversely affect the performance of the AIES.

The AESO recommends proceeding with the Project using Alternative 1 as the preferred alternative to respond to the Market Participant ’s request for system access service. The RAS mentioned above is recommended to mitigate the identified system performance issues.

Alternative 1 involves adding two 240 kV circuits to connect the existing Voyageur 29EDD-94 substation and the existing Thickwood Hills 951S substation, reconductoring the existing 240 kV transmission lines 29PL9-1 and 29PL9-2, and modifying the Thickwood Hills 951S substation, including by adding three 240 kV circuit breakers.

The conductor used for the new 240 kV circuits between Thickwood Hills 951S and Voyageur 29EDD-94 as well as the reconductored 29PL9-1/29PL9-2 should have a minimum thermal rating of 703 MVA each to meet the Market Participant’s requirements.

Attachment A:
Engineering Connection Assessment Results

Engineering Connection Assessment: Study Results

P2082 Suncor Base Plant Cogen

Suncor Energy Inc.

Date: October 29, 2020
Version: V1D2
Classification: Public

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October 30, 2020

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1 Introduction

This report presents the results of the engineering studies that were completed by Teshmont Consultants LP (the Studies Consultant) to assess the impact of the Project (as defined in Attachment A1: AESO Engineering Connection Assessment Scope) on the performance of the Alberta interconnected electric system (AIES). The studies were performed in accordance with Attachment A1: AESO Engineering Connection Assessment: Study Scope, which was prepared by the AESO.

The power system network analysis tool that was used for the studies in this connection assessment was PSS/E version 33.

2 Pre-Project Study Results

This section describes the results of the pre-Project power flow studies. The Pre-Project study scenarios are outlined in Table 2-1.

Table 2-1: Pre-Project Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Condition	Scenario Name
1	2023 Summer Peak (SP)	High Northeast Generation	2023 SP Pre-Project
2	2023 Summer Light (SL)	High Northeast Generation	2023 SL Pre-Project
3	2023 Winter Peak (WP)	High Northeast Generation	2023 WP Pre-Project

2.1 Power Flow Studies

Power flow diagrams illustrating the pre-Project power flow studies results for Category A and Category B conditions are provided in Attachment A2.

2.1.1 Scenario 1: 2023 SP Pre-Project

Category A Condition

No Reliability Criteria (as defined in Section 3.1 of Attachment A1) violations were observed under Category A condition.

Category B Conditions

Thermal Criteria Violations

No thermal criteria violations were observed under Category B conditions.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

2.1.2 Scenario 2: 2023 SL Pre-Project

Category A Condition

No Reliability Criteria violations were observed under Category A condition.

Category B Conditions

Thermal Criteria Violations

No thermal criteria violations were observed under Category B conditions.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

2.1.3 Scenario 3: 2023 WP Pre-Project

Category A Condition

No Reliability Criteria (as defined in Section 3.1 of Attachment A1) violations were observed under Category A condition.

Category B Conditions

Thermal Criteria Violations

No thermal criteria violations were observed under Category B conditions.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3 Post-Project Study Results

This section describes the results of the post-Project power flow studies and transient stability studies.

The Post-Project study scenarios are outlined in *Table 3-1*.

Table 3-1: Post-Project Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Condition	Scenario Name
4	2023 Summer Peak (SP)	High Northeast generation	2023 SP Post-Project
5	2023 Summer Light (SL)	High Northeast generation	2023 SL Post -Project
6	2023 Winter Peak (WP)	High Northeast generation	2023 WP Post -Project

As described in Section 2 of Attachment A1, the post-Project studies were performed using Alternative 1.

3.1 Power Flow Studies

Power flow diagrams illustrating the post-Project power flow studies results for Category A and Category B conditions are included in Attachment A3.

3.1.1 Scenario 4: 2023 SP Post-Project

Category A Condition

No Reliability Criteria violations were observed under Category A condition.

Category B Conditions

Thermal Criteria Violations

No thermal criteria violations were observed under Category B Conditions.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3.1.2 Scenario 5: 2023 SL Post-Project

Category A Condition

No Reliability Criteria violations were observed under Category A condition.

Category B Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category B conditions as shown in Table 3-2.

Table 3-2: Thermal Criteria Violations under Category B Conditions for Scenario 5

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating[a] (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow[b] (MVA)	% Loading[c]	Observed Power Flow (MVA)	% Loading	
12L41 (Sunnybrook 510S - Livock 939S)	9L74 (Dover 888S - Birchwood Creek 960S)	423.0	501.0	302.0	71.4	560.8	132.6	61.2
	9L57 (Livock 939S - Birchwood Creek 960S)	493.0	584.0	260.7	52.9	514.0	104.3	51.4
951S1201T (Thickwood Hills 951S Transformer 1201T)	9L74 (Dover 888S - Birchwood Creek 960S)	423.0	501.0	300.7	71.1	560.4	132.5	61.4
	9L57 (Livock 939S - Birchwood Creek 960S)	493.0	584.0	259.4	52.6	513.6	104.2	51.6
12L44 (Thickwood Hills 951S - Livock 939S)	9L74 (Dover 888S - Birchwood Creek 960S)	423.0	501.0	300.7	71.1	560.6	132.5	61.4
	9L57 (Livock 939S - Birchwood Creek 960S)	493.0	584.0	259.5	52.6	513.8	104.2	51.6

Notes:

[a] The facility ratings shown in Attachment A1 have been adjusted from a [72/144] kV voltage base to a [69/138] kV voltage base, as is used by the power system network analysis tool.

[b] Power flow (MVA) is current expressed as MVA (i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$)

[c] Reported as a percentage of the power flow (in MVA, i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$) relative to the transmission line's Normal Rating (also in MVA), as shown in Attachment A1.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3.1.3 Scenario 6: 2023 WP Post-Project

Category A Condition

No Reliability Criteria violations were observed under Category A condition.

Category B Conditions

Thermal Criteria Violations

No thermal criteria violations were observed under Category B Conditions.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3.2 Transient Stability Studies

Transient stability studies were completed for Scenario 4 (2023 Summer Peak Post-Project), Scenario 5 (2023 Summer Light Post-Project) and Scenario 6 (2023 Winter Peak Post-Project).

The results did not indicate any transient stability concerns, and the system showed acceptable dynamic response to all Category B conditions studied, as shown in Table 3-3. The post-Project transient stability plots are provided in Attachment A4. The dynamic data and assumptions of all equipment proposed for the Facility are provided in Attachment A5.

Table 3-3: Transient Stability Study Results under Category B Conditions for Scenario 4, Scenario 5 and Scenario 6

Studied Contingency	Fault Description and Location	Results
12L44 (Thickwood Hills 951S – Livock 939S)	3-phase fault at Thickwood Hills 951S	Stable
	3-phase fault at Livock 939S	Stable
12L41 (Livock 939S - Sunnybrook 510S)	3-phase fault at Livock 939S	Stable
	3-phase fault at Sunnybrook 510S	Stable
9L01 (Ruth Lake 848S - Thickwood Hills 951S)	3-phase fault at Ruth Lake 848S	Stable
	3-phase fault at Thickwood Hills 951S	Stable
9L07 (Thickwood Hills 951S - Dawes 2011S)	3-phase fault at Thickwood Hills 951S	Stable
	3-phase fault at Dawes 2011S	Stable
9L08 (Dover 888S - Joslyn Creek 849S)	3-phase fault at Dover 888S	Stable
	3-phase fault at Red Joslyn Creek 849S	Stable
9L23 (Ruth Lake 848S - Salt Creek 977S)	3-phase fault at Ruth Lake 848S	Stable
	3-phase fault at Salt Creek 977S	Stable
9L43 (Dover 888S - Mackay River 874S)	3-phase fault at Dover 888S	Stable
	3-phase fault at Mackay River 874S	Stable
9L57 (Birchwood Creek 960S - Livock 939S)	3-phase fault at Birchwood Creek 960S	Stable
	3-phase fault at Michichi Livock 939S	Stable
9L58 (Ruth Lake 848S - Dover 888S)	3-phase fault at Ruth Lake 848S	Stable
	3-phase fault at Dover 888S	Stable
9L69 (Black Fly 934S – McClelland 957S)	3-phase fault at Black Fly 934S	Stable
	3-phase fault at McClelland 957S	Stable
9L85 (Salt Creek 977S - Kinosis 856S)	3-phase fault at Salt Creek 977S	Stable
	3-phase fault at Kinosis 856S	Stable
29PL9-1 (Ruth Lake 848S - Millennium 29EDD-1)	3-phase fault at Ruth Lake 848S	Stable
	3-phase fault at Millennium 29EDD-1	Stable
9L162 (Voyageur 29EDD-94 – Thickwood Hills 951S)	3-phase fault at Voyageur 29EDD-94	Stable
	3-phase fault at Thickwood Hills 951S	Stable

4 Short Circuit Studies

4.1 Pre-Project Results

Pre-Project short-circuit current levels are provided in Table 4-1 - Table 4-3[1].

4.1.1 Scenario 3: 2023 WP Pre-Project

Post-Project short-circuit current levels for Scenario 3 are provided in Table 4-1.

Table 4-1: Pre-Project Short-Circuit Current Levels for Scenario 3

Substation Name and Number	Base Voltage (kV)	Pre-Fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (pu)	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (pu)
Birchwood Creek 960S	240.0	261.8	7.1	0.0075 + 0.0363j	5.7	0.0077 + 0.0645j
Black Fly 934S	240.0	260.9	6.4	0.0071 + 0.0405j	5.3	0.0109 + 0.065j
Dover 888S	240.0	262.9	15.8	0.003 + 0.0164j	13.1	0.0043 + 0.0273j
Firebag 29EDD-65	240.0	262.7	10.4	0.0031 + 0.0251j	10.0	0.0028 + 0.0284j
Livock 939S	240.0	262.5	4.8	0.0125 + 0.0536j	4.3	0.0078 + 0.0749j
Livock 939S	240.0	264.4	4.6	0.0129 + 0.0562j	4.1	0.0082 + 0.0798j
Livock 939S	500.0	509.8	4.6	0.0022 + 0.0256j	3.4	0.0118 + 0.0514j
Livock 939S	138.0	144.9	4.8	0.0144 + 0.0912j	7.9	-0.0011 + -0.0173j
Millennium 29EDD-1	240.0	262.7	17.2	0.0024 + 0.0152j	17.5	0.0013 + 0.0146j
Millennium 29EDD-1	69.0	74.2	27.5	0.0032 + 0.0326j	28.7	0.0016 + 0.0292j
Ruth Lake 848S	240.0	262.7	18.0	0.0023 + 0.0145j	18.2	0.0014 + 0.0143j
Ruth Lake 848S	138.0	146.9	3.6	0.0314 + 0.1215j	3.6	0.0131 + 0.121j
Ruth Lake 848S	138.0	146.2	3.6	0.0315 + 0.1193j	3.8	0.0118 + 0.1017j
Salt Creek 977S	240.0	264.4	9.7	0.0052 + 0.0268j	8.7	0.006 + 0.0371j
Salt Creek 977S	138.0	143.4	8.6	0.0083 + 0.0498j	9.8	0.0032 + 0.0319j
Syncrude D05	240.0	262.7	15.7	0.0026 + 0.0166j	15.6	0.0017 + 0.0172j
Thickwood 951S	500.0	504.7	5.3	0.0022 + 0.0221j	4.5	0.0054 + 0.0333j
Thickwood 951S	240.0	263.2	14.6	0.003 + 0.0179j	12.1	0.0062 + 0.0292j
Voyageur 29EDD-94	240.0	262.6	13.2	0.0032 + 0.0198j	11.2	0.0051 + 0.0303j

[1] Short-circuit current studies were based on modeling information provided to the AESO by third parties. The authenticity of the modeling information has not been validated. Fault levels could change as a result of system developments, new customer connections, or additional generation in the area. It is recommended that these changes be monitored and fault levels reviewed to ensure that the fault levels are within equipment operating limits. The information provided in this study should not be used as the sole source of information for electrical equipment specifications or for the design of safety-grounding systems.

4.2 Post-Project Results

4.2.1 Scenario 6: 2023 WP Post-Project

Post-Project short-circuit current levels for Scenario 6 are provided in Table 4-2.

Table 4-2: Post-Project Short-Circuit Current Levels for Scenario 6

Substation Name and Number	Base Voltage (kV)	Pre-Fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (pu)	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (pu)
Birchwood Creek 960S	240.0	258.3	7.4	0.007 + 0.0346j	5.8	0.0076 + 0.0635j
Black Fly 934S	240.0	260.6	6.6	0.0066 + 0.0393j	5.4	0.0109 + 0.065j
Dover 888S	240.0	262.9	18.4	0.0024 + 0.0142j	14.7	0.004 + 0.0252j
Firebag 29EDD-65	240.0	264.0	11.8	0.0026 + 0.0224j	11.0	0.003 + 0.0272j
Livock 939S	240.0	256.1	4.8	0.0121 + 0.0526j	4.3	0.0076 + 0.0737j
Livock 939S	240.0	258.8	4.6	0.0126 + 0.0554j	4.1	0.0081 + 0.0786j
Livock 939S	500.0	508.5	5.1	0.0017 + 0.0233j	3.8	0.0103 + 0.046j
Livock 939S	138.0	143.0	4.7	0.0144 + 0.0914j	7.8	-0.0011 + -0.0172j
Millennium 29EDD-1	240.0	264.4	23.4	0.0015 + 0.0112j	23.9	0.0012 + 0.0106j
Millennium 29EDD-1	69.0	74.5	30.3	0.0024 + 0.0298j	31.6	0.0014 + 0.0267j
Ruth Lake 848S	240.0	263.9	22.9	0.0016 + 0.0115j	22.7	0.0015 + 0.0119j
Ruth Lake 848S	138.0	147.6	3.6	0.0305 + 0.1197j	3.7	0.0131 + 0.1209j
Ruth Lake 848S	138.0	146.8	3.7	0.0306 + 0.1175j	3.9	0.0118 + 0.1016j
Salt Creek 977S	240.0	264.3	10.3	0.0047 + 0.0254j	9.0	0.0061 + 0.0369j
Salt Creek 977S	138.0	143.3	8.9	0.0078 + 0.0485j	10.1	0.0032 + 0.0318j
Syncrude D05	240.0	263.8	19.1	0.0019 + 0.0138j	18.4	0.0018 + 0.0154j
Thickwood 951S	500.0	505.1	6.2	0.0014 + 0.019j	5.5	0.003 + 0.0255j
Thickwood 951S	240.0	264.0	20.8	0.0018 + 0.0126j	18.2	0.0032 + 0.0181j
Voyageur 29EDD-94	240.0	265.4	22.6	0.0015 + 0.0117j	22.8	0.0012 + 0.0115j
Inglis Island	240.0	266.0	19.1	0.0017 + 0.0139j	18.9	0.0014 + 0.0146j
Inglis Island	240.0	266.0	19.1	0.0017 + 0.0139j	18.9	0.0014 + 0.0146j

4.2.2 Scenario 7: 2029 WP Post-Project

Post-Project short-circuit current levels for Scenario 7 are provided in Table 4-3.

Table 4-3: Post-Project Short-Circuit Current Levels for Scenario 7

Substation Name and Number	Base Voltage (kV)	Pre-Fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (pu)	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (pu)
Birchwood Creek 960S	240.0	257.0	7.5	0.0069 + 0.0337j	5.9	0.0076 + 0.0632j
Black Fly 934S	240.0	254.8	6.6	0.0066 + 0.038j	5.5	0.0103 + 0.062j
Dover 888S	240.0	261.9	19.1	0.0023 + 0.0136j	15.2	0.0038 + 0.0242j
Firebag 29EDD-65	240.0	263.4	11.8	0.0026 + 0.0223j	11.0	0.0029 + 0.0271j
Livock 939S	240.0	255.3	4.9	0.0116 + 0.0514j	4.3	0.0076 + 0.0734j
Livock 939S	240.0	257.7	4.7	0.012 + 0.0541j	4.1	0.0081 + 0.0784j
Livock 939S	500.0	528.6	5.2	0.0017 + 0.0235j	3.9	0.0109 + 0.0461j
Livock 939S	138.0	142.0	4.8	0.0138 + 0.0897j	7.9	-0.0011 + -0.0172j
Millennium 29EDD-1	240.0	263.7	23.8	0.0015 + 0.011j	24.4	0.0011 + 0.0104j
Millennium 29EDD-1	69.0	77.2	30.8	0.0024 + 0.0304j	32.1	0.0014 + 0.027j
Ruth Lake 848S	240.0	263.3	23.3	0.0016 + 0.0112j	23.3	0.0013 + 0.0114j
Ruth Lake 848S	138.0	147.6	3.7	0.0296 + 0.118j	3.7	0.0128 + 0.1193j
Ruth Lake 848S	138.0	147.3	3.7	0.0299 + 0.1166j	3.9	0.0117 + 0.1015j
Salt Creek 977S	240.0	258.4	10.5	0.0046 + 0.0244j	9.3	0.0054 + 0.0342j
Salt Creek 977S	138.0	148.6	9.0	0.0084 + 0.0496j	10.1	0.0034 + 0.0329j
Syncrude D05	240.0	263.3	19.3	0.0019 + 0.0136j	18.7	0.0016 + 0.0151j
Thickwood 951S	500.0	525.1	6.5	0.0014 + 0.0188j	6.0	0.0026 + 0.0232j
Thickwood 951S	240.0	266.4	21.5	0.0017 + 0.0124j	18.9	0.003 + 0.0173j
Voyageur 29EDD-94	240.0	265.6	22.7	0.0015 + 0.0116j	22.8	0.0012 + 0.0117j
Inglis Island	240.0	266.0	19.1	0.0017 + 0.0139j	18.6	0.0015 + 0.0151j
Inglis Island	240.0	266.0	19.1	0.0017 + 0.0139j	18.6	0.0015 + 0.0151j

5 Mitigation Measure Development and Evaluation

The Studies Consultant, in consultation with the AESO, developed mitigation measures to address the system performance issues that were identified in the post-Project scenarios. Existing remedial action schemes (RASs) are described in Section 1.2.2 of Attachment A1.

5.1 Post-Project

Post-Project mitigation measures are summarized in Table 5-1.

Table 5-1: Post-Project Mitigation Measures

Mitigation Measure	Location of Observed Violation
New P2082 RAS[a]	9L74 (Dover 888S - Birchwood Creek 960S)
	9L57 (Livock 939S - Birchwood Creek 960S)

Notes:

[a]New P2082 RAS is a new RAS proposed for the planned Suncor Base Plant Cogen Project to mitigate thermal violation on 9L74 (Dover 888S - Birchwood Creek 960S)

.

5.2 Evaluation of Mitigation Measures

This section describes the results of the power flow studies that were performed to assess the impact of the Project on the performance of the AIES following the implementation of proposed mitigation measures.

The post-mitigation measures studies were performed under Category B conditions for Scenario 4 (2023 SP Post-Project), Scenario 5 (2023 SL Post-Project), and Scenario 6 (2023 WP Post-Project) using Alternative 1 and the RAS described in the previous section.

The post-mitigation power flow diagrams for selected Category B conditions are provided in Attachment A6. Post-mitigation power flow diagrams present only those post-Project contingencies that result in thermal criteria violations that require RAS mitigation. Post-Project contingencies that result in thermal criteria violations that can be mitigated by real time operational practices or TFO capital maintenance projects were not studied.

5.2.1 Scenario 5: 2023 SL Post-Project

Category B Conditions

Thermal and voltage criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by RASs as shown in Table 5-2.

Table 5-2: Post-RAS Power Flow Study Results for Scenario 4

Contingency (System Element Lost)	Details of Violation	Seasonal Continuous	Short-term (Emergency)	Post-Project Results	Post-RAS Action Results

	(Violation Observed On)	Rating (MVA)	Rating (MVA)	Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
12L41 (Sunnybrook 510S - Livock 939S)	9L74 (Dover 888S - Birchwood Creek 960S)	423.0	501.0	560.8	132.6	403.1	95.3
	9L57 (Livock 939S - Birchwood Creek 960S)	493.0	584.0	514.0	104.3	360.3	73.1
951S1201T (Thickwood Hills 951S Transformer 1201T)	9L74 (Dover 888S - Birchwood Creek 960S)	423.0	501.0	560.4	132.5	401.6	94.9
	9L57 (Livock 939S - Birchwood Creek 960S)	493.0	584.0	513.6	104.2	358.9	72.8
12L44 (Thickwood Hills 951S - Livock 939S)	9L74 (Dover 888S - Birchwood Creek 960S)	423.0	501.0	560.6	132.5	401.7	95.0
	9L57 (Livock 939S - Birchwood Creek 960S)	493.0	584.0	513.8	104.2	359.0	72.8

5.3 Constraint Effective Factor Studies

Constraint effective factor studies were conducted for all post-Project scenarios. The constraint effective factors were calculated for all Category B conditions when the loadings of the monitored transmission elements in the Study Area exceeded 100% (i.e., for all of the contingencies that resulted in thermal criteria violations). The results of the constraint effective factor studies are provided in Attachment A7.

Attachment A1
Engineering Connection Assessment: Study Scope

Engineering Connection Assessment: Study Scope

Suncor Base Plant Cogen

Suncor Energy Inc.

AESO Project Number: P2082

Date: October 7, 2020

Version: V6

Classification: Public

Company Name	Name and Credentials	Date	Signature
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Market Participant (Suncor Energy Inc.)	Edward McMartin, P.Eng		emcmartin Digitally signed by emcmartin Date: 2020.10.30 12:51:57 -06'00'

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Attachments

Attachment A: Transmission Planning Criteria – Basis and Assumptions

1 Introduction

This Study Scope provides an overview of the engineering studies to be completed by Teshmont Consultants LP (the Studies Consultant) to assess the impact of the Project (as defined in section 1.1) on the performance of the Alberta Interconnected Electric System (AIES). Technical criteria, assumptions and methods for performing these engineering studies are provided in this document.

1.1 Project Overview

Suncor Energy Inc. (Market Participant) has submitted a request for system access service to the Alberta Electric System Operator (AESO) to connect additional new on-site generation to the AIES.

The Market Participant's request includes: a request for a new system access service in the area, with a Rate STS, *Supply Transmission Service*, contract capacity of 1265 MW; no change to the existing Rate DTS, *Demand Transmission Service,* contract capacity of 150 MW; and a request for transmission development (collectively, the Project).

The scheduled in-service date of the Project is July 1, 2022

Load and generation components of the Project are listed in Table 1-1.

Table 1-1: Project Load and Generation Details

Project Component		Description
Load	Existing Rate DTS, *Demand Transmission Service,* contract capacity	150 MW
	Requested Rate DTS	No change
	Type	Oilsands
	Motors (number and size)	Not applicable
	Power factor	Not applicable
	Future load expansion plans	No
Generation	Generation type	Cogeneration
	Existing Rate STS, *Supply Transmission Service,* contract capacity	450 MW
	Requested Rate STS	An increase of 815 MW, from existing 450 MW to 1265 MW
	Number and size of generating units	2 units at 403 MW each
	Maximum authorized real power (MARP)	806 MW
	Maximum capability (MC)	806 MW
	Reactive power capability	390 MVAr (0.9 pf absorbing)
		265 MVAr (0.95 pf producing)

Project Component		Description
	Future generation expansion plans	No

Note:

MARP and MC are defined in the AESO's *Consolidated Authoritative Document Glossary*, which can be found on the AESO's website.

1.2 Existing System Overview

1.2.1 Study Area

Geographically, the Project is located in the AESO planning area of Fort McMurray (Area 25).

The Study Area consists of the AESO planning areas of Fort McMurray (Area 25) and Athabasca/Lac La Biche (Area 27), including the tie lines connecting these planning areas to the rest of the AIES.

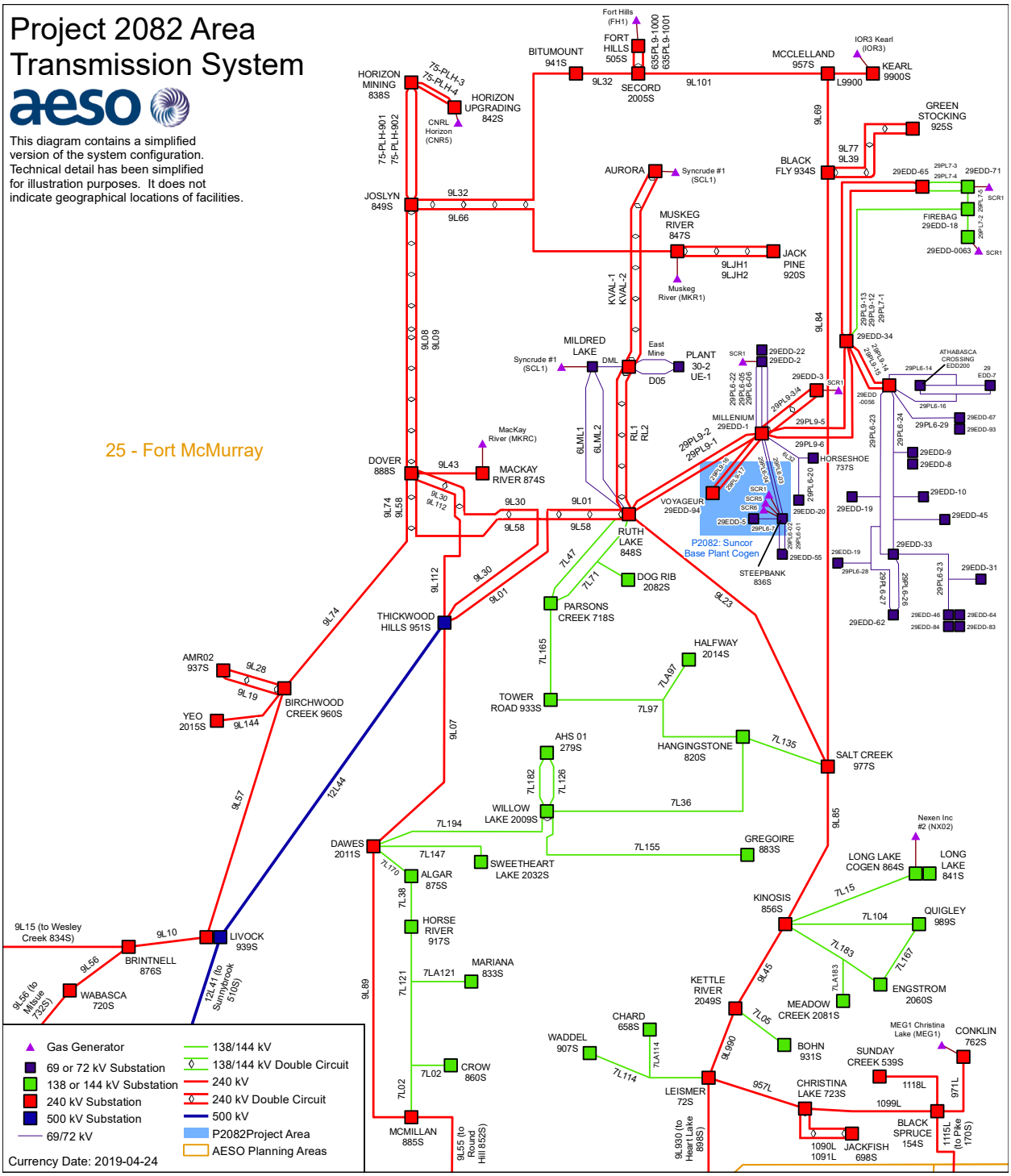
The existing transmission system in the Study Area is shown in Figure 1-1.

1.2.2 Existing Constraints

Existing constraints in the Study Area are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule).

There are a number of constraints in the Study Area that are mitigated by existing remedial action schemes (RASs) and/or other protection schemes.

Figure 1-1: Transmission System in the Study Area



2 Connection Alternative to be Studied

The following alternative will be studied:

2.1 Alternative 1: New Connection between Voyageur 29EDD-94 Substation and Thickwood Hills 951S Substation, Reinforce Millennium 29EDD-1 Substation to Ruth Lake 848S Substation

This alternative included the following developments:

- Add two 240 kV circuits, approximately 37 km each in length, to connect the existing Voyageur 29EDD-94 substation to the existing Thickwood Hills 951S substation;
- Increase the rating of the existing 29PL9-1 and 29PL9-2 transmission lines, approximately 5 km in length, between the existing Millennium 29EDD-1 and Ruth Lake 848S substations;
- Modify the existing Thickwood Hills 951S substation by adding three 240 kV circuit breakers; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-1.

As part of this alternative involves increasing the rating of 29PL9-1 and 29PL9-2, requiring outages, the interim configuration prior to the commercial operation date of the generation component of the Project would be to normally open 29PL9-1 and 29PL9-2 and energize the two new 260 kV circuits between Voyageur 29EDD-94 and Thickwood Hills 951S in order to maintain the Market Participant's connection to the AIES. This proposed configuration is shown in Figure 2-2

Figure 2-1: Alternative 1

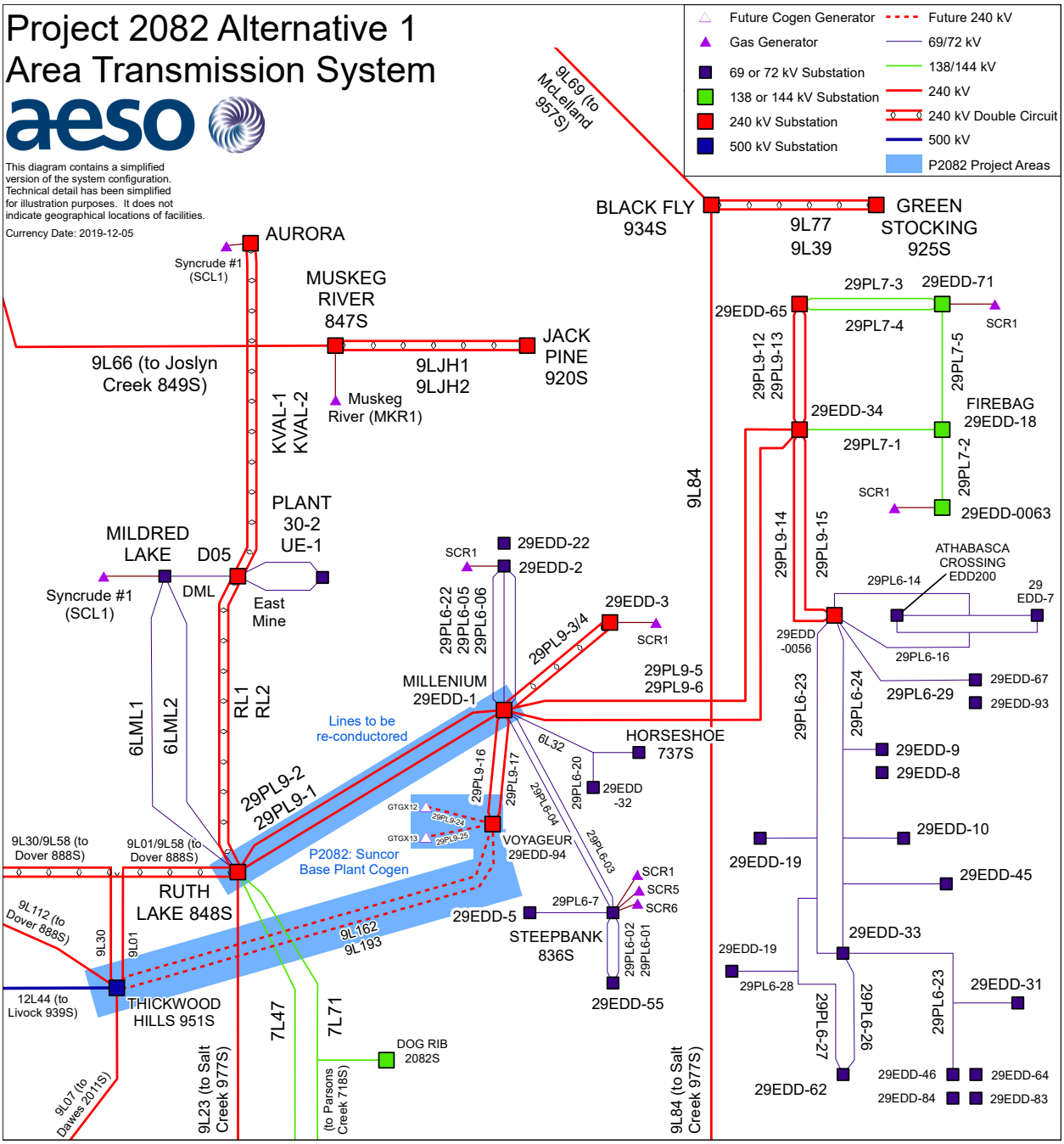
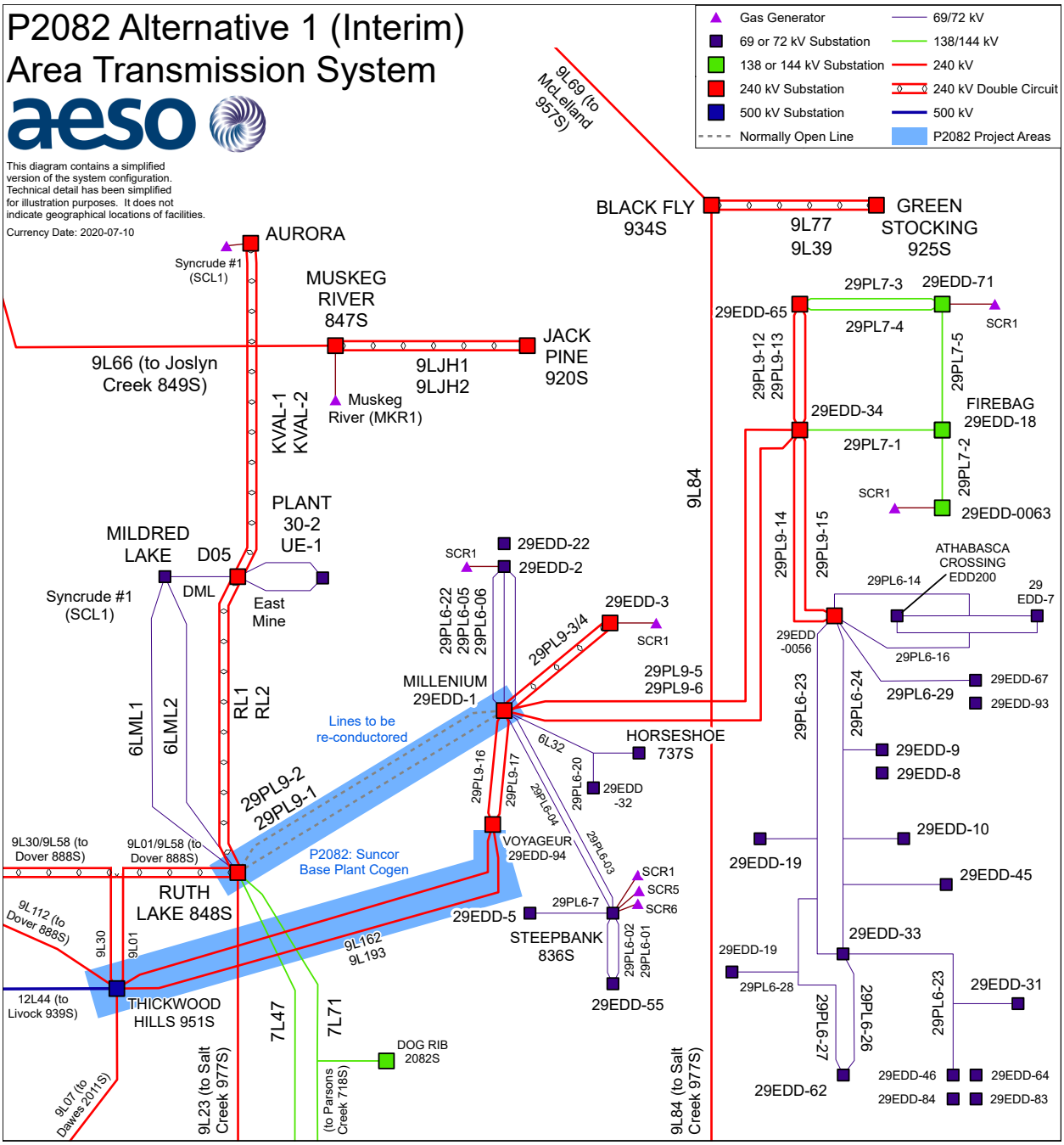


Figure 2-2: Alternative 1 Interim Configuration


P2082 Alternative 1 (Interim)
Area Transmission System
aeso
This diagram contains a simplified version of the system configuration. Technical detail has been simplified for illustration purposes. It does not indicate geographical locations of facilities.
Currency Date: 2020-07-10
Gas Generator
69 or 72 kV Substation
138 or 144 kV Substation
240 kV Substation
500 kV Substation
Normally Open Line
69/72 kV
138/144 kV
240 kV
240 kV Double Circuit
500 kV
P2082 Project Areas
9L69 (to McLelland 957S)
BLACK FLY 934S
9L77
9L39
GREEN STOCKING 925S
AURORA
Syncrude #1 (SCL1)
MUSKEG RIVER 847S
JACK PINE 920S
9L66 (to Joslyn Creek 849S)
9LJH1
9LJH2
Muskeg River (MKR1)
KVAL-1
KVAL-2
PLANT 30-2 UE-1
MILDRED LAKE
D05
DML
East Mine
Syncrude #1 (SCL1)
6LML1
6LML2
RL1
RL2
29EDD-22
29EDD-2
SCR1
29PL6-22
29PL6-05
29PL6-06
29EDD-3
29PL9-3/4
29PL9-5
29PL9-6
MILLENIUM 29EDD-1
Lines to be re-conductored
HORSESHOE 737S
6L32
29PL9-16
29PL9-17
29PL6-20
29EDD -32
29PL6-04
29PL6-03
29PL9-2
29PL9-1
VOYAGEUR 29EDD-94
P2082: Suncor Base Plant Cogen
9L30/9L58 (to Dover 888S)
9L01/9L58 (to Dover 888S)
RUTH LAKE 848S
9L112 (to Dover 888S)
9L30
9L01
29EDD-5
29PL6-7
SCR1
SCR5
SCR6
STEEPBANK 836S
9L162
9L193
29PL6-02
29PL6-01
29EDD-55
12L44 (to Livock 939S)
THICKWOOD HILLS 951S
7L47
7L71
DOG RIB 2082S
9L07 (to Dawes 201S)
9L23 (to Salt Creek 977S)
(to Parsons Creek 718S)
9L84
9L84 (to Salt Creek 977S)
29EDD-65
29PL7-3
29EDD-71
29PL7-4
SCR1
29PL9-12
29PL9-13
29PL7-5
29EDD-34
FIREBAG 29EDD-18
29PL7-1
29PL7-2
SCR1
29EDD-0063
29PL9-14
29PL9-15
ATHABASCA CROSSING EDD200
29PL6-14
29 EDD-7
29EDD -0056
29PL6-16
29PL6-23
29PL6-24
29PL6-29
29EDD-67
29EDD-93
29EDD-9
29EDD-8
29EDD-10
29EDD-19
29EDD-45
29EDD-33
29EDD-19
29PL6-28
29PL6-27
29PL6-26
29PL6-23
29EDD-31
29EDD-62
29EDD-46
29EDD-64
29EDD-84
29EDD-83

3 Criteria, Standards and Requirements

3.1 AESO Reliability Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and *Transmission Planning Criteria – Basis and Assumptions (see Attachment A),* (collectively, the Reliability Criteria) will be applied to evaluate system performance under Category A system conditions (i.e., all elements in-service) and following Category B contingencies (i.e., single element outage), prior to and following the studied alternatives. Below is a summary of Category A and Category B system conditions.

Category A, often referred to as the N-0 condition, represents a normal system with no contingencies and all facilities in service. Under this condition, the system must be able to supply all firm load and firm transfers to other areas. All equipment must operate within its applicable rating, voltages must be within their applicable range, and the system must be stable with no cascading outages.

Category B events, often referred to as an N-1 or N-G-1 with the most critical generator out of service, result in the loss of any single specified system element under specified fault conditions with normal clearing. These elements are a generator, a transmission circuit, a transformer, or a single pole of a DC transmission line. The acceptable impact on the system is the same as Category A. Planned or controlled interruptions of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall reliability of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted firm (non-recallable reserved) transmission service electric power transfers.

The TPL standards, TPL-001-AB-0 and TPL-002-AB1-0, have referenced Applicable Ratings when specifying the required system performance under Category A and Category B events. For the purpose of applying the TPL standards to the studies documented in this report, Applicable Ratings are defined as follows:

- Normal thermal rating of the line's loading limits for each season;
- The highest specified loading limits for transformers;
- For Category A conditions: Voltage range under normal operating condition per AESO Information Document #2010-007RS, *General Operating Practices – Voltage Control* (ID #2010-007RS). For the busses not listed in ID #2010-007RS, Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions* applies;
- For Category B conditions: The extreme voltage range values per Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions;* and
- Desired post-contingency voltage deviation limits for three defined post-event timeframes as provided in Table 3-1.

Table 3-1: Post-Contingency Voltage Deviation Guidelines for Low Voltage Busses

Parameter and reference point	Time Period		
	Post Transient (up to 30 sec)	Post Auto Control (30 sec to 5 min)	Post Manual Control (Steady State)
Voltage deviation from steady state at point of delivery (POD) low voltage bus.	±10%	±7%	±5%

3.2 ISO Rules and Information Documents

ID #2010-007RS will be used to establish system normal (i.e., pre-contingency) voltage profiles for the Study Area.

The TCM Rule will be followed to set up the study scenarios and assess the impact of the Project. In addition, due regard will be given to the AESO's *Connection Study Requirements*, the AESO's *Generation and Load Interconnection Standard*, Section 502.5 of the ISO rules, *Generating Unit Technical Requirements*, and Section 502.6 of the ISO rules, *Generating Unit Operating Requirements*.

4 Scenarios and Assumptions

4.1 Scenarios

The following section describes the scenarios to be studied and the assumptions to be used in the studies.

The scheduled ISD for the Project is June 1, 2022. However, the expected commercial operation date of the new generation facility is July 1, 2023. Therefore, the studies will be conducted using 2023 Summer Peak, Summer Light and Winter Peak study scenarios.

Connection scenarios must be studied as outlined in Table 4-1.

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Generation (MW)	Suncor Net-to-Grid (MW)
Pre-Project					
1	2023 Summer Peak (SP)	High Northeast generation	2023 SP Pre-Project	0	450
2	2023 Summer Light (SL)		2023 SL Pre-Project	0	450
3	2023 Winter Peak (WP)		2023 WP Pre-Project	0	450
Post-Project					
7	2023 SP	High Northeast generation	2023 SP Post-Project	815	1265
8	2023 SL		2023 SL Post-Project	815	1265
9	2023 WP		2023 WP Post -Project	815	1265
10	2029 WP	All machines in Study Area in-service	2029 WP Post-Project	815	1265

4.2 Assumptions

4.2.1 System Project Assumptions

The pre-Project and post-Project connection assessment will not include any system transmission projects because there are no planned system transmission developments in the Study Area that are expected to be in service before the scheduled Project ISD.

4.2.2 Connection Project Assumptions

There are no connection projects in the Study Area that will be included in the studies in addition to projects included in the 2019 Planning Base Case Suite.

4.2.3 Load Assumptions

The load forecast to be used for the studies is shown in Table 4-2 and is a forecast for the AESO Northeast Planning Region peak based on the *AESO 2019 Long-term Outlook* (2019 LTO)[1]. For the post-Project studies, when the Study Area loads are modified to align with the regional load forecast in the 2019 LTO, the active power to reactive power ratio in the base case scenarios shall be maintained.

Table 4-2: Forecast Load (at AESO Northeast Planning Region Peak)

AESO Planning Area or Region Name	Forecast Peak Load by Year/Season (MW)		
	2023 SP	2023 SL	2023 WP
Northeast Planning Region[1]	3253	2761	3534

Note:
[1] The Northeast Region comprises the following AESO planning areas: Fort McMurray (Area 25), Athabasca/Lac La Biche (Area 27), and Fort Saskatchewan (Area 33).

IDEV files contain non-motor loads in zones 34, 36, and 351. These loads are not accounted for in the forecasted peak loads shown above and should not be considered when scaling load. The AESO engineer will provide guidance to load scaling procedures as required.

4.2.4 Generation Assumptions

The generation forecast to be used for the studies is based on the 2019 LTO. The generation assumptions for the studies will assume high Northeast export. Additional studies may be required in the event of changes to the AESO's corporate forecast.

The non-renewable generation dispatch conditions for the study scenarios are described in Table 4-3.

Table 4-3: Existing Non-Renewable Generation Dispatch Conditions

Facility Name	Unit No.	Bus No.	Pmax (MW)	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario		
					2023 SL	2023 SP	2023 WP
Horizon	G1, 5, G2	18264, 19264 2268	203	25	193.7	176	201.8
Meg Christina Lake	G1, 1, 2	16690, 2405, 3405	202	25	167.3	158.6	188.5
MacKay	1	18274	205	25	191.9	188	205.8
Long Lake	G1, G2, G3, G4	11241, 12249, 13249	220	25	173.8	173.4	181.8

[1] The 2019 LTO is available on the AESO website.

Facility Name	Unit No.	Bus No.	Pmax (MW)	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario		
					2023 SL	2023 SP	2023 WP
Syncrude	G1, G2, G3, G4, G5, G6, 1, 2, 11, 12	19209, 18209, 17209, 17210, 18210, 19210, 18207, 18206, 17233, 16233	510	25	377.5	414.4	432
Suncor Fort Hills	G1, G2	14781, 14782	199	25	180.4	164.8	185.3
IOL Kearl	G1	1695	84	25	70.9	68.8	76.1
Muskeg River	1, 2	10236, 12236	202	25	174.8	171	196

Notes:
[a] "Unit Net Generation" refers to gross generating unit output (MW) less unit service load.

4.2.5 Intertie Flow Assumptions

The Alberta-British Columbia (AB-BC), Alberta-Saskatchewan (AB-SK), and Alberta-Montana (MATL) intertie points are deemed to be too far away from the Study Area to have any material impact on the connection assessment. Therefore, intertie flow values shall be set to the AESO planning base case values and will not be adjusted for the studies.

4.2.6 HVDC Power Order Assumptions

The Western Alberta Transmission Line (WATL) and the Eastern Alberta Transmission Line (EATL) are high-voltage direct current (HVDC) transmission lines. WATL and EATL are not expected to have a material impact on the connection assessment. Therefore, the HVDC assumptions shall be the same as in the AESO planning base cases and will not be adjusted for the studies.

4.2.7 Transmission Facility Ratings

The legal owners of transmission facilities (TFOs) provided the thermal ratings assumptions for the existing transmission lines in the Study Area. Table 4-4 shows the normal ratings and emergency ratings for the key transmission lines in the Study Area, which will be used to perform the engineering studies.

Table 4-4: Thermal Rating Assumptions for Key Transmission Lines in the Study Area

Line ID	Line Description	Voltage Class (kV)	Normal Rating (MVA)		Emergency Rating (MVA)	
			Summer	Winter	Summer	Winter
9L01	THICKWOOD 951S - RUTH LAKE 848S	240	641	808	788	831CT

Line ID	Line Description	Voltage Class (kV)	Normal Rating (MVA)		Emergency Rating (MVA)	
			Summer	Winter	Summer	Winter
9L07	THICKWOOD 951S - DAWES 2011S	240	640	811	787	831 GS
9L08	JOSLYN 849S - DOVER 888S	240	457 bus cond	578 bus cond	714 bus cond	831 GS
9L09	JOSLYN 849S - DOVER 888S	240	457 bus cond	578 bus cond	714 bus cond	831 GS
9L10	LIVOCK 939S - BRINTNELL 876S	240	491	658	583	798
9L101	SECORD 2005S - McCLELLAND 957S	240	759	831CT	831CT	831CT
9L112	THICKWOOD 951S - DOVER 888S	240	457 bus cond	578 bus cond	688 bus cond	831 GS
9L144	YEO 2015S - BIRCHWOOD CREEK 960S	240	M433L	M524L	433L	524L
9L22	HEART LAKE 898S - WHITEFISH LAKE 825S	240	457 bus cond	578 bus cond	663 CT	663 CT
9L23	SALT CREEK 977S - RUTH LAKE 848S	240	553	742	670	831 GS
9L28	BIRCHWOOD CREEK 960S - AMR02 937S	240	433L	498CT	433L	498CT
9L30	THICKWOOD 951S - DOVER 888S	240	457 bus cond	578 bus cond	688 bus cond	831 GS
9L32	SECORD 2005S - JOSLYN 849S	240	761	831 GS	831 GS	831 GS
9L39	GREEN STOCKING 925S - BLACKFLY 934S	240	560	753	689	831 CT
9L43	DOVER 888S - MACKAY RIVER 874S	240	457 bus cond	578 bus cond	653	831 GS
9L45	KINOSIS 856S - KETTLE RIVER 2049S	240	560	757	664	831 CT
9L57	LIVOCK 939S - BIRCHWOOD CREEK 960S	240	493	660	584	800
9L58	RUTH LAKE 848S - DOVER 888S	240	416	565	585	831
9L66	MUSKEG RIVER 847S - JOSLYN 849S	240	380	515	517	725
9L69	McCLELLAND 957S - BLACKFLY 934S	240	777	831CT	831CT	831CT
9L74	DOVER 888S - BIRCHWOOD CREEK 960S	240	423	575	501	691
9L77	GREEN STOCKING 925S - BLACKFLY 934S	240	560	753	689	831 GS
9L84	SALT CREEK 977S - BLACKFLY 934S	240	775	831CT	831CT	831CT
9L85	SALT CREEK 977S - KINOSIS 856S	240	559	750	661	831CT
9L89	MCMILLAN 885S - DAWES 2011S	240	499 bus cond	609 bus cond	683 bus cond	831 GS

Line ID	Line Description	Voltage Class (kV)	Normal Rating (MVA)		Emergency Rating (MVA)	
			Summer	Winter	Summer	Winter
9L930	HEART LAKE 898S - HEART LAKE 898S	240	535	717	665	831 GS
9L990	KETTLE RIVER 2049S - LEISMER 72S	240	556	748	660	831 CT
7L125	GERMAIN 950S - LIVOCK 939S	144	164	210	188	222P
7L135	HANGINGSTONE 820S - SALT CREEK 977S	144	151 bus cond	190 bus cond	194 bus cond	252 bus cond
7L165	PARSONS CREEK 718S - TOWER ROAD	144	116	150 GS	129	150 GS
7L47	PARSONS CREEK 718S - RUTH LAKE	144	100CT	100CT	100CT	100CT
7L71	PARSONS CREEK 718S – Dog Rib tap	144	100CT	100CT	100CT	100CT
7L71	Ruth Lake 848S – Dog Rib tap	144	117	125 CT	125 CT	125 CT
7L97	HANGINGSTONE 820S - TOWER ROAD 933S	144	117	155	130	176

Note:

Ratings for transmission lines are limited by the line conductor unless otherwise noted.
"CT" indicates that the transmission line is limited by current transformer.

"GS" indicates that the transmission line rating is limited by gang switch.

"M" indicates that the transmission line rating is limited for reasons other than protection equipment, transformer, current transformer, line, ganged switch, circuit breaker, or regulator.

"bus cond" indicates that the transmission line rating is limited by the bus conductor.

The TFOs provided the details of the substation transformers in the Study Area. The key transformers in the Study Area are shown in Table 4-5.

Table 4-5: Summary of Key Transformer Ratings in the Study Area

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	Transformer Rating (MVA)
DAWES 2011S	901T	250/144	300
LIVOCK 939S	901T	240/144	300
Thickwood 951S	1201T	525/258	1250
SALT CREEK 977S	901T	260/144	300
KINOSIS 856S	902T	260/144	200
	903T	260/144	300
MCMILLAN 885S	902T	260/144	200
RUTH LAKE 848S	901T	260/72	100
RUTH LAKE 848S	902T	260/72	107.2

The TFOs provided the details of the shunt elements in the Study Area. The key shunt elements in the Study Area are shown in Table 4-6.

Table 4-6: Summary of Key Shunt Elements in the Study Area

Substation Name and Number	Voltage Class (kV)	Capacitors		Reactors	
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
Dover 888S	240	1	100	1	-40
Salt Creek 977S	240	-	-	1	-34.96
Ruth Lake 848S	14.4	-	-	3	-15
Ruth Lake 848S	14.4	-	-	1	-20
Kinosis 856S	138	2	55.10	-	-
Leismer 72S	138	2	54.38	-	-
Livock 939S	500			1	217.69
	500			2	45.35
Thickwood 951S	500			1	45.35
	240	SVC +200/-100 MVAr with 100 MVAr external capacitor controlled by SVC			

4.2.8 Protection Fault Clearing Times

The transient stability studies will be performed using the actual fault clearing times for the selected contingencies, as provided by the TFOs and as shown in Table 4-7. Only those contingencies shown in Table 4-7 will be studied for transient stability studies. If the TFOs did not specify the fault clearing times (e.g. for new transmission lines) for a selected contingency, then the studies for that contingency will be performed using the standard fault clearing times that are specified in Table 2-3 of the AESO's *Transmission Planning Criteria – Basis and Assumptions*.

Table 4-7: Protection Fault Clearing Times

Contingency (System Element Lost)	Fault Location	Clearing Times (Cycles)	
		Near End	Far End
12L44 (Thickwood Hills 951S – Livock 939S)	Thickwood Hills 951S	4	5
12L44 (Livock 939S – Thickwood Hills 951S)	Livock 939S	4	5
12L41 (Livock 939S - Sunnybrook 510S)	Livock 939S	4	5
12L41 (Sunnybrook 510S – Livock 939S)	Sunnybrook 510S	4	5
9L01 (Ruth Lake 848S - Thickwood 951S)	Ruth Lake 848S	5	6
9L01 (Ruth Lake 848S - Thickwood 951S)	Thickwood 951S	5	6
9L07 (Thickwood 951S - Dawes 2011S)	Thickwood 951S	5	6
9L07 (Thickwood 951S - Dawes 2011S)	Dawes 2011S	5	6

Contingency (System Element Lost)	Fault Location	Clearing Times (Cycles)	
		Near End	Far End
9L08 (Dover 888S - Joslyn Creek 849S)	Dover 888S	5	6
9L08 (Dover 888S - Joslyn Creek 849S)	Joslyn Creek 849S	5	6
9L23 (Ruth Lake 848S - Salt Creek 977S)	Ruth Lake 848S	5	6
9L23 (Ruth Lake 848S - Salt Creek 977S)	Salt Creek 977S	5	6
9L43 (Dover 888S - Mackay River 874S)	Dover 888S	5	6
9L43 (Dover 888S - Mackay River 874S)	Mackay River 874S	5	6
9L57 (Birchwood Creek 960S - Livock 939S)	Birchwood Creek 960S	5	6
9L57 (Birchwood Creek 960S - Livock 939S)	Livock 939S	5	6
9L58 (Ruth Lake 848S - Dover 888S)	Ruth Lake 848S	5	6
9L58 (Ruth Lake 848S - Dover 888S)	Dover 888S	5	6
9L69 (Black Fly 934S – McClelland 957S)	Black Fly 934S	5	6
9L69 (McClelland 957S - Black Fly 934S)	McClelland 957S	5	6
9L85 (Salt Creek 977S - Kinosis 856S)	Salt Creek 977S	5	6
9L85 (Salt Creek 977S - Kinosis 856S)	Kinosis 856S	5	6
29PL9-1 (Ruth Lake 848S - Millennium 29EDD-1)	Ruth Lake 848S	5	6
29PL9-1 (Ruth Lake 848S - Millennium 29EDD-1)	Millennium 29EDD-1	5	6
9L162 (Voyageur 29EDD-94 - Thickwood 951S)	Voyageur 29EDD-94	5	6
9L162 (Voyageur 29EDD-94 - Thickwood 951S)	Thickwood 951S	5	6

4.2.9 Project Dynamic Data

Dynamic data for the Project can be found in Attachment A7.

4.2.10 Voltage Profile Assumption

ID #2010-007RS will be used to establish system normal (i.e., pre-contingency) voltage profiles for key area busses prior to commencing any studies. Table 2-1 of the *Transmission Planning Criteria – Basis and Assumptions* applies for the busses not included in ID #2010-007RS. These voltages will be used to set the voltage profile for the study base cases prior to the power flow studies.

5 Study Methodology

The studies to be performed for this connection assessment are identified in Table 5-1.

Table 5-1: Studies to be performed

Scenario No. and Name		Power Flow		Voltage Stability		Transient Stability		Motor Starting		Short Circuit
		Category		Category		Category		Category		Category A
		A	B	A	B	A	B	A	B	
Pre-Project										
1	2023SP	X	X			X*	X*			
2	2023SL	X	X			X*	X*			
3	2023WP	X	X			X*	X*			X
Post-Project										
4	2023SP	X	X			X	X			
5	2023SL	X	X			X	X			
6	2023WP	X	X			X	X			X
7	2029WP									X

*if stability issues are identified in the post-Project scenarios

For the engineering studies, all transmission facilities 69 kV and above, within the Study Area and the transmission lines connecting these planning areas to neighbouring planning areas will be studied and monitored to assess the impact of the Project on the performance of the AIES, including any violations of the Reliability Criteria (as defined in Section 3.1).

5.1 Power Flow Studies

Power flow studies will be performed to identify thermal and voltage criteria violations as per the Reliability Criteria, and any deviations from the limits listed in Table 3-1.

For the Category B power flow studies, the transformer taps and switched shunt reactive compensating devices such as shunt capacitors and reactors will be locked and continuous shunt devices will be enabled.

Voltage deviations at point-of-delivery (POD) low voltage busses will also be assessed for both the pre-Project and post-Project networks by first locking all tap changers and area shunt reactive compensating devices to identify any post-transient voltage deviations above 10%. Second, tap changers will be allowed to move while shunt reactive compensating devices remained locked to determine if any voltage deviations above 7% would occur in the area. Third, all the taps and shunt reactive compensating devices will be allowed to adjust, and voltage deviations above 5% will be reported.

The scenarios to be studied are shown in Table 5-1.

5.1.1 Contingencies to be Studied

Power flow studies will be performed for the Category A and all Category B conditions in the Study Area.

5.2 Transient Stability Studies

Keephills Unit 3 in Wabamun (Area 40) will be used as the reference for the studies.

The report presenting the results of the transient stability studies must provide response plots for several variables, including rotor angle, and active and reactive power output for the generating units in the Study Area. The results report must also provide the 500 kV, 240 kV and 138 kV bus voltage levels for substations near the point of connection. Other busses will be monitored and will be reported as determined by the results. The results report must also provide the key branch active and reactive power flow surrounding the Facility.

Transient stability studies will be performed for the post-Project scenarios as shown in Table 5-1. If any transient stability issues are observed, transient stability analysis will be performed for the corresponding pre-Project scenarios.

5.2.1 Contingencies to be Studied

Transient stability studies will be performed for the contingencies shown in Table 4-7.

5.3 Short-Circuit Current Level Studies

A maximum fault level must be provided for the substations in the vicinity of the Project assuming normal system operation with all transmission elements in service and generation dispatched. Three-phase faults and single line-to-ground faults will be simulated. Polar coordinates and per-unit values will be used for reporting the results.

Winter peak scenarios will be used for the short-circuit studies because winter peak scenarios generally produce higher short-circuit current levels than summer peak scenarios.

Estimated maximum three-phase faults and single line-to-ground short-circuit current levels will be reported for the following substations:

- Inglis Island 29EDD-27
- Dover 888S
- Millennium 29EDD-1
- Voyageur 29EDD-94
- Ruth Lake 848S
- Syncrude D05
- Black Fly 934S
- Salt Creek 977S
- Thickwood 951S
- McClelland 957S

- Firebag 29EDD-65
- Livock 939S
- Birchwood Creek 960S

Further sensitivity studies, in consultation with the TFO, may be required if the primary short-circuit analysis indicates a potential to exceed or approach the existing fault rating of the transmission facilities.

The scenarios to be studied are as shown in Table 5-1.

6 Mitigation Measures

6.1 Development

Mitigation measures may be required if the post-Project study results identify system performance issues. Mitigation measures for the Project may involve modifying or adding real-time operational practices and/or remedial action schemes (RASs).

The Studies Consultant must notify the AESO of any system performance issues in a timely manner, following which the AESO Studies Engineer may instruct the Studies Consultant as follows:

- Develop tables showing the constraint effective factors[2] for generation or load based on thermal criteria violations that are observed.
- Collaborate with the AESO to propose changes, if any, to the connection alternatives that could remove the requirement for a RAS.
- Collaborate with the AESO to study modifications to existing and/or planned RASs, proposed by the AESO, to ensure the coordination of existing protection schemes with the addition of any proposed protection schemes.
- Collaborate with the AESO to identify and study new RASs, if any, that may be required to ensure system reliability is maintained after connecting the Project to the AIES.

The AESO Studies Engineer will work closely with the Studies Consultant and guide the development and/or modifications of the proposed mitigation measures to ensure system reliability, security and compliance with AESO ID #2018-018T, *Provision of System Access Service and the Connection Process*.

6.2 Evaluation

6.2.1 Post-Mitigation Studies

Studies to evaluate the effectiveness of mitigation measures, if required, will be performed in accordance with the technical criteria, assumptions, and methods provided in this Study Scope and in accordance with further instructions from the AESO.

6.2.2 Constraint Effective Factor Studies

Constraint effective factor analysis are used to determine the generator- and load- constraint effective factors and to identify the most effective generators or loads to manage the thermal criteria violations, if any, that are observed under Category B conditions.

[2] Constraint effective factor studies are performed to determine the generator- and load- constraint effective factors. Constraint effective factors are used to estimate the ability of generators and loads to manage transmission constraints. A generator's or load's constraint effective factor is defined as the change in power flow over a specific transmission line following a change in the generator's energy production or in the load's energy consumption. The greater the constraint effective factor, the more effective a generator or load can be in managing a thermal criteria violation on the specific transmission line.

7 Changes to Study Assumptions

This study will utilize the AESO's planning base cases, which include the AESO's current corporate forecast (2019 LTO). Sensitivity studies or restudy may be required in the event of revisions to the AESO's corporate forecast. Additional engineering studies may also be required to assess new connection alternatives, changes to project ISD, or delays in proposed system developments. Any additional or revised study requirements shall be captured in a signed Study Scope Amendment document.

Attachment A: Transmission Planning Criteria – Basis and Assumptions

Transmission Planning Criteria – Basis and Assumptions

Date: July 9, 2019

Version: V1.2

Alberta Electric System Operator

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1. Introduction

This document presents the reliability standards, criteria, and assumptions to be used as the basis for planning the Alberta Transmission System. The criteria, standards and assumptions identified in this document supersede those previously established.

2. Transmission Reliability Standards and Criteria[1]

The AESO applies the following Alberta Reliability Standards to ensure that the transmission system is planned to meet applicable performance requirements under a defined set of system conditions and contingencies. A brief description of each of these standards is given below:

1. **TPL-001-AB-0: System Performance Under Normal Conditions**

   Category A represents a normal system condition with all elements in service (N-0). All equipment must be within its applicable rating, voltages must be within their applicable ratings and the system must be stable with no cascading outages. Under Category A, electric supply to load cannot be interrupted and generating units cannot be removed from service.

2. **TPL-002-AB1-0: System Performance Following Loss of a Single BES Element**

   Category B events result in the loss of any single element (N-1) under specified fault conditions with normal clearing. The specified elements are a generating unit, a transmission circuit, a transformer or a single pole of a direct current transmission line. The acceptable impact on the system is the same as Category A with the exception that radial customers or some local network customers, including loads or generating units, are allowed to be disconnected from the system if they are connected through the faulted element. The loss of opportunity load or opportunity interchanges is allowed. No cascading can occur.

3. **TPL-003-AB-0: System Performance Following Loss of Two or More BES Elements**

   Category C events result in the loss of two or more bulk electric system elements (sequential, N-1-1 or concurrent, N-2) under specified fault conditions and include both normal and delayed fault clearing. All of the system limits for Category A and B events apply with the exception that planned and controlled loss of firm load, firm transfers and/or generation is acceptable provided there is no cascading.

4. **TPL-004-AB-0: System Performance Following Extreme BES Events**

   Category D represents a wide variety of extreme, rare and unpredictable events, which may result in the loss of load and generation in widespread areas. The system may not be able to reach a new stable steady state, which means a blackout is a possible outcome. The AESO needs to evaluate these events, at its discretion, for risks and consequences prior to creating mitigation plans.

5. **FAC-014-AB1-2: Establishing and Communicating System Operating Limits**

   The AESO is required to establish system operating limits where a contingency is not mitigated through construction of transmission facilities

[1] A complete description of the *Alberta Reliability Standards* can be found on the AESO's website: https://www.aeso.ca/rules-standards-and-tariff/alberta-reliability-standards/

2.1 Thermal Loading Criteria

The AESO Thermal Loading Criteria require that the continuous thermal rating of any transmission element is not exceeded under normal and post-contingency operating conditions. Thermal limits are assumed to be 100% of the respective normal summer and winter ratings. Emergency limits are not considered in the planning evaluations.

2.2 Voltage Range and Voltage Stability Criteria

The normal minimum and maximum voltage limits as specified in the following table are used to identify Category A system voltage violations, while the extreme minimum and maximum limits are used to identify Category B and C system violations. Table 2-1 presents the acceptable steady state and contingency state voltage ranges for the AIES. Table 2-2 provides voltage stability criteria used to test the system performance.

Table 2-1: Acceptable Range of Steady State Voltage (kV)

Nominal Voltage	Extreme Minimum	Normal Minimum	Normal Maximum	Extreme Maximum
500	475	500	525	550
240	216	234	252	264
260 (Northeast & Northwest)*	234	247	266	275
144	130	137	151	155
138	124	135	145	152
72	65	68.5	75.5	79
69	62	65.5	72.5	76

Table 2-2: Voltage Stability Criteria

Performance Level	Disturbance (1)(2)(3)(4) Initiated by: Fault of No Fault DC Disturbance	MW Margin (P-V method) (5)(6)(7)	MVAr Margin (V-Q method) (6)(7)
A	Any element such as: One Generator One Circuit One Transformer One Reactive Power Source One DC Monopole	≥5%	Worst Case Scenario(8)
B	Bus Section	≥5%	50% of Margin Requirement in Level A
C	Any combination of two elements such as: A Line and a Generator A Line and a Reactive Power Source Two Generators Two Circuits Two Transformers Two Reactive Power Sources DC Bipole	≥2.5%	50% of Margin Requirement in Level A
D	Any combination of three or more elements such as: Three or More Circuits on ROW Entire Substation Entire Plant Including Switchyard	> 0	> 0

2.3 Transient Stability Analysis Assumptions

Standard fault clearing times as shown in Table 2-3 are used for the new facilities or when the actual clearing times are not available for the existing facilities. Double line-to-ground faults are applied for the Category C5 events with normal clearing times. Single line-to-ground faults are applied for Category C6 to C9 events with delayed clearing times as depicted in Table 2-4 and Table 2-5.

Table 2-3: Fault Clearing Times

Nominal (kV)	Near End (Cycles)	Far End (Cycles)
500	4	5
240	5	6
144/138 with telecommunications	6	8
144/138 without telecommunications	6	30

Table 2-4: Stuck Breaker Clearing Times for Lines

Voltage (kV)	Fault Clearing Times (Cycles)		
	Near End	Far End	2nd Ckt (C5 and C7 only)
138/144	15	24	24
240	12	6	14
500	9	5	11

Table 2-5: Stuck Breaker Clearing Times for Transformers

Voltage (kV)	Fault Location	Fault Clearing Times (Cycles)		
		High Side	Low Side	2nd Ckt (breaker fail)
240/138	240 kV side	12	6	14
	138 kV side	5	15	24
500/240	500 kV side	9	5	11
	240 kV side	4	12	14

Attachment A2

Pre-Project Power Flow Diagrams

List of Figures

Scenario and Case Name	Contingency (System Element Lost)	Figure Number
2023SL_Pre-Project	N-0 (System Normal Condition)	Figure A2-1
	12L41 (Sunnybrook 510S - Livock 939S)	Figure A2-2
	12L44 (Thickwood Hills 951S - Livock 939S)	Figure A2-3
	1201T (Thickwood Hills 951S Transformer 1201T)	Figure A2-4
2023SP_Pre-Project	N-0 (System Normal Condition)	Figure A2-5
	12L41 (Sunnybrook 510S - Livock 939S)	Figure A2-6
	12L44 (Thickwood Hills 951S - Livock 939S)	Figure A2-7
	1201T (Thickwood Hills 951S Transformer 1201T)	Figure A2-8
2023WP_Pre-Project	N-0 (System Normal Condition)	Figure A2-9
	Parsons Creek 718S Transformer 718S701T	Figure A2-10
	Parsons Creek 718S Transformer 718S702T	Figure A2-11
	12L41 (Sunnybrook 510S - Livock 939S)	Figure A2-12
	12L44 (Thickwood Hills 951S - Livock 939S)	Figure A2-13
	1201T (Thickwood Hills 951S Transformer 1201T)	Figure A2-14

Figure A2-1: 2023 Summer Light Pre-Project N-0 (System Normal Condition)

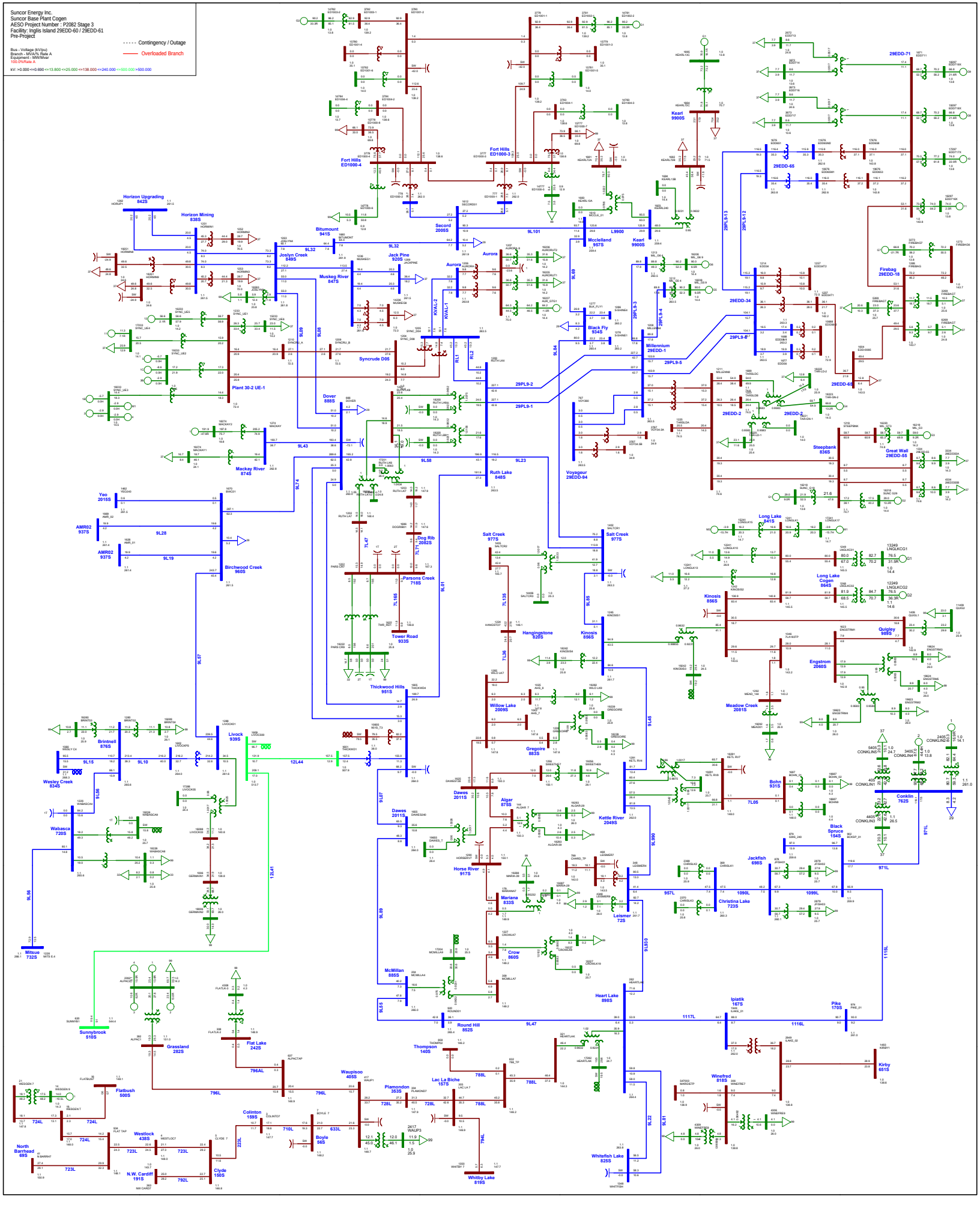


Figure A2-2: 2023 Summer Light Pre-Project Contingency of 12L41 (Sunnybrook 510S - Livock 939S)

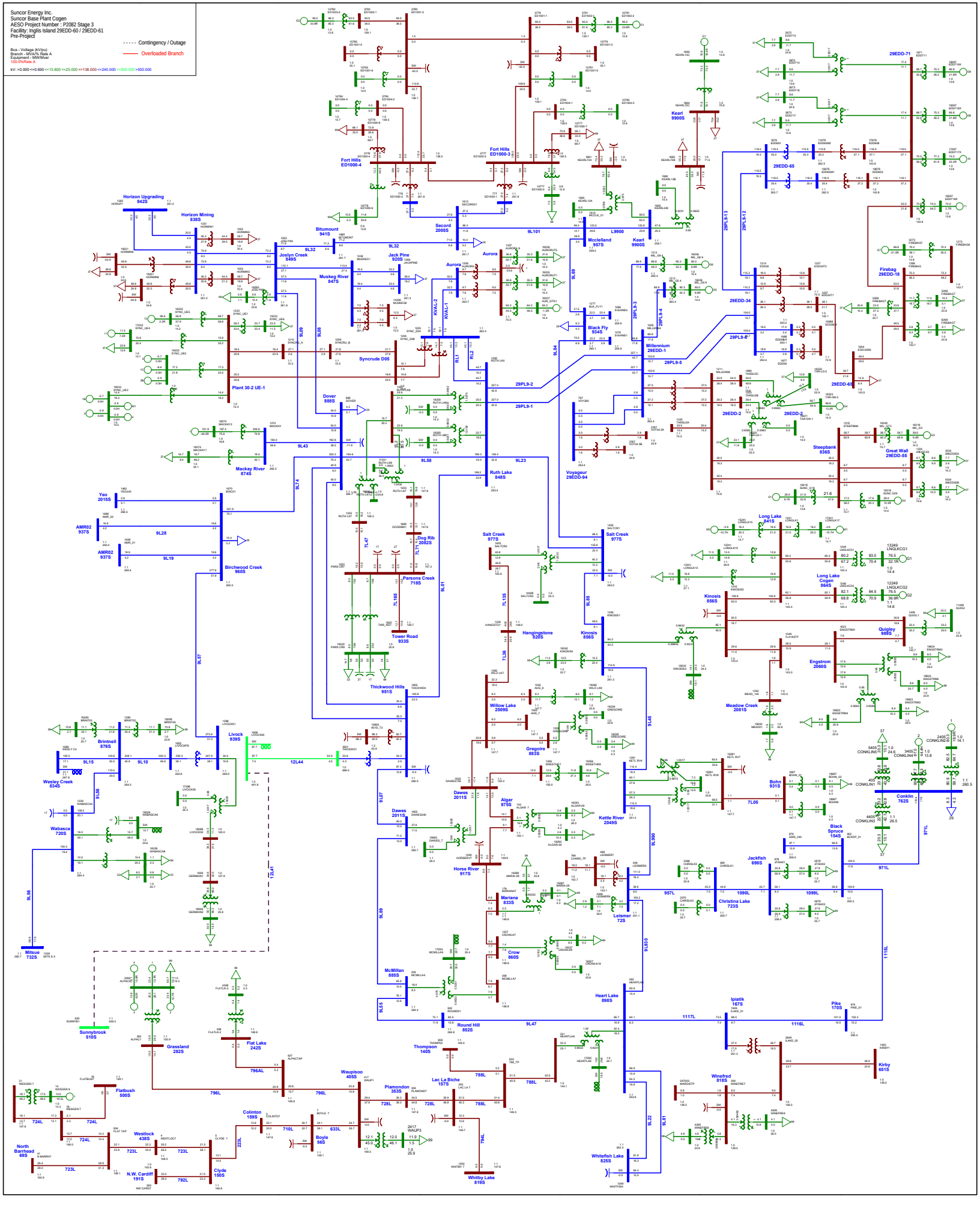


Figure A2-3: 2023 Summer Light Pre-Project Contingency of 12L44 (Thickwood Hills 951S - Livock 939S)

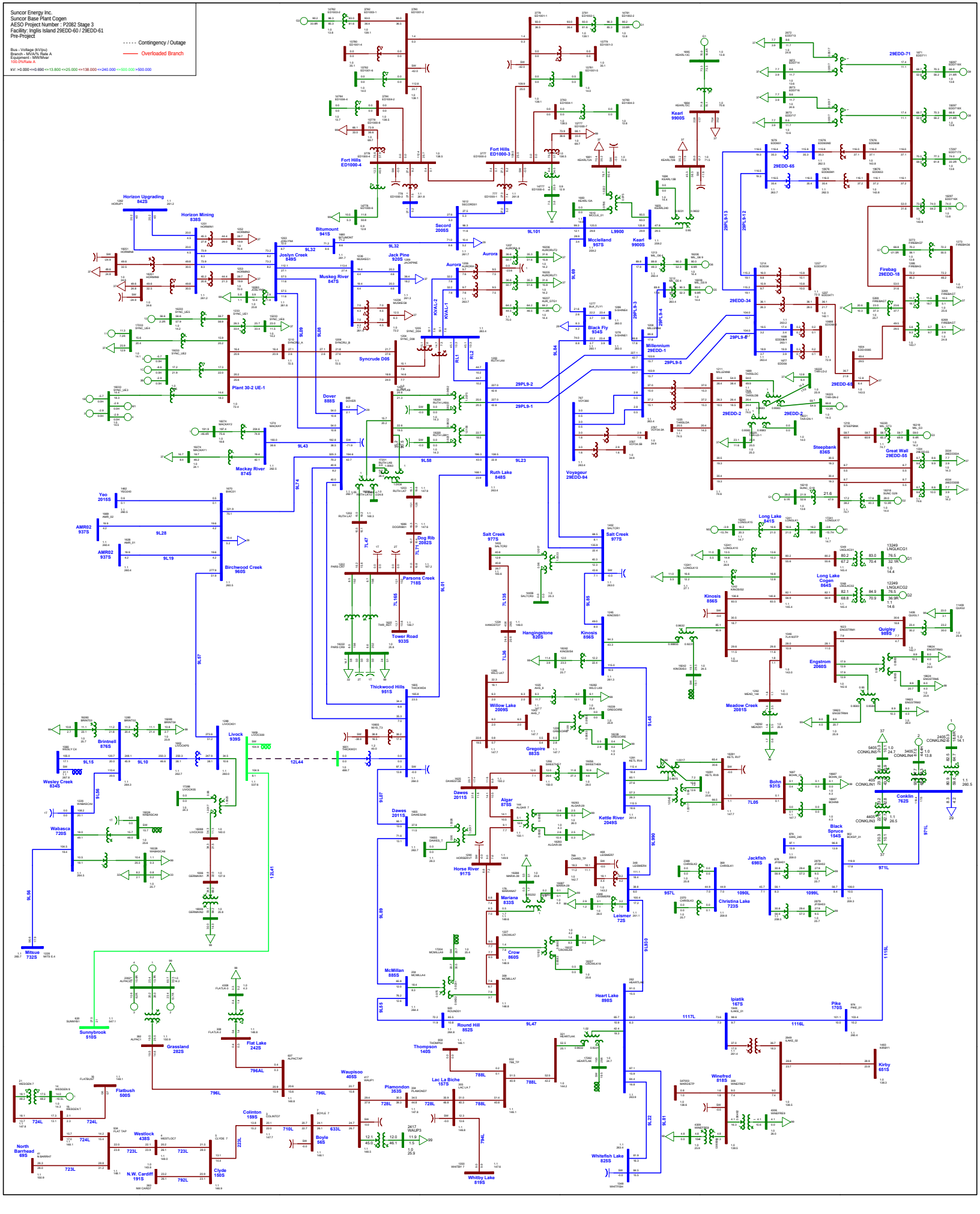


Figure A2-4: 2023 Summer Light Pre-Project Contingency of Thickwood Hills 951S Transformer 1201T

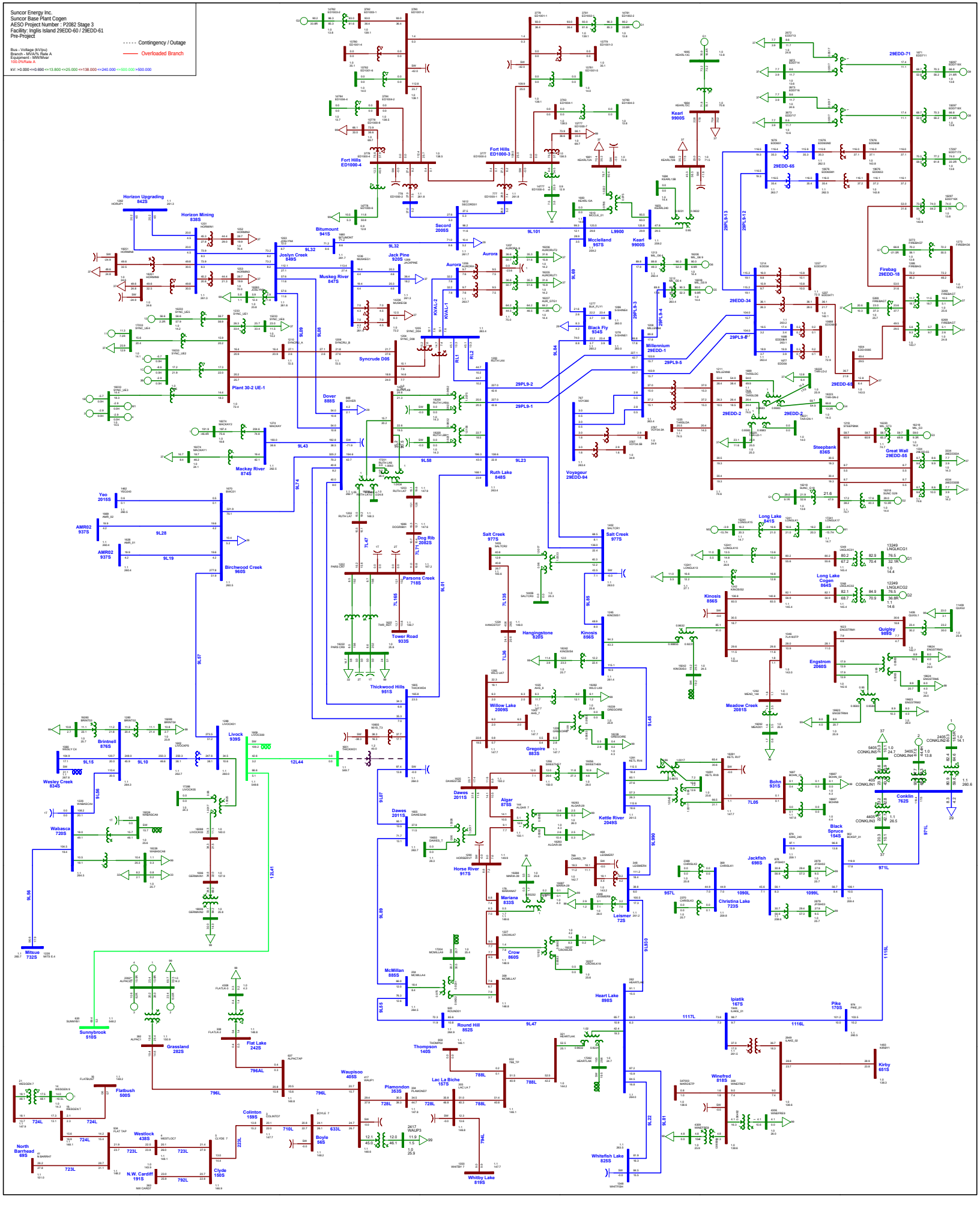


Figure A2-5: 2023 Summer Peak Pre-Project N-0 (System Normal Condition)

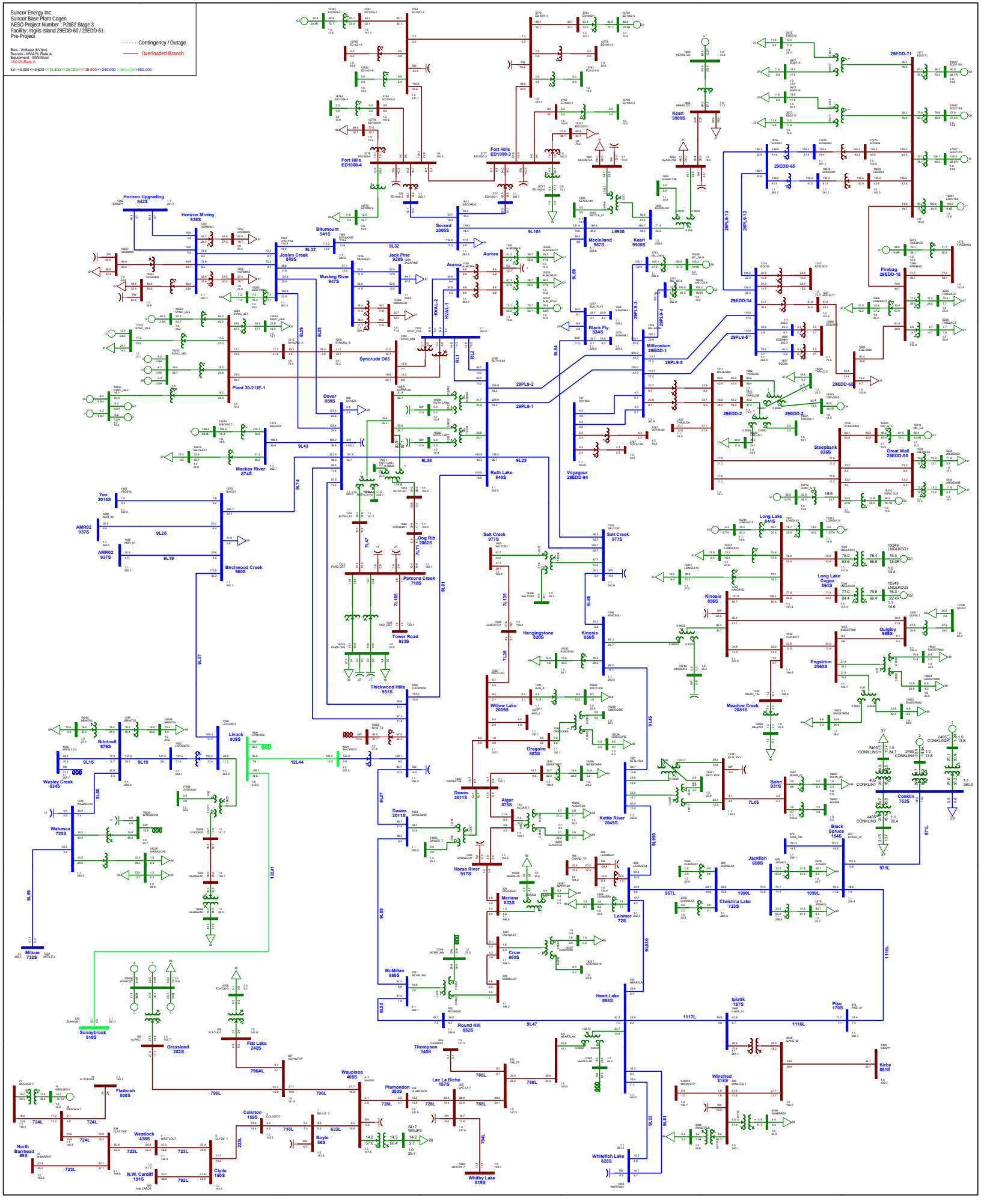


Figure A2-6: 2023 Summer Peak Pre-Project Contingency of 12L41 (Sunnybrook 510S - Livock 939S)

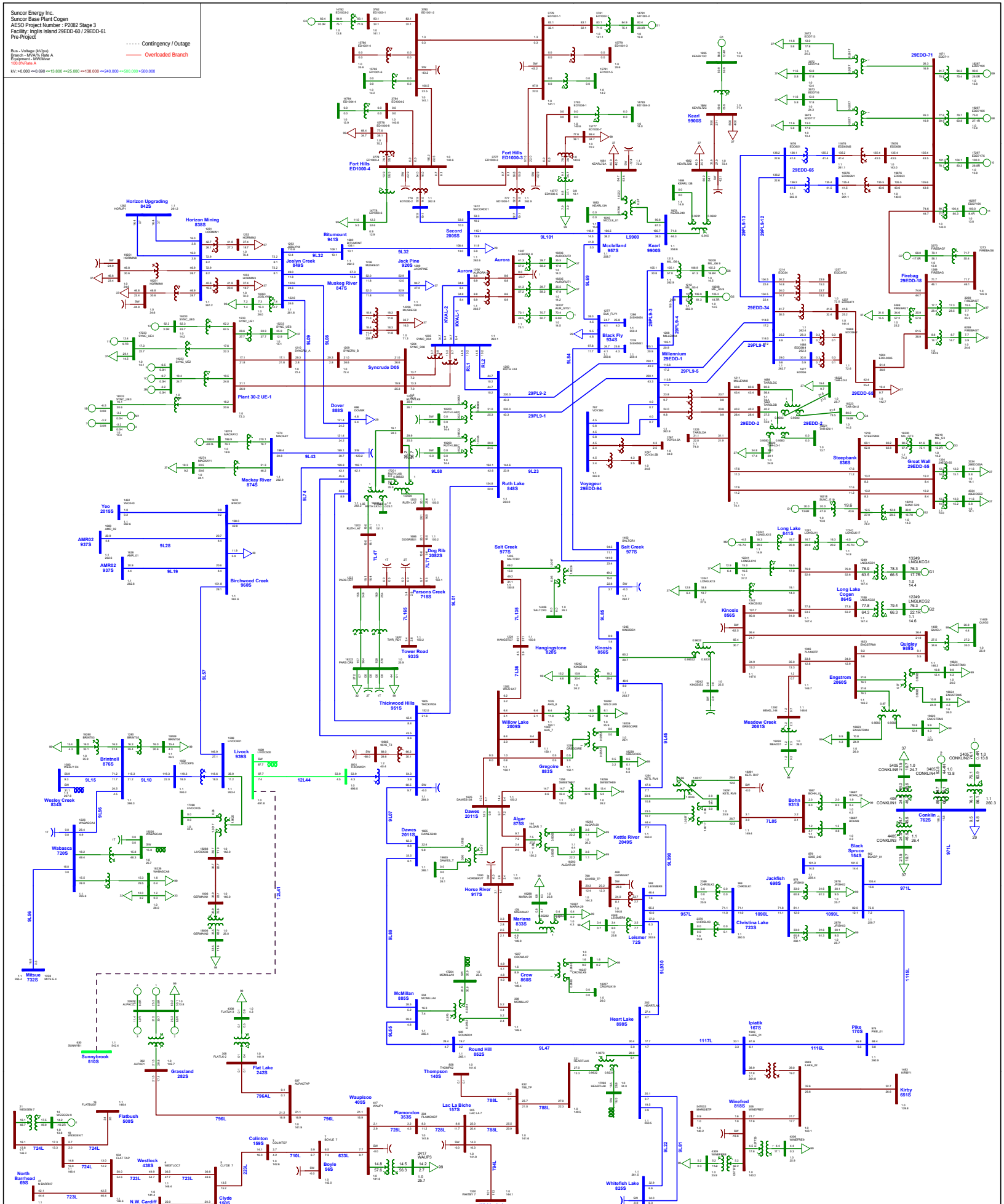


Figure A2-7: 2023 Summer Peak Pre-Project Contingency of 12L44 (Thickwood Hills 951S - Livock 939S)

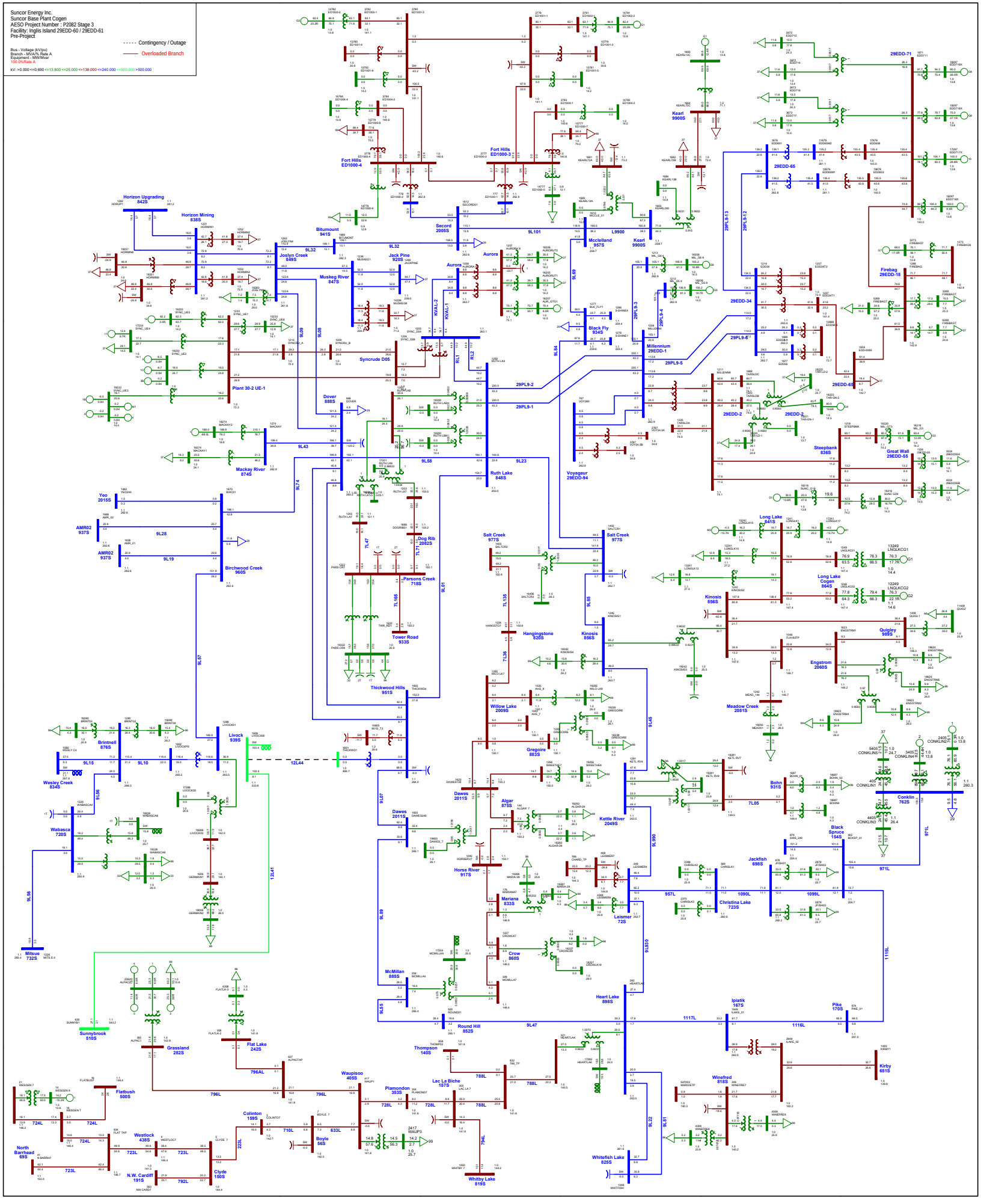


Figure A2-8: 2023 Summer Peak Pre-Project Contingency of Thickwood Hills 951S Transformer 1201T

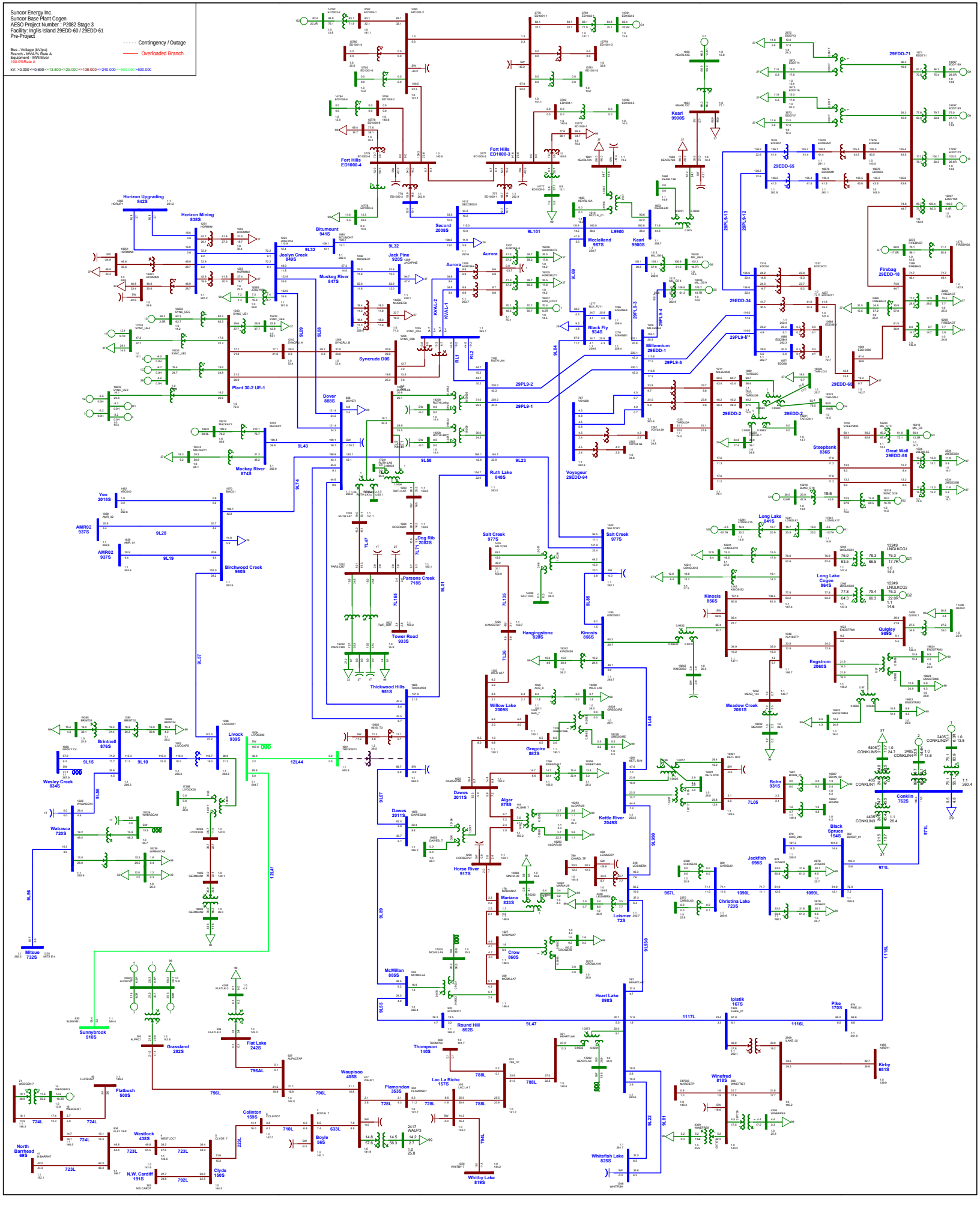


Figure A2-9: 2023 Winter Peak Pre-Project N-0 (System Normal Condition)

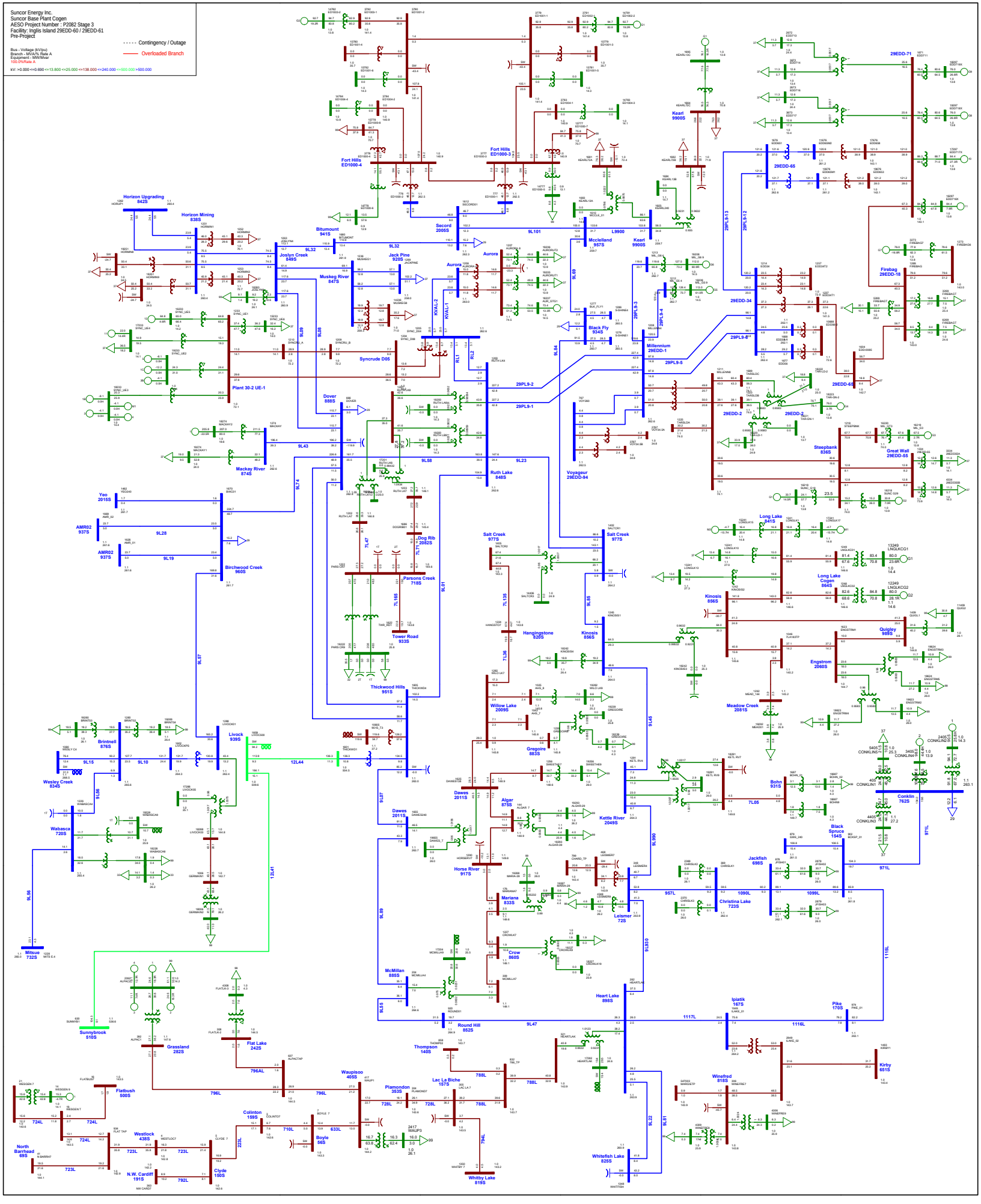


Figure A2-10: 2023 Winter Peak Pre-Project Contingency of Parsons Creek 718S Transformer 718S701T

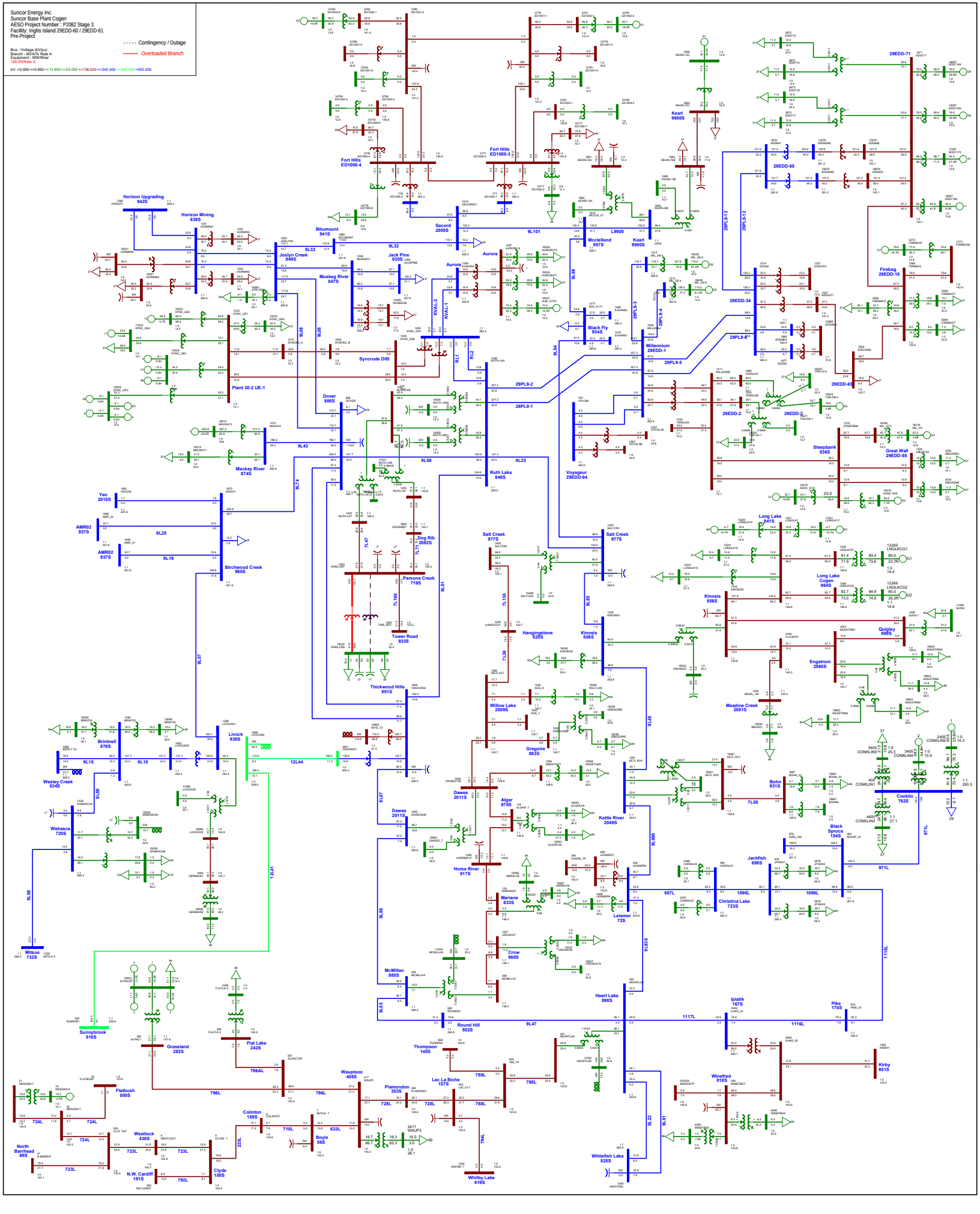
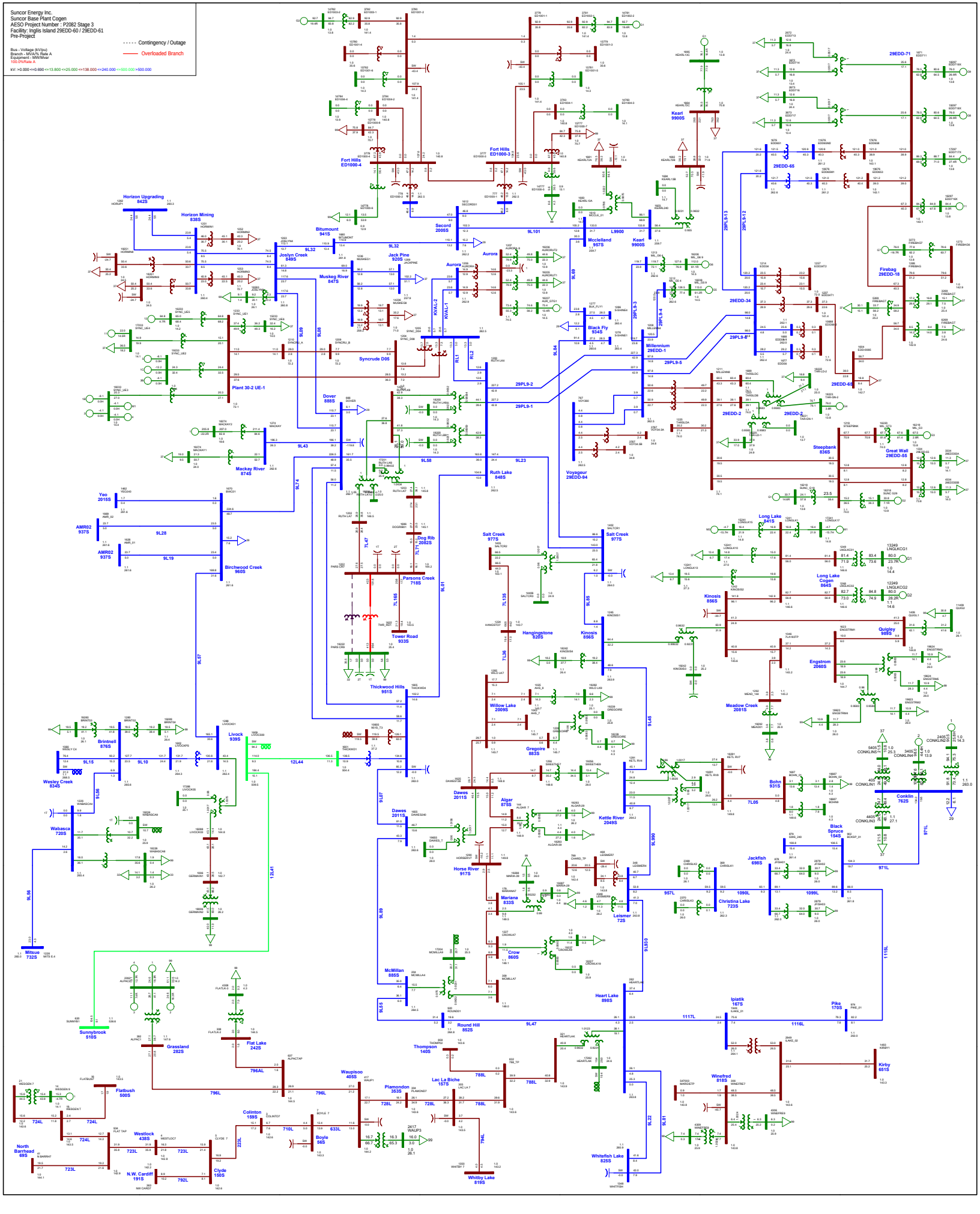


Figure A2-11: 2023 Winter Peak Pre-Project Contingency of Parsons Creek 718S Transformer 718S702T


Suncor Energy Inc.
Suncor Base Plant Cogen
AESO Project Number : P2082 Stage 3
Facility: Inglis Island 29EDD-60 / 29EDD-61
Pre-Project
Contingency / Outage
Overloaded Branch
Bus - Voltage (kV/pu)
Branch - MVA/% Rate A
Equipment - MW/Mvar
100.0/Rate A
kV: >0.000 <=0.690 <=13.800 <=25.000 <=138.000 <=240.000 <=500.000 >500.000
Horizon Upgrading 942S
Horizon Mining 838S
Bitumount 941S
Joslyn Creek 849S
Muskeg River 847S
Jack Pine 920S
Second 2005S
Fort Hills ED1000-4
Fort Hills ED1000-3
Aurora
Mcclelland 957S
L9900
Kearl 9900S
29EDD-71
29EDD-65
29EDD-34
29EDD-18
29EDD-66
29EDD-55
29EDD-2
29PL9-5
29PL9-4
29PL9-3
29PL9-2
29PL9-1
Millennium 29EDD-1
Black Fly 934S
Voyageur 29EDD-94
Steepbank 836S
Great Wall
Long Lake 841S
Long Lake Cogen 864S
Kinosis 856S
Quigley 989S
Engstrom 2060S
Meadow Creek 2081S
Bohn 931S
Jackfish 698S
Christina Lake 723S
Conklin 762S
Black Spruce 154S
Leismer 72S
Kettle River 2049S
Hangingstone 920S
Kinosis 856S
Salt Creek 977S
Dog Rib 2082S
Parsons Creek 718S
Tower Road 933S
Thickwood Hills 951S
Willow Lake 2009S
Gregoire 883S
Algar 879S
Dawes 2011S
Horse River 917S
Mariana 833S
Crow 860S
McMillan 888S
Heart Lake 899S
Round Hill 852S
Thompson 140S
Lac La Biche 157S
Plamondon 383S
Waupisoo 408S
Flat Lake 242S
Sunnybrook 510S
Grassland 282S
Flatbush 500S
Wesley Creek 834S
Wabasca 720S
Brintnell 876S
Livock 939S
Birchwood Creek 960S
Yoo 2015S
AMR02 937S
Mackay River 874S
Plant 30-2 UE-1
Syncrude D05
Dover 888S
Ruth Lake 848S
Kearl 9900S
Millennium 29EDD-1
Steepbank 836S
Great Wall 29EDD-55
Long Lake 841S
Long Lake Cogen 864S
Kinosis 856S
Quigley 989S
Engstrom 2060S
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Jackfish 698S
Christina Lake 723S
Conklin 762S
Black Spruce 154S
Leismer 72S
Kettle River 2049S
Hangingstone 920S
Salt Creek 977S
Dog Rib 2082S
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Willow Lake 2009S
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Lac La Biche 157S
Plamondon 383S
Waupisoo 408S
Flat Lake 242S
Sunnybrook 510S
Grassland 282S
Flatbush 500S
Wesley Creek 834S
Wabasca 720S
Brintnell 876S
Livock 939S
Birchwood Creek 960S
Yoo 2015S
AMR02 937S
Mackay River 874S
Plant 30-2 UE-1
Syncrude D05
Dover 888S
Ruth Lake 848S
Bitumount 941S
Joslyn Creek 849S
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Fort Hills ED1000-4
Fort Hills ED1000-3
Aurora
Mcclelland 957S
L9900
Kearl 9900S
Horizon Upgrading 942S
Horizon Mining 838S
29EDD-71
29EDD-65
29EDD-34
29EDD-18
29EDD-66
29EDD-55
29EDD-2
29PL9-5
29PL9-4
29PL9-3
29PL9-2
29PL9-1
Millennium 29EDD-1
Black Fly 934S
Voyageur 29EDD-94
Steepbank 836S
Great Wall

Figure A2-12: 2023 Winter Peak Pre-Project Contingency of 12L41 (Sunnybrook 510S - Livock 939S)

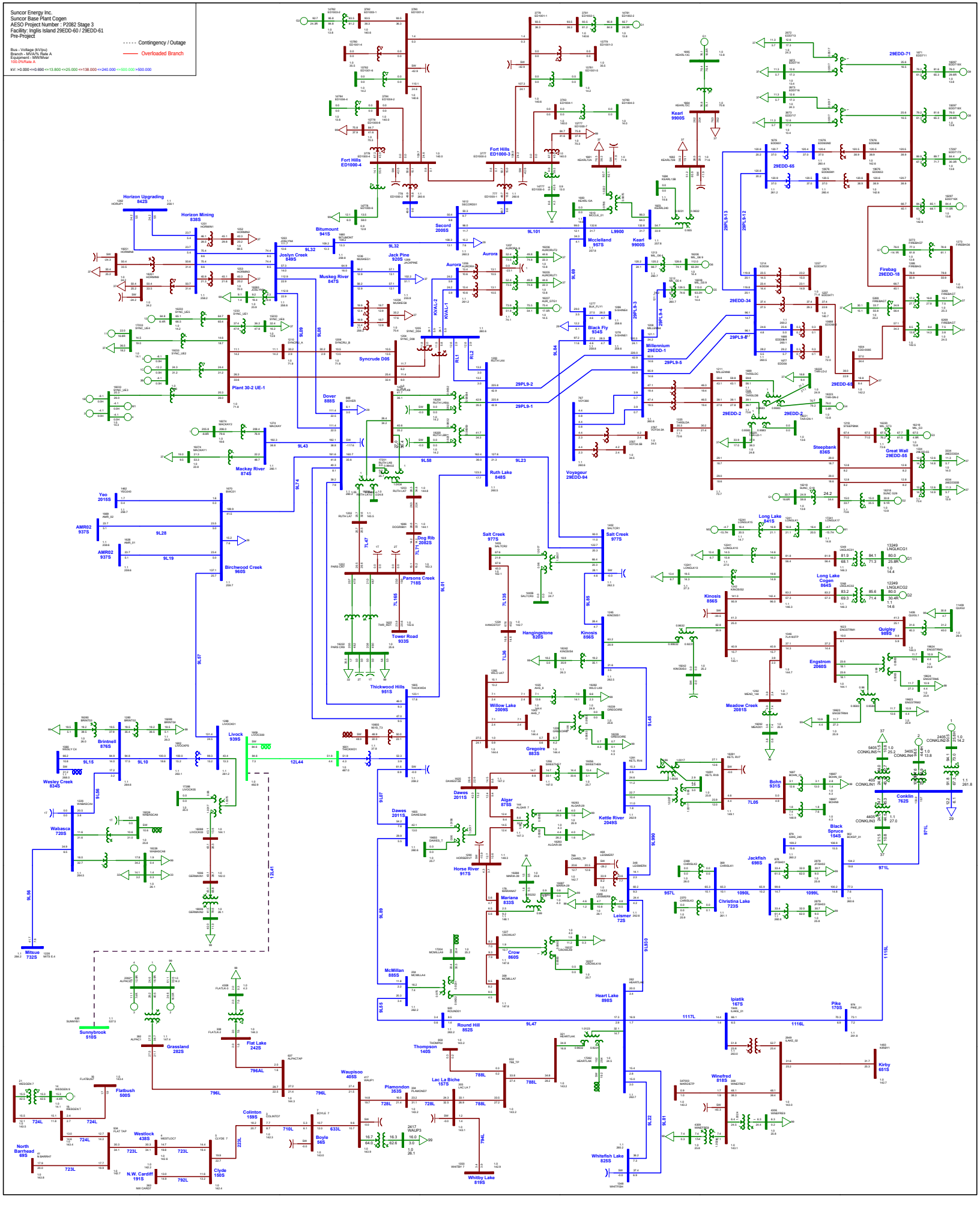


Figure A2-13: 2023 Winter Peak Pre-Project Contingency of 12L44 (Thickwood Hills 951S - Livock 939S)

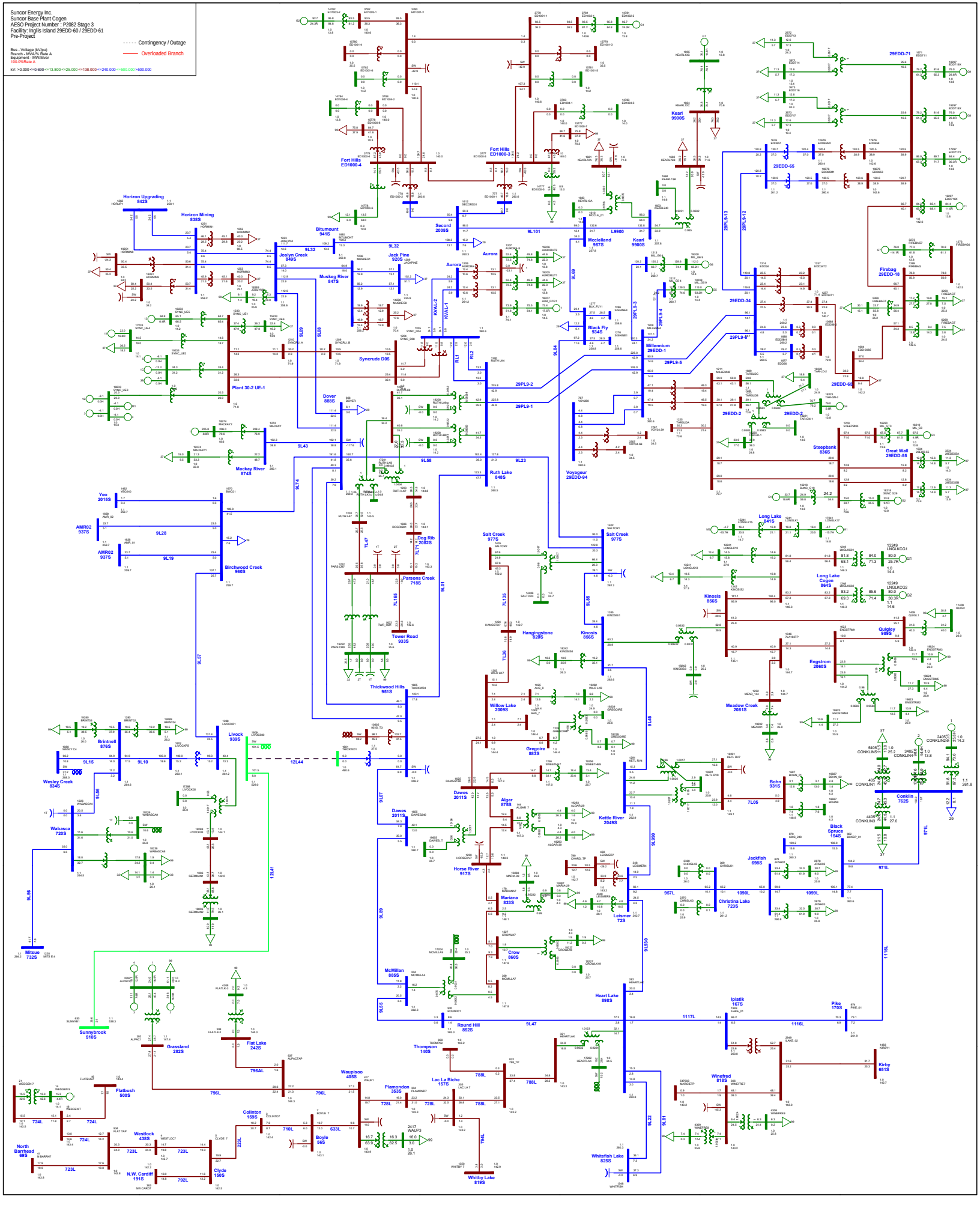
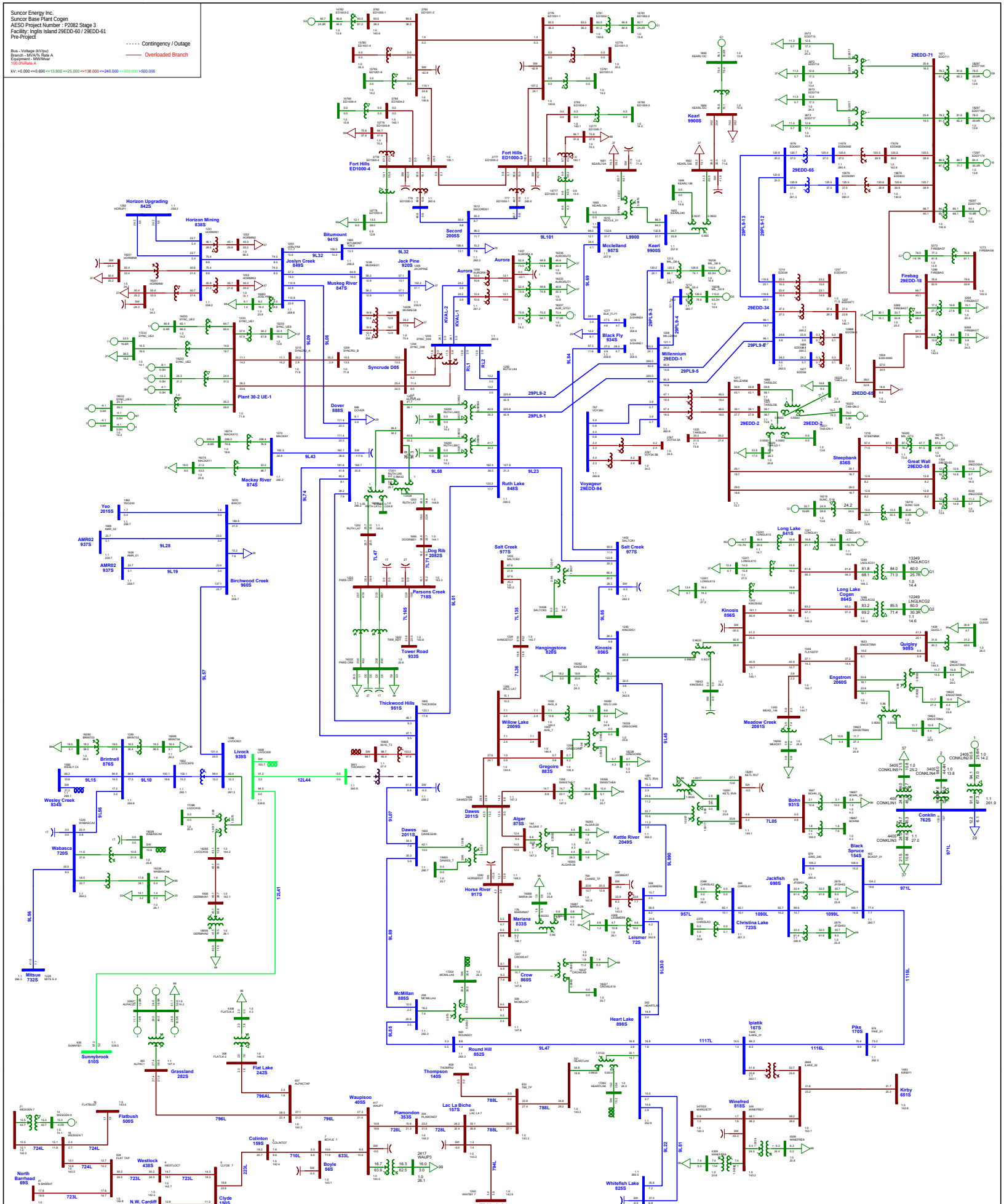


Figure A2-14: 2023 Winter Peak Pre-Project Contingency of Thickwood Hills 951S Transformer 1201T



Attachment A3

Post-Project Power Flow Diagrams

List of Figures

Scenario and Case Name	Contingency (System Element Lost)	Figure Number
2023SL_Post-Project	N-0 (System Normal Condition)	Figure A3-1
	12L41 (Sunnybrook 510S - Livock 939S)	Figure A3-2
	12L44 (Thickwood Hills 951S - Livock 939S)	Figure A3-3
	Thickwood Hills 951S Transformer 1201T	Figure A3-4
2023SP_Post-Project	N-0 (System Normal Condition)	Figure A3-5
	12L41 (Sunnybrook 510S - Livock 939S)	Figure A3-6
	12L44 (Thickwood Hills 951S - Livock 939S)	Figure A3-7
	Thickwood Hills 951S Transformer 1201T	Figure A3-8
2023WP_Post-Project	N-0 (System Normal Condition)	Figure A3-9
	Parsons Creek 718S Transformer 718S701T	Figure A3-10
	Parsons Creek 718S Transformer 718S702T	Figure A3-11
	12L41 (Sunnybrook 510S - Livock 939S)	Figure A3-12
	12L44 (Thickwood Hills 951S - Livock 939S)	Figure A3-13
	Thickwood Hills 951S Transformer 1201T	Figure A3-14

Figure A3-1: 2023 Summer Light Post-Project N-0 (System Normal Condition)

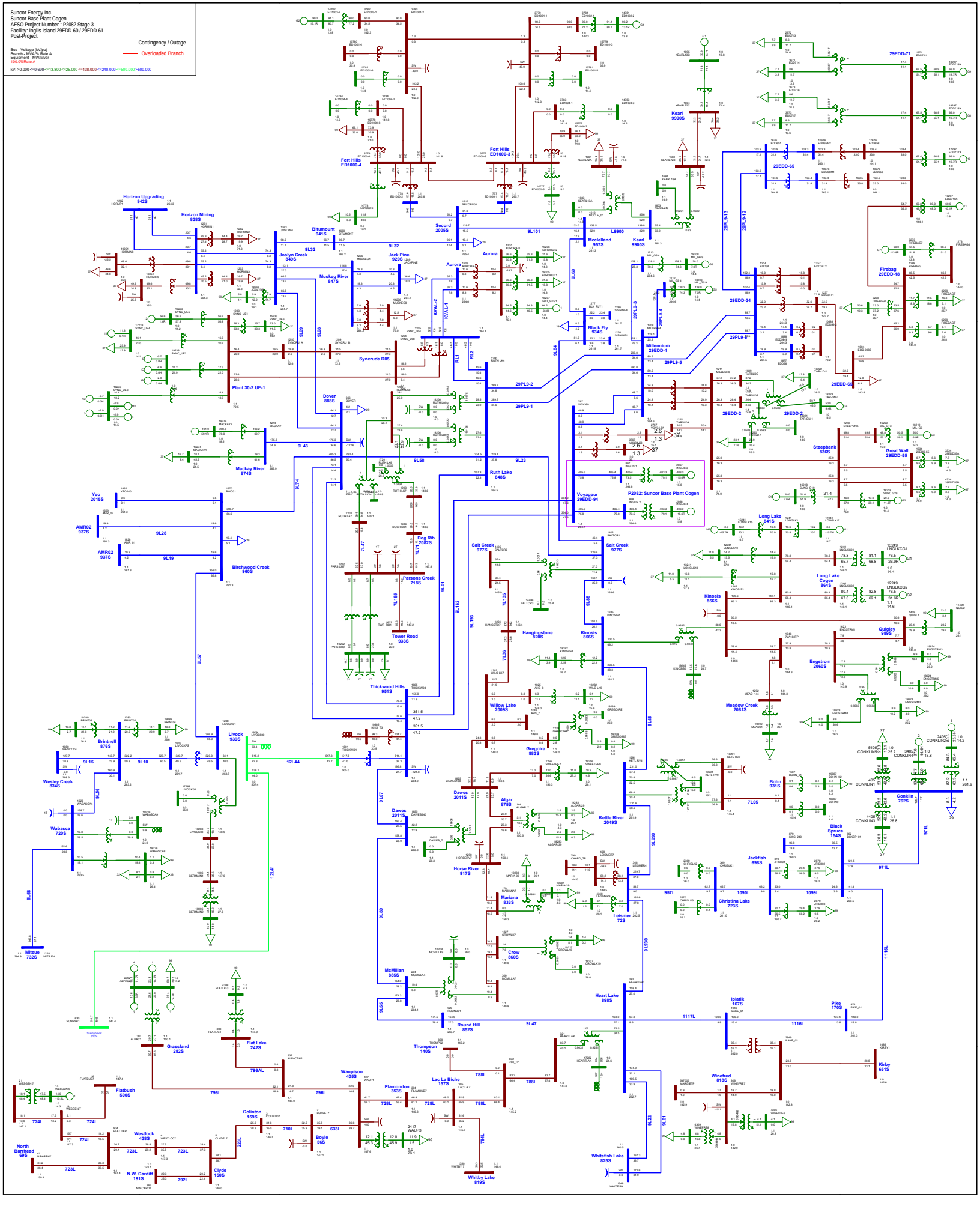


Figure A3-2: 2023 Summer Light Post-Project Contingency of 12L41 (Sunnybrook 510S - Livock 939S)

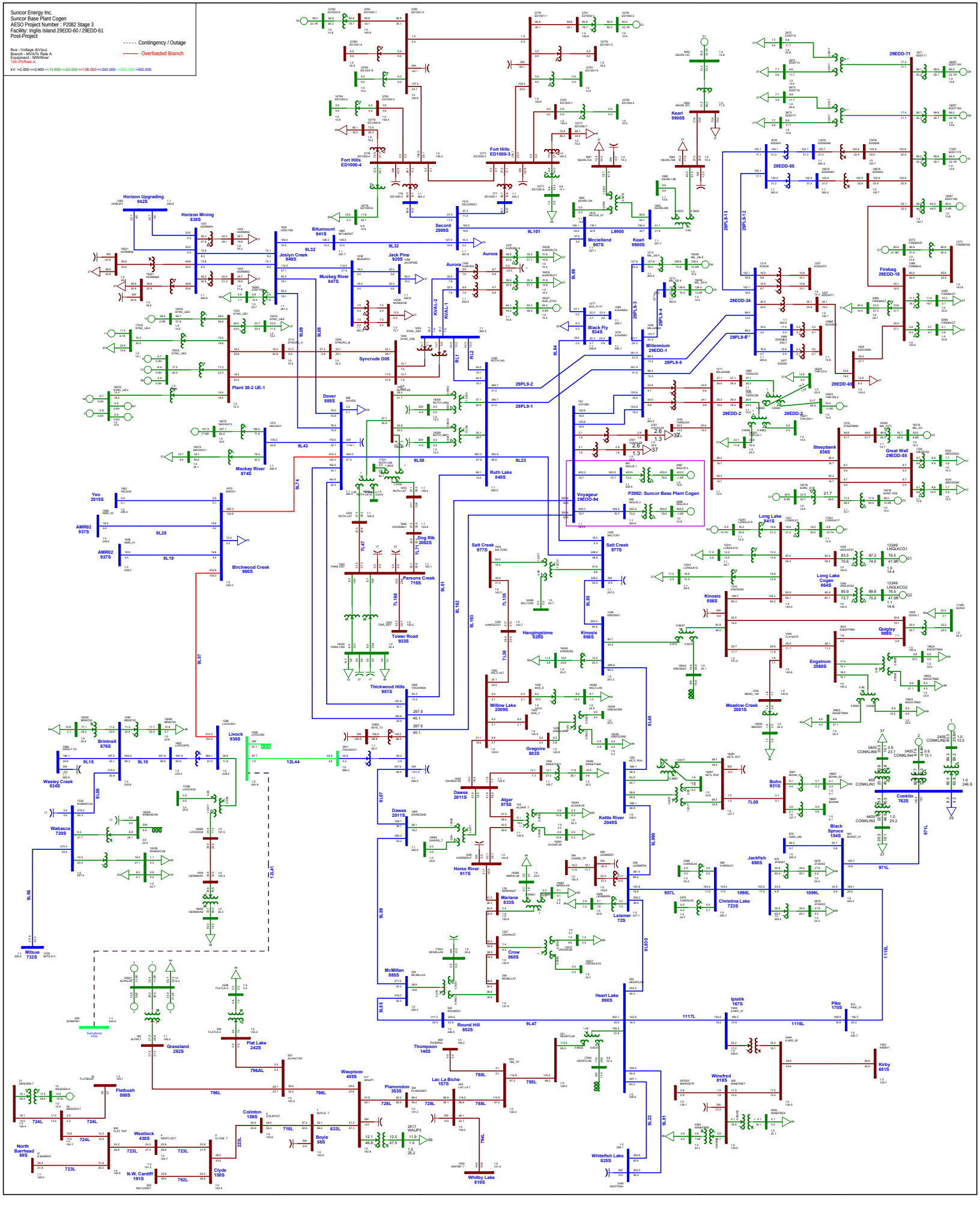
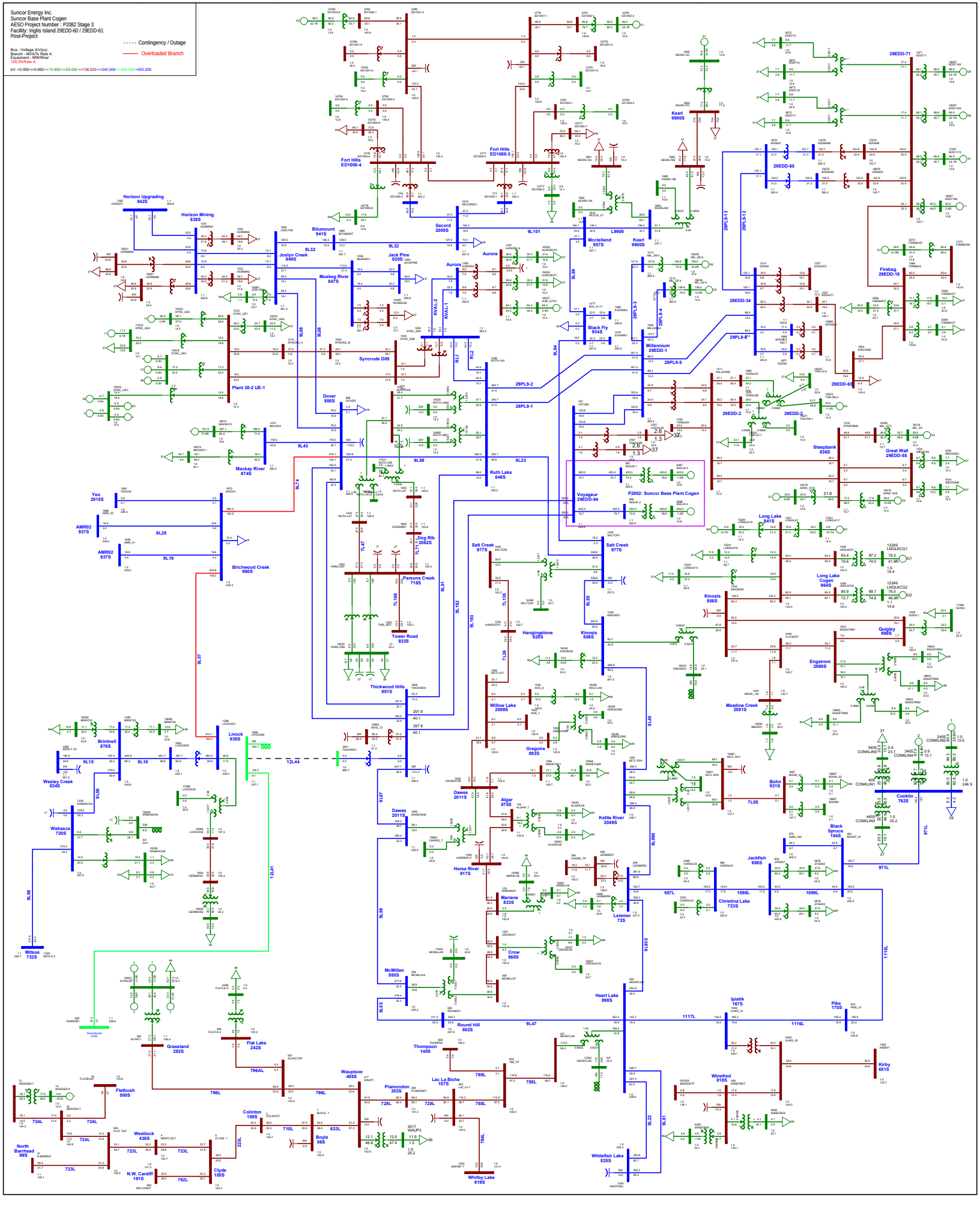


Figure A3-3: 2023 Summer Light Post-Project Contingency of 12L44 (Thickwood Hills 951S - Livock 939S)


Suncor Energy Inc.
Suncor Base Plant Cogen
AESO Project Number : P2082 Stage 3
Facility: Inglis Island 29EDD-60 / 29EDD-61
Post-Project
Contingency / Outage
Overloaded Branch
Bus - Voltage (kV)pu)
Branch - MVA/% Rate A
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=0.690 <=13.800 <=25.000 <=138.000 <=240.000 <=500.000 >500.000
Horizon Upgrading 942S
Horizon Mining 938S
Bitumount 941S
Second 2005S
Fort Hills ED1000-4
Fort Hills ED1000-3
Kearl 9900S
Mcclelland 987S
Millennium 29EDD-1
Black Fly 934S
Joslyn Creek 849S
Muskeg River 847S
Jack Pine 920S
Aurora
Syncrude D05
Plant 30-2 UE-1
Dover 888S
Mackay River 874S
Ruth Lake 848S
Voyageur 29EDD-94
P2082: Suncor Base Plant Cogen
Yeo 2015S
AMR02 937S
Birchwood Creek 960S
Dog Rib 2082S
Parsons Creek 718S
Tower Road 933S
Thickwood Hills 951S
Salt Creek 977S
Hangingstone 920S
Kinosis 856S
Willow Lake 2009S
Gregoire 883S
Dawes 2011S
Algar 879S
Kettle River 2049S
Horse River 917S
Mariana 833S
Crow 860S
McMillan 888S
Heart Lake 899S
Round Hill 852S
Thompson 140S
Lac La Biche 157S
Plamondon 383S
Waupisoo 408S
Flat Lake 242S
Grassland 282S
Livock 939S
Brintnell 876S
Wesley Creek 834S
Wabasca 720S
Mitsue 732S
Sunnybrook 910S
Flatbush 500S
Westlock 438S
North Barrhead 69S
Clyde 160S
N.W. Cardiff 191S
Colinton 159S
Boyle 66S
Whitefish Lake 925S
Whitby Lake 819S
Leismer 72S
Christina Lake 723S
Conklin 762S
Jackfish 698S
Bohn 931S
Kirby 651S
Pike 1792S
Winefred 818S
Iplatik 167S
Meadow Creek 2081S
Quigley 989S
Engstrom 2060S
Steepbank 836S
Great Wall 29EDD-55
Firebag 29EDD-18
Long Lake 841S
Long Lake Cogen 864S
29EDD-71
29EDD-65
29EDD-34
29EDD-66
29EDD-2
29PL9-1
29PL9-2
29PL9-3
29PL9-4
29PL9-5
29PL9-6
29PL9-12
29PL9-13
L9900
9L01
9L09
9L32
9L43
9L58
9L23
9L84
9L74
9L28
9L19
9L57
9L56
9L15
9L10
9L66
9L08
9L89
9L91
9L162
9L193
9L45
9L07
9L69
9L22
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9L47
9L55
9L359
12L44
12L41
7L05
7L36
7L47
7L71
7L72
7L465
7L155
796L
724L
723L
710L
633L
794L
971L
957L
1090L
1099L
1116L
1117L
Kearl138
Kearl13A
Kearl240
Kearl13C
Kearl138
Kearl240
Kearl13A
Kearl13C
Kearl138
Kearl240
Kearl13A
Kearl13C
Kearl138
Kearl240
Kearl13A

Figure A3-4: 2023 Summer Light Post-Project Contingency of Thickwood Hills 951S Transformer 1201T

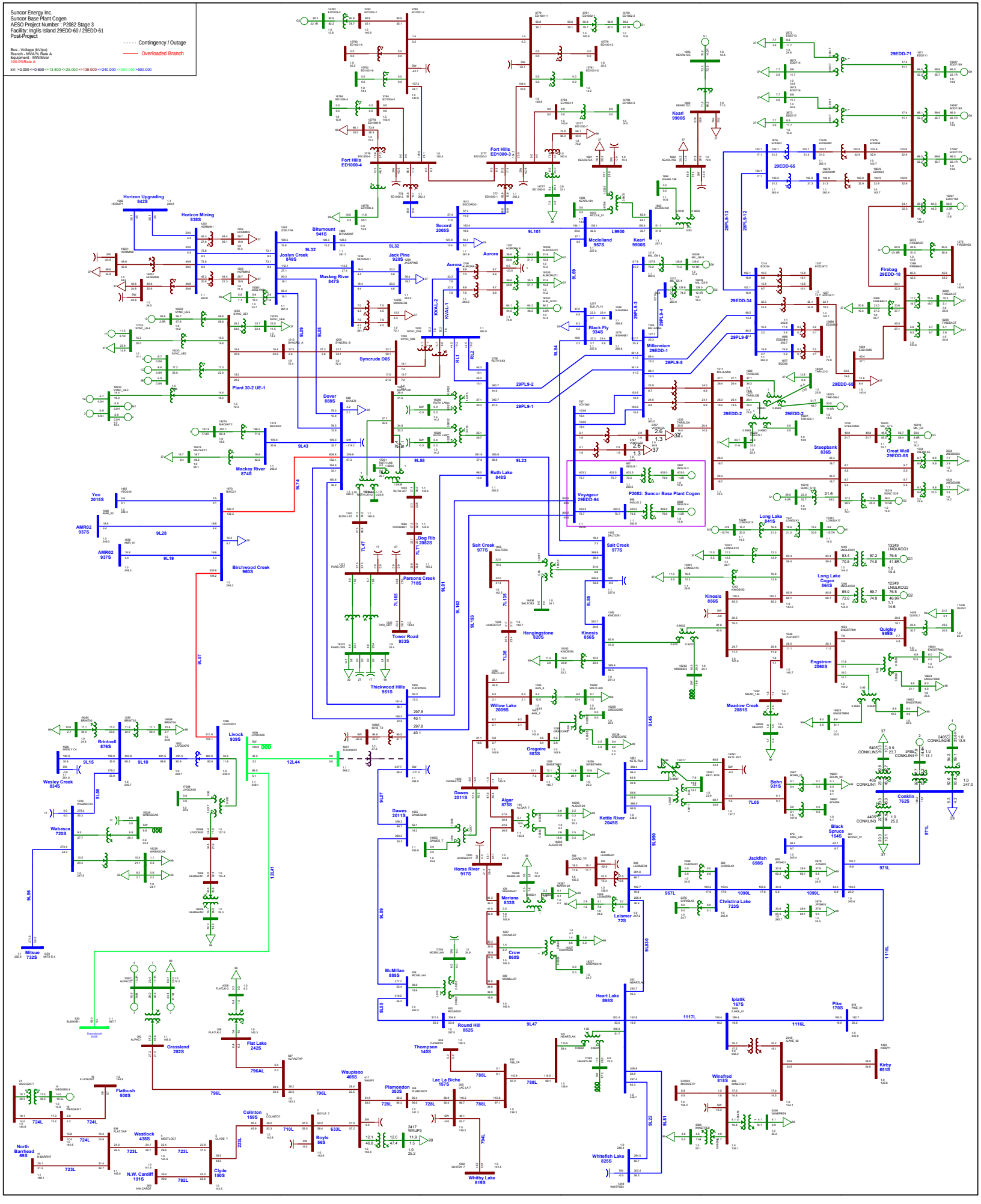


Figure A3-5: 2023 Summer Peak Post-Project N-0 (System Normal Condition)

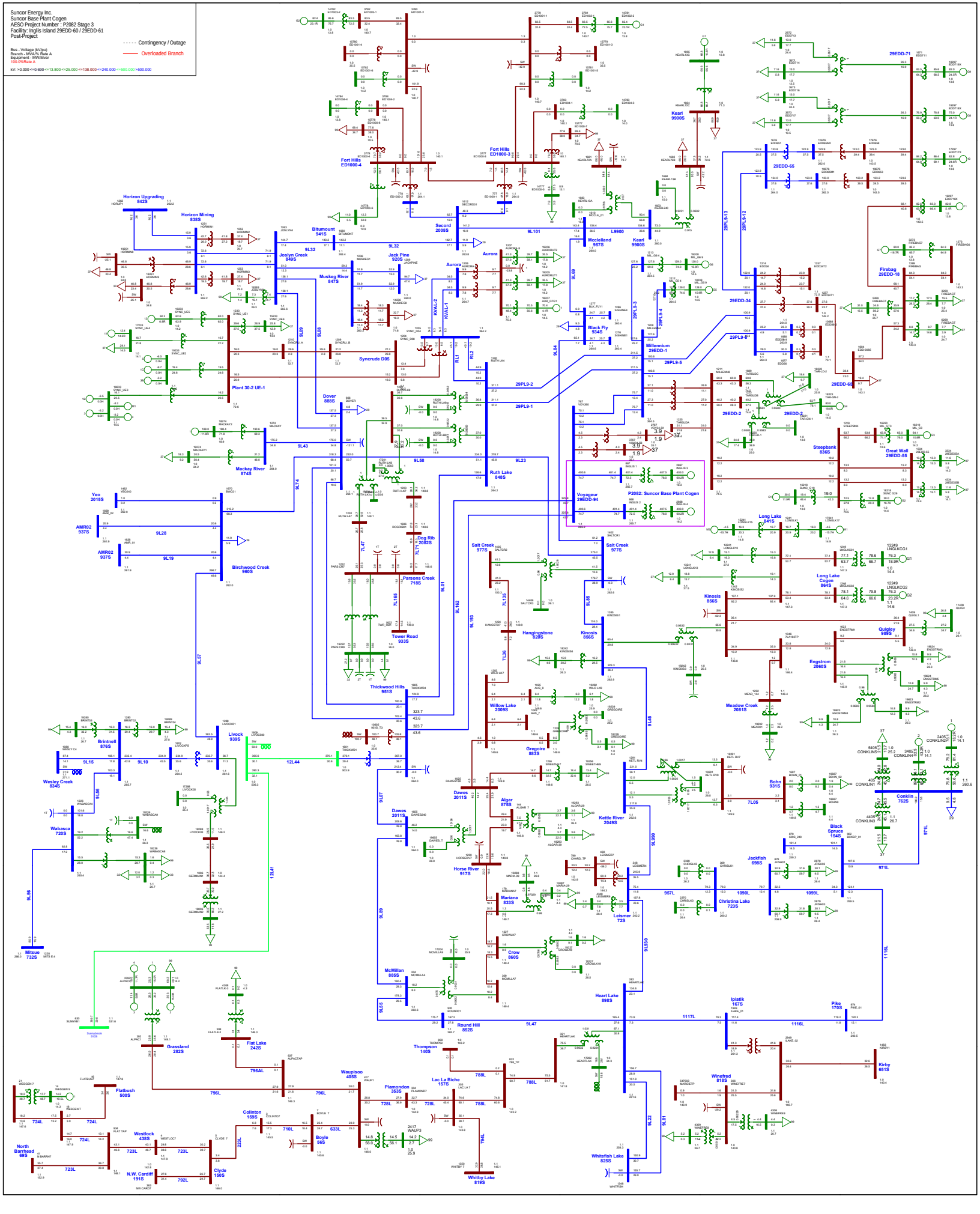


Figure A3-6: 2023 Summer Peak Post-Project Contingency of 12L41 (Sunnybrook 510S - Livock 939S)

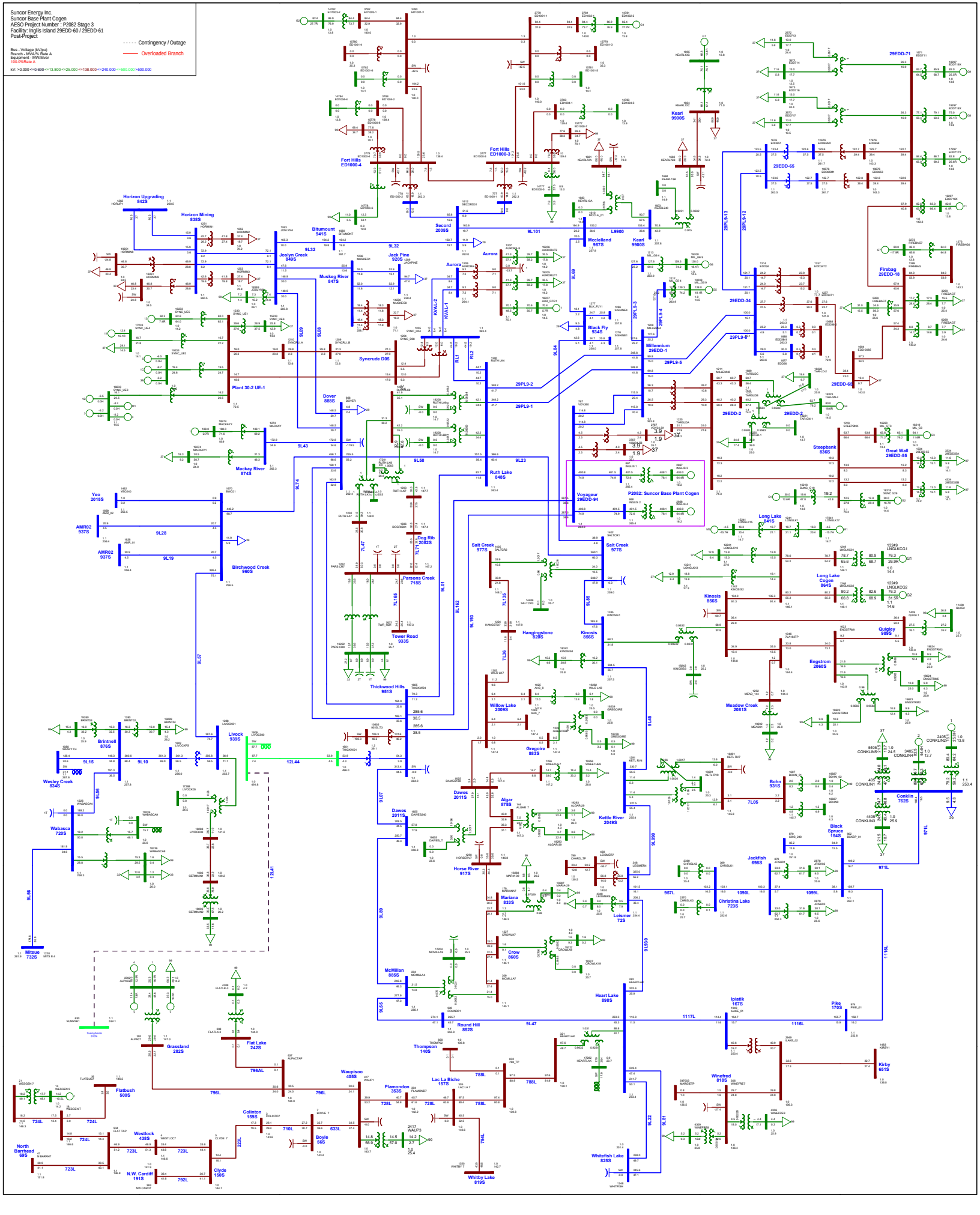


Figure A3-7: 2023 Summer Peak Post-Project Contingency of 12L44 (Thickwood Hills 951S - Livock 939S)

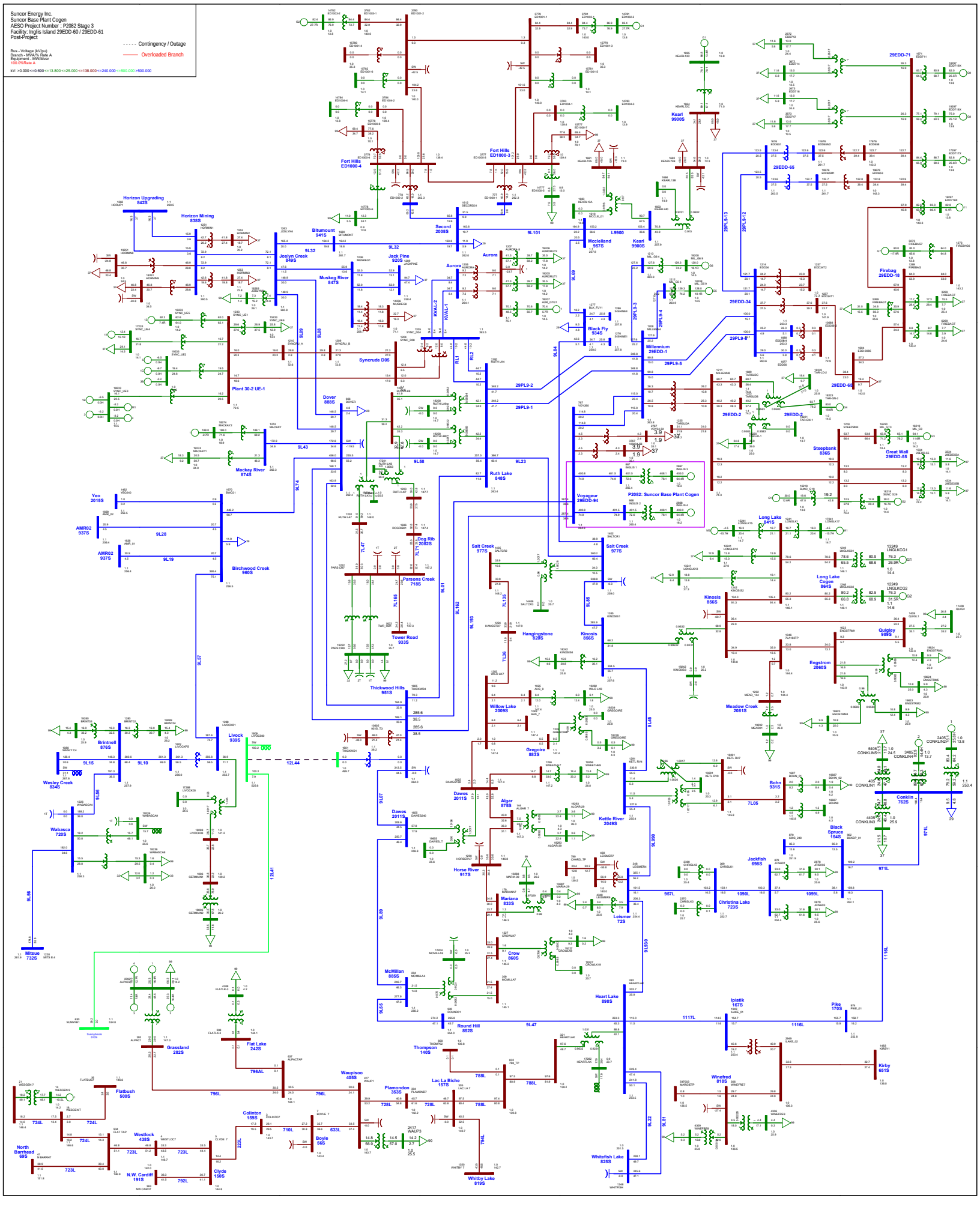


Figure A3-8: 2023 Summer Peak Post-Project Contingency of Thickwood Hills 951S Transformer 1201T

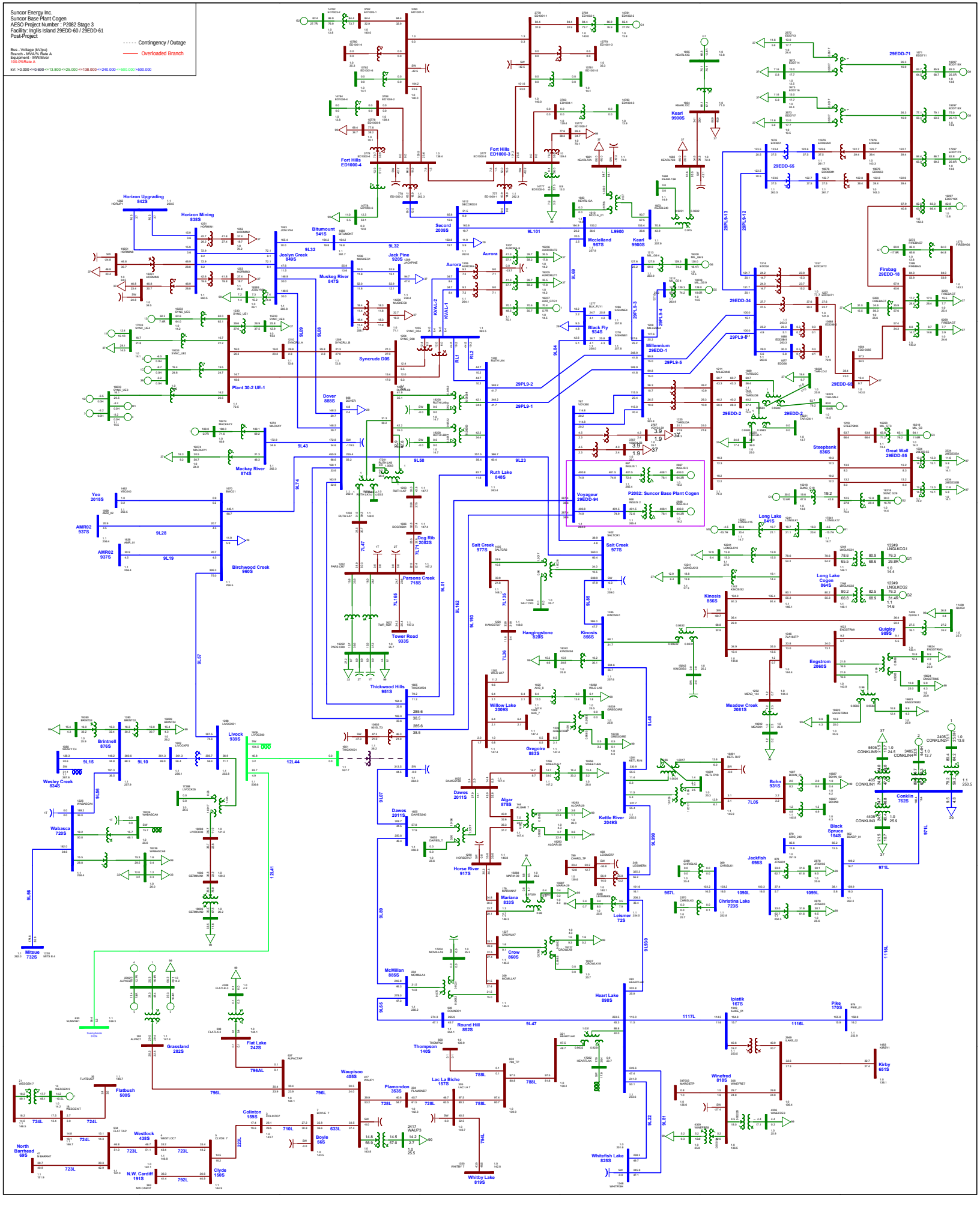


Figure A3-9: 2023 Winter Peak Post-Project N-0 (System Normal Condition)

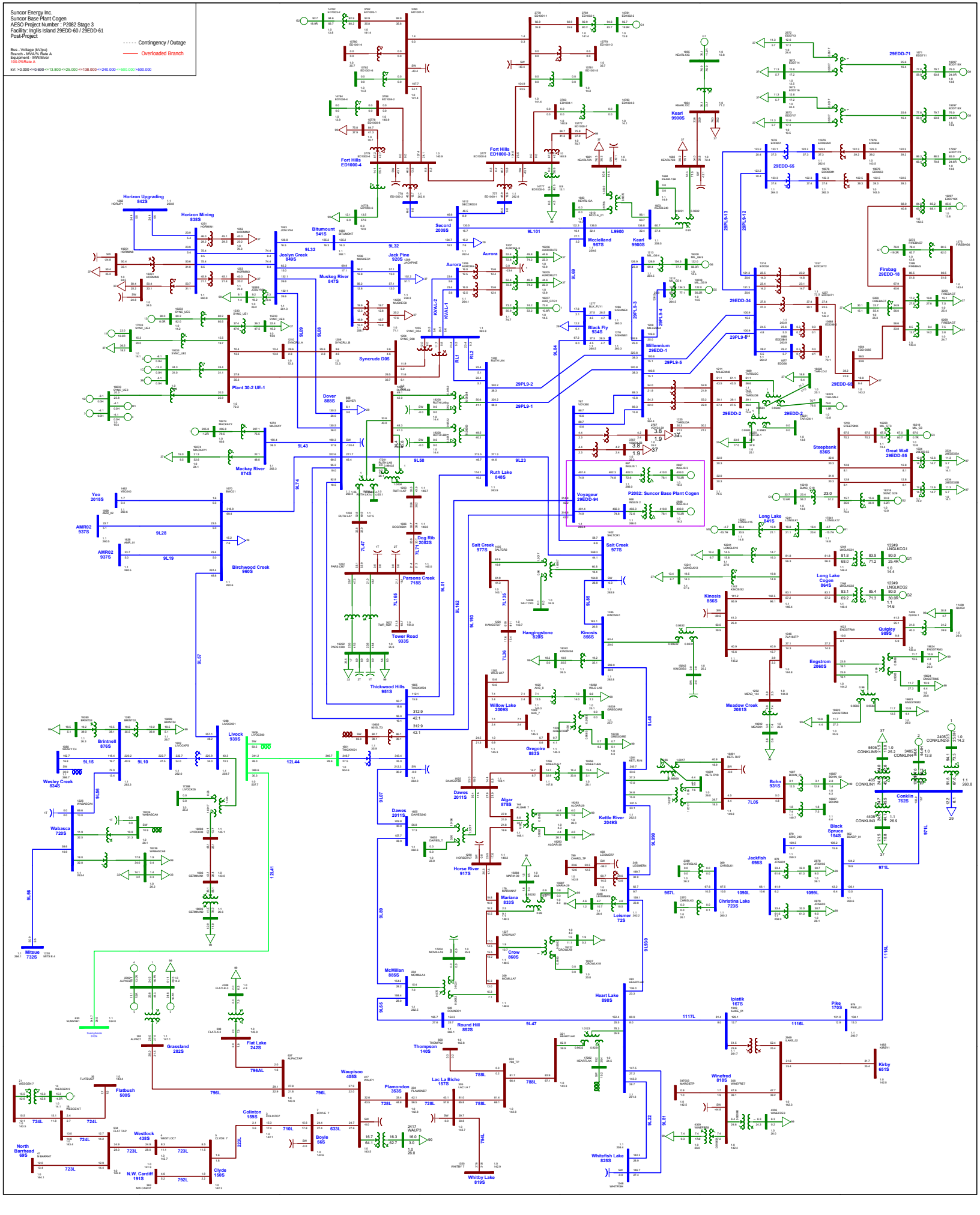


Figure A3-10: 2023 Winter Peak Post-Project Contingency of Parsons Creek 718S Transformer 718S701T

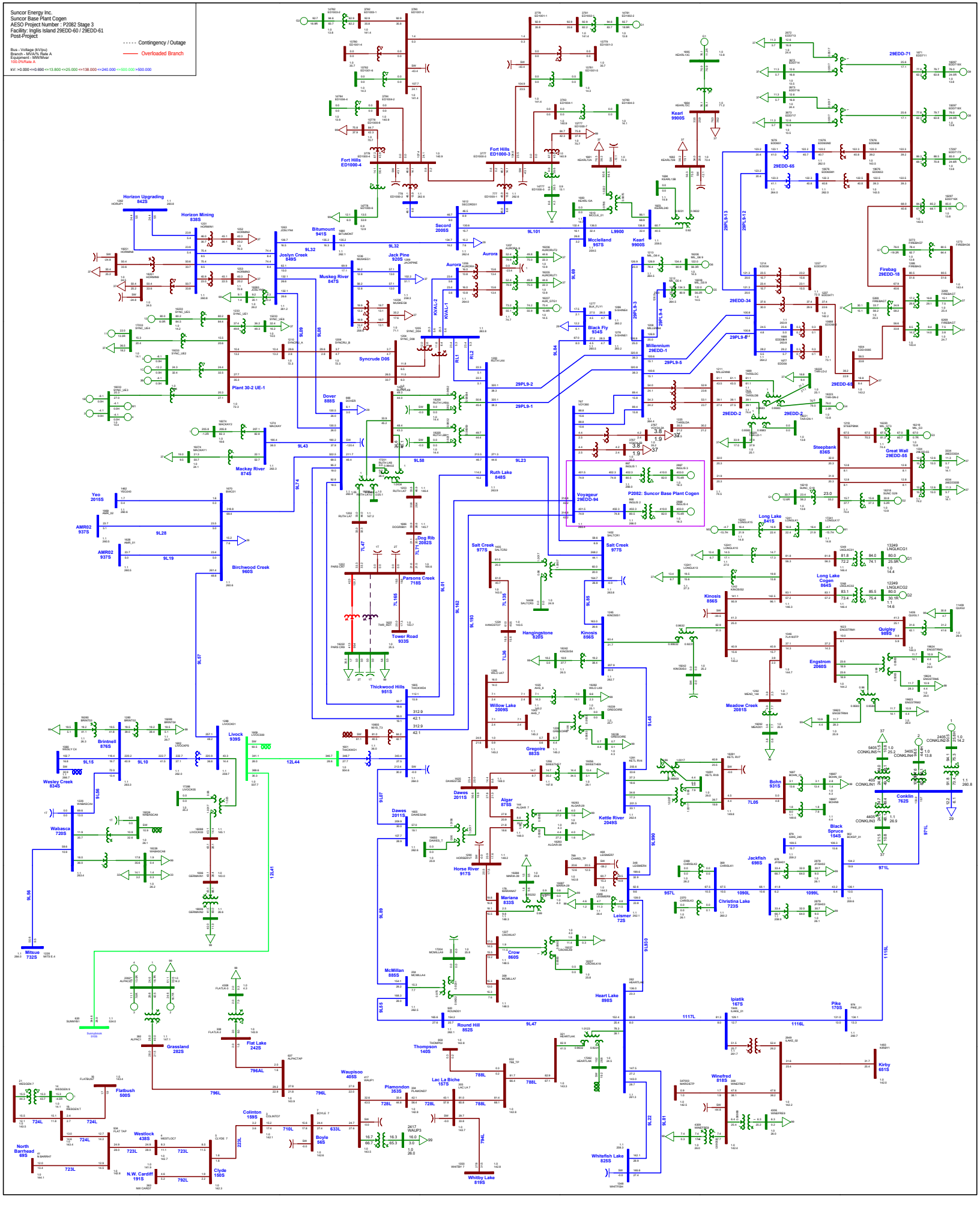


Figure A3-11: 2023 Winter Peak Post-Project Contingency of Parsons Creek 718S Transformer 718S702T

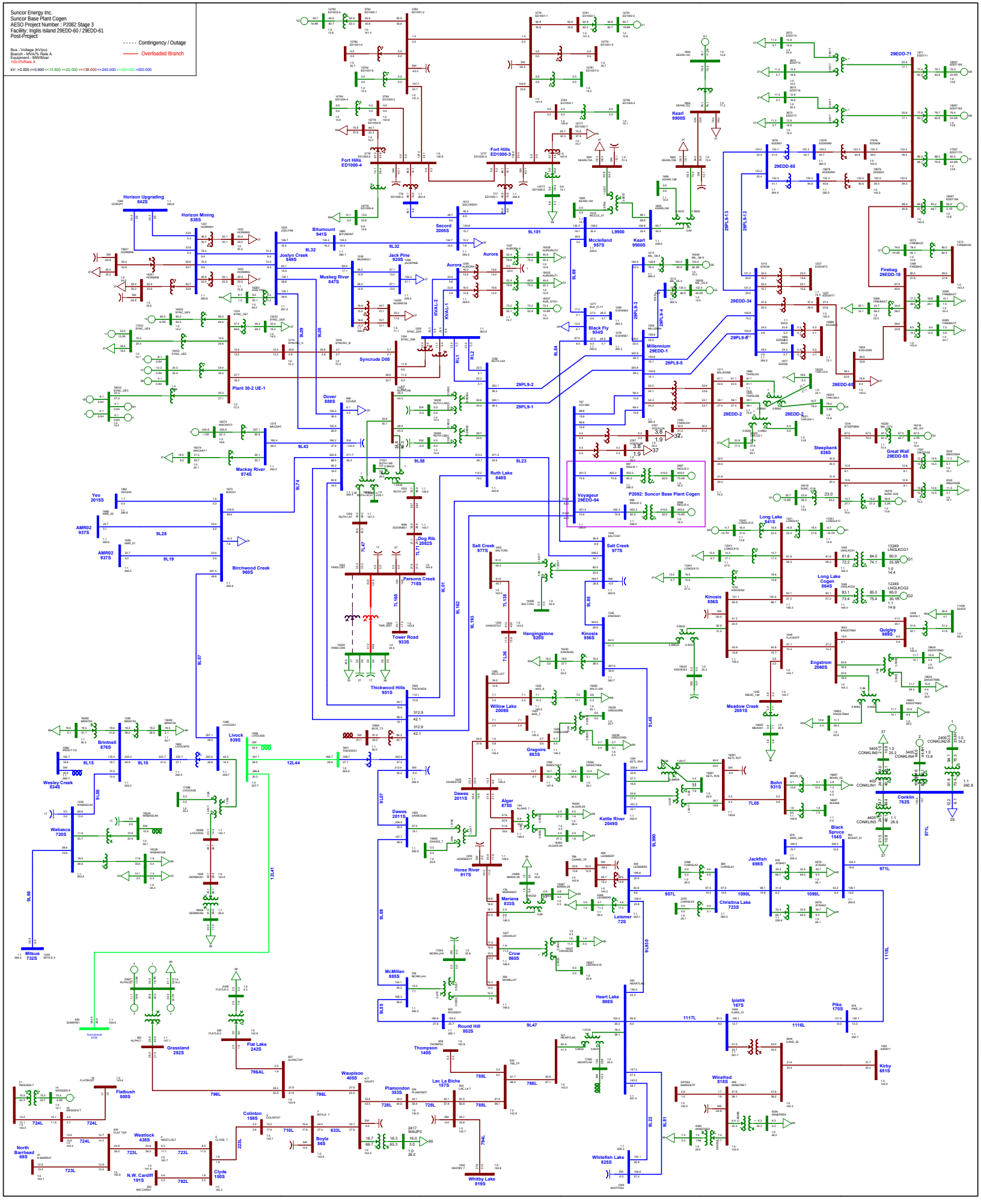

Suncor Energy Inc.
Suncor Base Plant Cogen
AESO Project Number : P2082 Stage 3
Facility: Inglis Island 29EDD-60 / 29EDD-61
Post-Project
Contingency / Outage
Overloaded Branch
Bus - Voltage (kV/pu)
Branch - MVA/% Rate A
Equipment - MW/Mvar
100.0/Rate A
kV: >0.000 <=0.690 <=13.800 <=25.000 <=138.000 <=240.000 <=500.000 >500.000
Horizon Upgrading 942S
Horizon Mining 838S
Bitumount 941S
Second 2005S
Fort Hills ED1000-4
Fort Hills ED1000-3
Kearl 9900S
Mcclelland 987S
Millennium 29EDD-1
Black Fly 934S
Joslyn Creek 849S
Muskeg River 847S
Jack Pine 920S
Aurora
Syncrude D06
Plant 30-2 UE-1
Dover 888S
Mackay River 874S
Ruth Lake 848S
Voyageur 29EDD-94
P2082: Suncor Base Plant Cogen
Yeo 2015S
AMR02 937S
Birchwood Creek 960S
Dog Rib 2082S
Parsons Creek 718S
Salt Creek 977S
Hangingstone 920S
Kinosis 856S
Kinosis 886S
Long Lake 841S
Long Lake Cogen 864S
Steepbank 836S
Great Wall 29EDD-55
Firebag 29EDD-18
29EDD-71
29EDD-65
29EDD-34
29EDD-66
29EDD-2
Quigley 989S
Engstrom 2060S
Meadow Creek 2081S
Bohn 931S
Jackfish 698S
Christina Lake 723S
Conklin 762S
Black Spruce 154S
Brintnell 876S
Wesley Creek 834S
Wabasca 720S
Livock 939S
Dawes 2011S
Algar 879S
Gregoire 883S
Willow Lake 2009S
Thickwood Hills 951S
Kettle River 2049S
Horse River 917S
Mariana 833S
Crow 860S
Leismer 72S
Heart Lake 899S
Round Hill 852S
Thompson 140S
Lac La Biche 157S
Plamondon 383S
Waupisoo 408S
Grassland 282S
Flat Lake 242S
Flatbush 500S
Colinton 159S
Westlock 438S
North Barrhead 69S
Clyde 160S
N.W. Cardiff 191S
Boyle 66S
Whitefish Lake 925S
Whitby Lake 819S
Winefred 818S
Iplatik 167S
Pike 1702S
Kirby 651S
Mitsue 732S
Wabasca
Livock
Dawes
Algar
Gregoire
Willow Lake
Thickwood Hills
Kettle River
Horse River
Mariana
Crow
Leismer
Heart Lake
Round Hill
Thompson
Lac La Biche
Plamondon
Waupisoo
Grassland
Flat Lake
Flatbush
Colinton
Westlock
North Barrhead
Clyde
N.W. Cardiff
Boyle
Whitefish Lake
Whitby Lake
Winefred
Iplatik
Pike
Kirby
Bohn
Jackfish
Christina Lake
Conklin
Black Spruce
Meadow Creek
Engstrom
Quigley
Long Lake
Steepbank
Great Wall
Firebag
Kinosis
Salt Creek
Hangingstone
Dog Rib
Parsons Creek
Tower Road
Thickwood Hills
Dawes
Algar
Gregoire
Willow Lake
Livock
Brintnell
Wesley Creek
Wabasca
Mitsue

Figure A3-12: 2023 Winter Peak Post-Project Contingency of 12L41 (Sunnybrook 510S - Livock 939S)

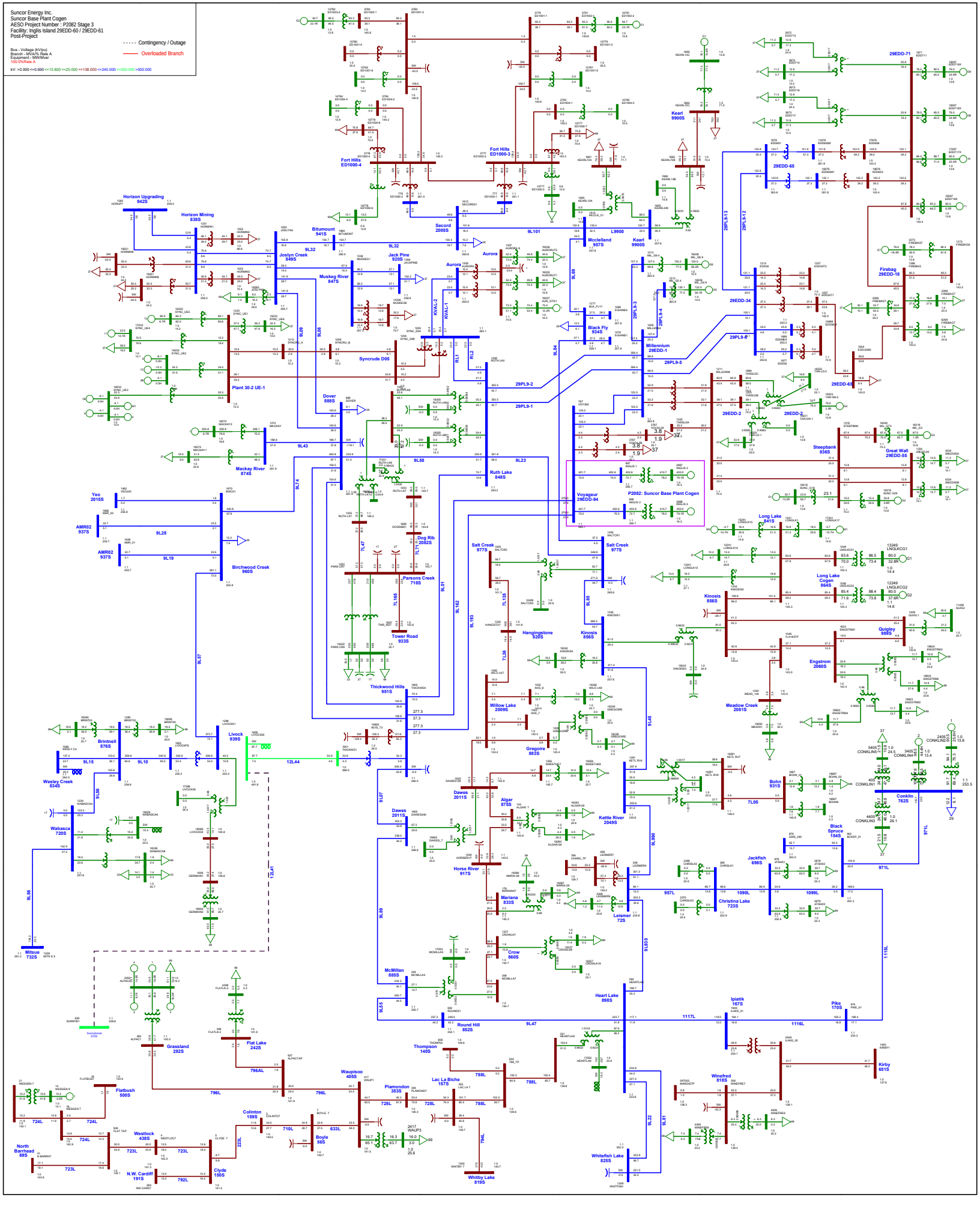


Figure A3-13: 2023 Winter Peak Post-Project Contingency of 12L44 (Thickwood Hills 951S - Livock 939S)

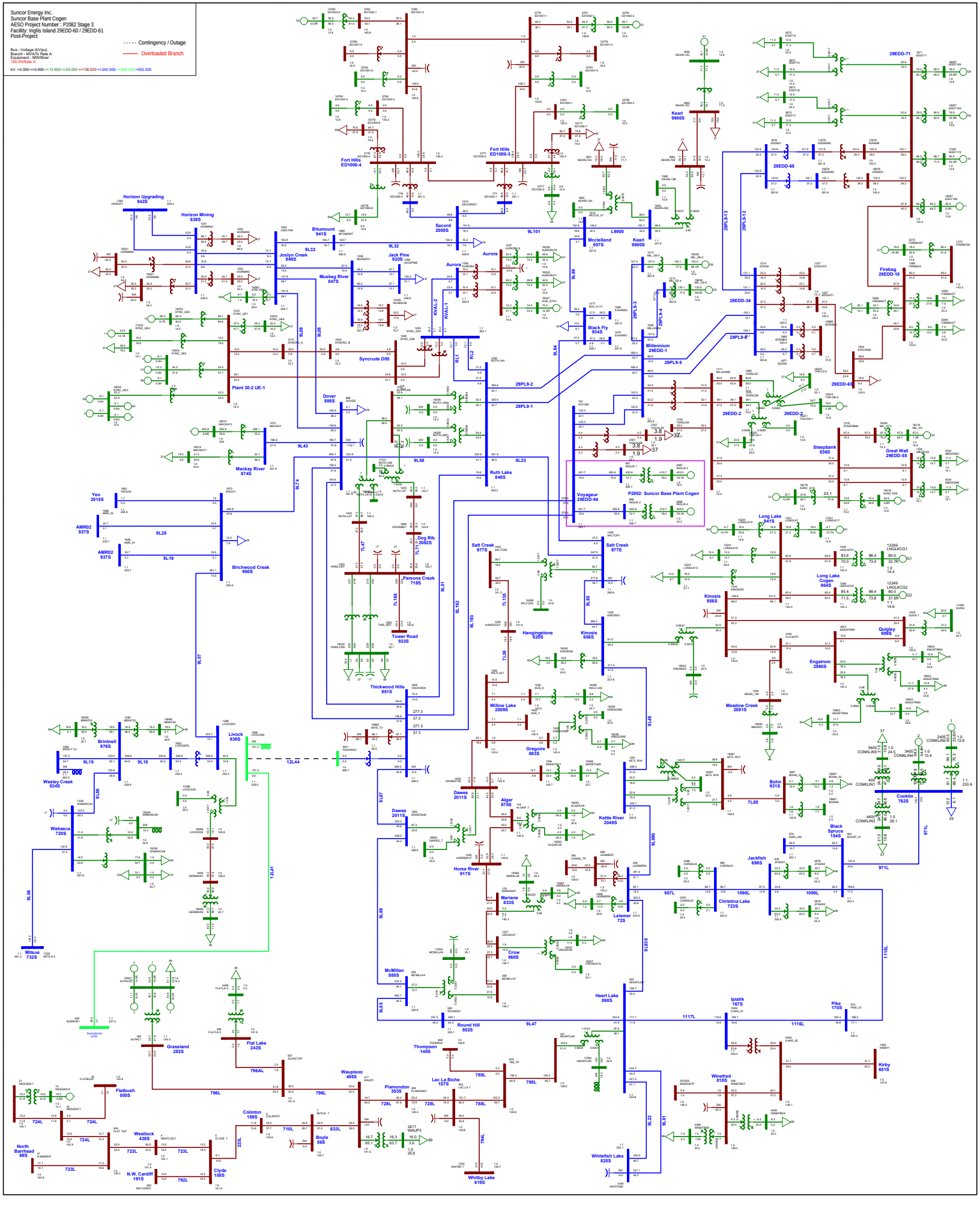
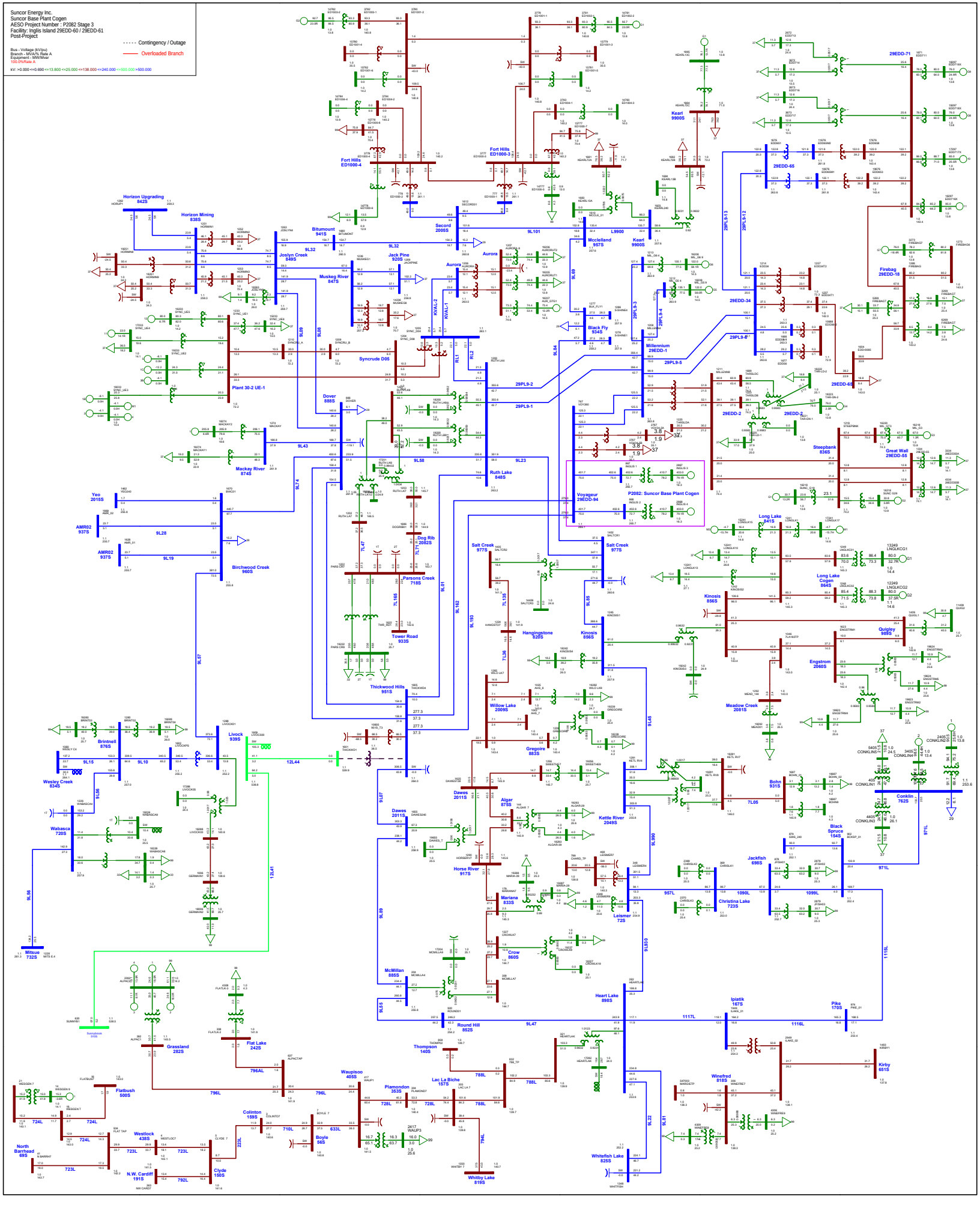


Figure A3-14: 2023 Winter Peak Post-Project Contingency of Thickwood Hills 951S Transformer 1201T



Attachment A4

Post-Project Transient Stability Diagrams

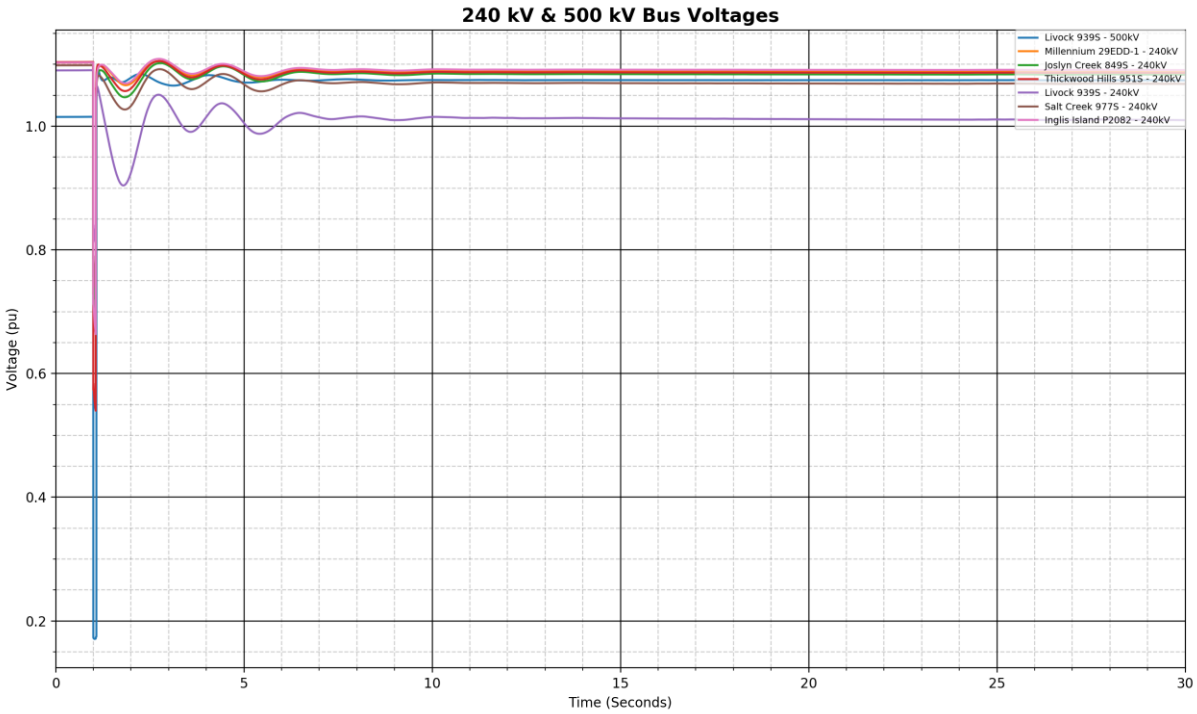
Table A4-1: Transient Stability Figures for Contingencies

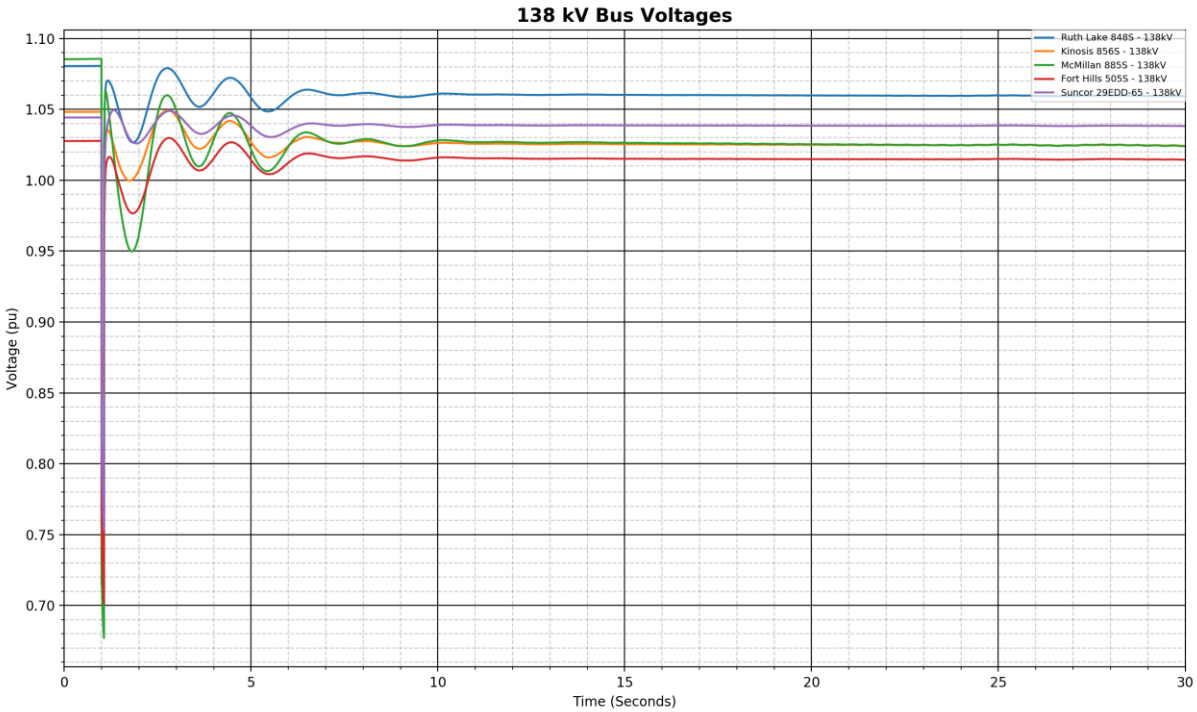
Category	Contingency	Fault Location	Fault Clearing Time		2023 SL	2023 SP	2023 WP
			Near End Cycle	Far End Cycle			
Category B	12L44 (Thickwood Hills 951S to Livock 939S)	Thickwood Hills 951S	4	5	A4-1	A4-27	A4-53
		Livock 939S	4	5	A4-2	A4-28	A4-54
Category B	12L41 (Livock 939S to Sunnybrook 510S)	Livock 939S	4	5	A4-3	A4-29	A4-55
		Sunnybrook 510S	4	5	A4-4	A4-30	A4-56
Category B	9L01 (Ruth Lake 848S to Thickwood Hills 951S)	Ruth Lake 848S	5	6	A4-5	A4-31	A4-57
		Thickwood Hills 951S	5	6	A4-6	A4-32	A4-58
Category B	9L07 (Thickwood Hills 951S to Dawes 2011S)	Thickwood Hills 951S	5	6	A4-7	A4-33	A4-59
		Dawes 2011S	5	6	A4-8	A4-34	A4-60
Category B	9L08 (Dover 888S to Joslyn Creek 849S)	Dover 888S	5	6	A4-9	A4-35	A4-61
		Joslyn Creek 849S	5	6	A4-10	A4-36	A4-62
Category B	9L23 (Ruth Lake 848S to Salt Creek 977S)	Ruth Lake 848S	5	6	A4-11	A4-37	A4-63
		Salt Creek 977S	5	6	A4-12	A4-38	A4-64
Category B	9L43 (Dover 888S to Mackay River 874S)	Dover 888S	5	6	A4-13	A4-39	A4-65
		Mackay River 874S	5	6	A4-14	A4-40	A4-66
Category B	9L57 (9L57 Birchwood Creek 960S to Livock 939S)	Birchwood Creek 960S	5	6	A4-15	A4-41	A4-67
		Livock 939S	5	6	A4-16	A4-42	A4-68
Category B	9L58 (Ruth Lake 848S to Dover 888S)	Ruth Lake 848S	5	6	A4-17	A4-43	A4-69
		Dover 888S	5	6	A4-18	A4-44	A4-70
Category B	9L69 (Black Fly 934S to McClelland 957S)	Black Fly 934S	5	6	A4-19	A4-45	A4-71
		McClelland 957S	5	6	A4-20	A4-46	A4-72
Category B	9L85 (Salt Creek 977S to Kinosis 856S)	Salt Creek 977S	5	6	A4-21	A4-47	A4-73
		Kinosis 856S	5	6	A4-22	A4-48	A4-74
Category B	29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)	Ruth Lake 848S	5	6	A4-23	A4-49	A4-75
		Millennium 29EDD-1	5	6	A4-24	A4-50	A4-76
Category B	9L162 (Voyageur 29EDD-94 to Thickwood Hills 951S)	Voyageur 29EDD-94	5	6	A4-25	A4-51	A4-77
		Thickwood Hills 951S	5	6	A4-26	A4-52	A4-78

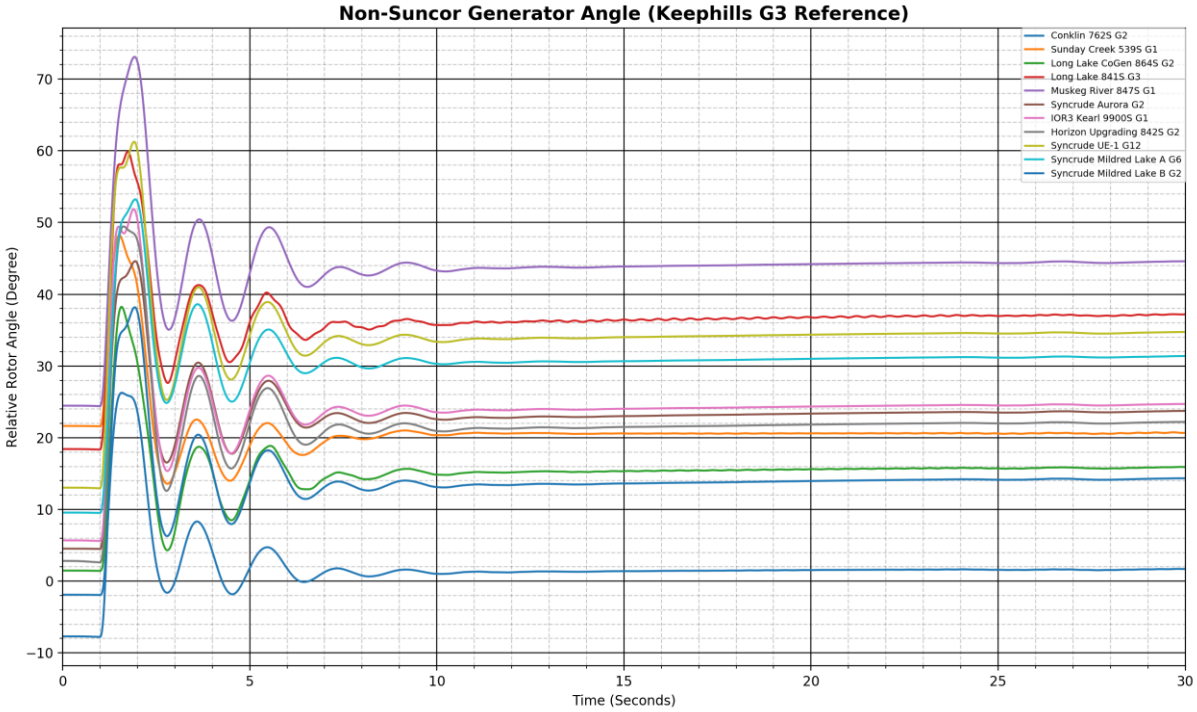
Transient Stability Results

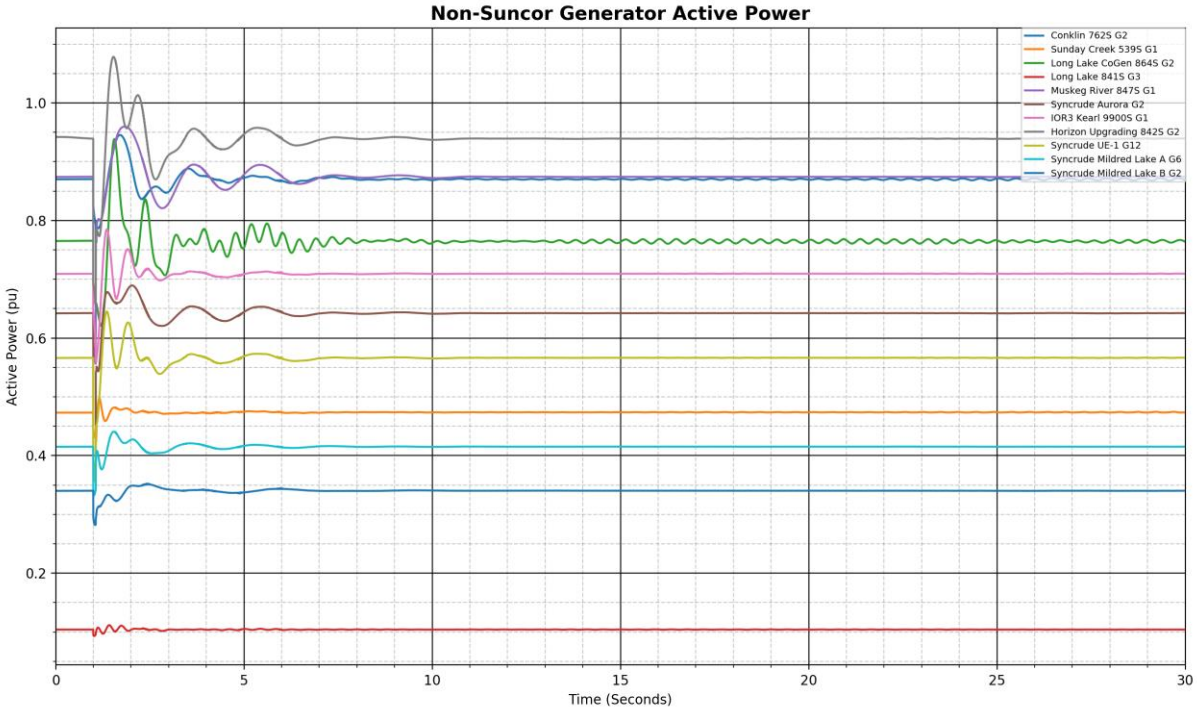
1. Stability Results 2023 Summer Light

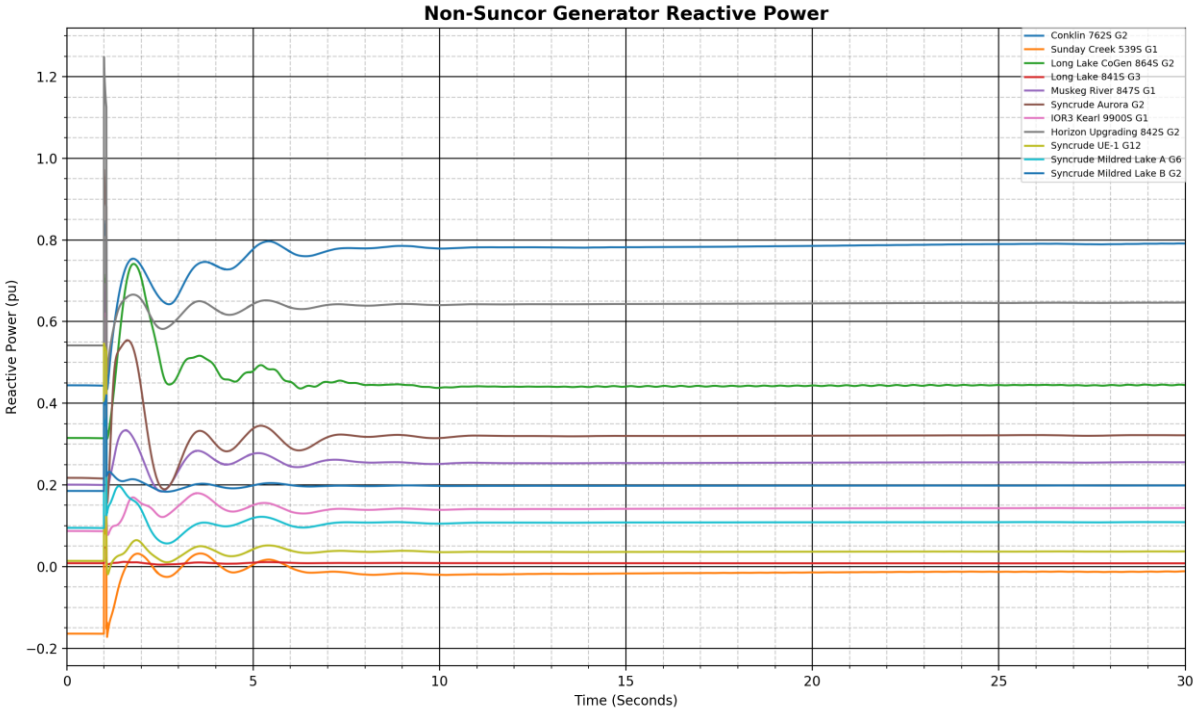
Figure A4-1: 12L44 (Thickwood Hills 951S to Livock 939S): Fault at Thickwood Hills 951S

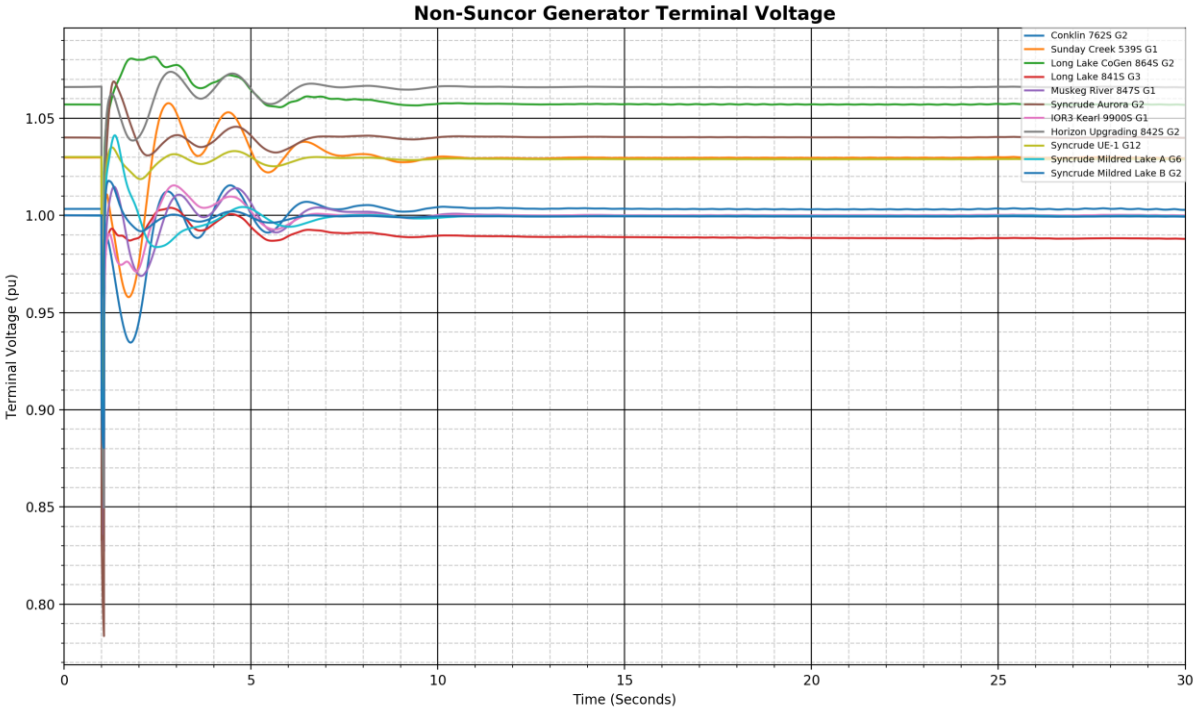


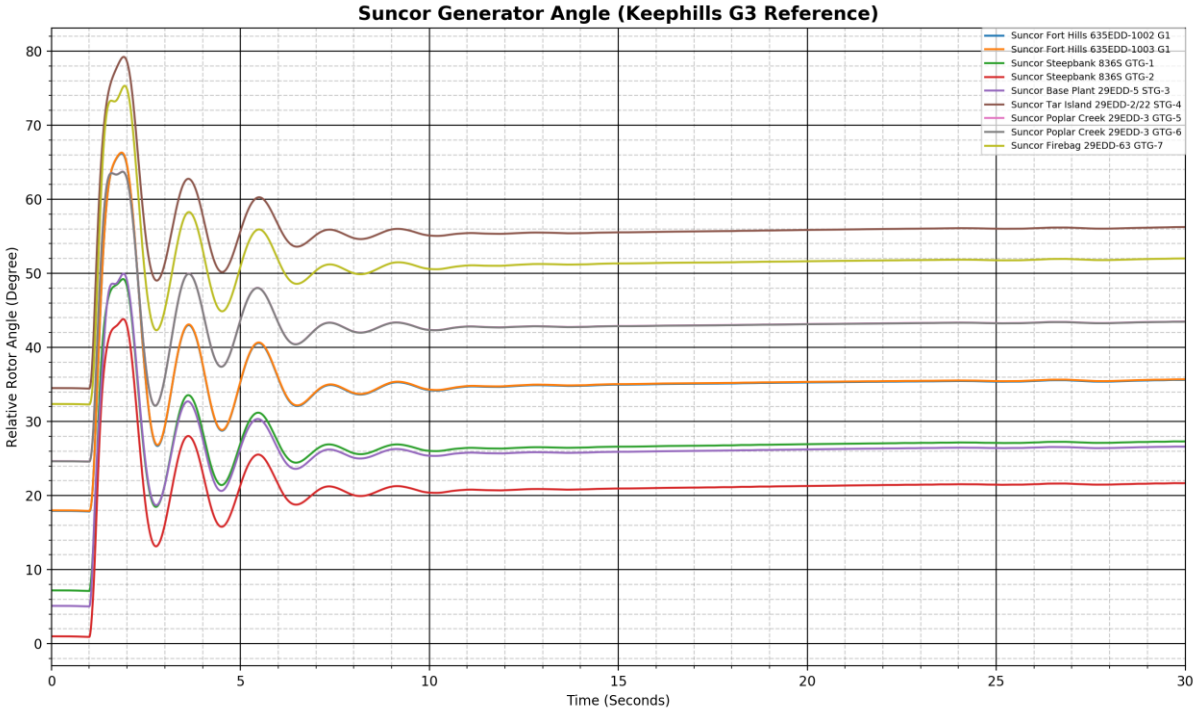


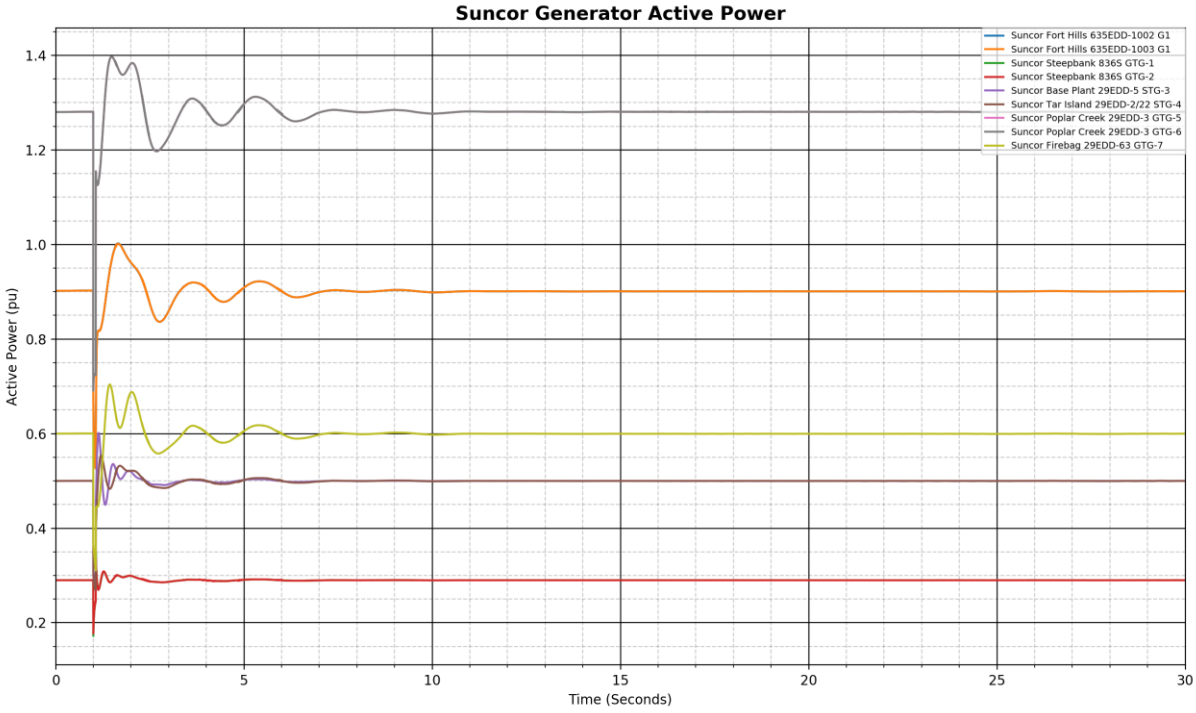

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

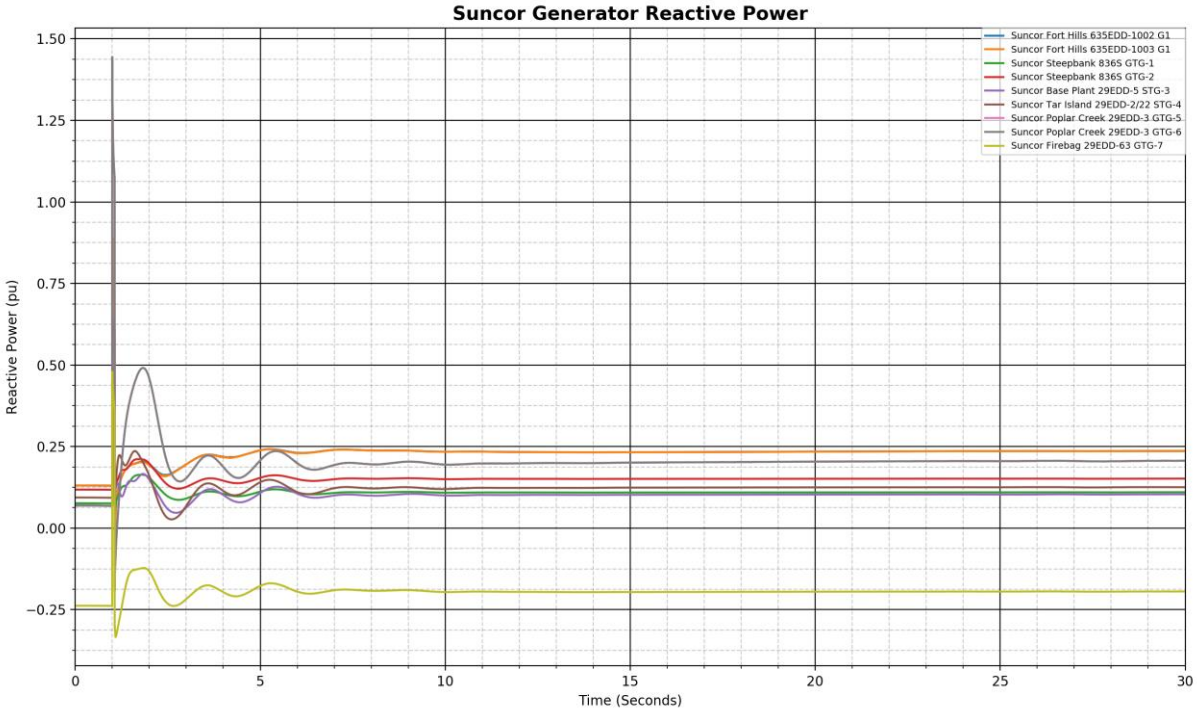

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

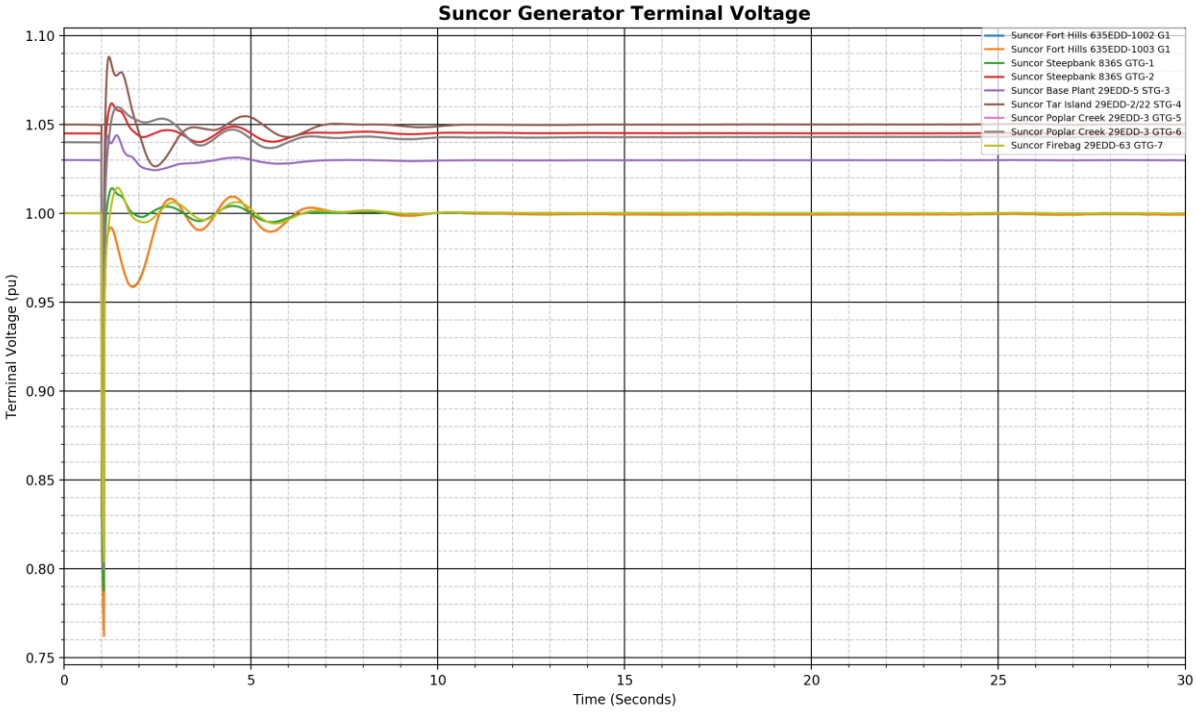

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

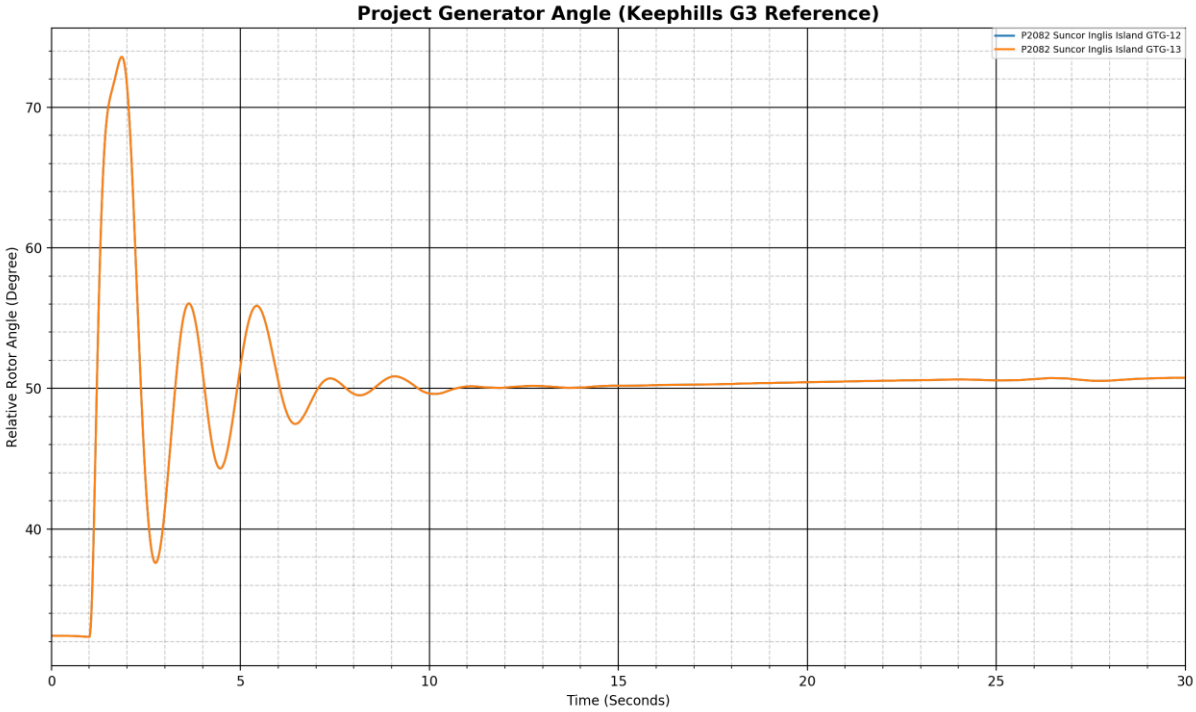

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

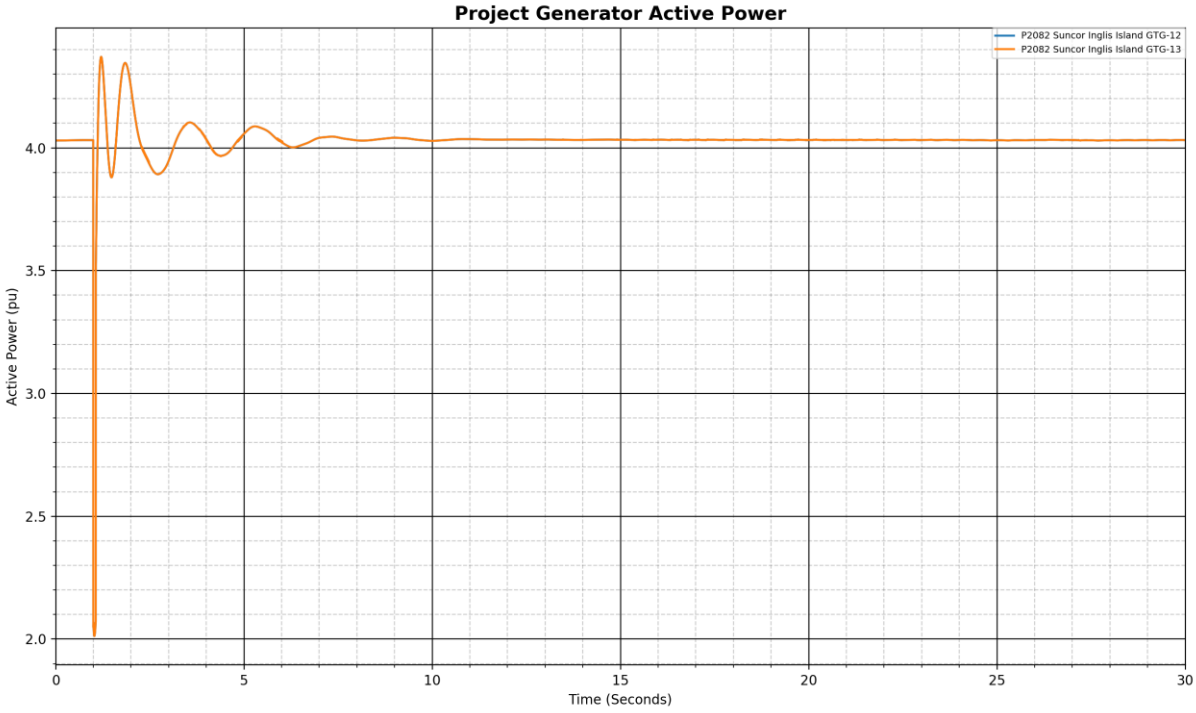

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

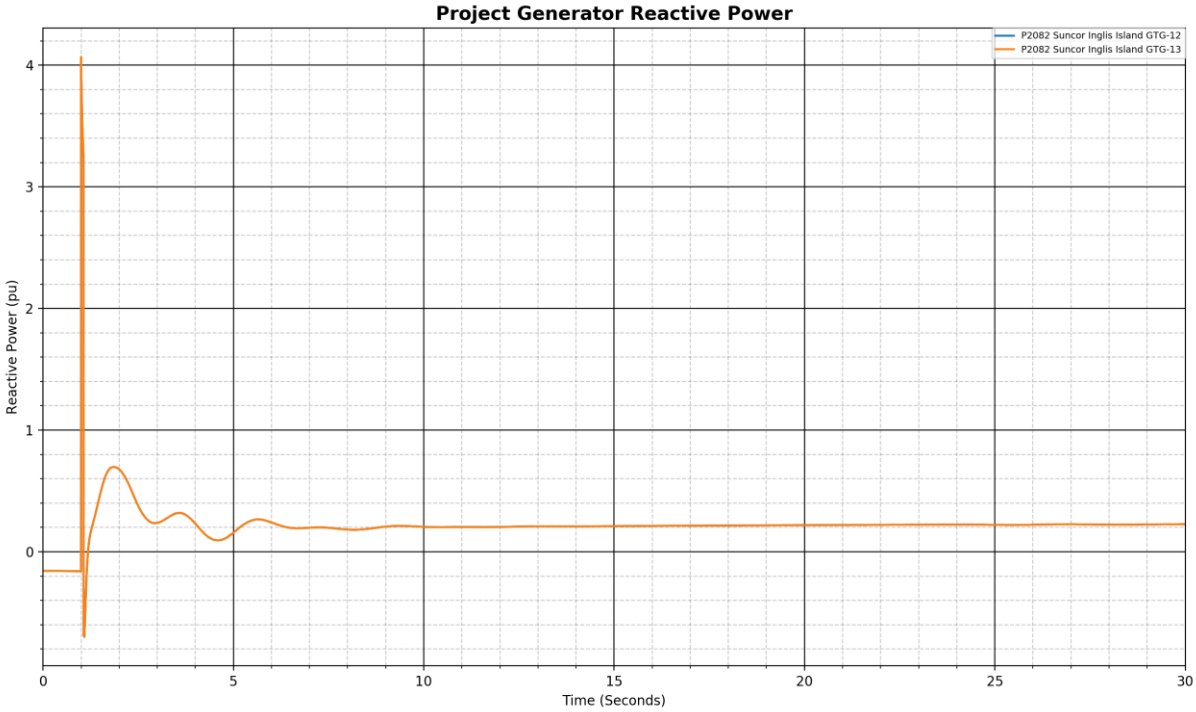

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

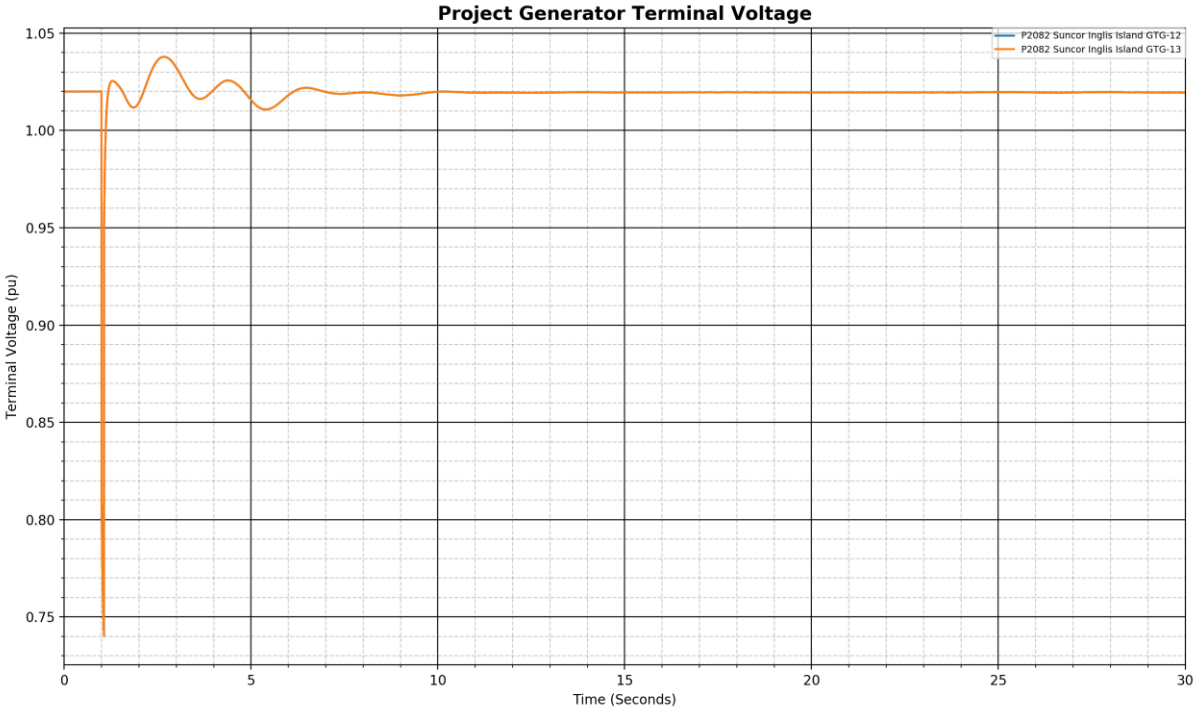

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

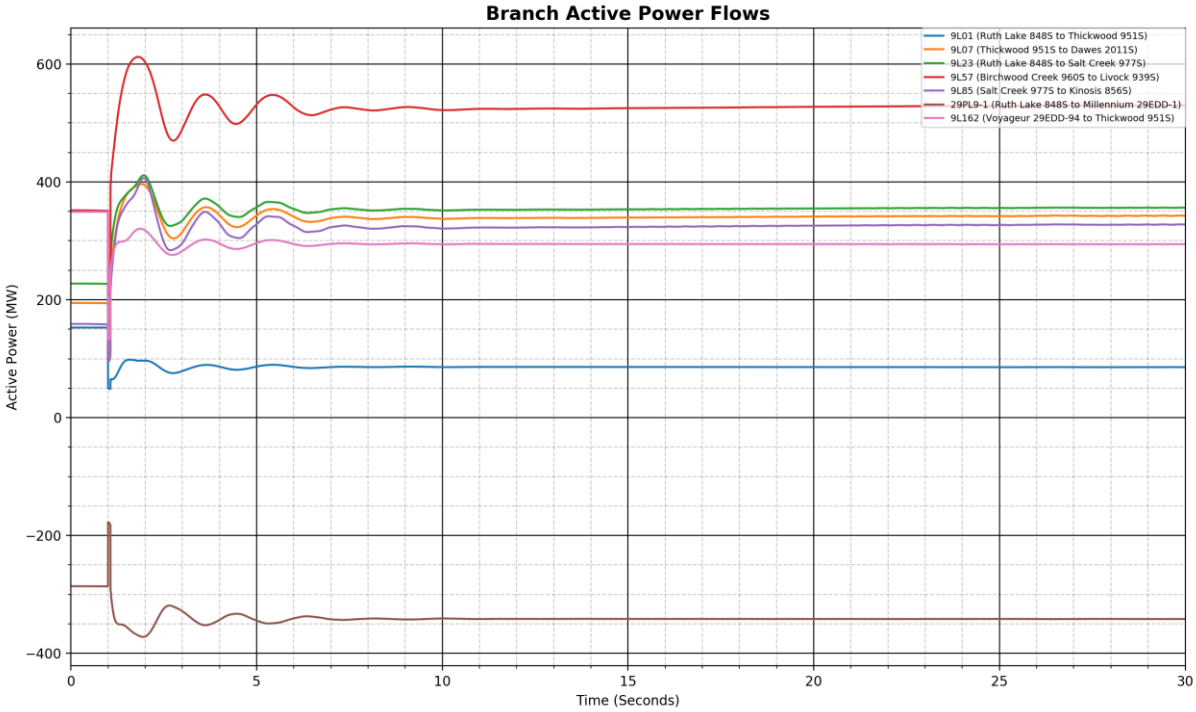

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
70
60
50
40
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.0
3.5
3.0
2.5
2.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

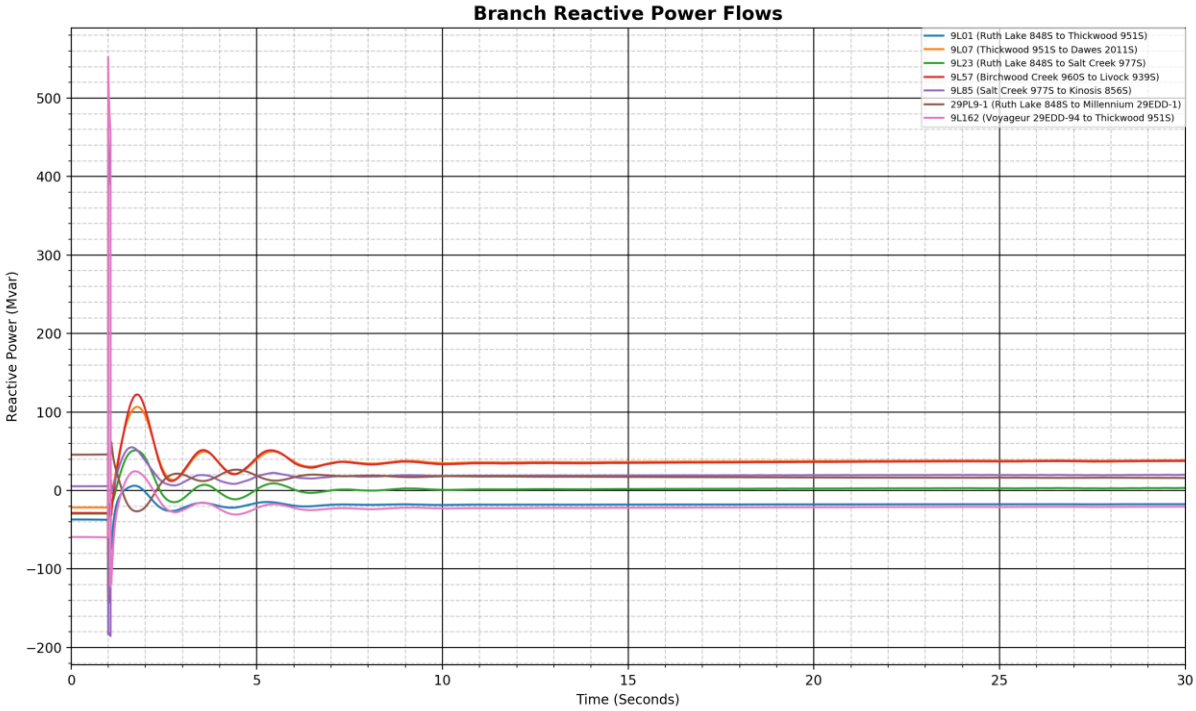
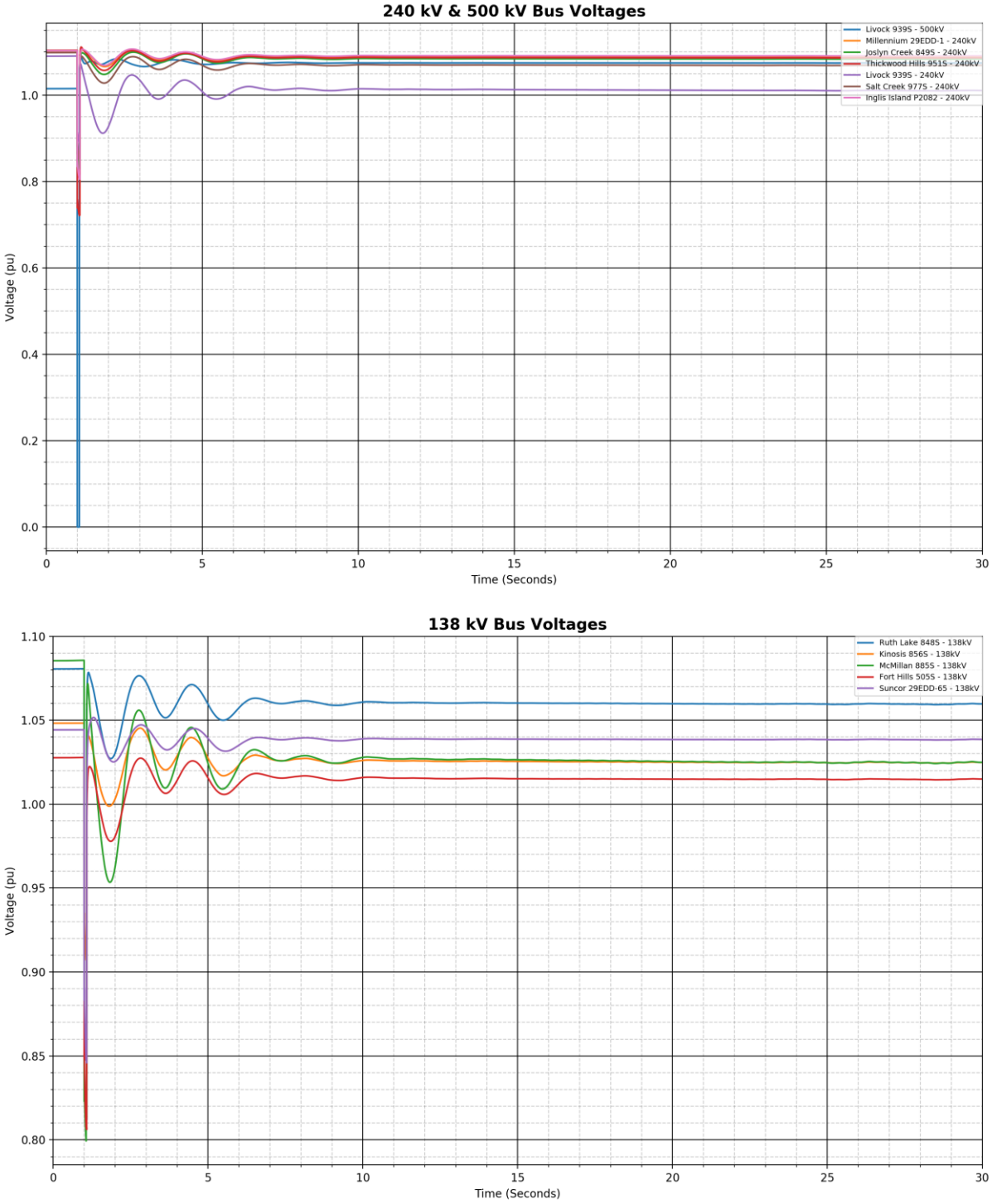
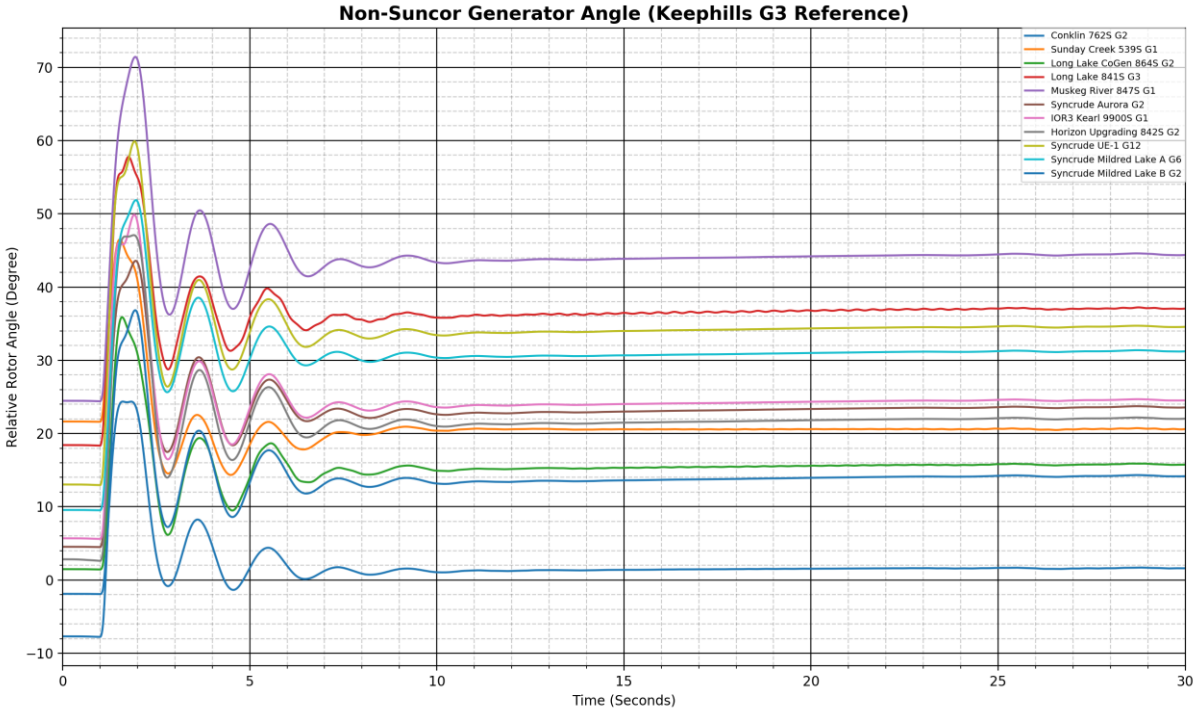
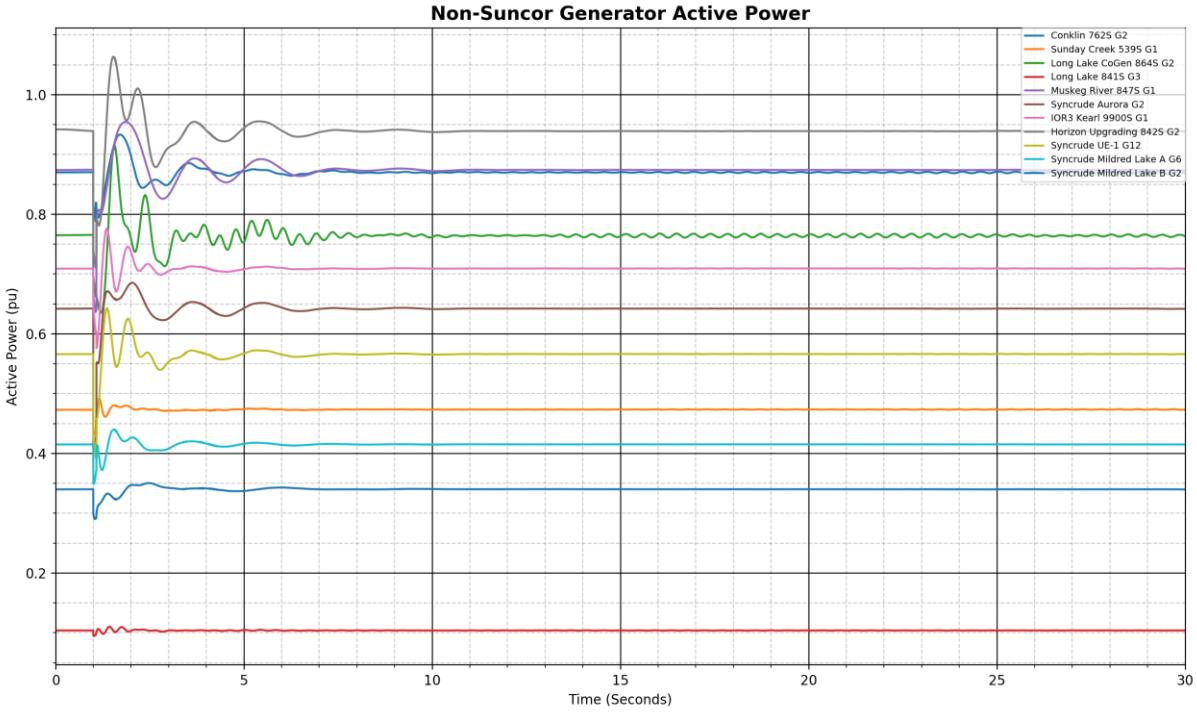
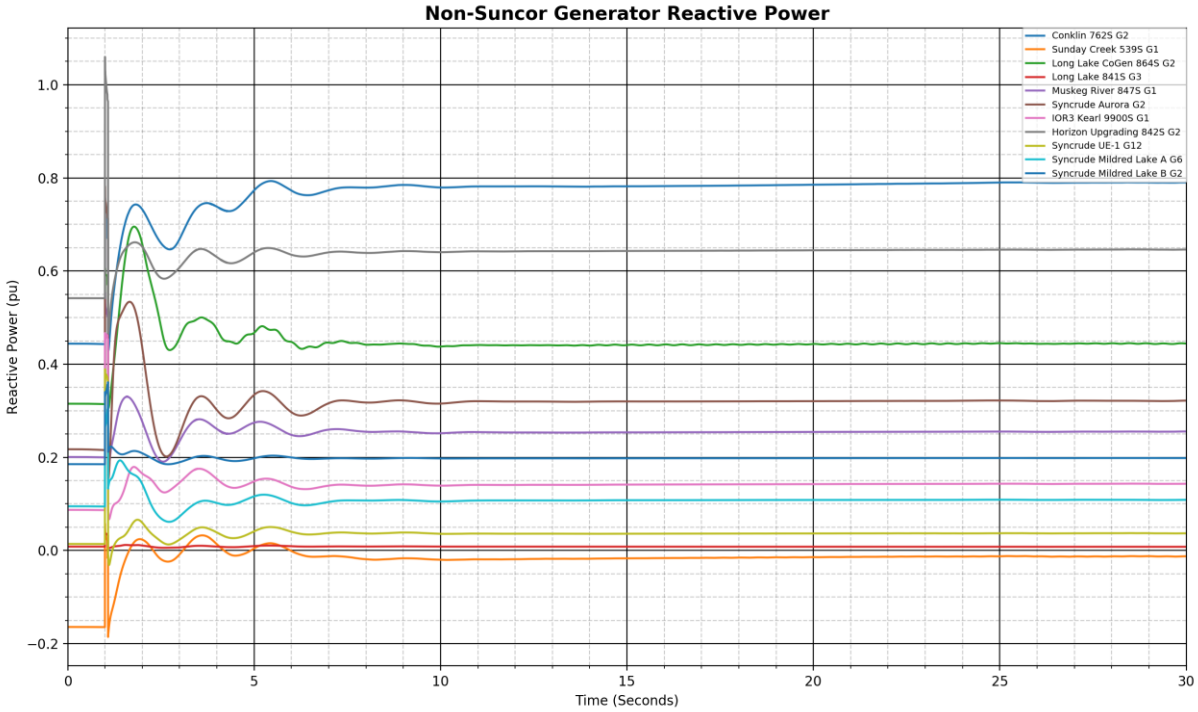

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
500
400
300
200
100
0
−100
−200
0
5
10
15
20
25
30
Time (Seconds)

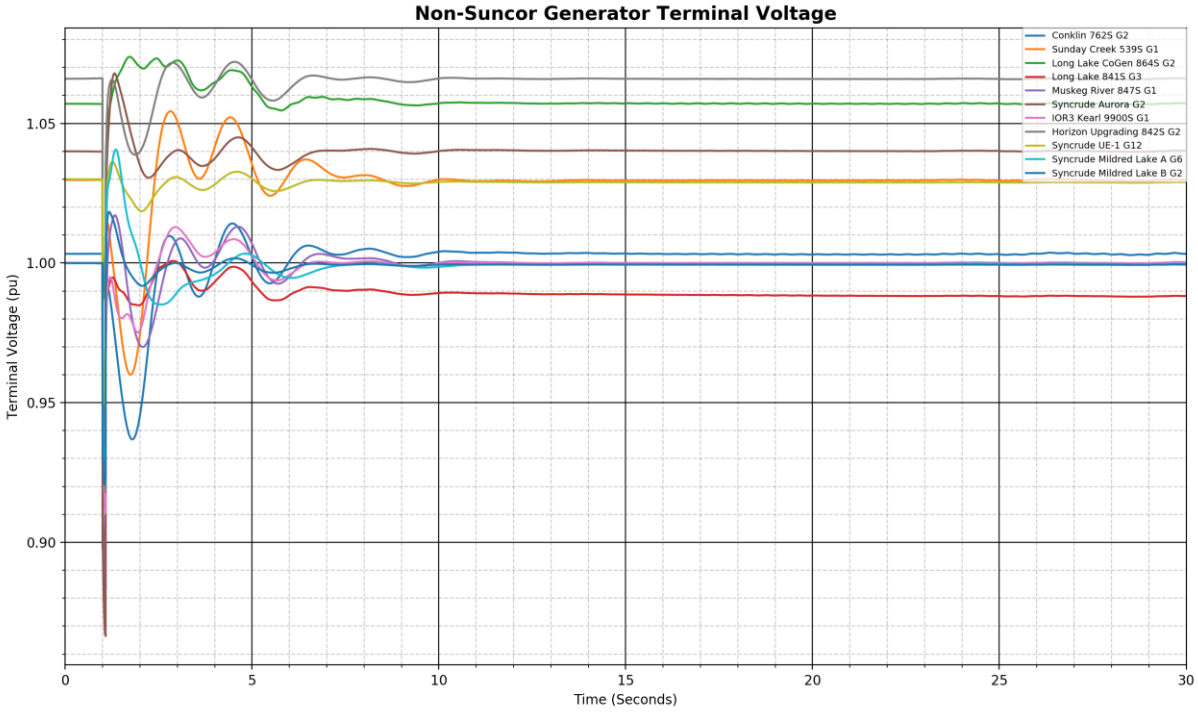
Figure A4-2: 12L44 (Thickwood Hills 951S to Livock 939S): Fault at Livock 939S

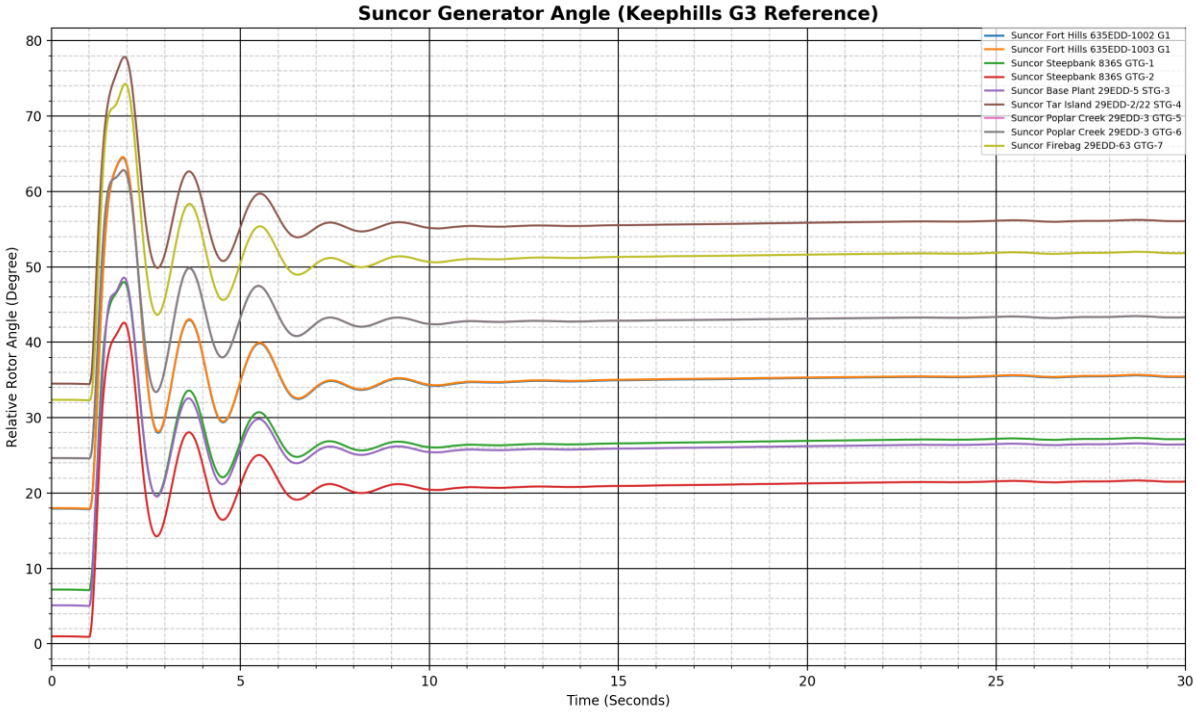


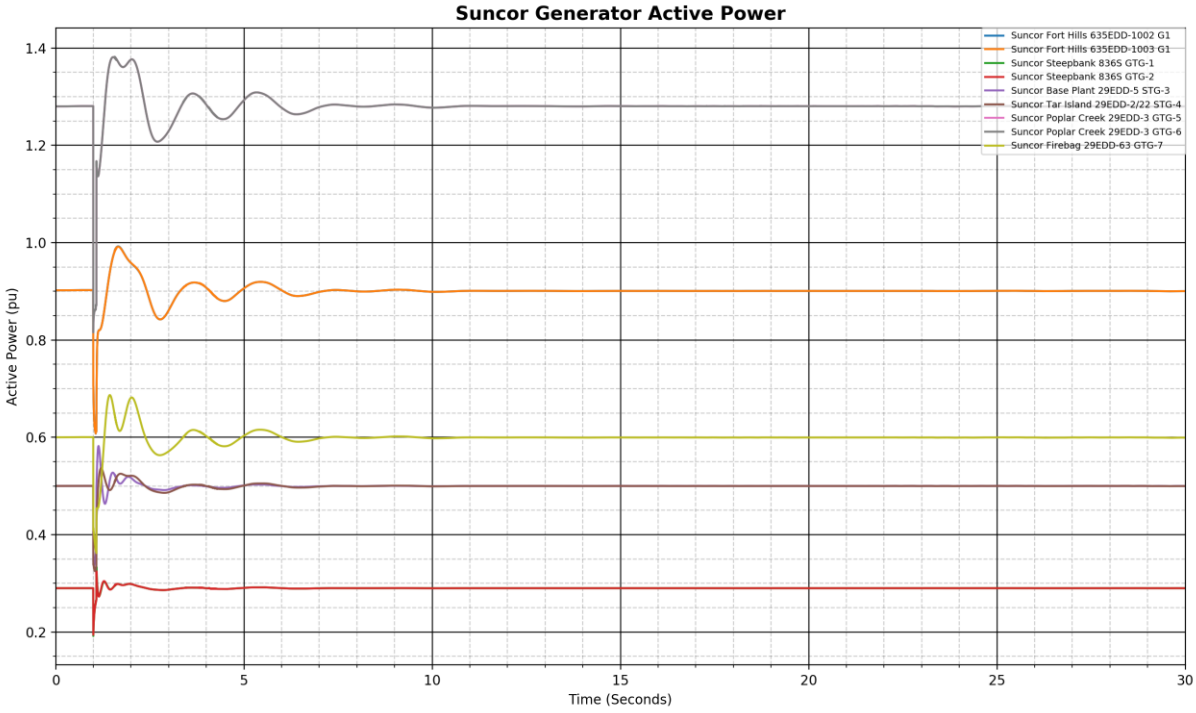

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

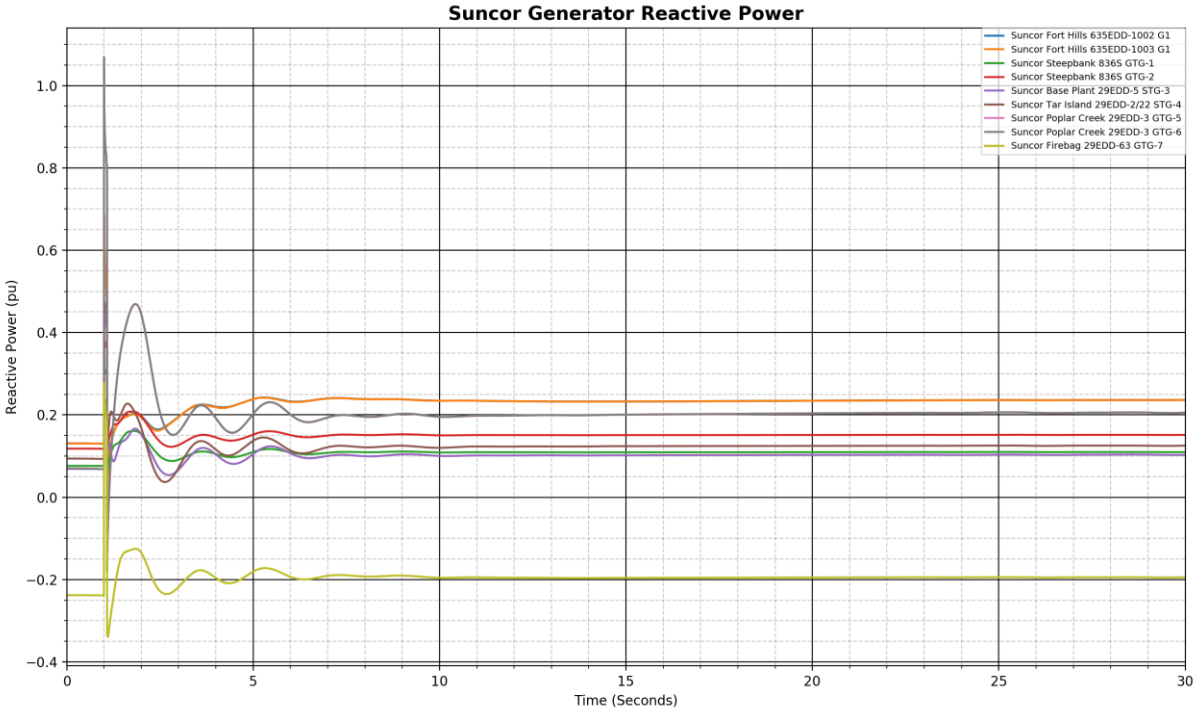

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

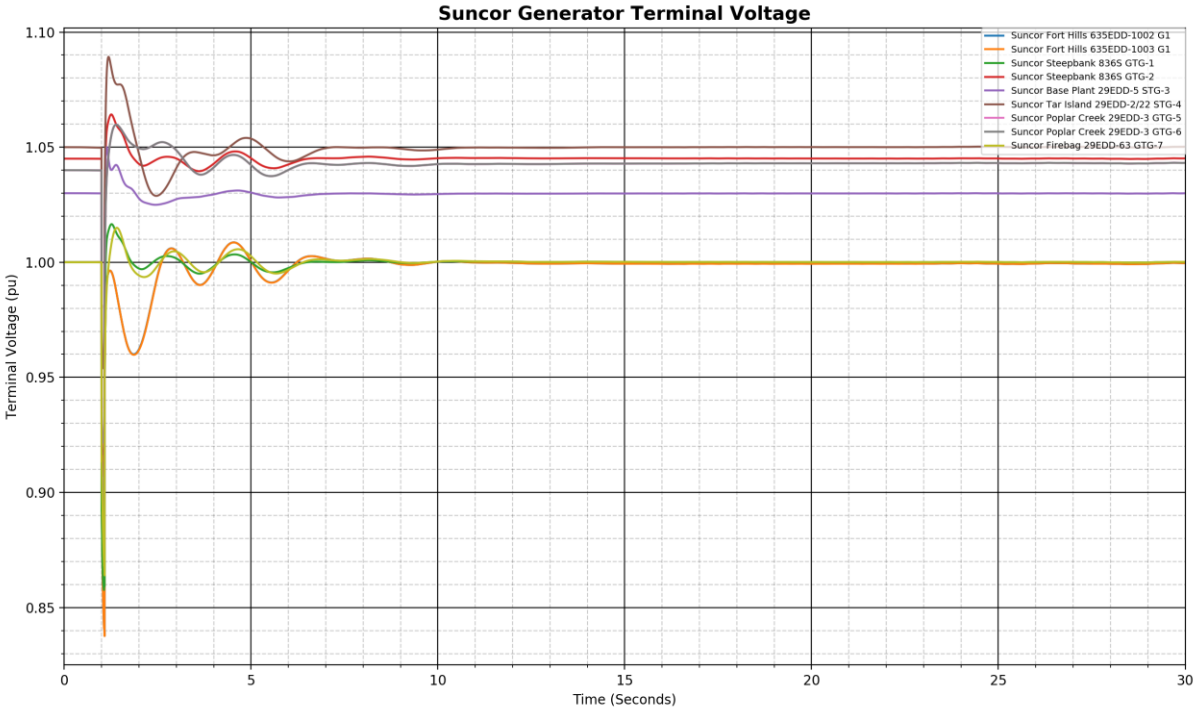

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

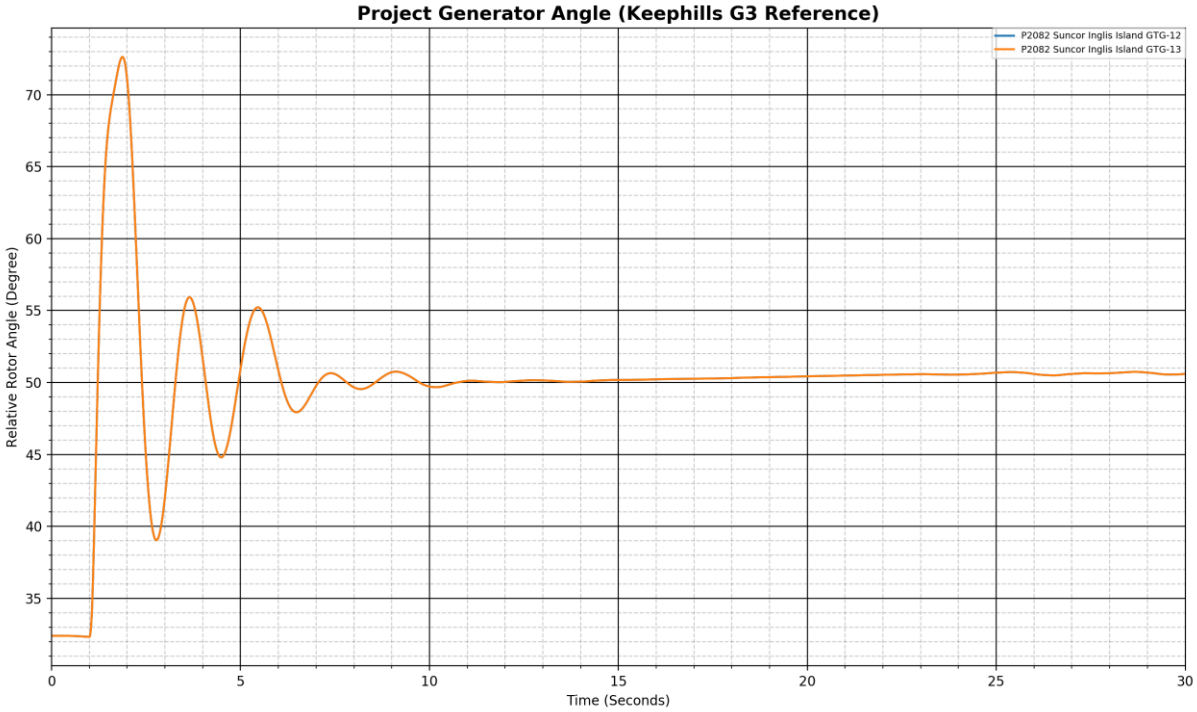

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

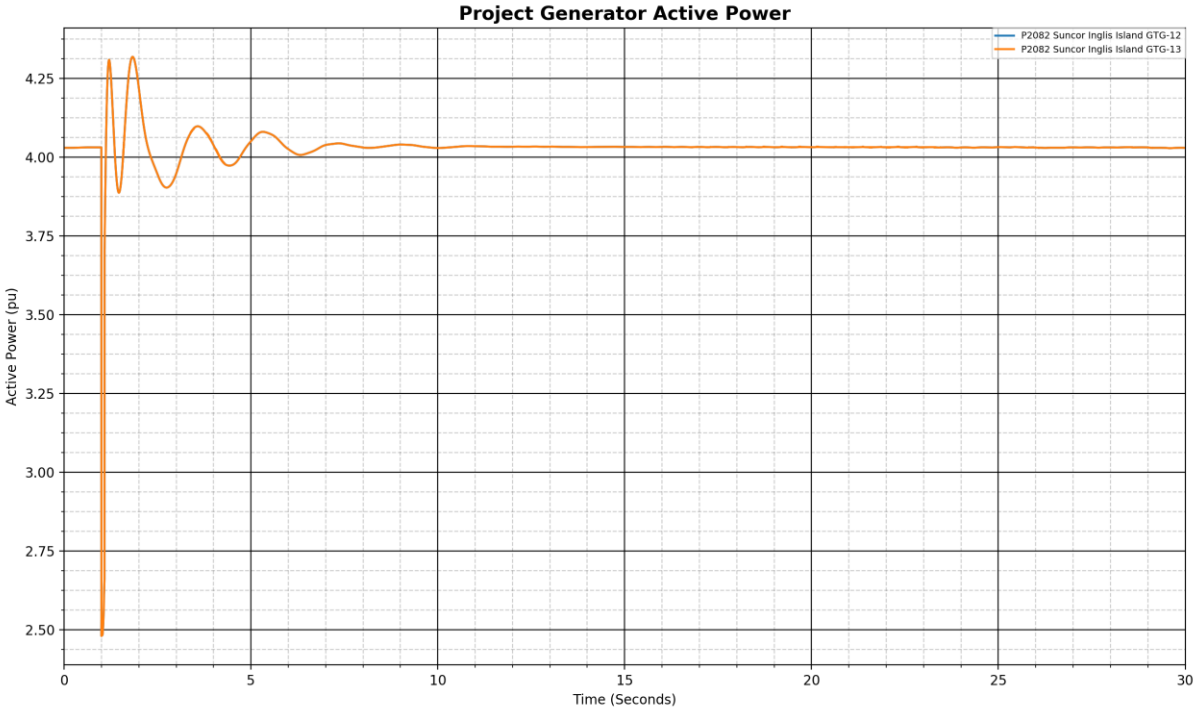

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

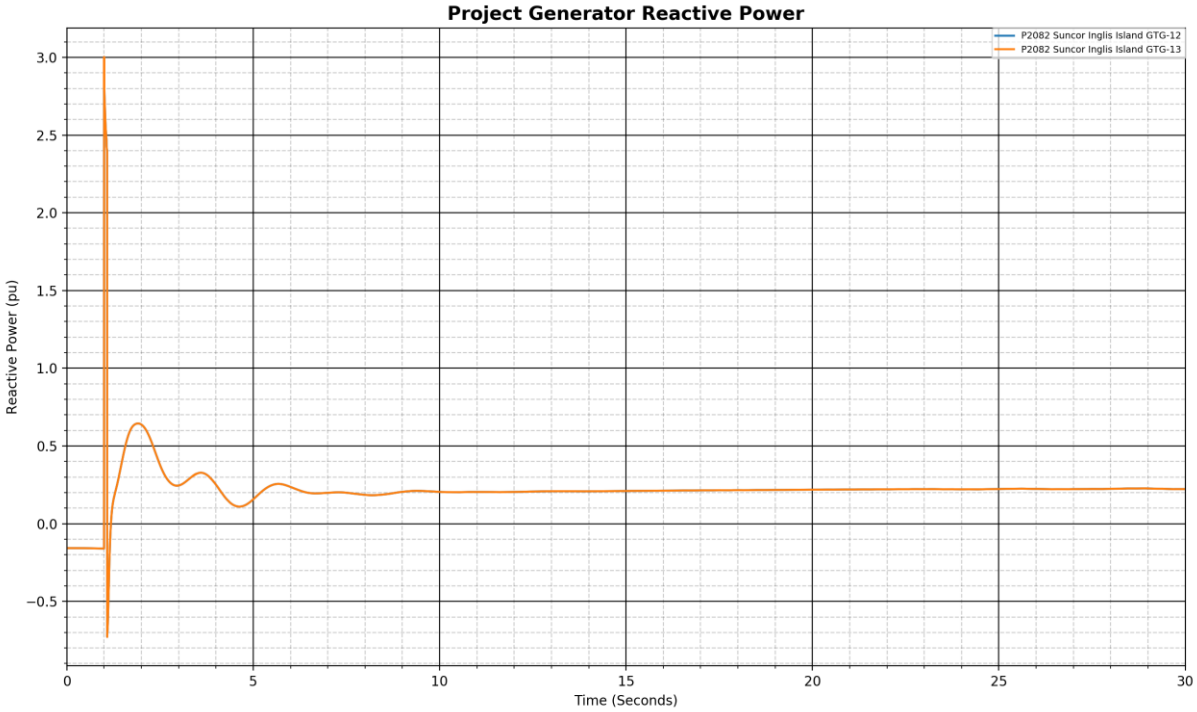

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

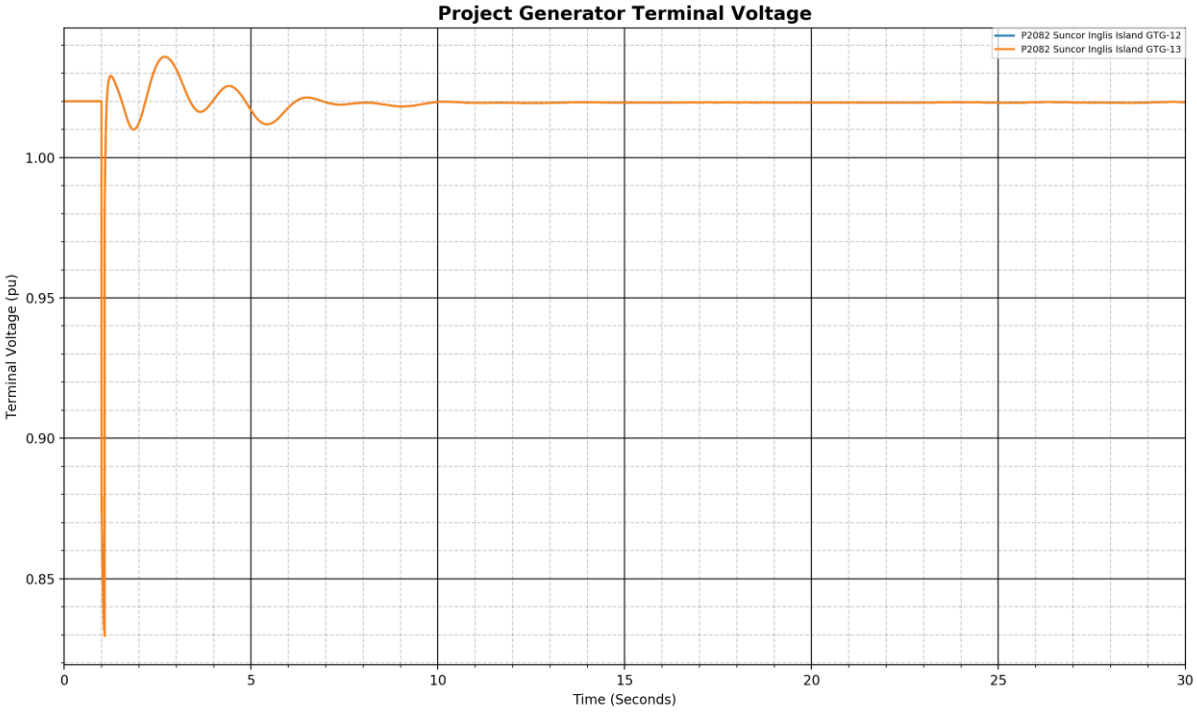

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

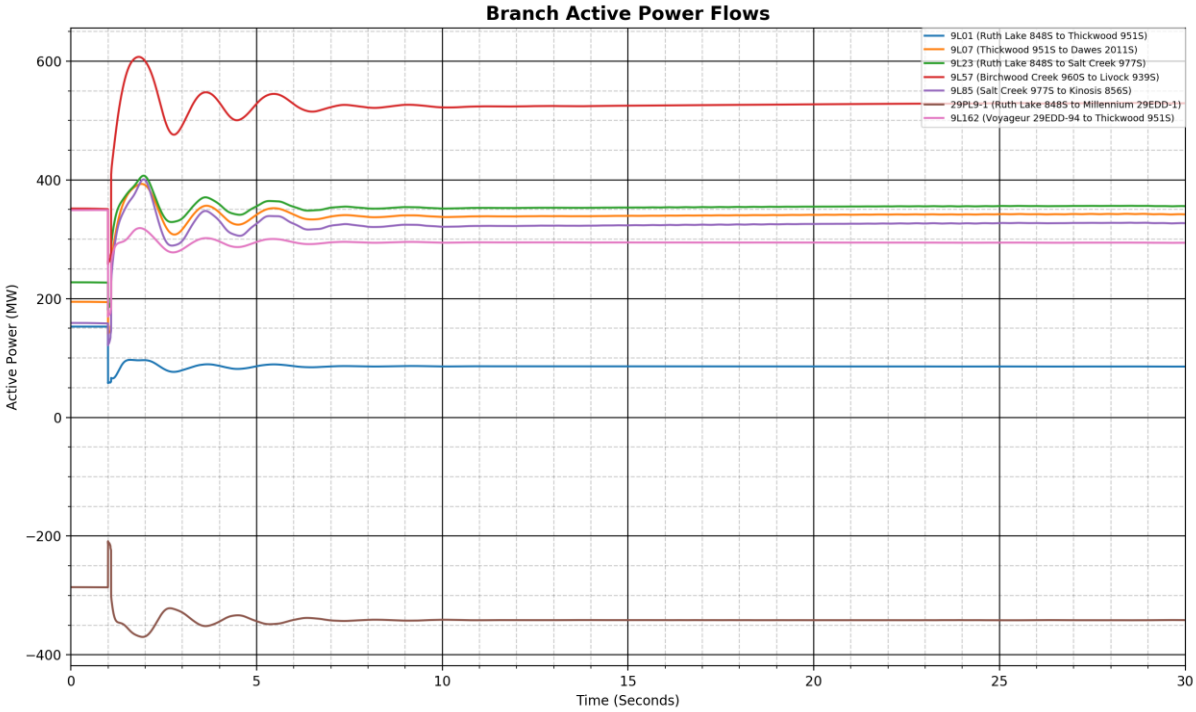

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
70
65
60
55
50
45
40
35
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

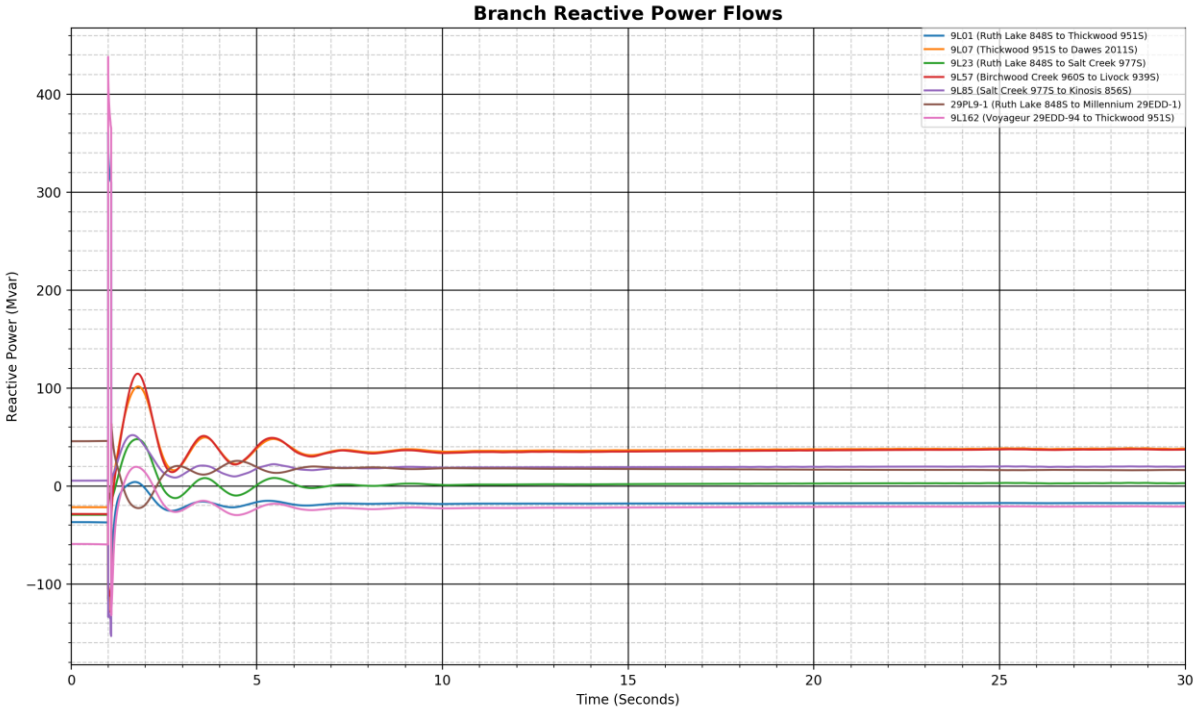
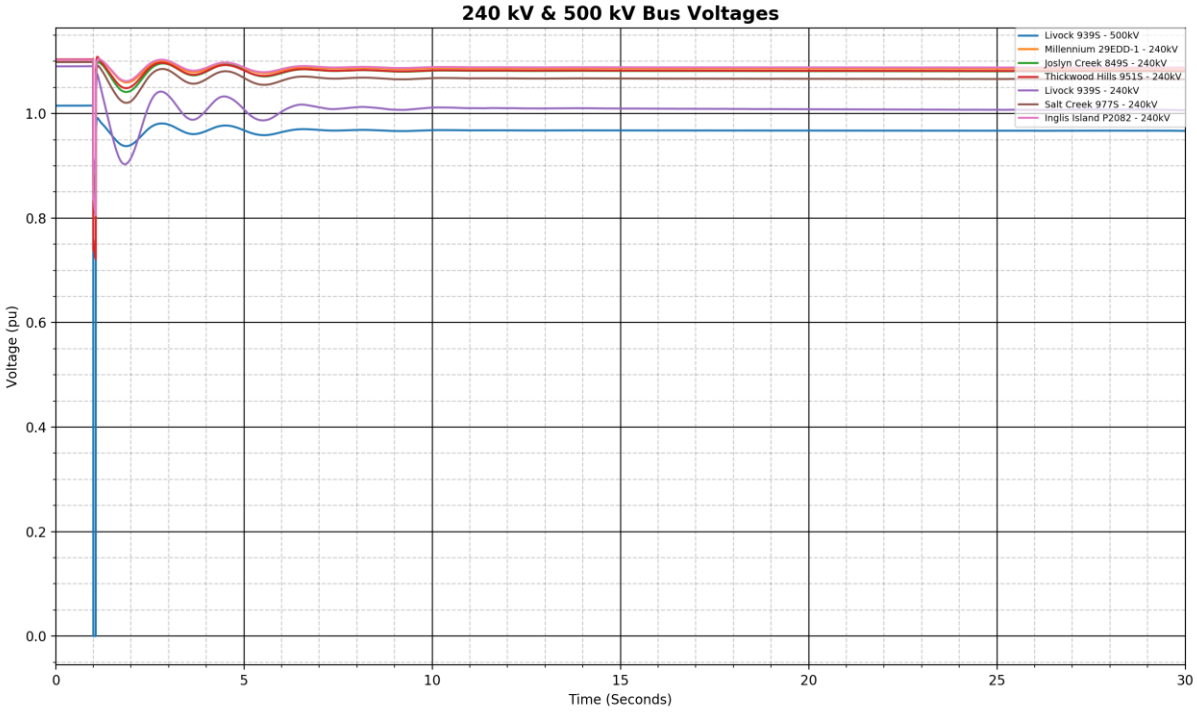
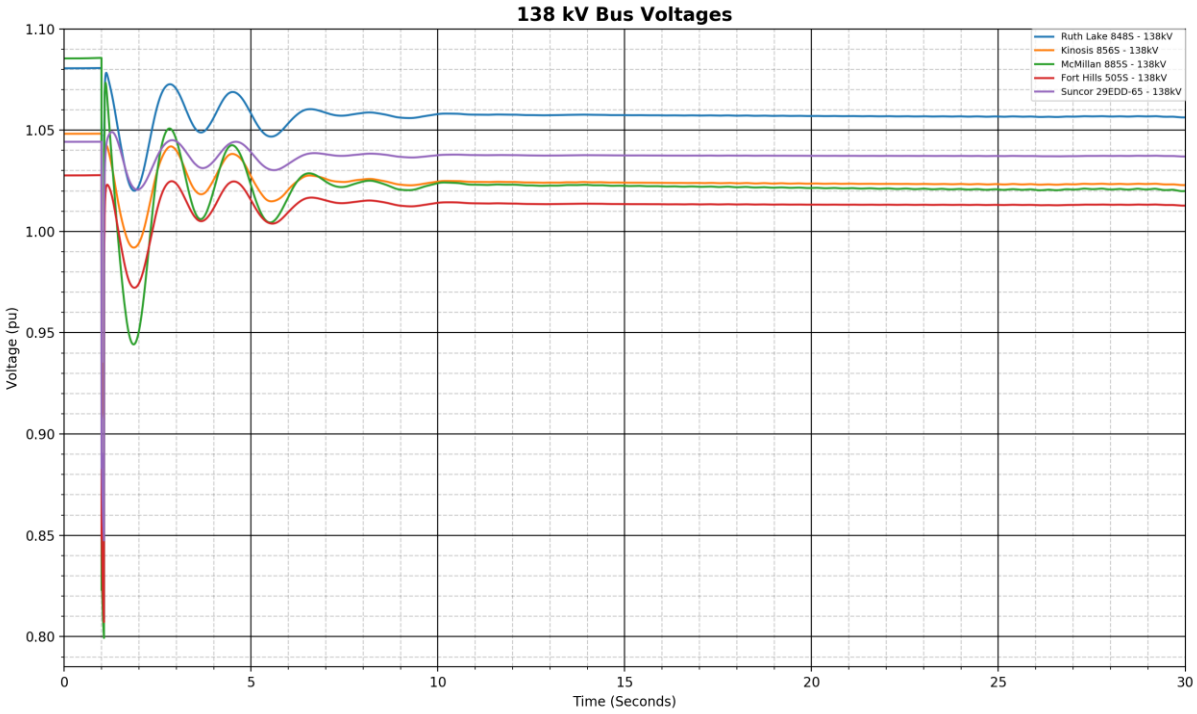
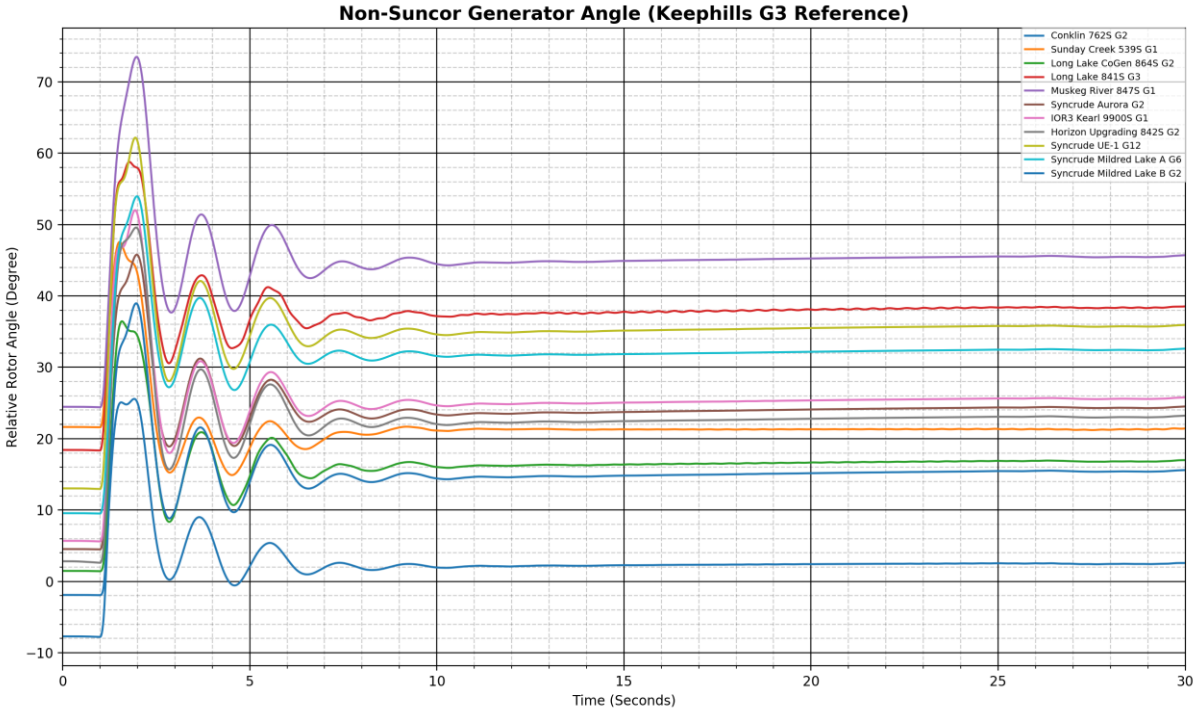
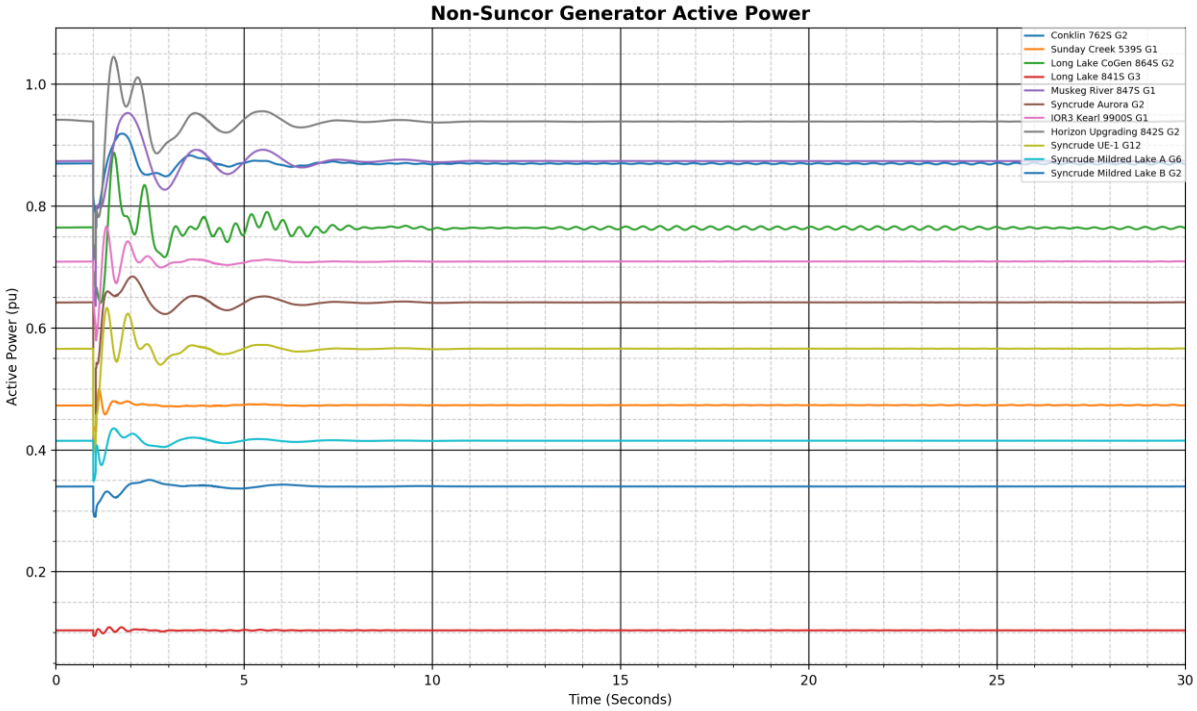

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
0
5
10
15
20
25
30
Time (Seconds)

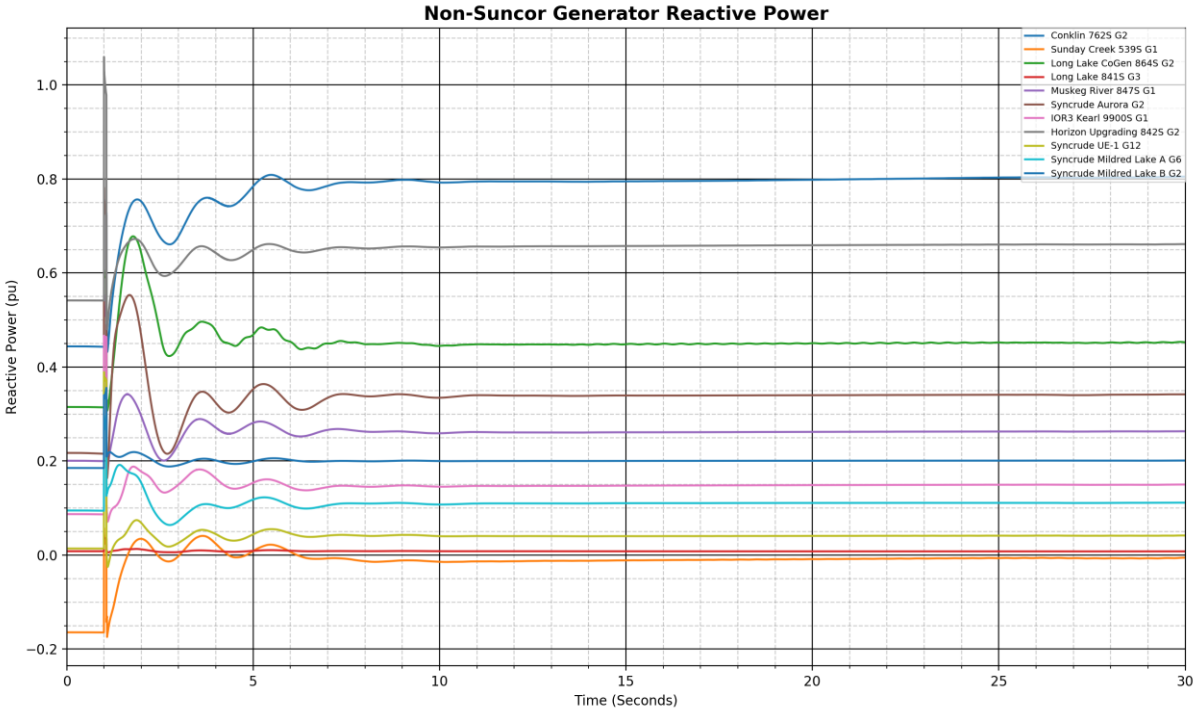
Figure A4-3: 12L41 (Livock 939S to Sunnybrook 510S): Fault at Livock 939S

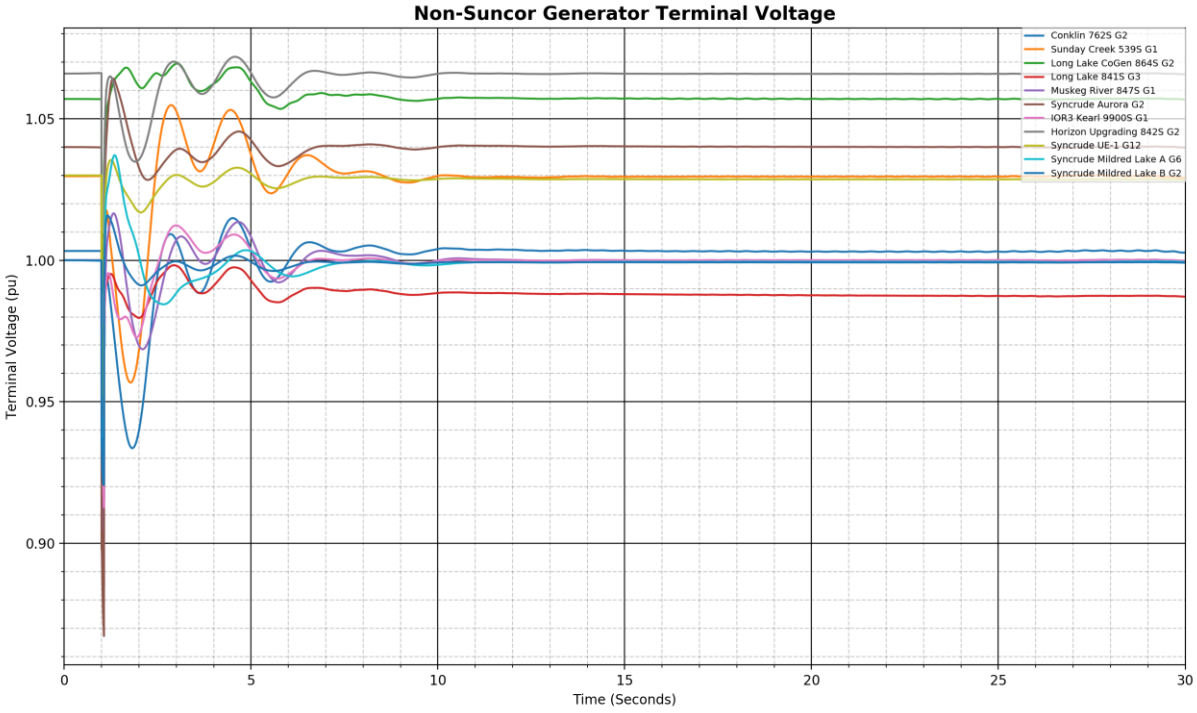


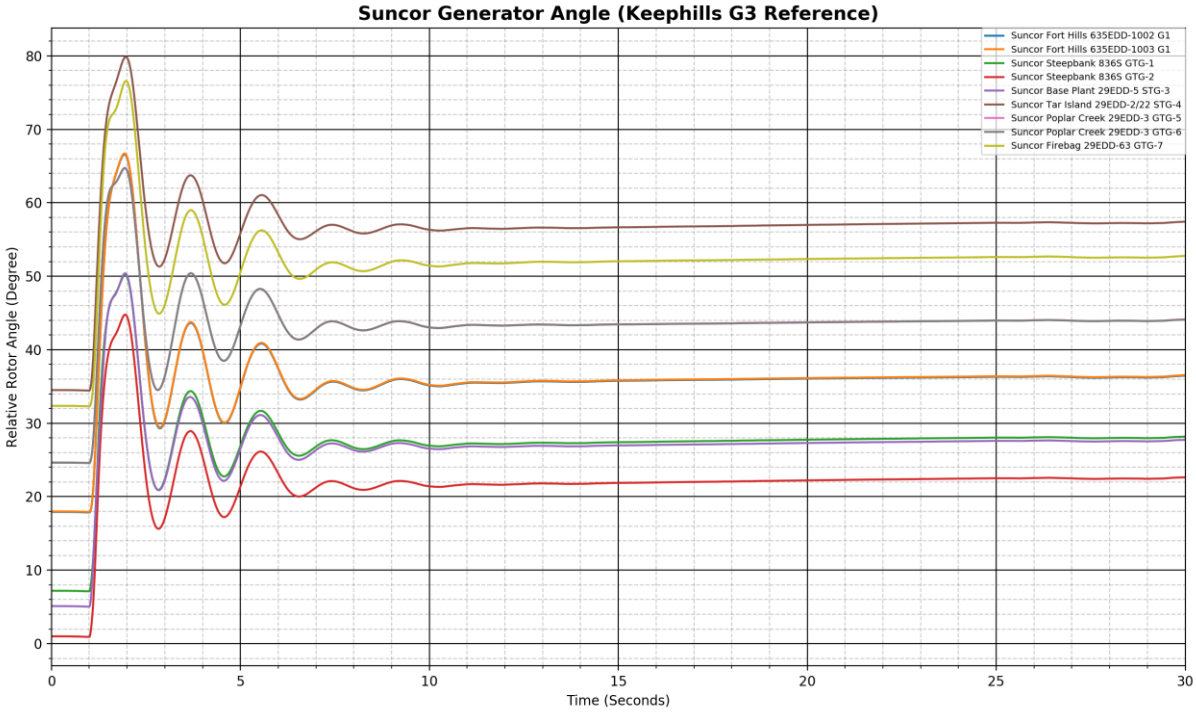


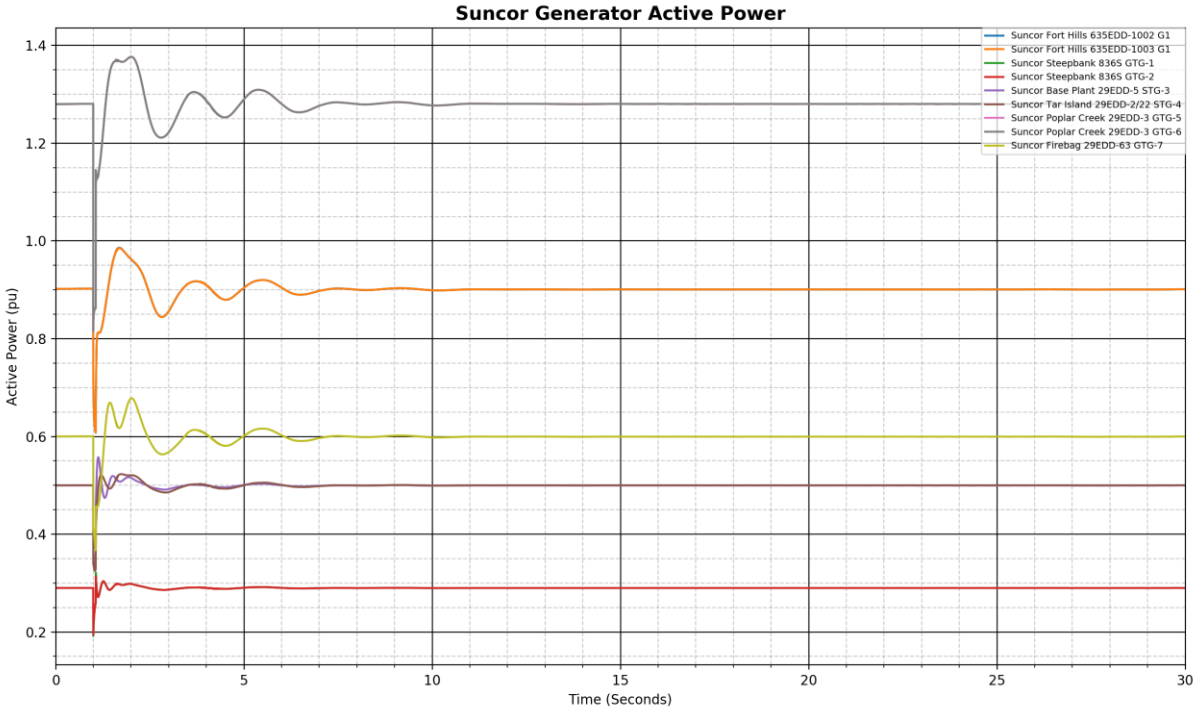

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

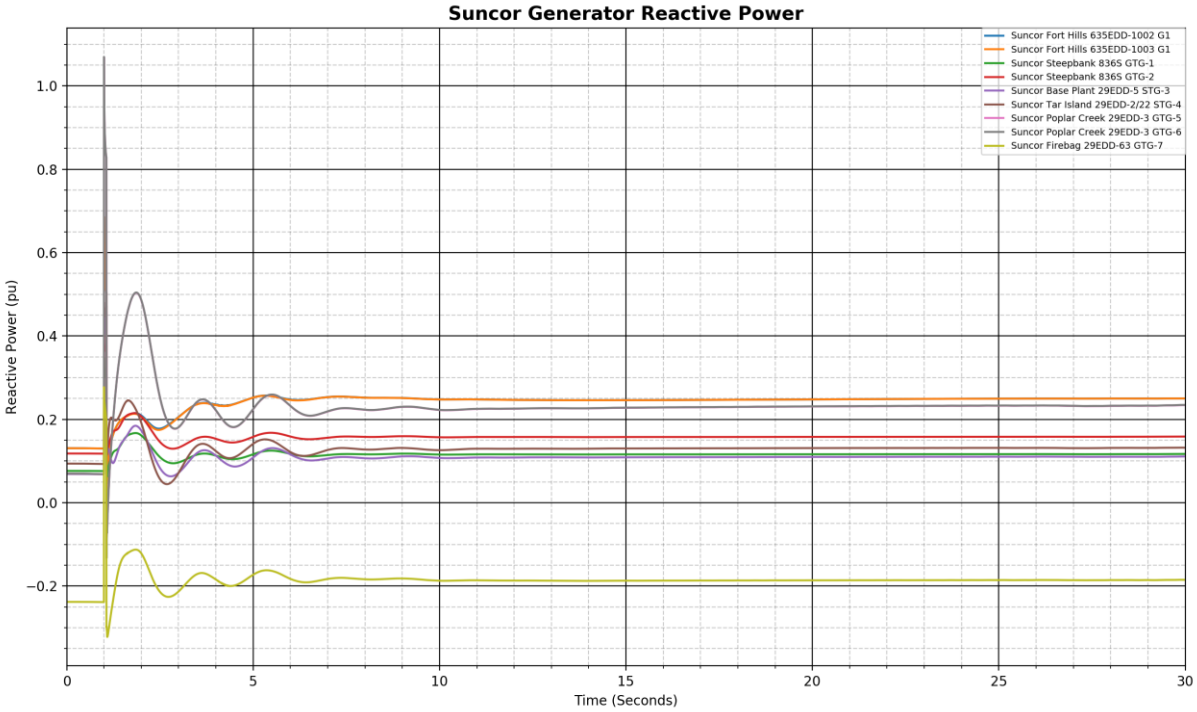

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

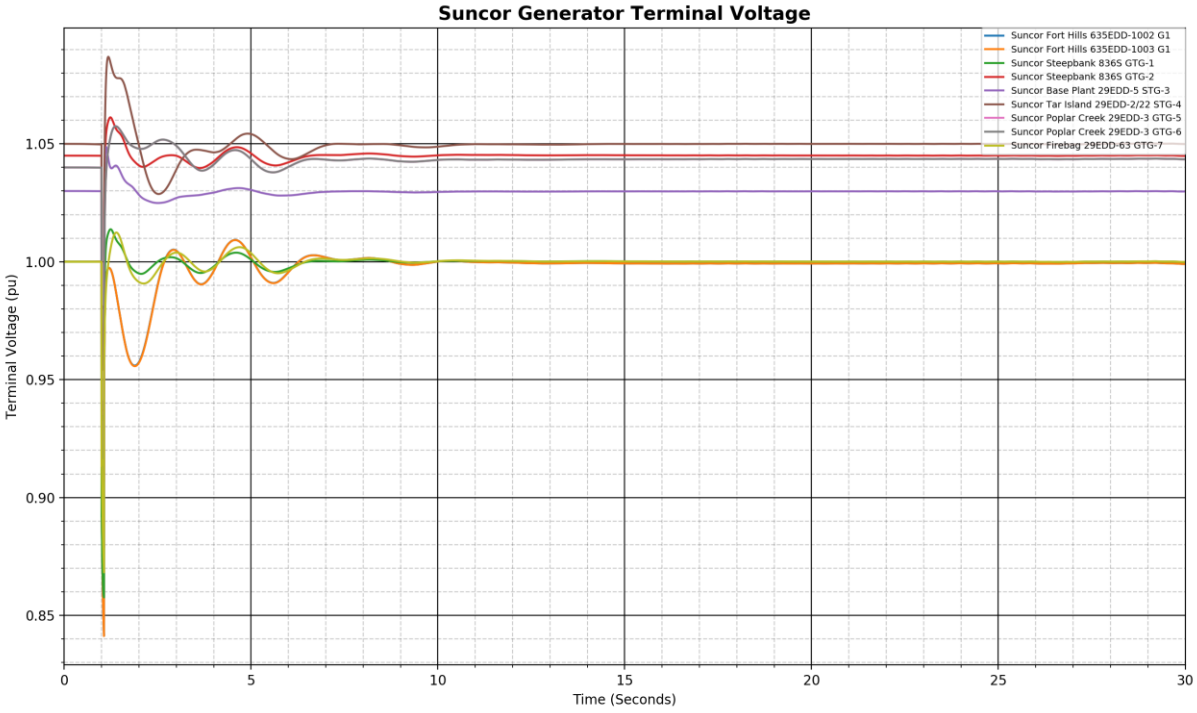

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

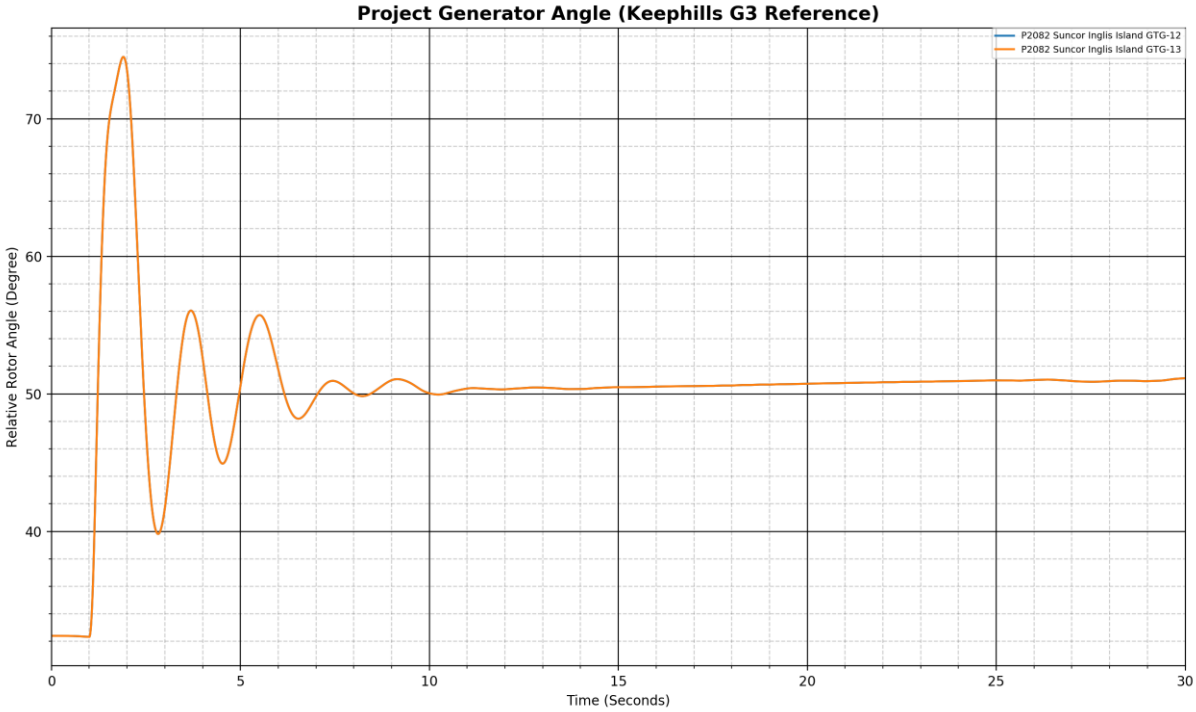

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

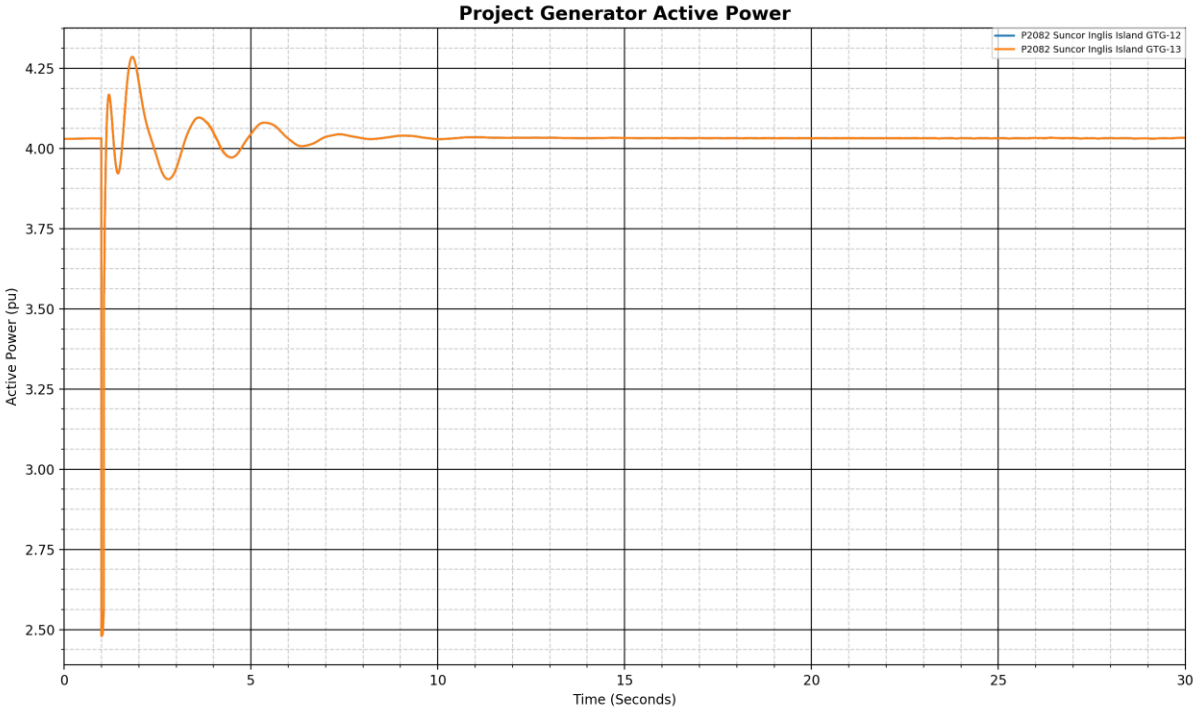

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

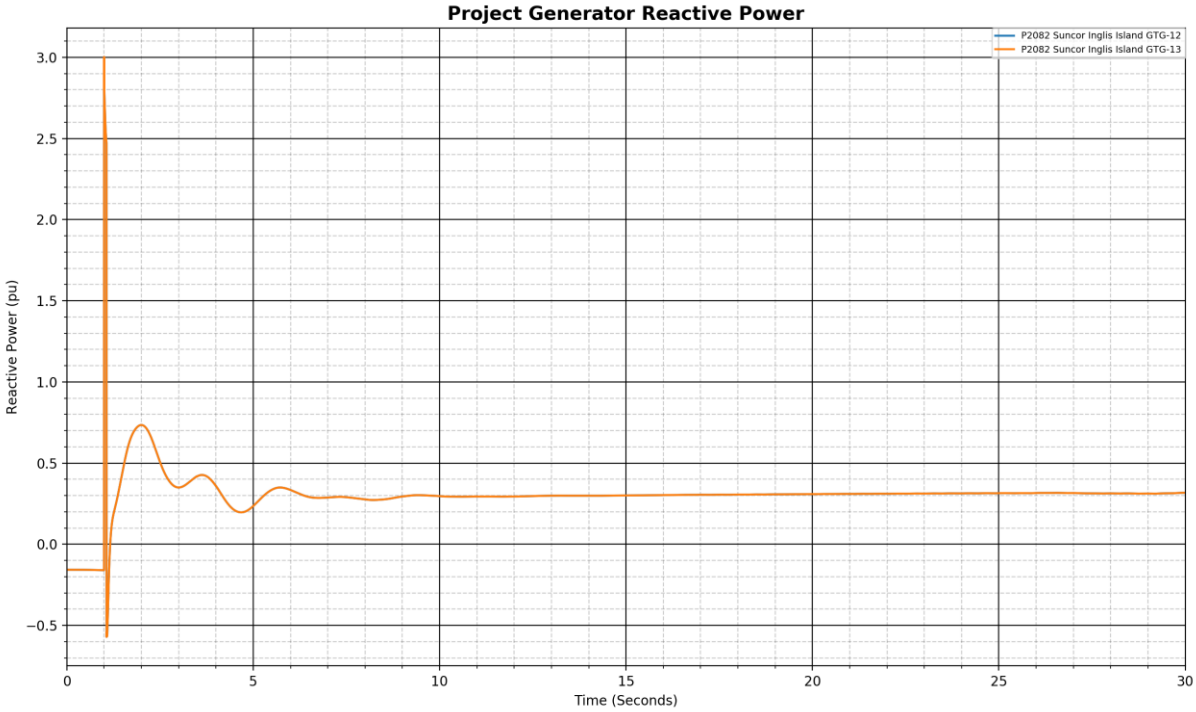

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

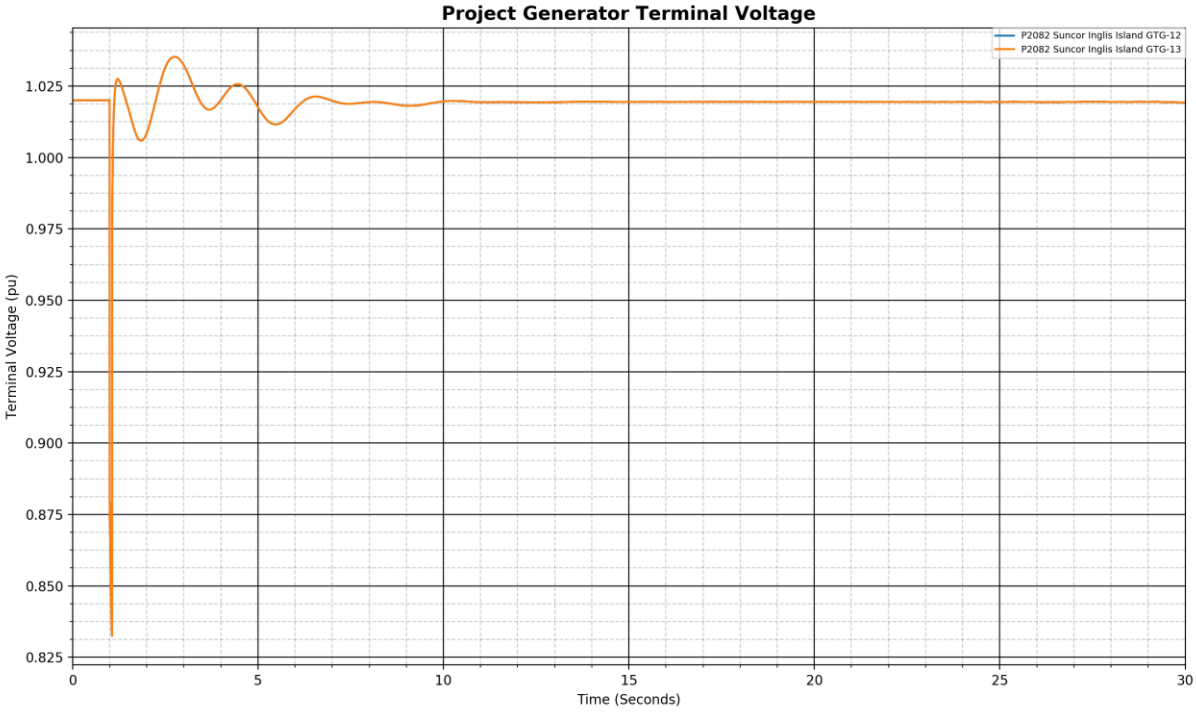

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

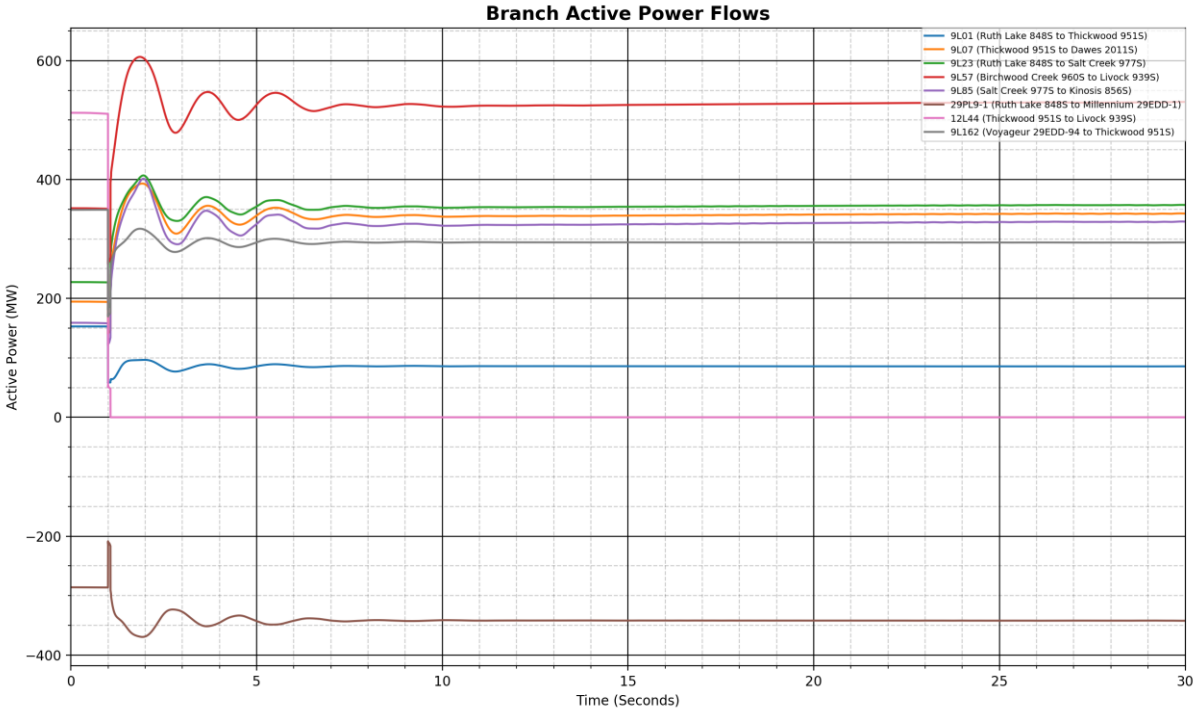

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
70
60
50
40
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.025
1.000
0.975
0.950
0.925
0.900
0.875
0.850
0.825
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

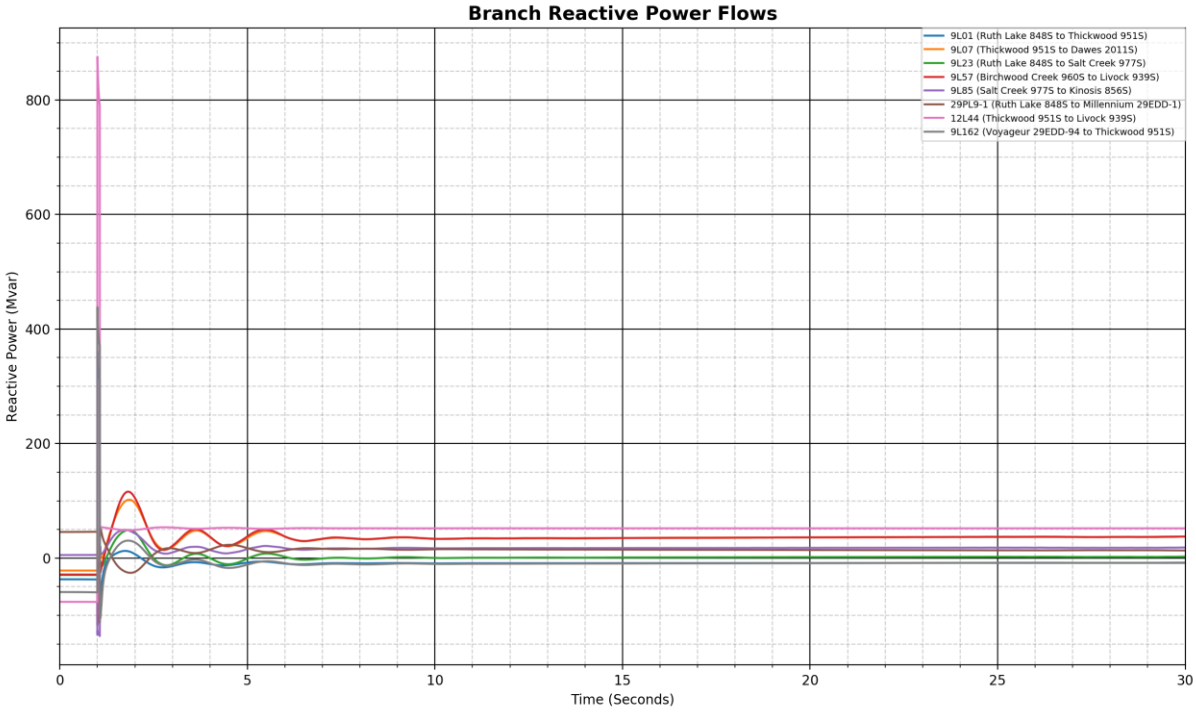
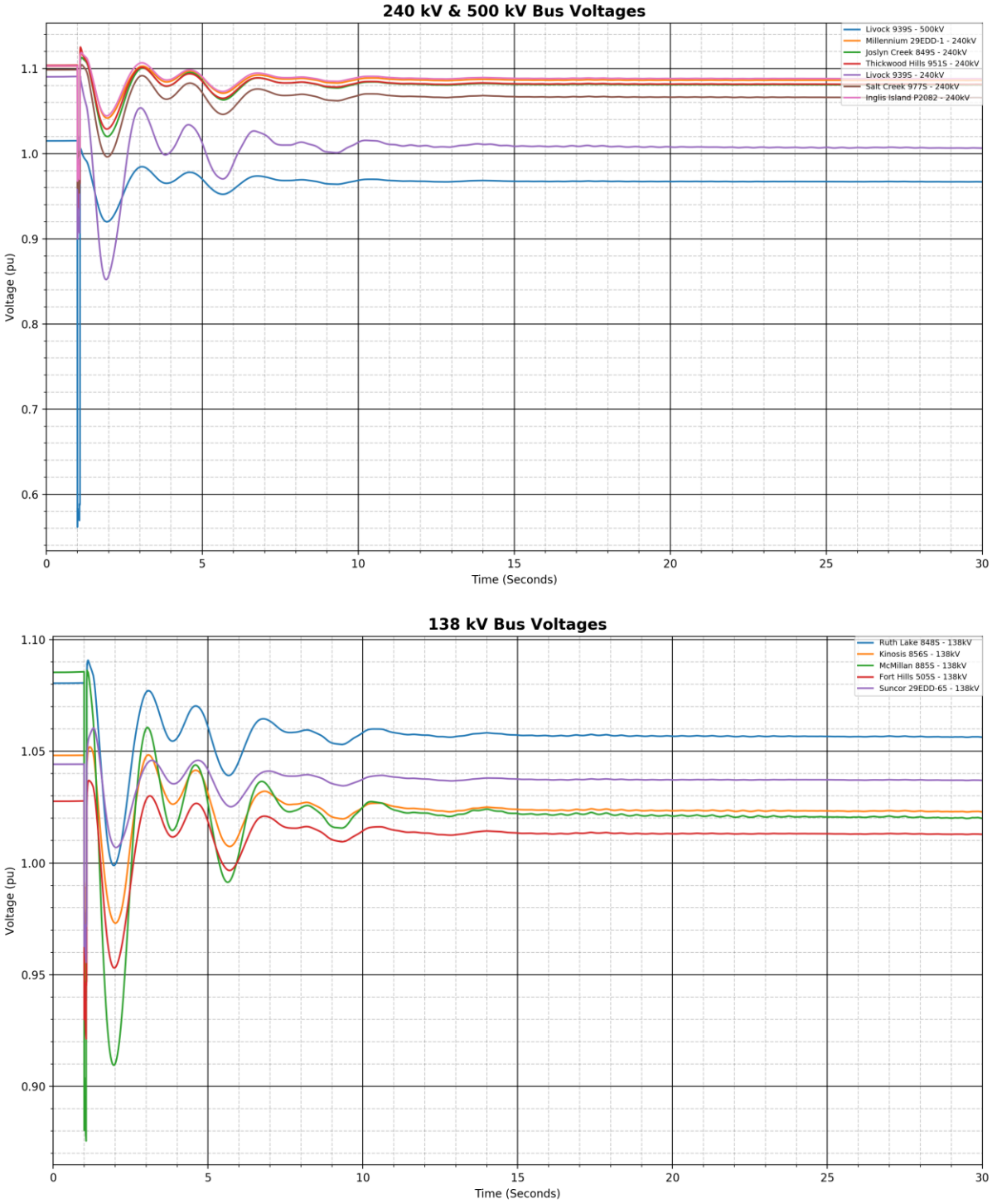
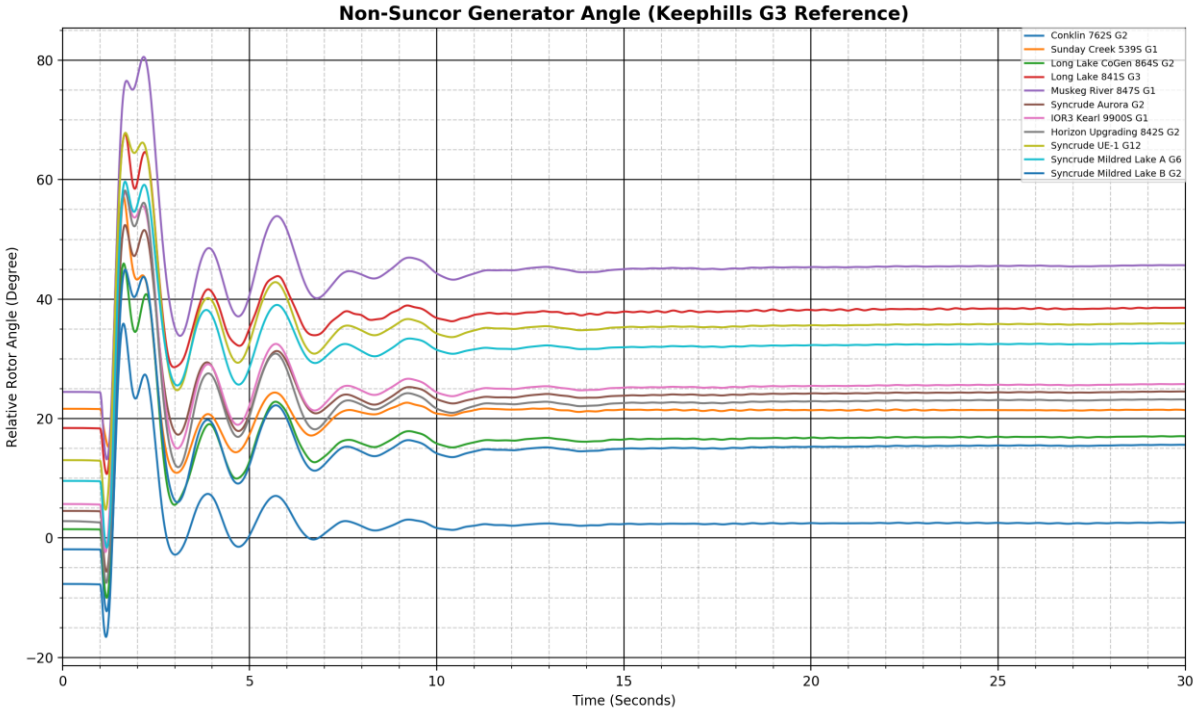
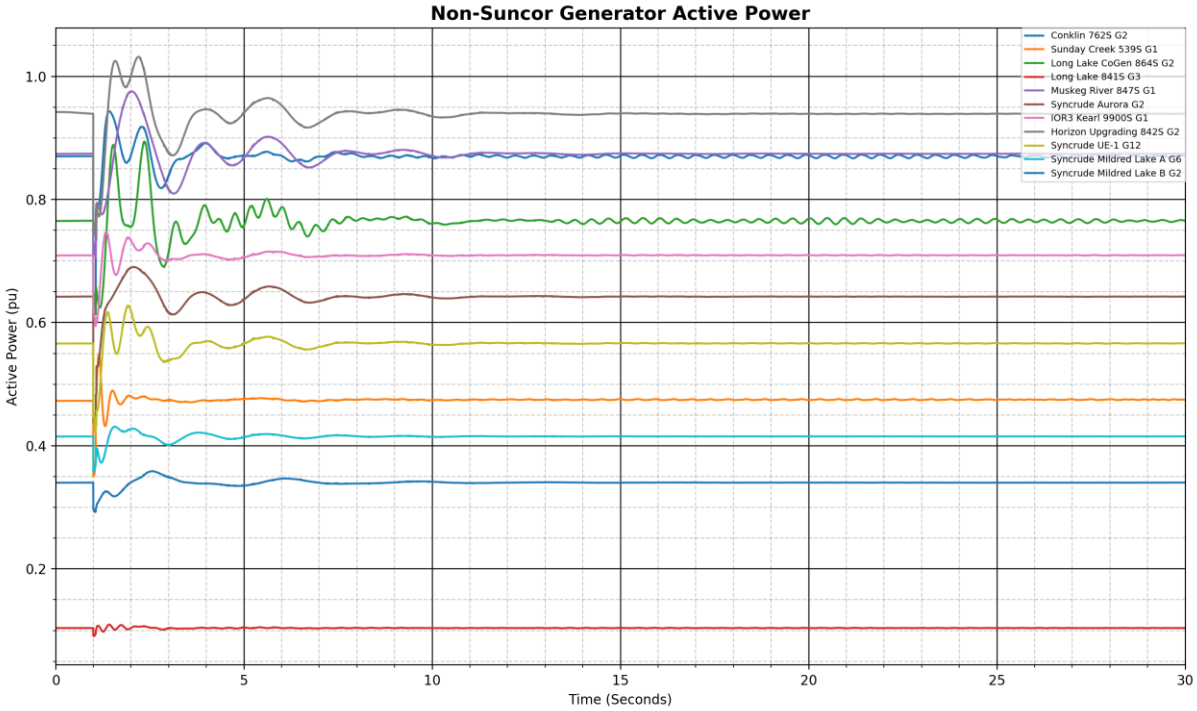
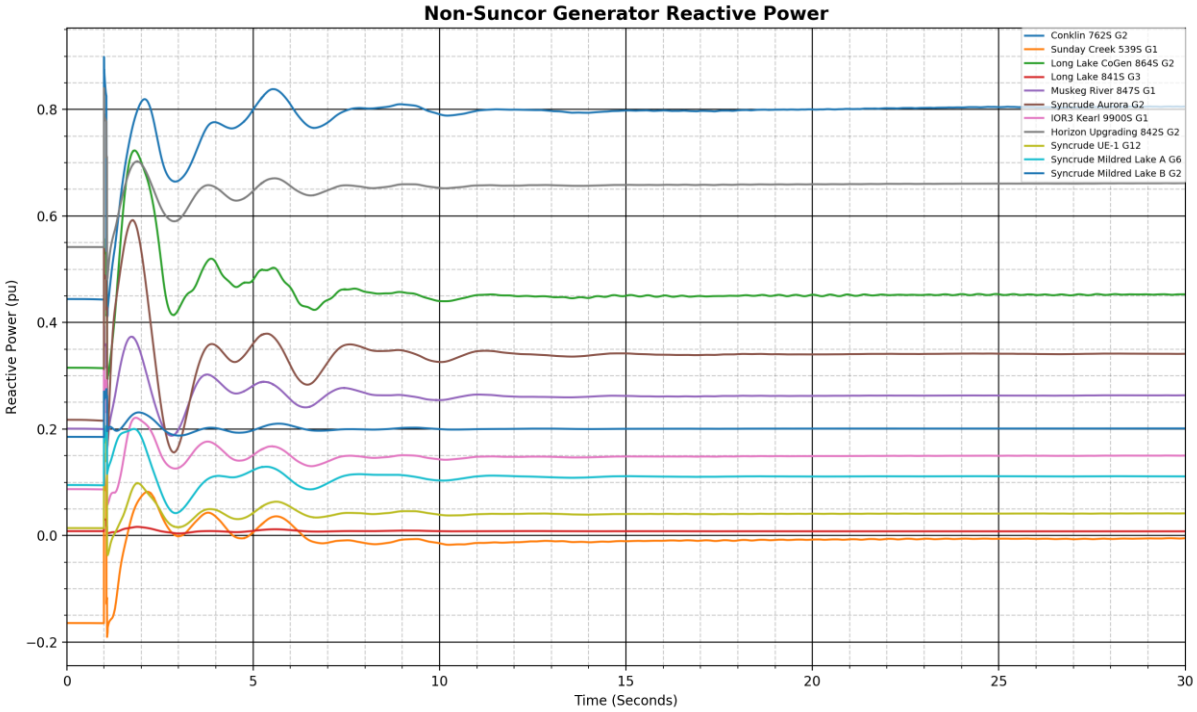

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
800
600
400
200
0
0
5
10
15
20
25
30
Time (Seconds)

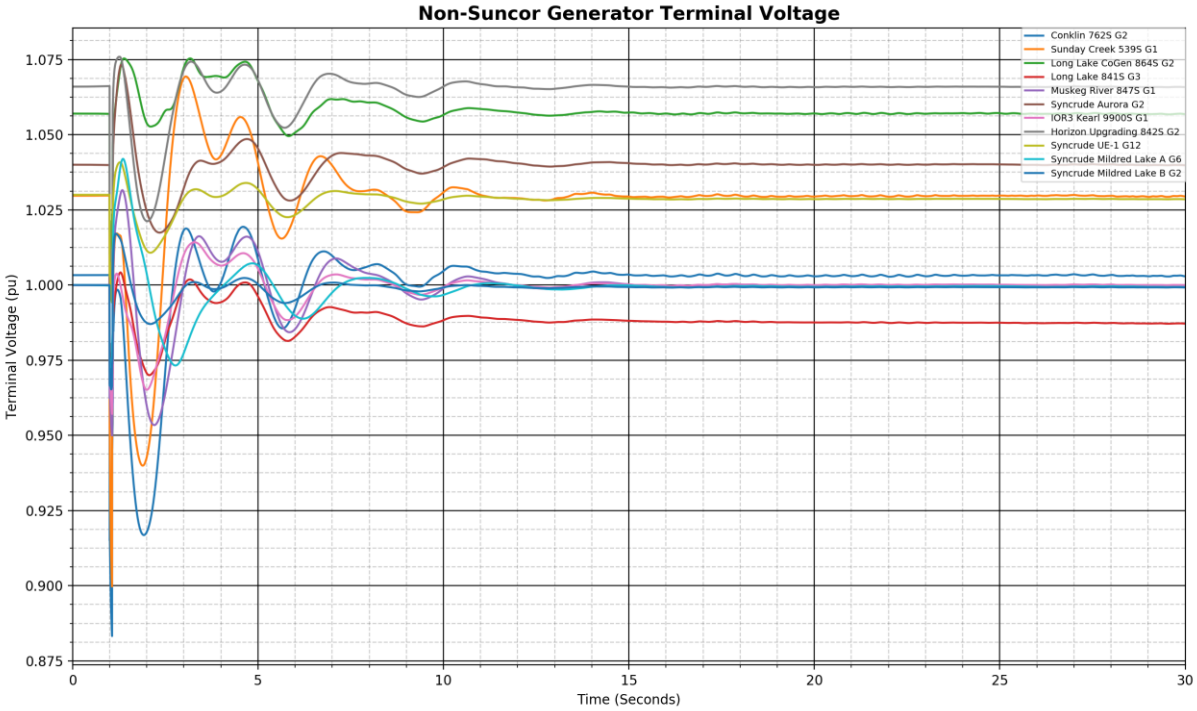
Figure A4-4: 12L41 (Livock 939S to Sunnybrook 510S): Fault at Sunnybrook 510S

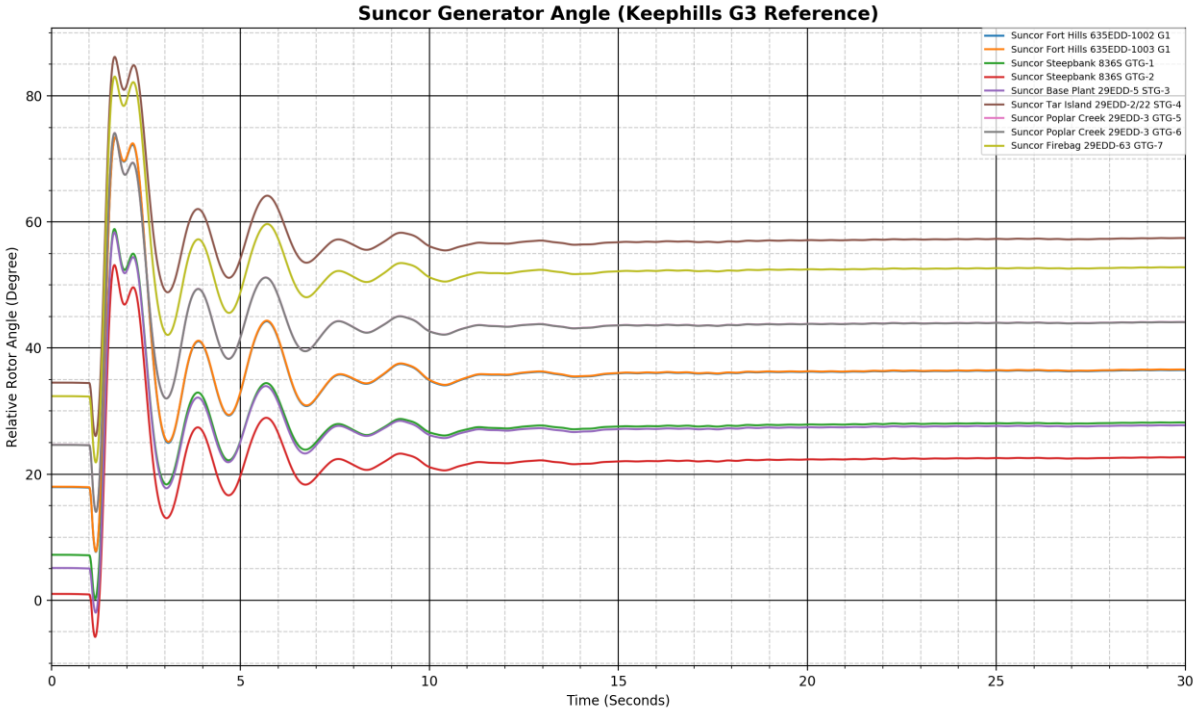


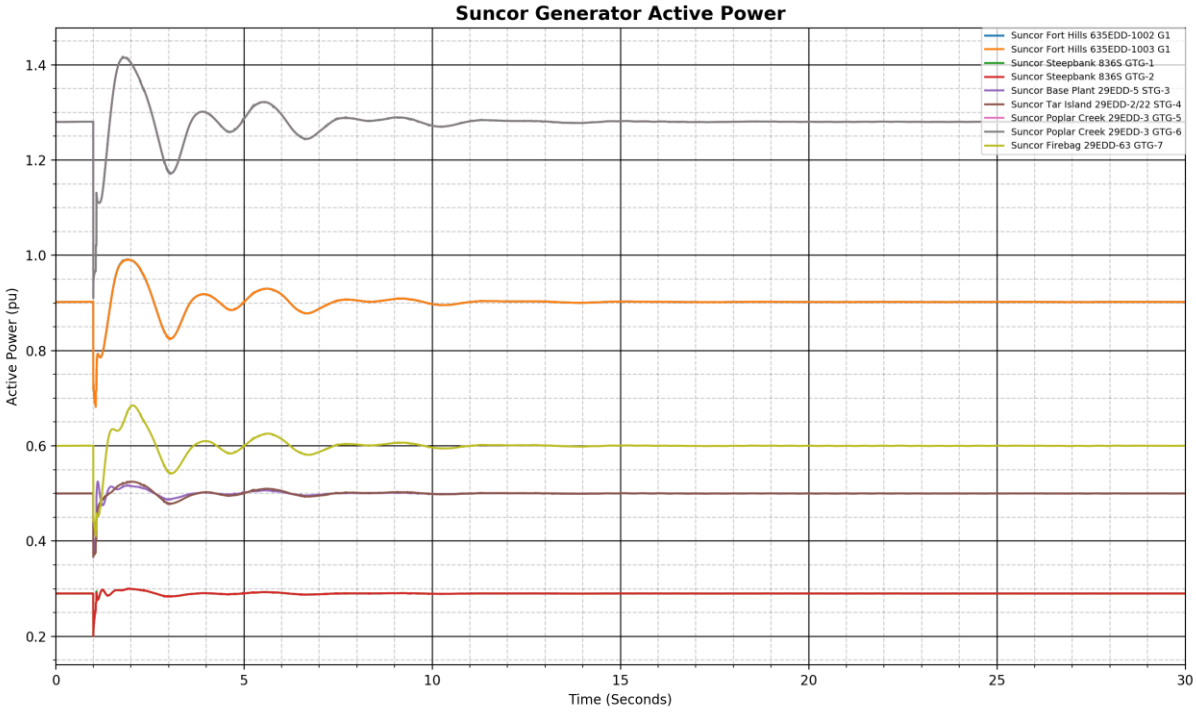

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

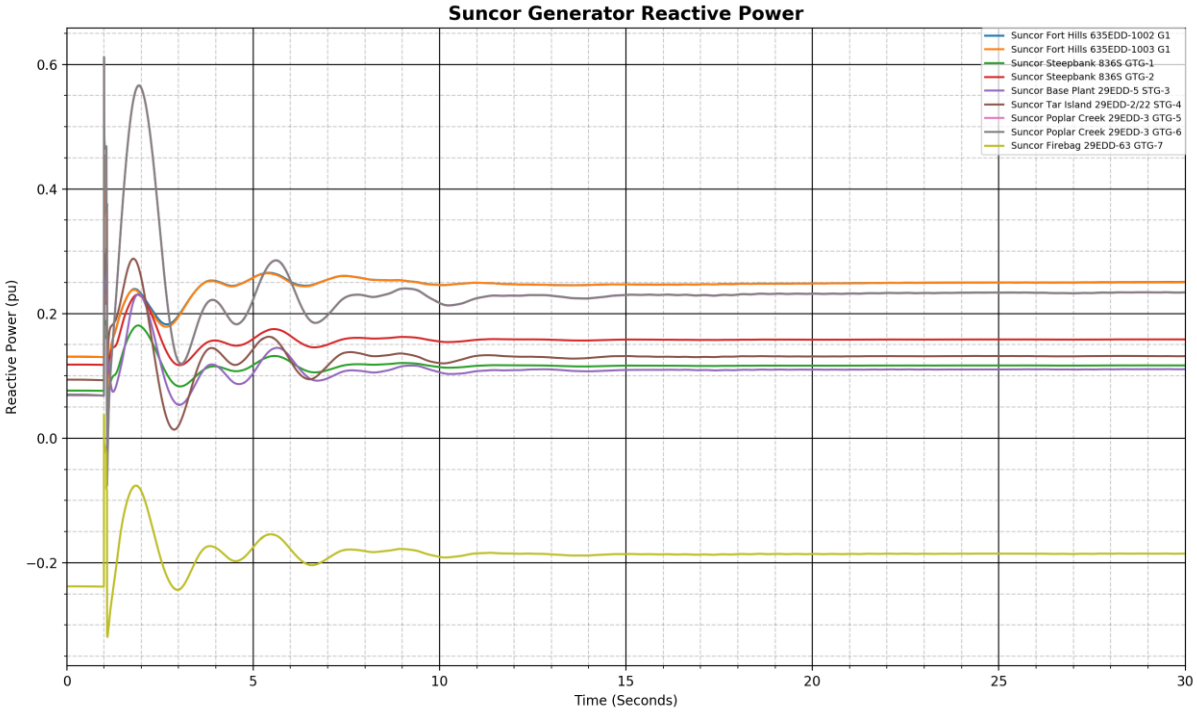

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

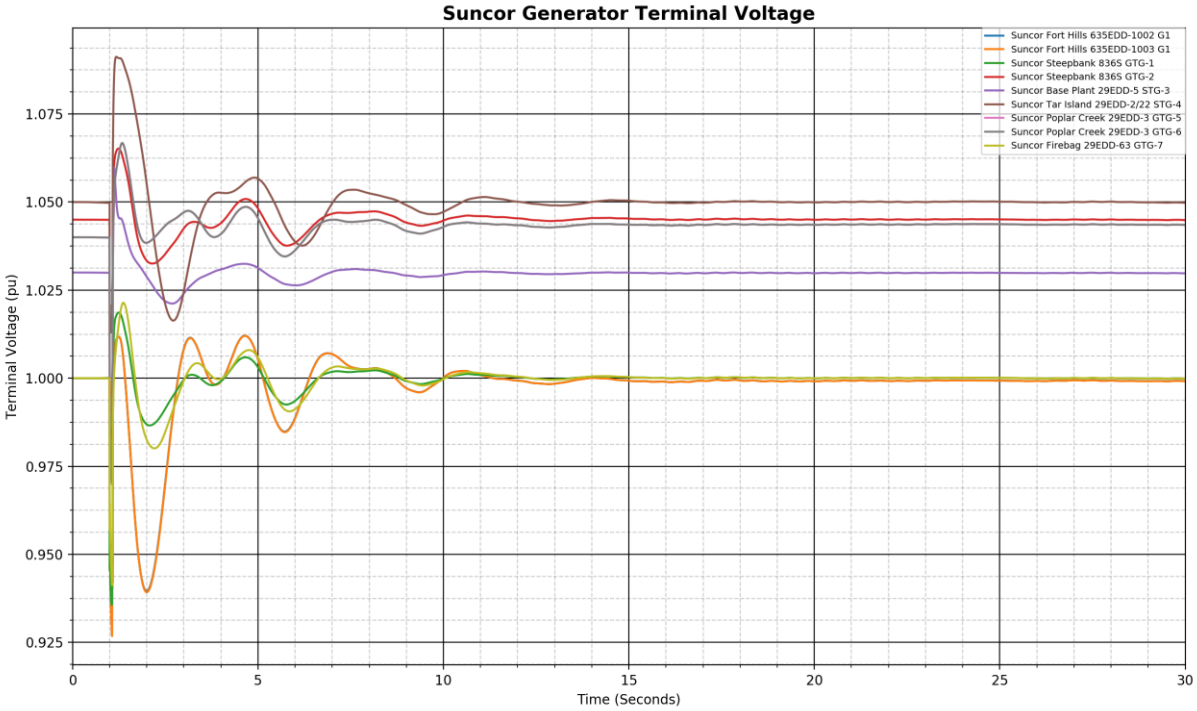

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

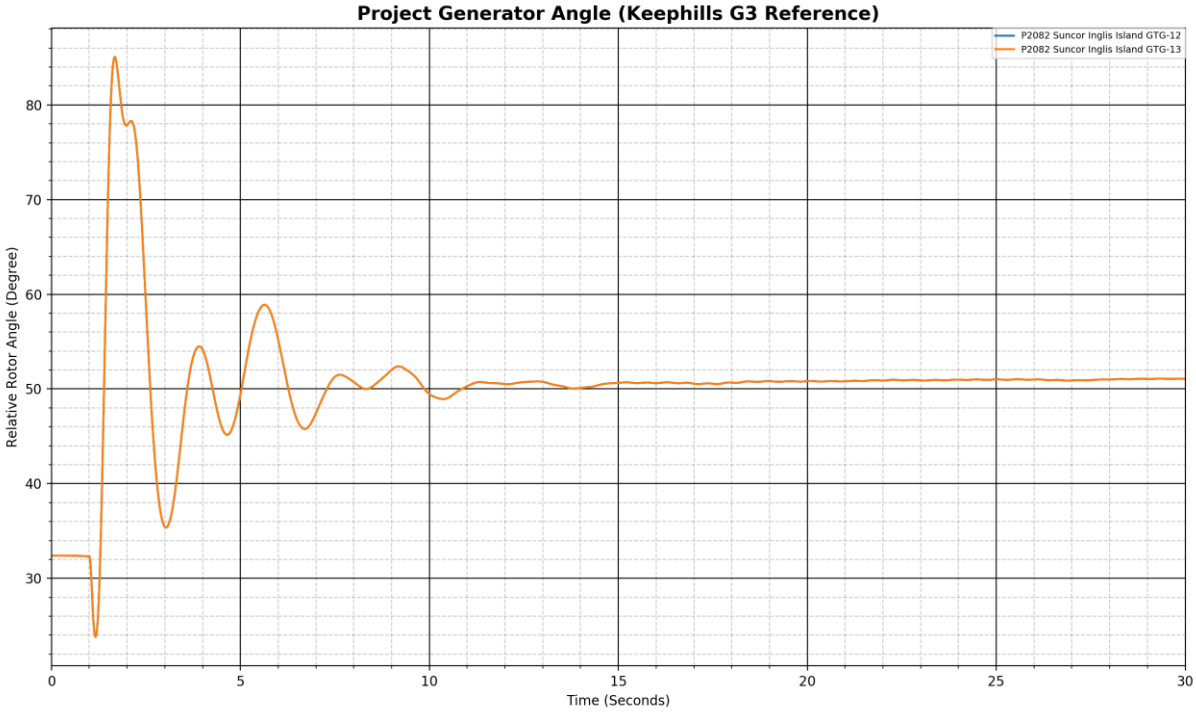

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

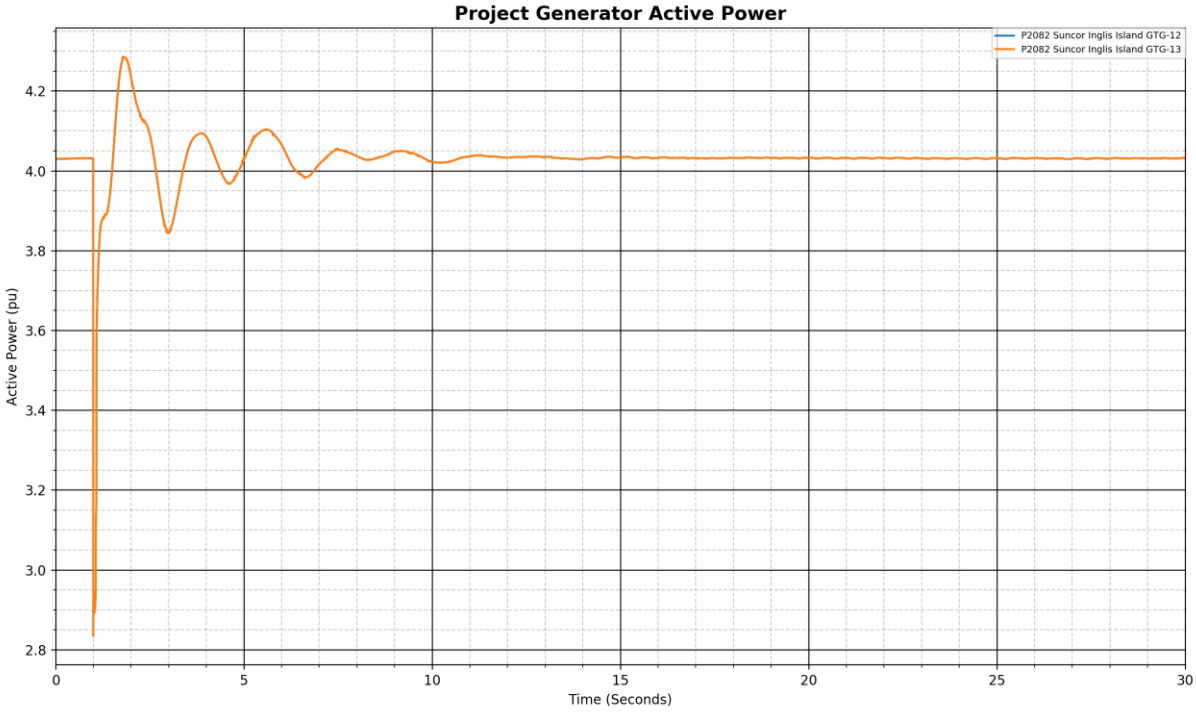

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

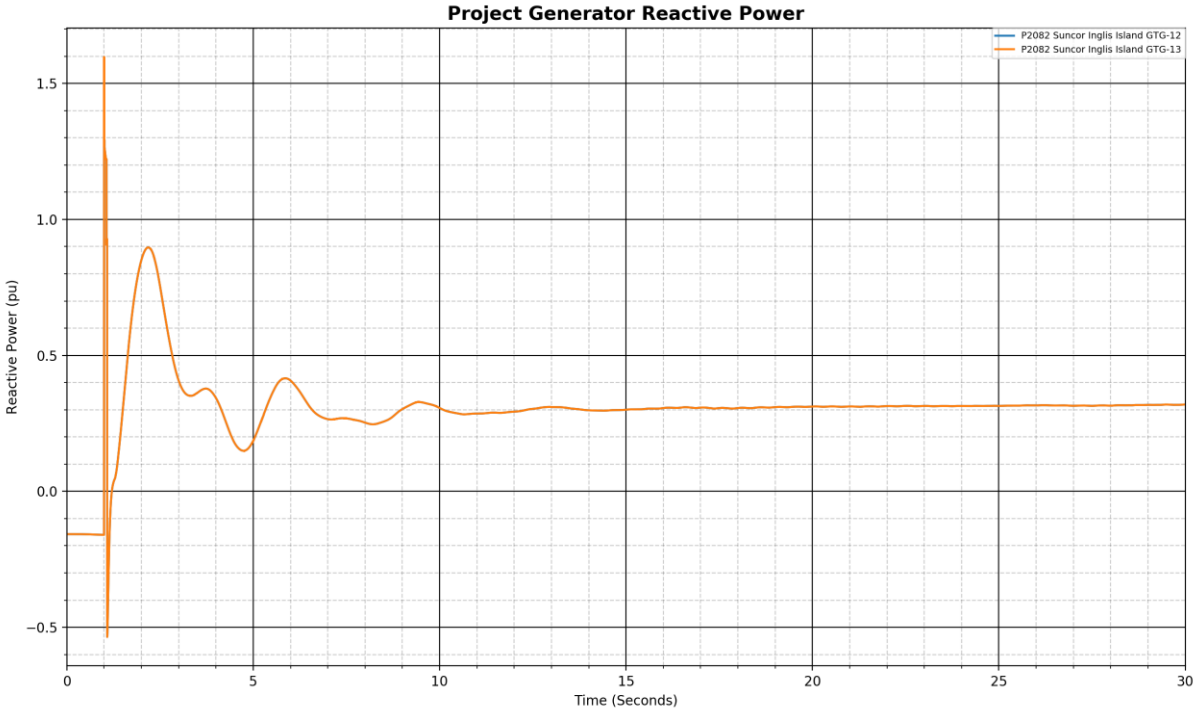

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

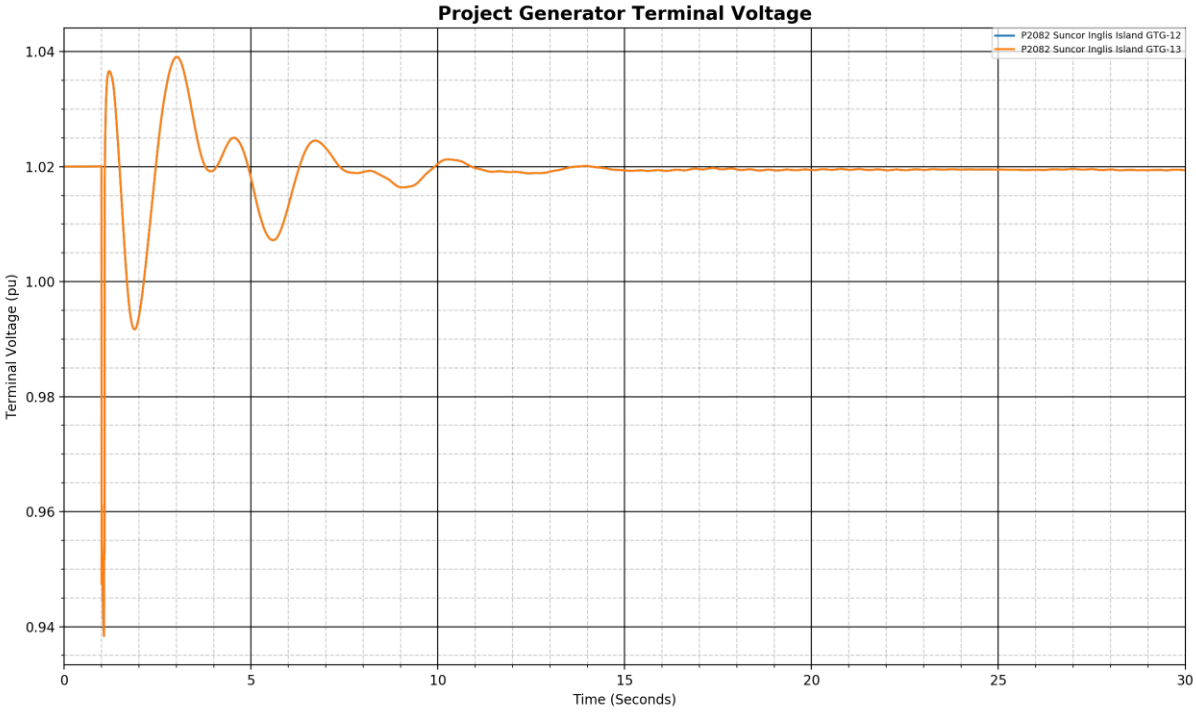

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

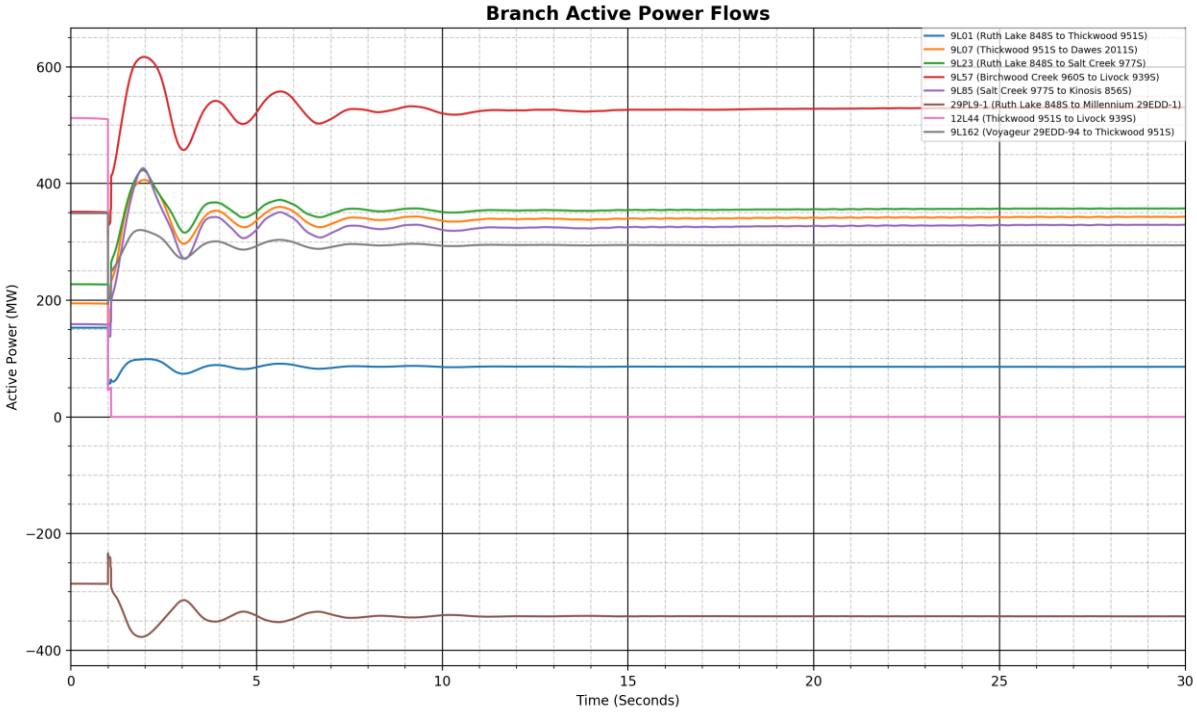

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
80
70
60
50
40
30
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.04
1.02
1.00
0.98
0.96
0.94
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

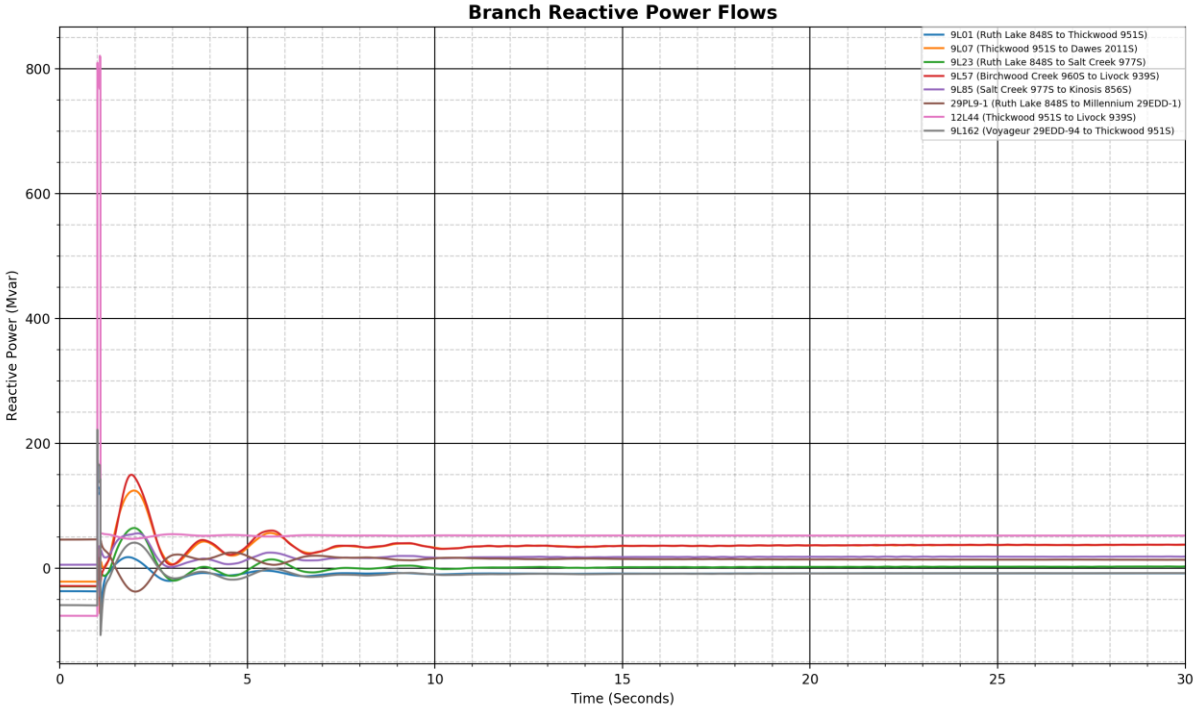
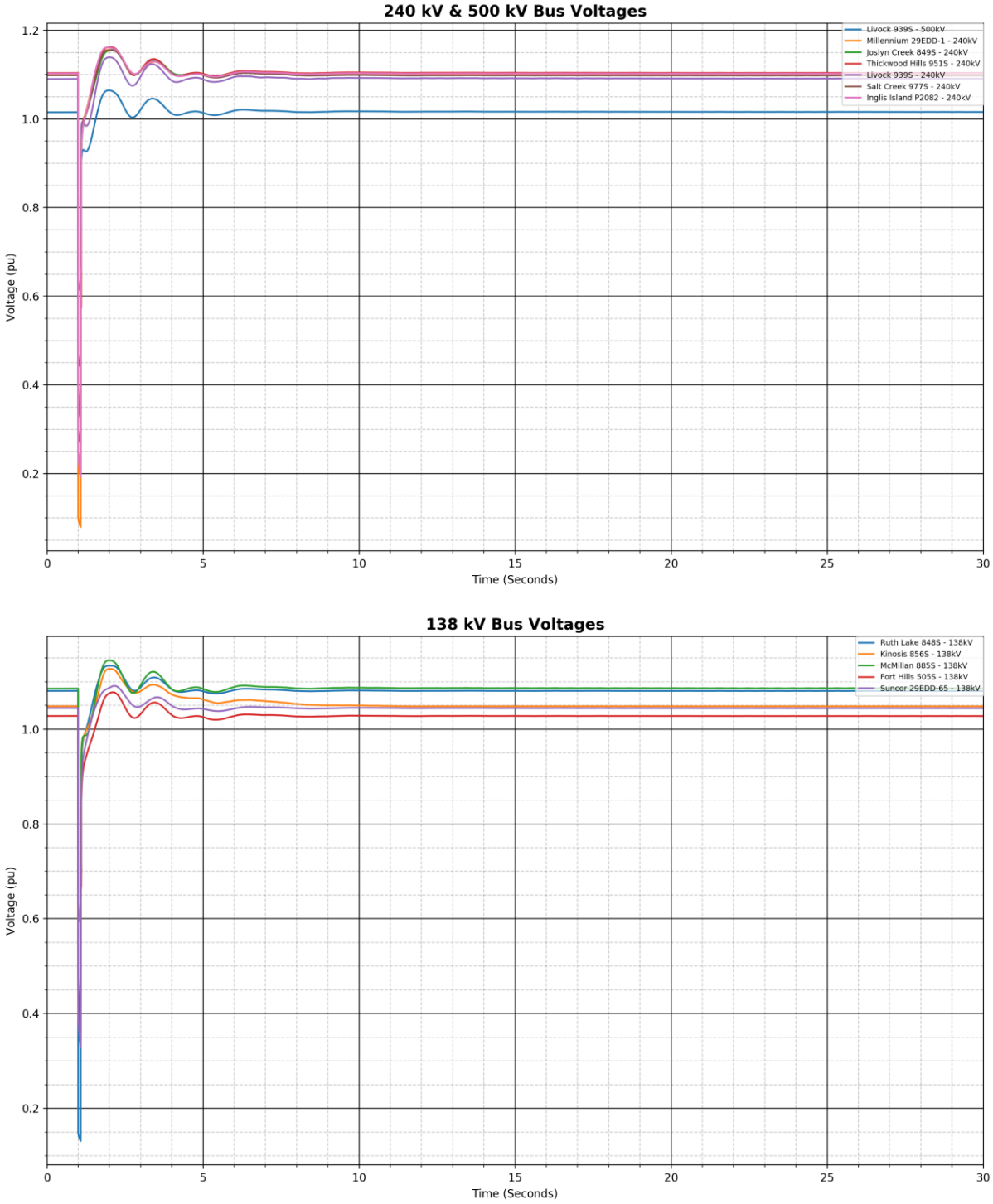
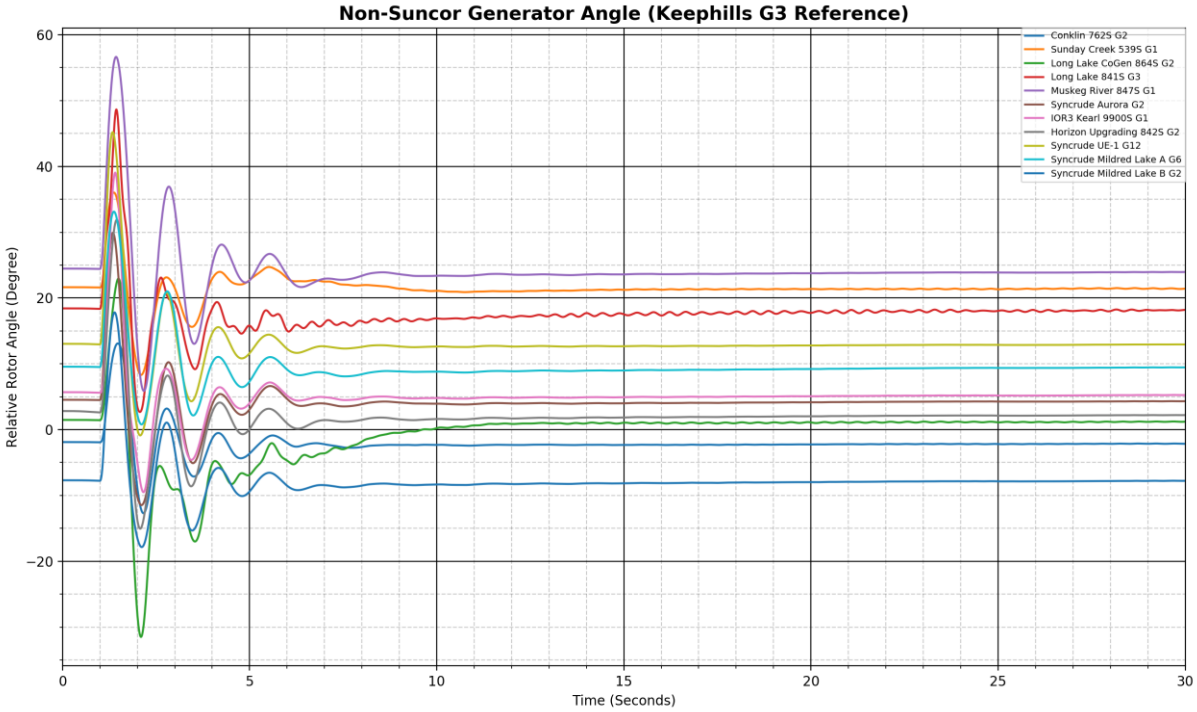
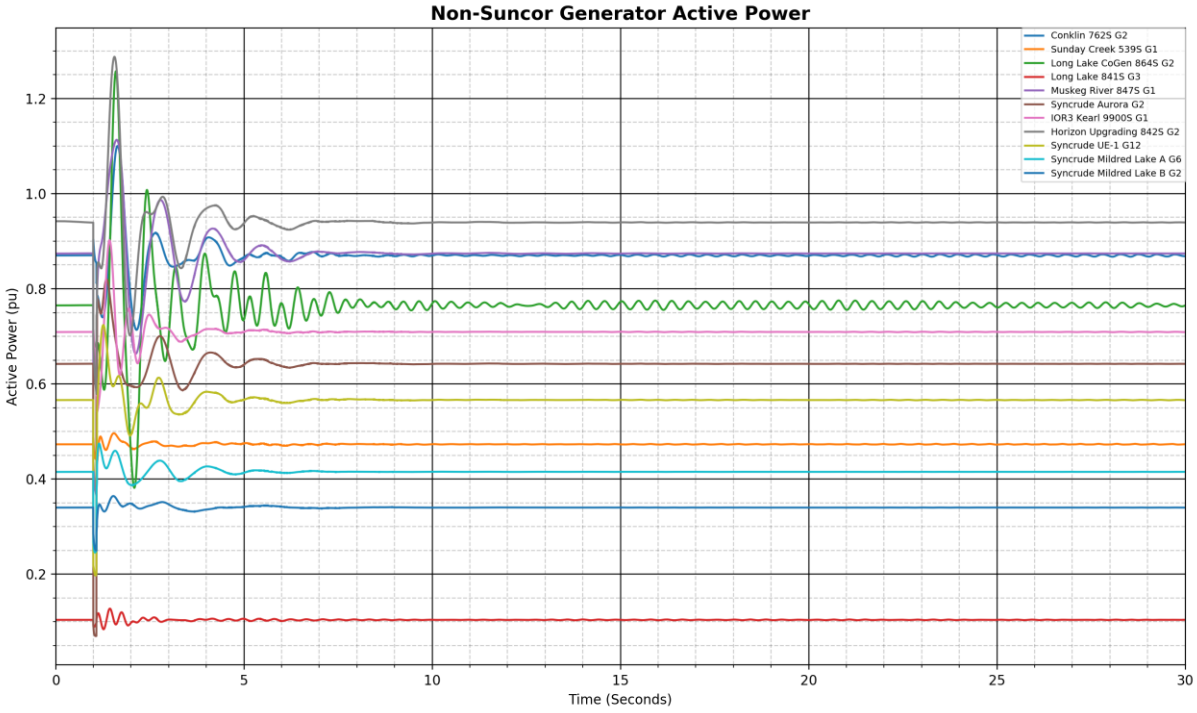
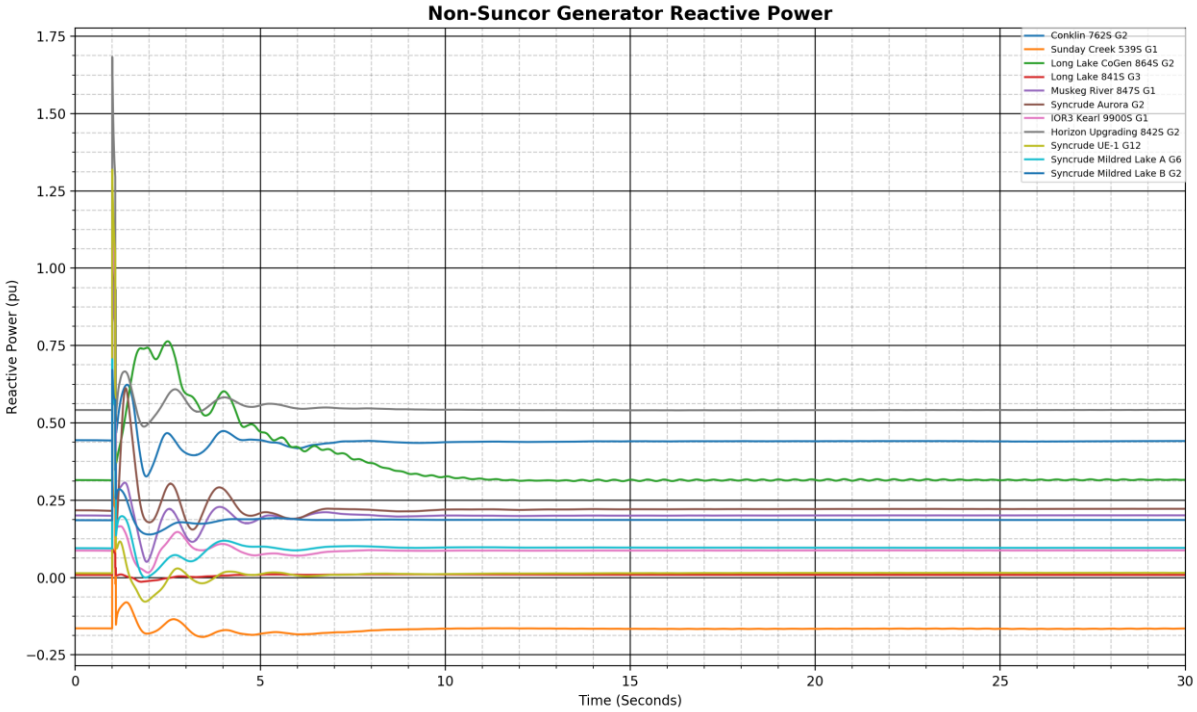

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
800
600
400
200
0
0
5
10
15
20
25
30
Time (Seconds)

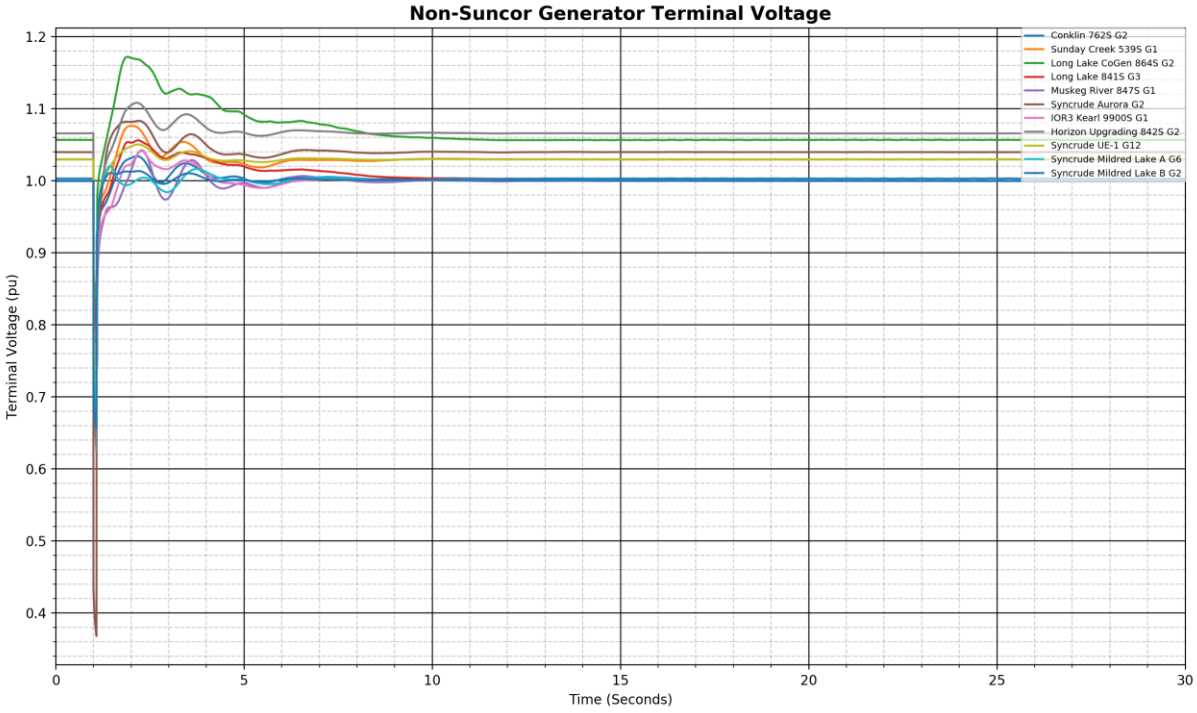
Figure A4-5: 9L01 (Ruth Lake 848S to Thickwood Hills 951S): Fault at Ruth Lake 848S

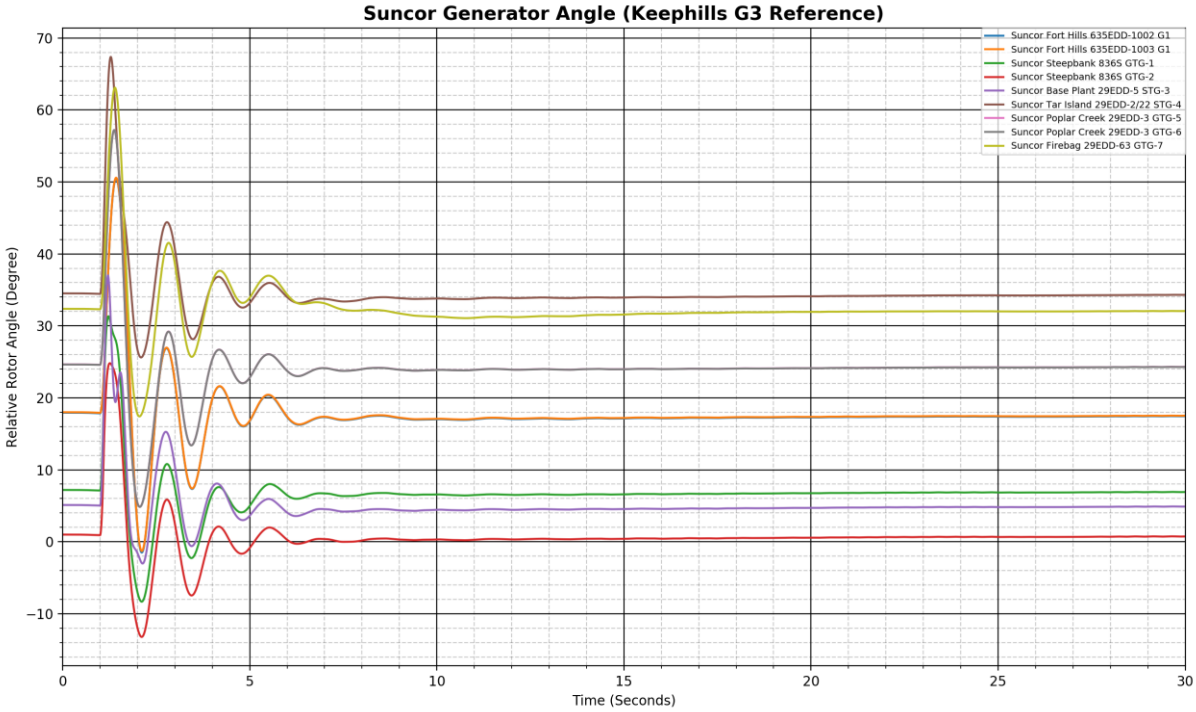


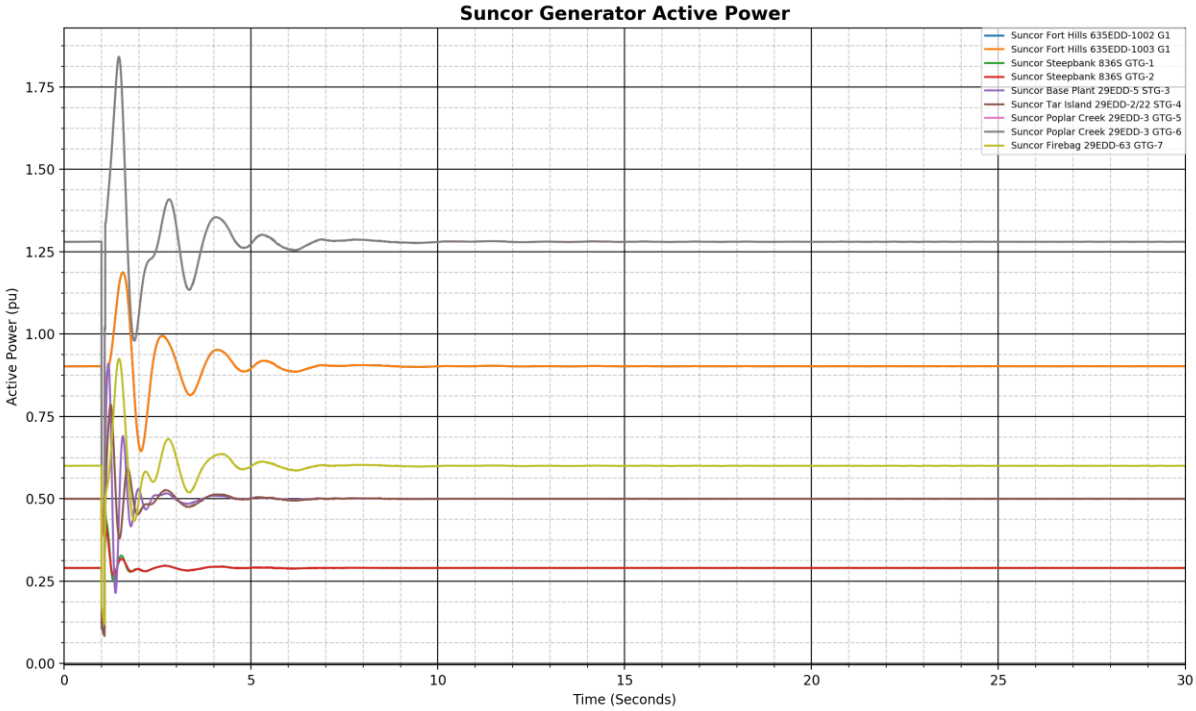

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

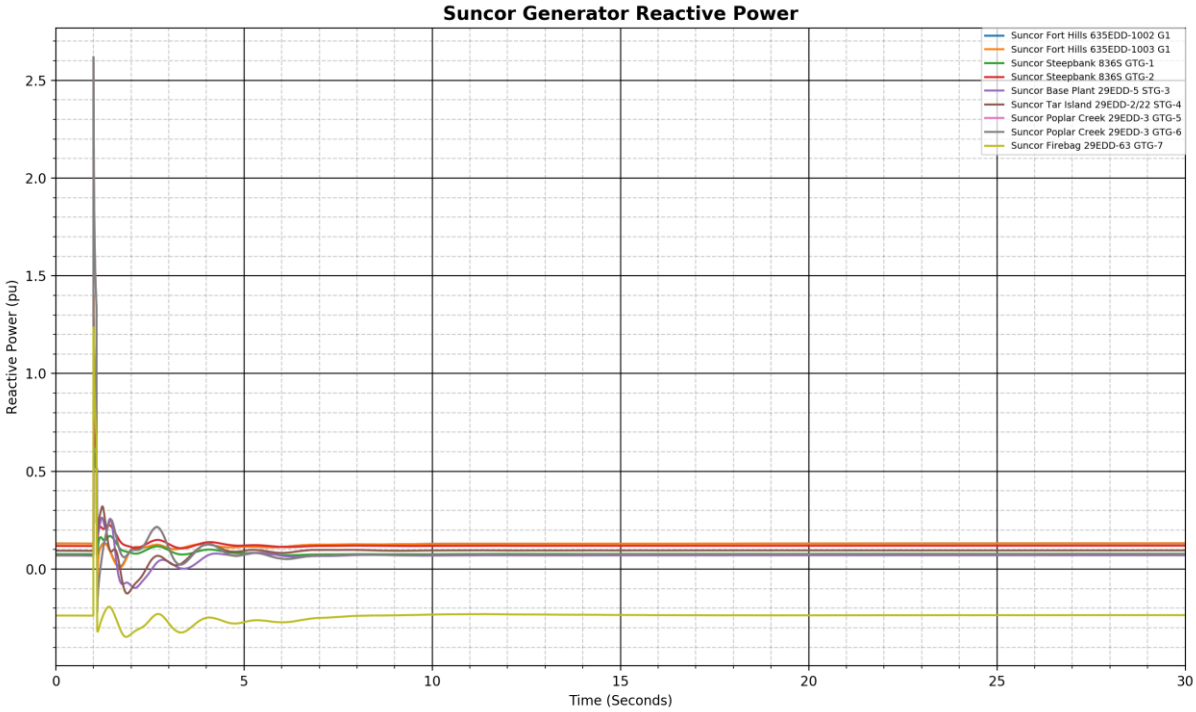

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

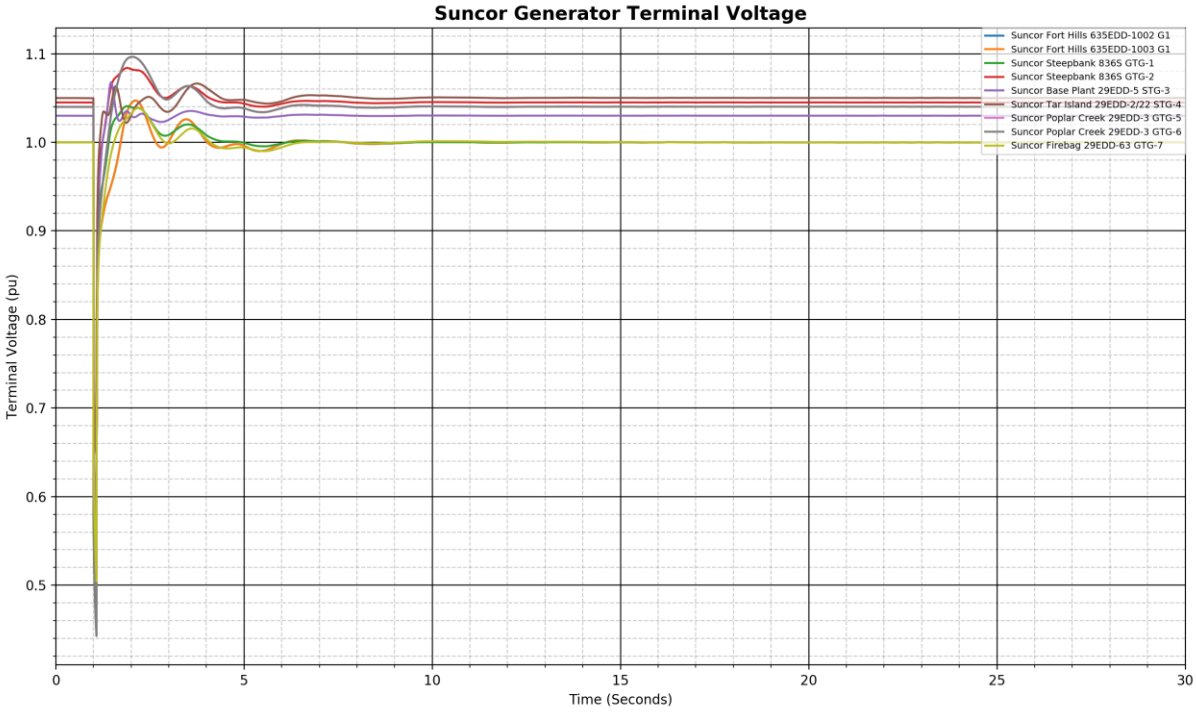

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

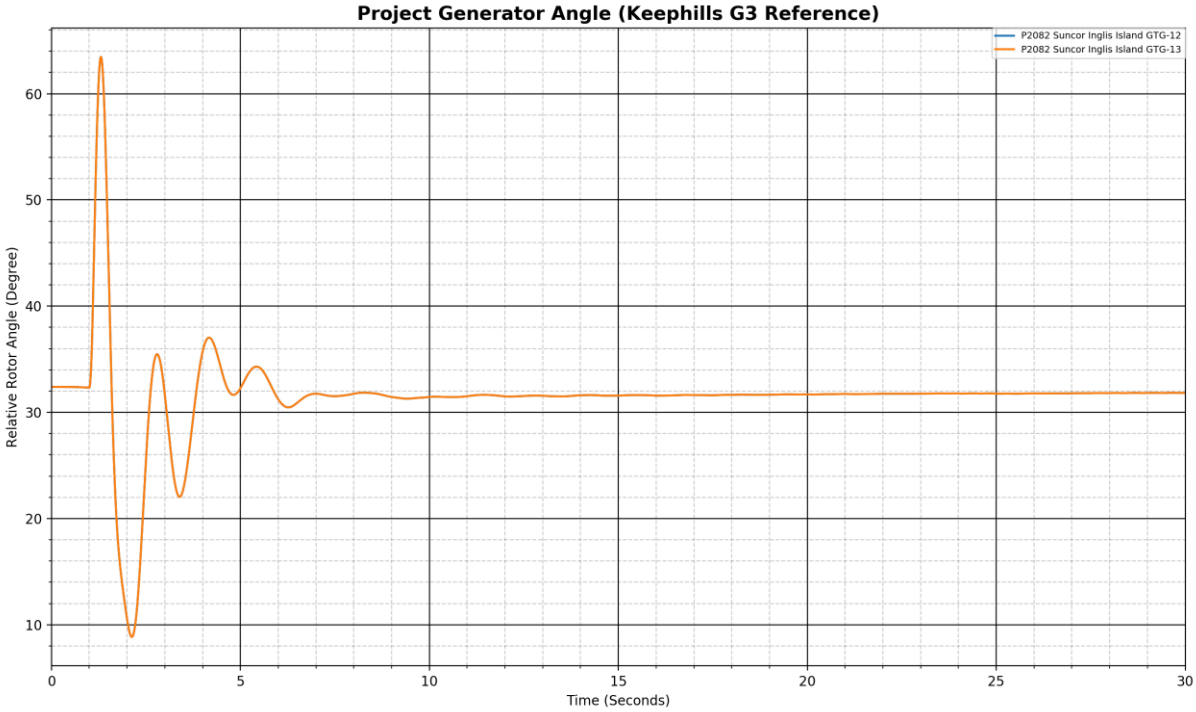

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

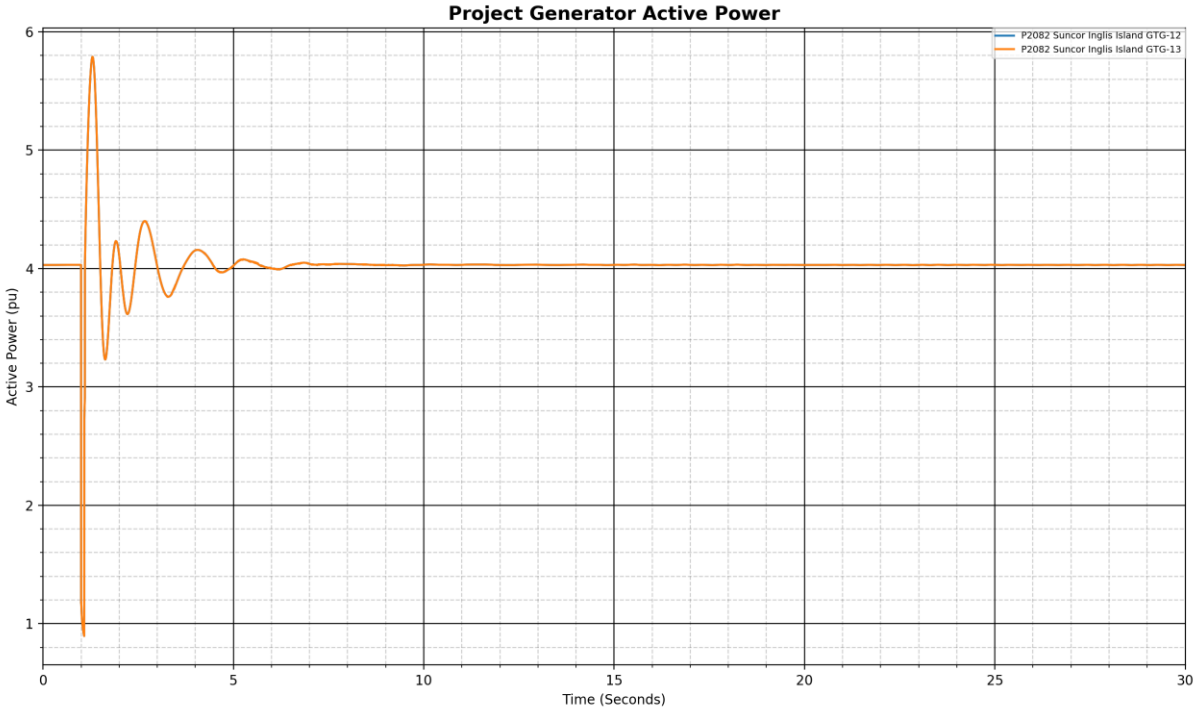

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

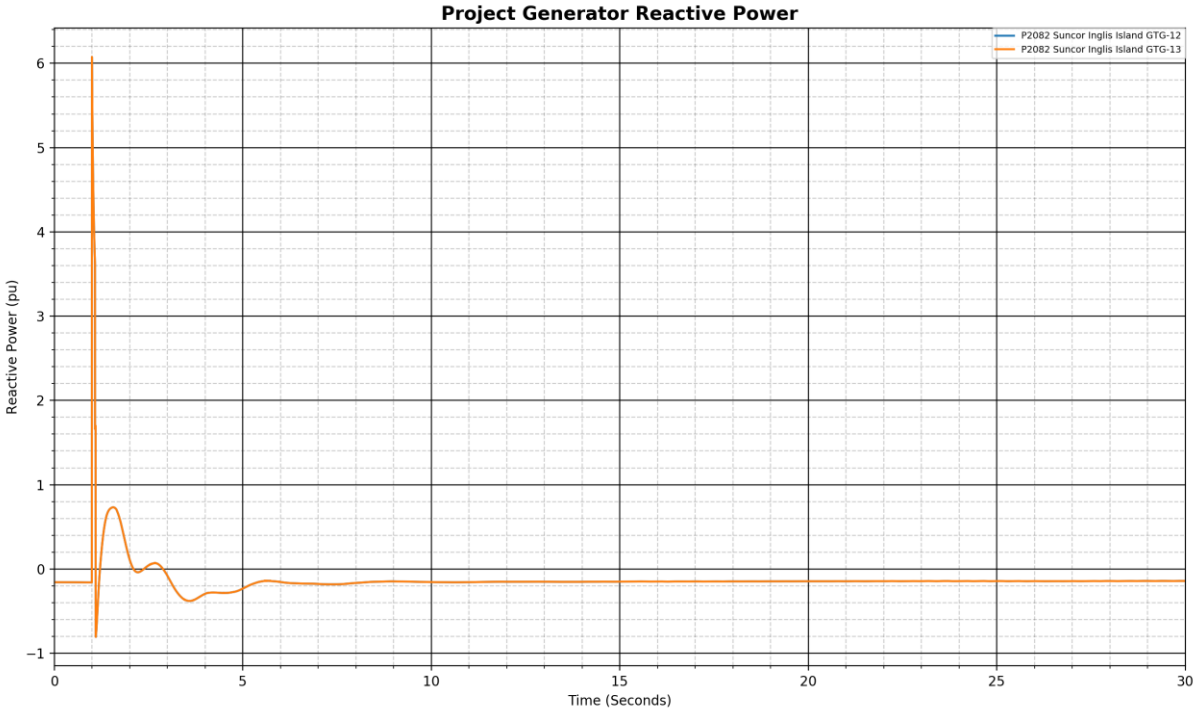

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

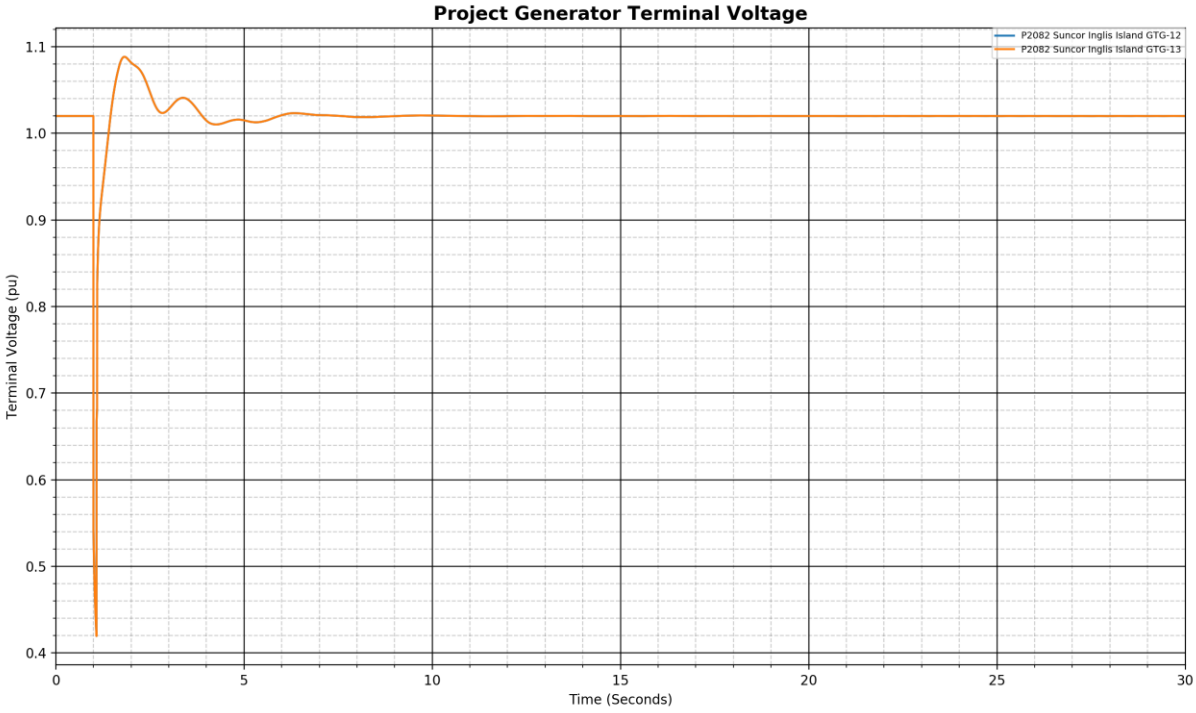

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

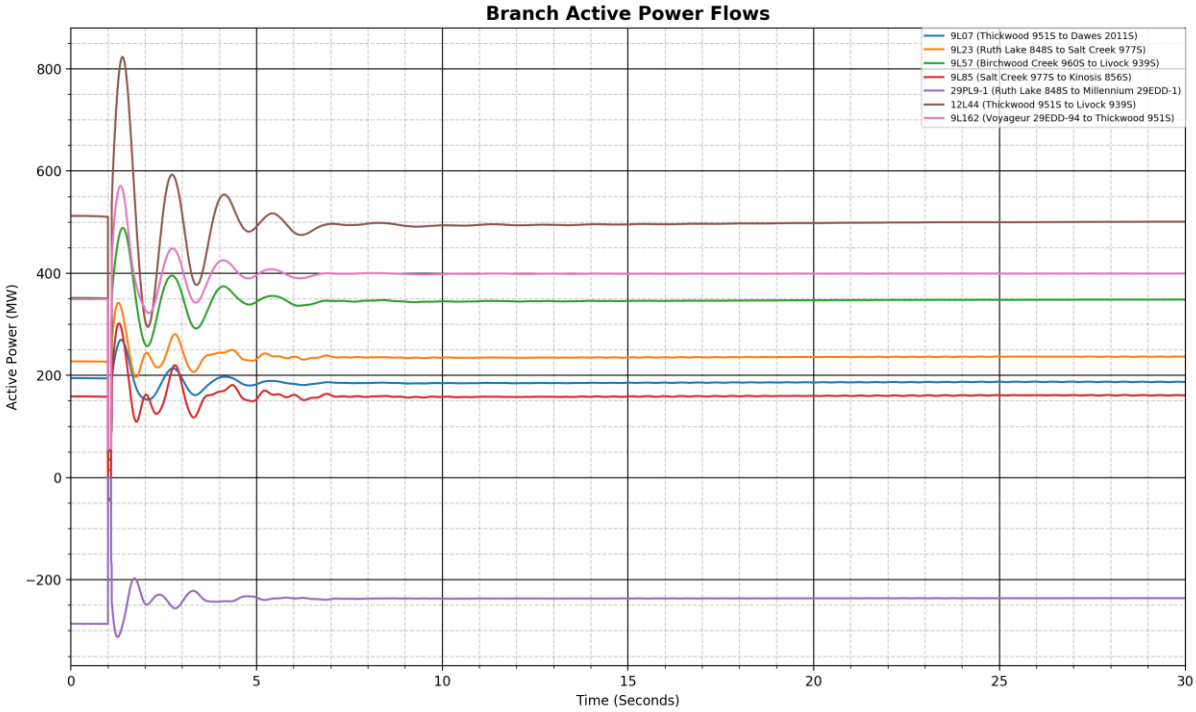

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)


Branch Active Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

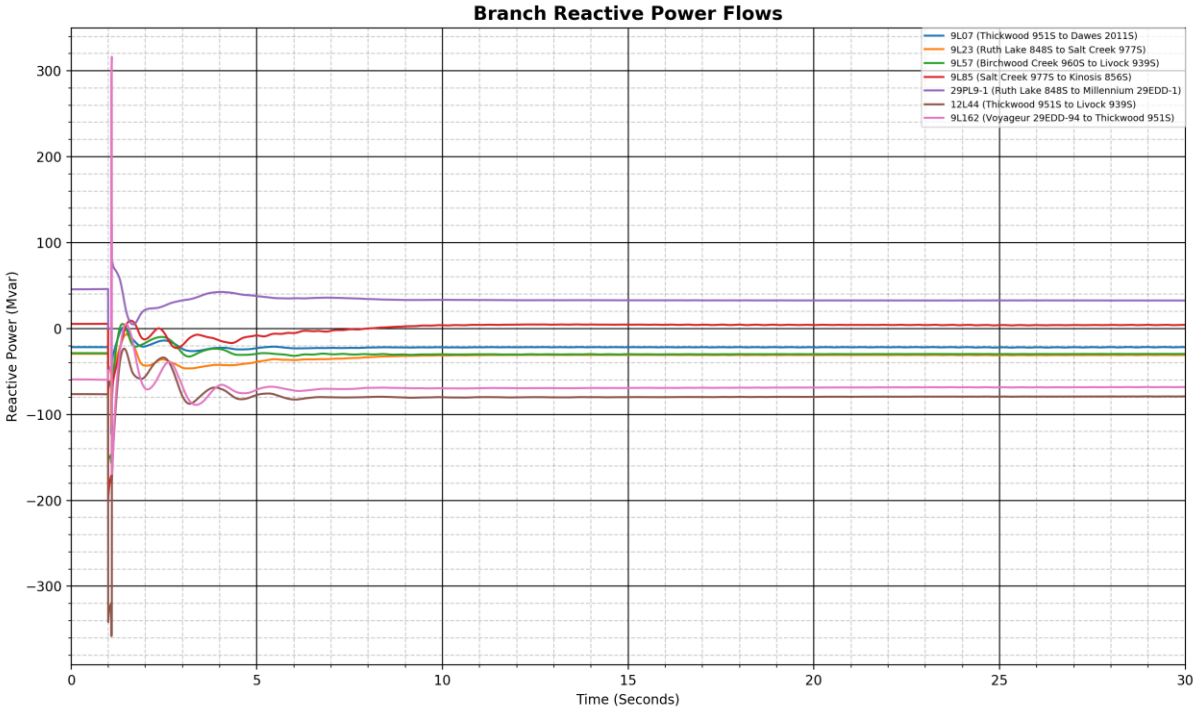
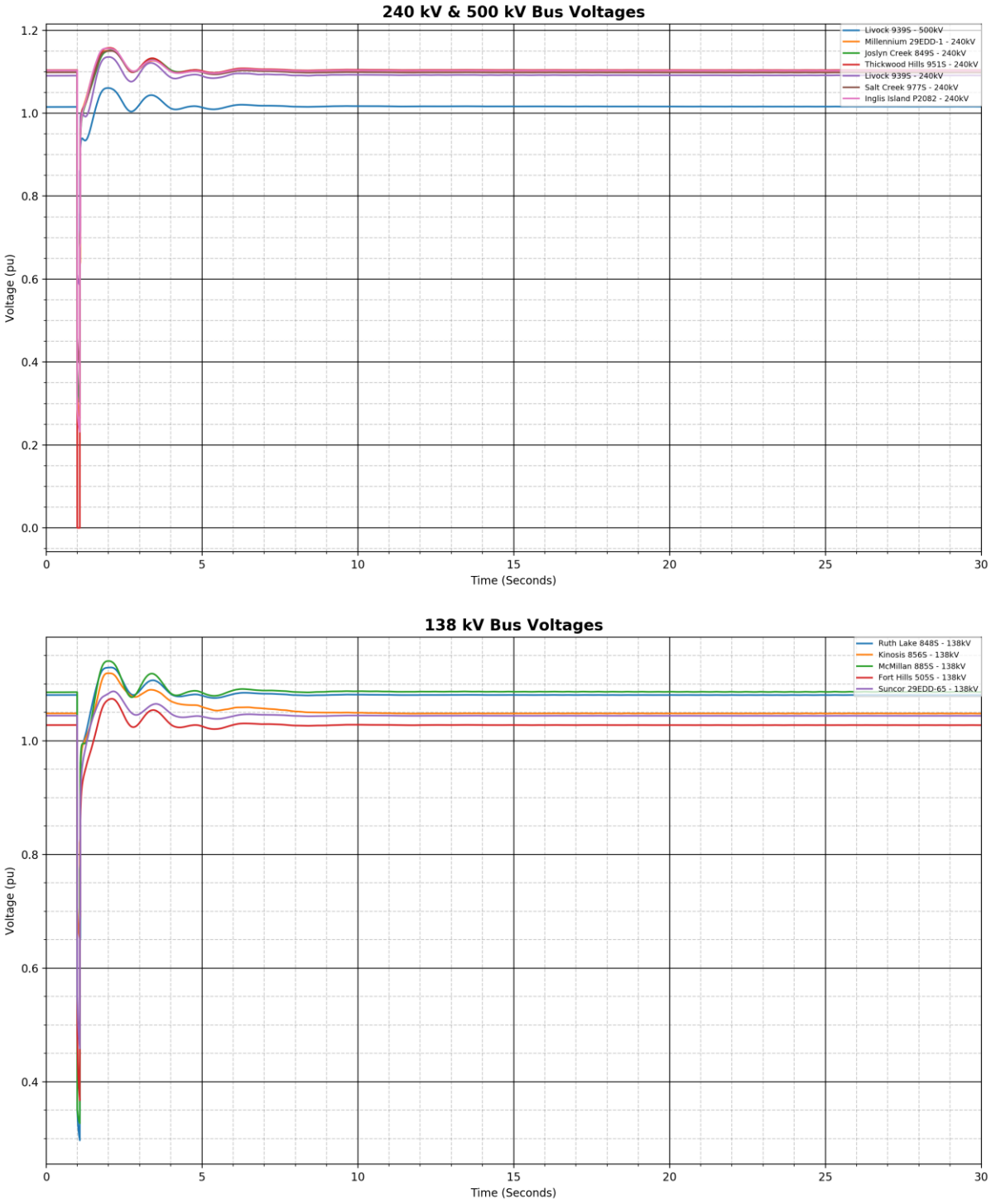
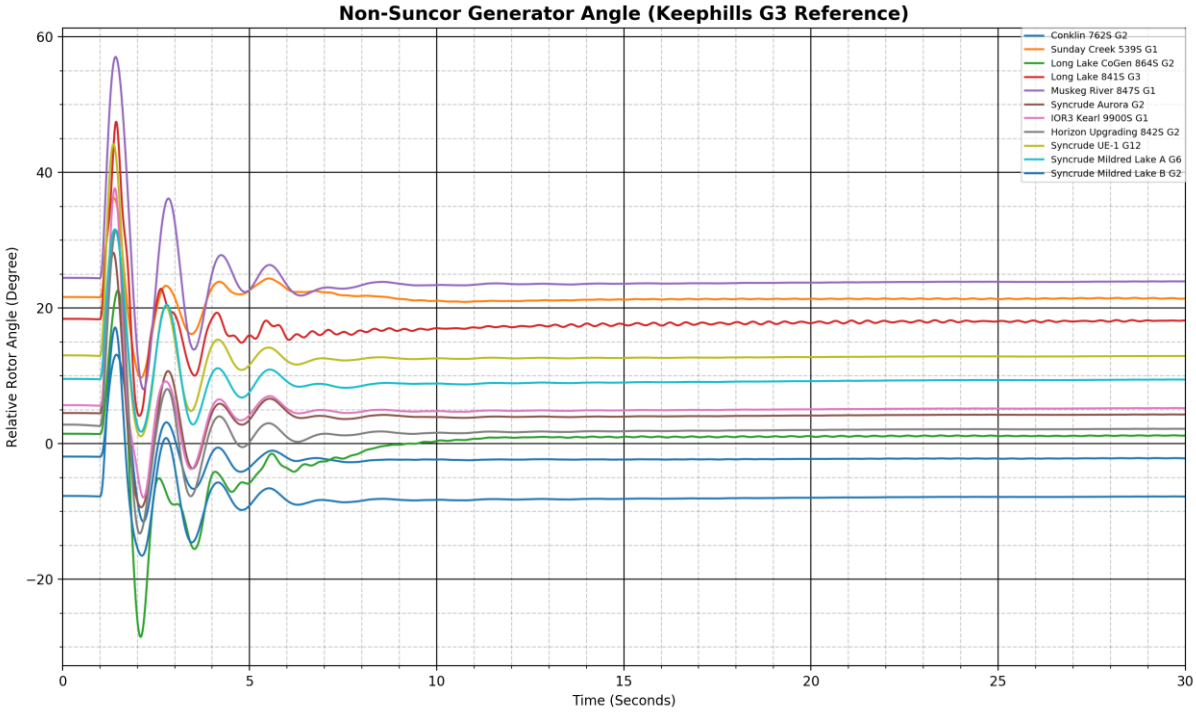
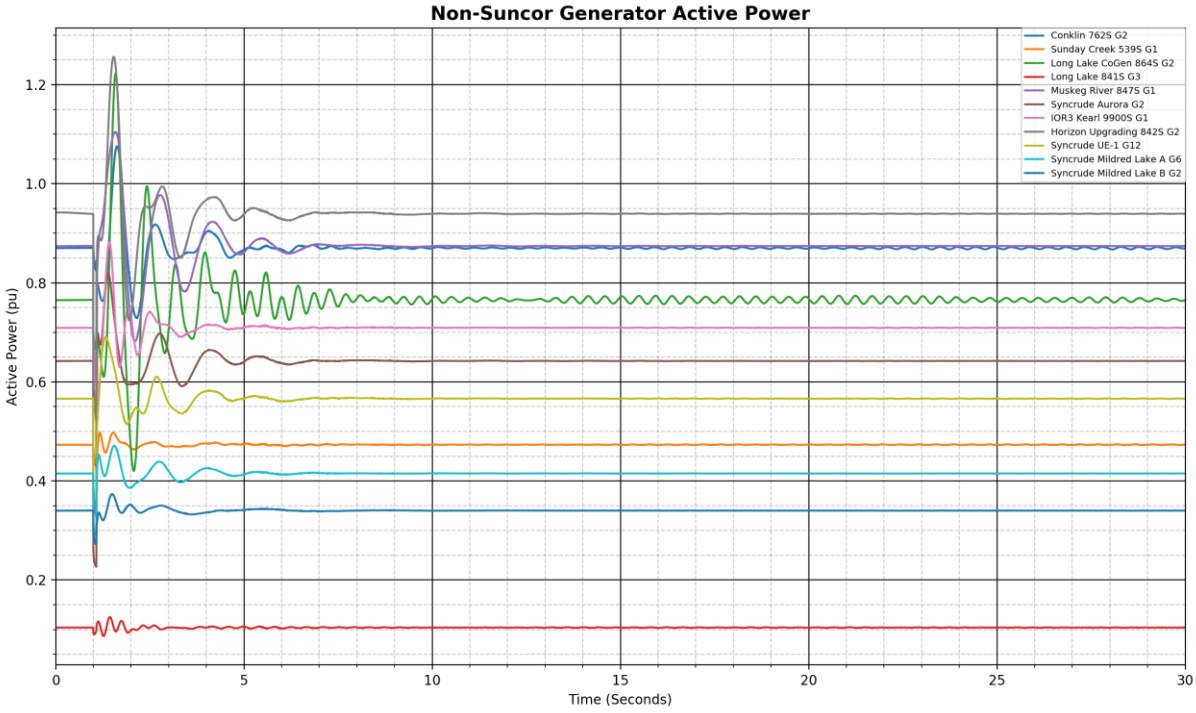
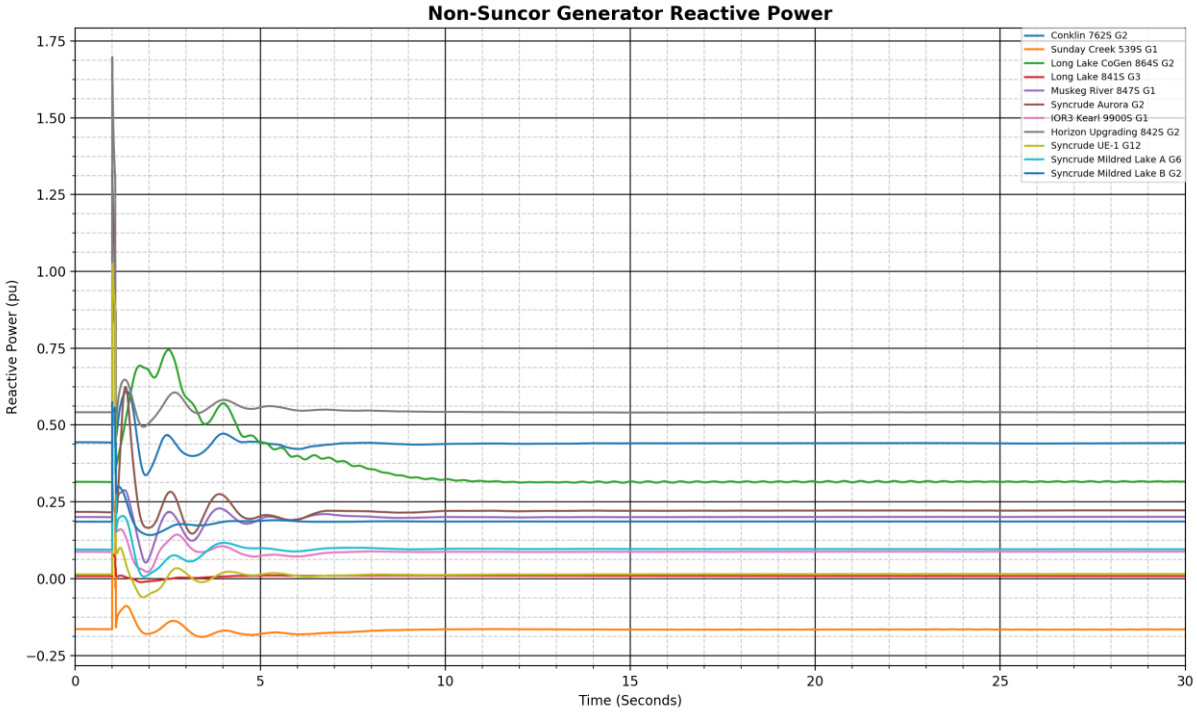

Branch Reactive Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

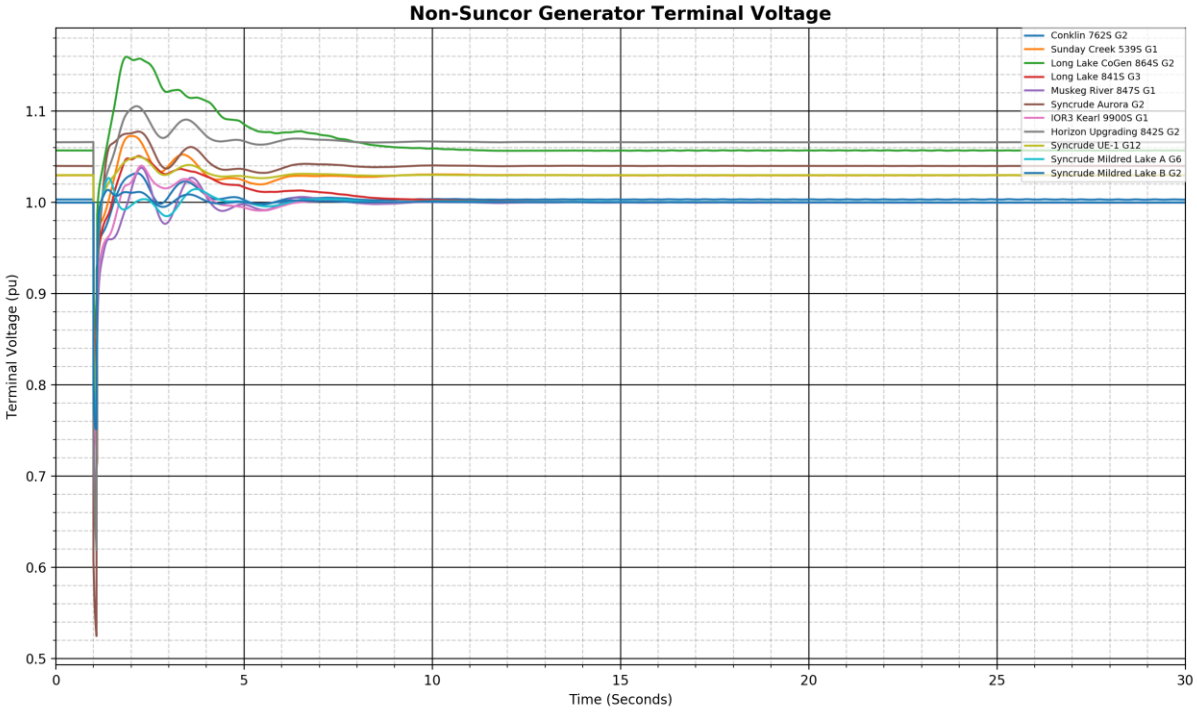
Figure A4-6: 9L01 (Ruth Lake 848S to Thickwood Hills 951S): Fault at Thickwood Hills 951S

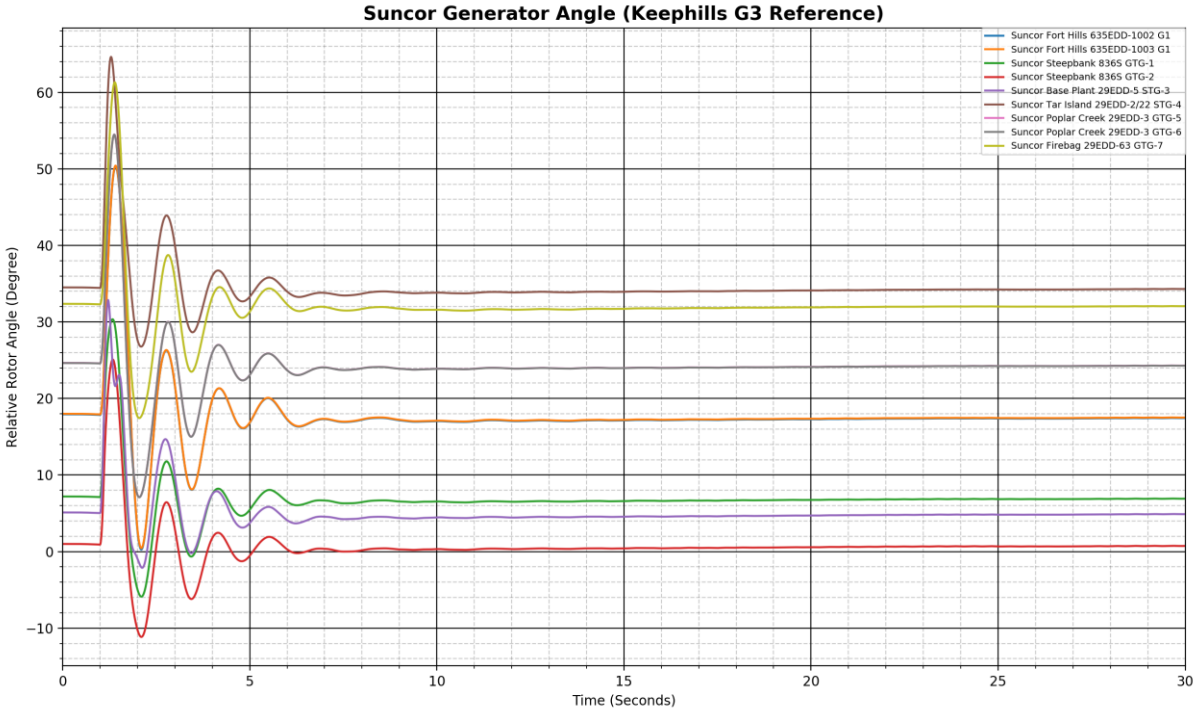


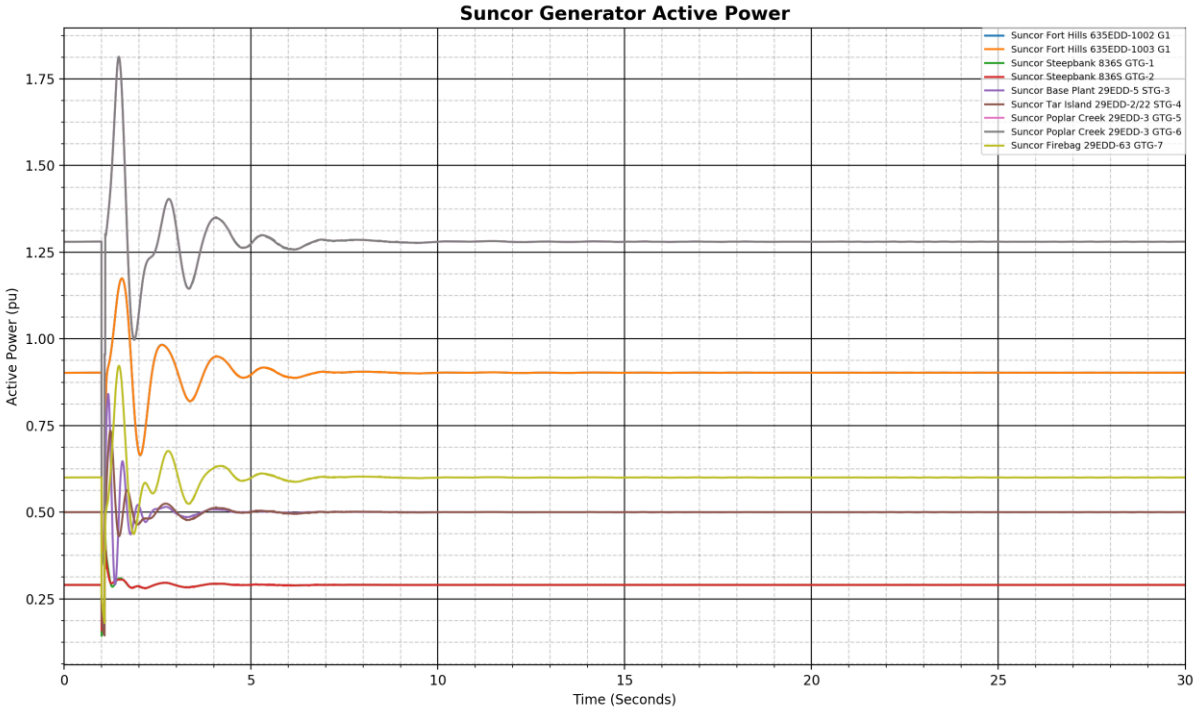

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

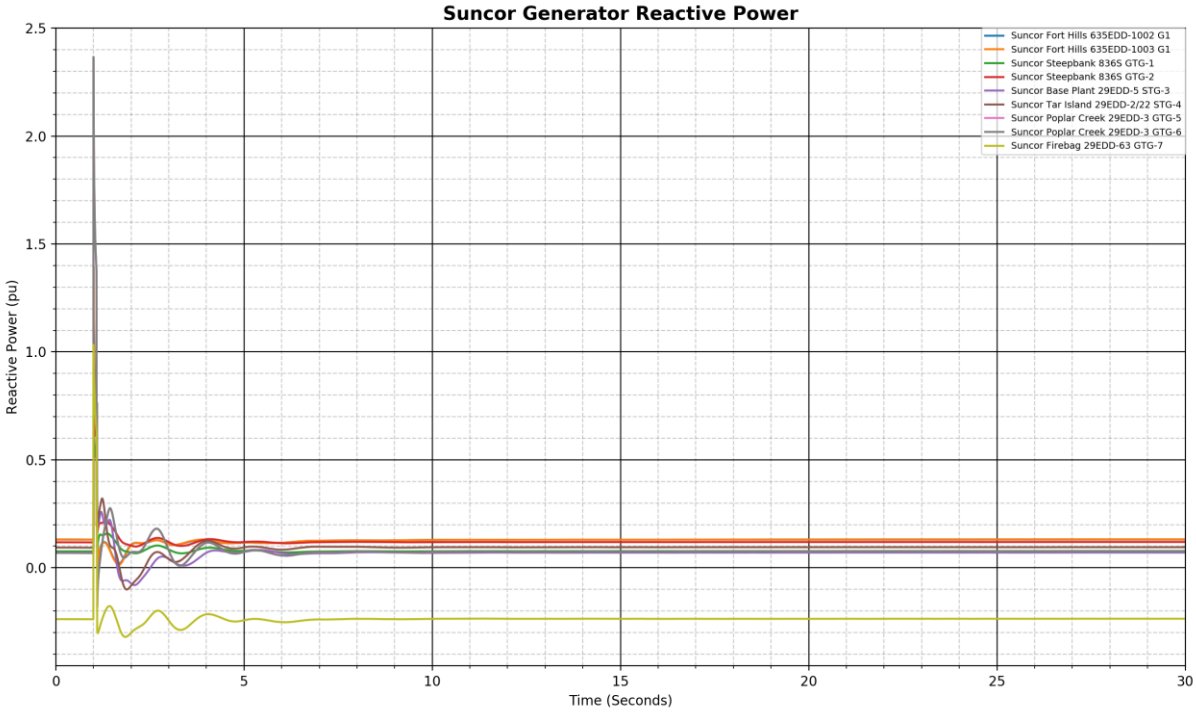

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

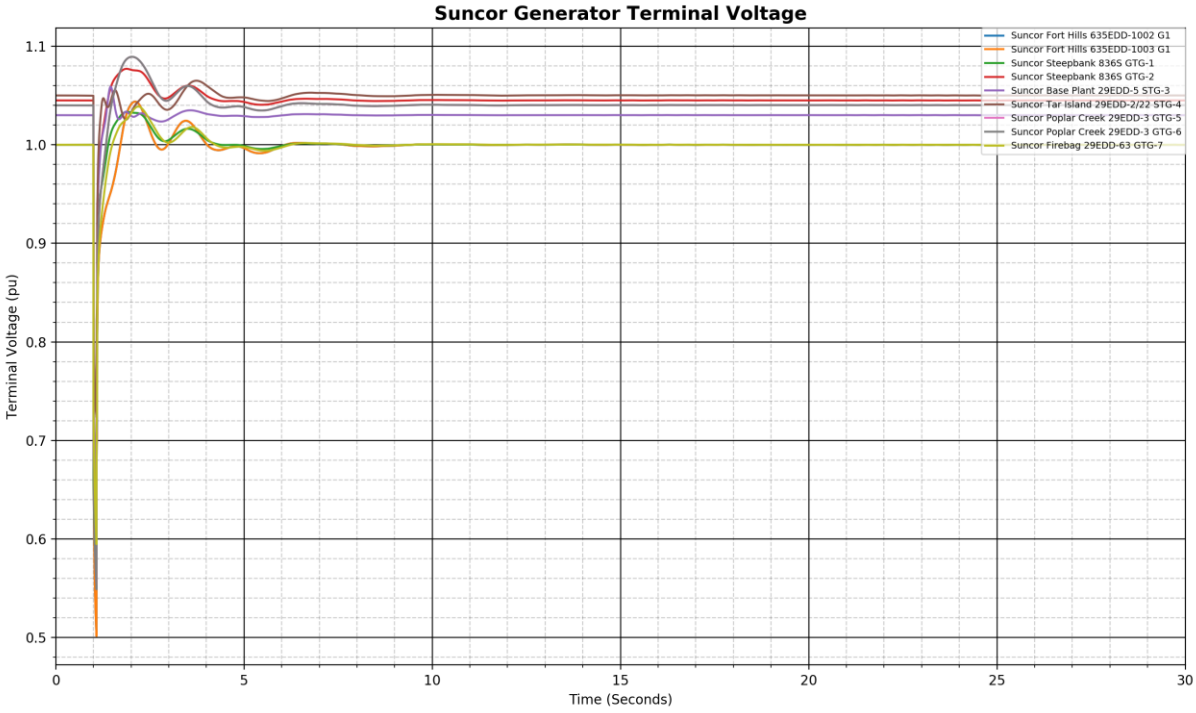

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

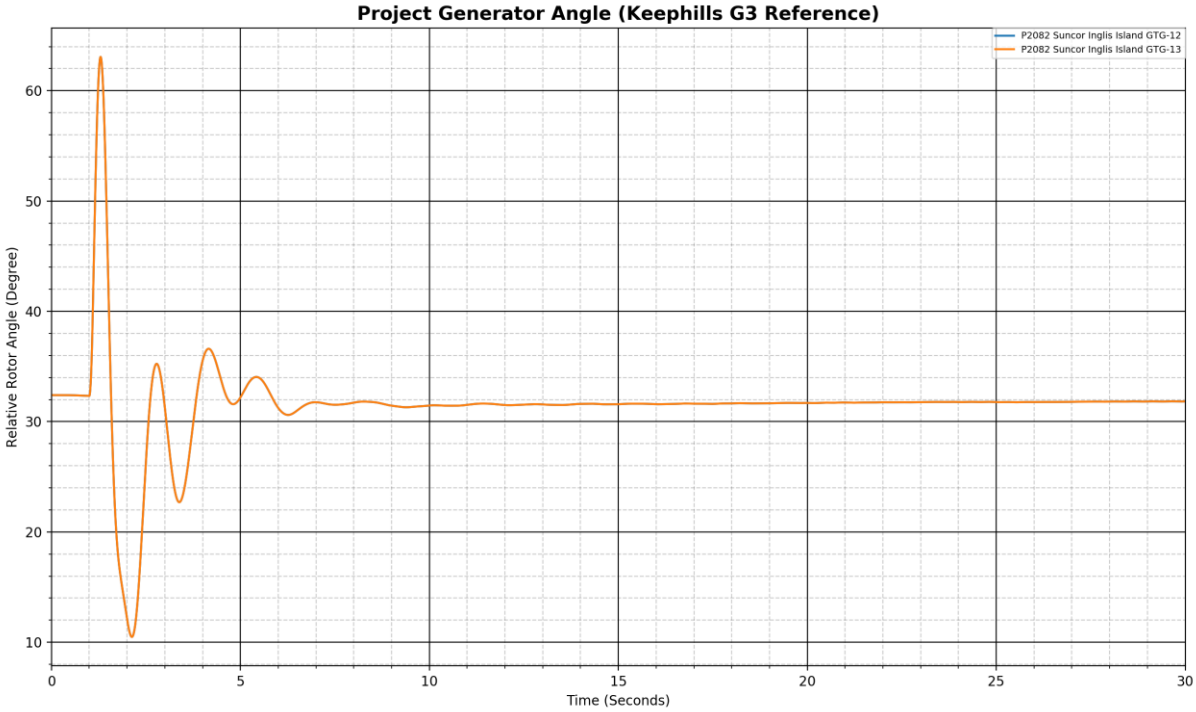

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

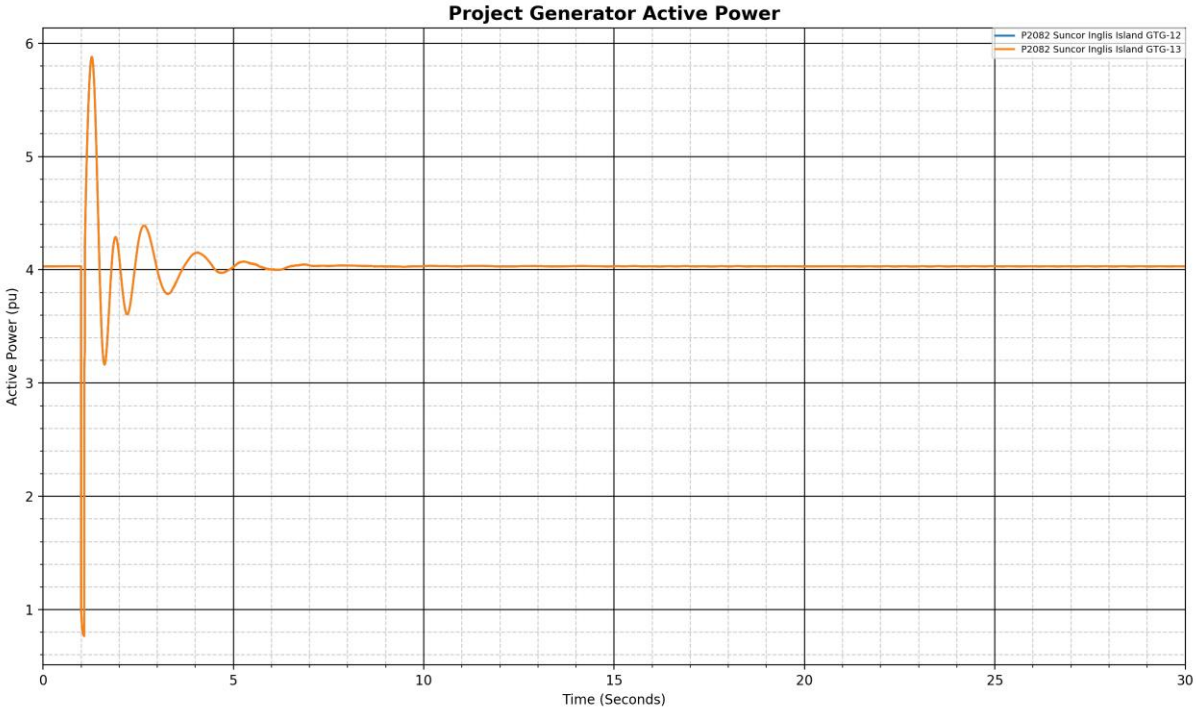

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

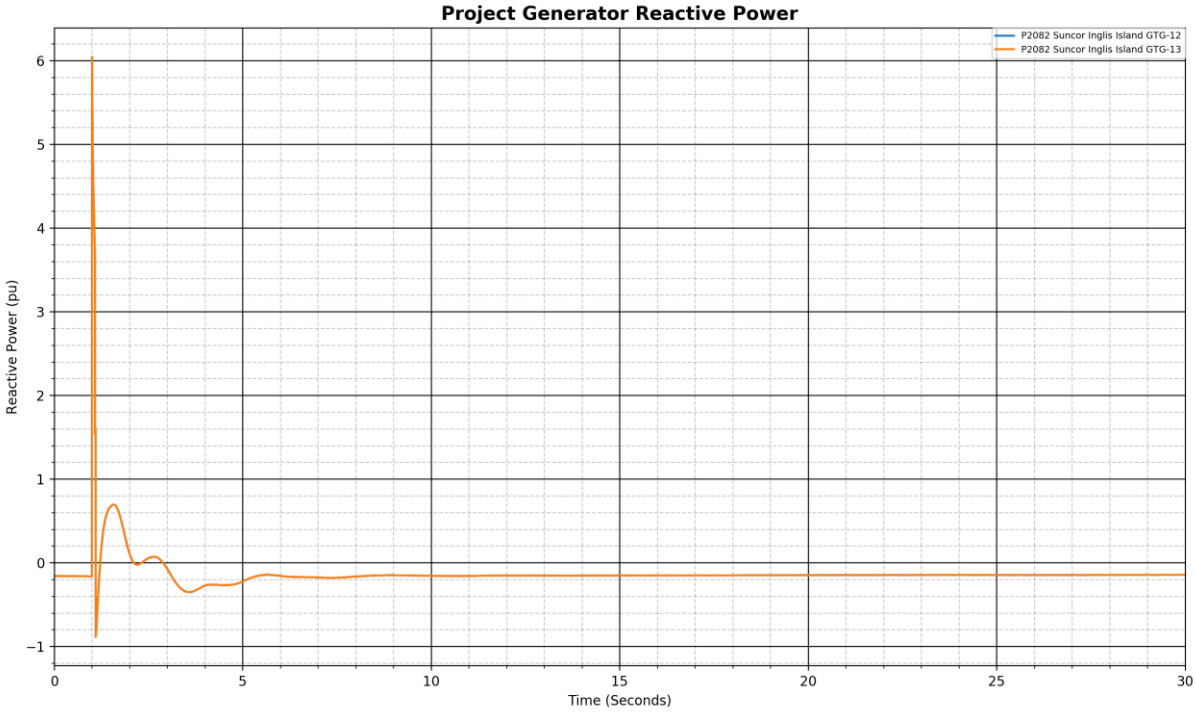

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

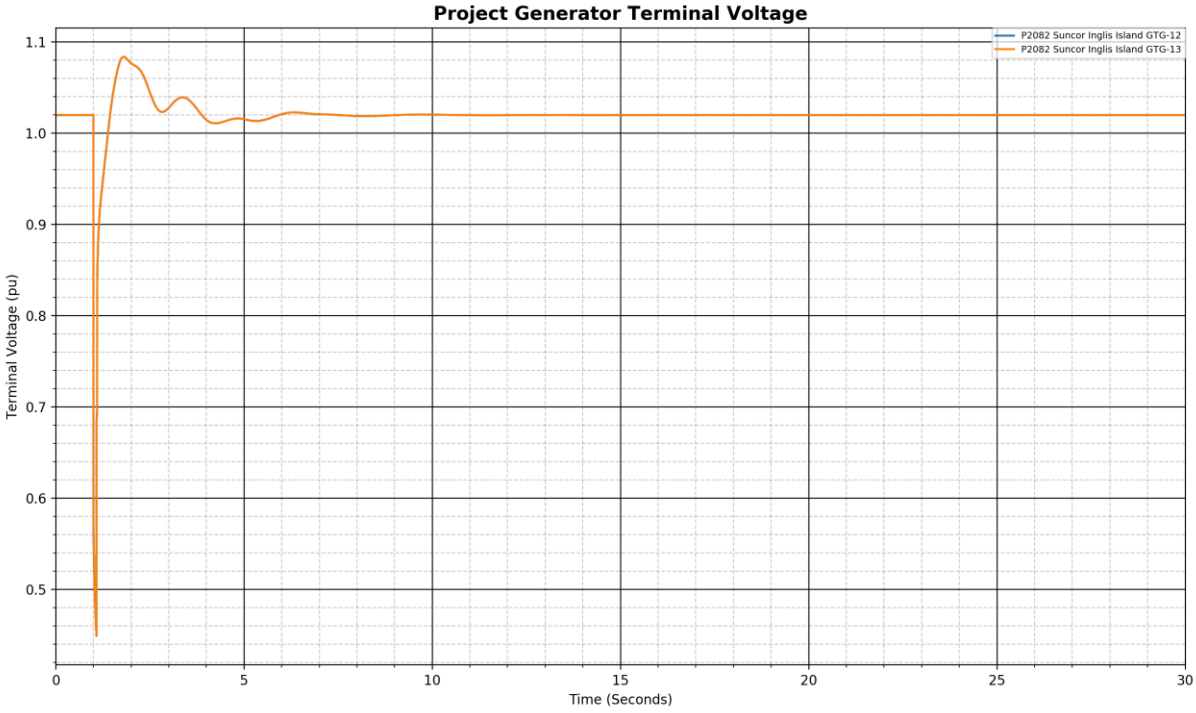

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

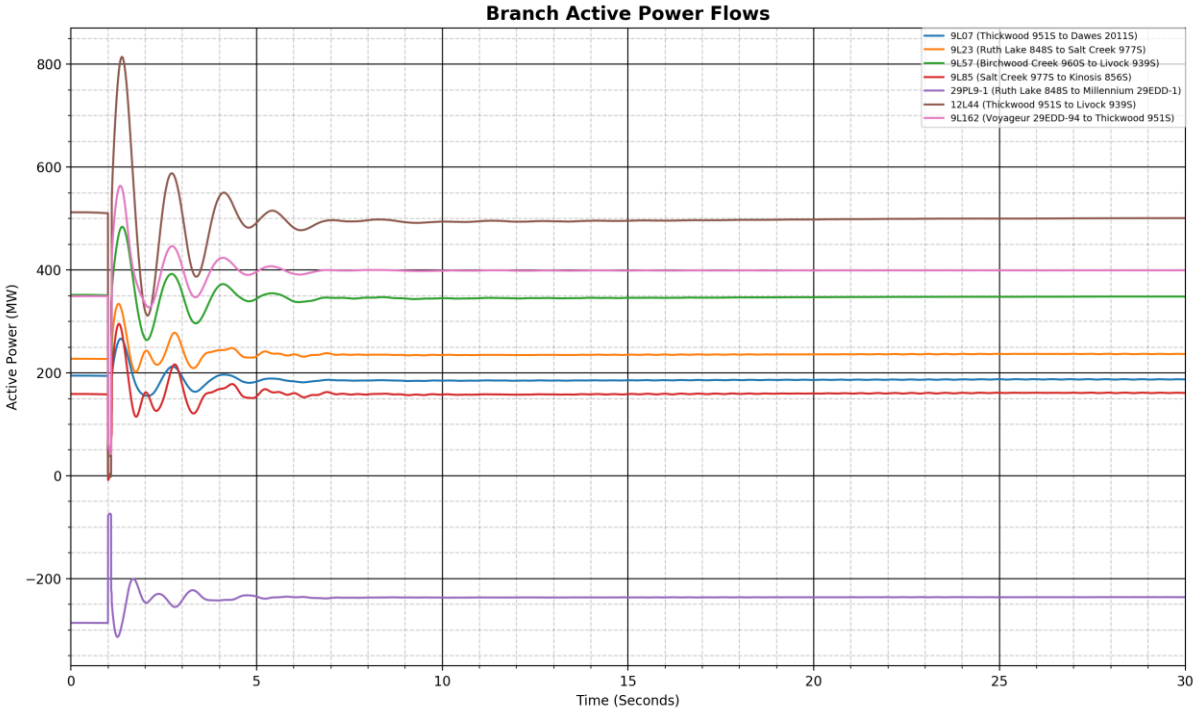

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
10
20
30
40
50
60
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
1
2
3
4
5
6
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)


Branch Active Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

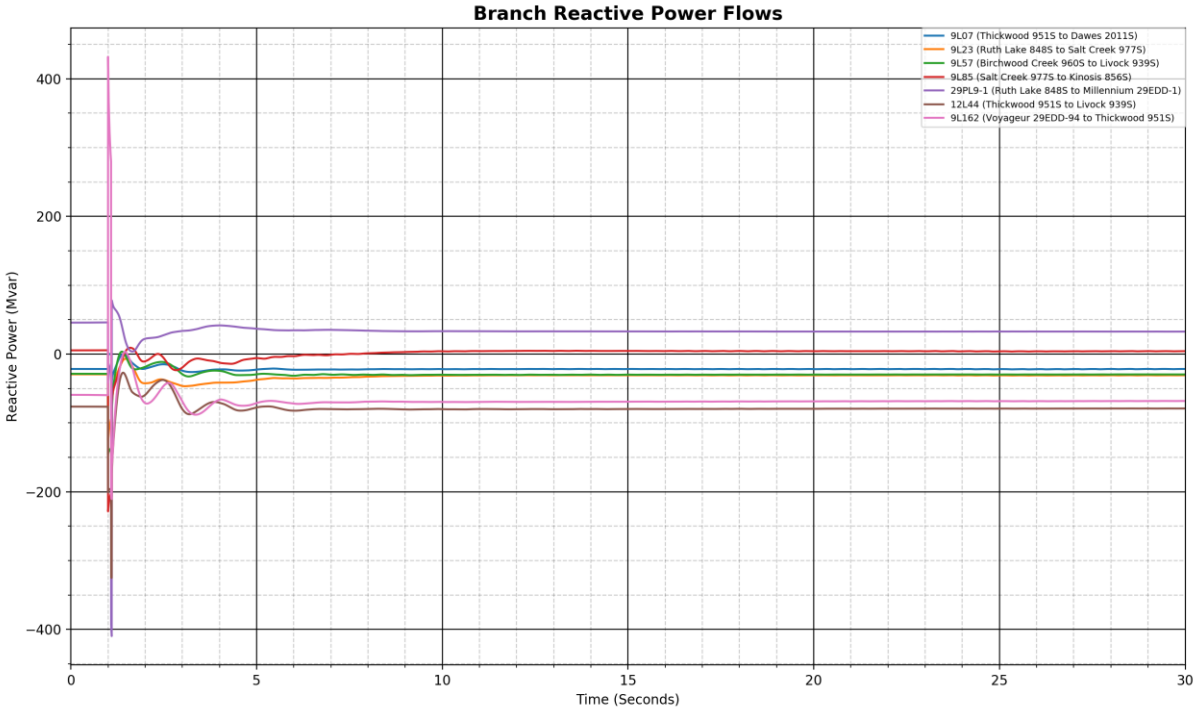
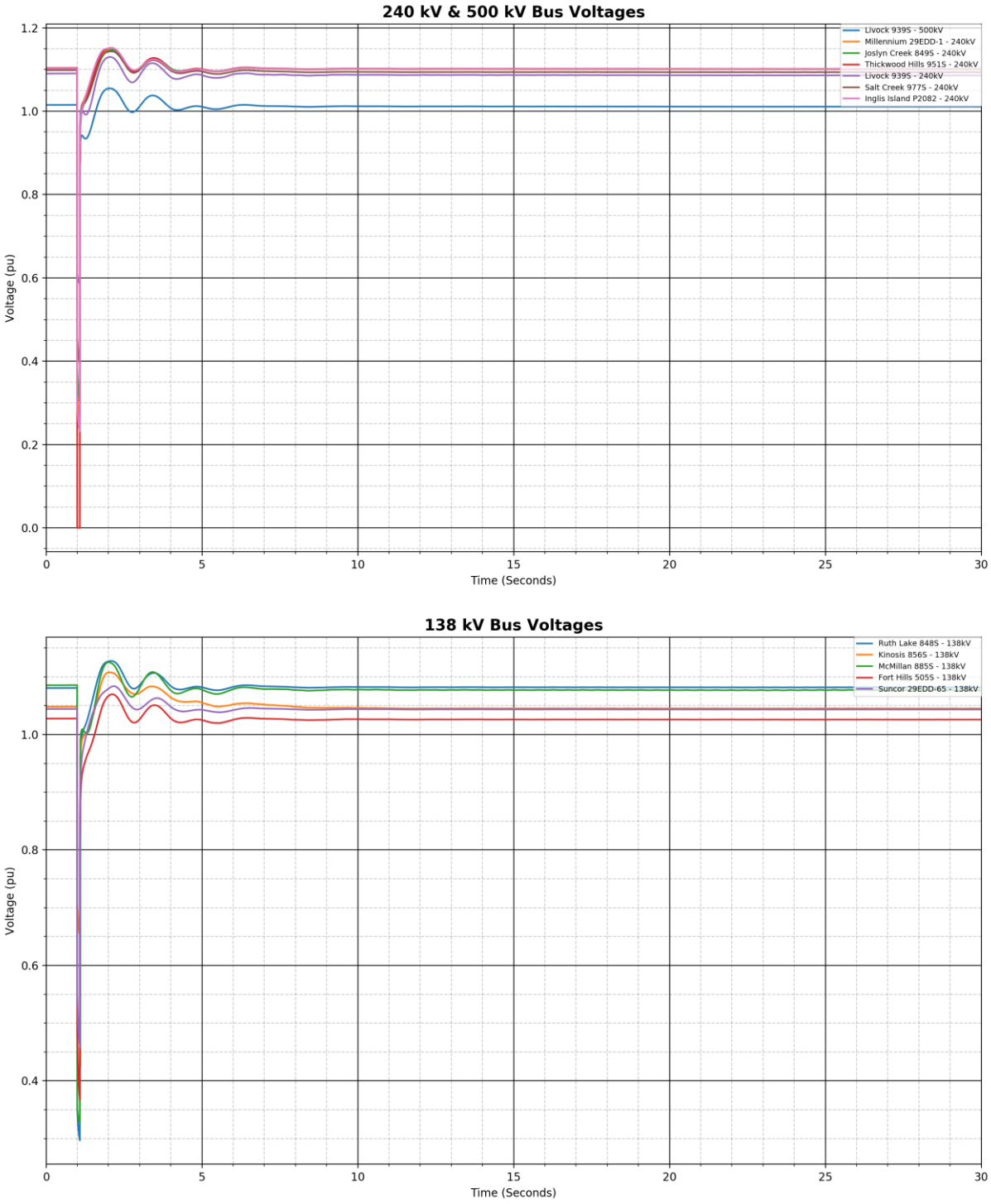
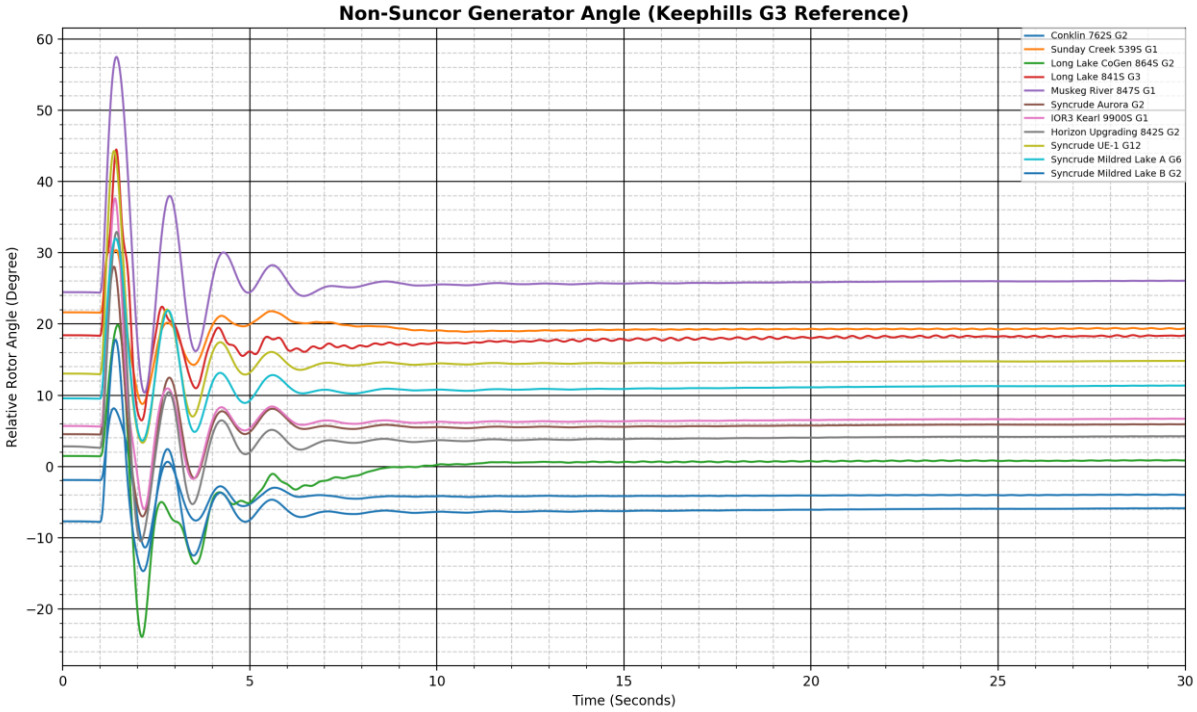
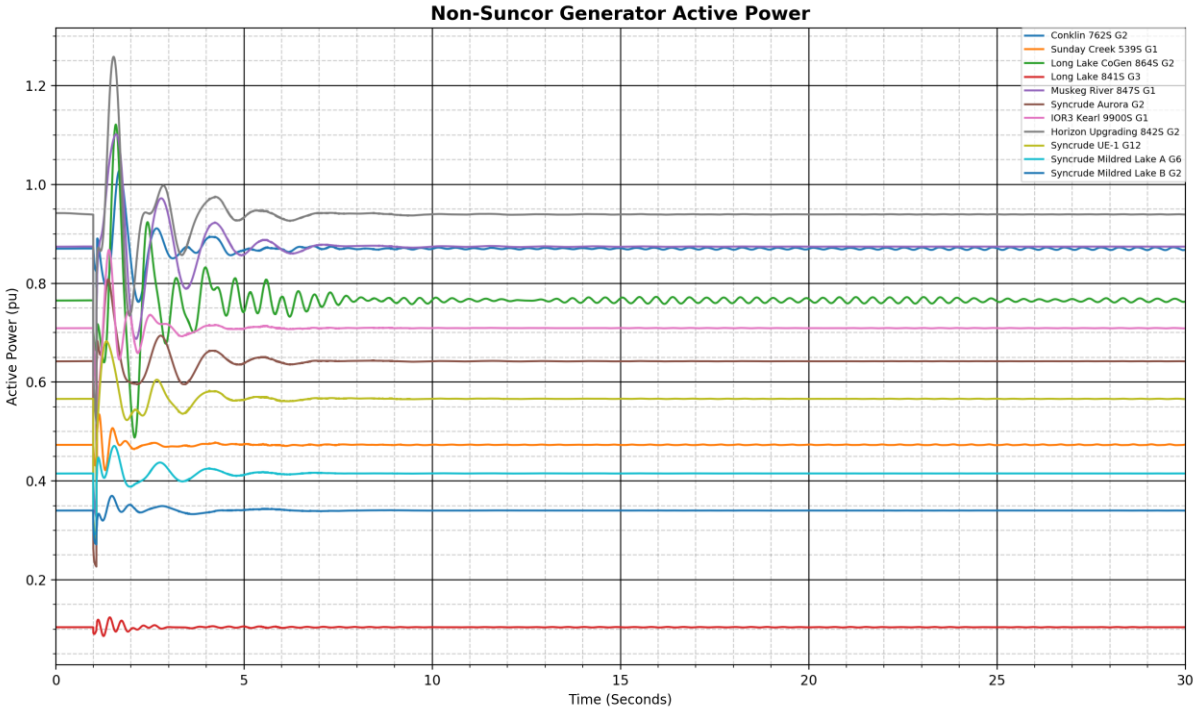
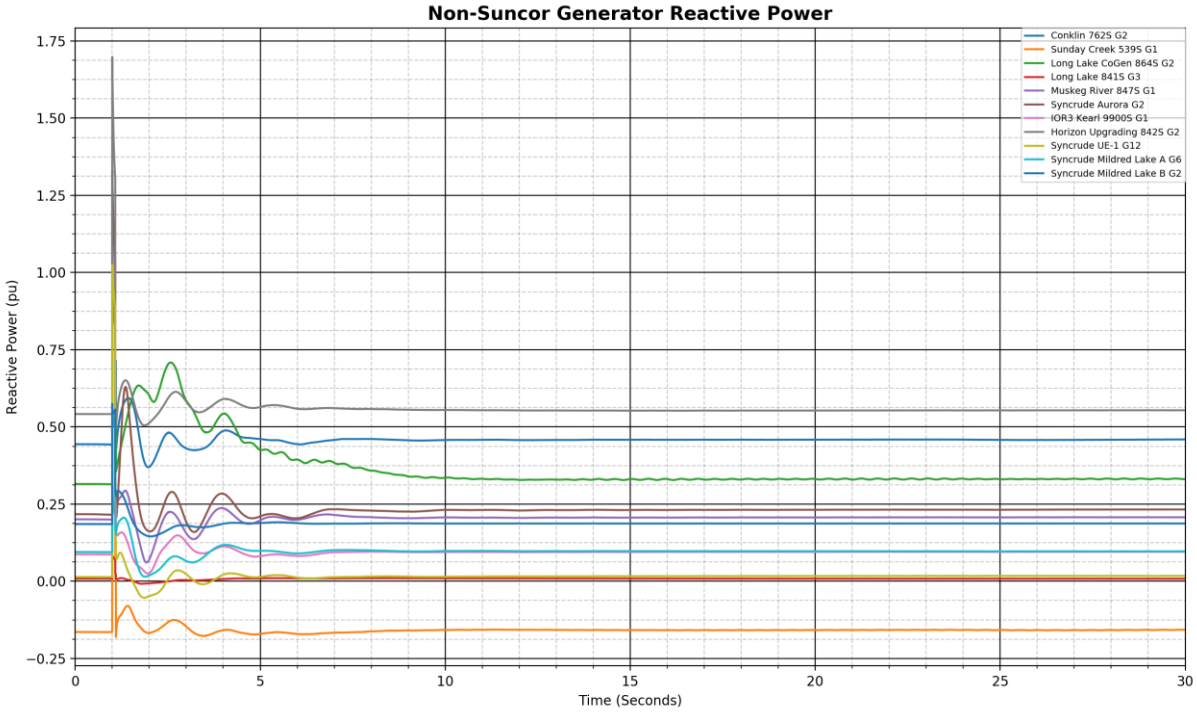

Branch Reactive Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

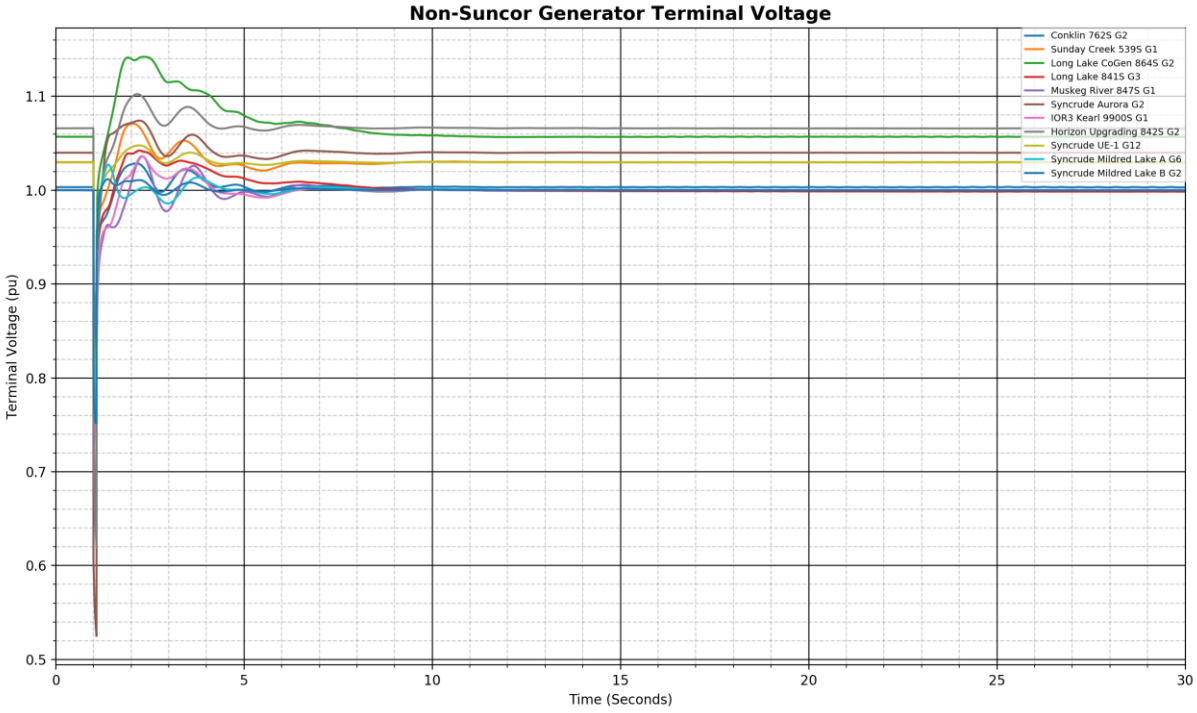
Figure A4-7: 9L07 (Thickwood Hills 951S to Dawes 2011S): Fault at Thickwood Hills 951S

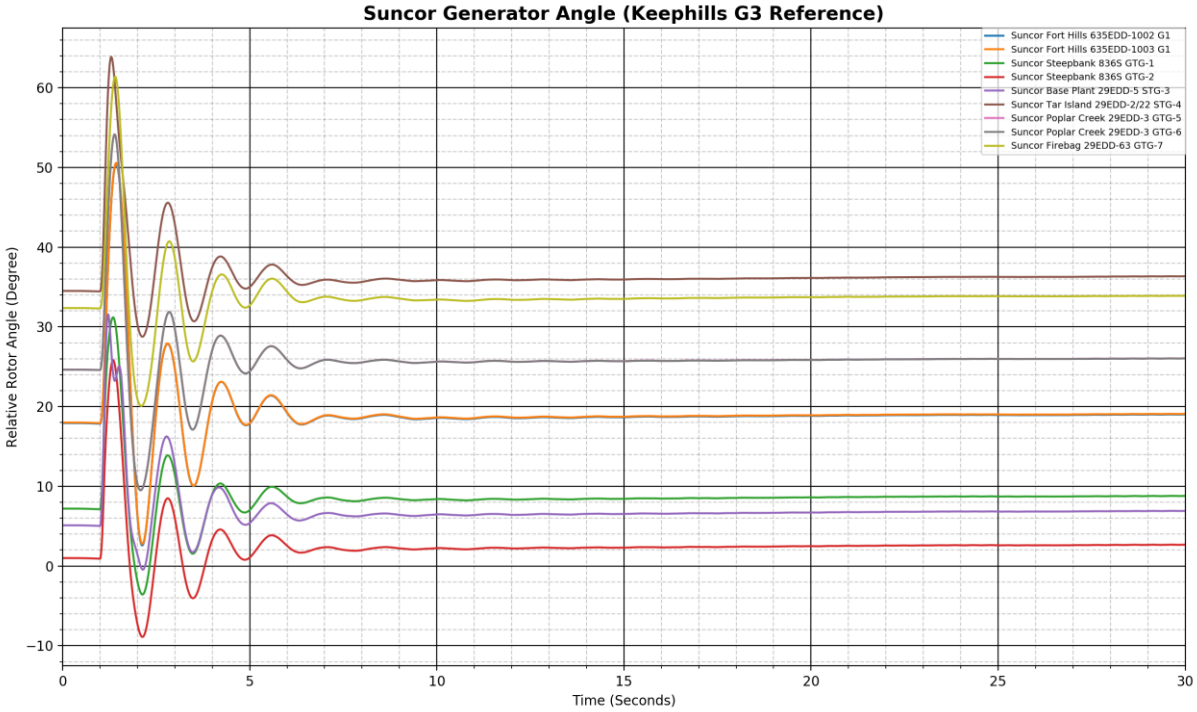


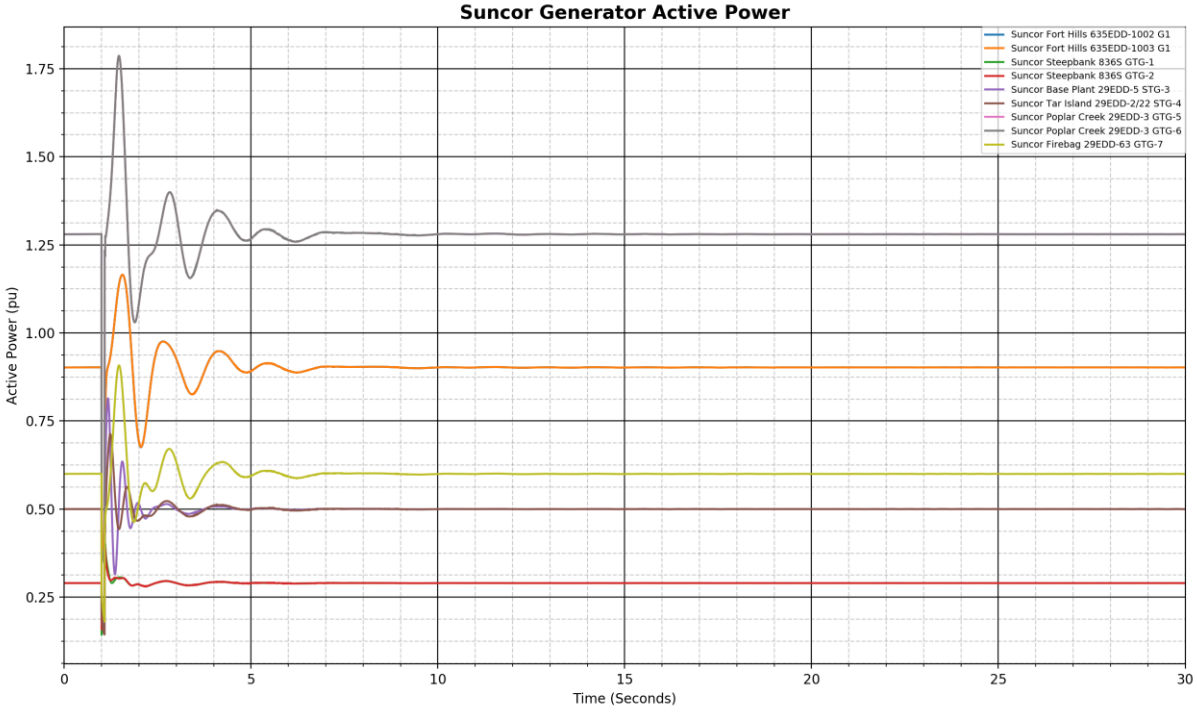

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

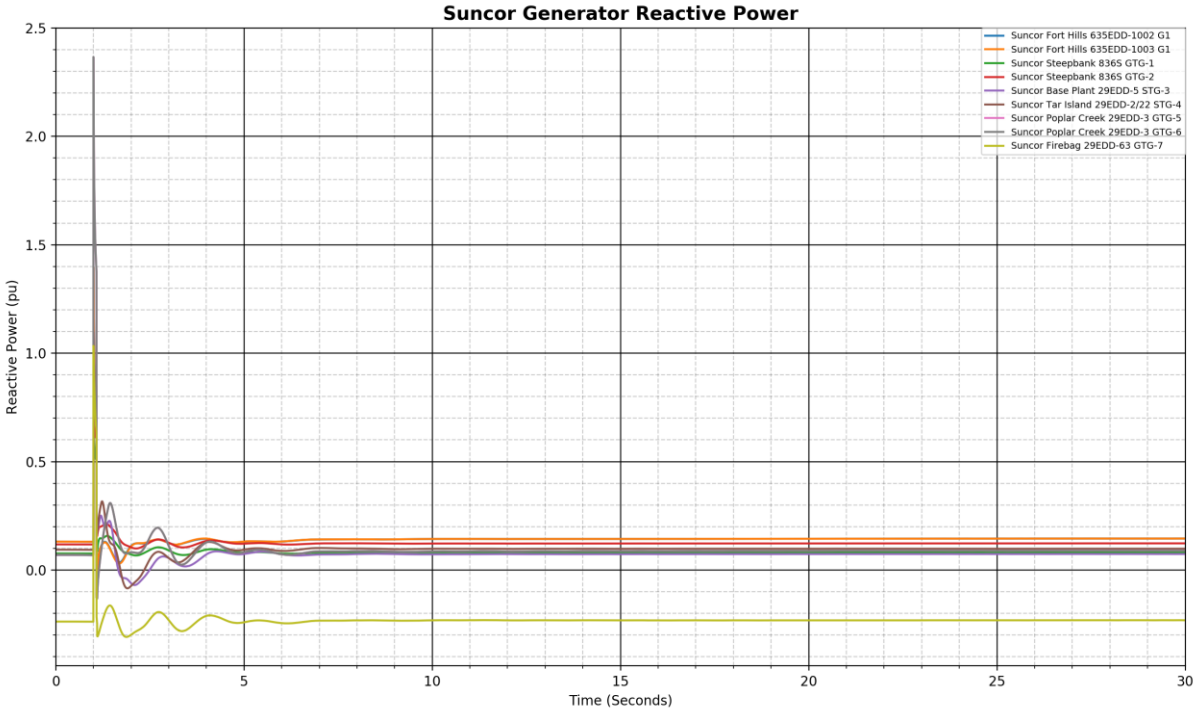

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

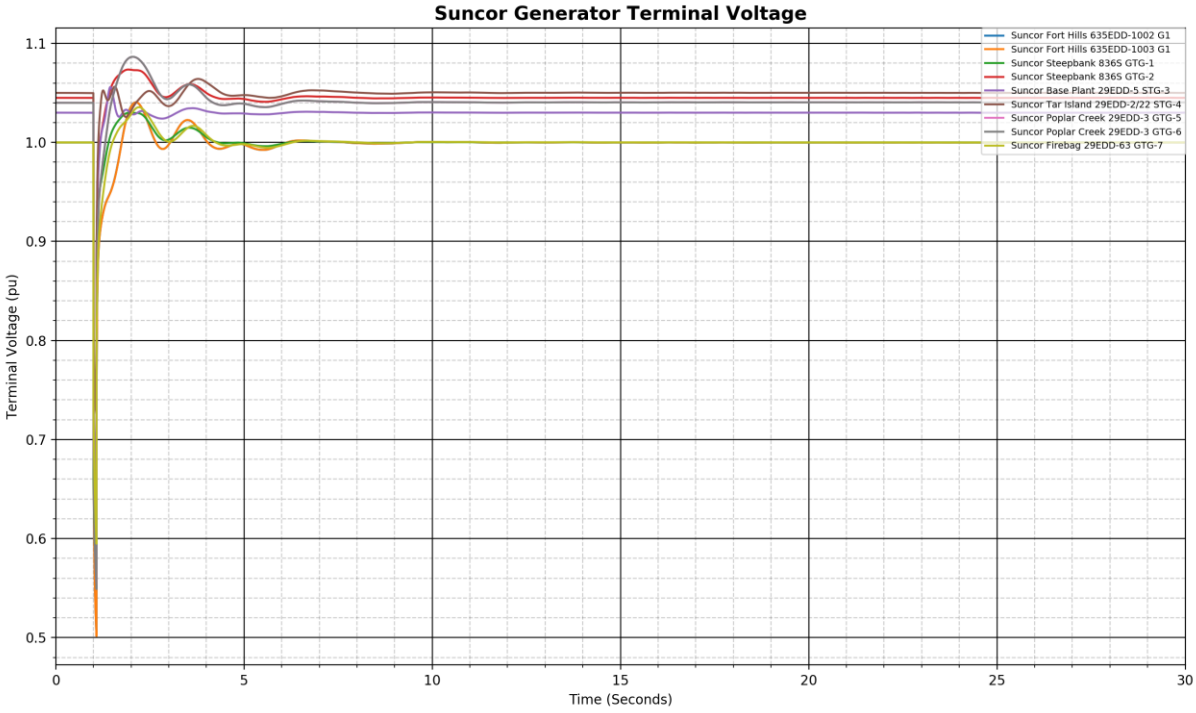

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

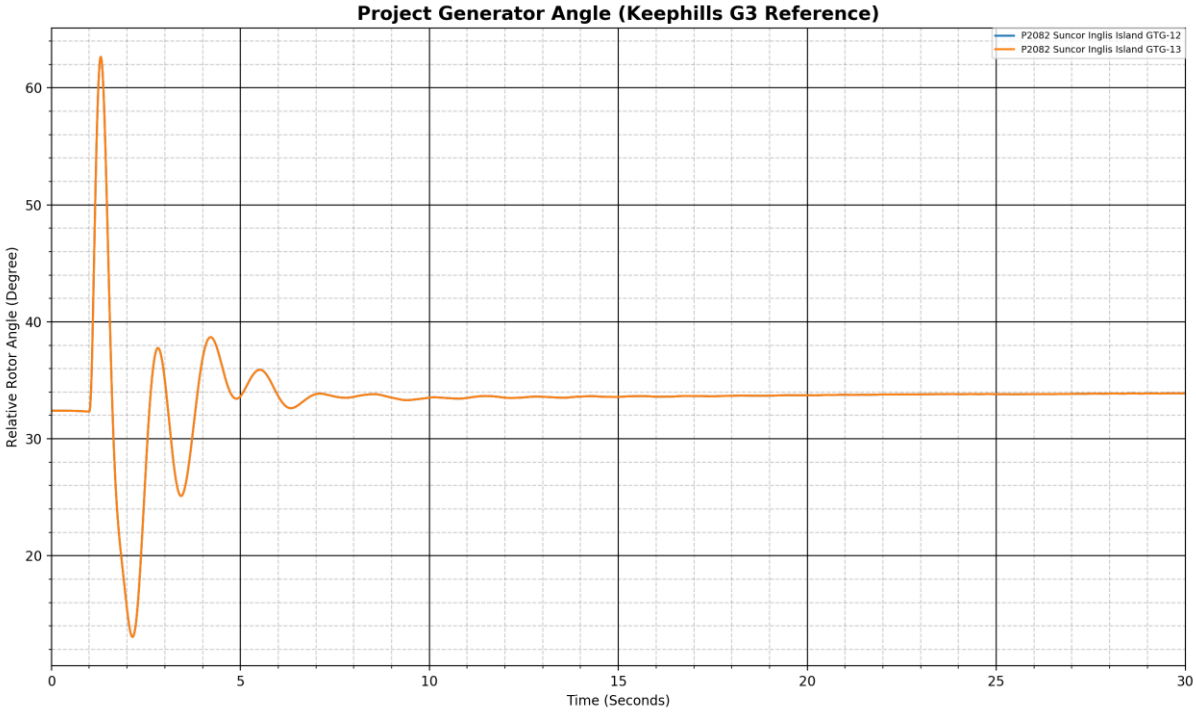

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

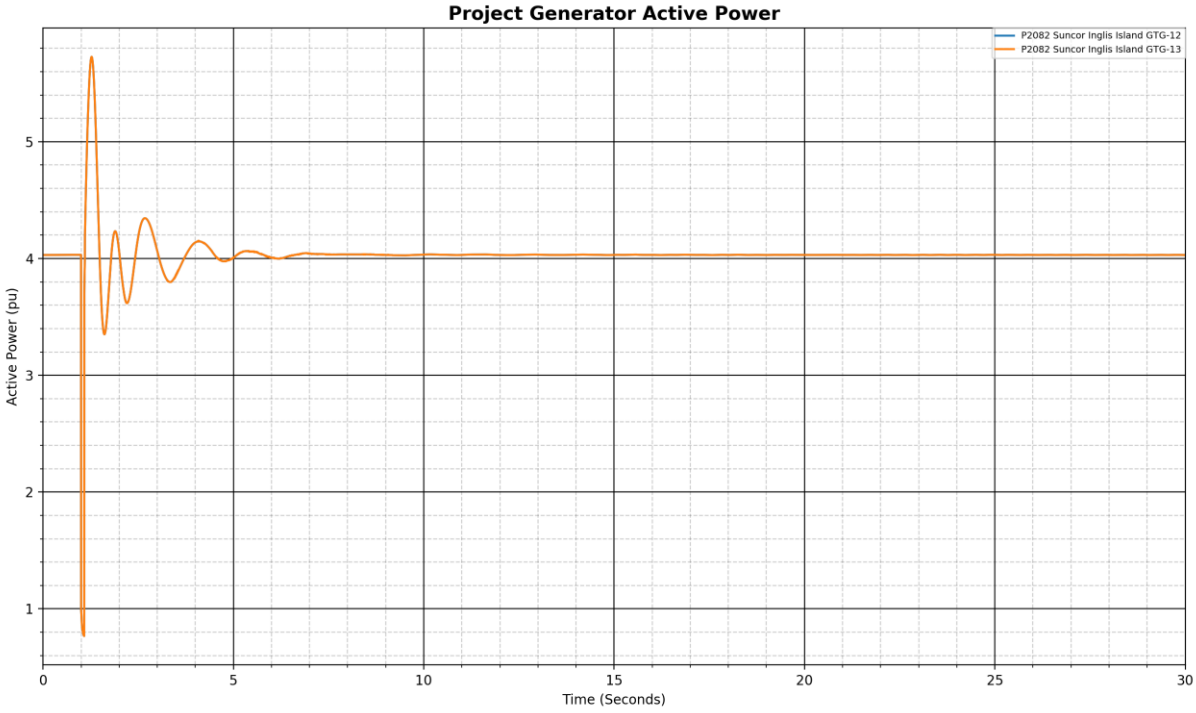

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

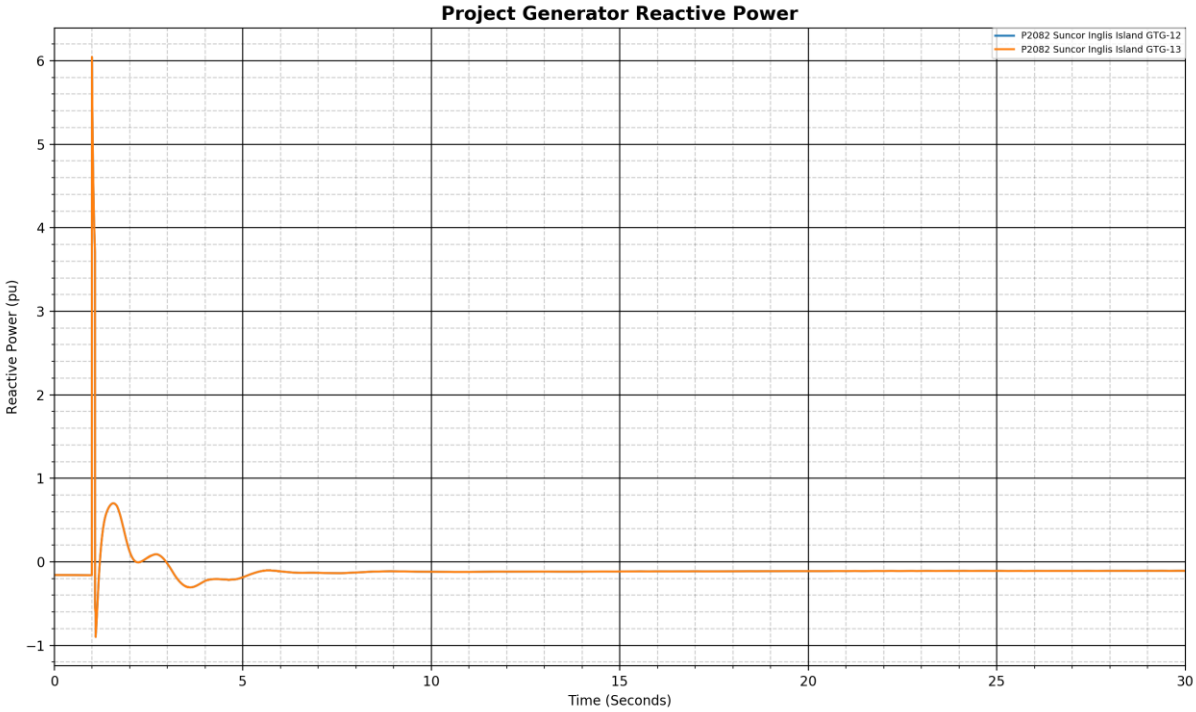

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

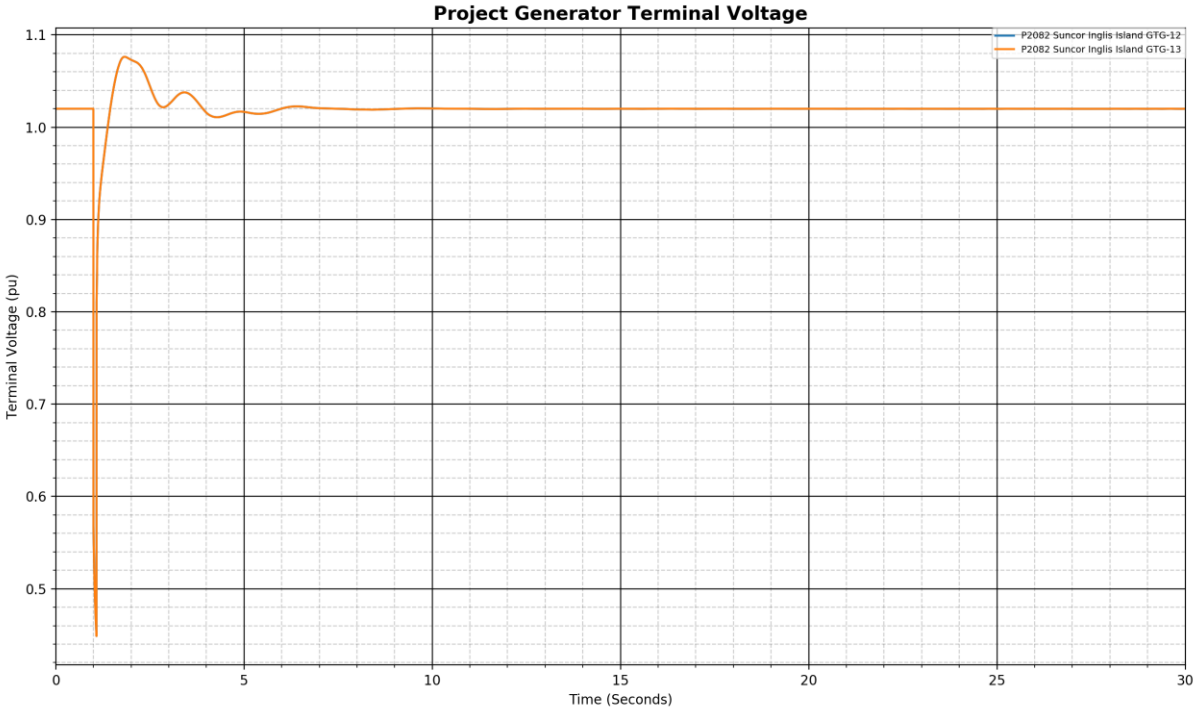

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
60
50
40
30
20
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5
4
3
2
1
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)

Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

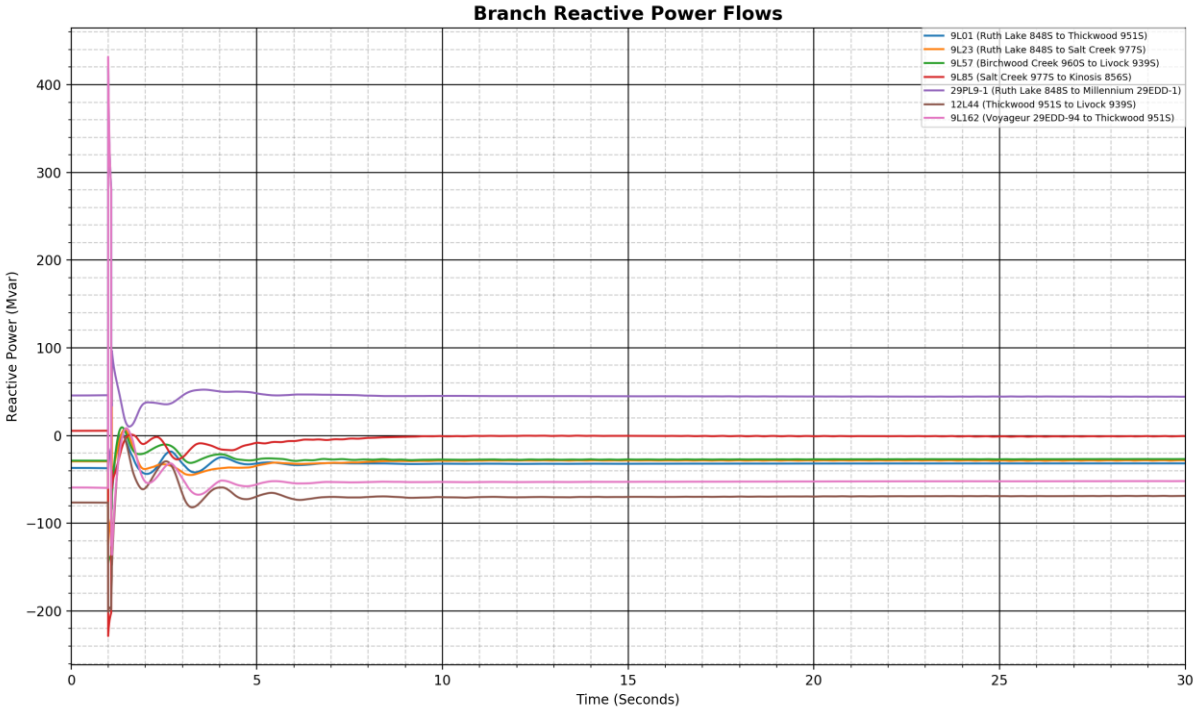
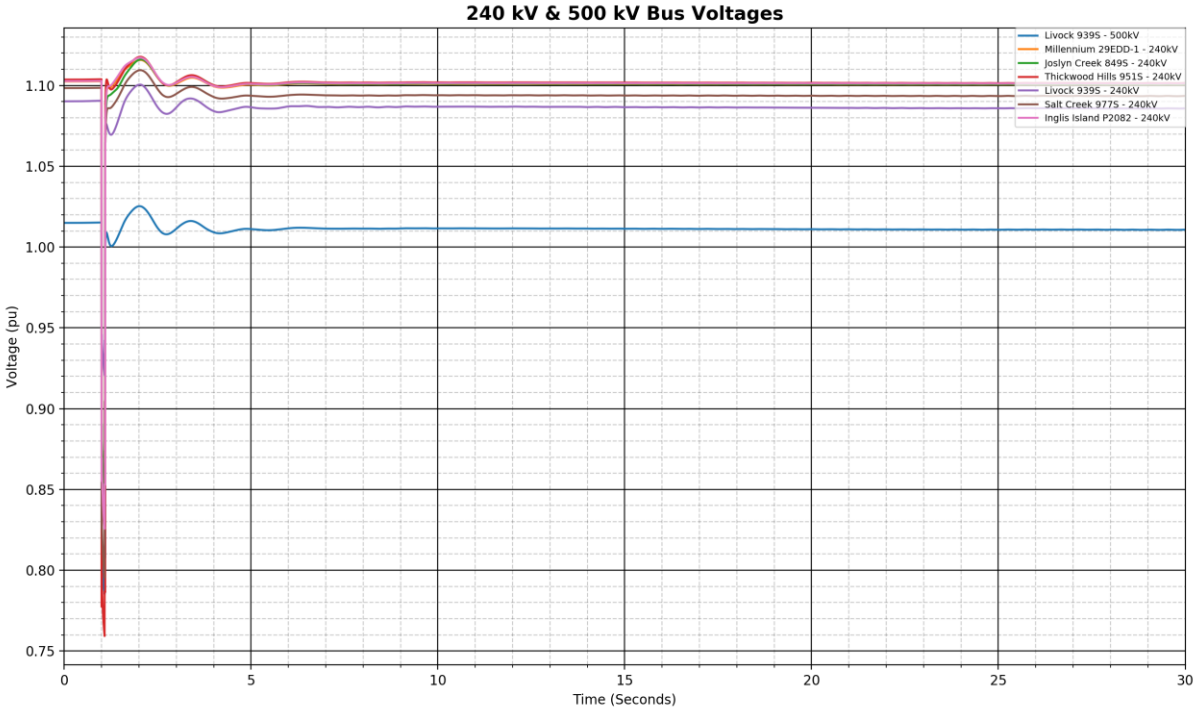
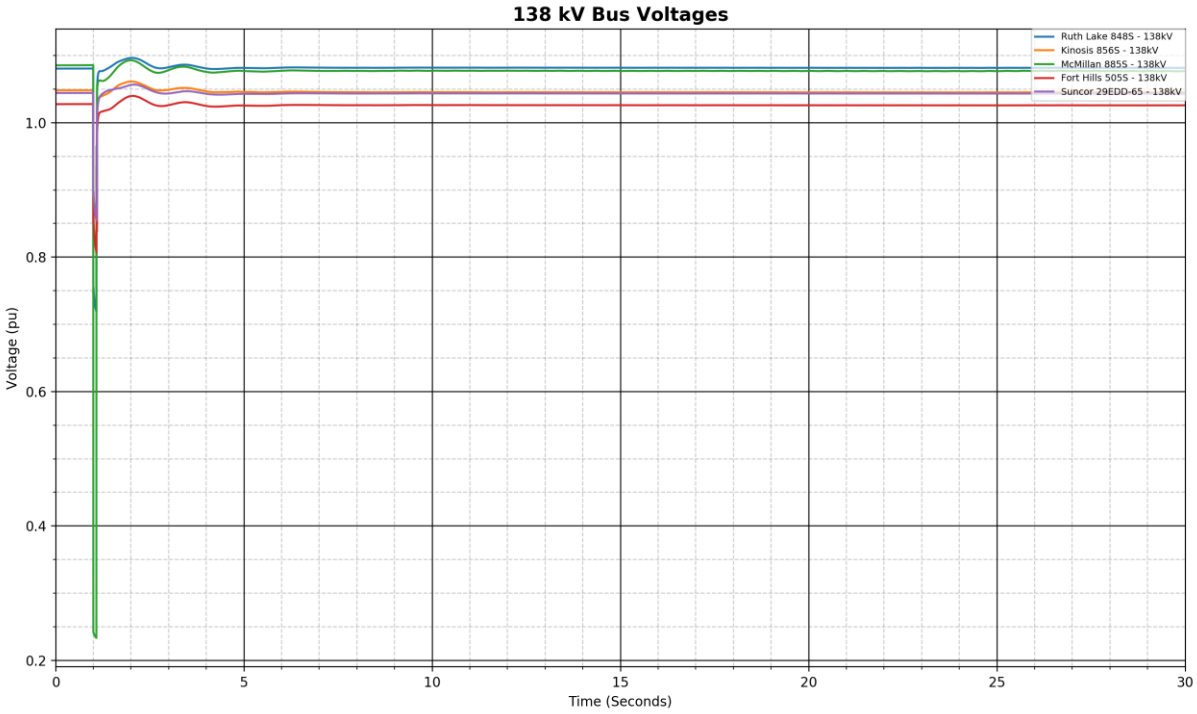
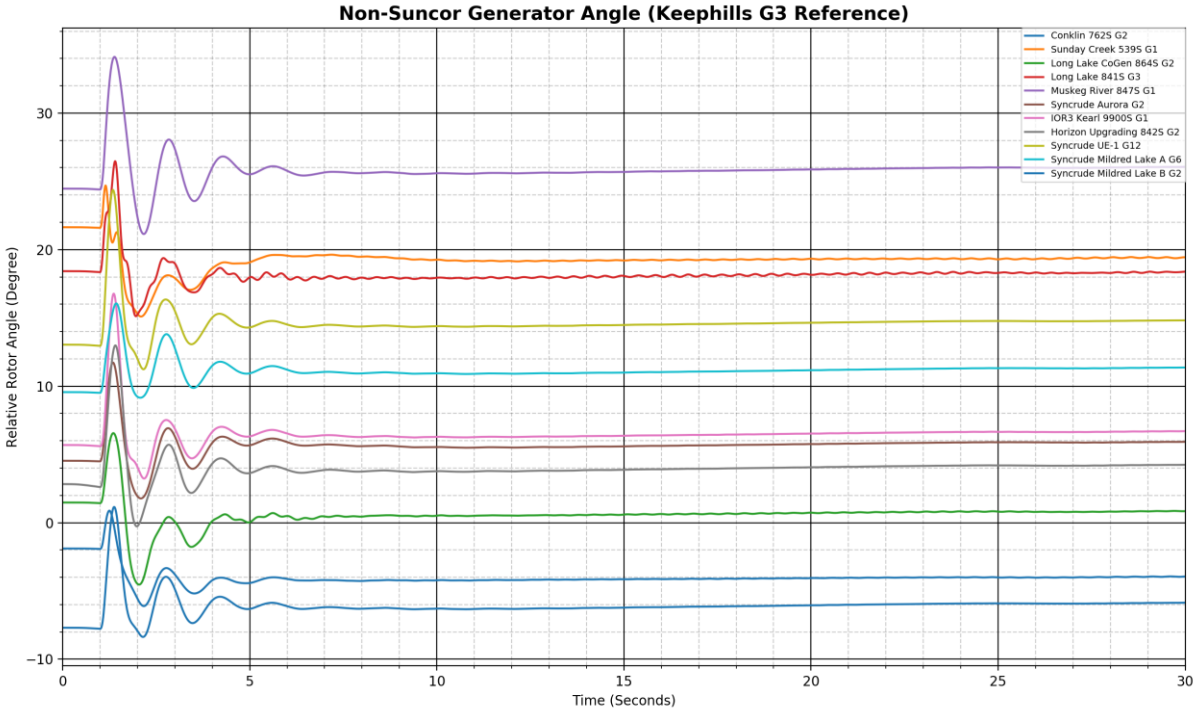
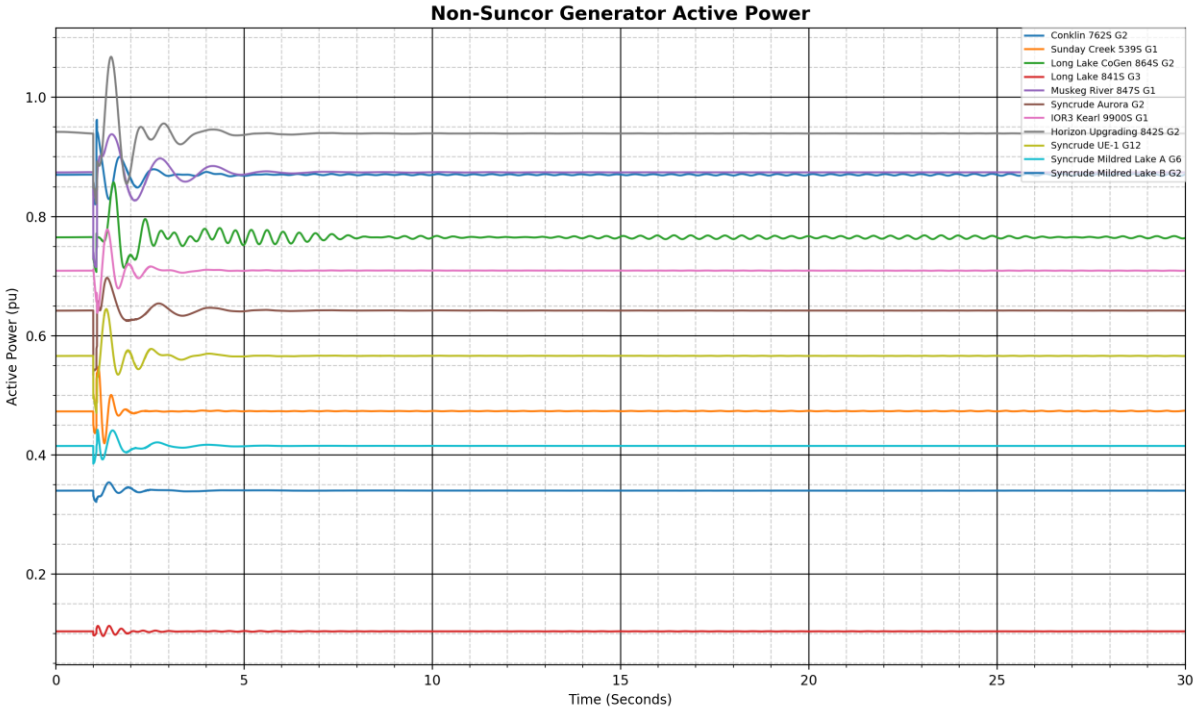

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
0
5
10
15
20
25
30
Time (Seconds)

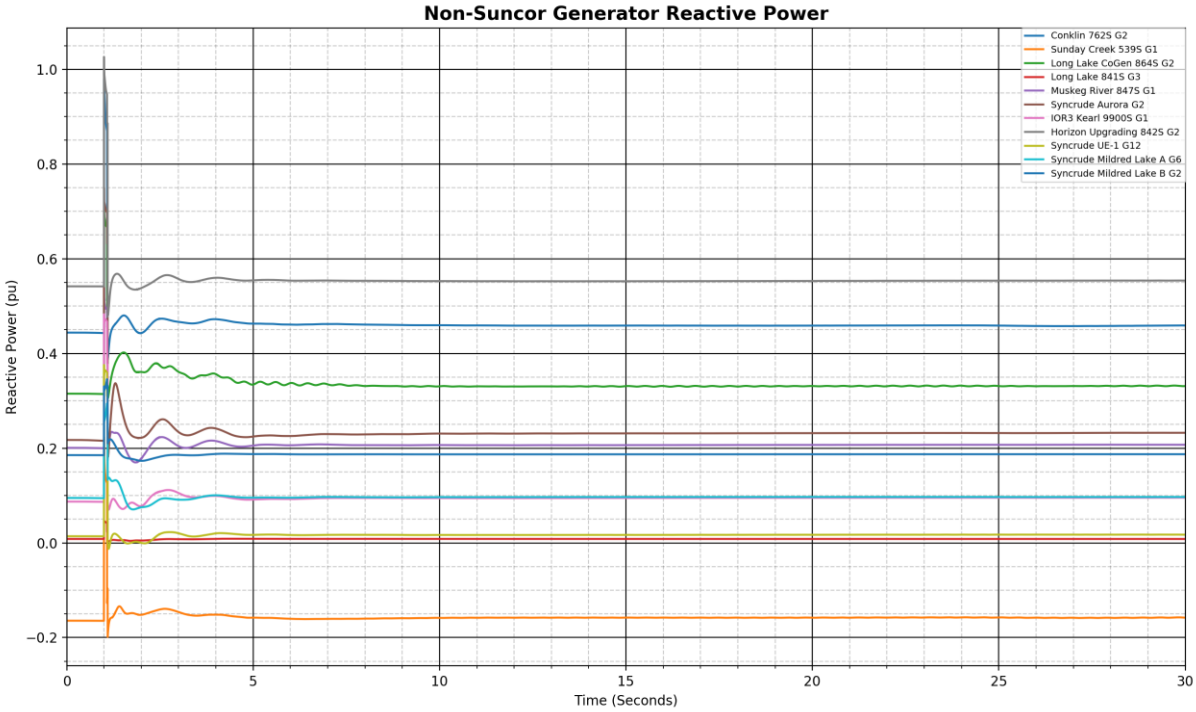
Figure A4-8: 9L07 (Thickwood Hills 951S to Dawes 2011S): Fault at Dawes 2011S

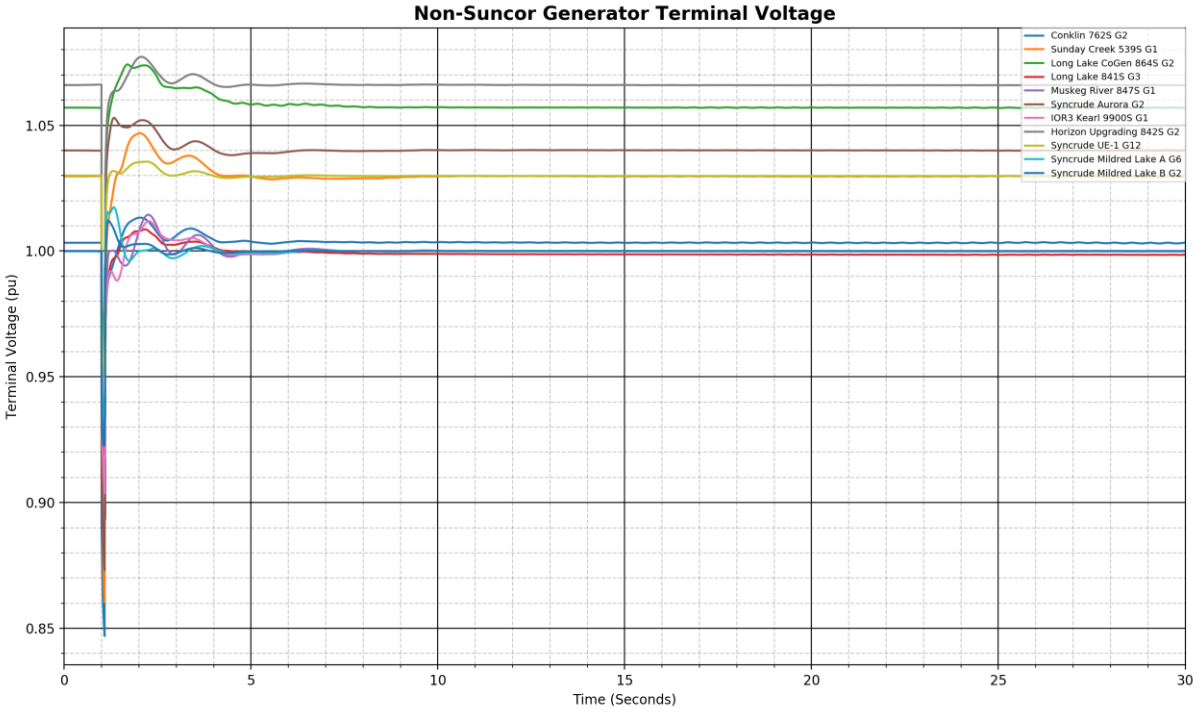


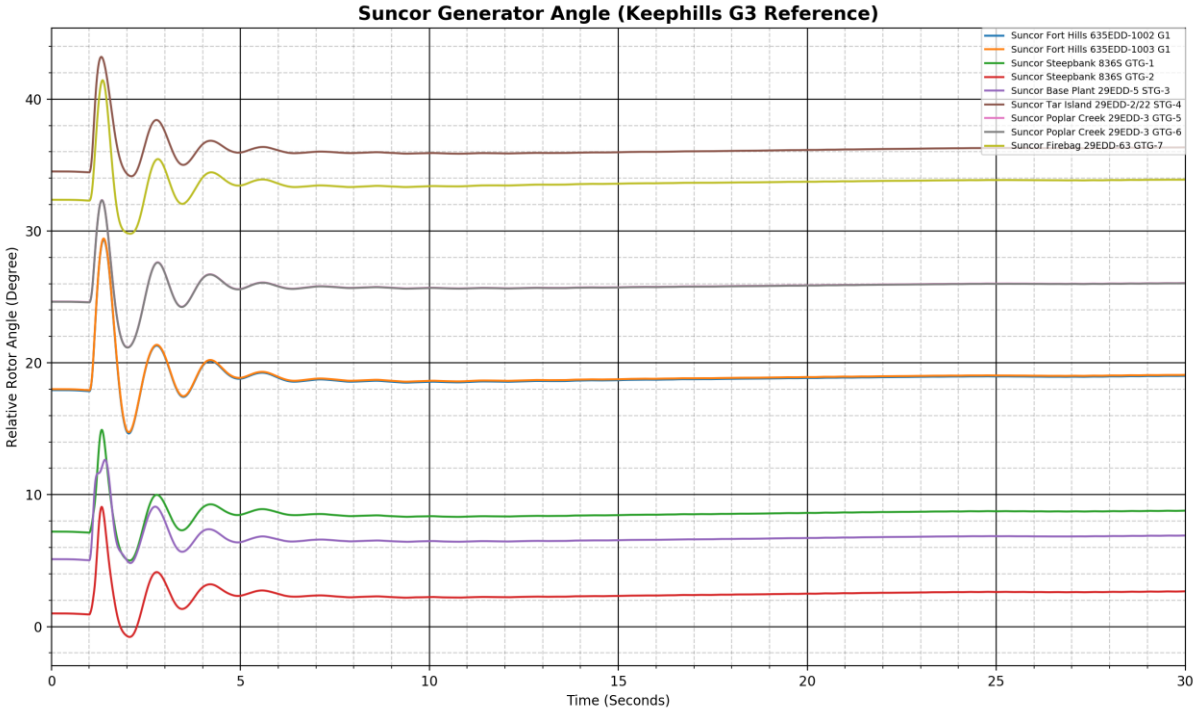


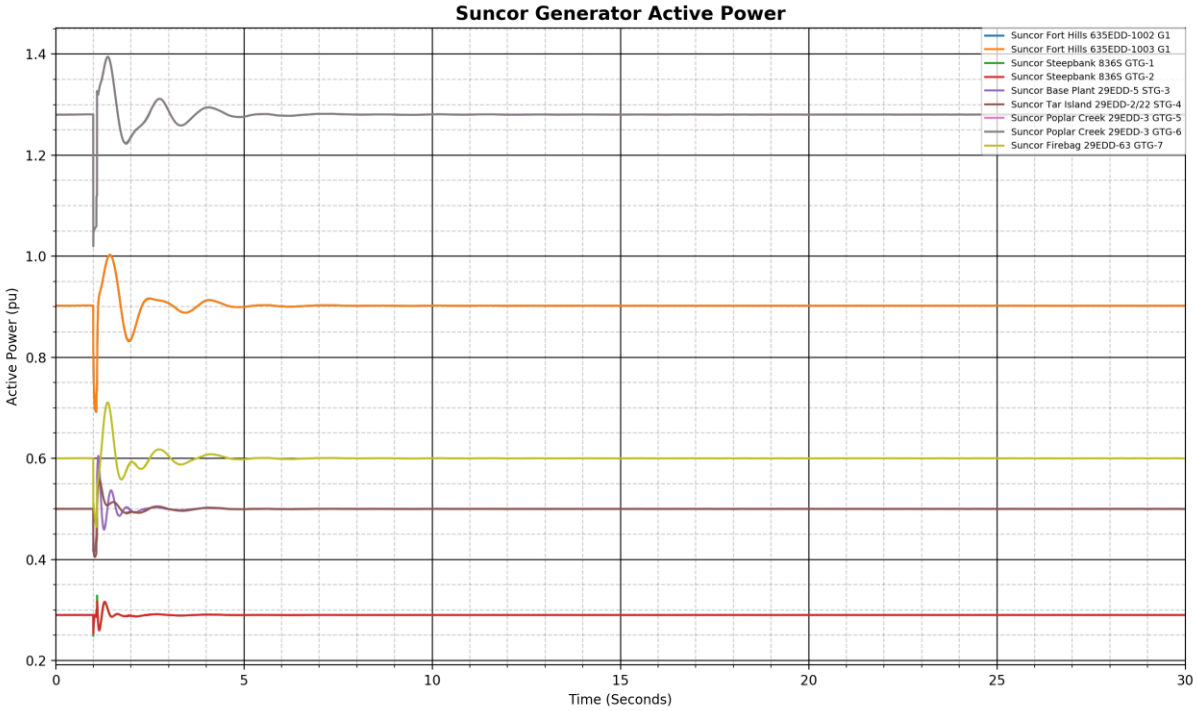

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

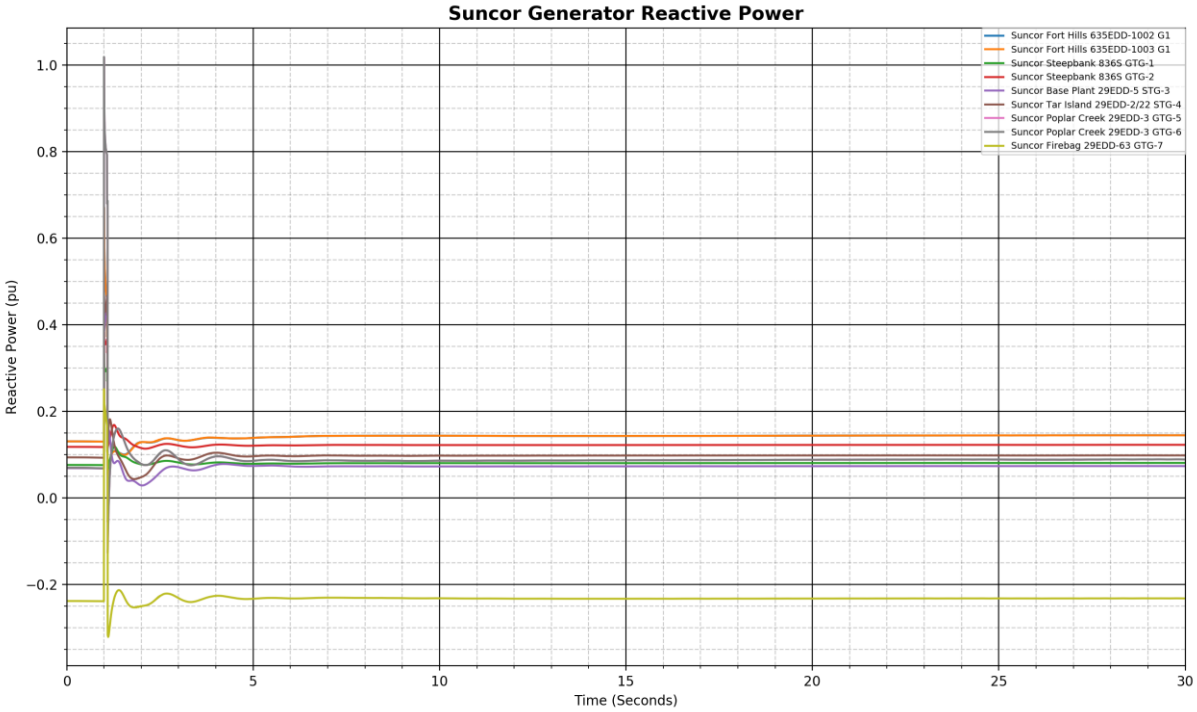

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

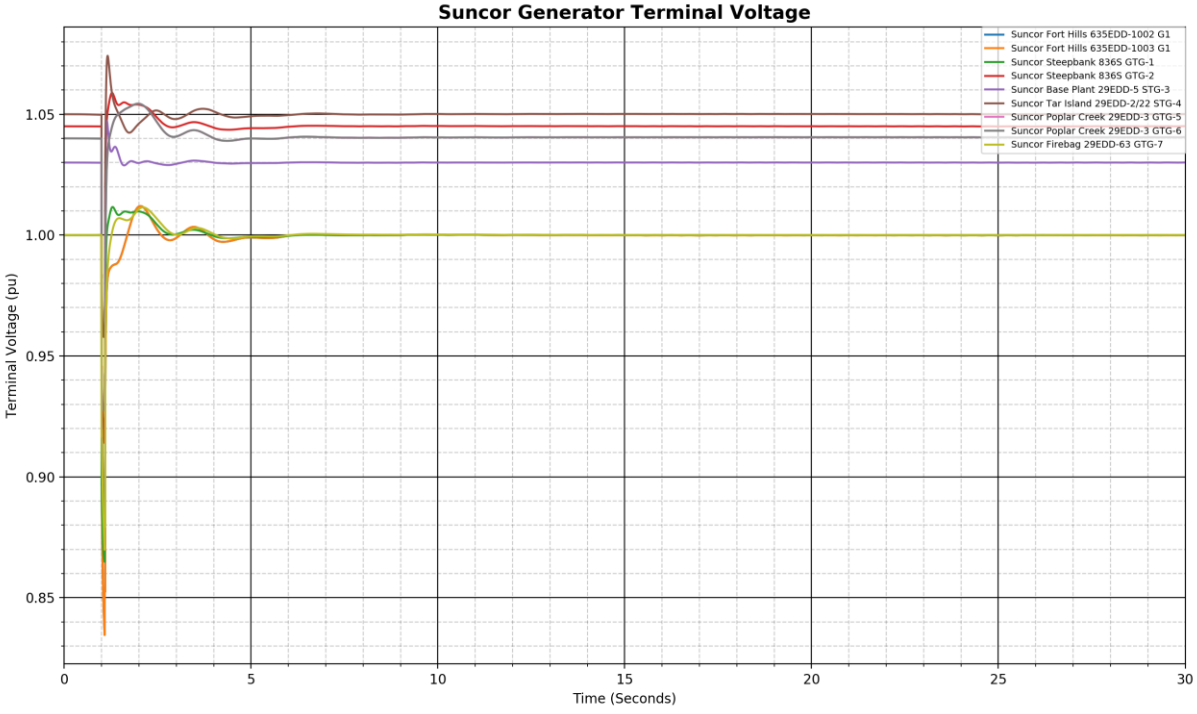

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

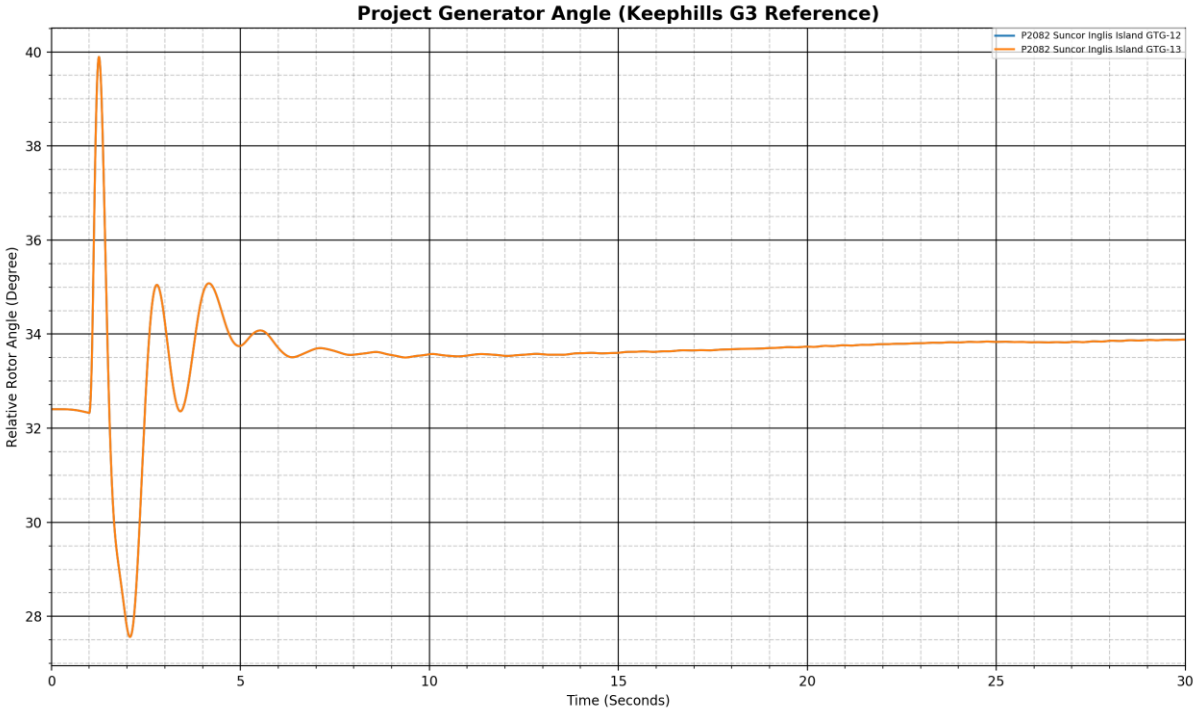

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

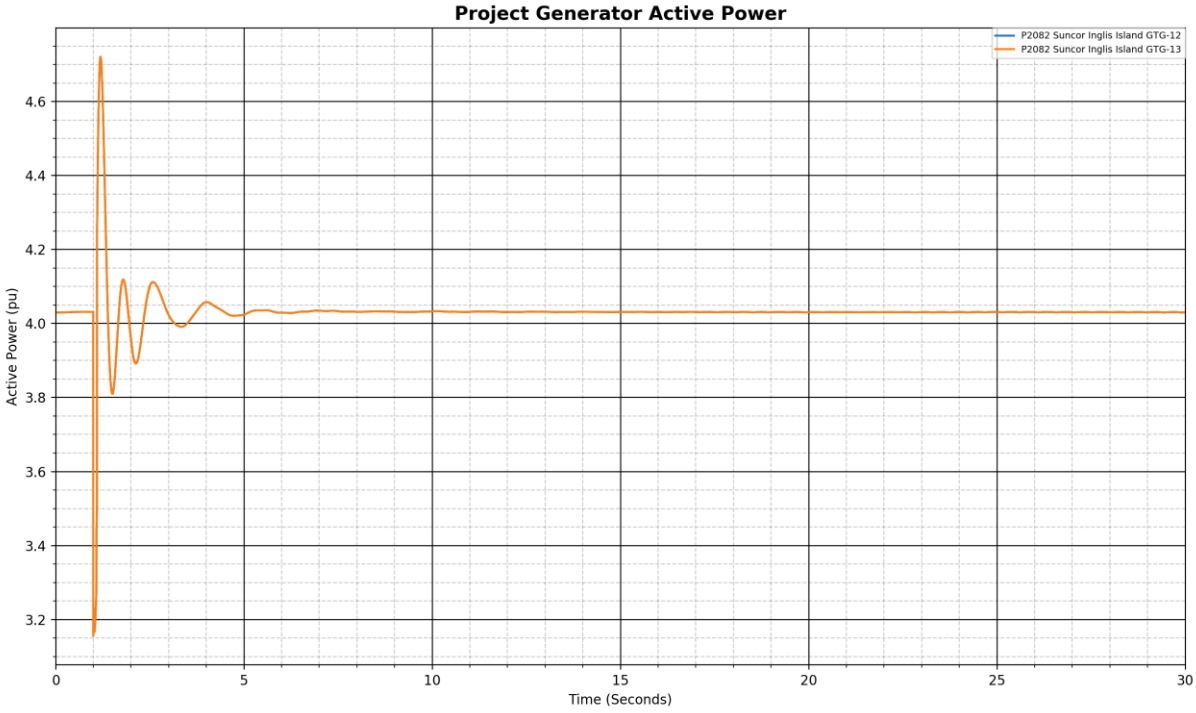

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

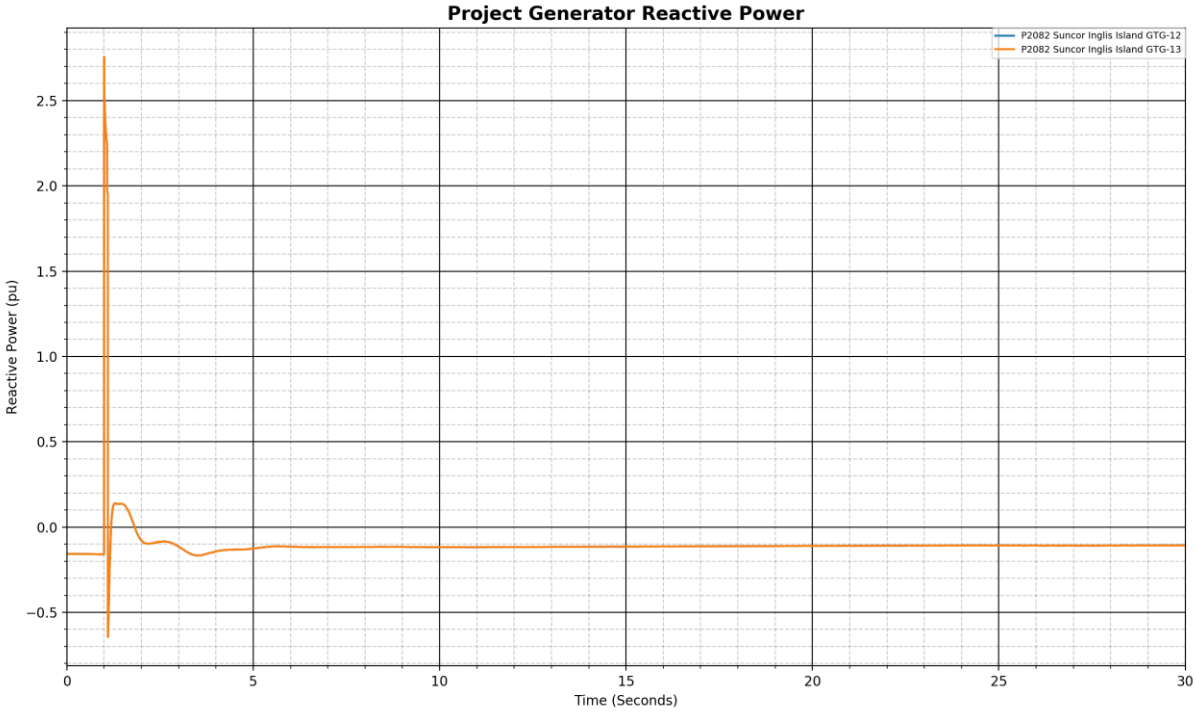

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

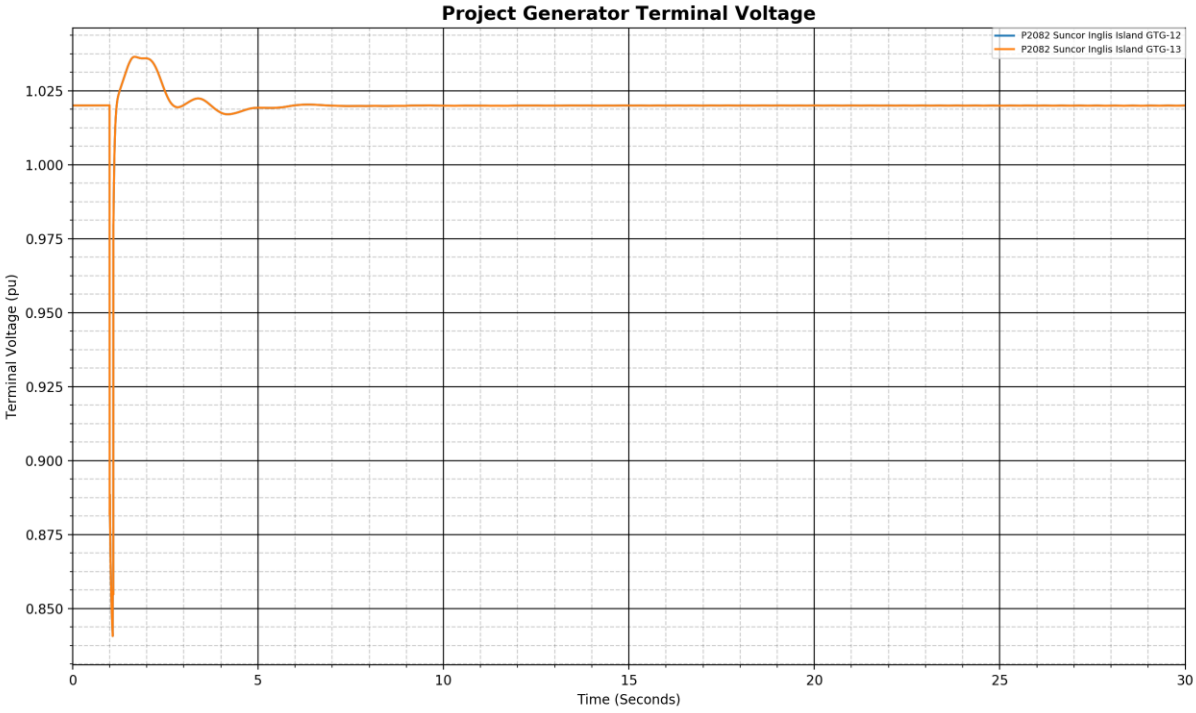

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

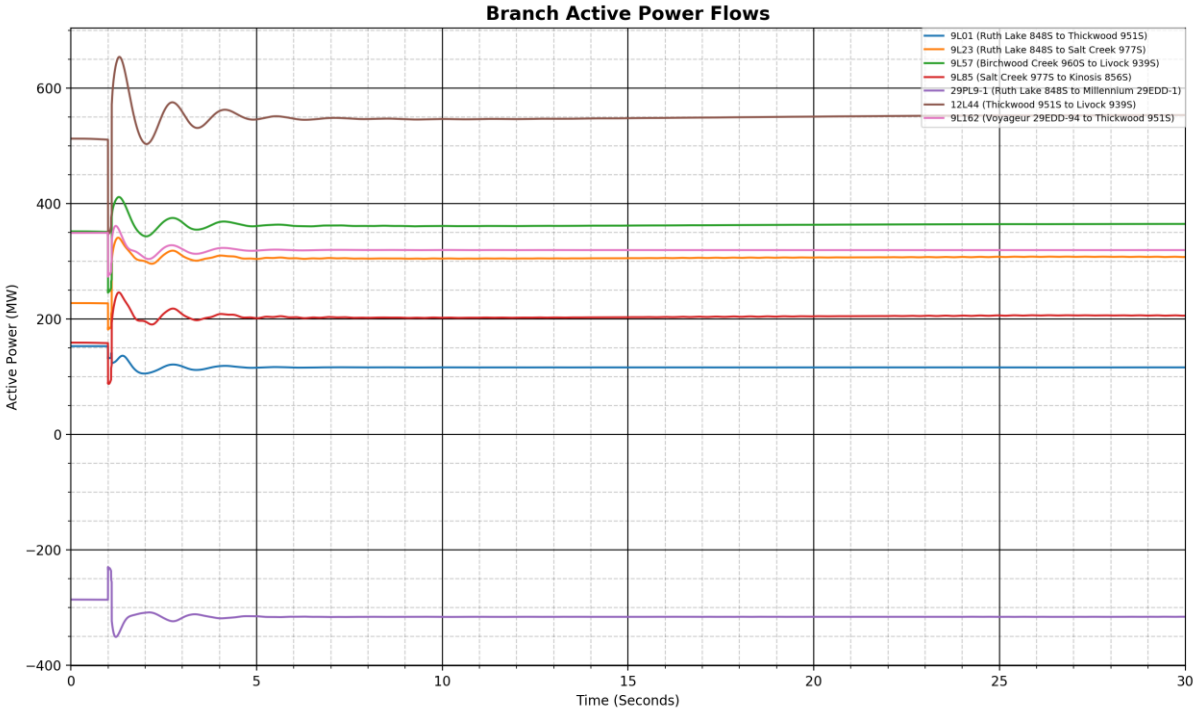

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
40
38
36
34
32
30
28
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.025
1.000
0.975
0.950
0.925
0.900
0.875
0.850
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

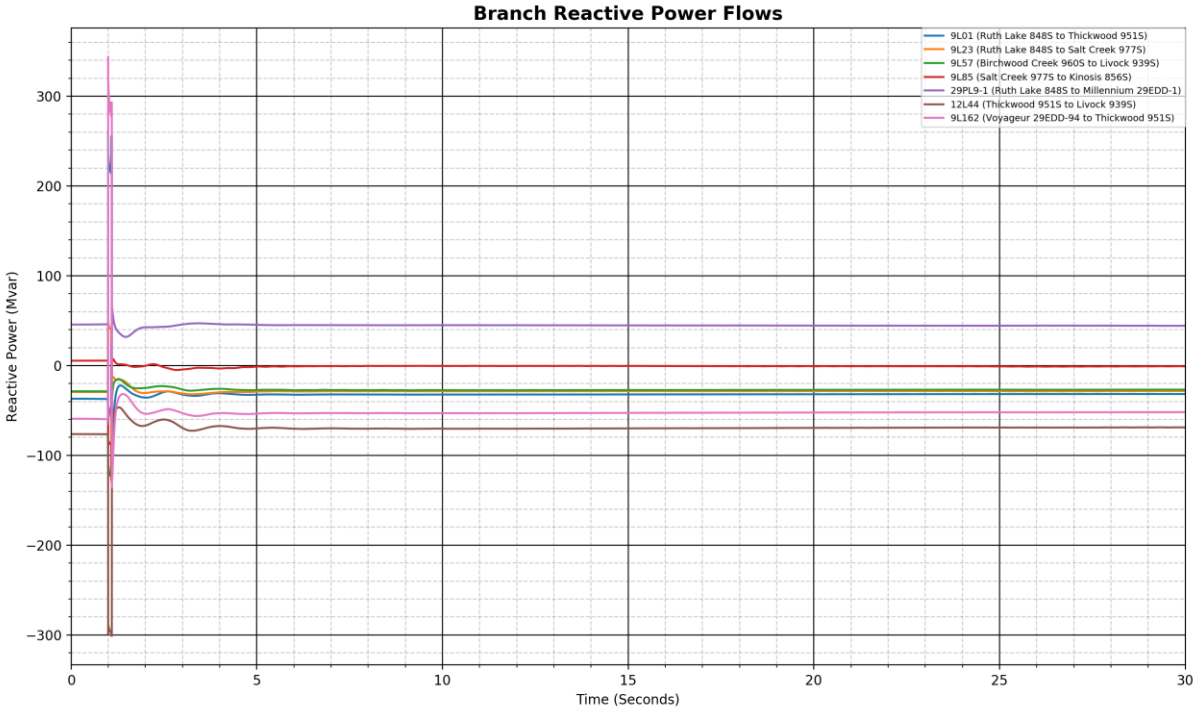
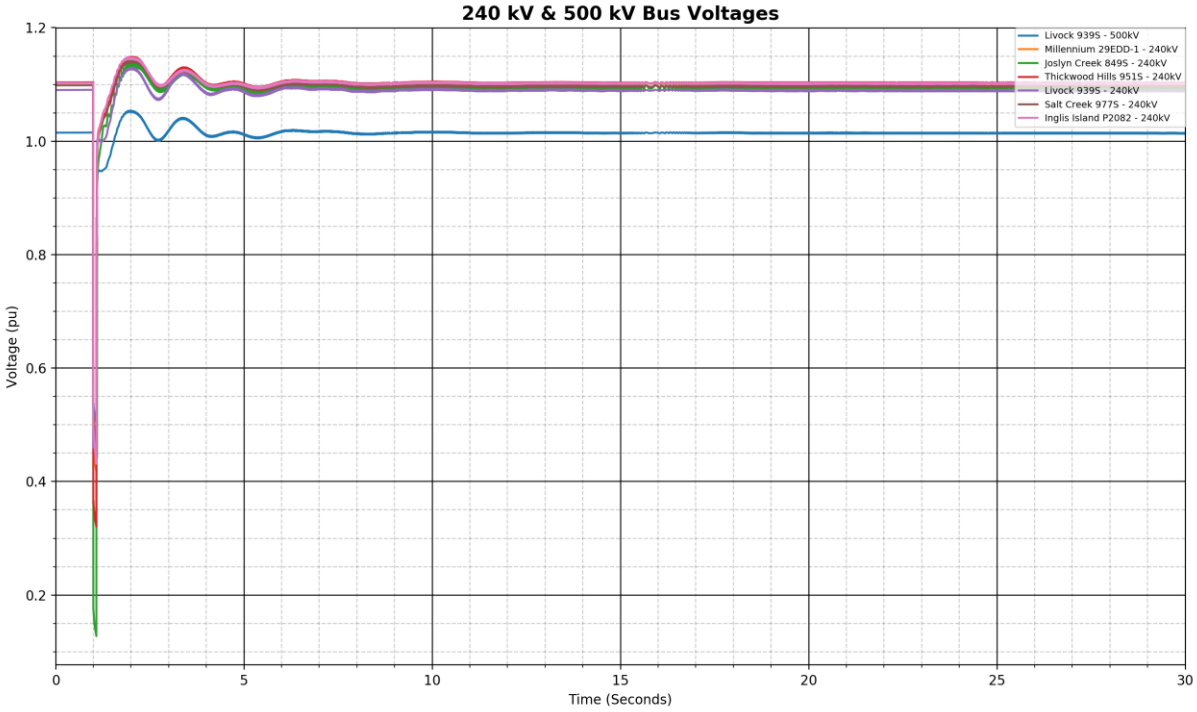
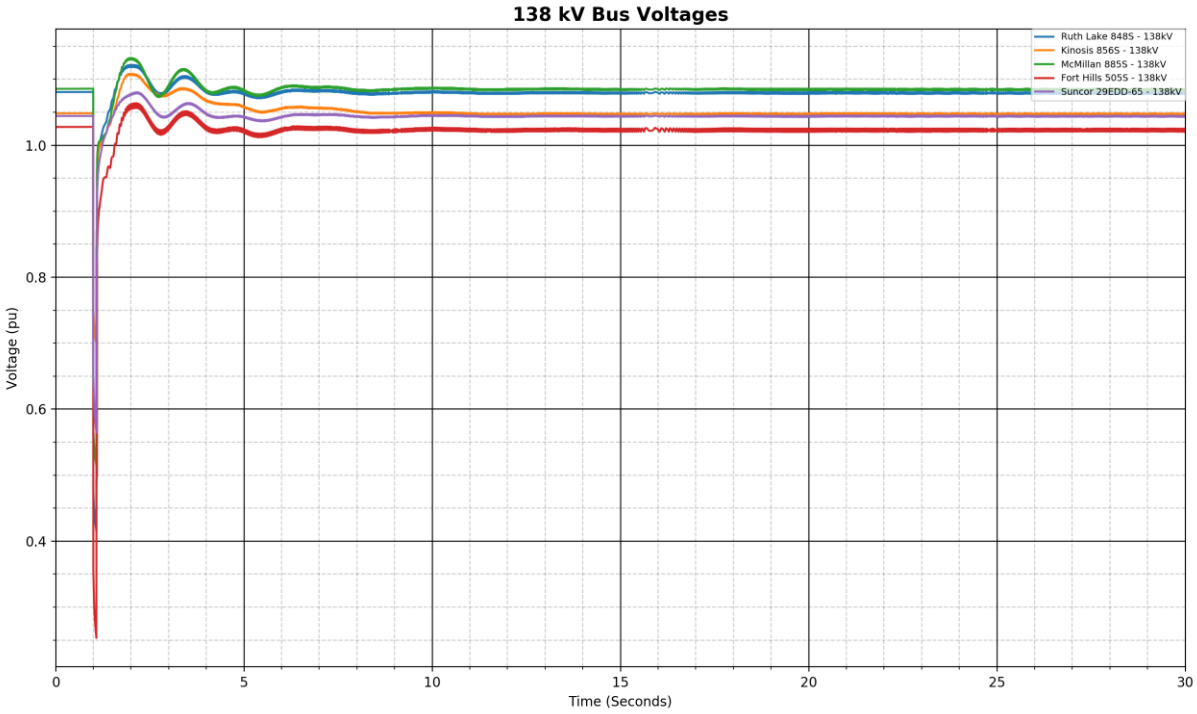
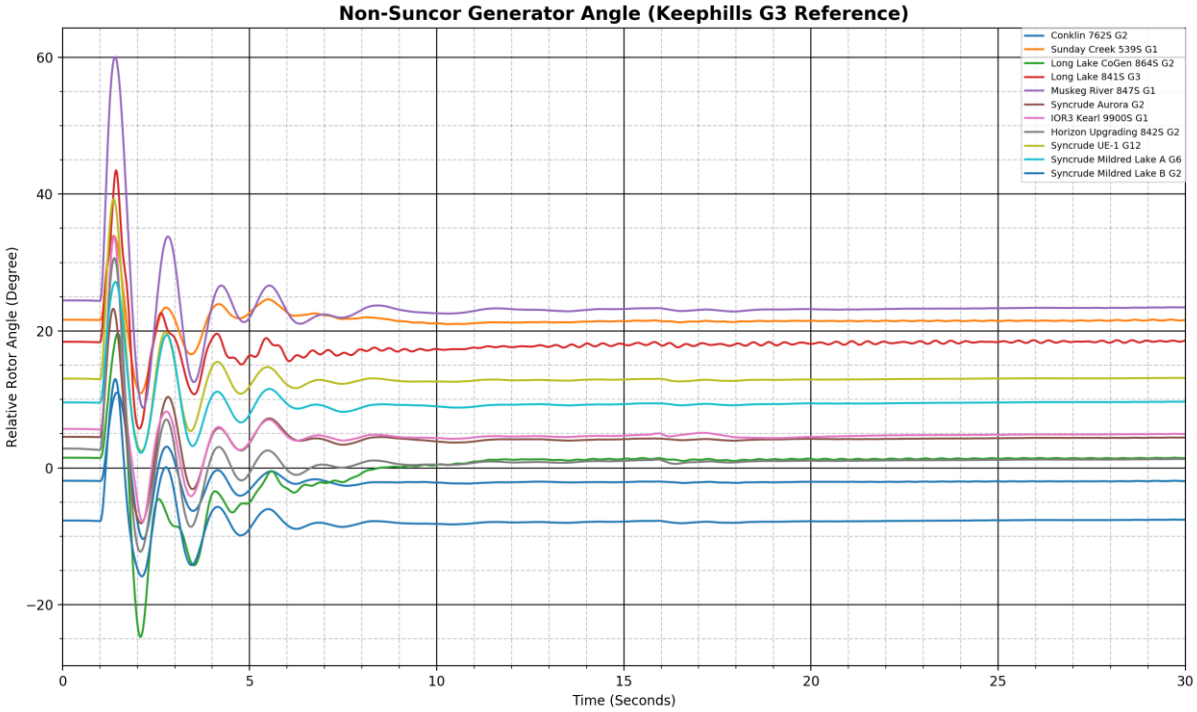
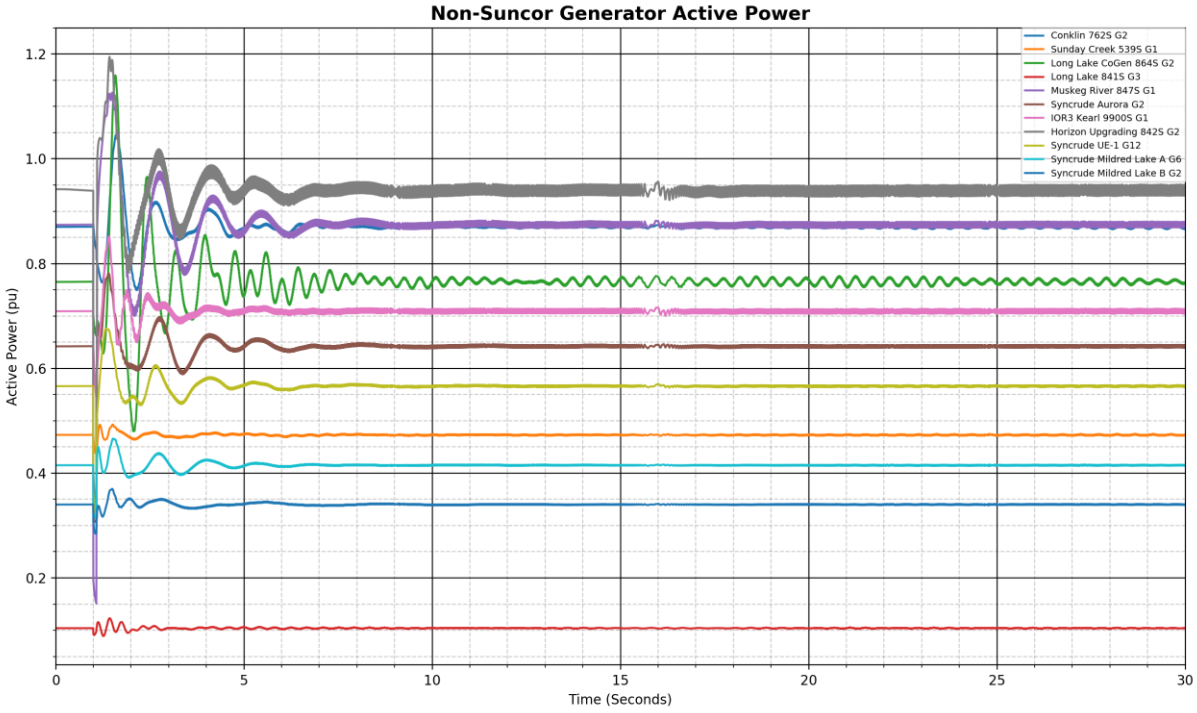

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

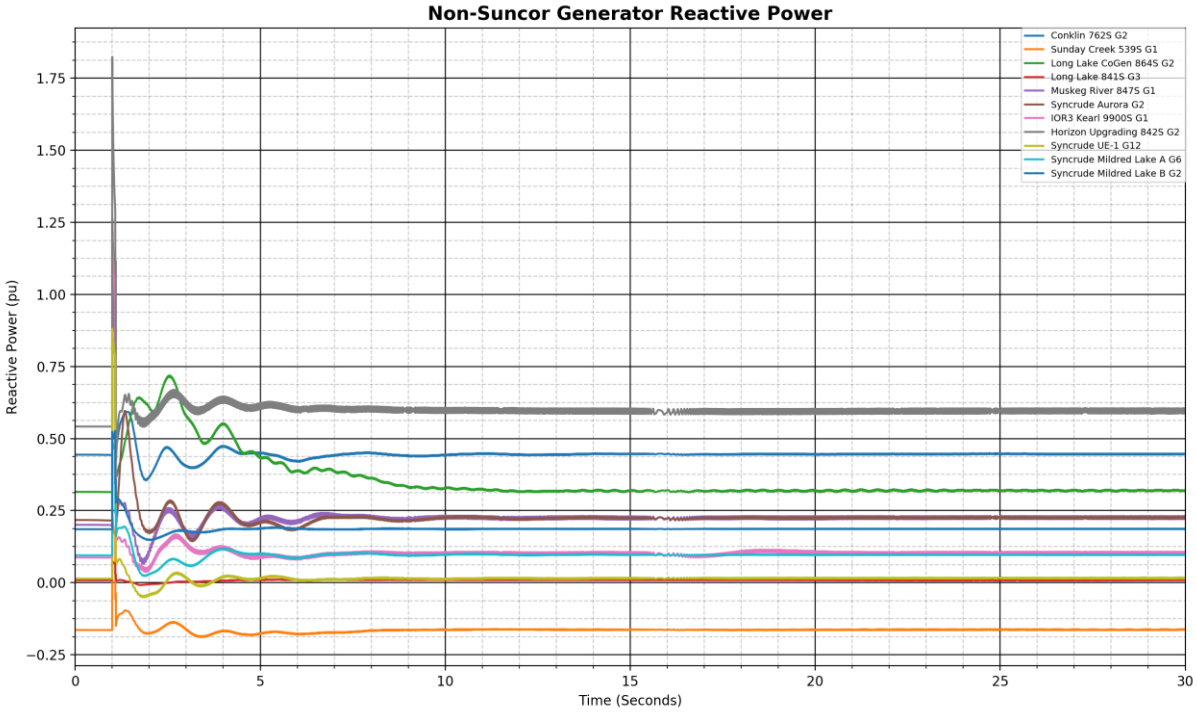
Figure A4-9: 9L08 (Dover 888S to Joslyn Creek 849S): Fault at Dover 888S

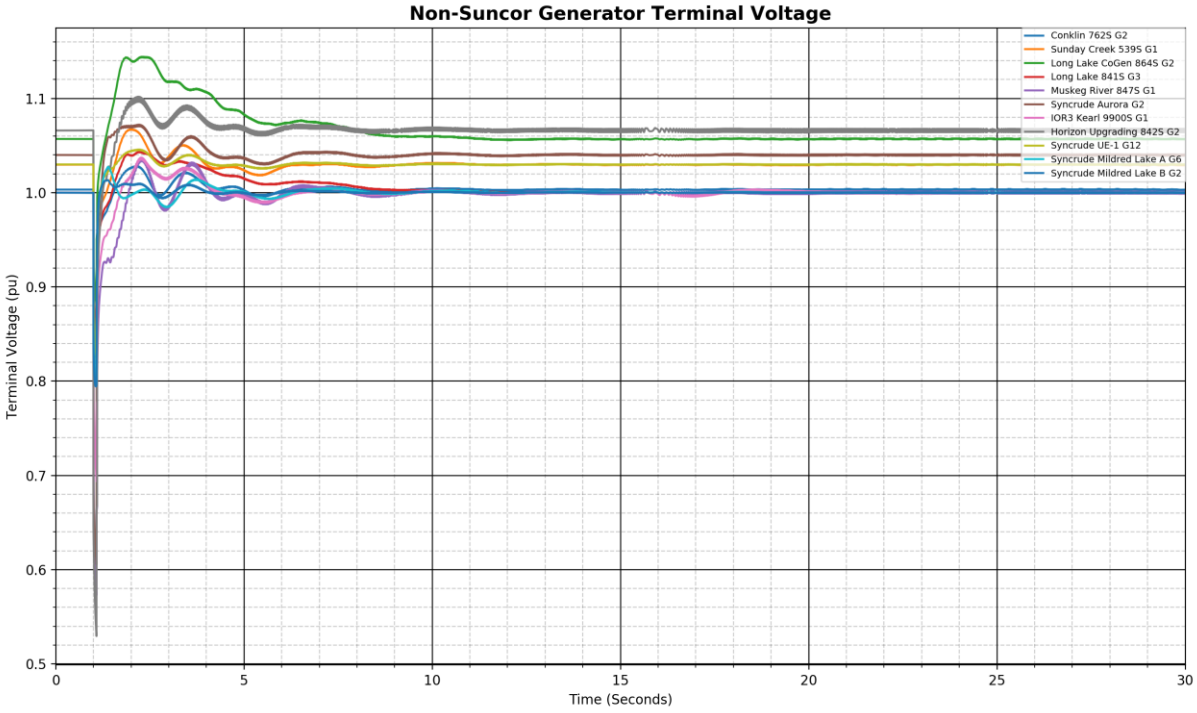


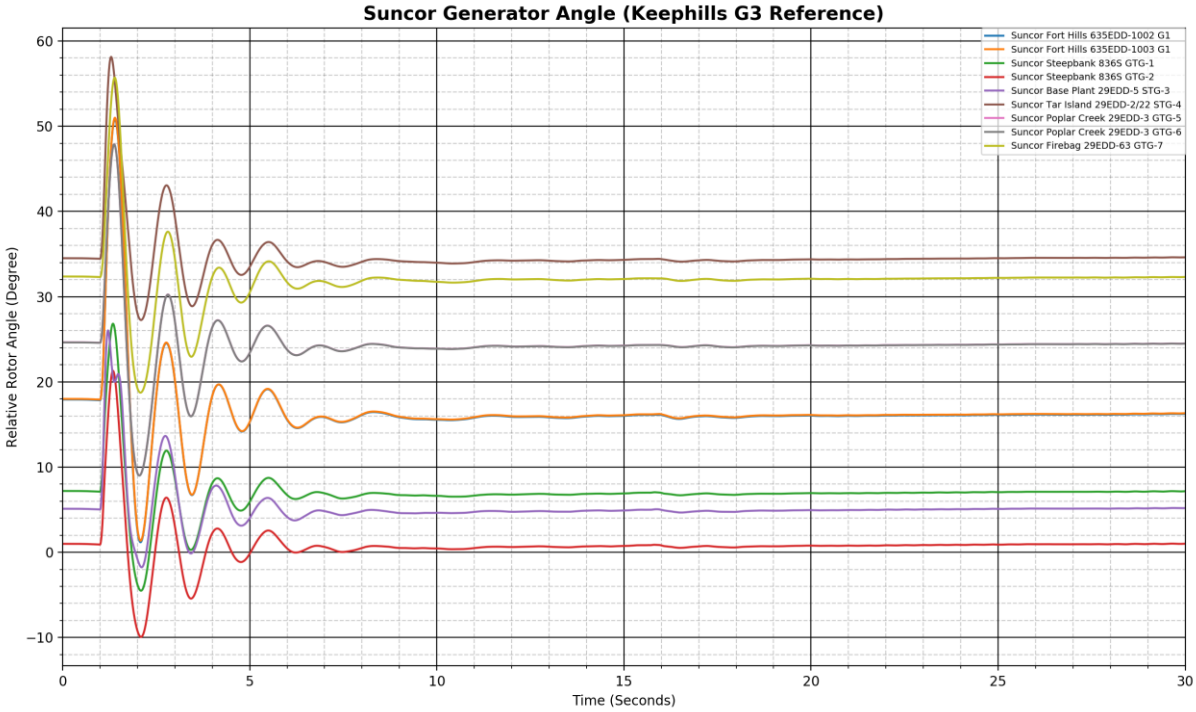


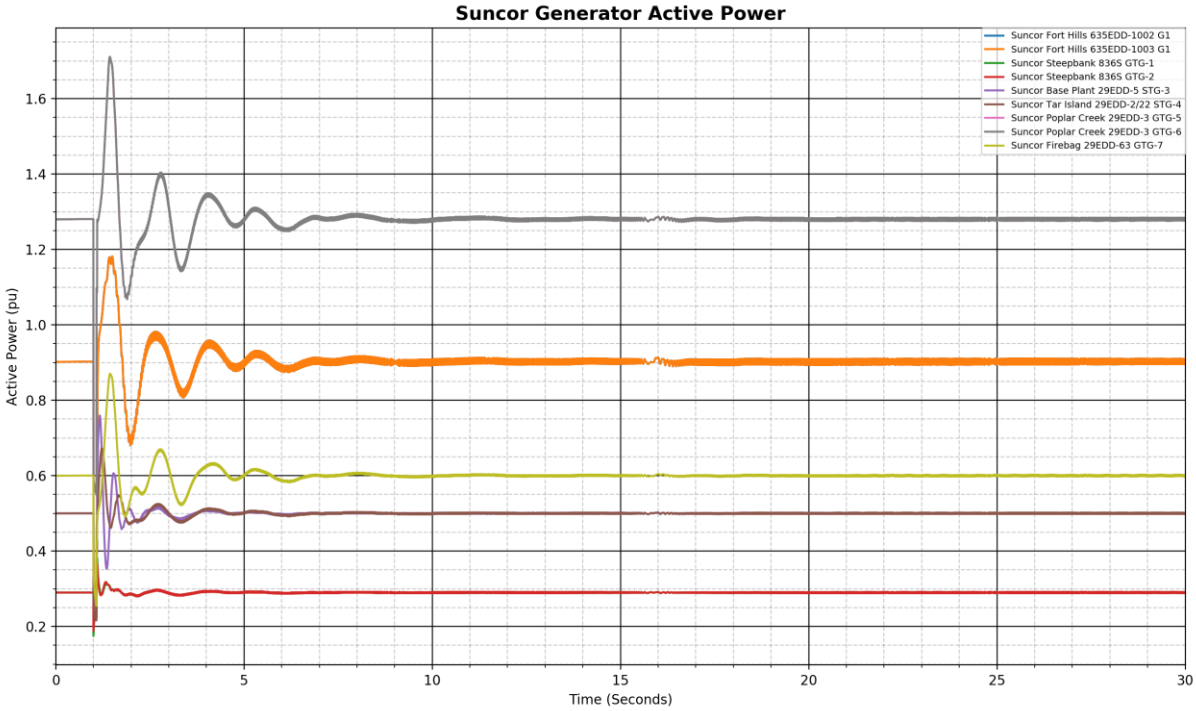

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

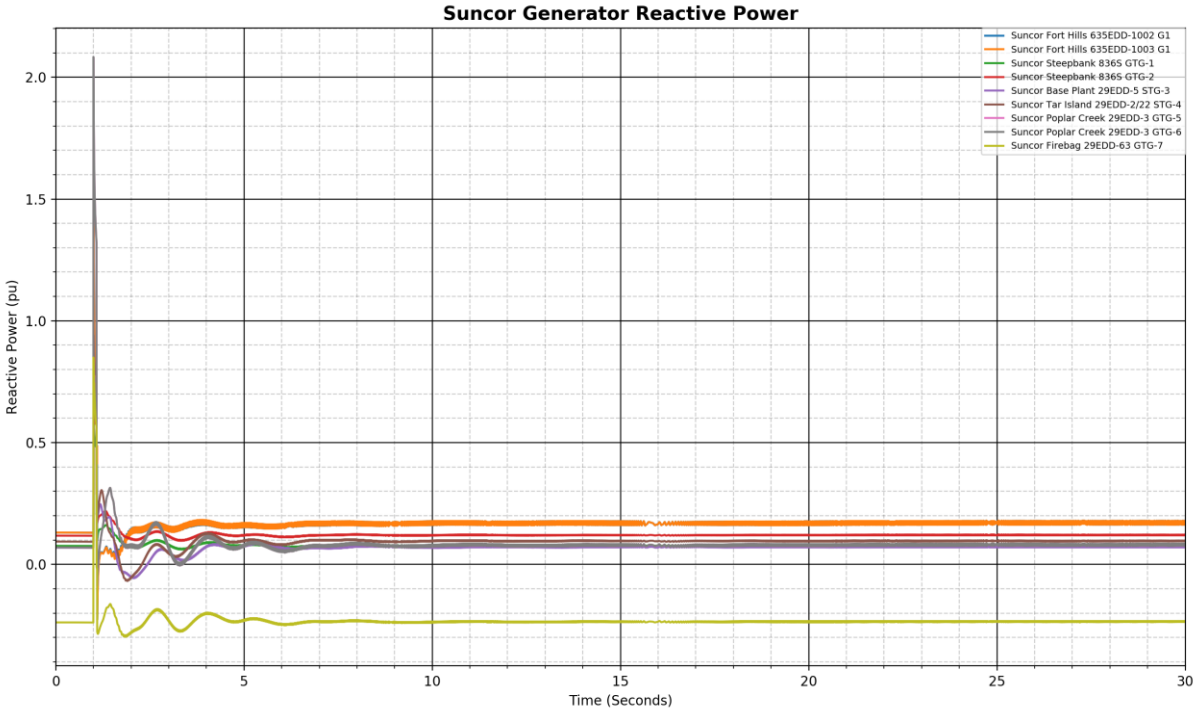

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

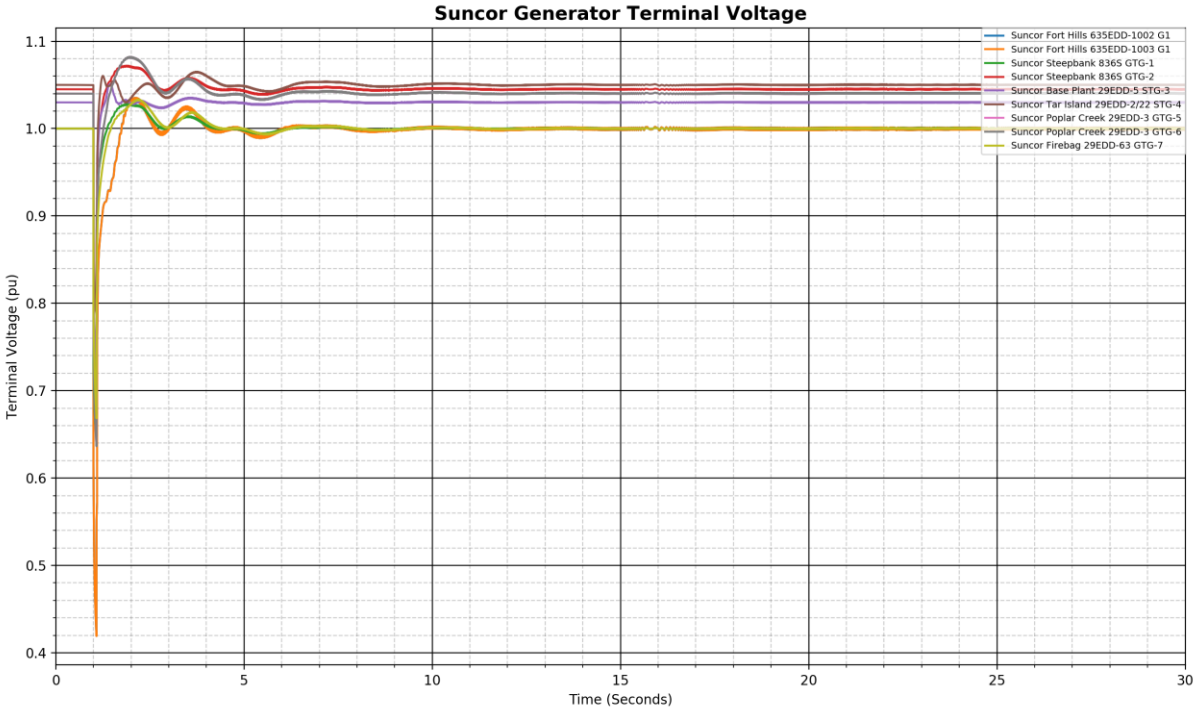

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

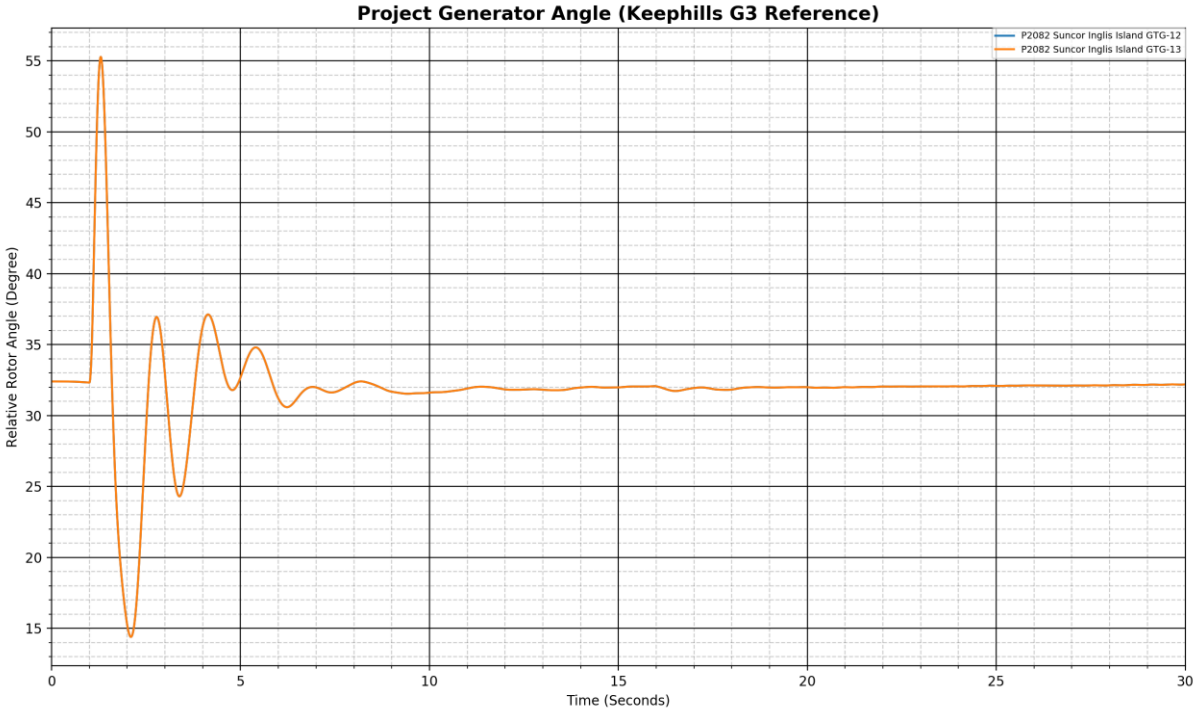

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

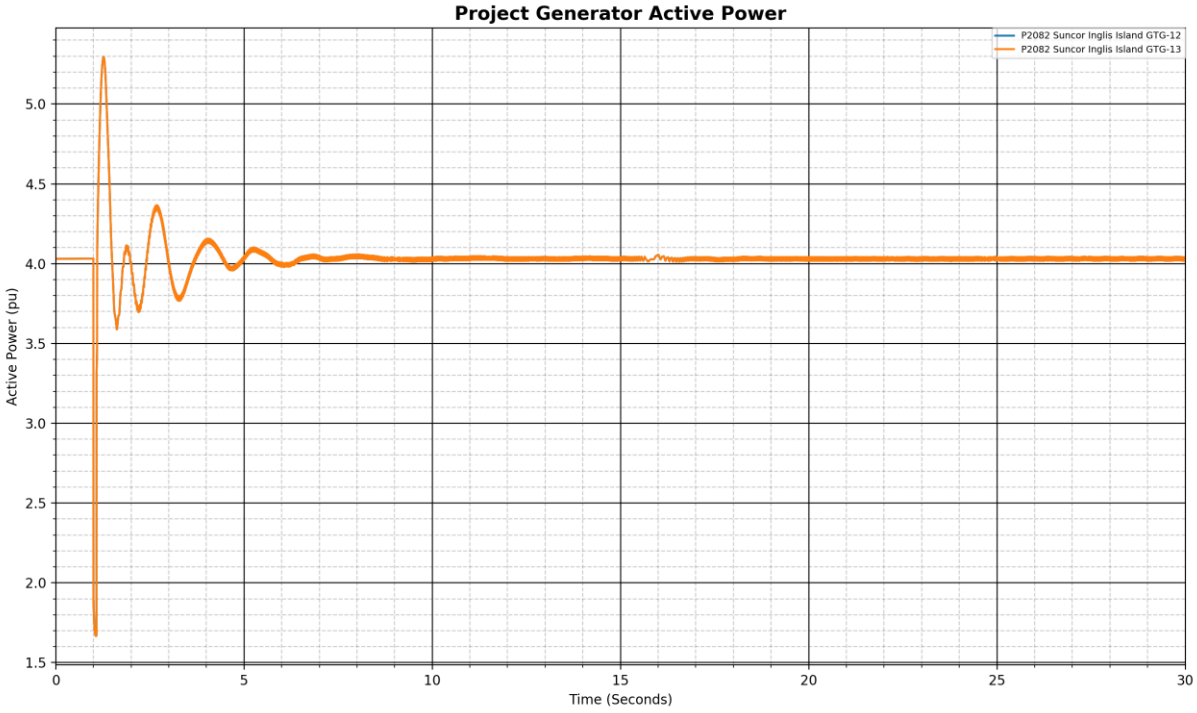

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

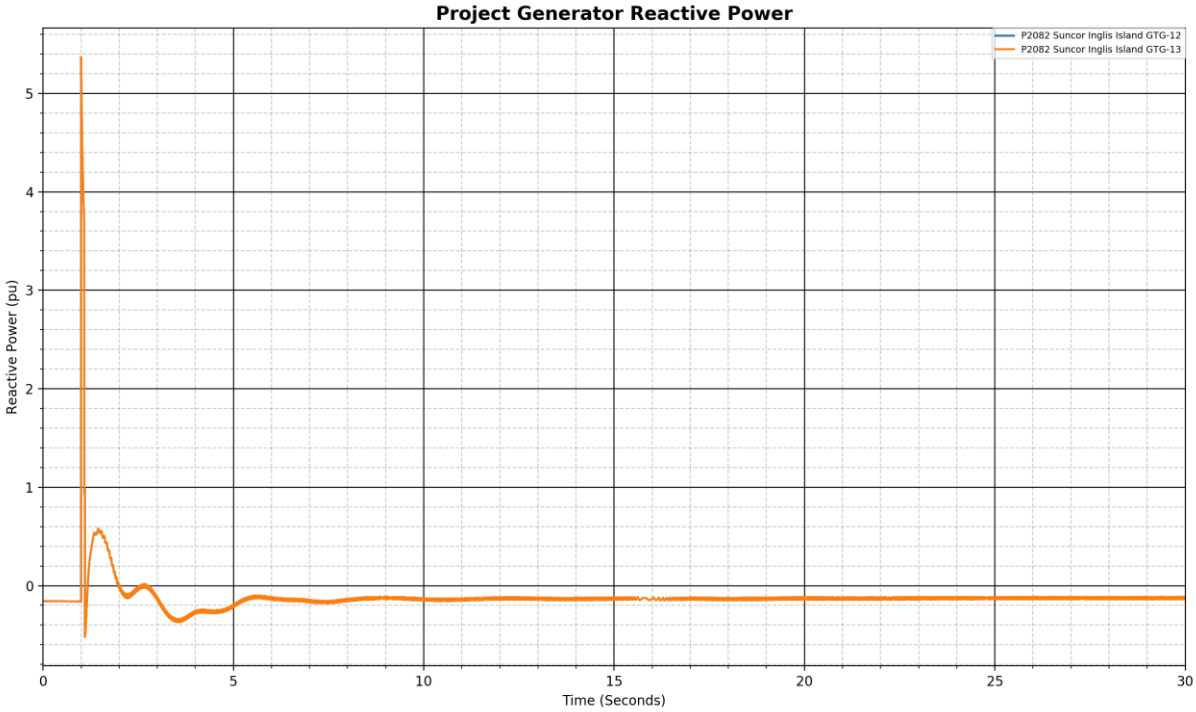

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

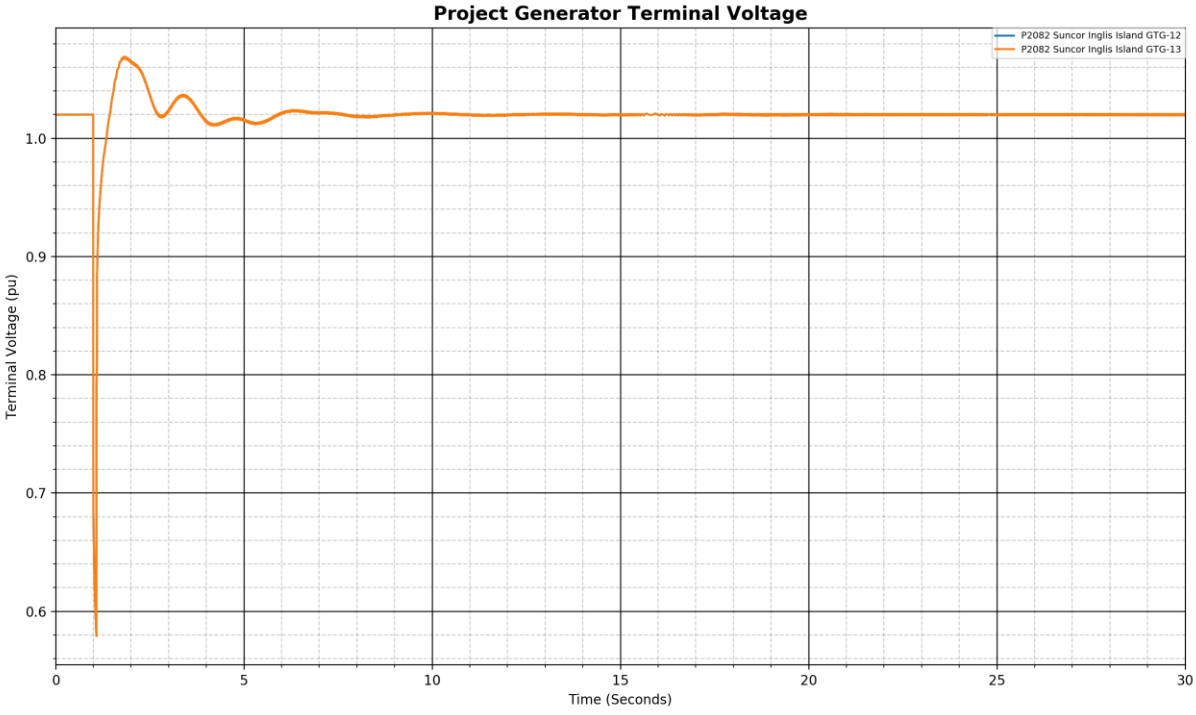

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

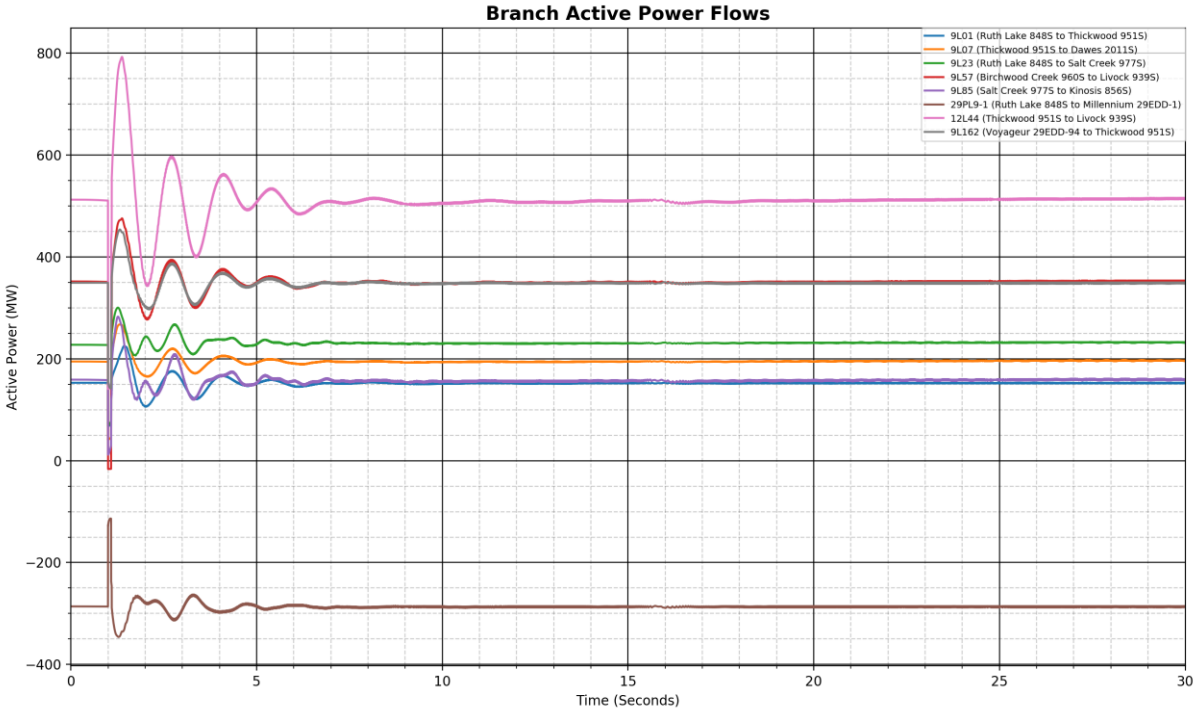

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
55
50
45
40
35
30
25
20
15
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.6
0.7
0.8
0.9
1.0
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

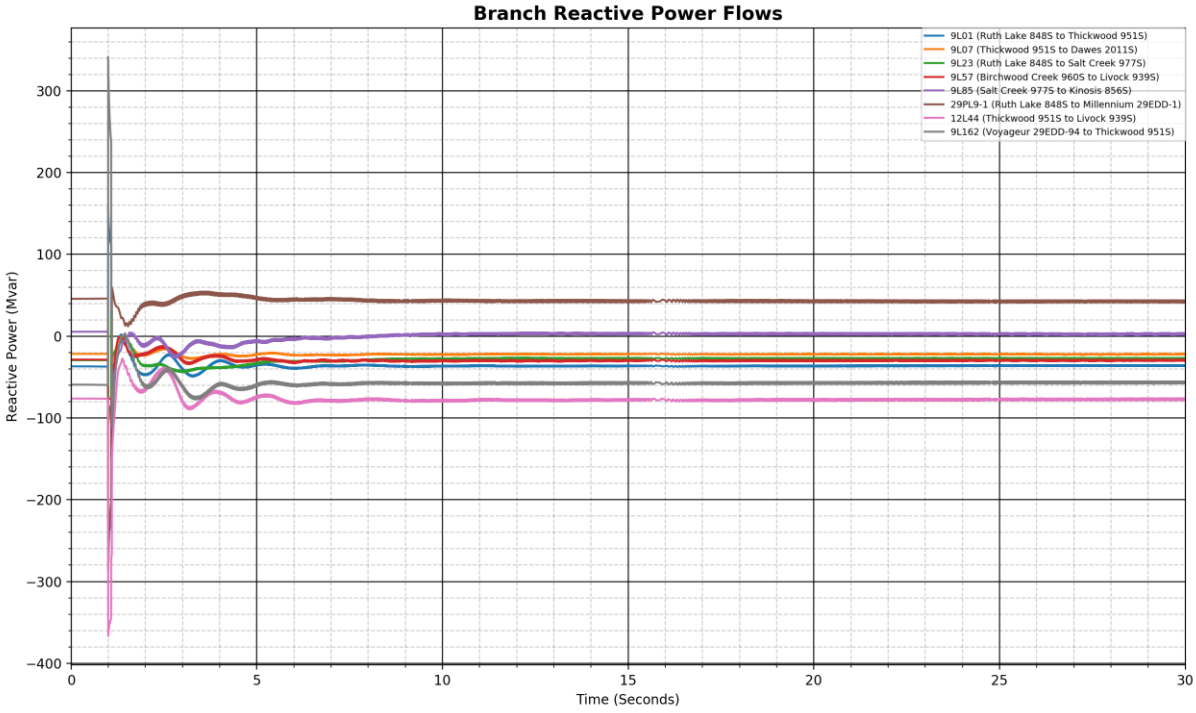
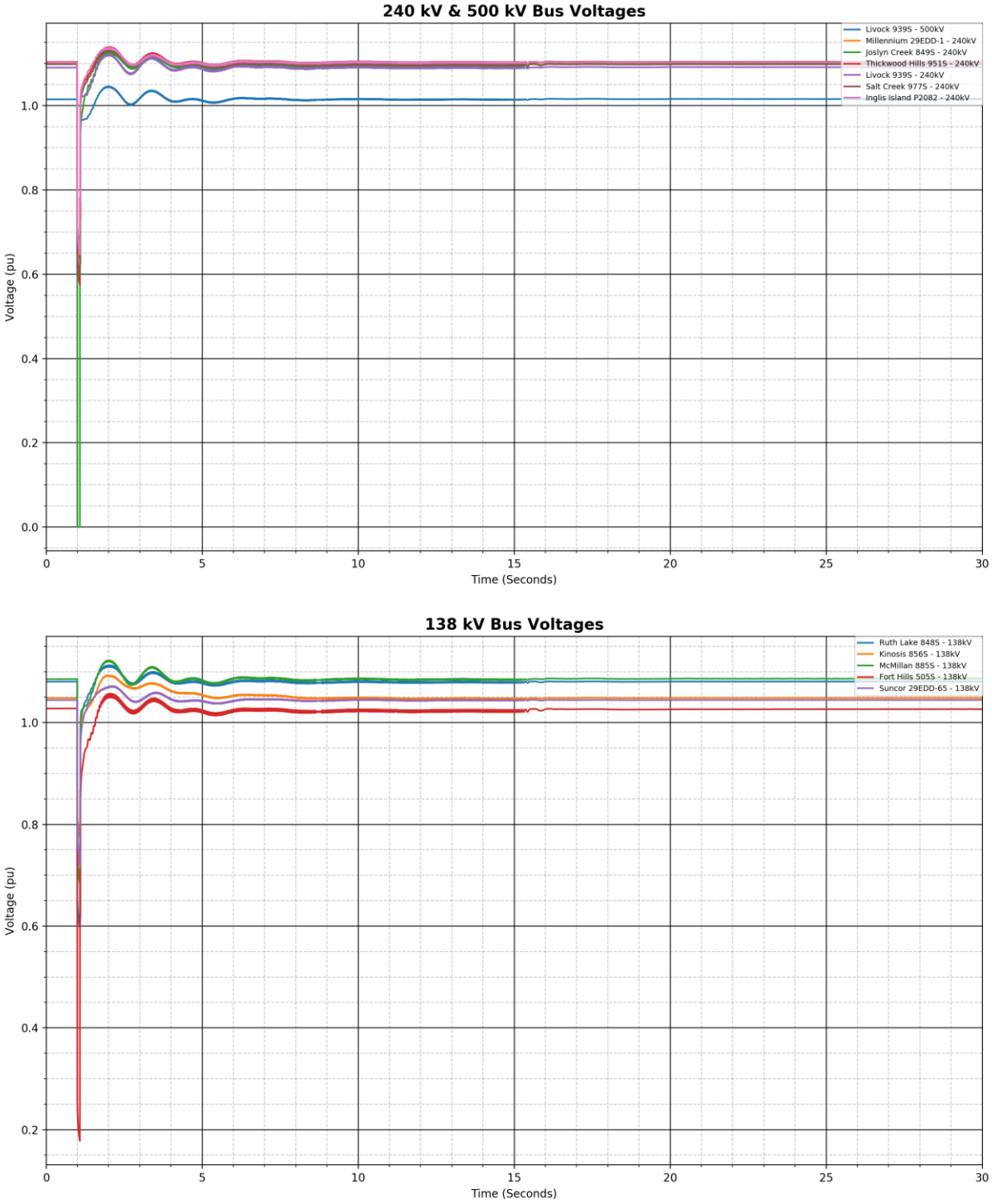
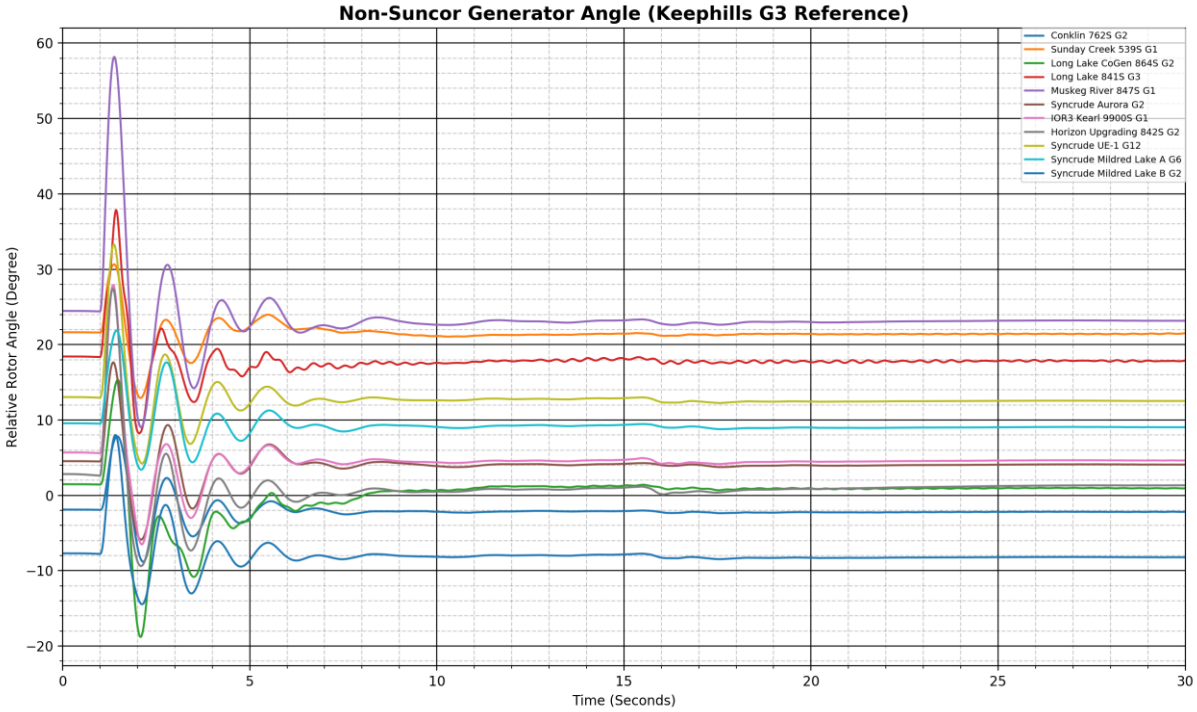
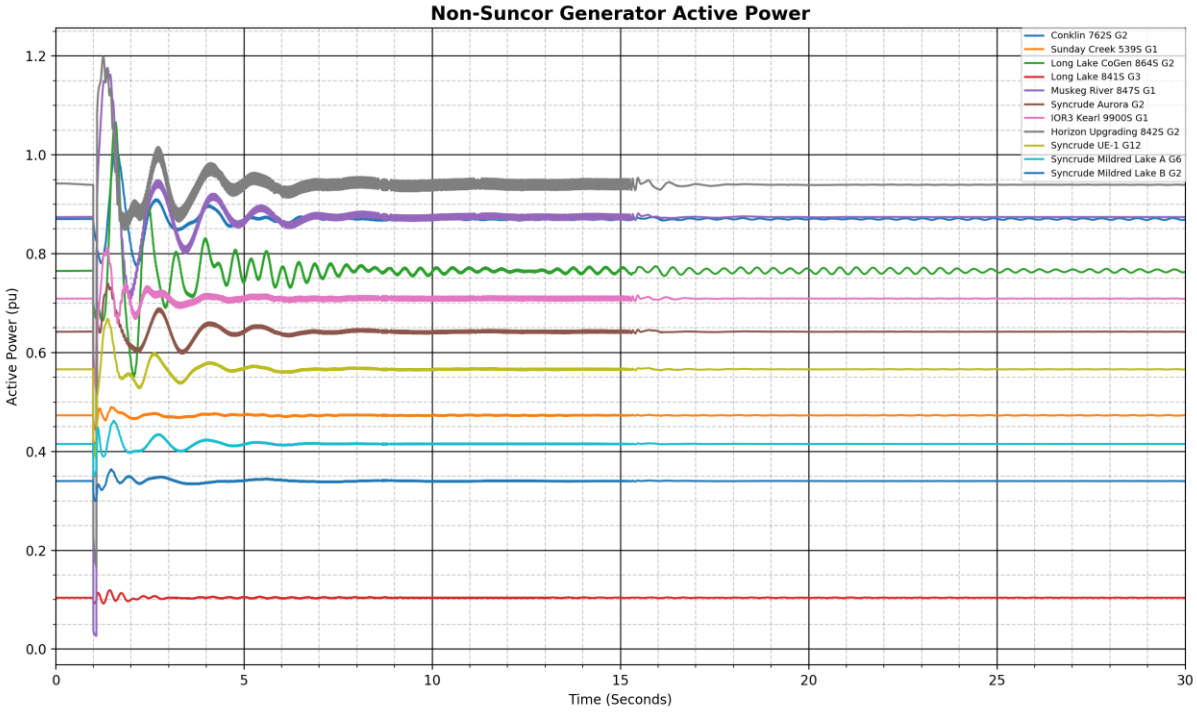
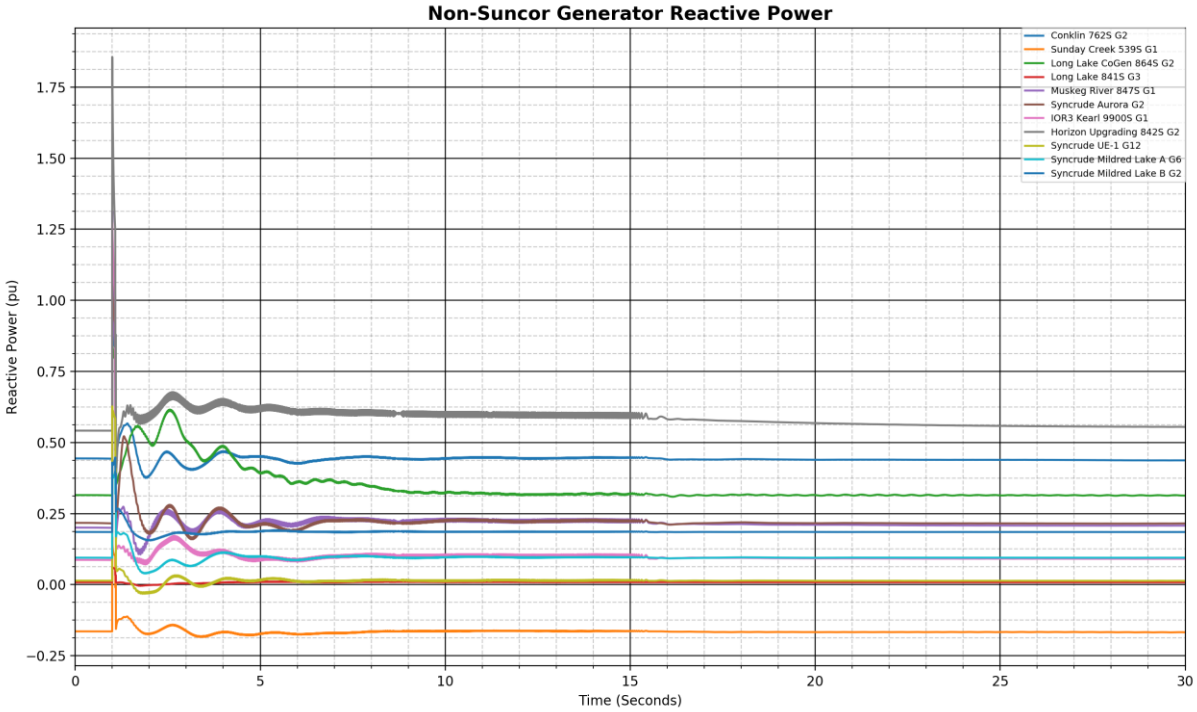

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

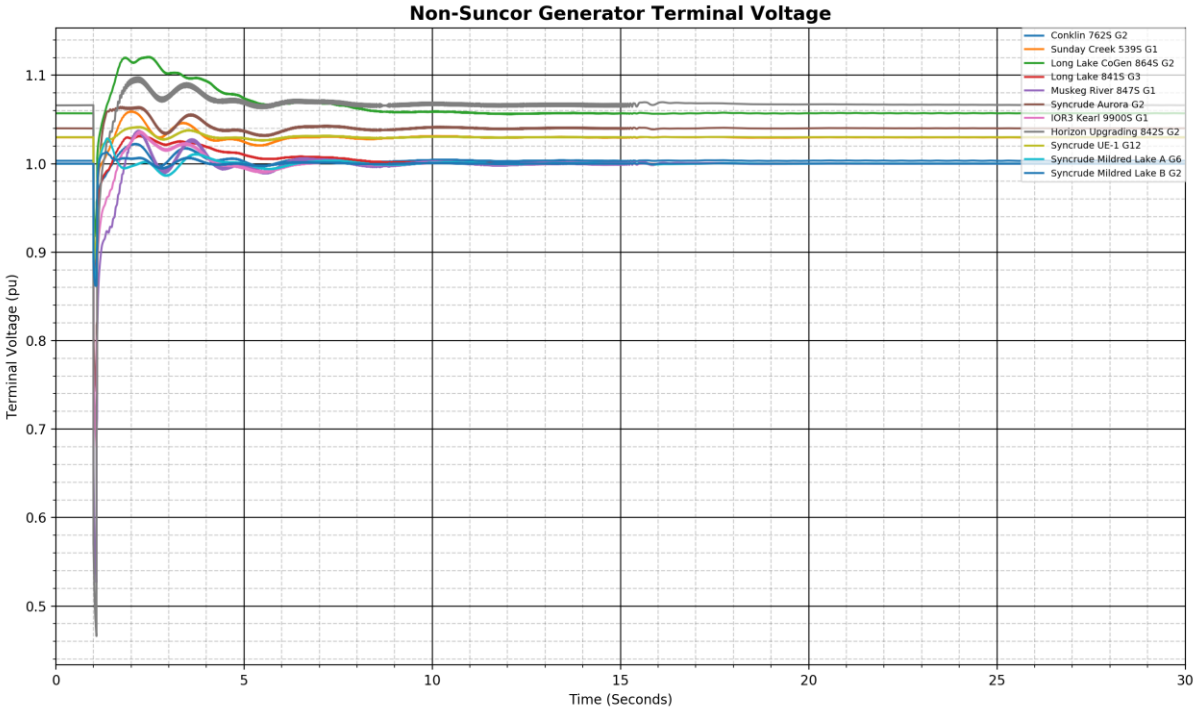
Figure A4-10: 9L08 (Dover 888S to Joslyn Creek 849S): Fault at Joslyn Creek 849S

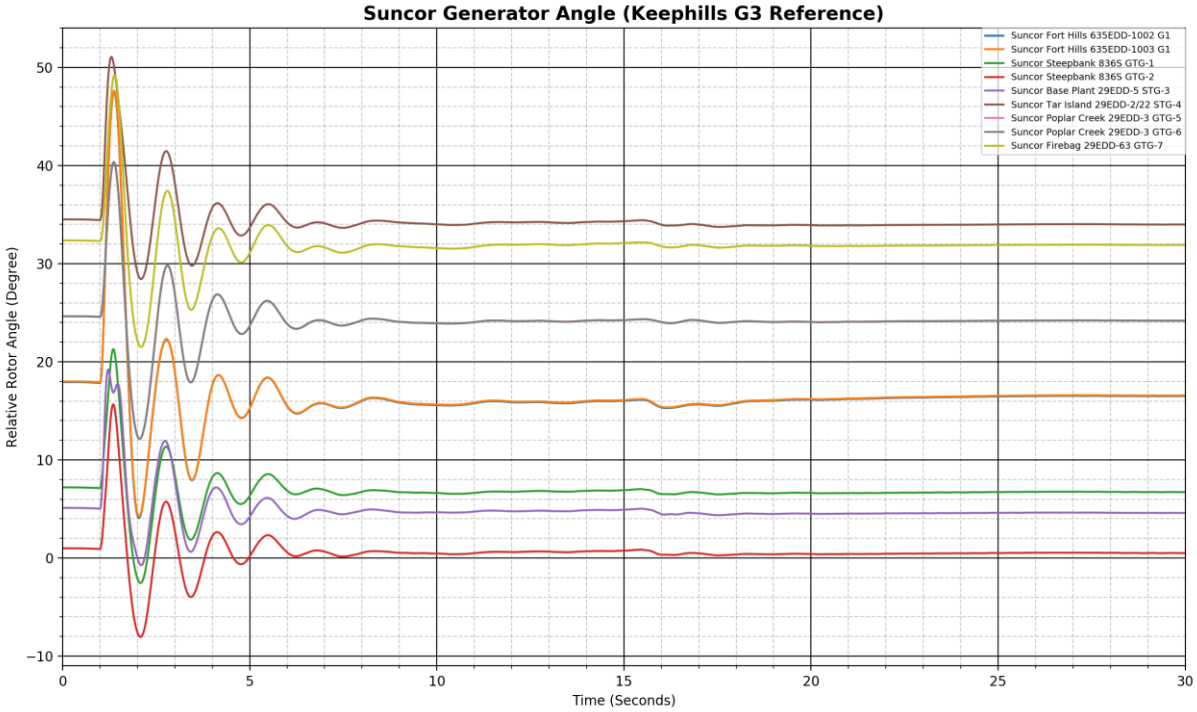


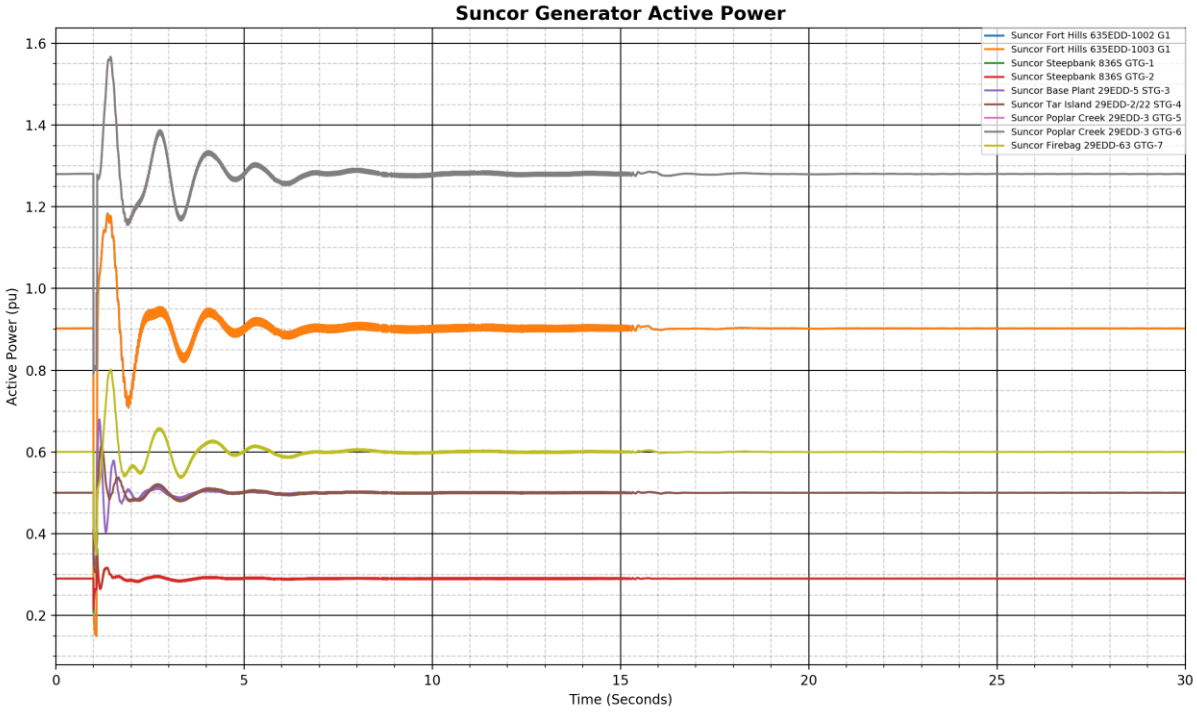

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

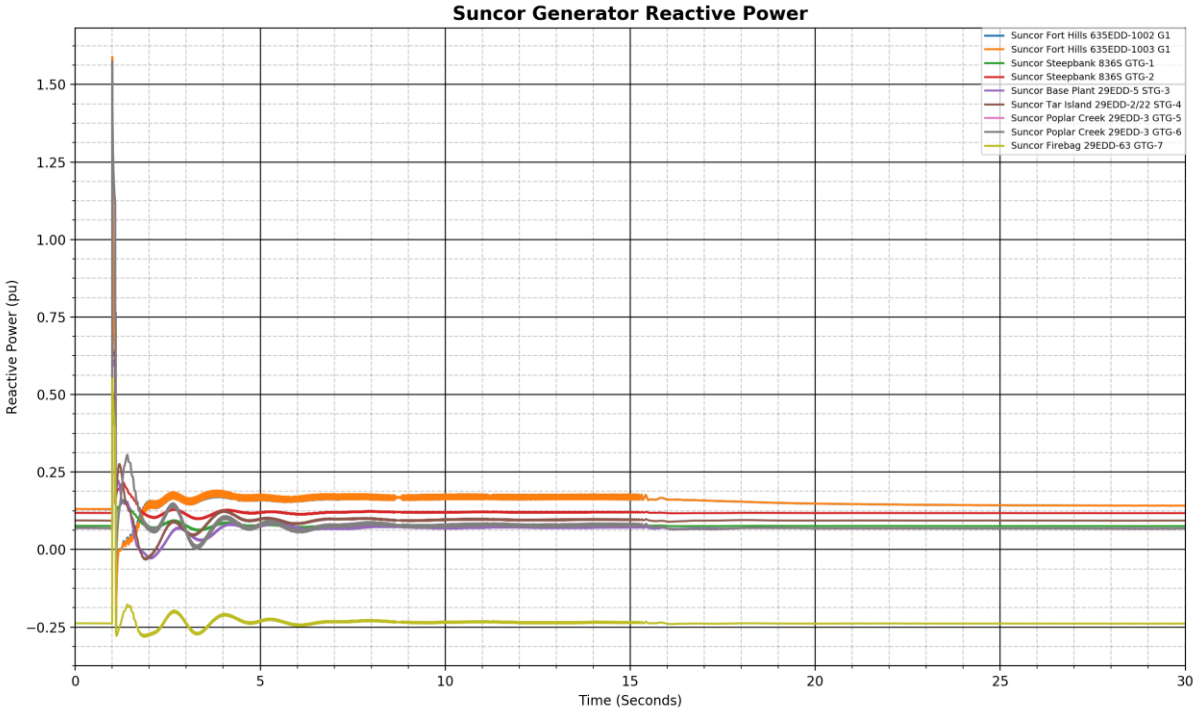

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

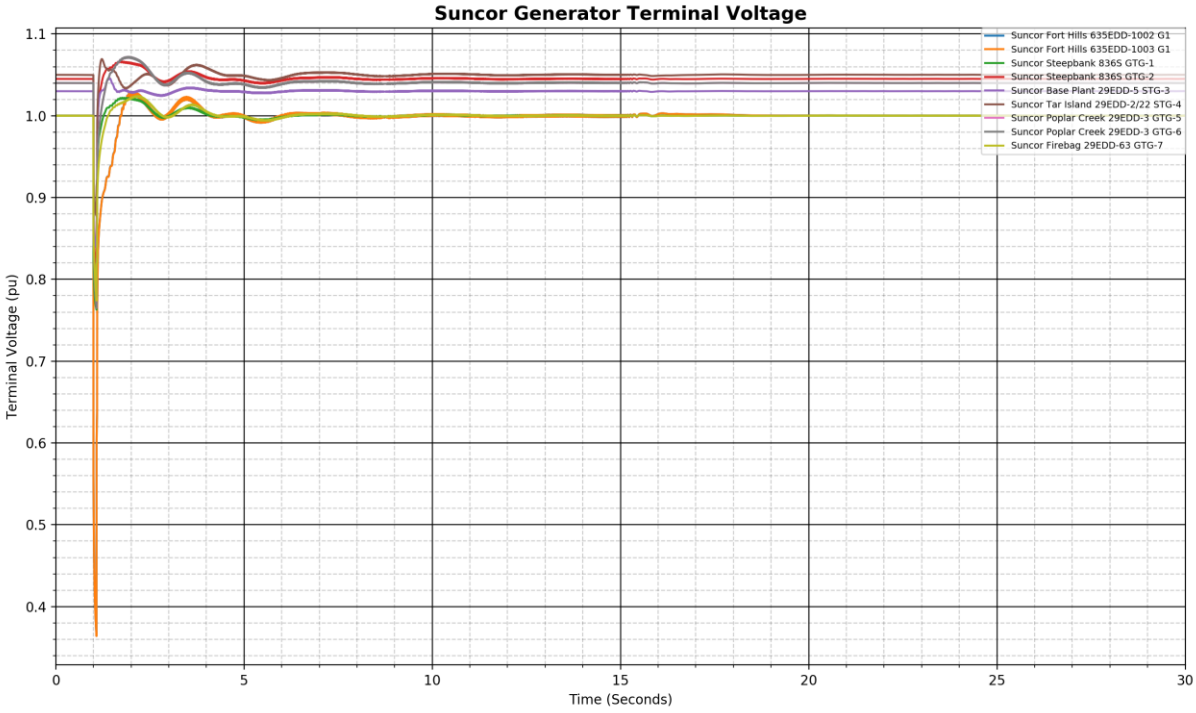

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

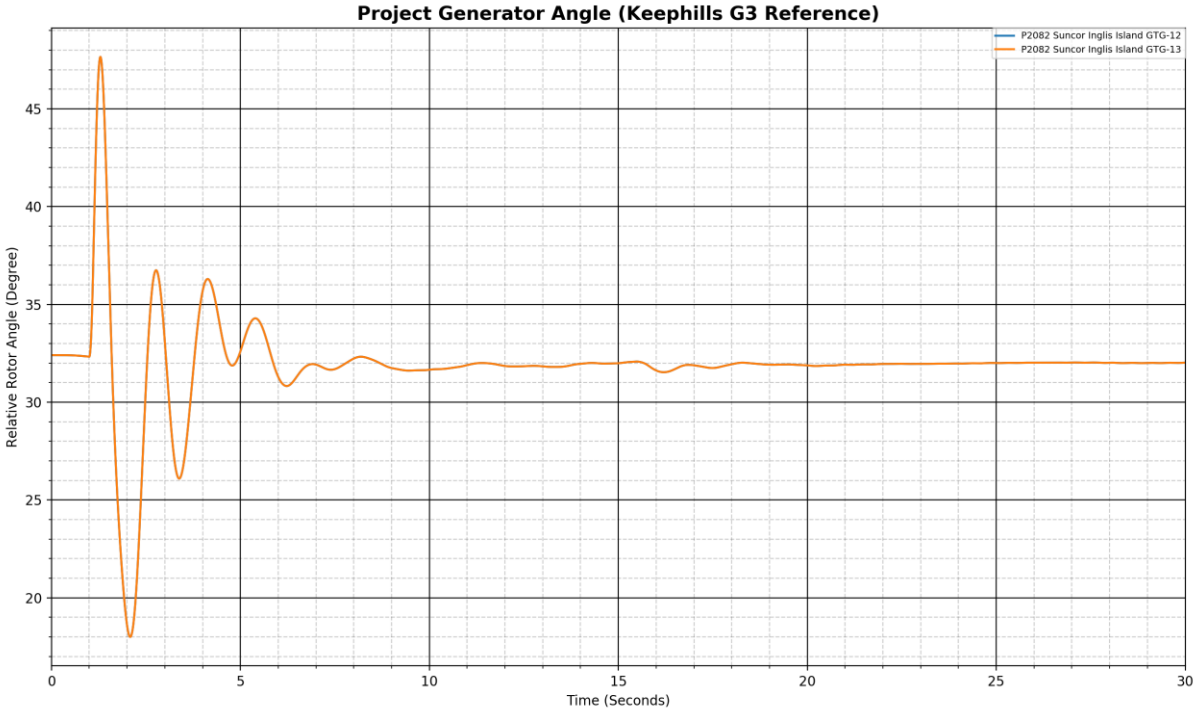

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

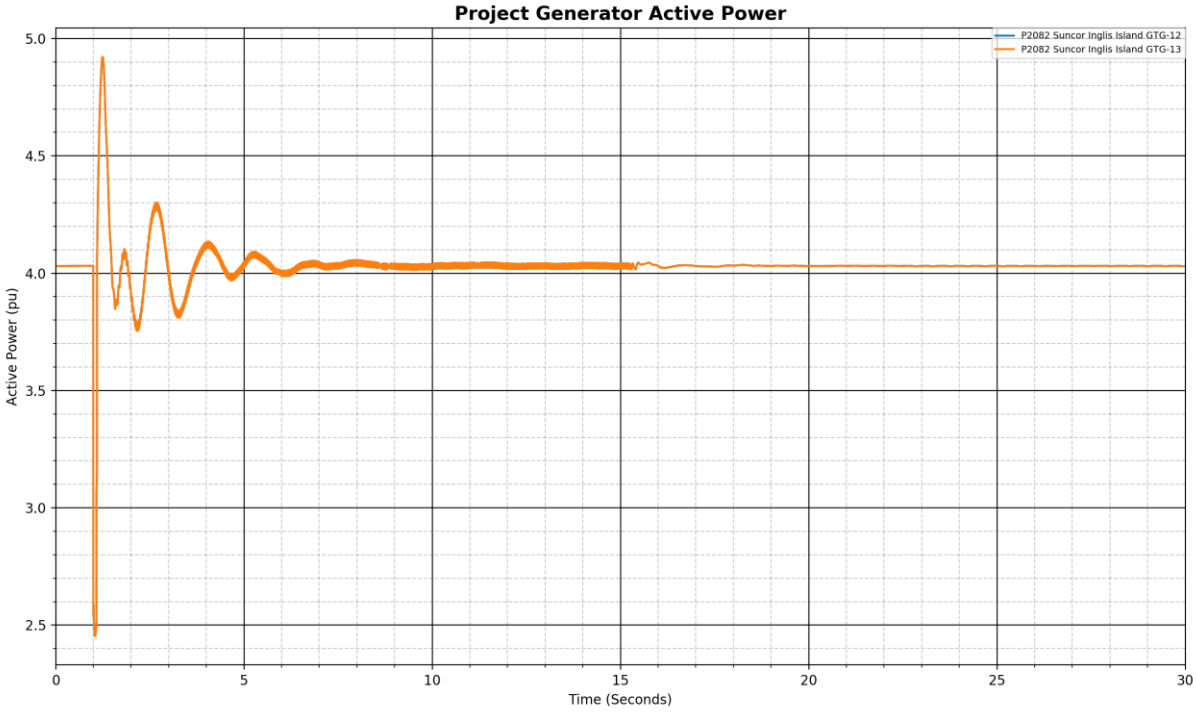

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

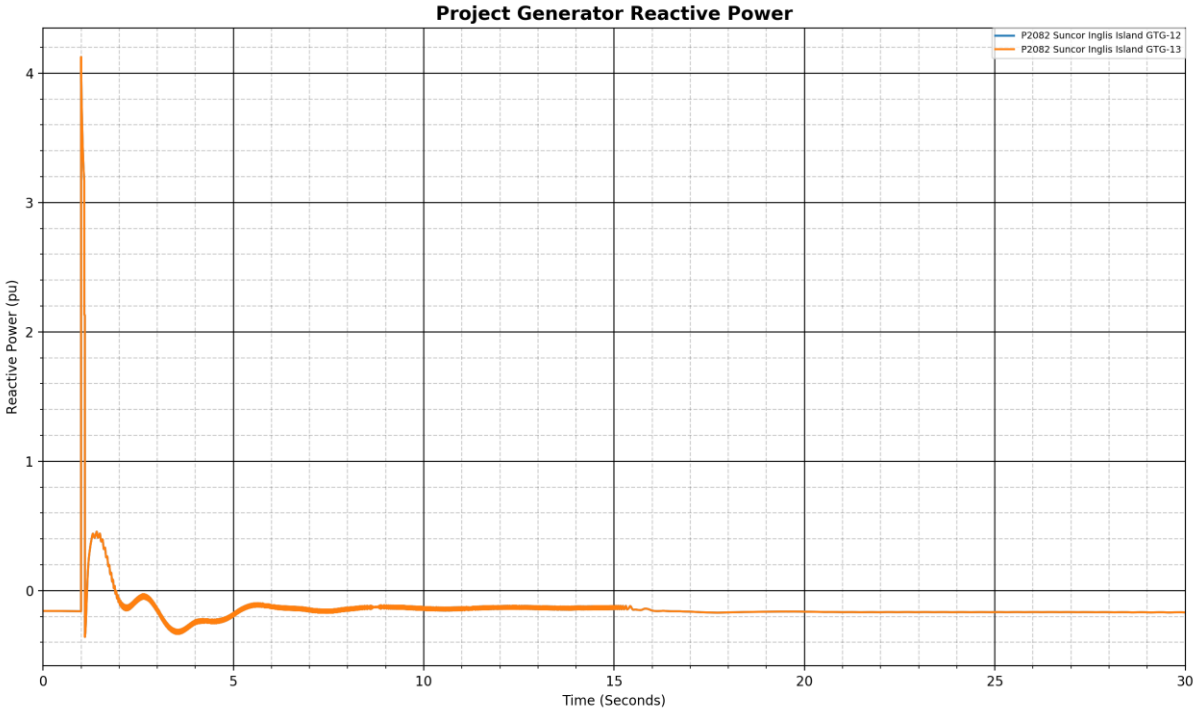

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

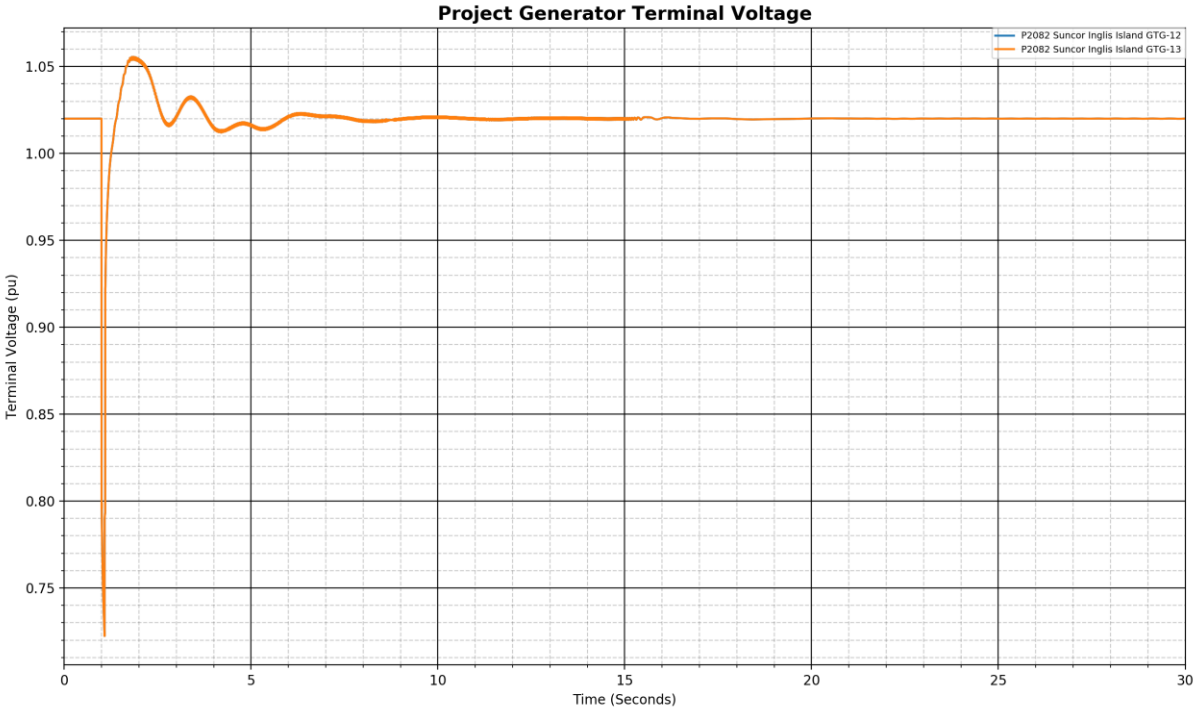

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

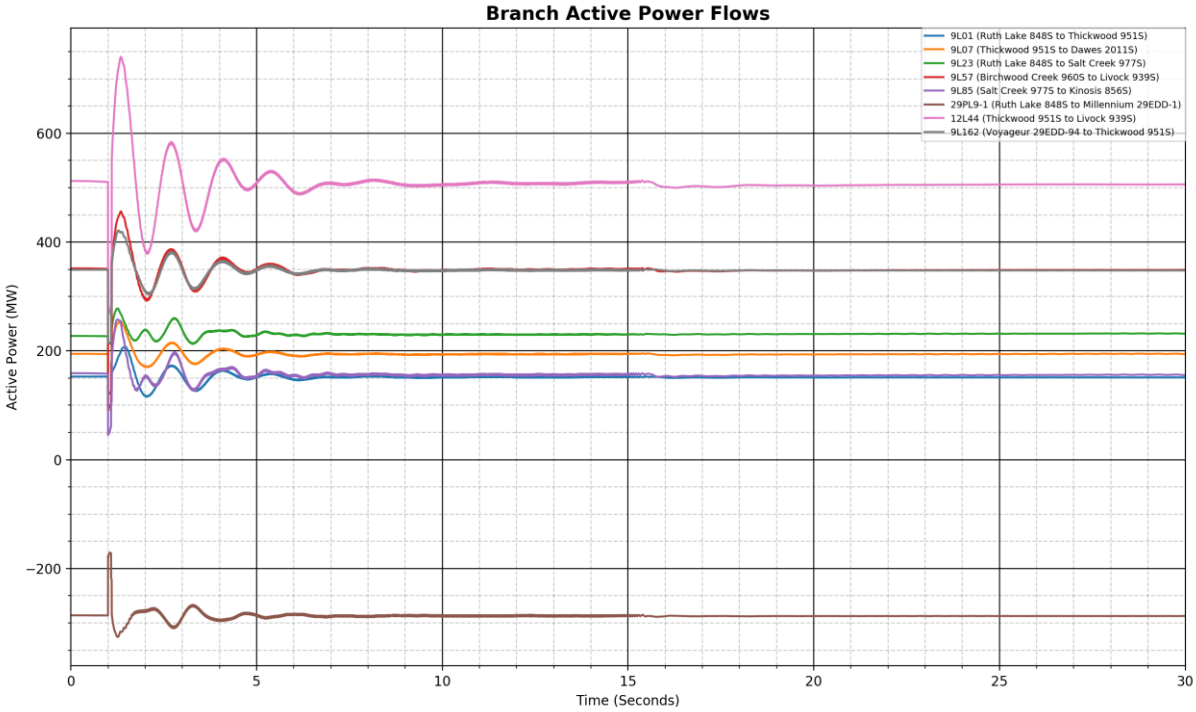

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
45
40
35
30
25
20
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5.0
4.5
4.0
3.5
3.0
2.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.75
0.80
0.85
0.90
0.95
1.00
1.05
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

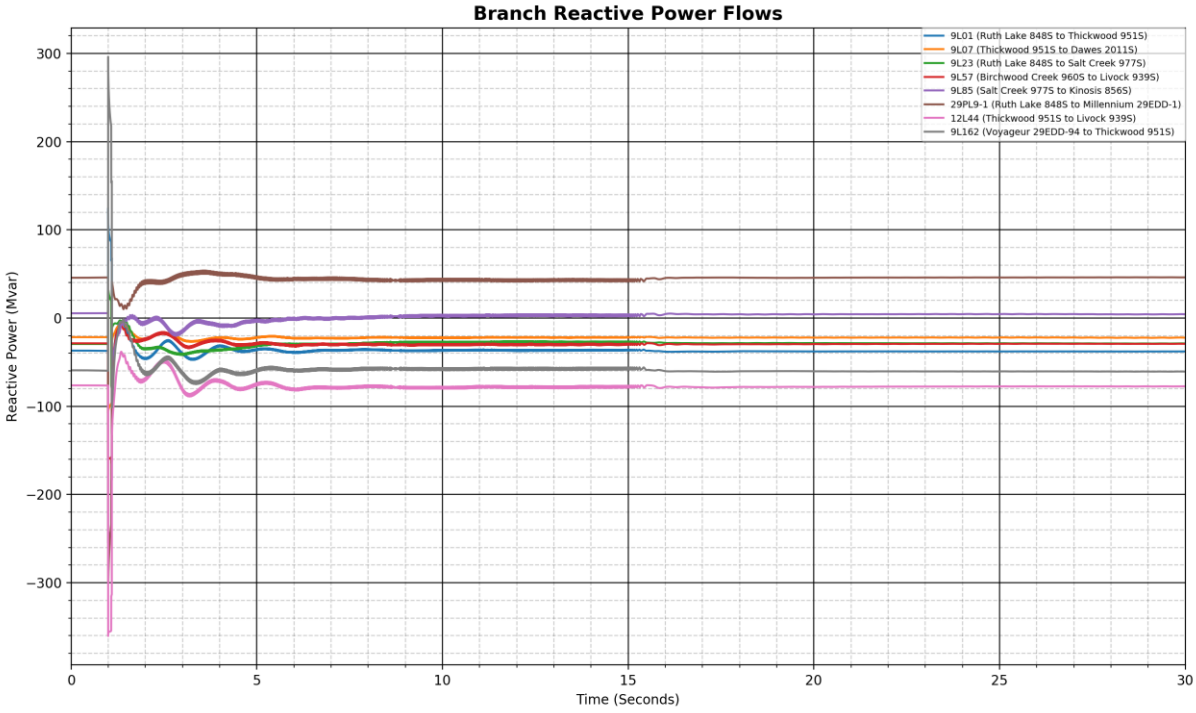
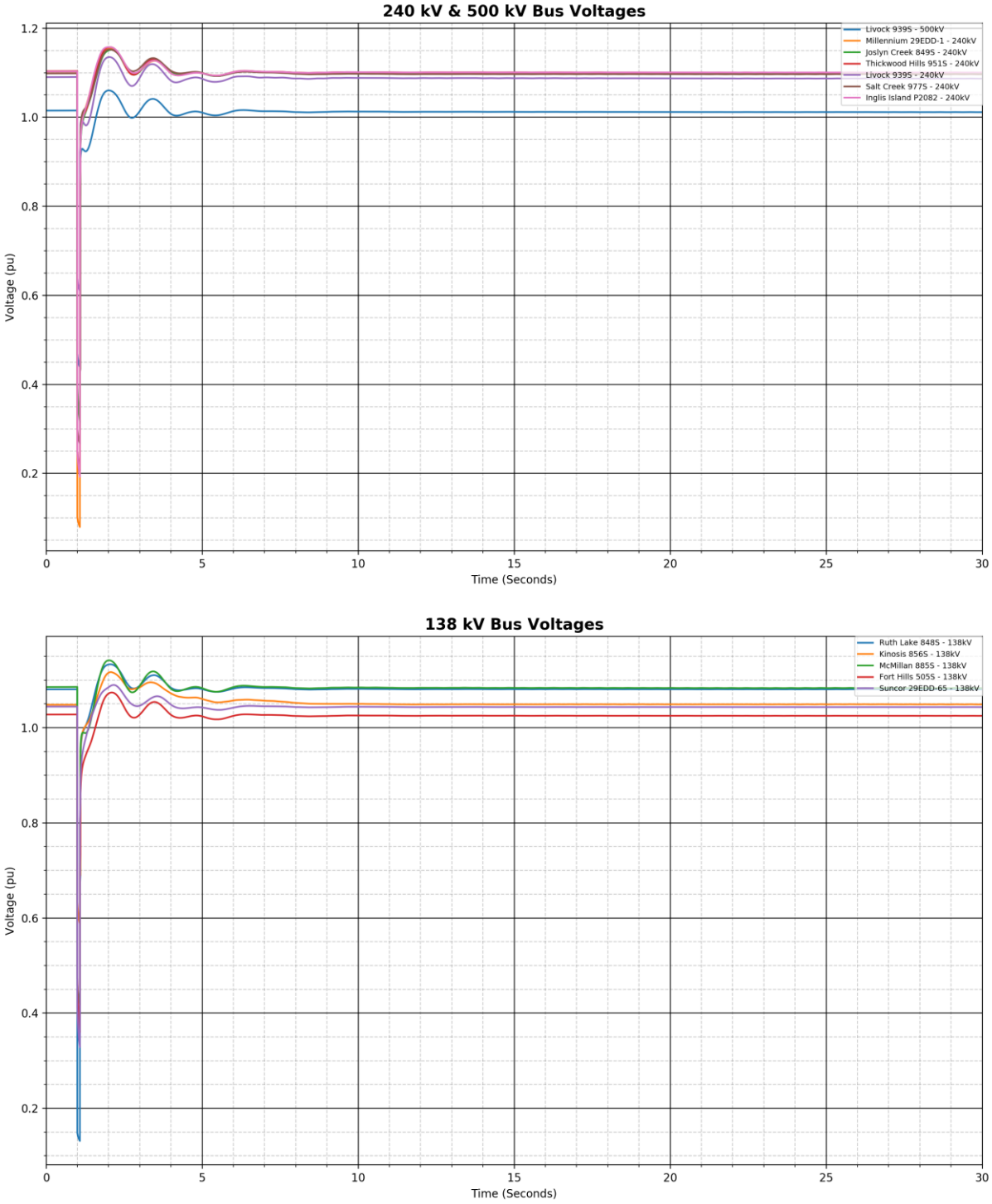
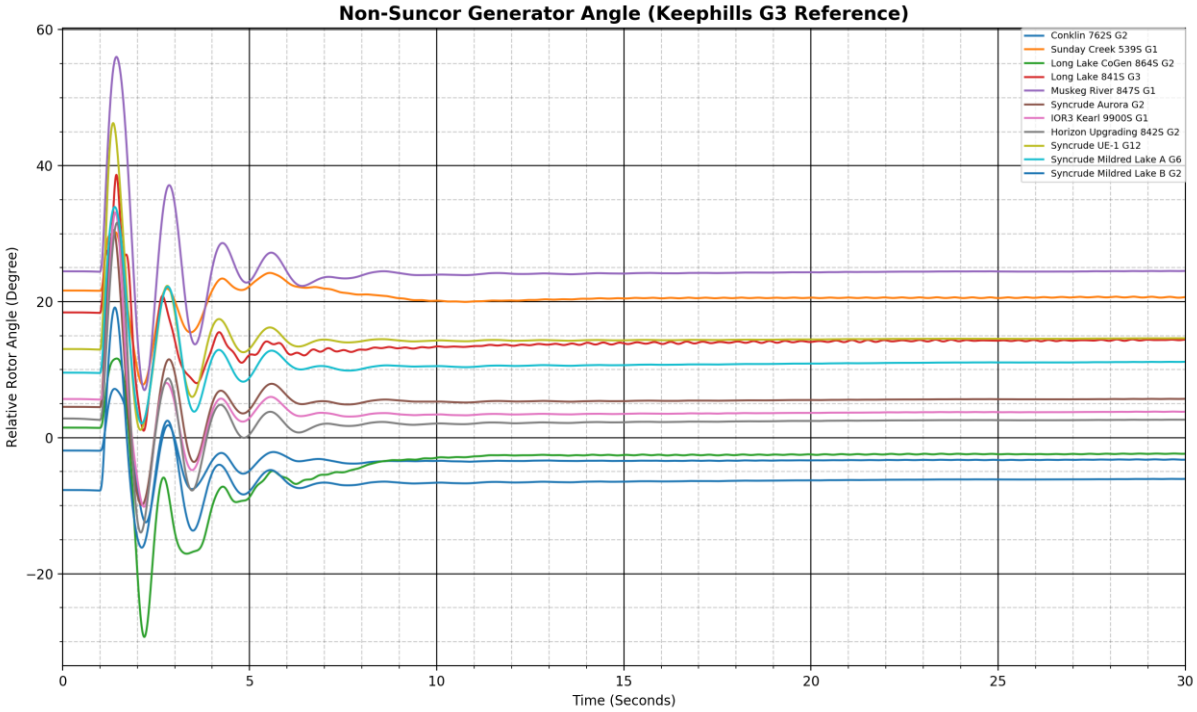
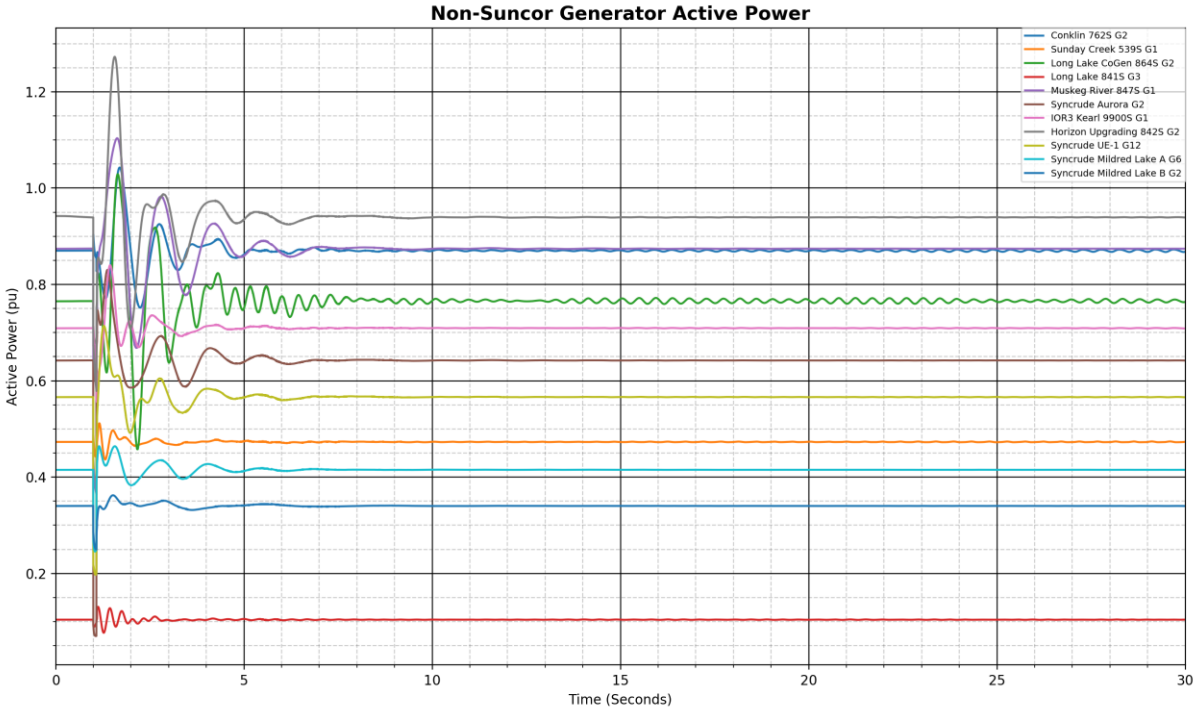
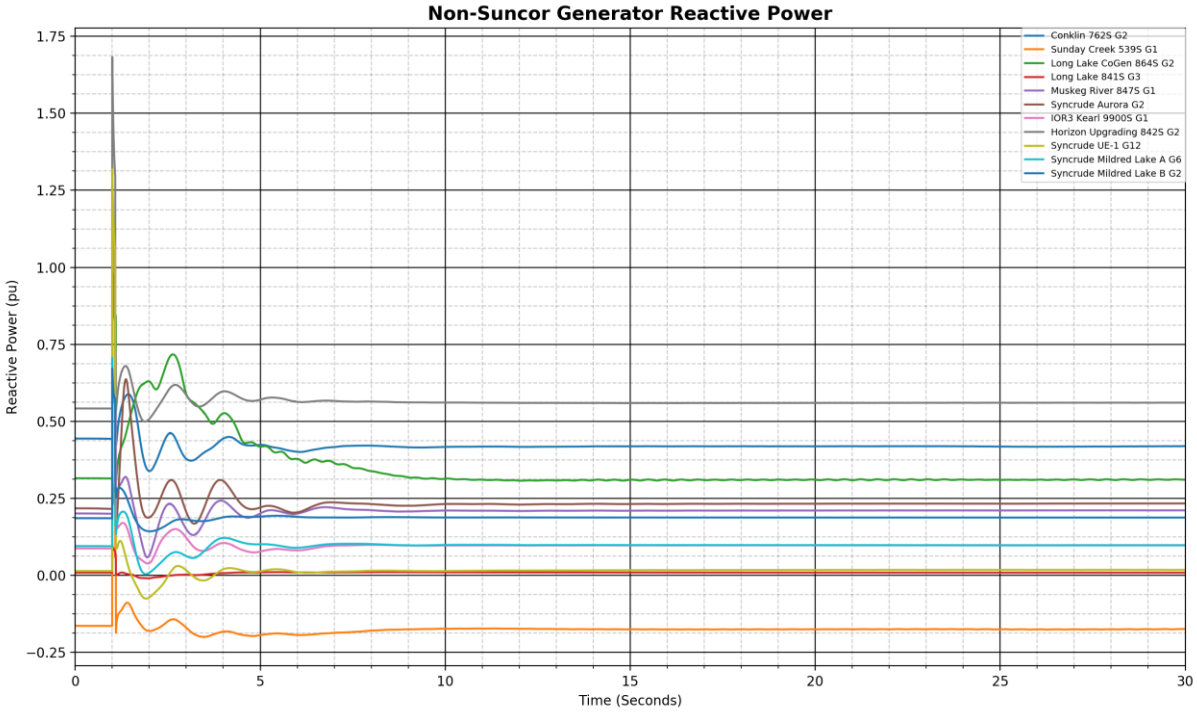

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

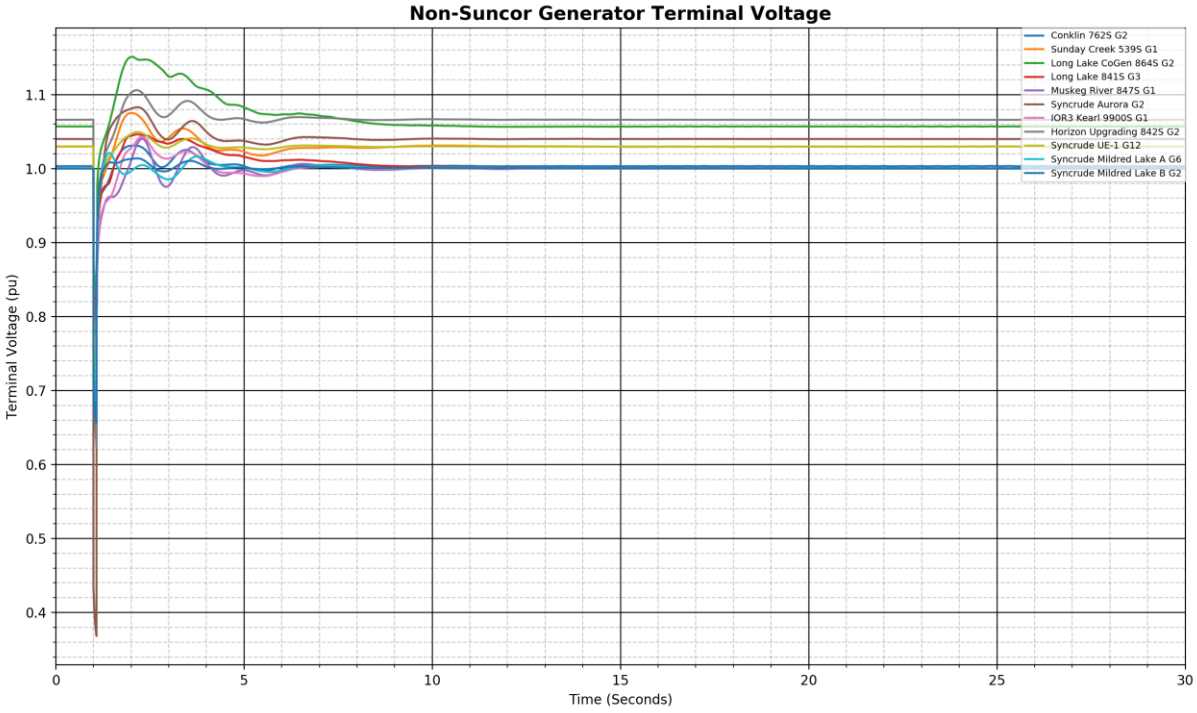
Figure A4-11: 9L23 (Ruth Lake 848S to Salt Creek 977S): Fault at Ruth Lake 848S

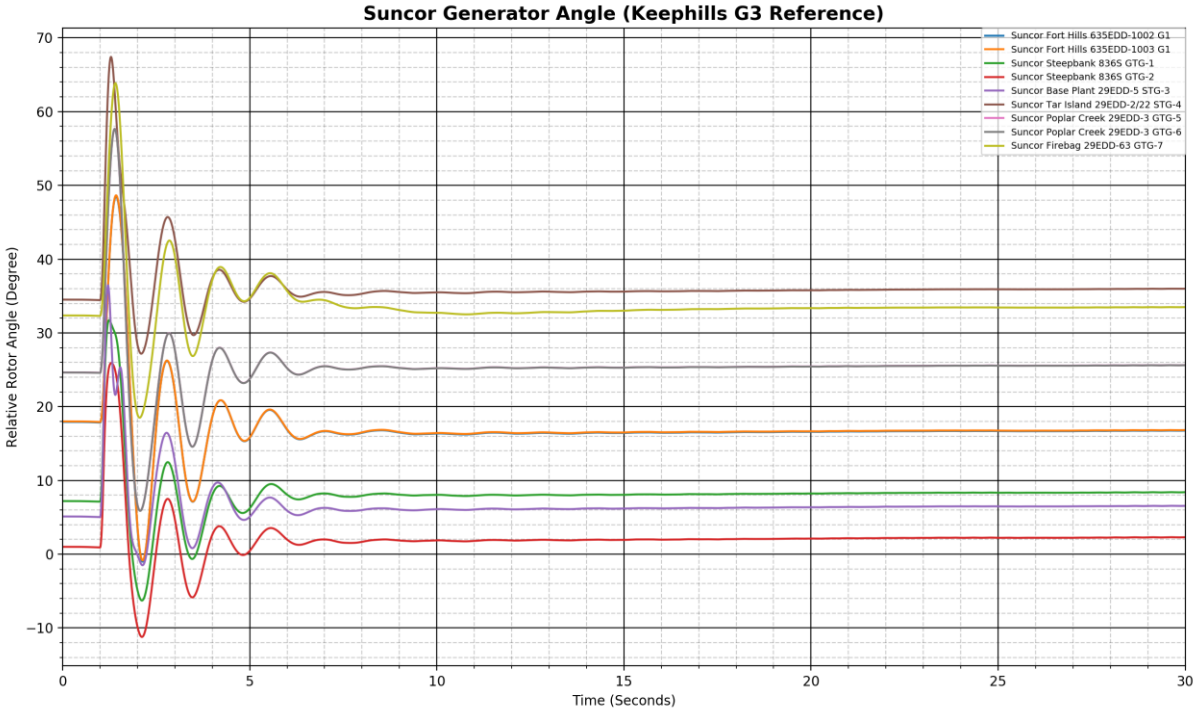


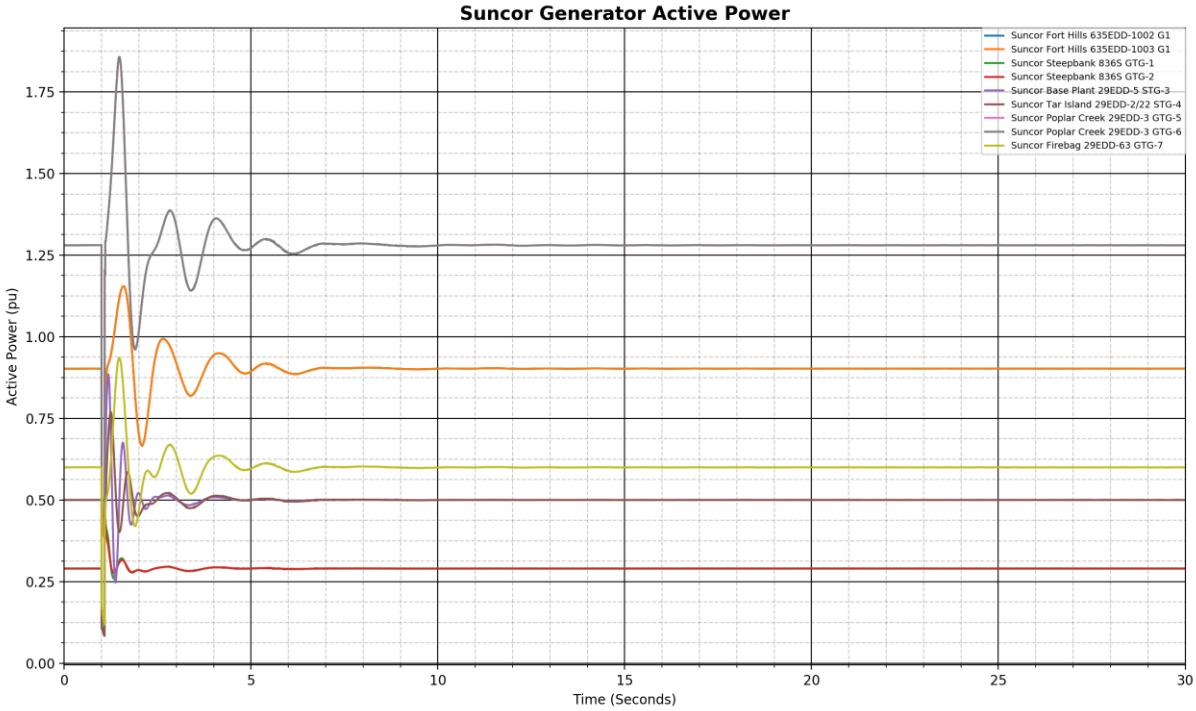

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

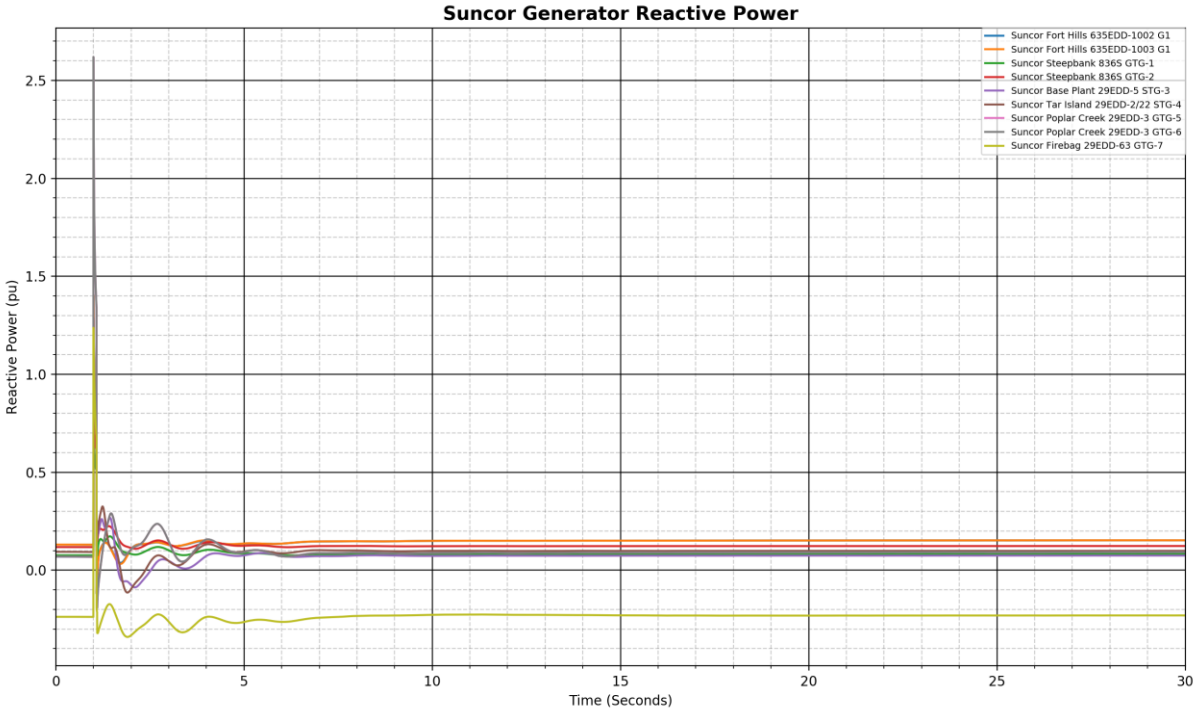

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

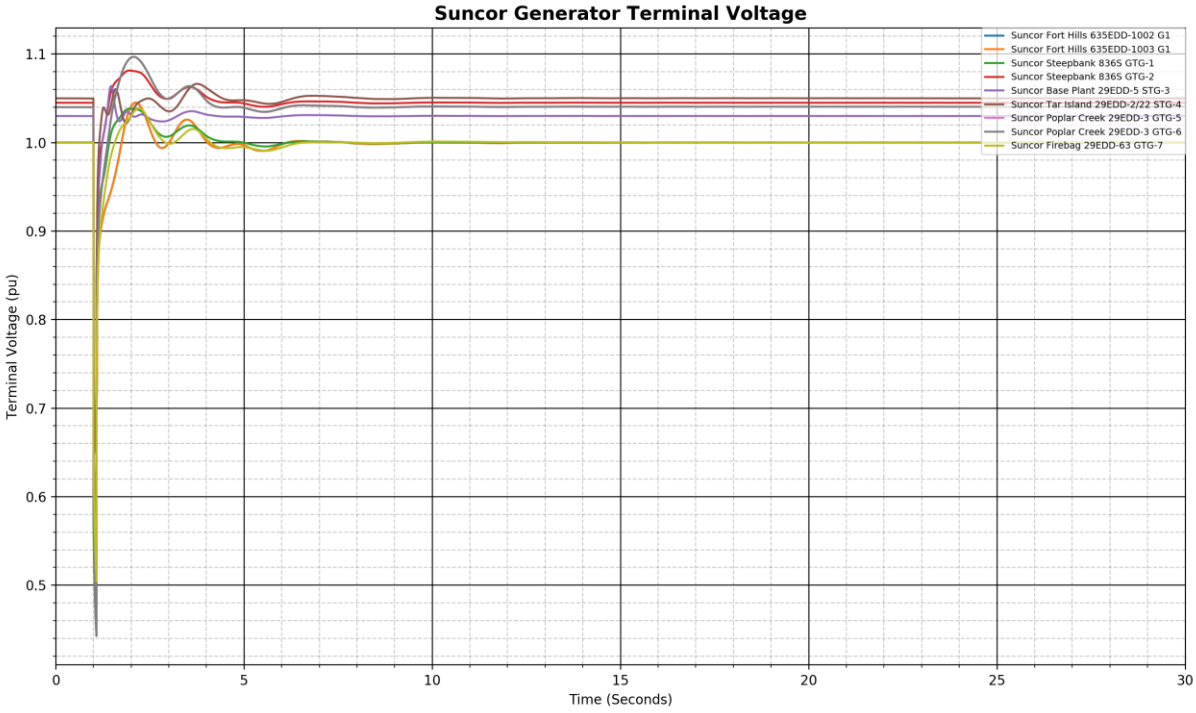

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

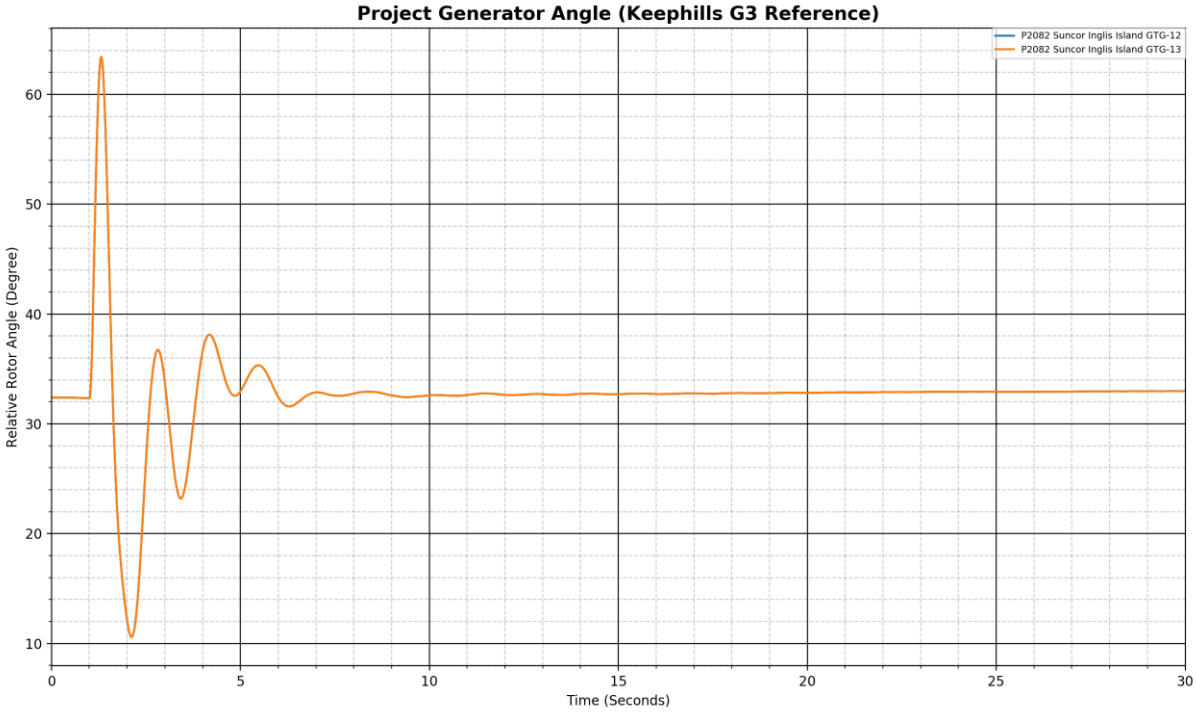

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

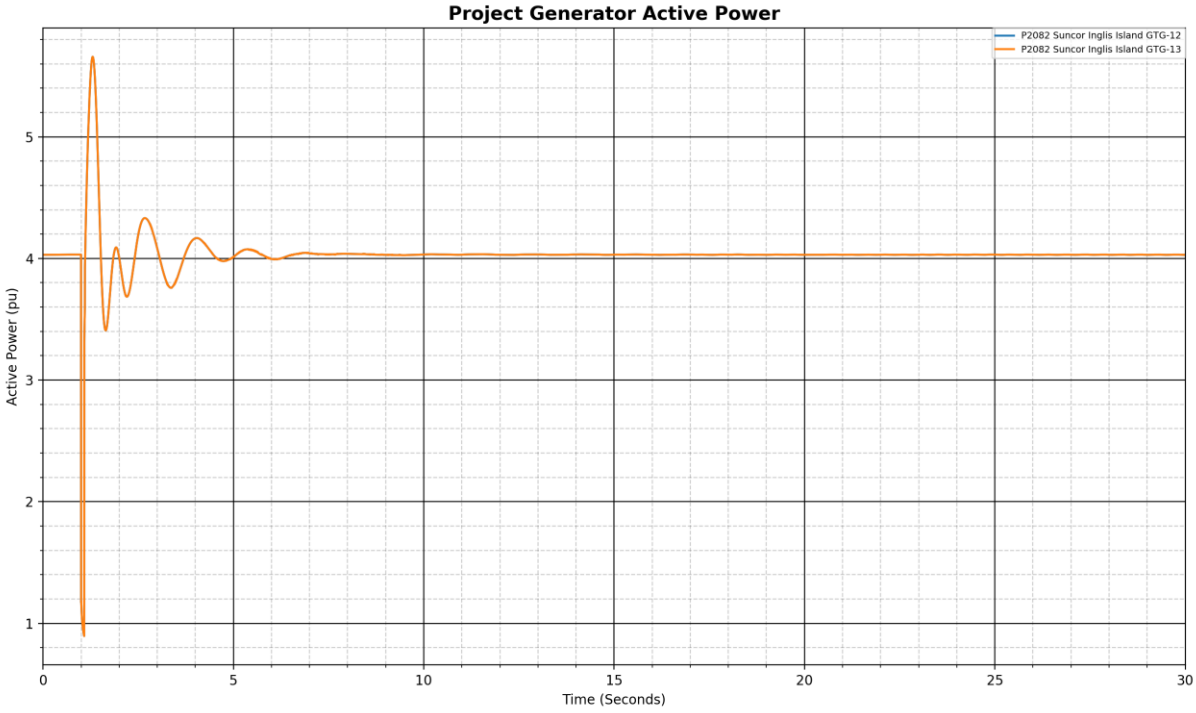

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

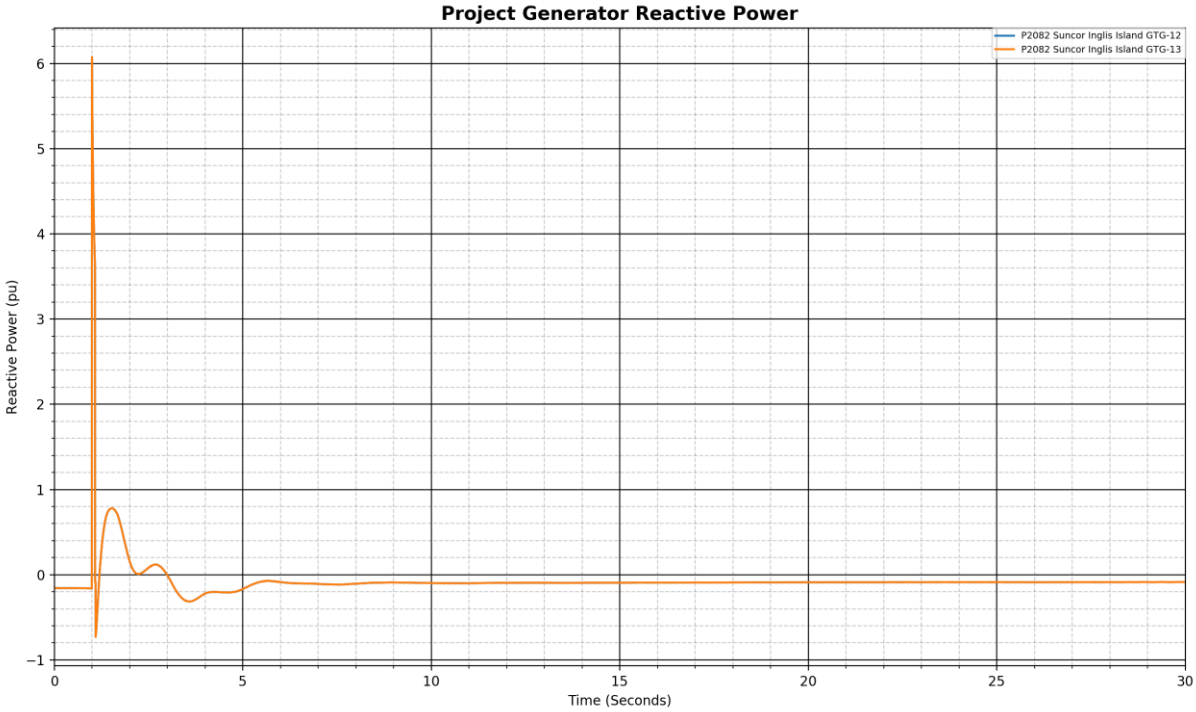

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

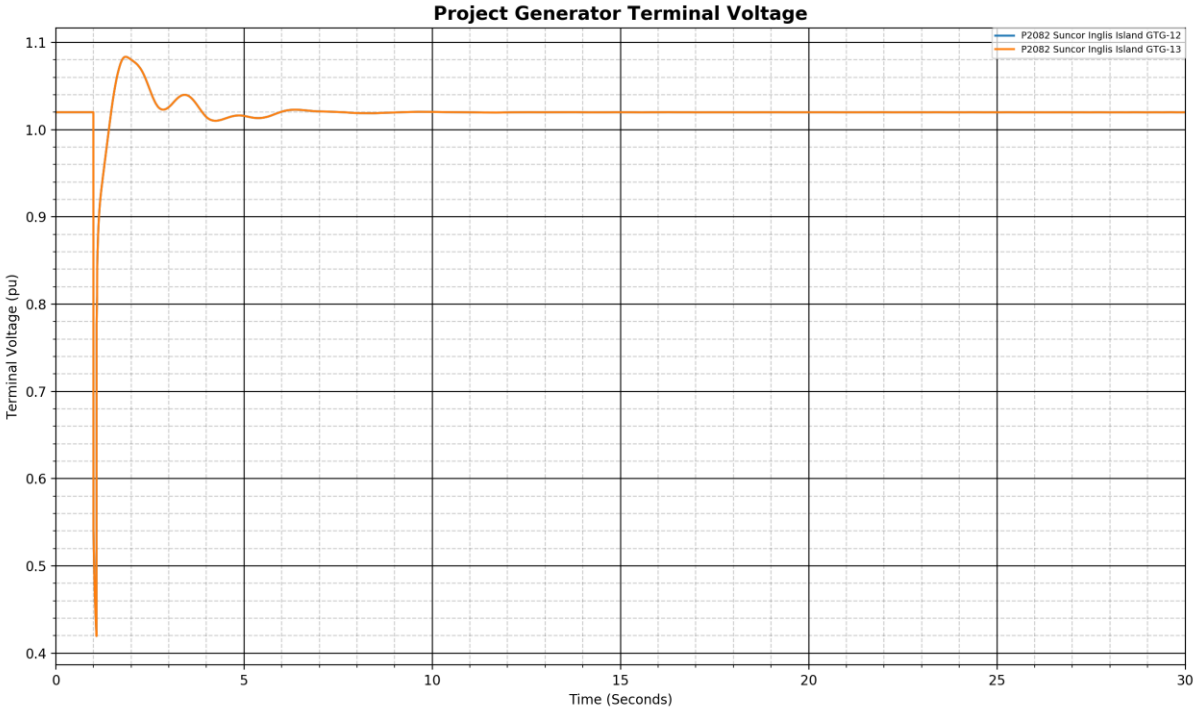

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

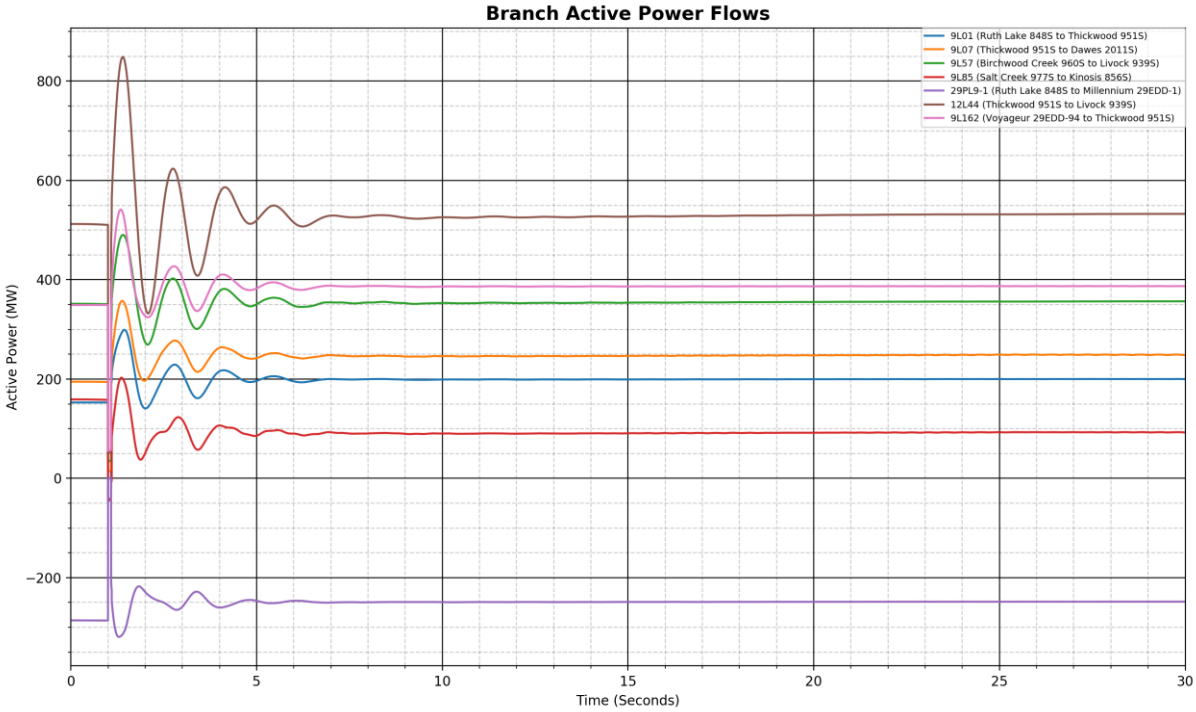

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
10
20
30
40
50
60
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

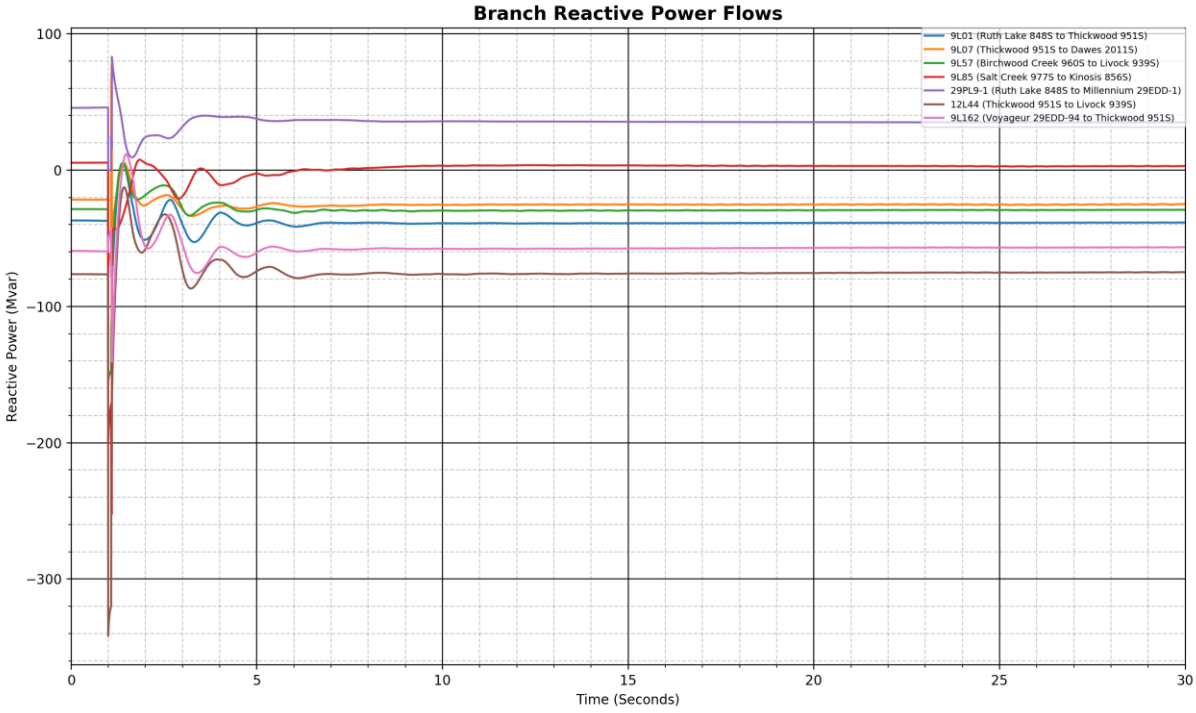
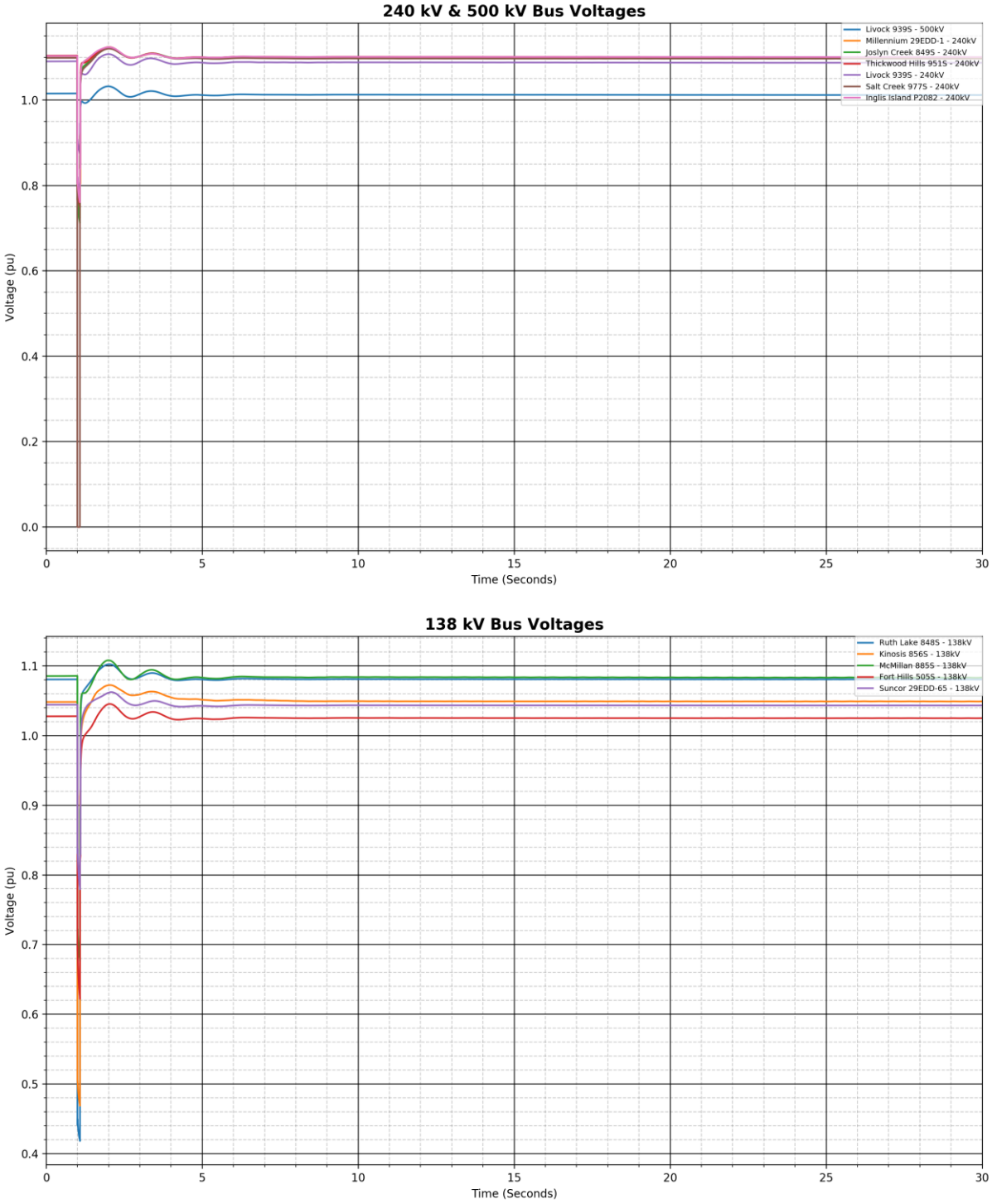
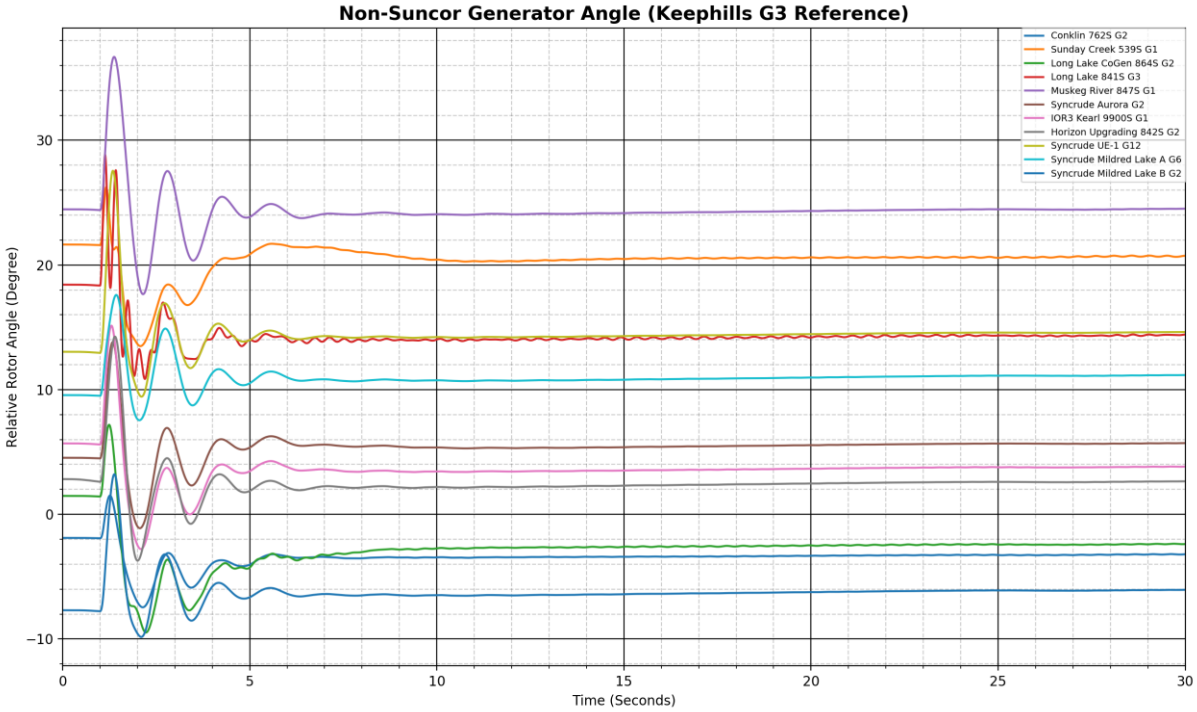
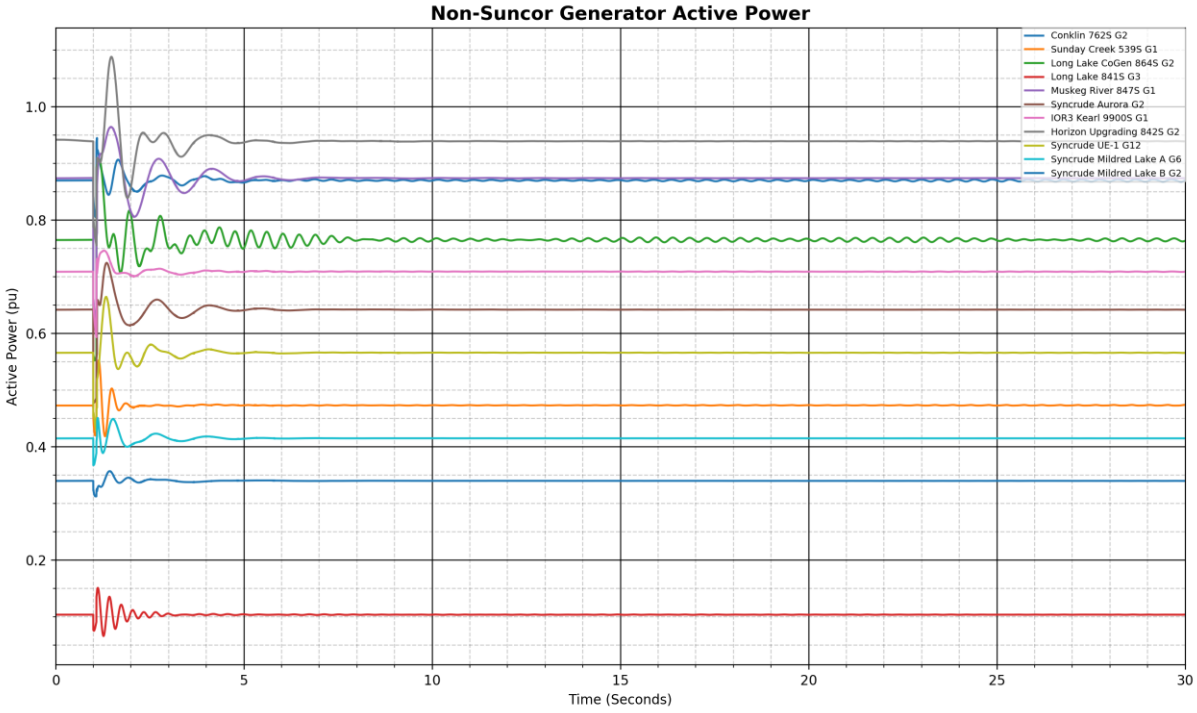
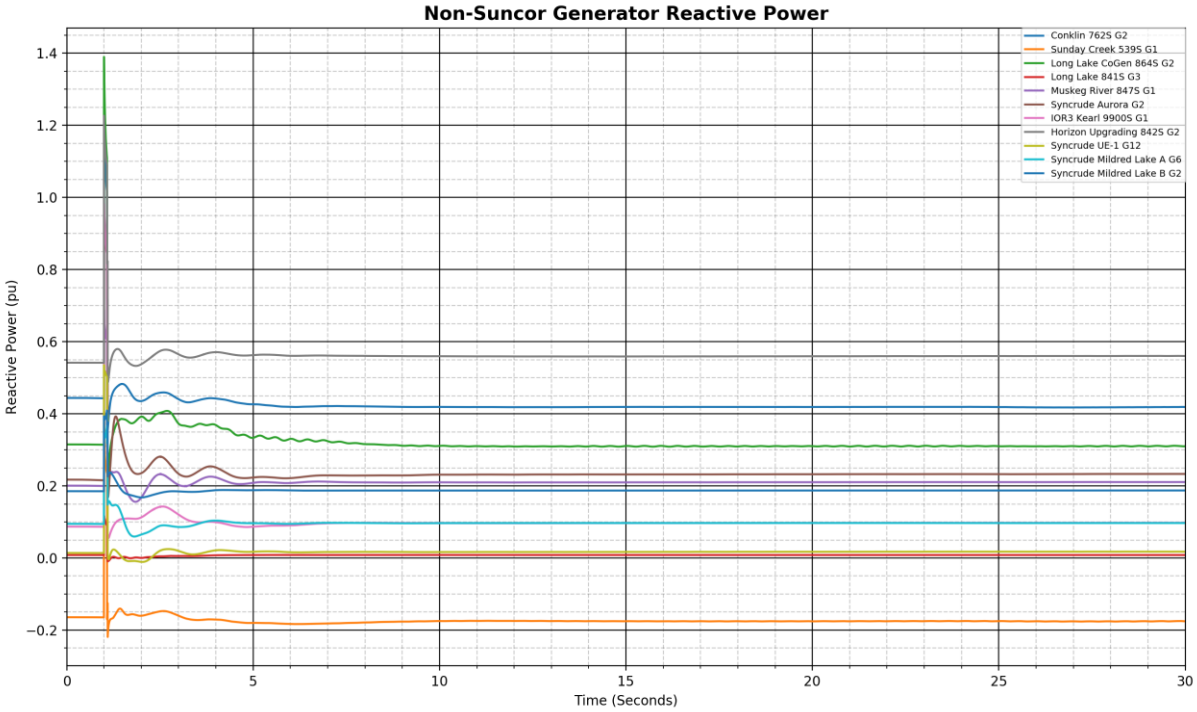

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

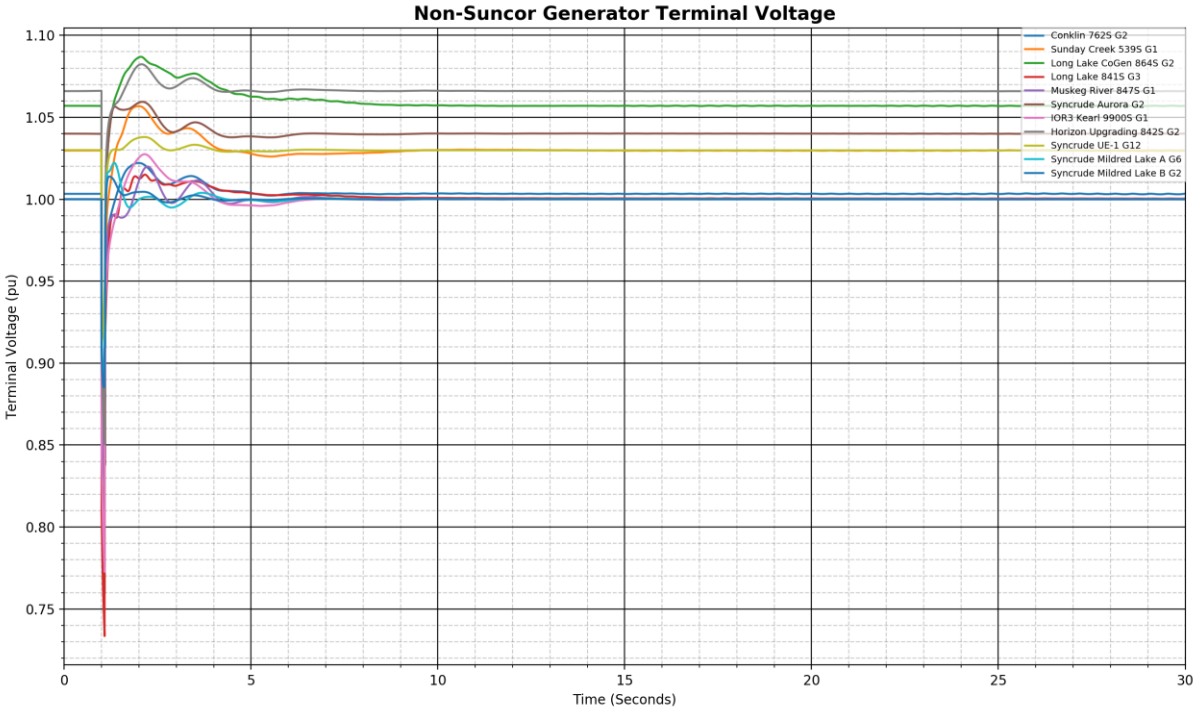
Figure A4-12: 9L23 (Ruth Lake 848S to Salt Creek 977S): Fault at Salt Creek 977S

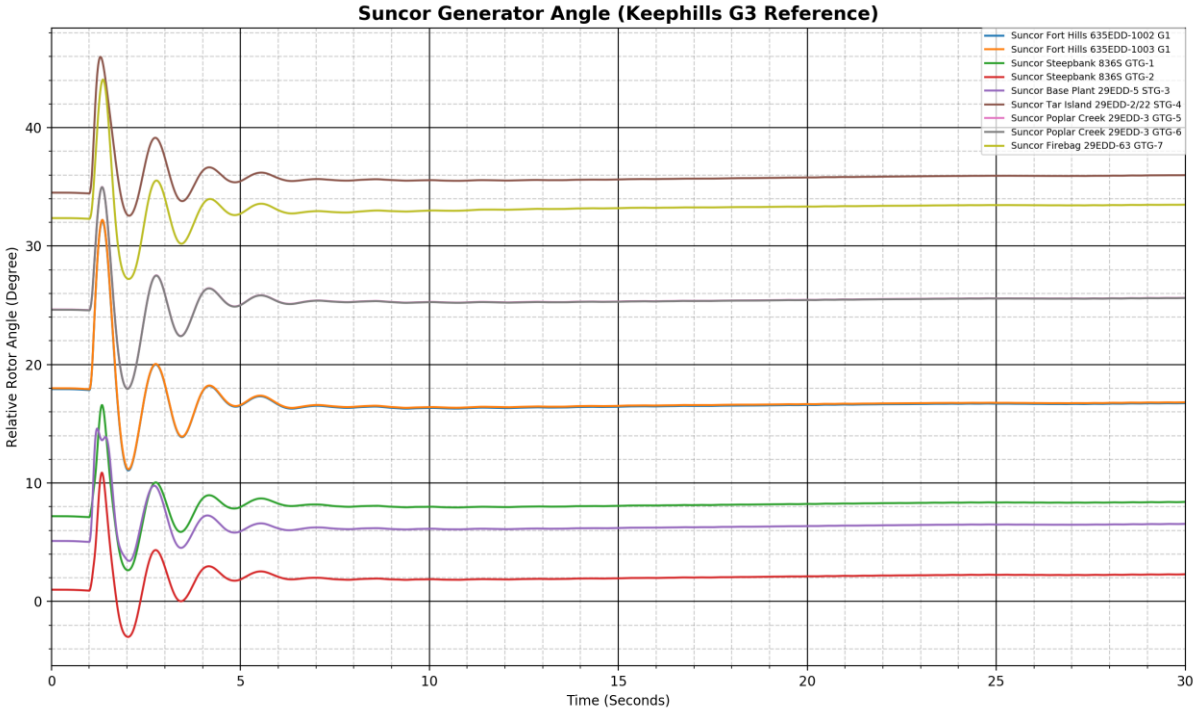


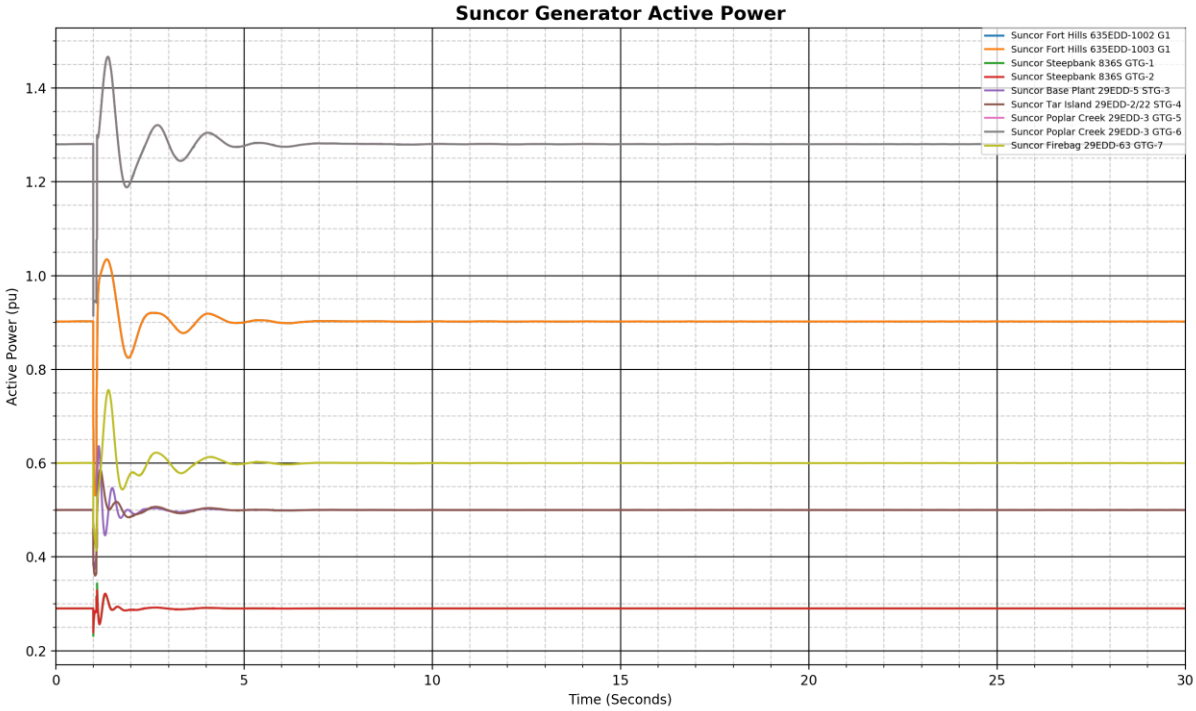

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

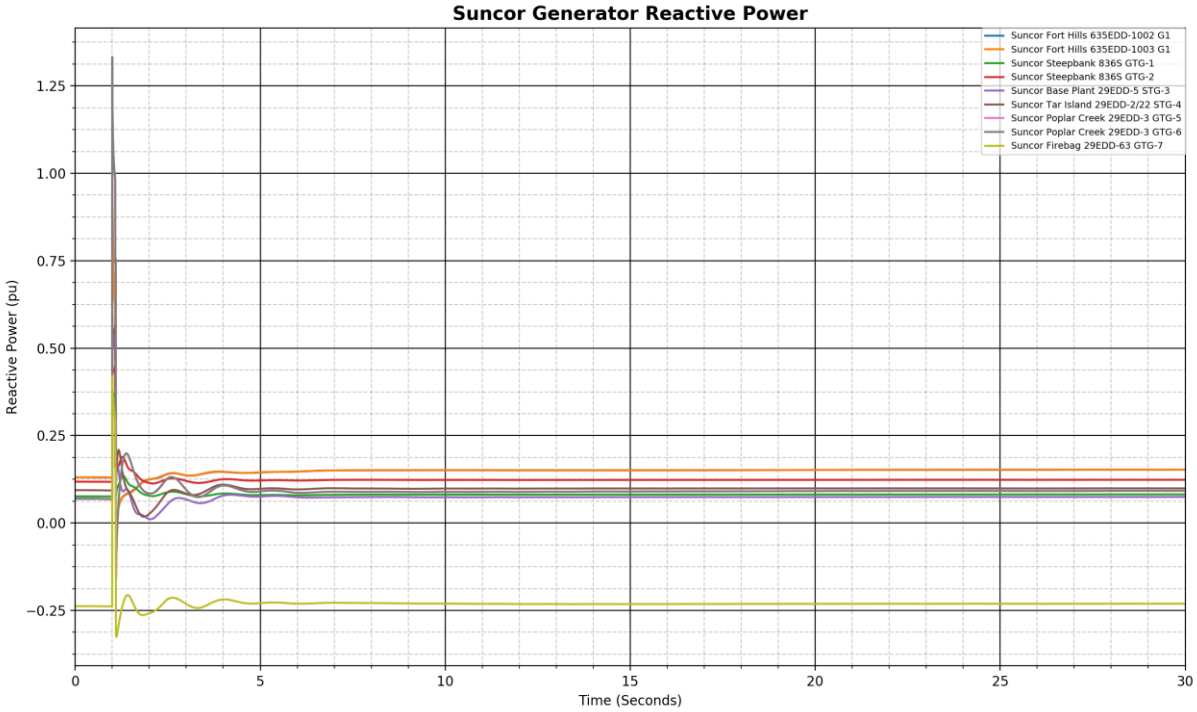

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

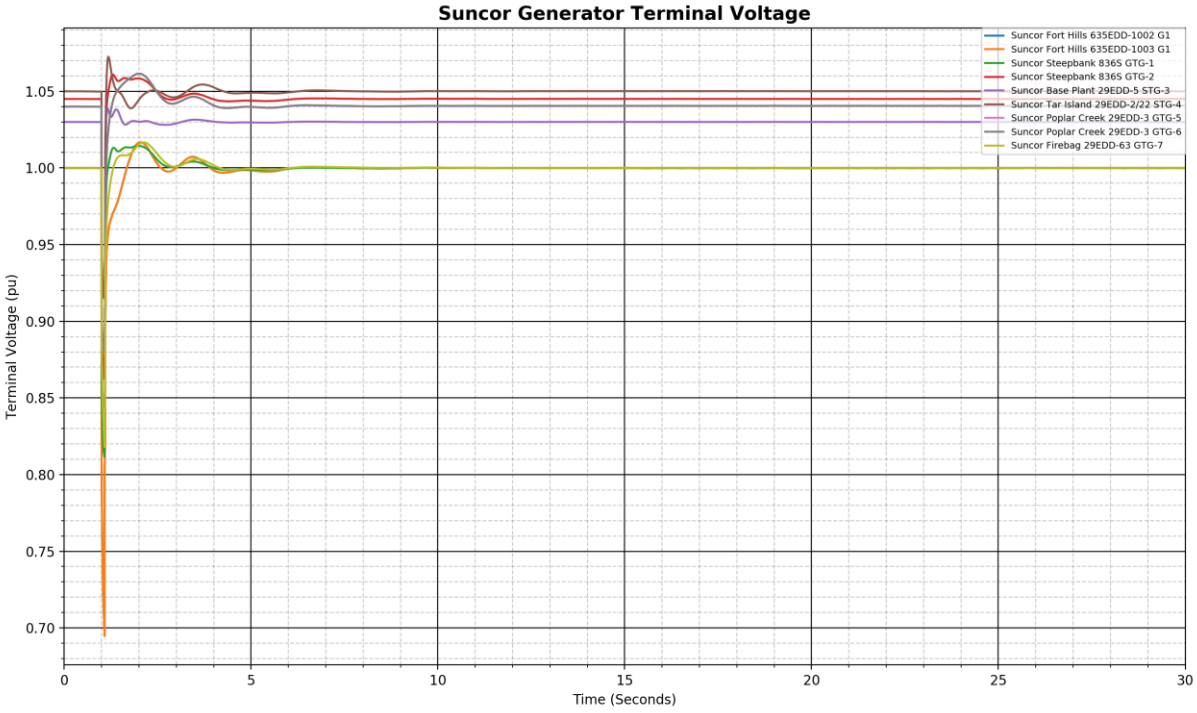

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

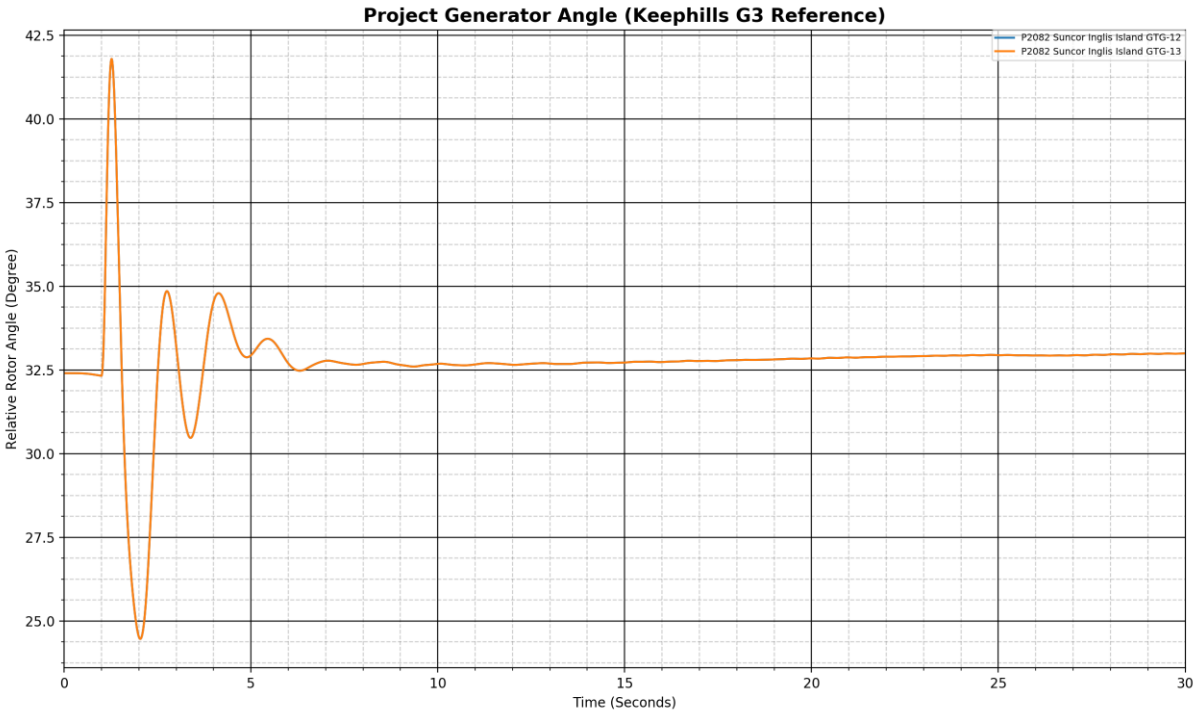

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

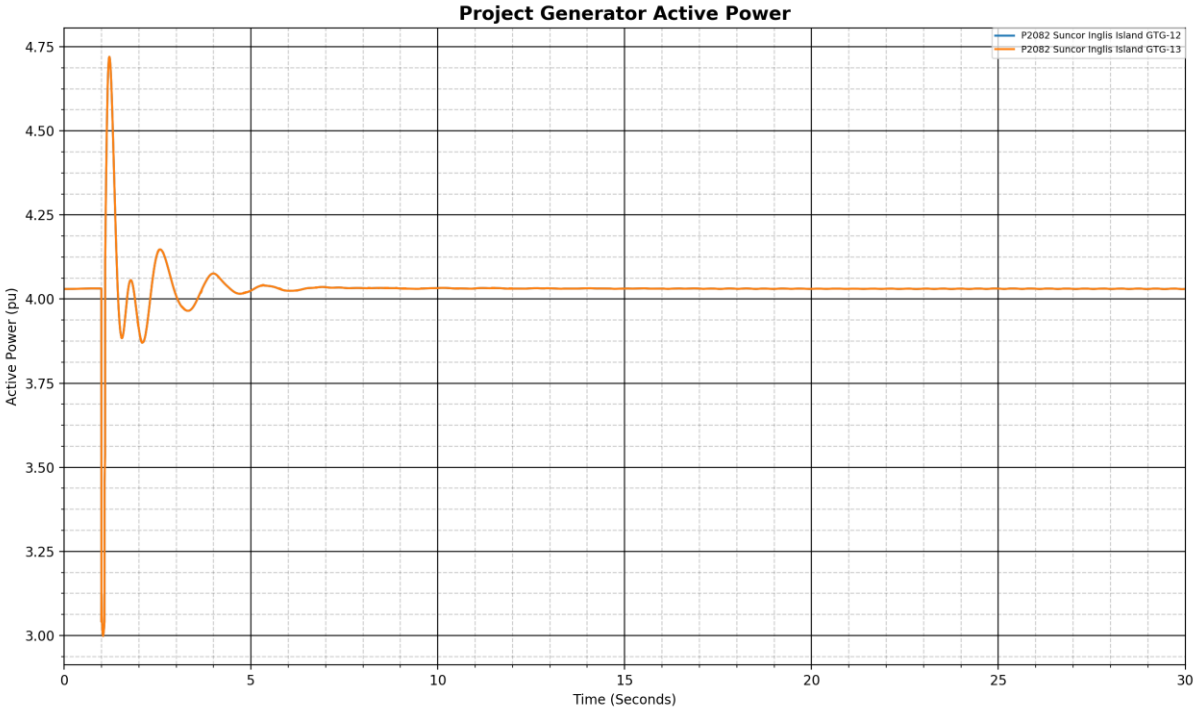

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

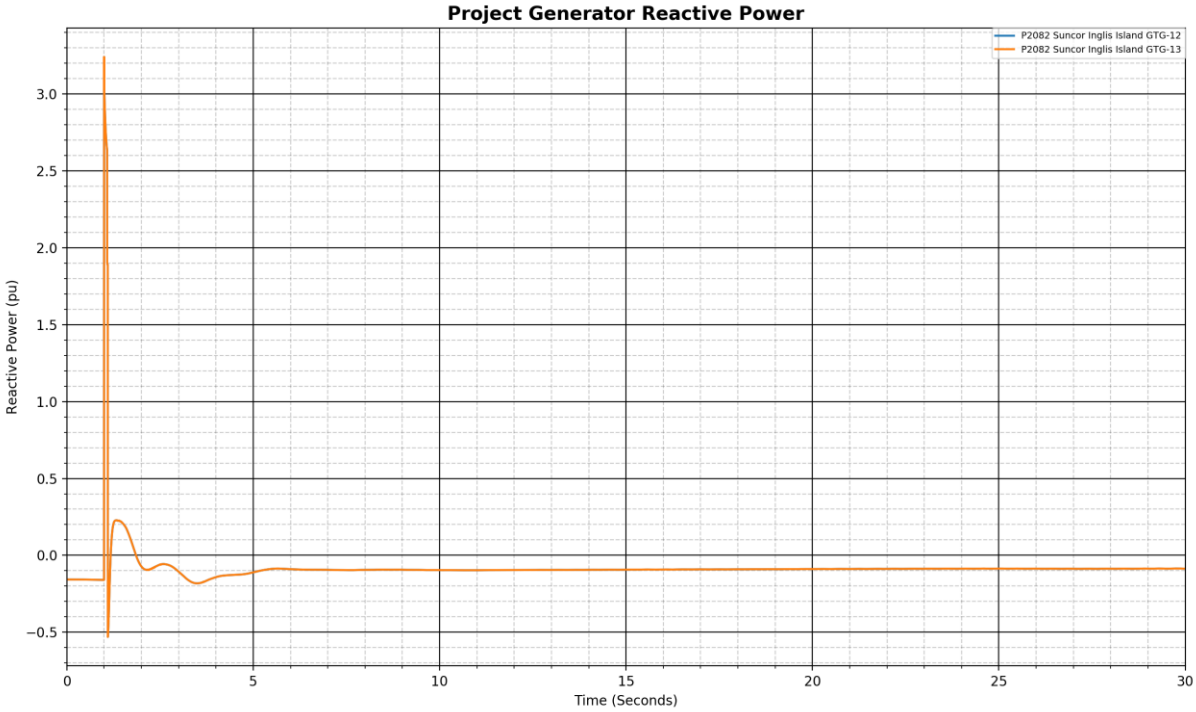

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

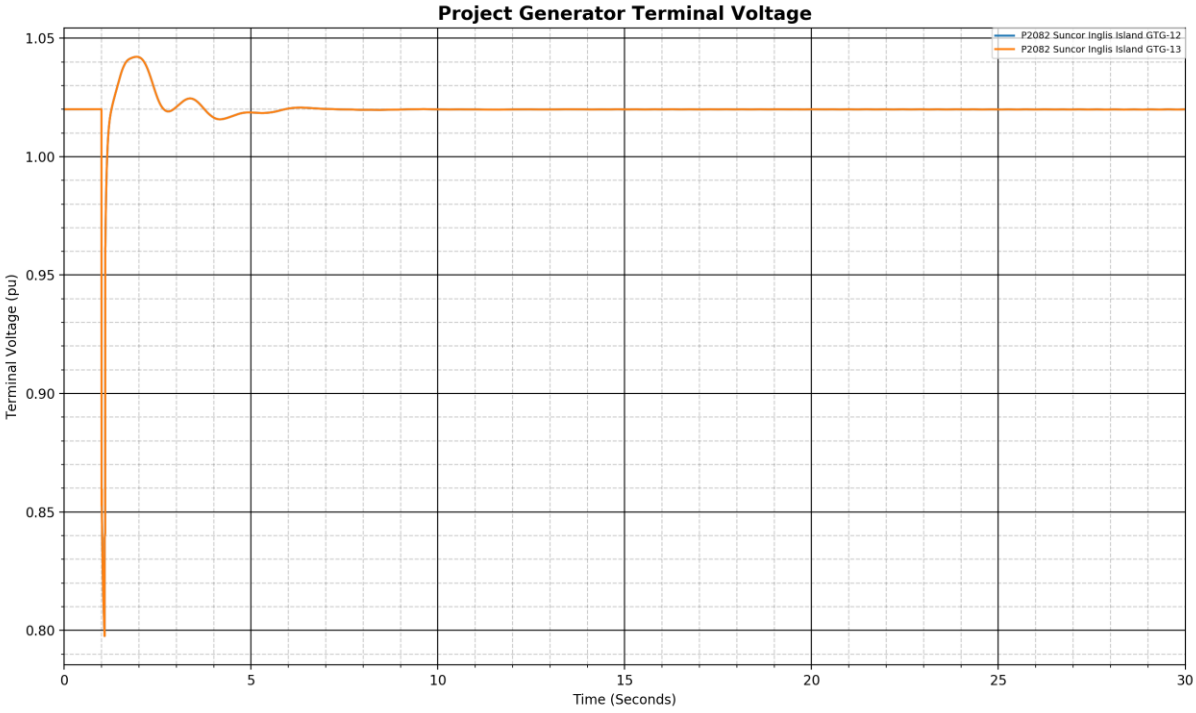

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

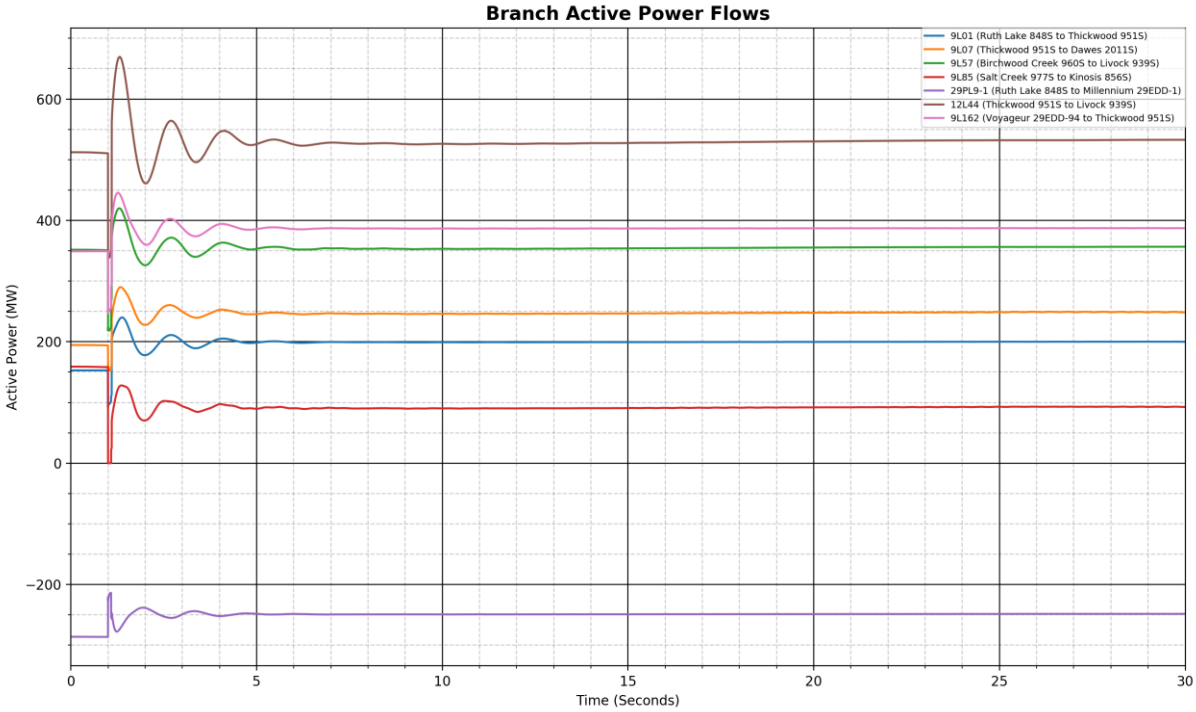

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

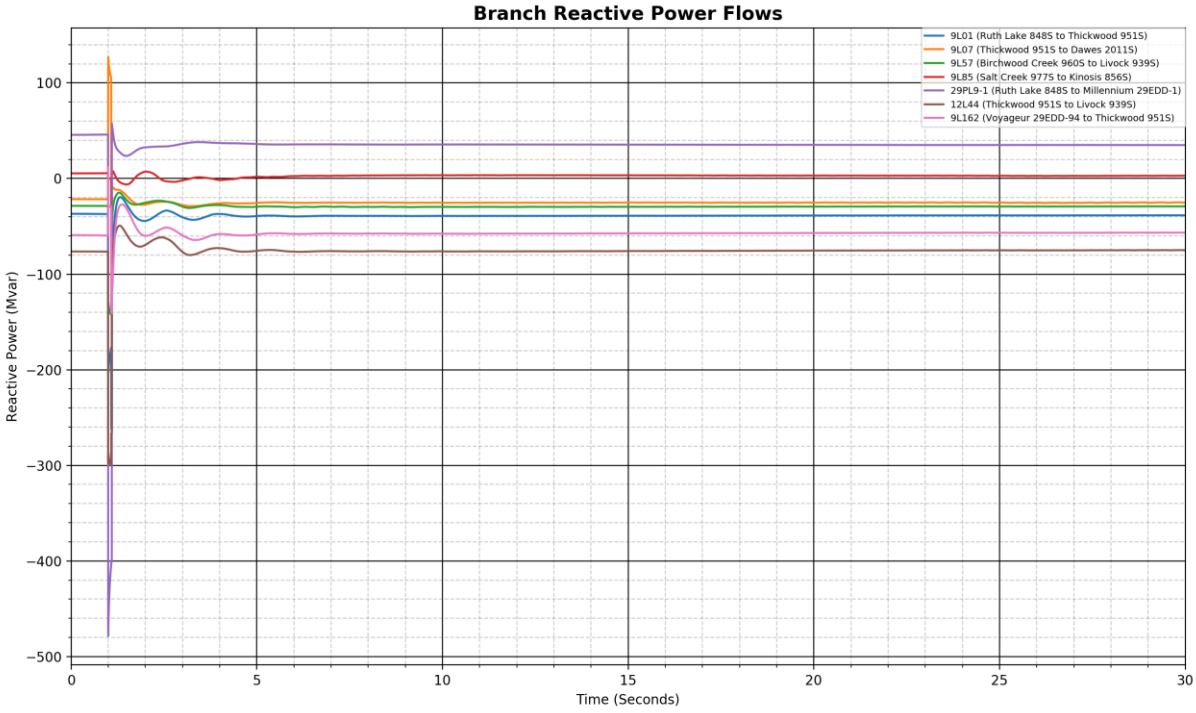
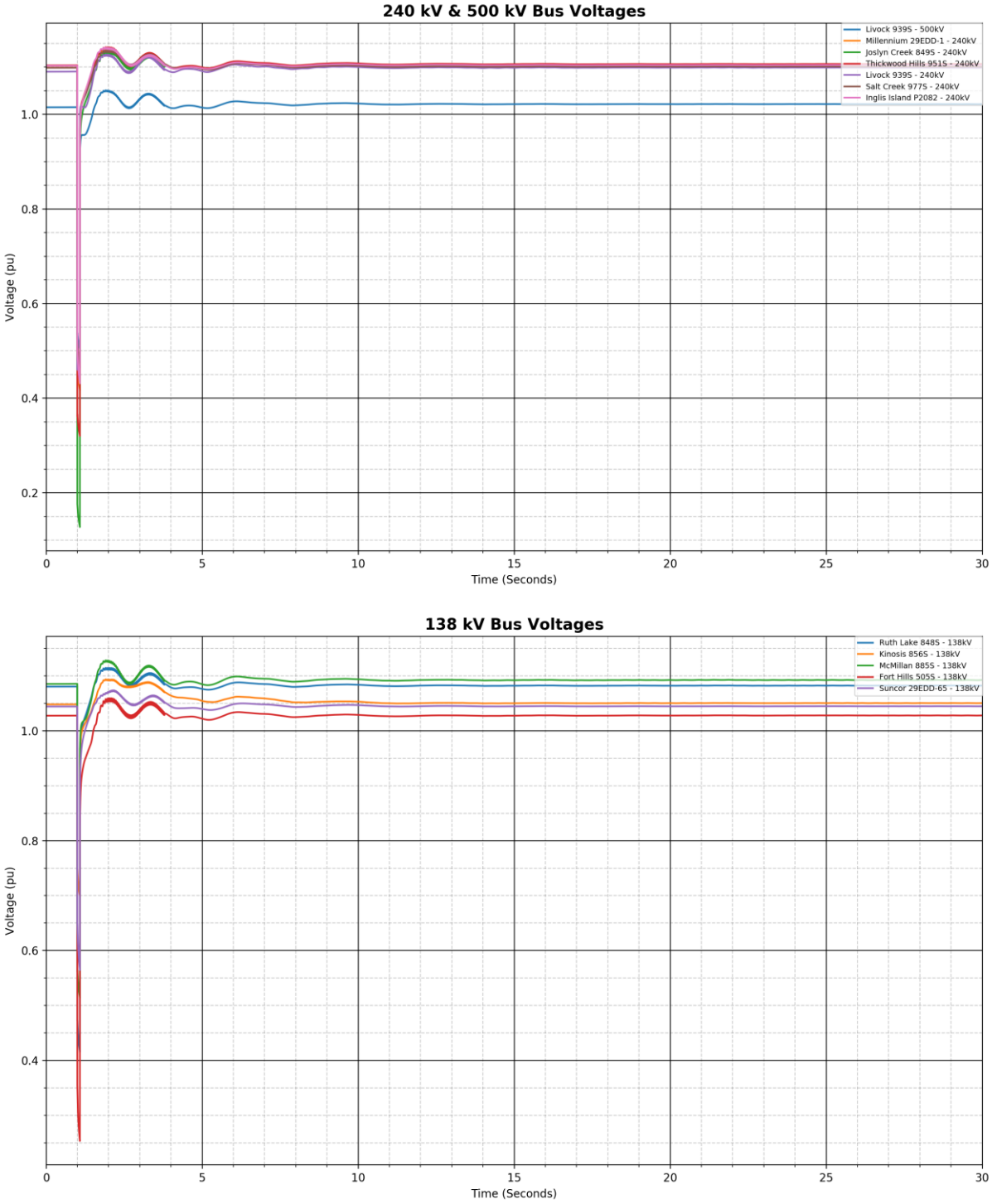
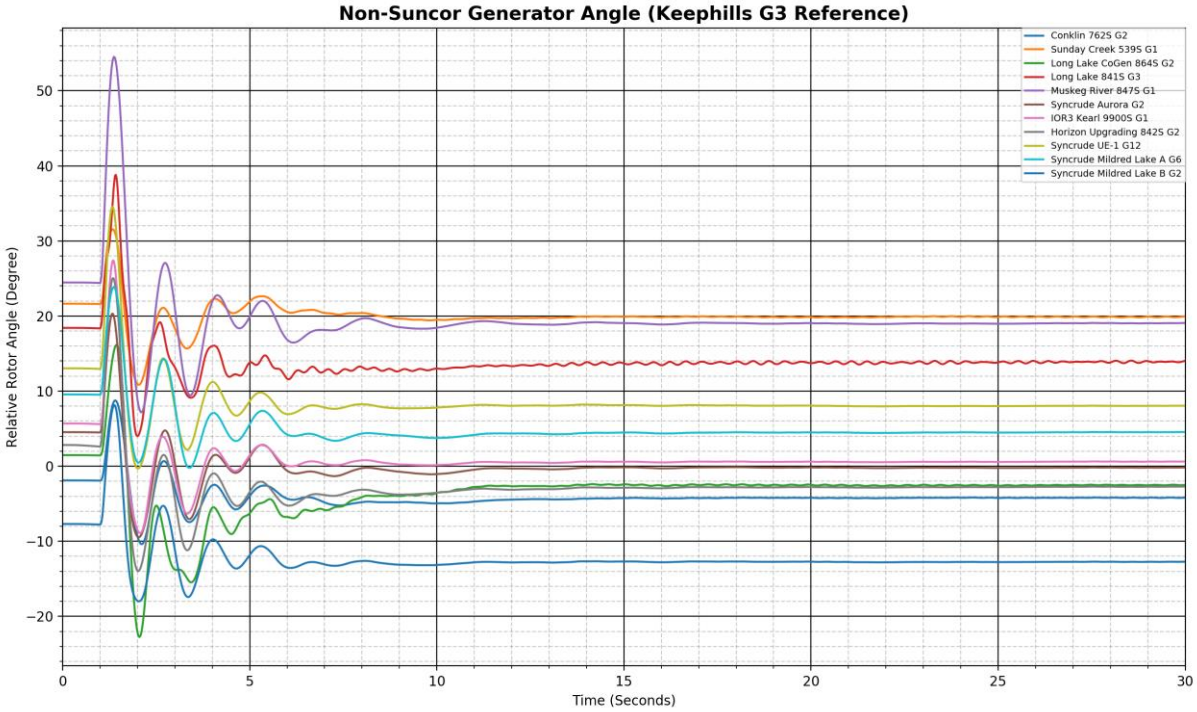
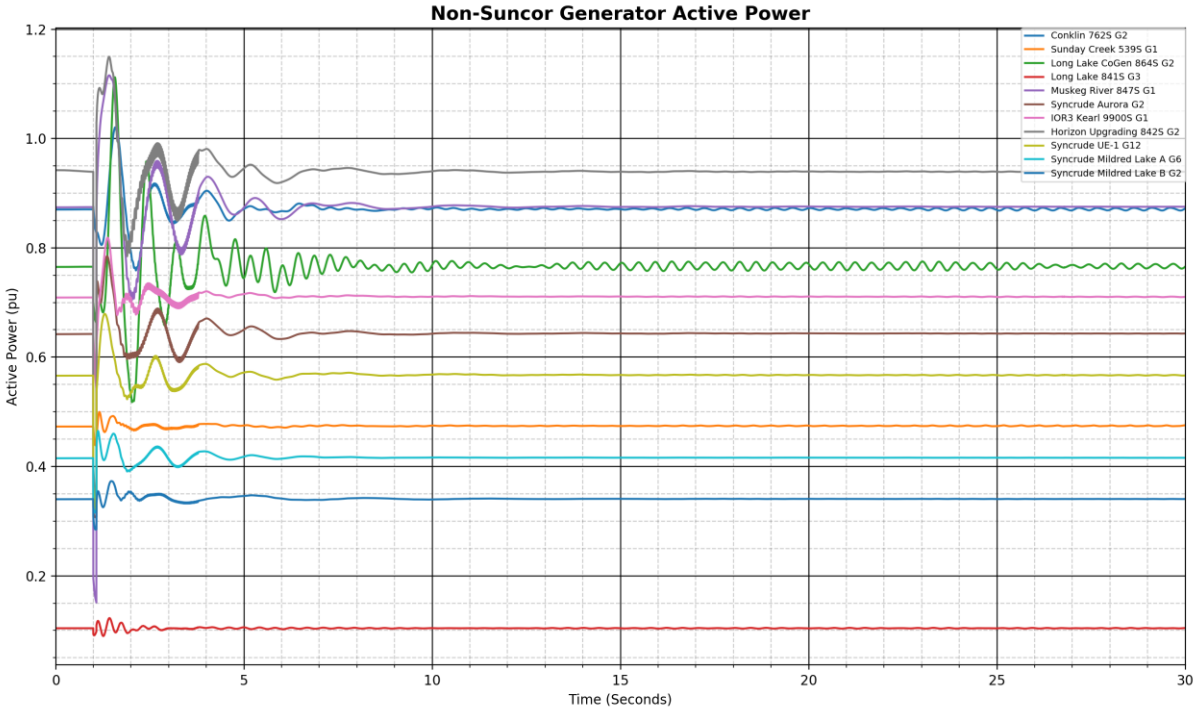
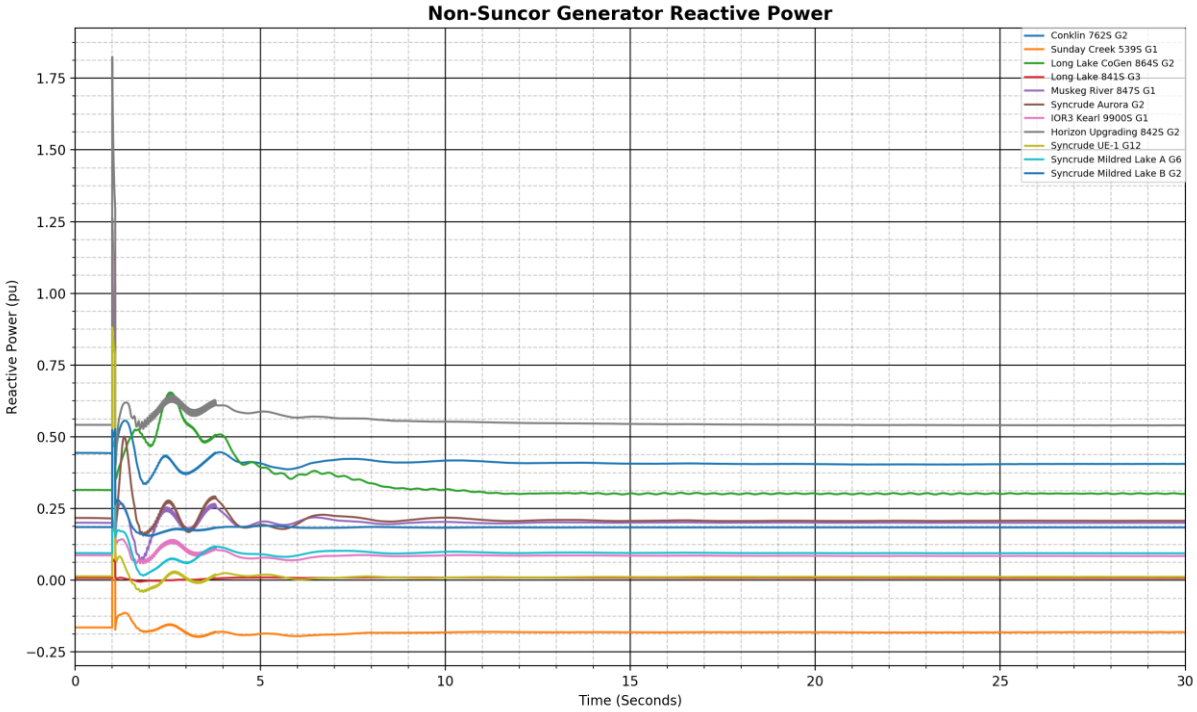

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
100
0
−100
−200
−300
−400
−500
0
5
10
15
20
25
30
Time (Seconds)

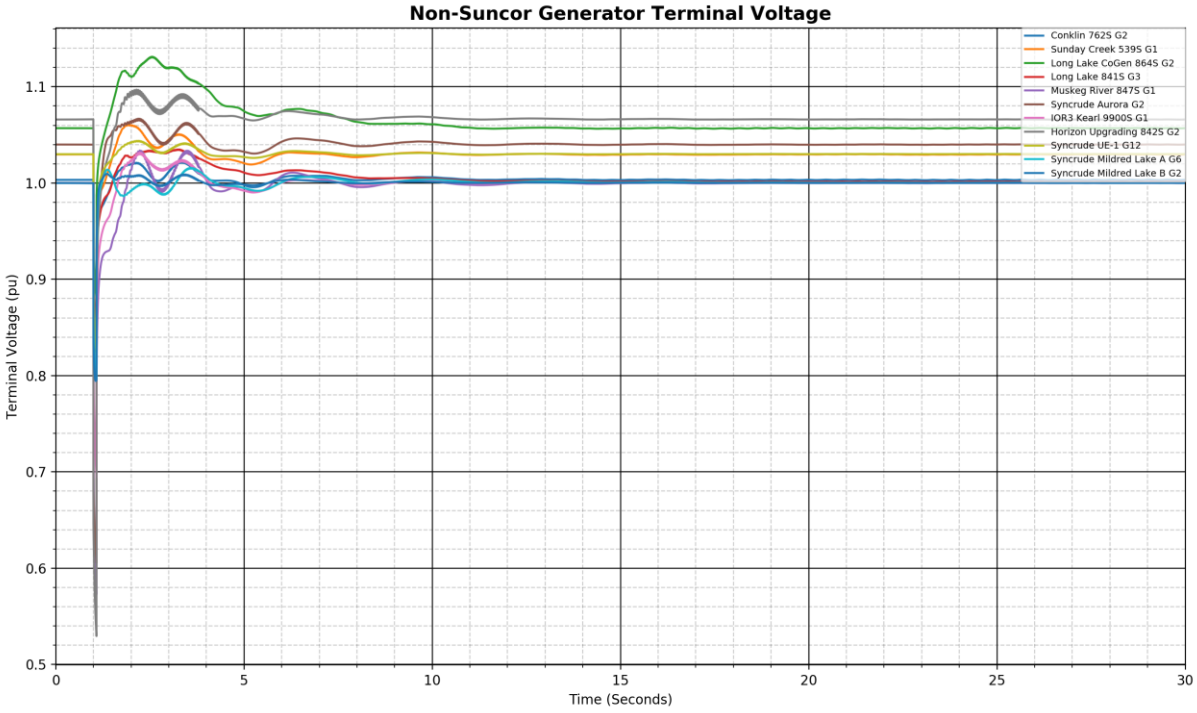
Figure A4-13: 9L43 (Dover 888S to Mackay River 874S): Fault at Dover 888S

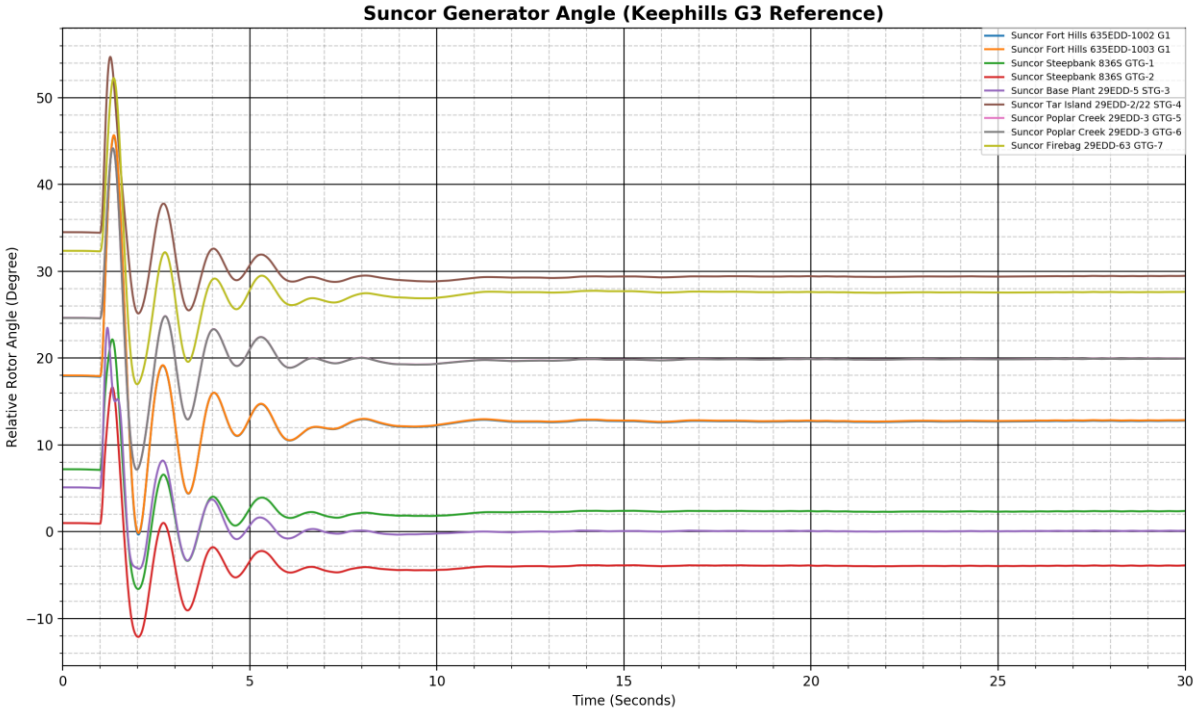


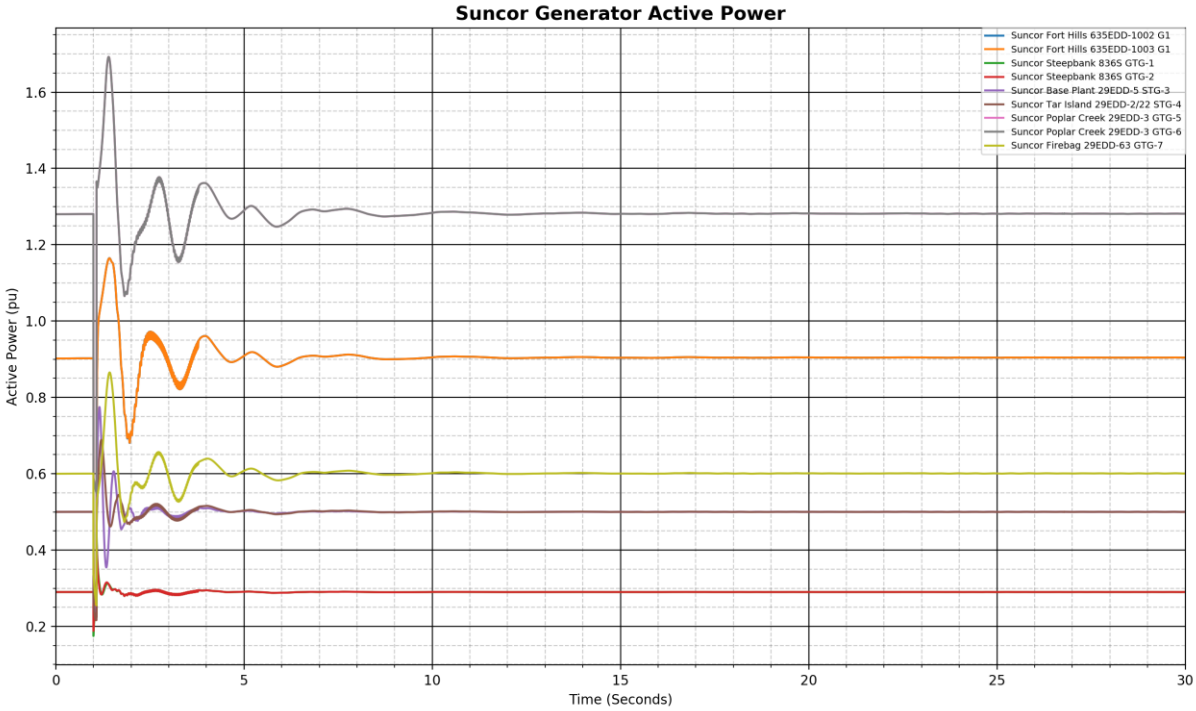

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

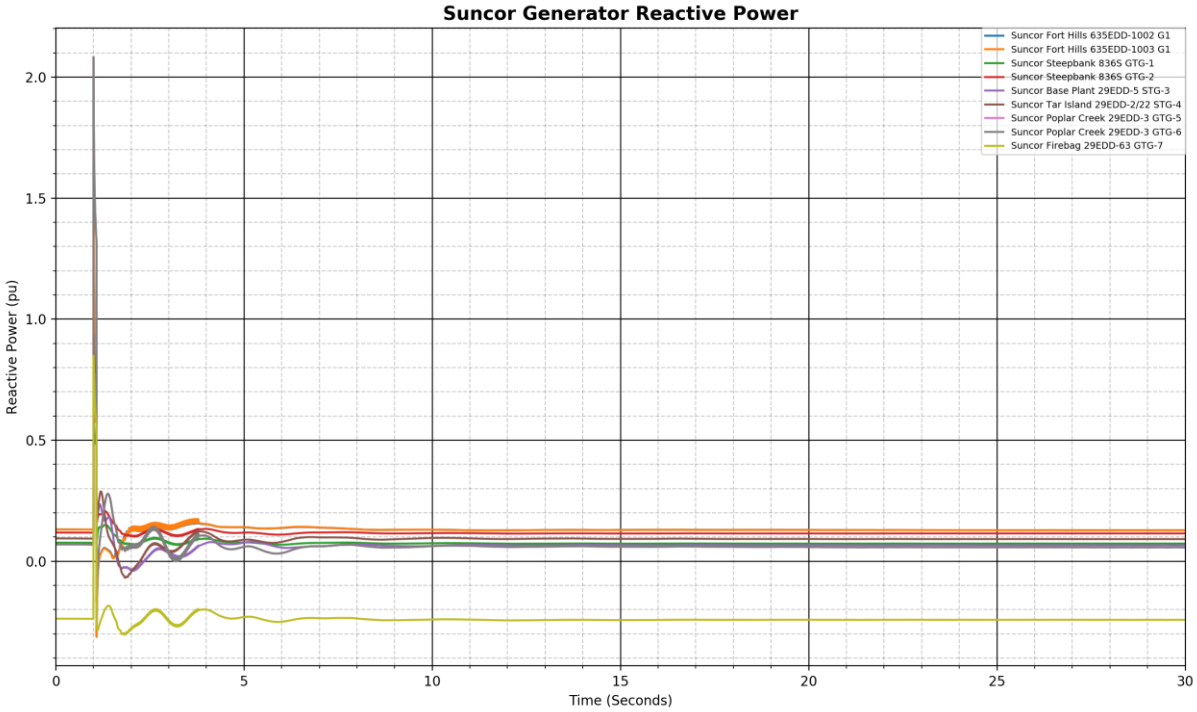

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

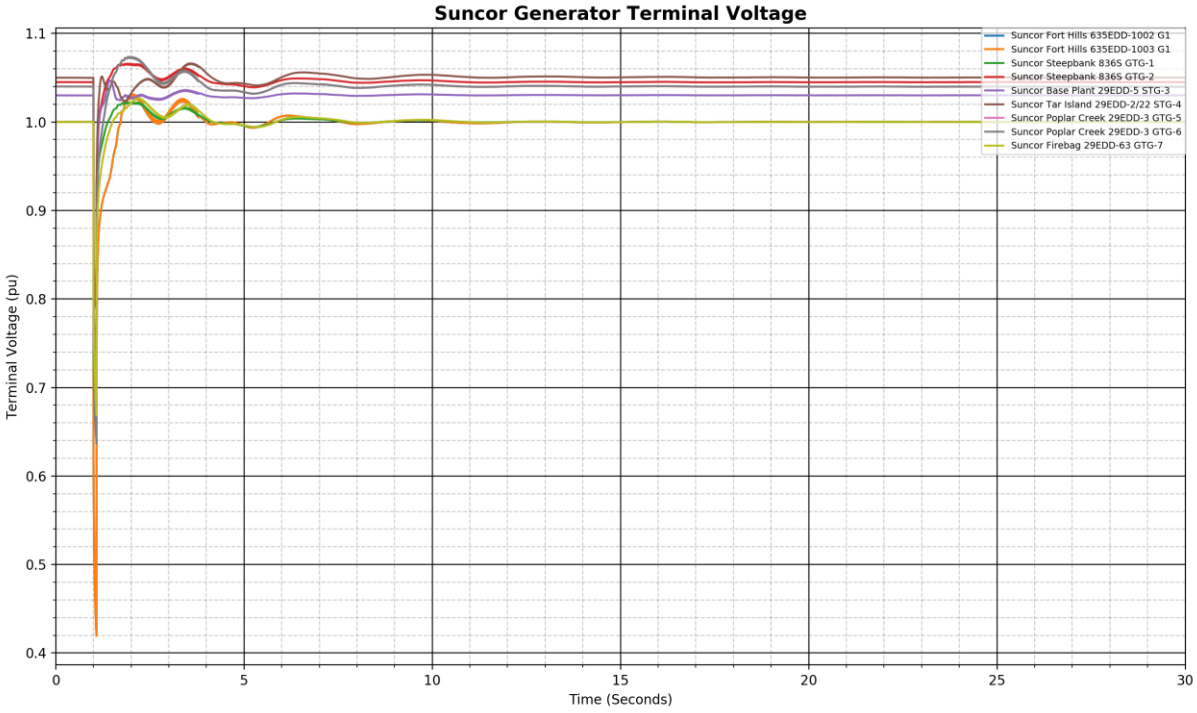

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

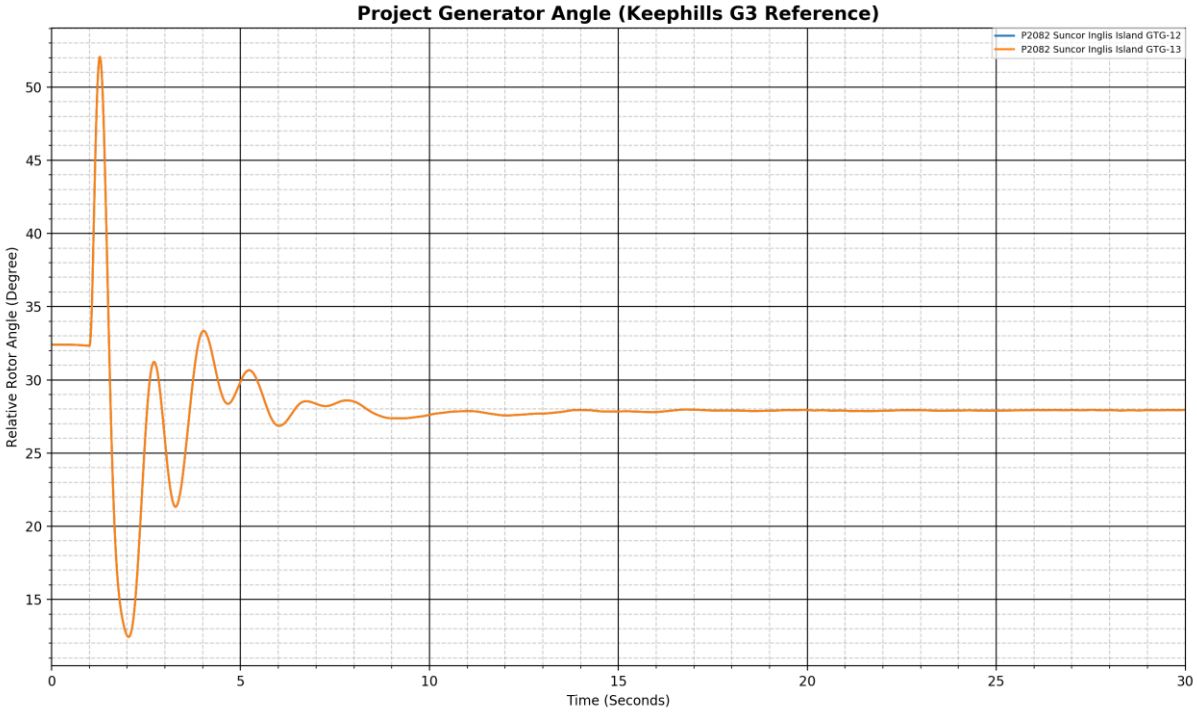

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

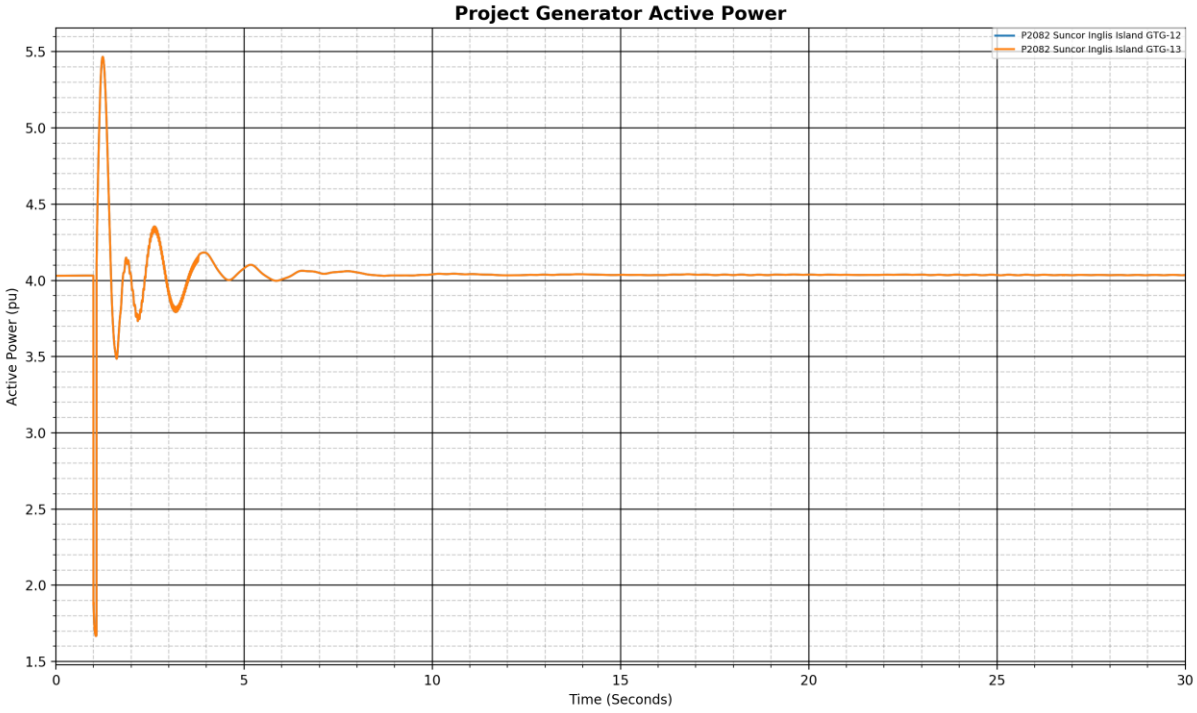

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

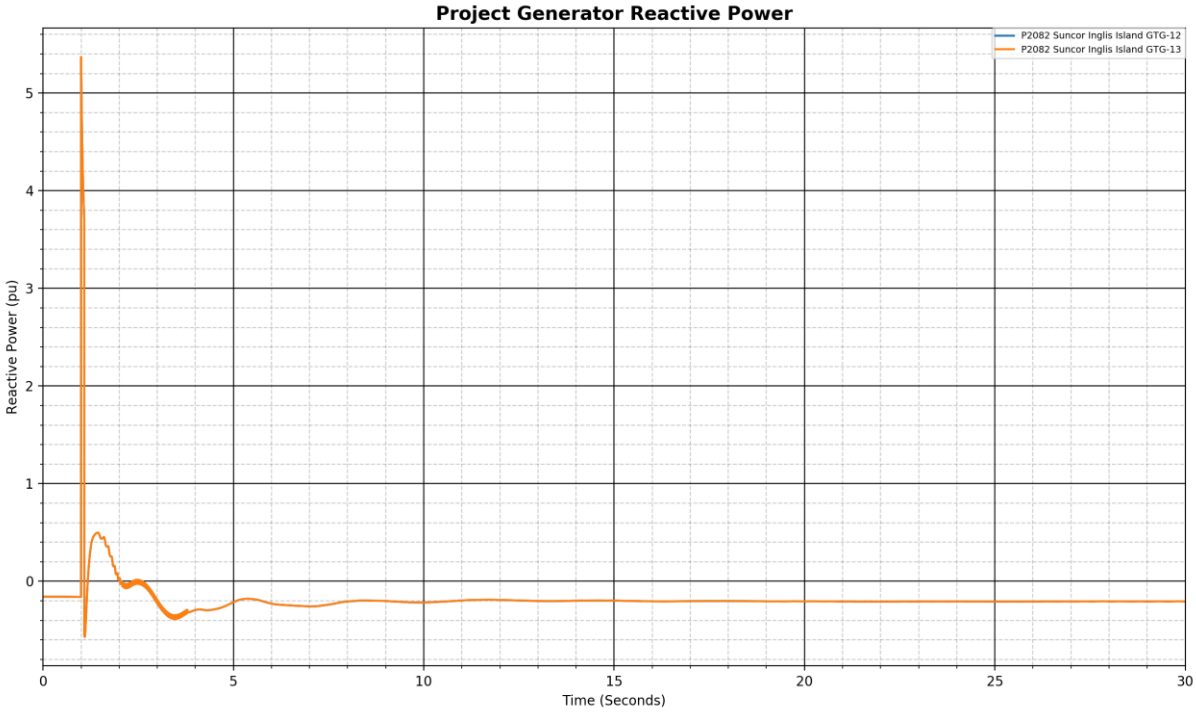

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

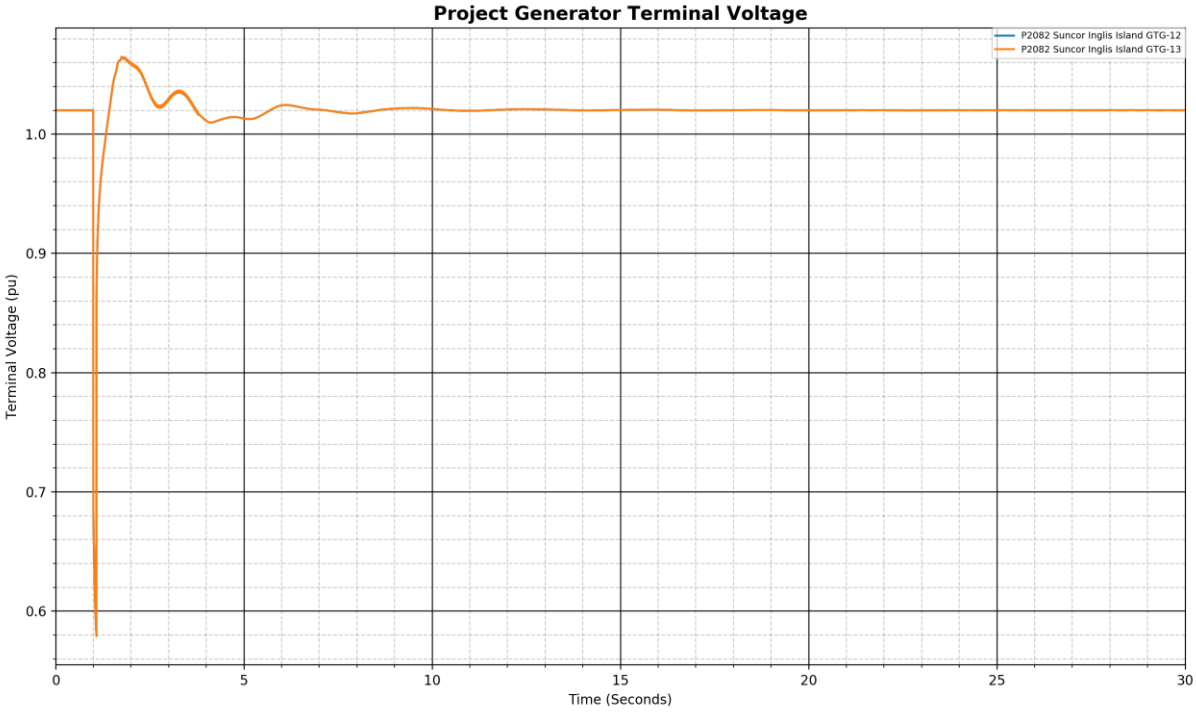

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

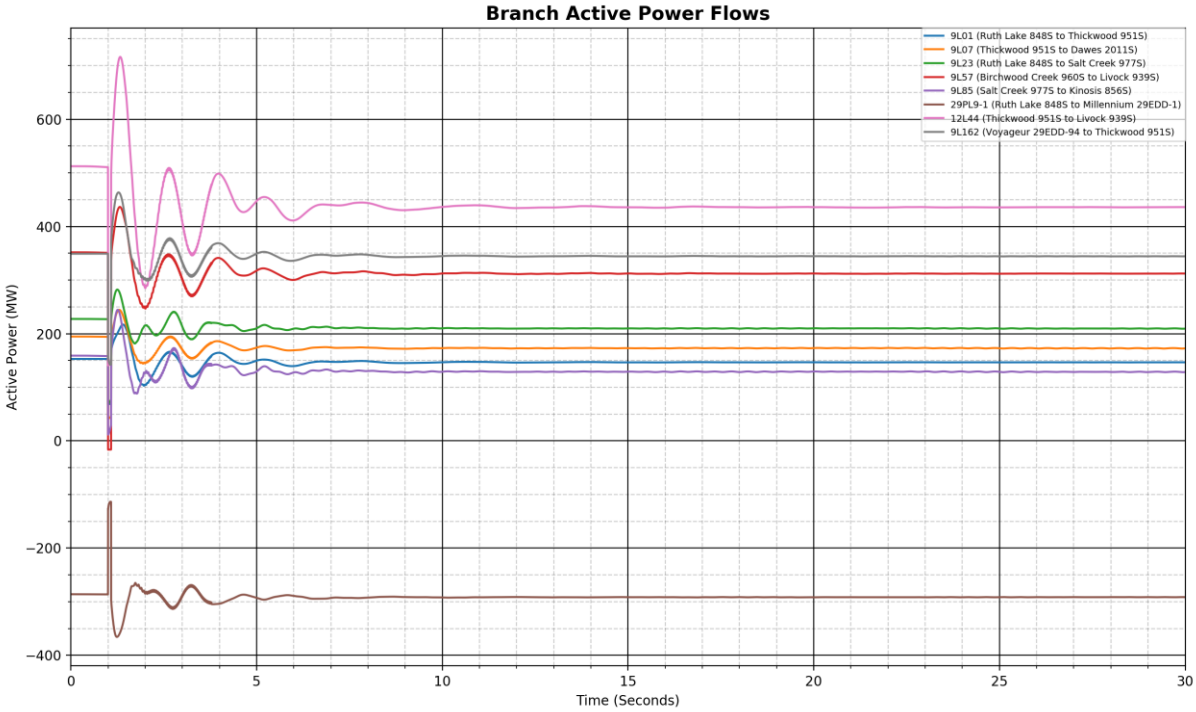

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.6
0.7
0.8
0.9
1.0
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

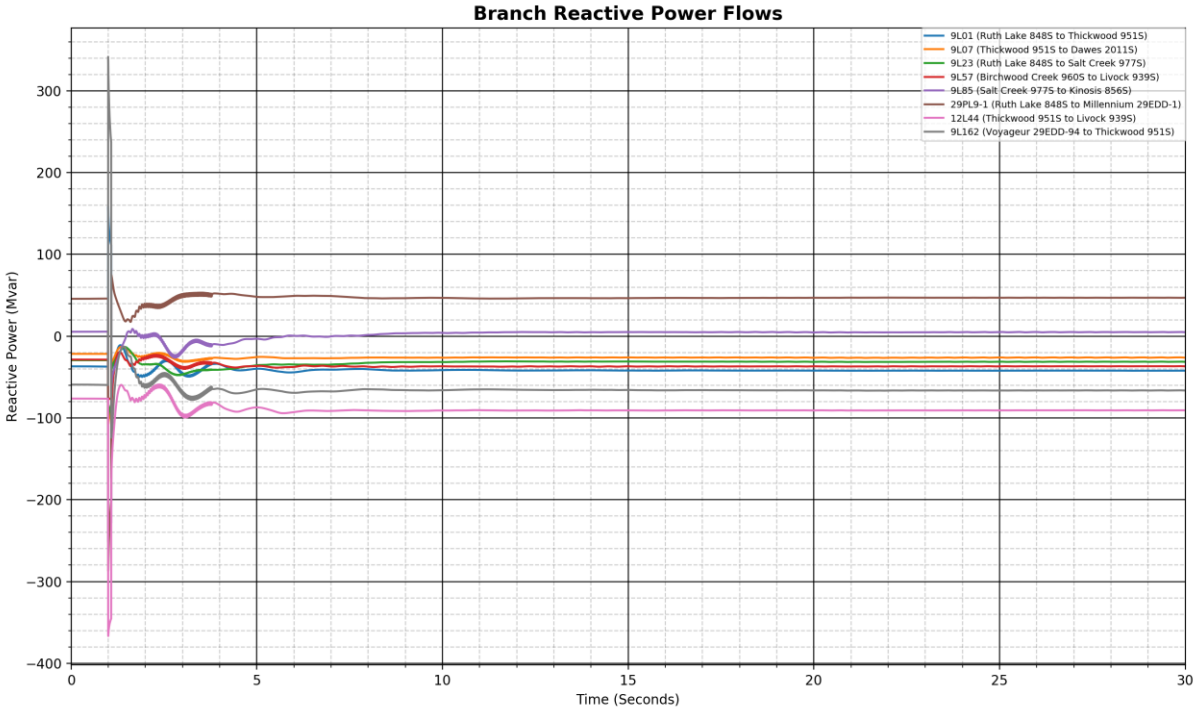
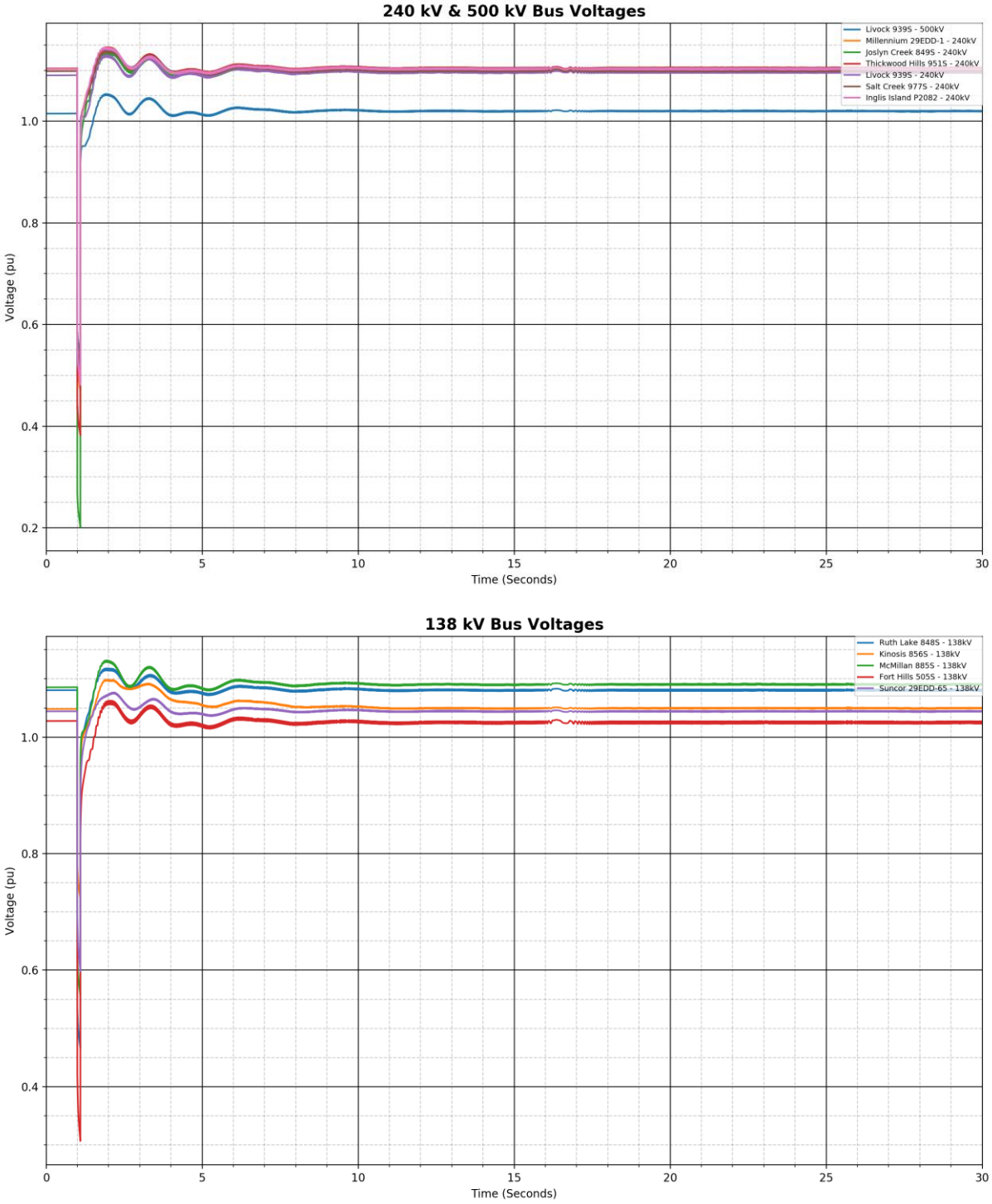
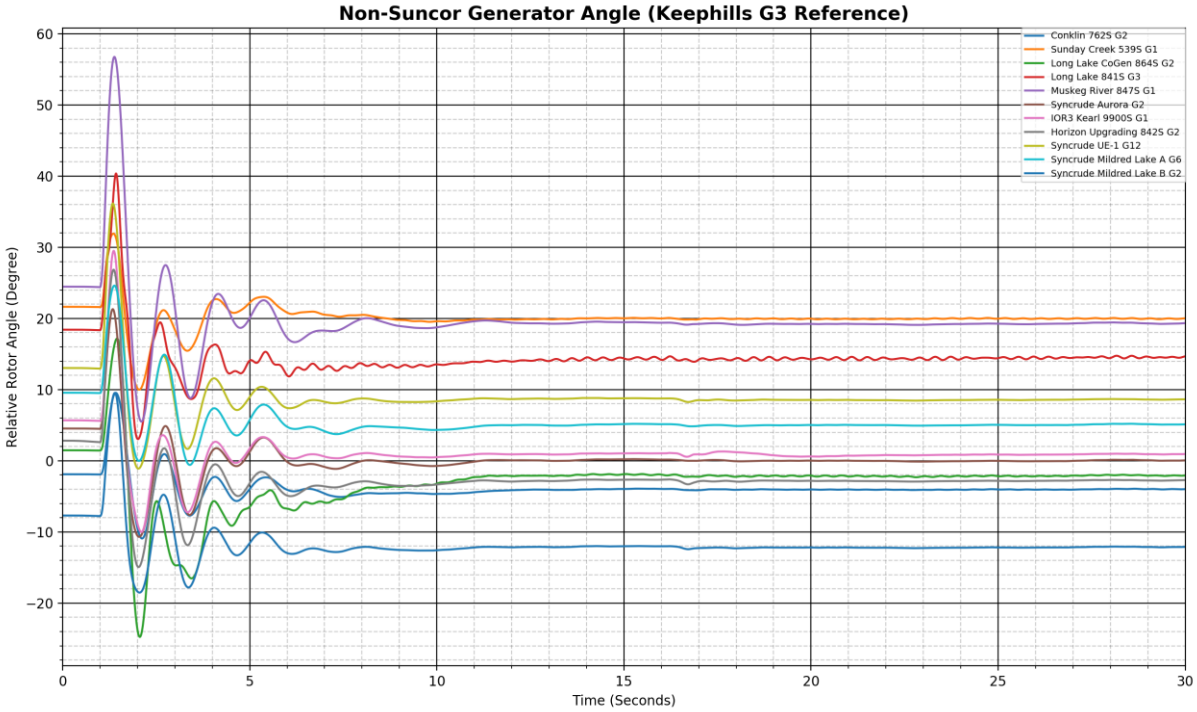
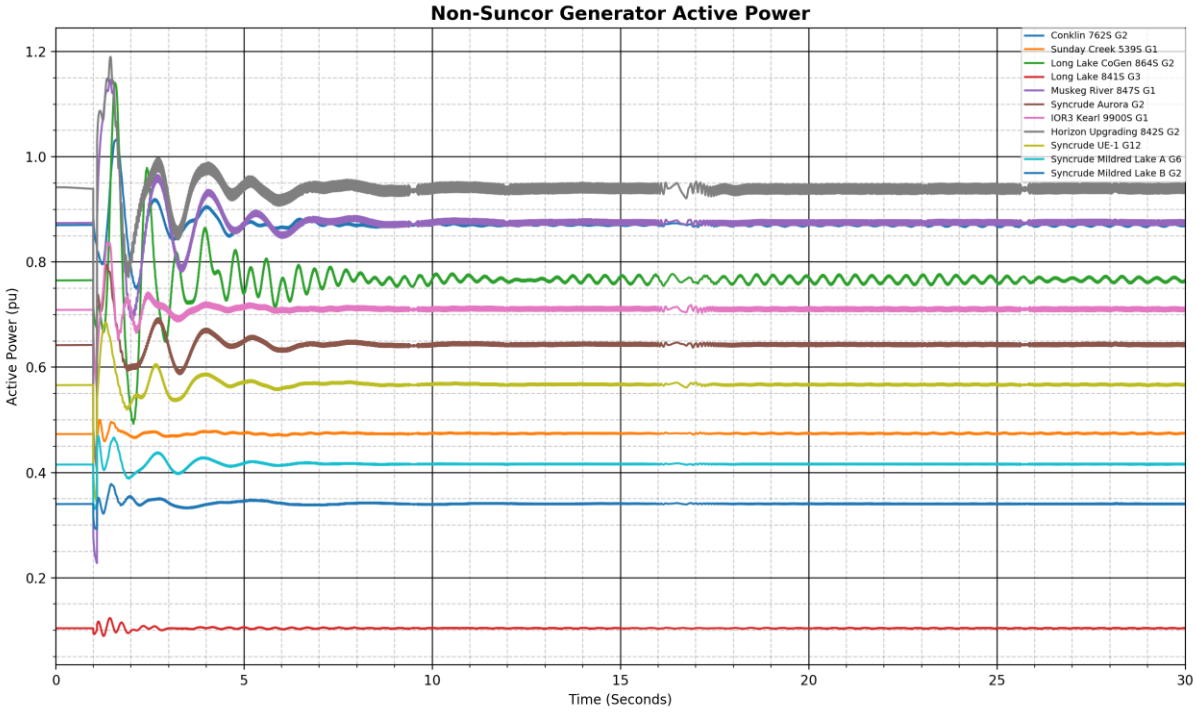
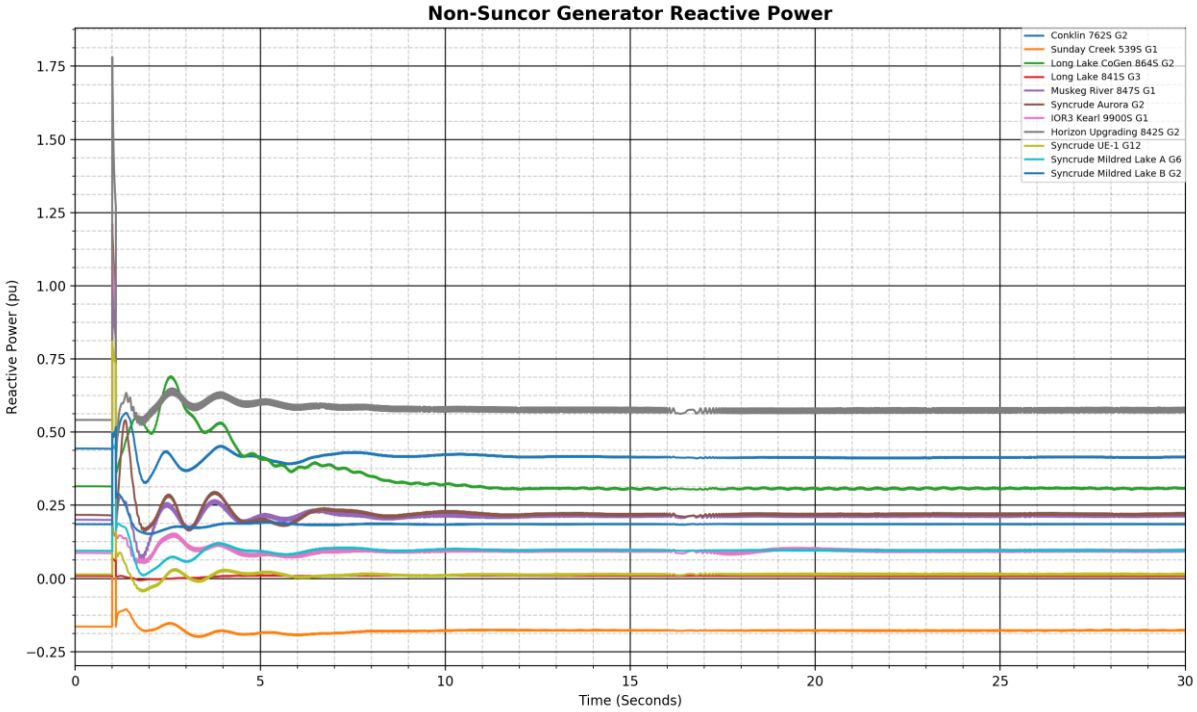

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

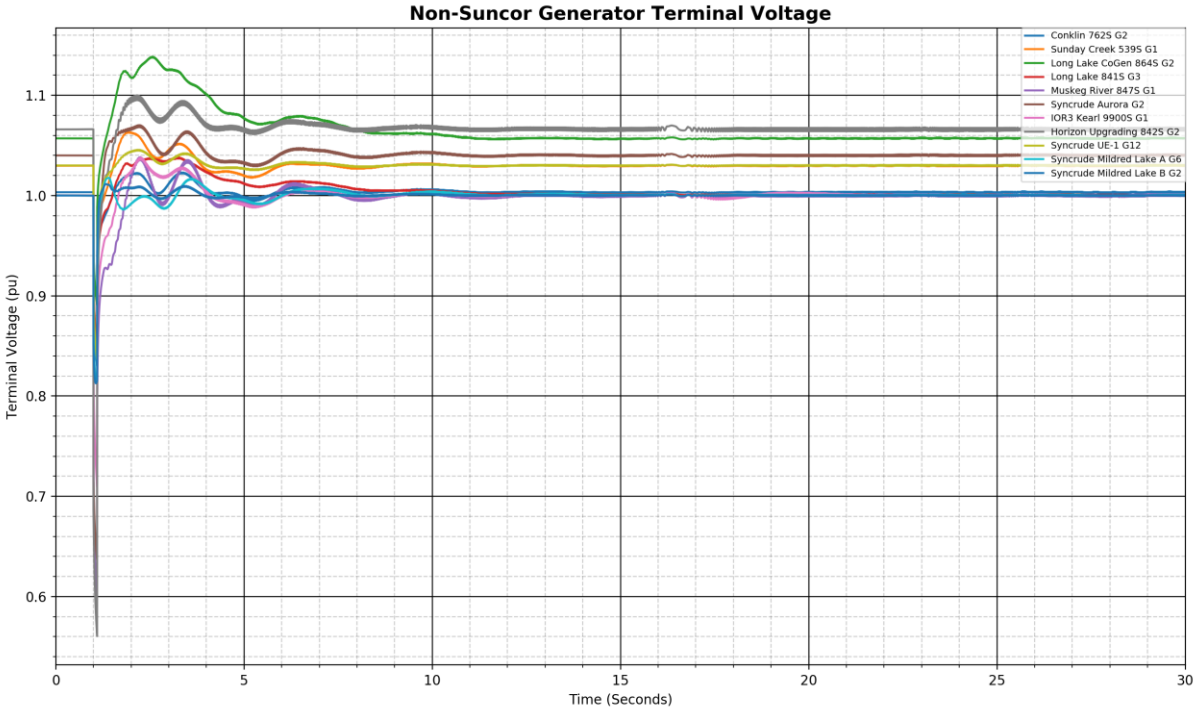
Figure A4-14: 9L43 (Dover 888S to Mackay River 874S): Fault at Mackay River 874S

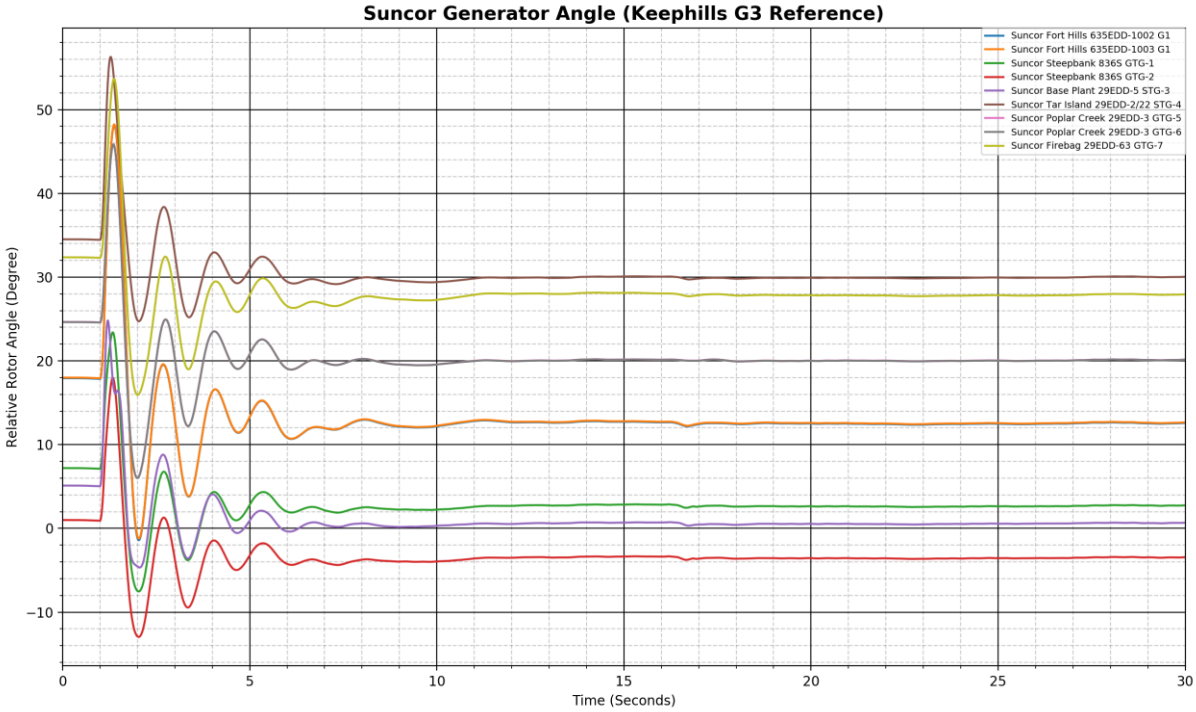


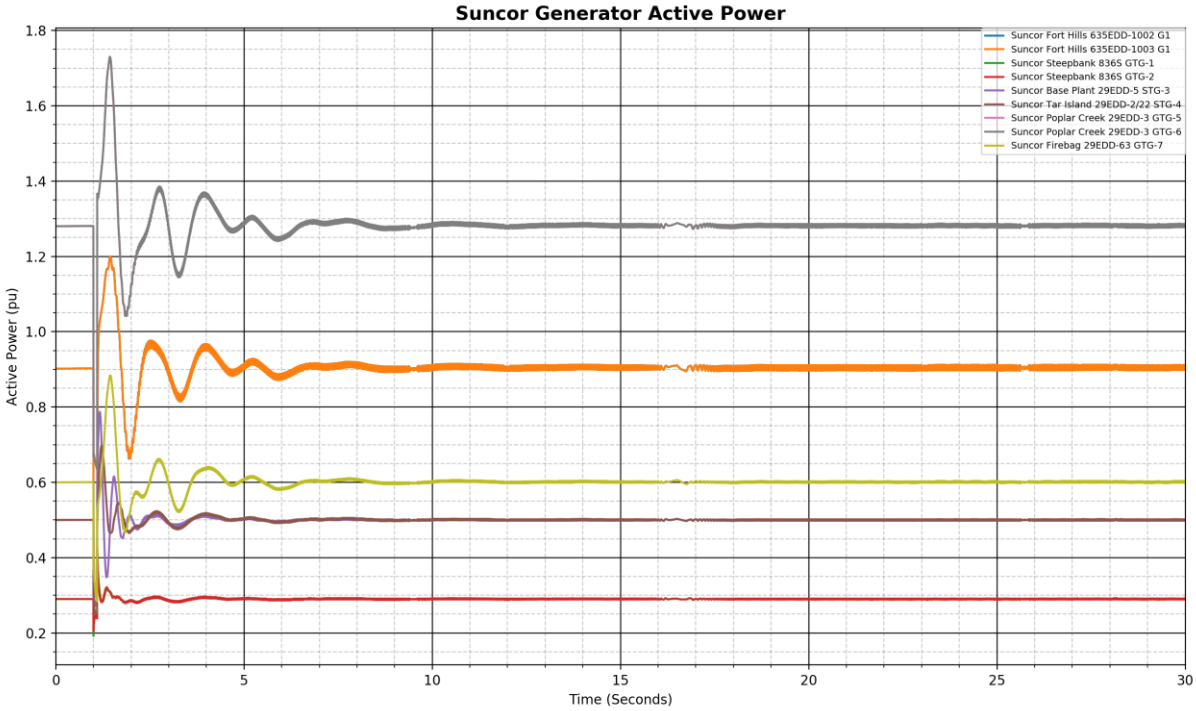

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

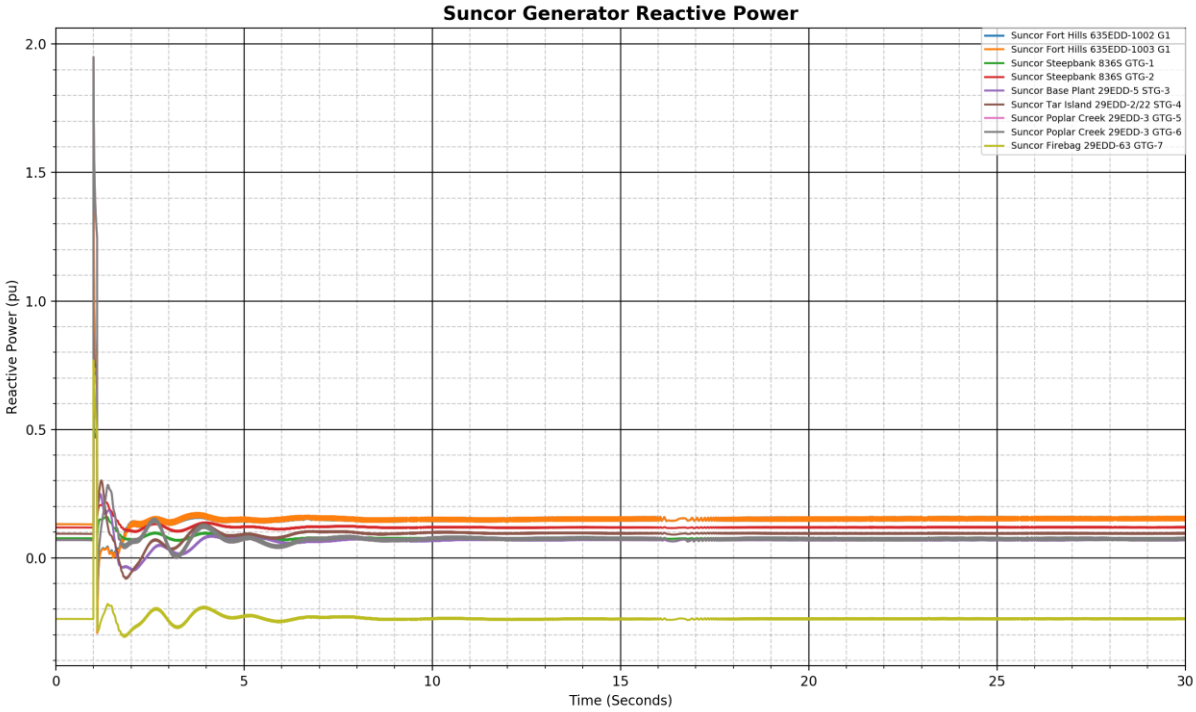

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

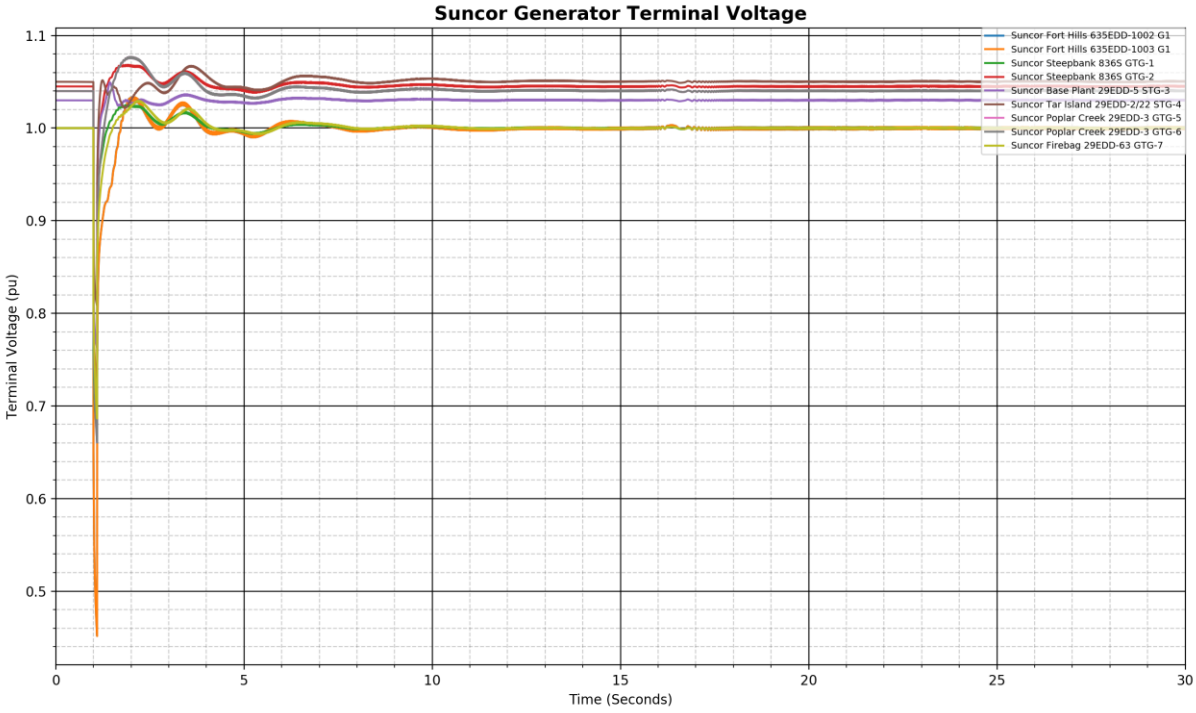

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

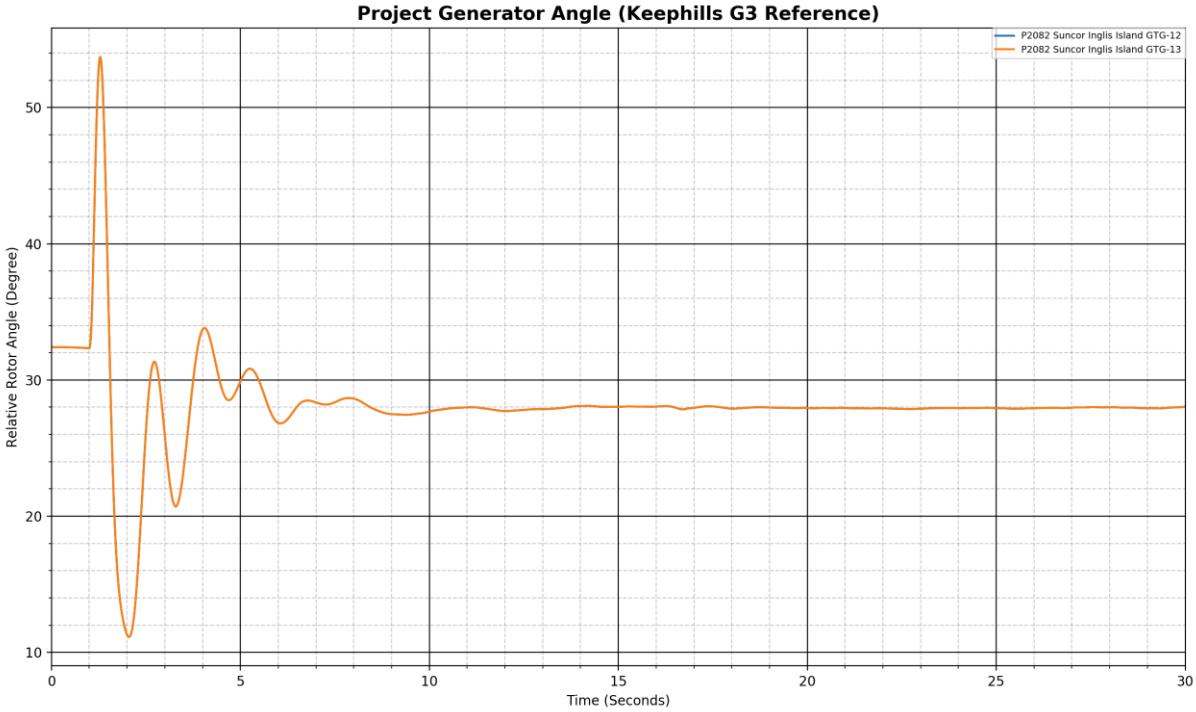

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

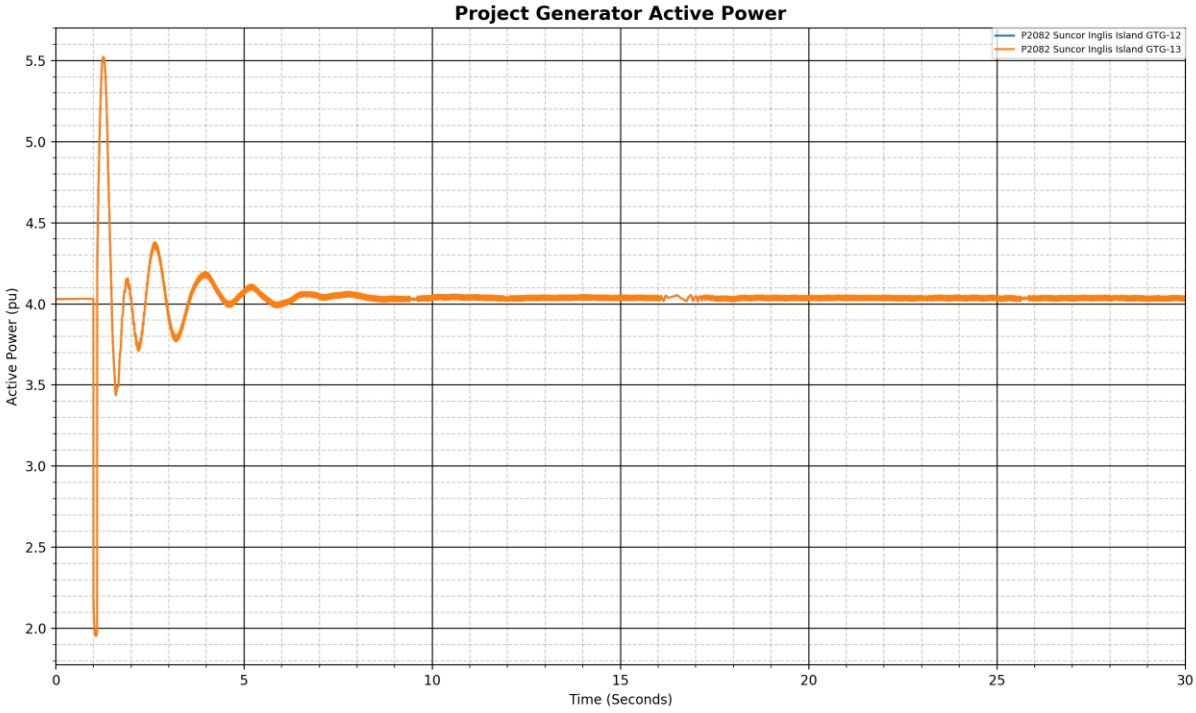

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

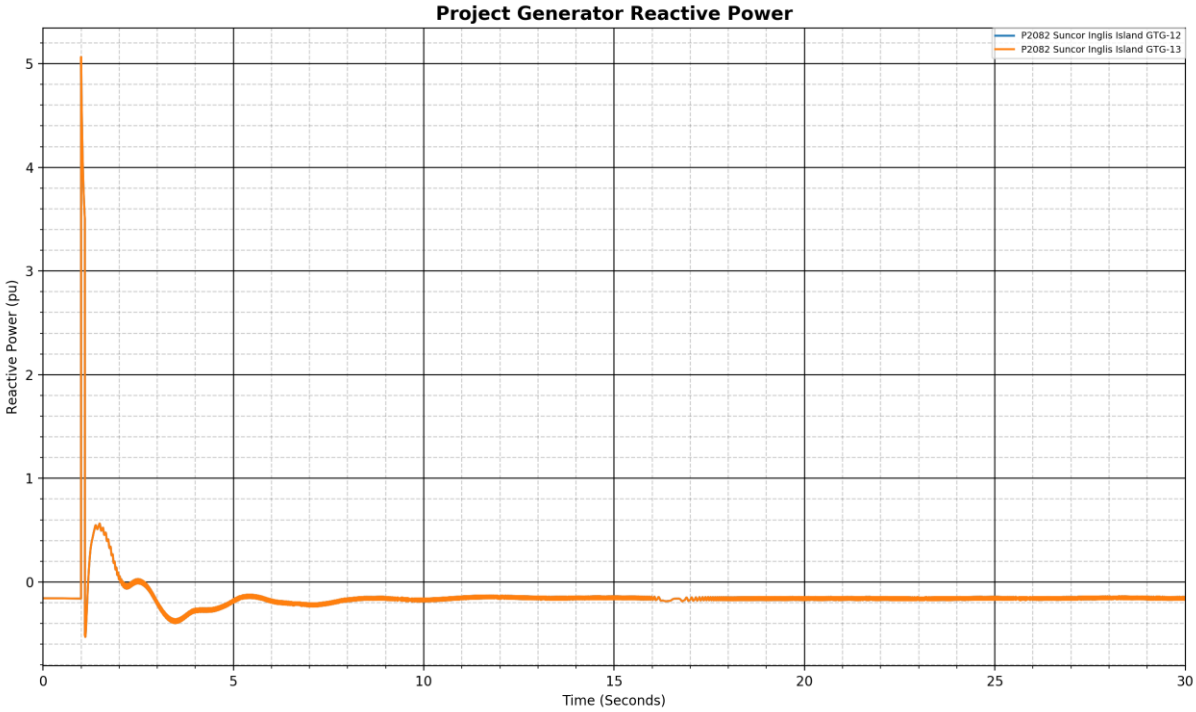

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

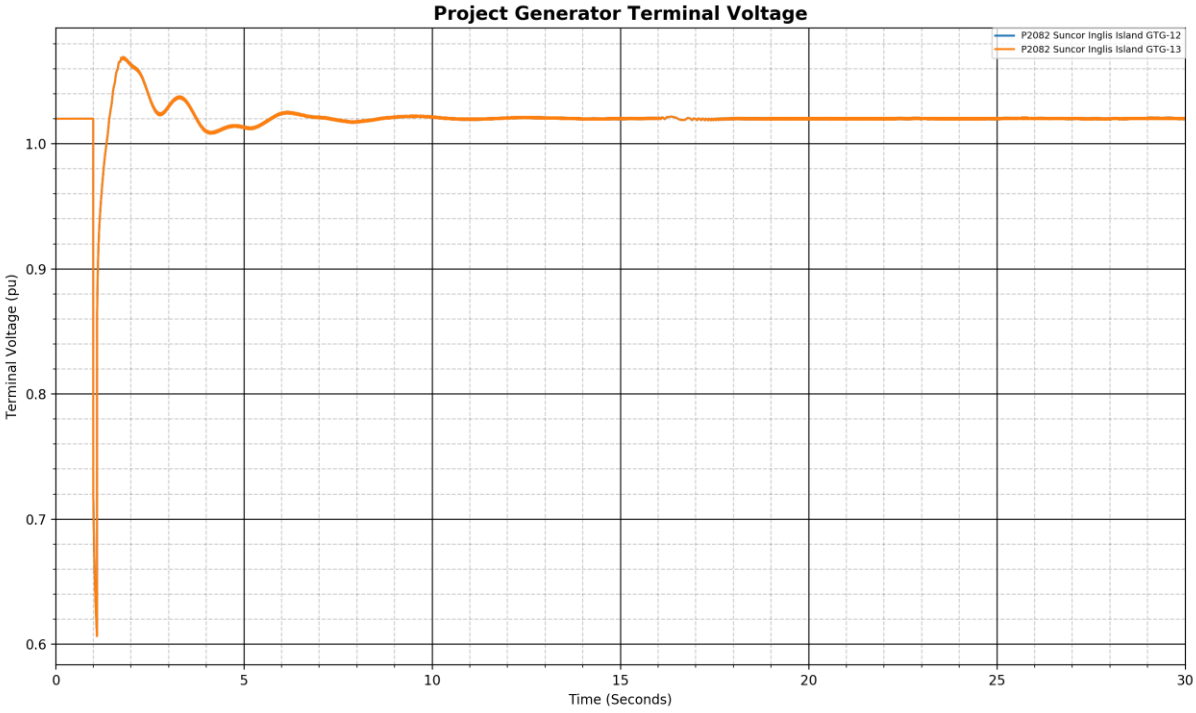

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

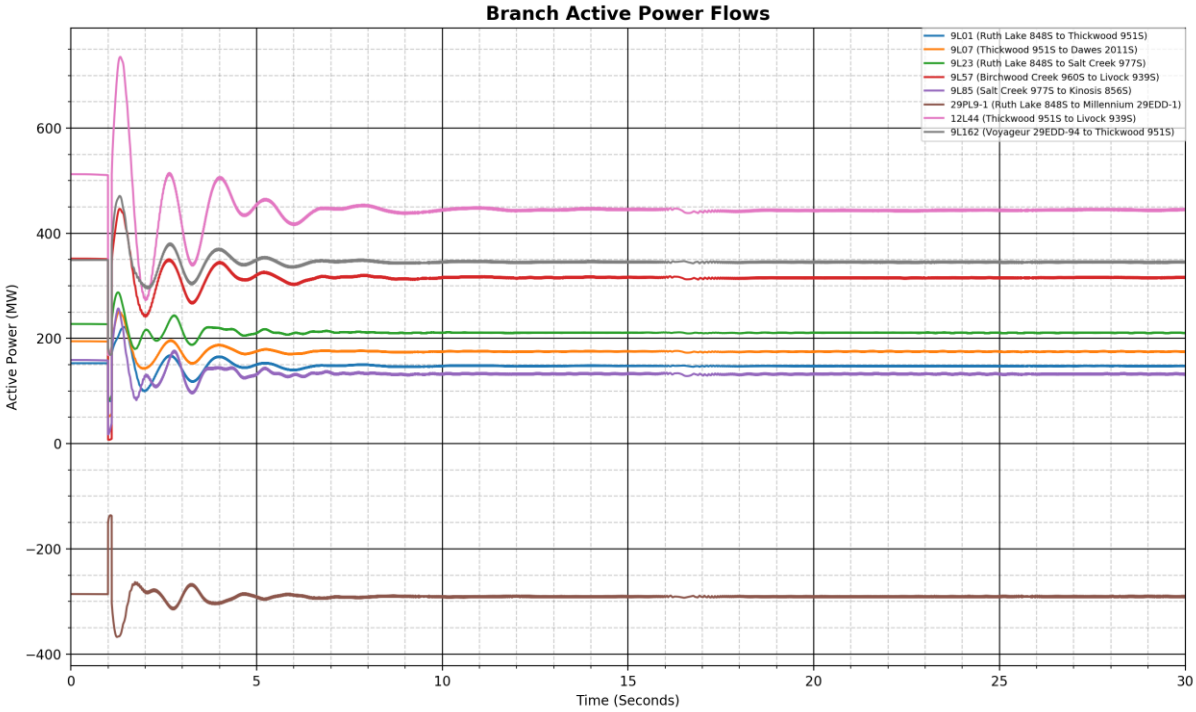

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
10
20
30
40
50
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.6
0.7
0.8
0.9
1.0
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

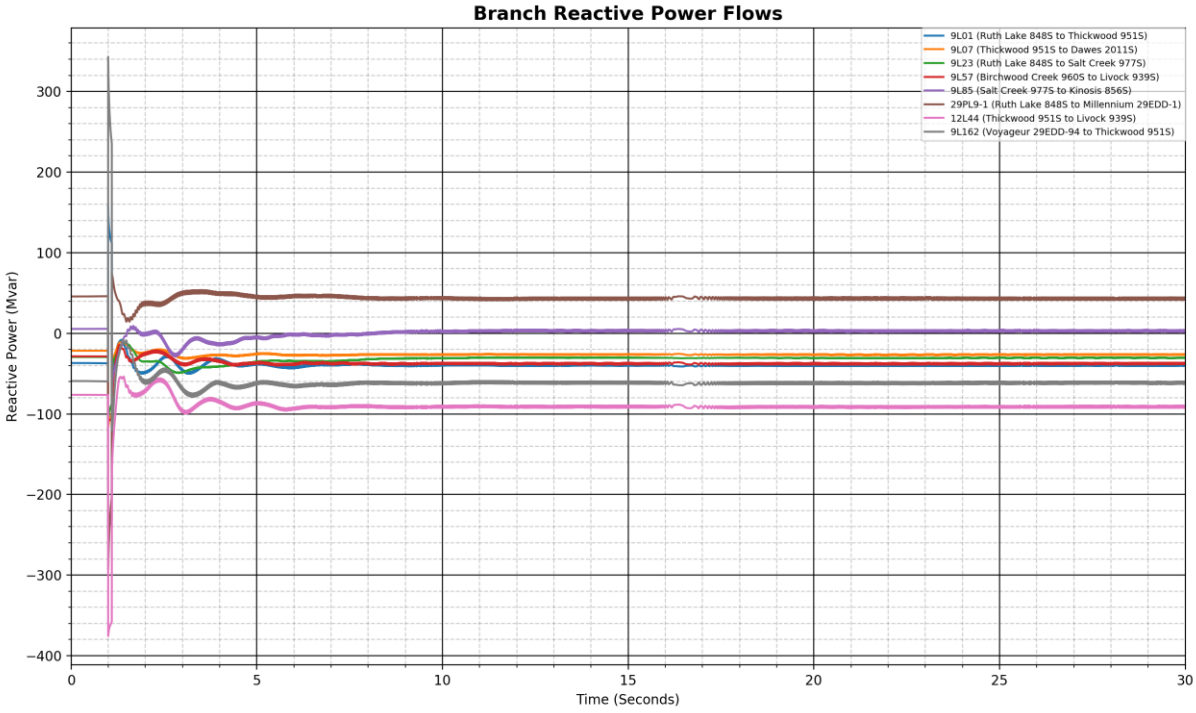
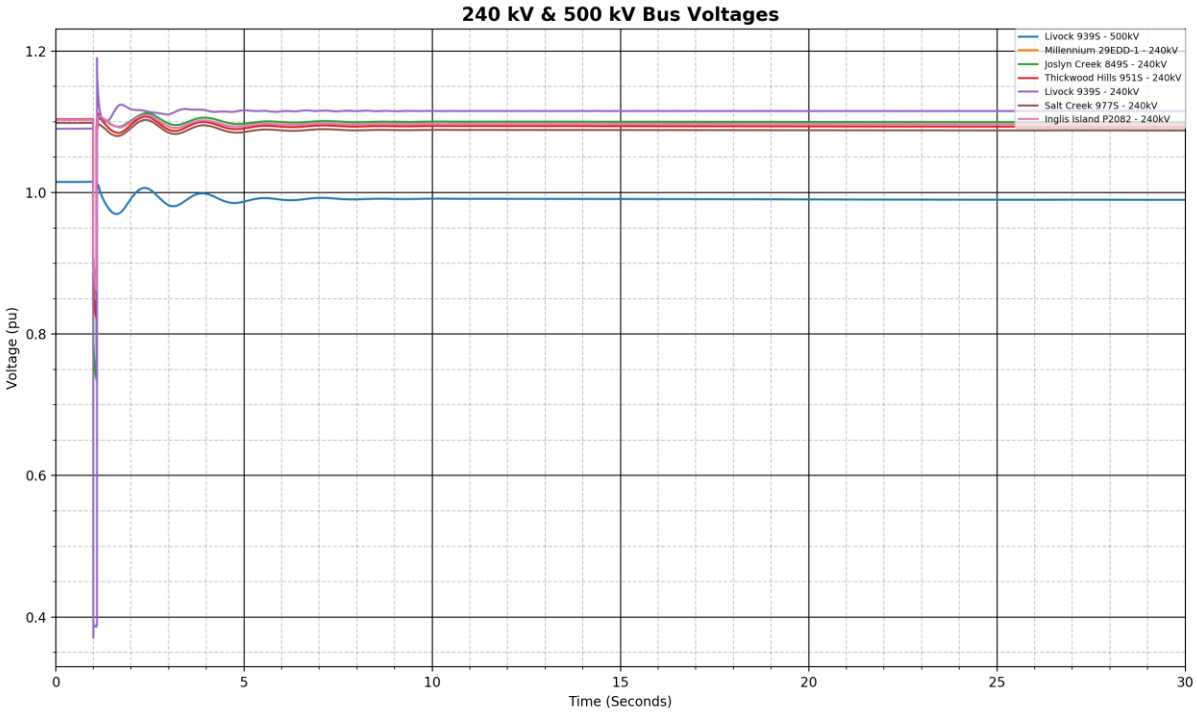
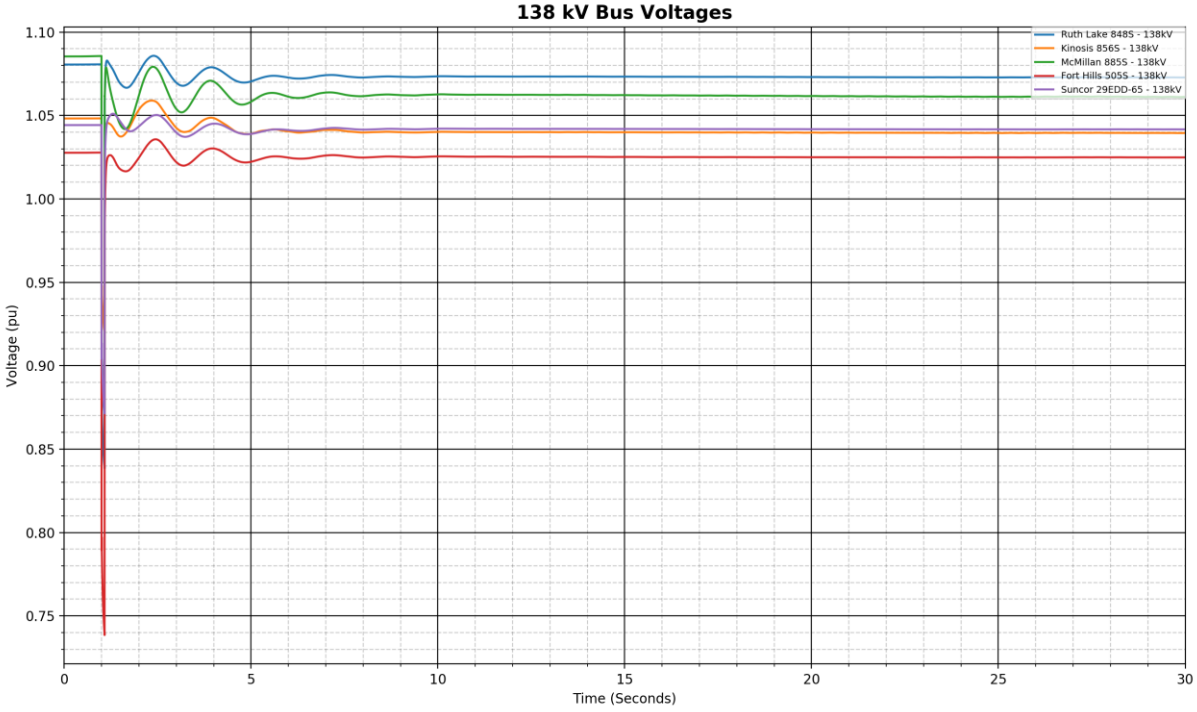
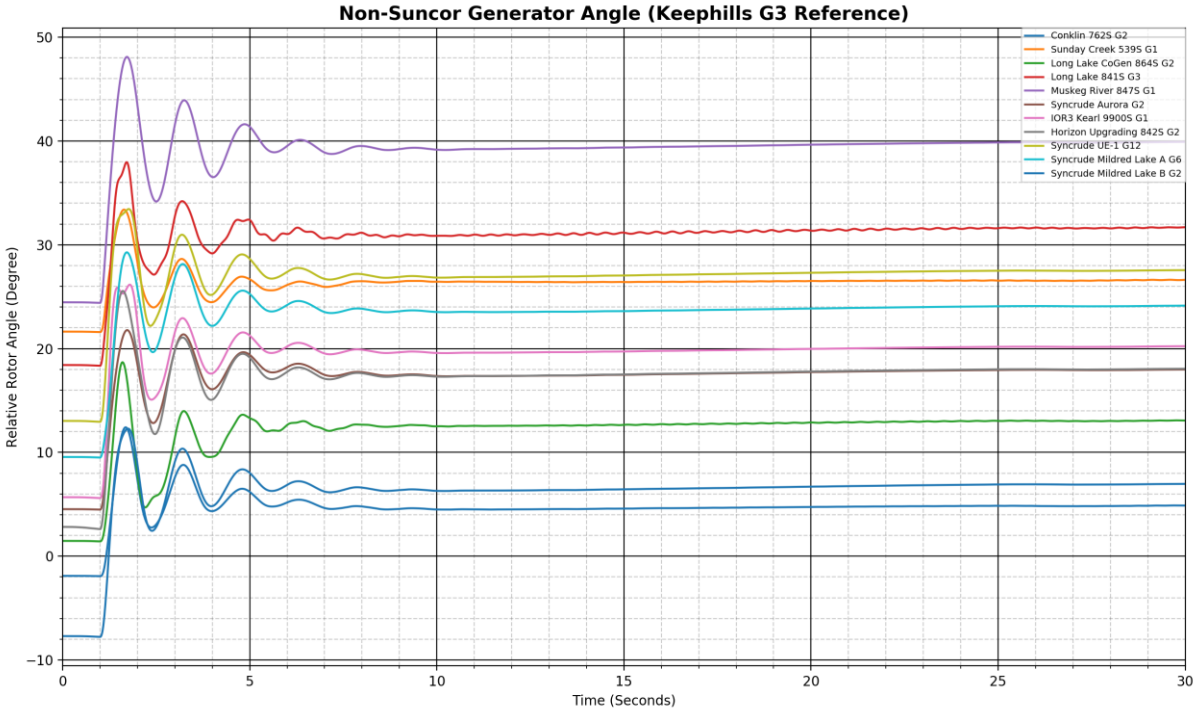
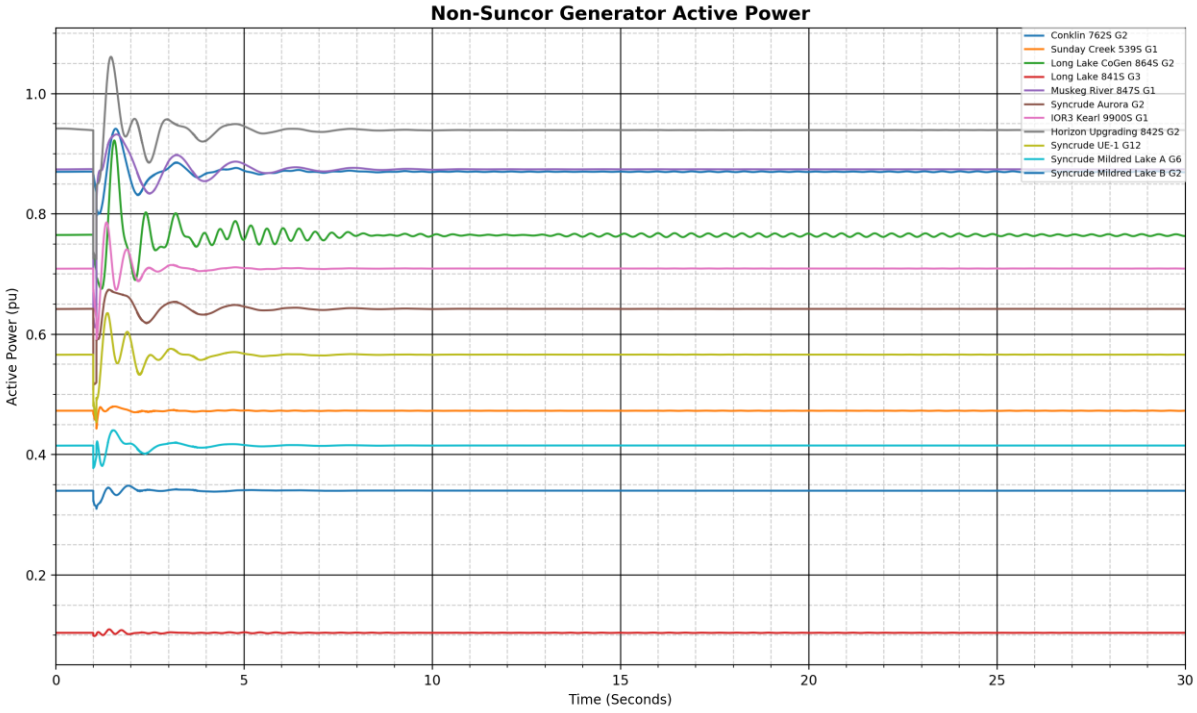

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

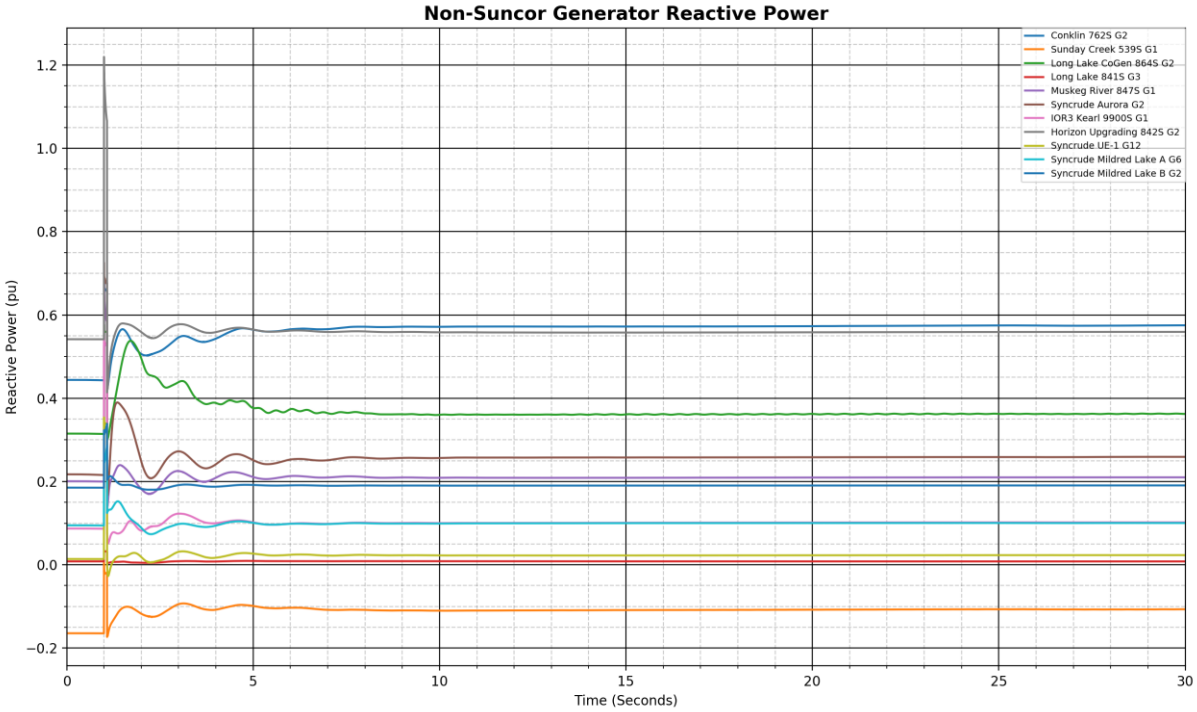
Figure A4-15: 9L57 (9L57 Birchwood Creek 960S to Livock 939S): Fault at Birchwood Creek 960S

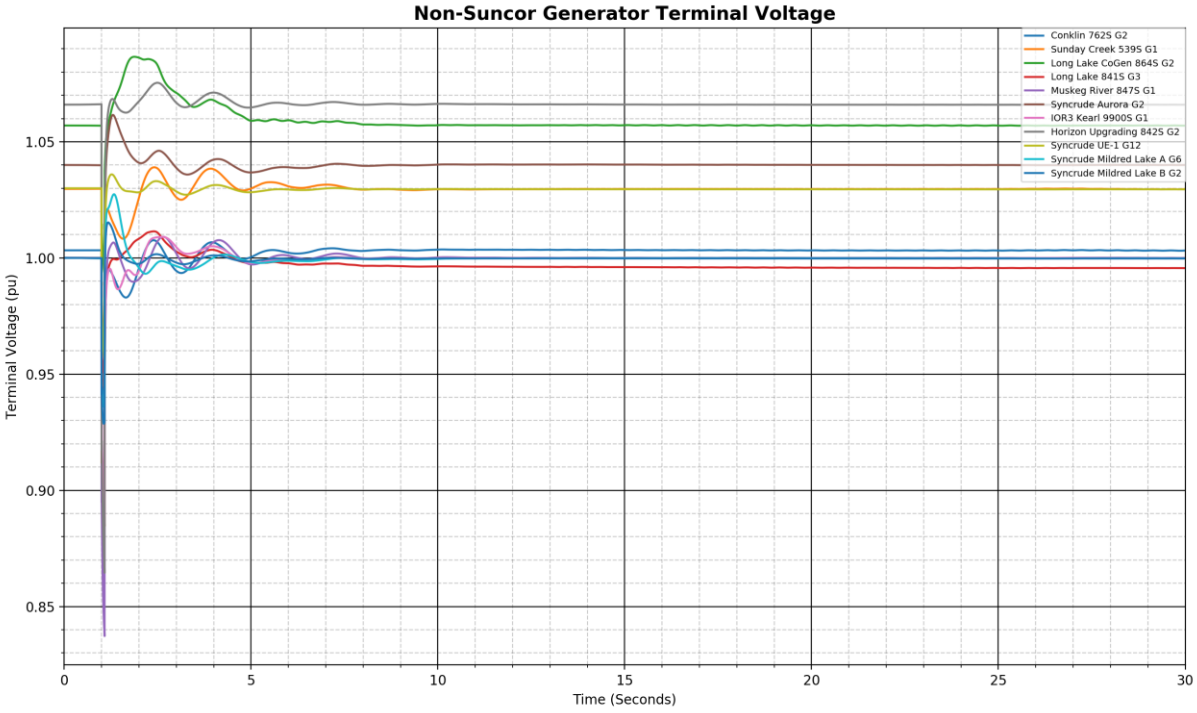


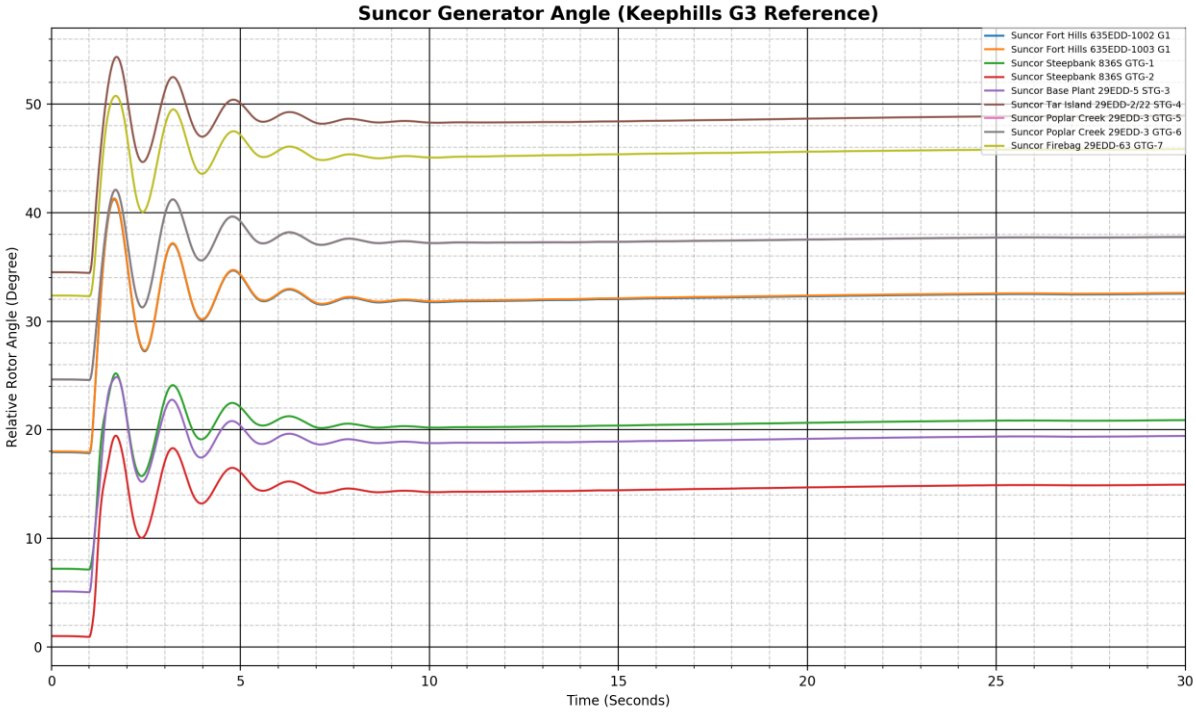


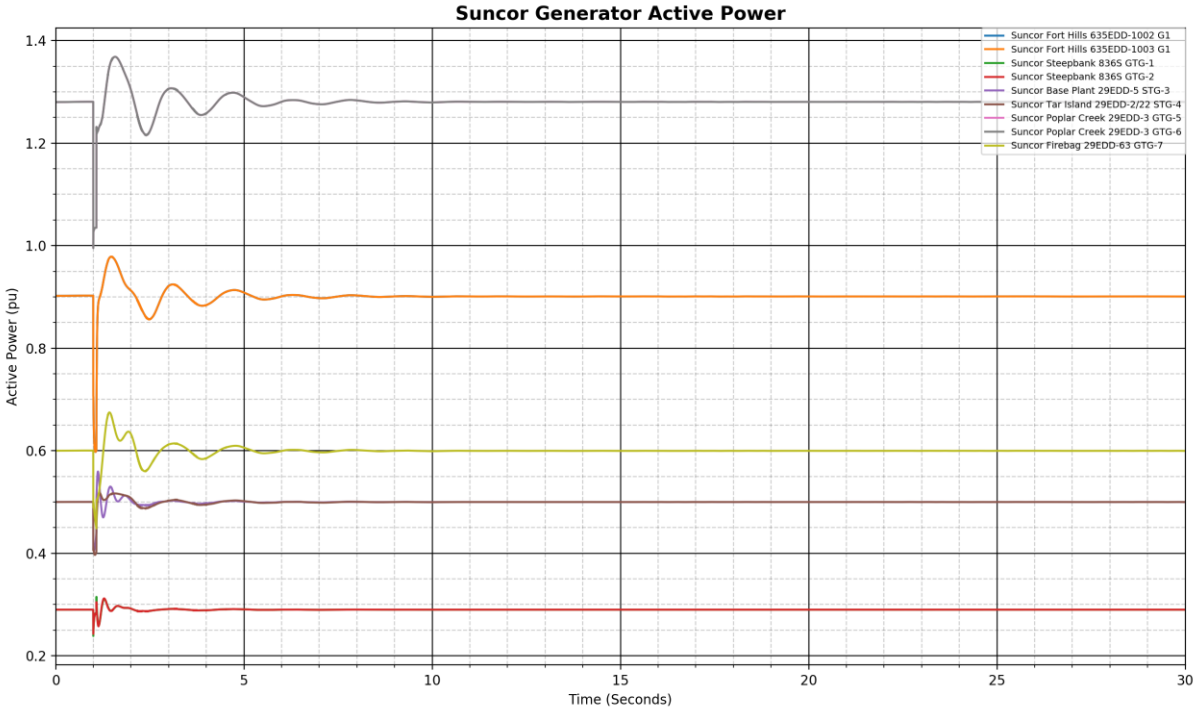

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

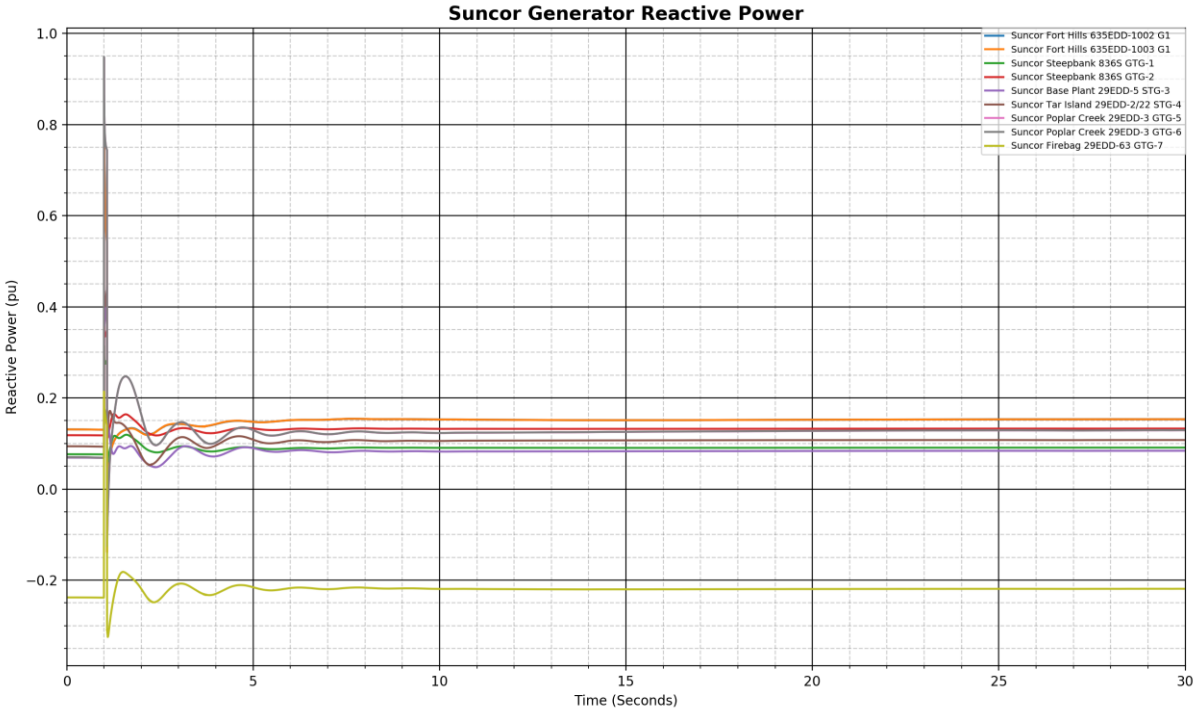

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

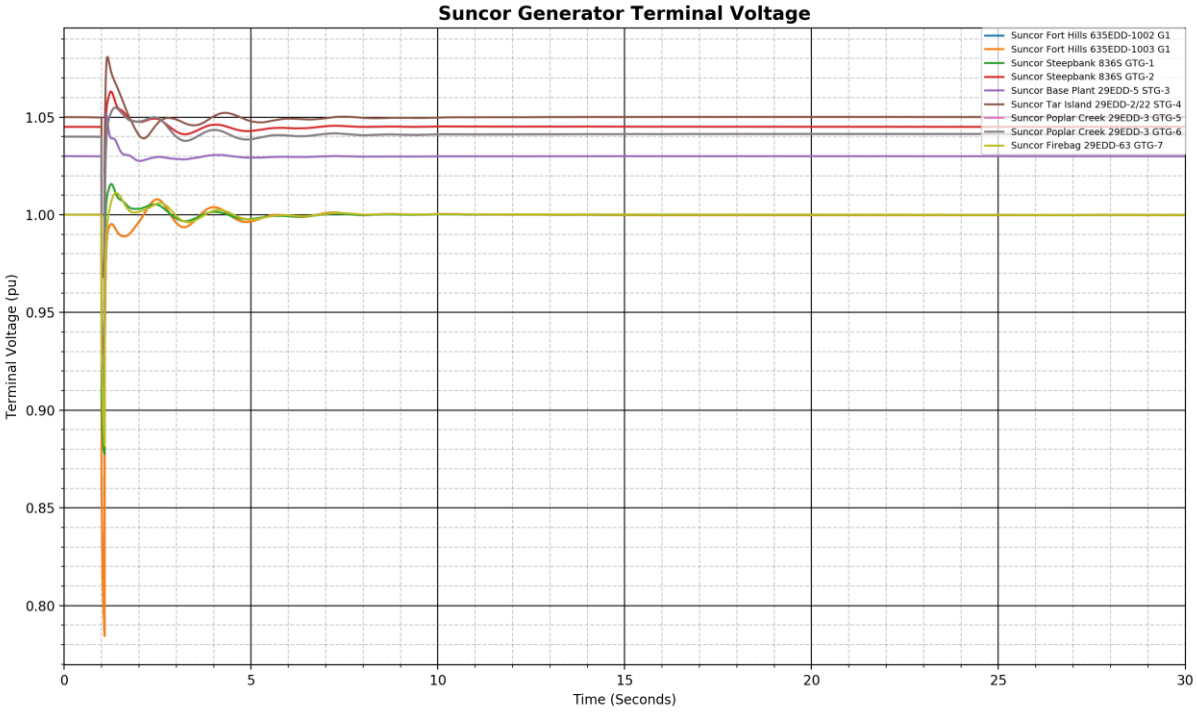

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

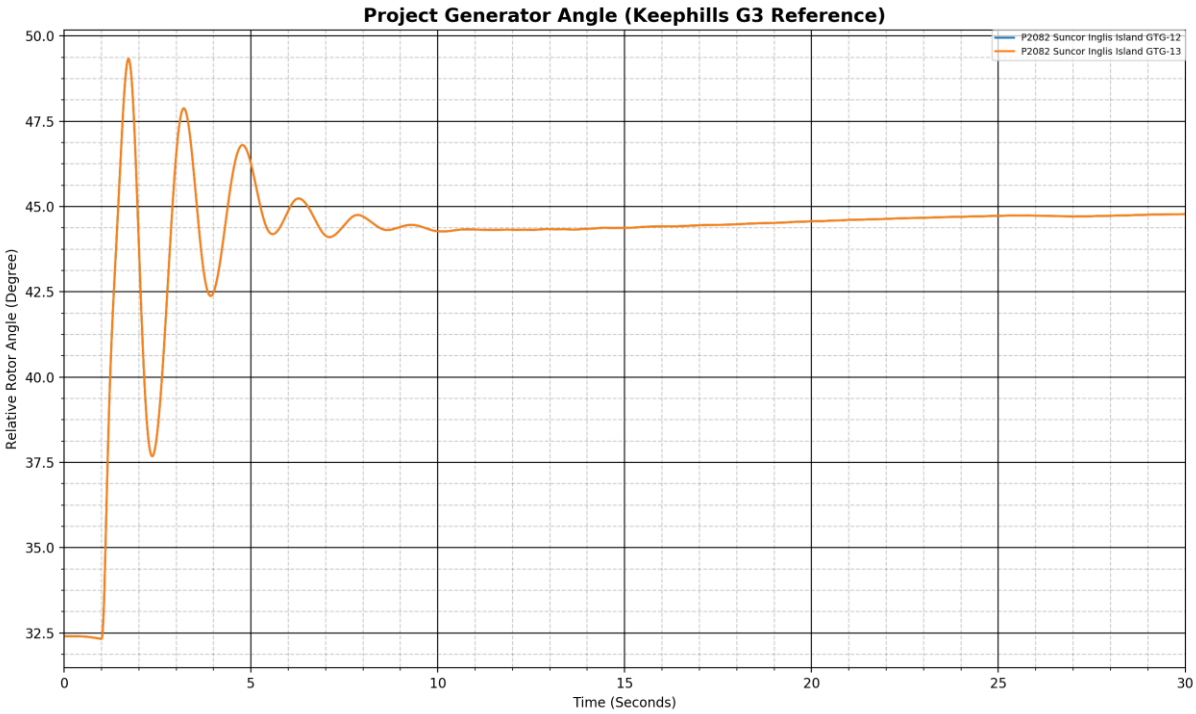

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

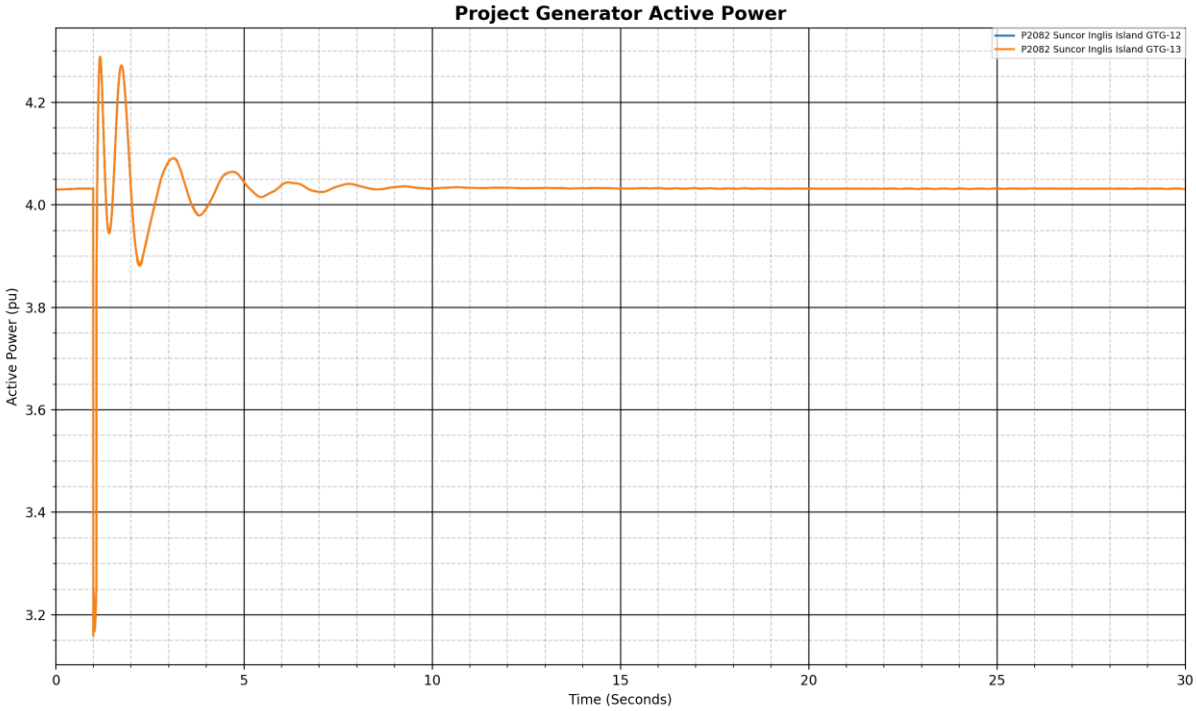

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

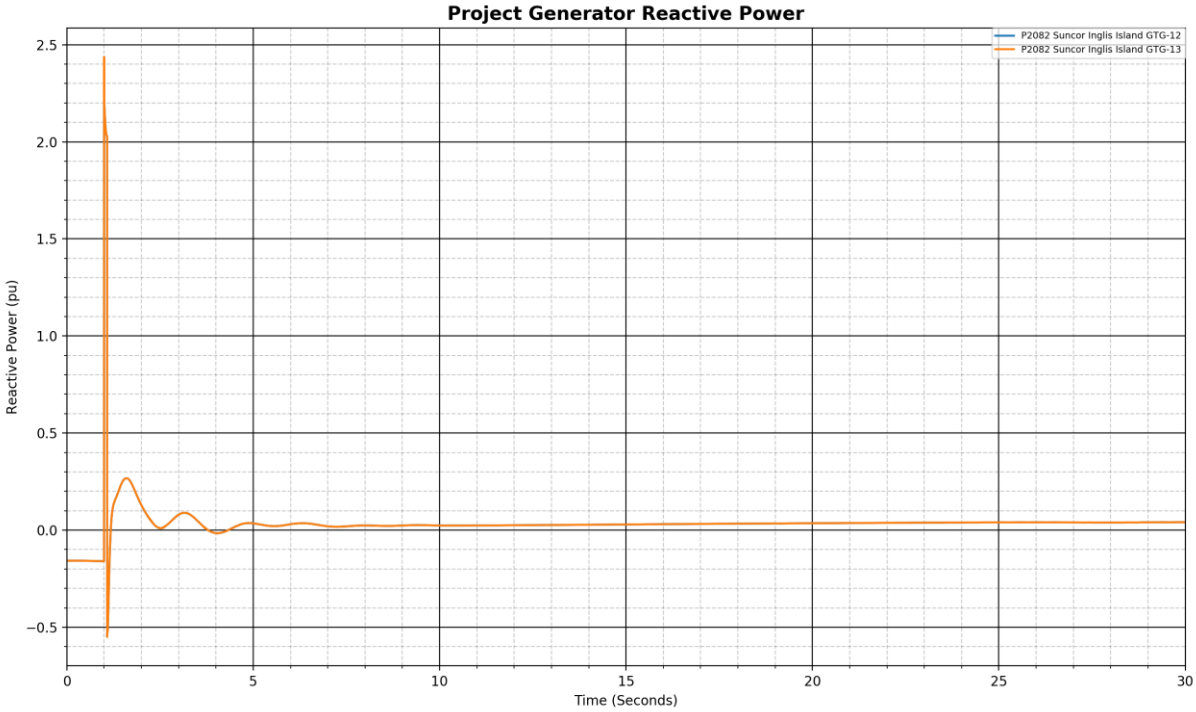

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

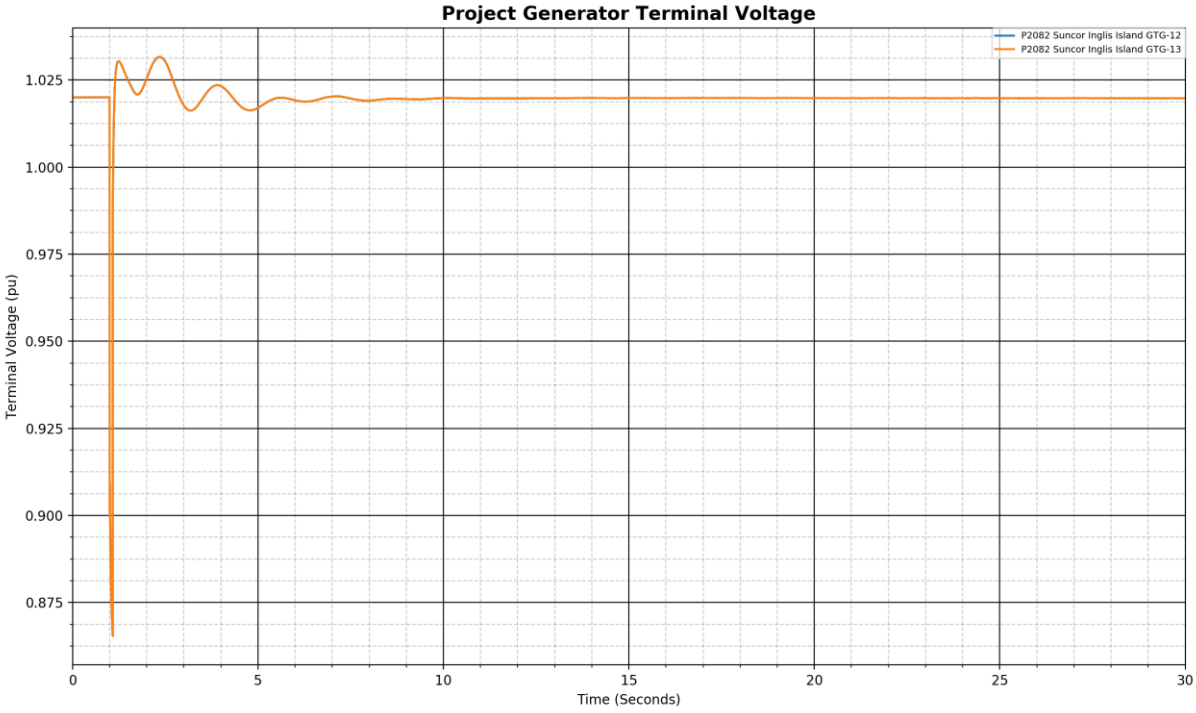

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

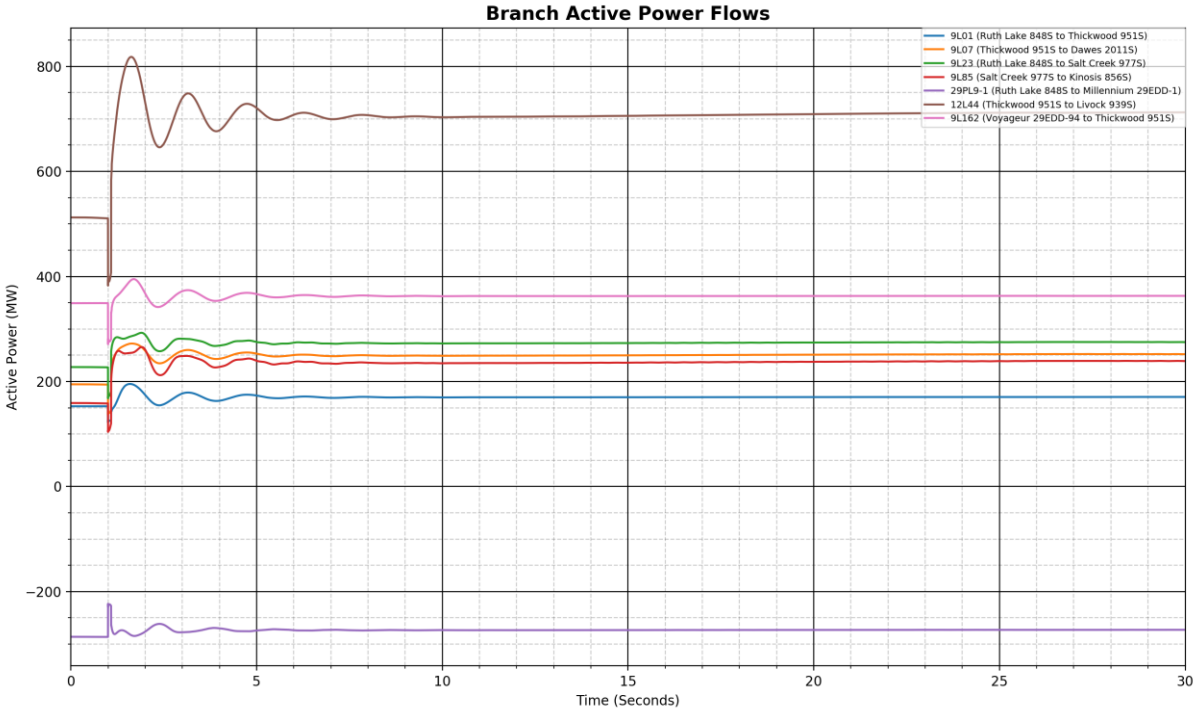

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.2
4.0
3.8
3.6
3.4
3.2
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.025
1.000
0.975
0.950
0.925
0.900
0.875
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

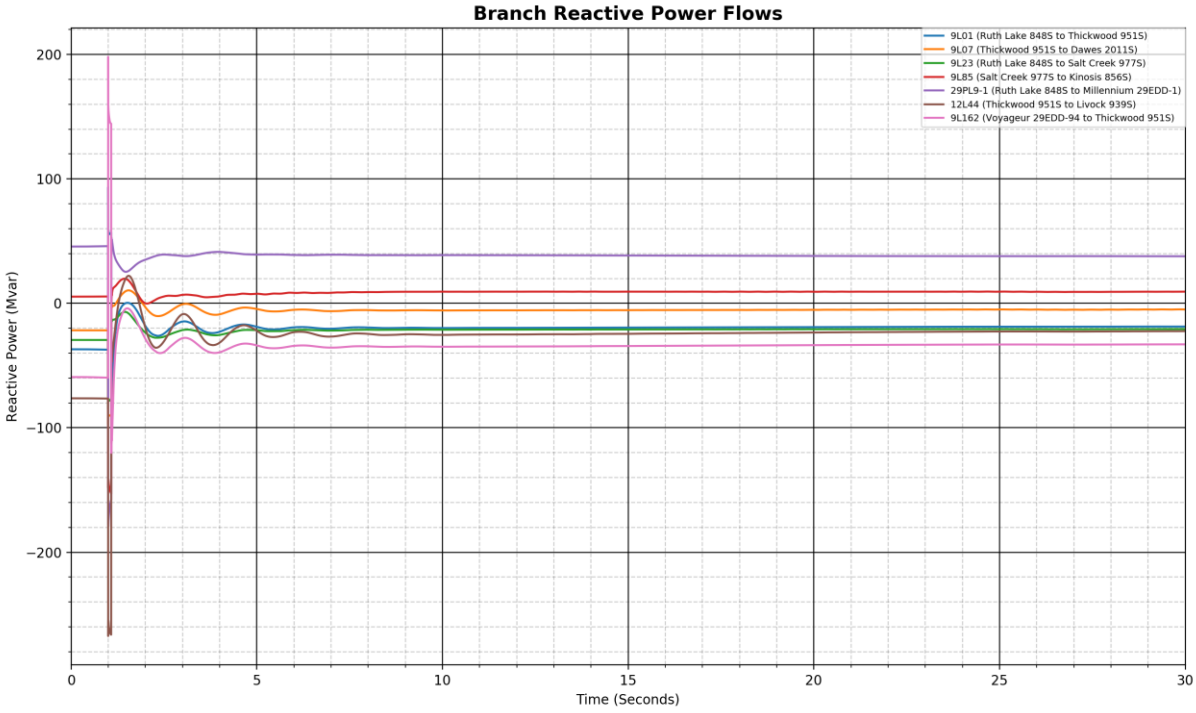
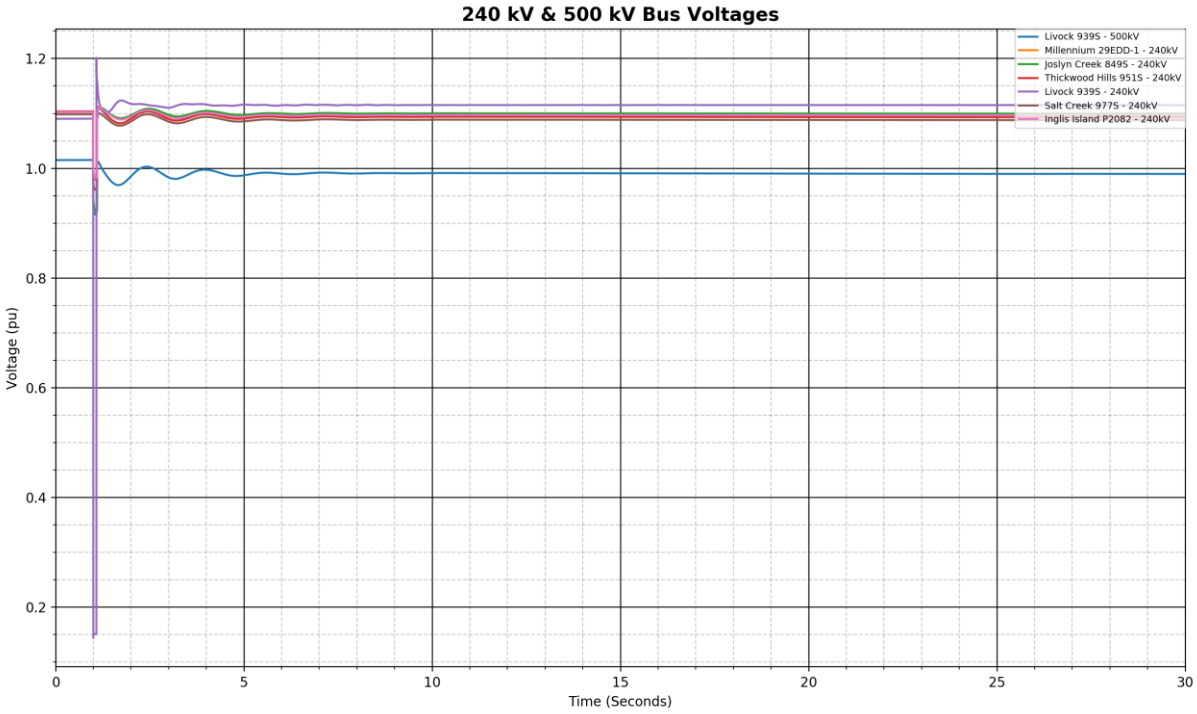
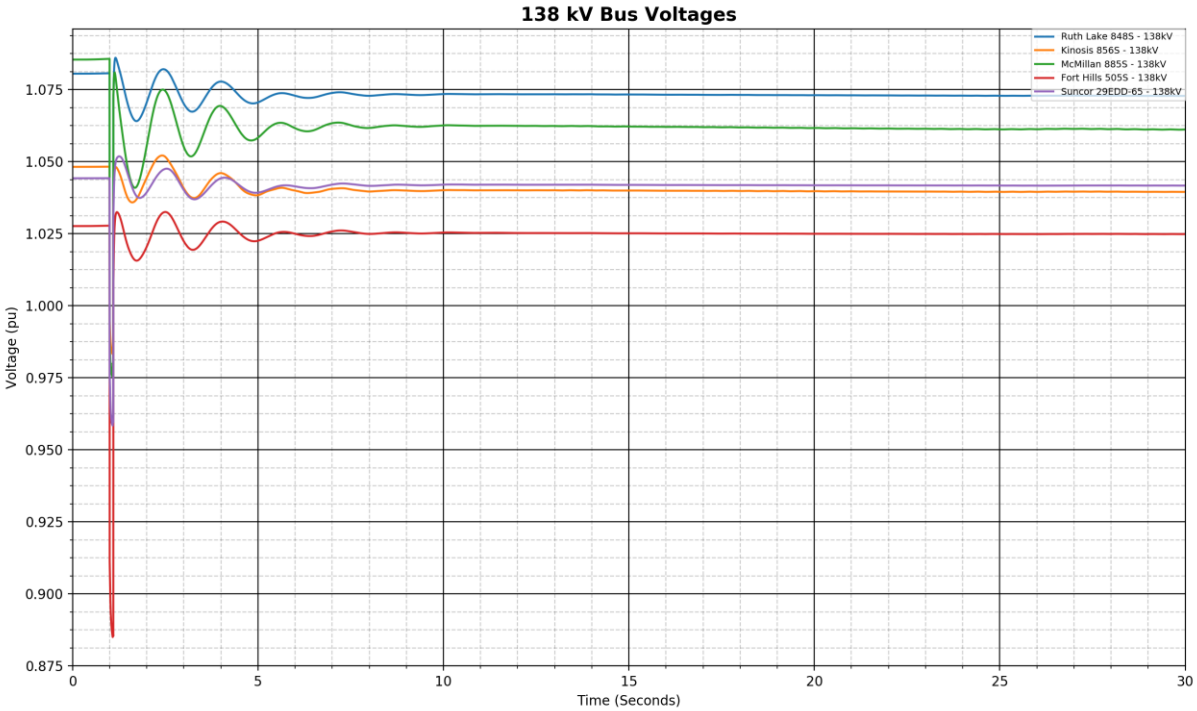
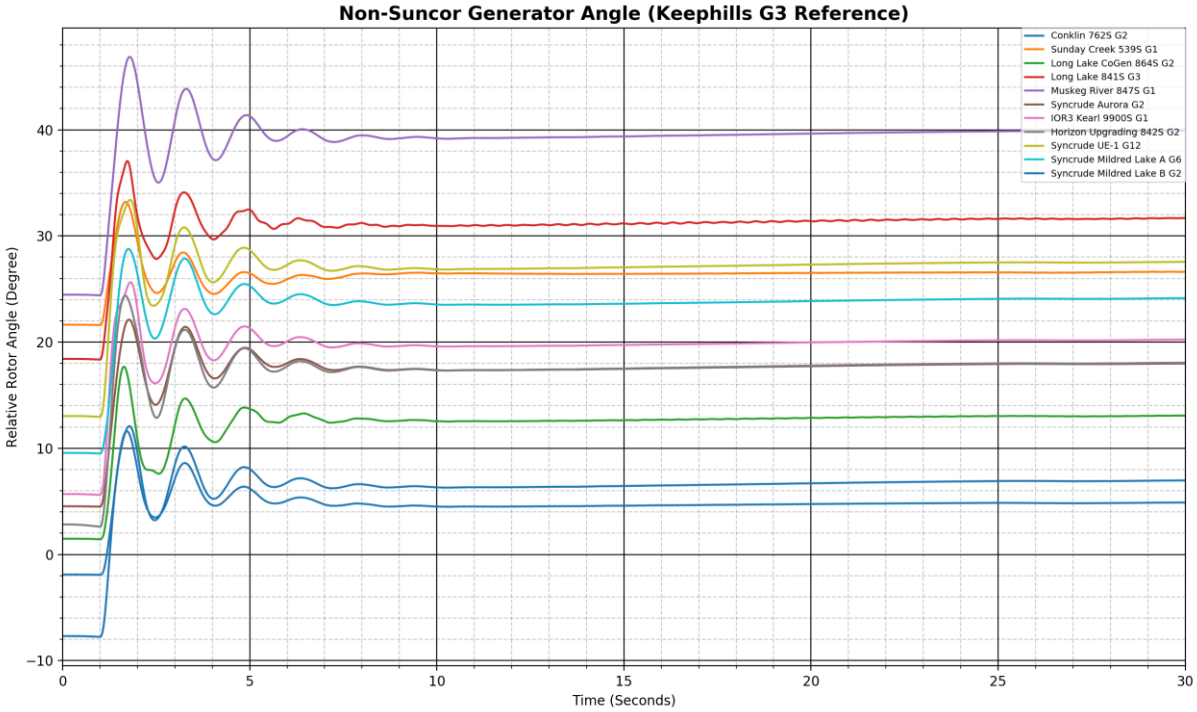
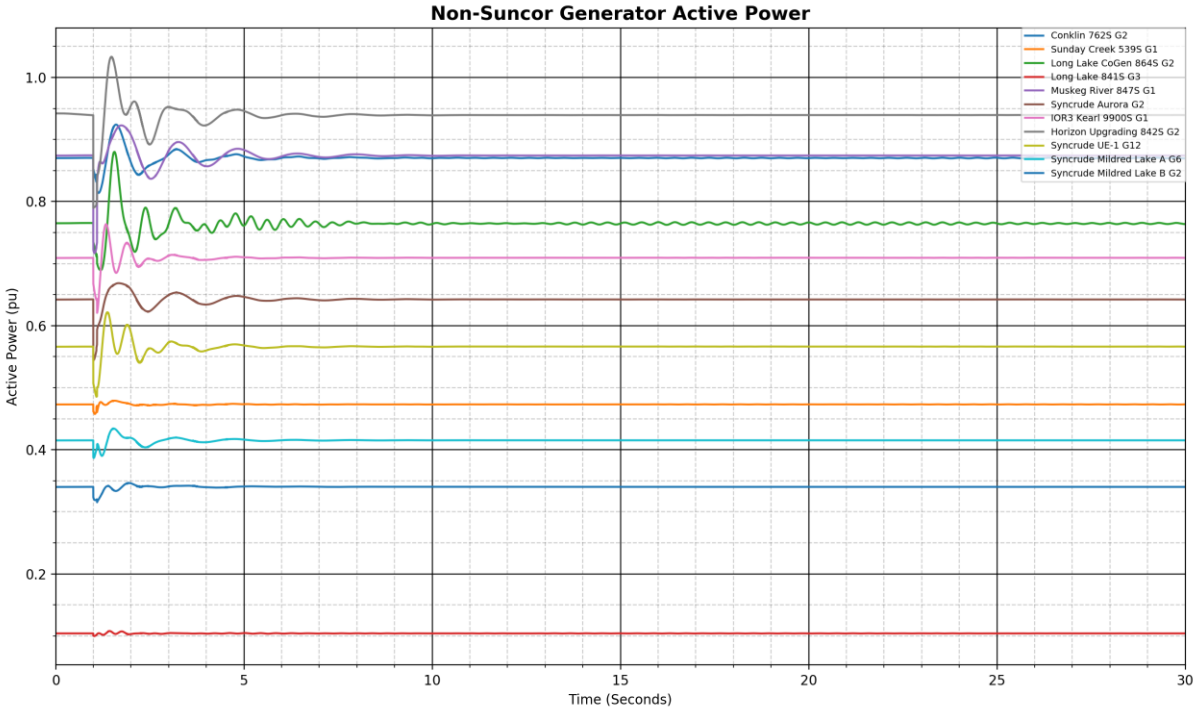

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
200
100
0
−100
−200
0
5
10
15
20
25
30
Time (Seconds)

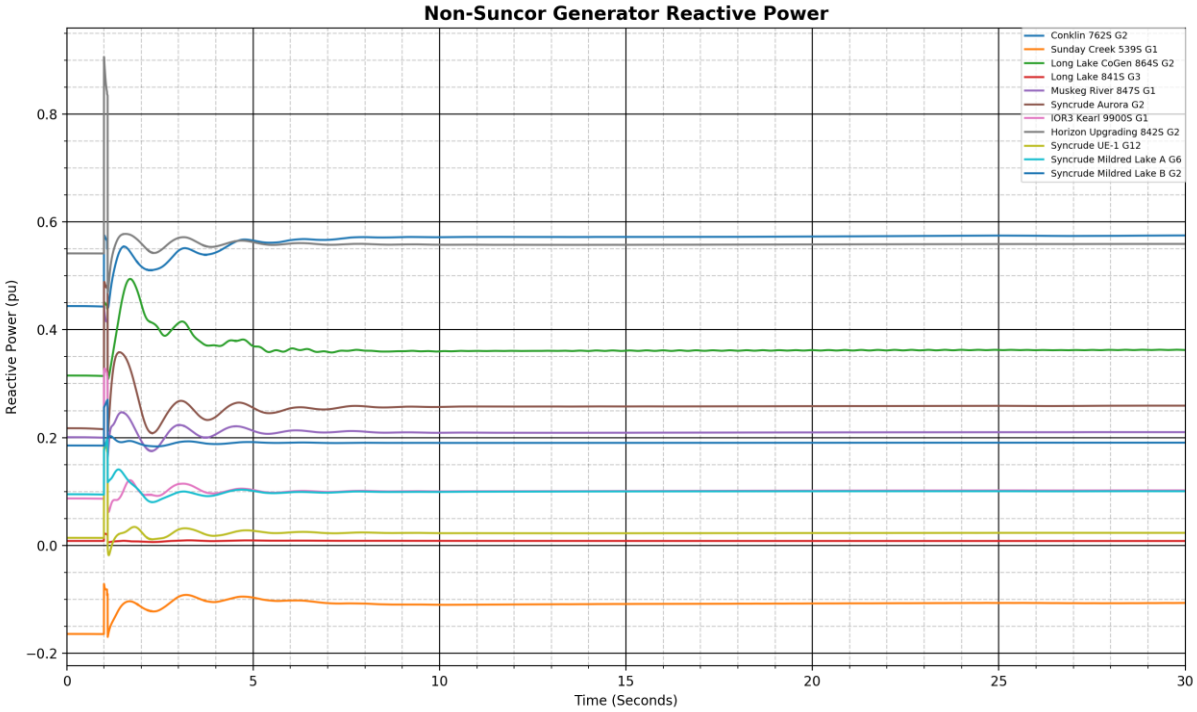
Figure A4-16: 9L57 (9L57 Birchwood Creek 960S to Livock 939S): Fault at Livock 939S

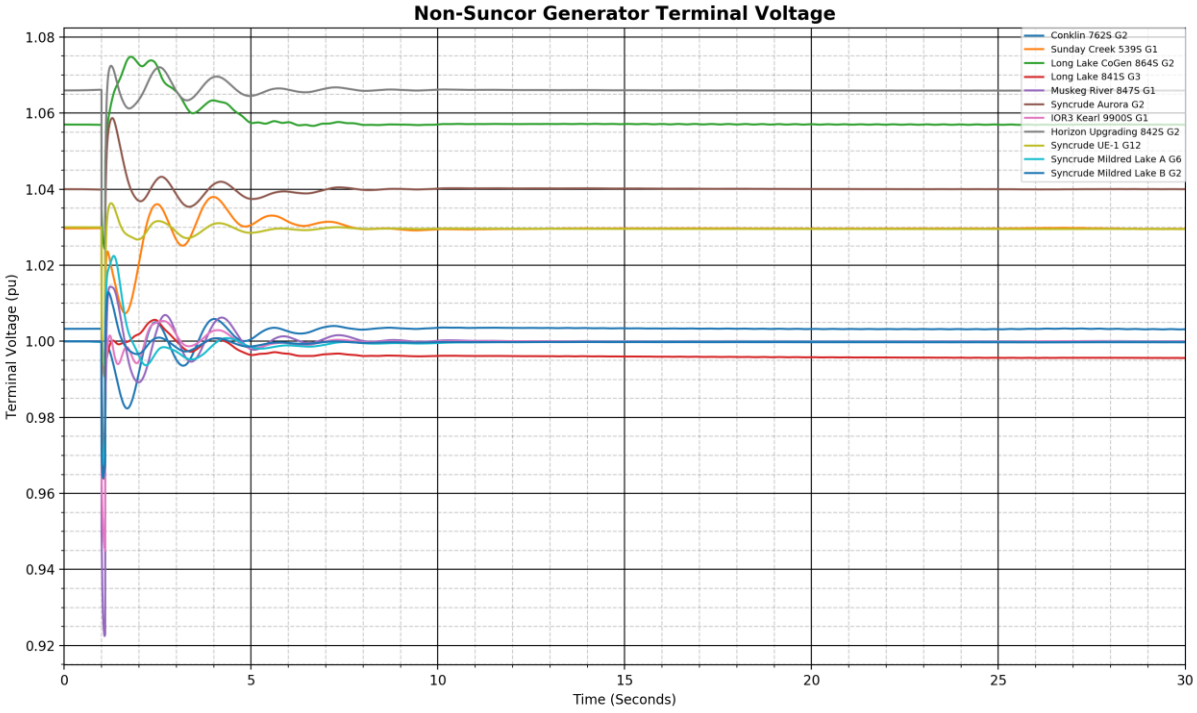


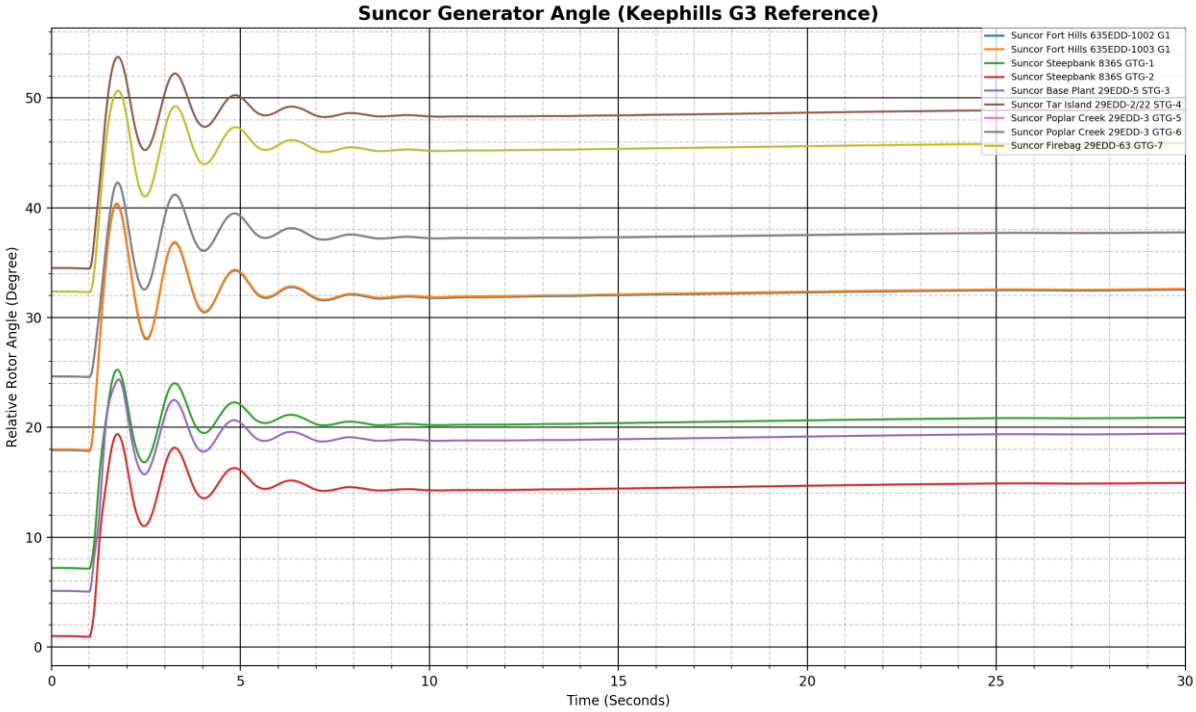


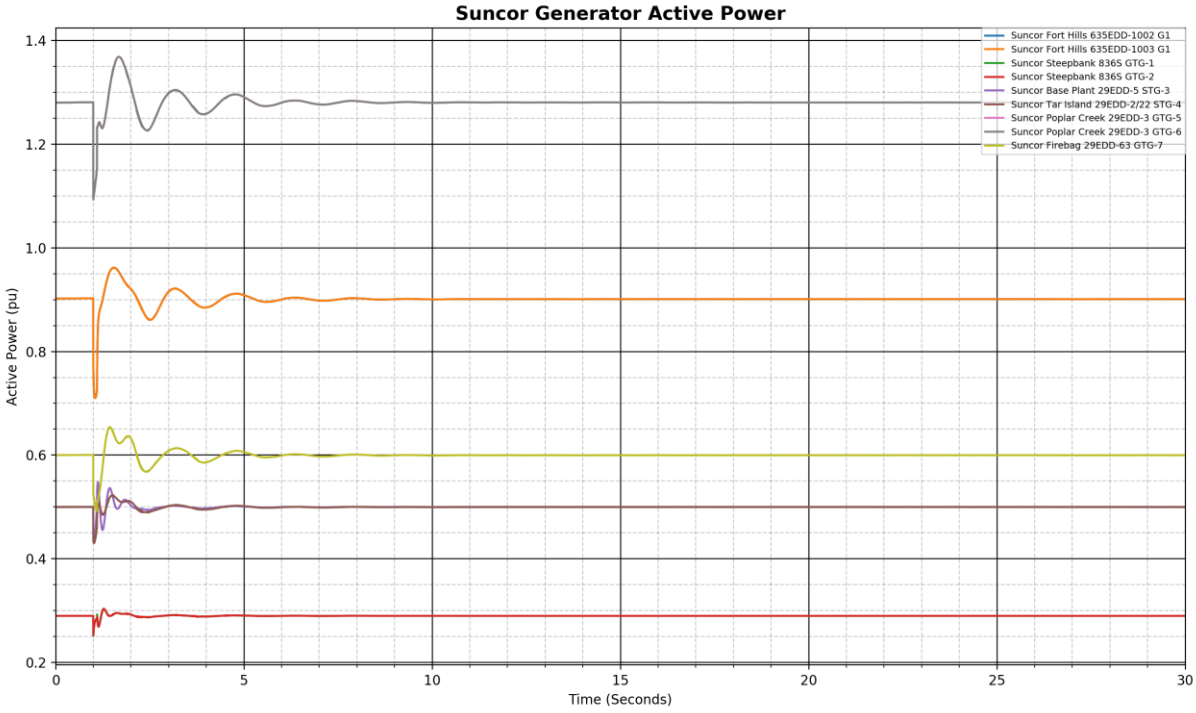

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

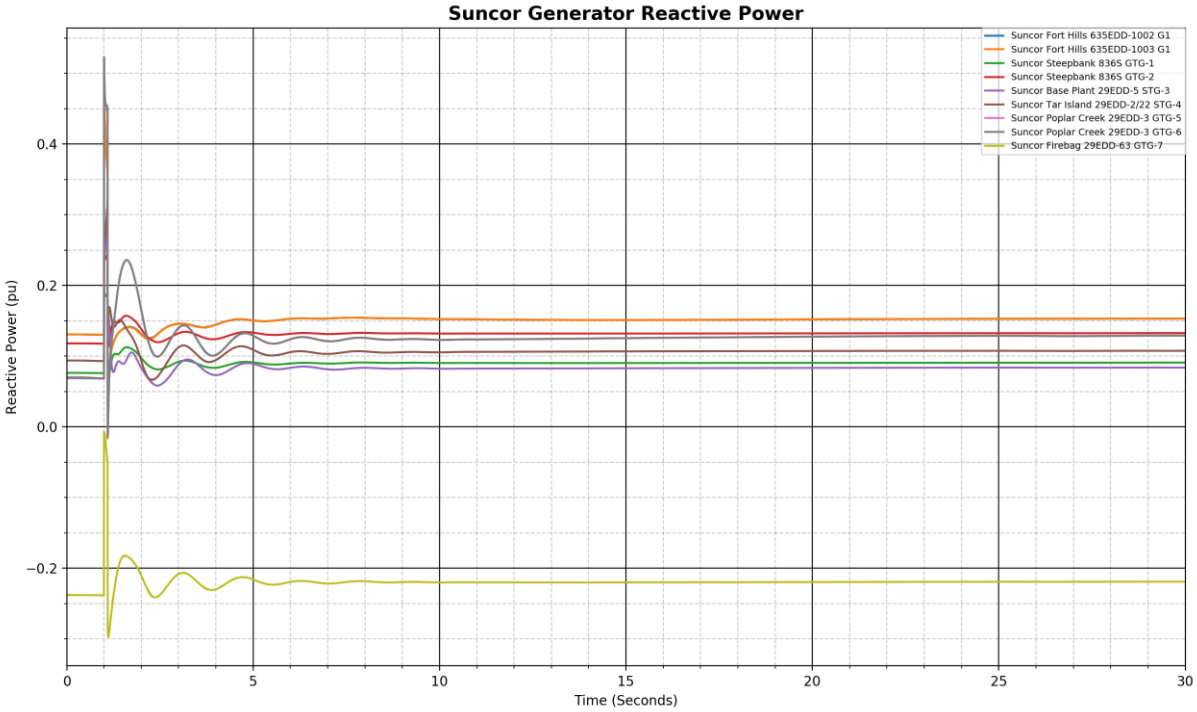

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

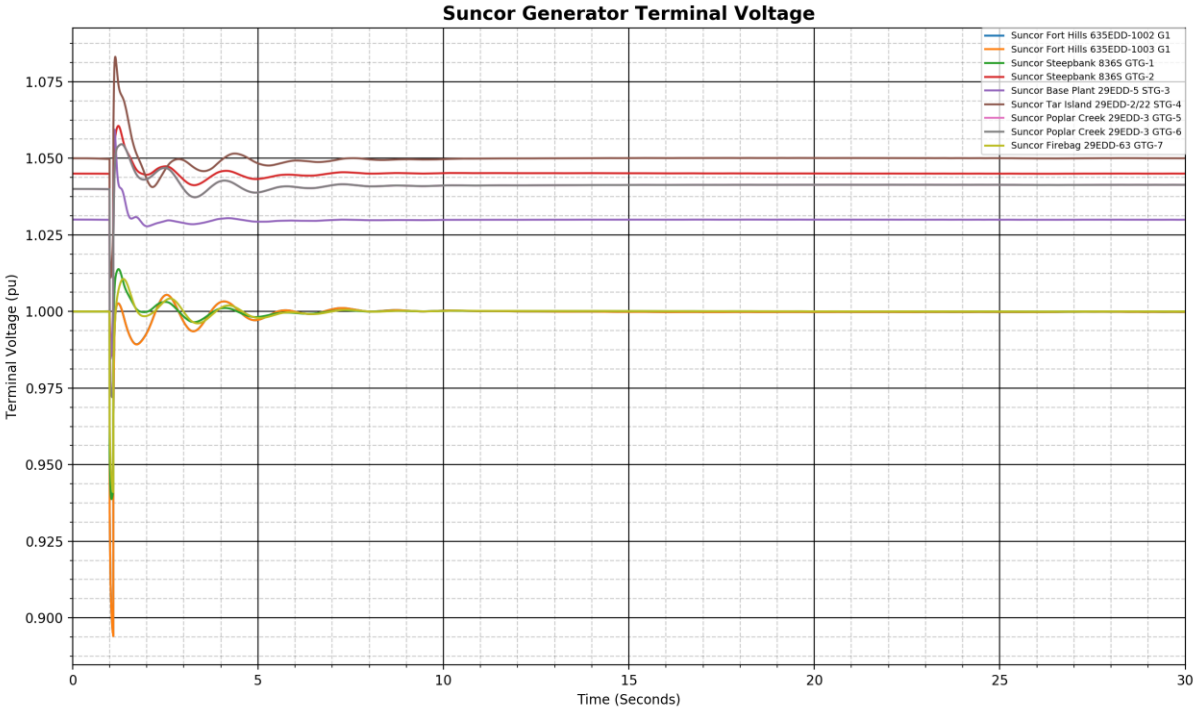

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

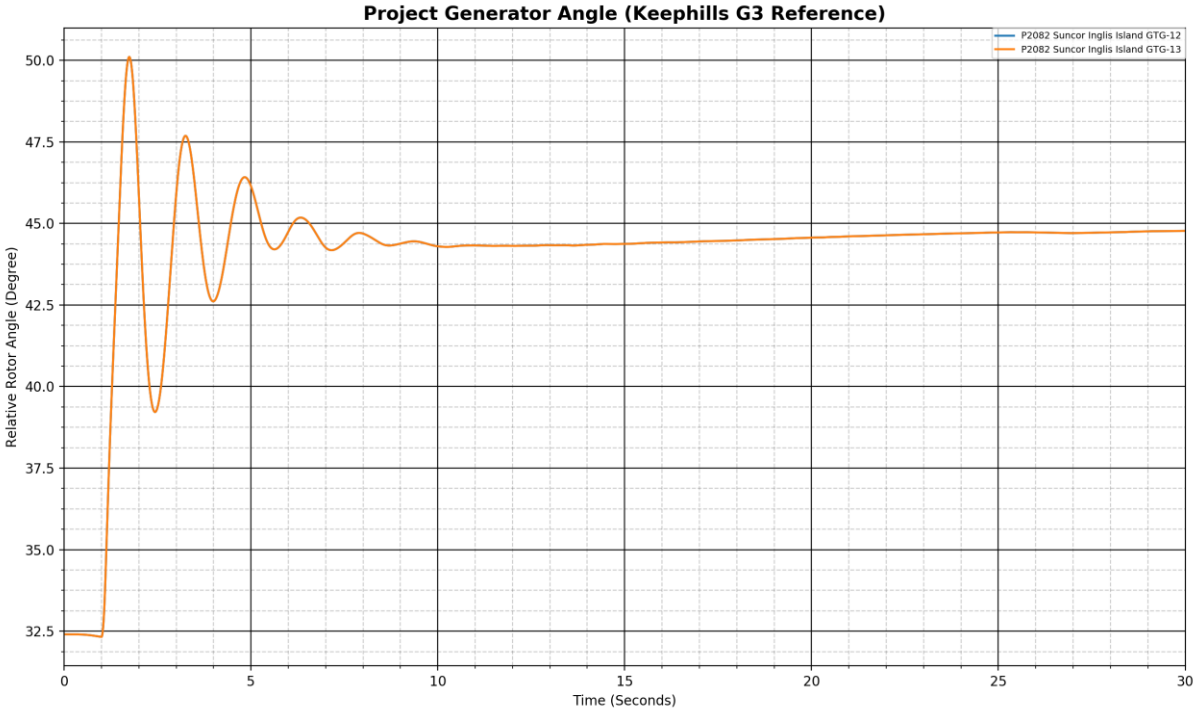

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

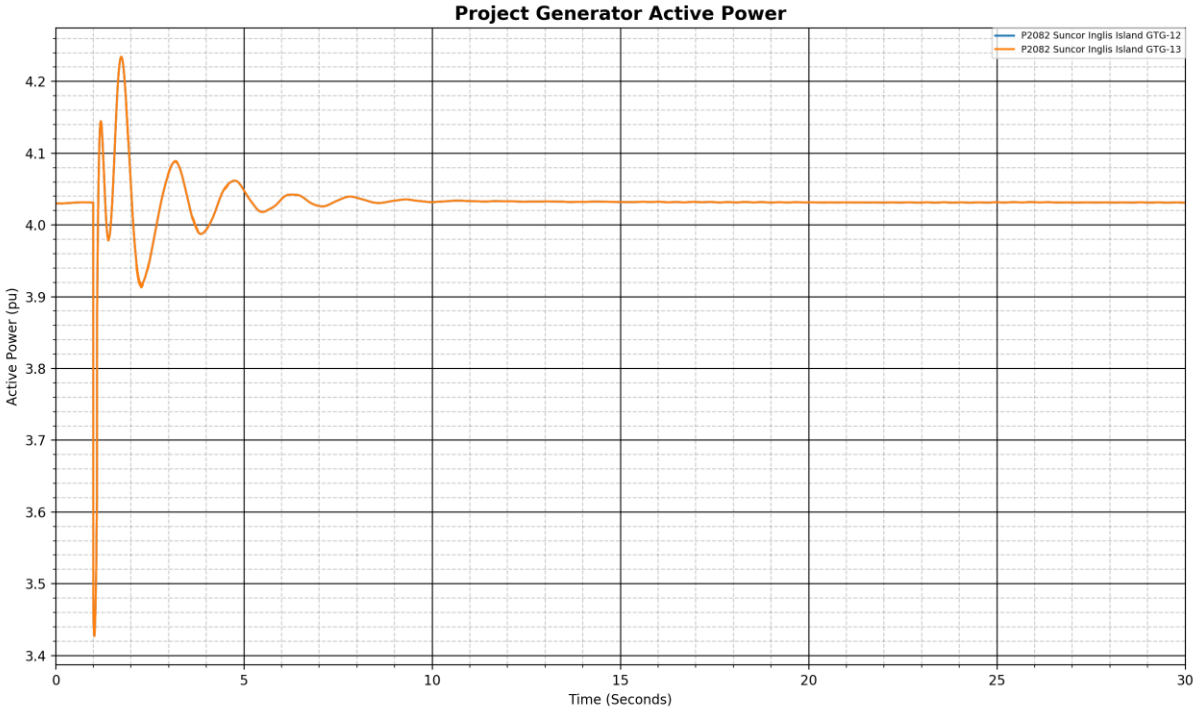

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

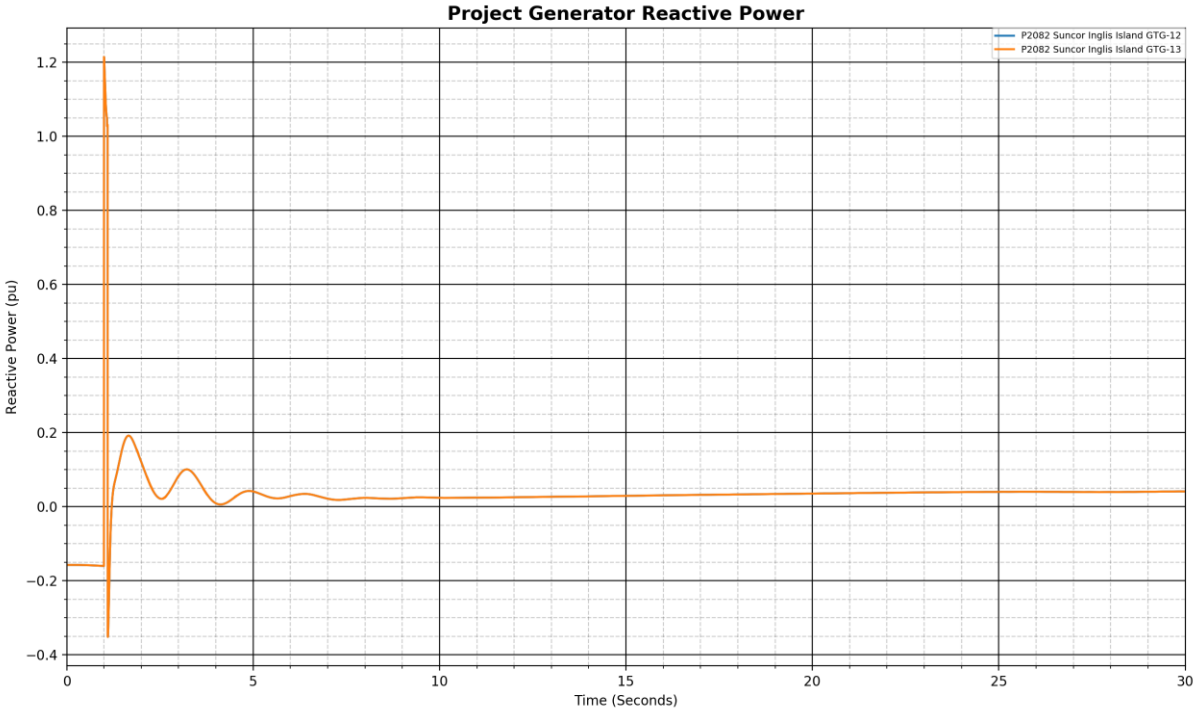

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

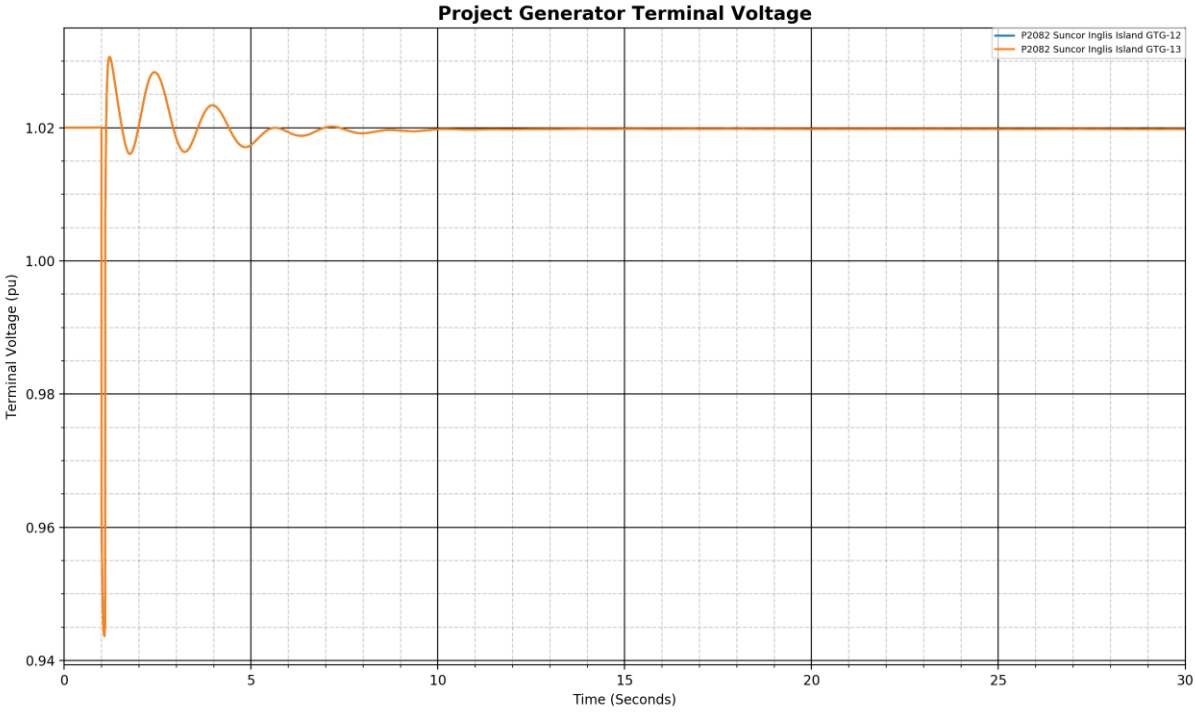

Suncor Generator Reactive Power
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7
Reactive Power (pu)
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
Time (Seconds)

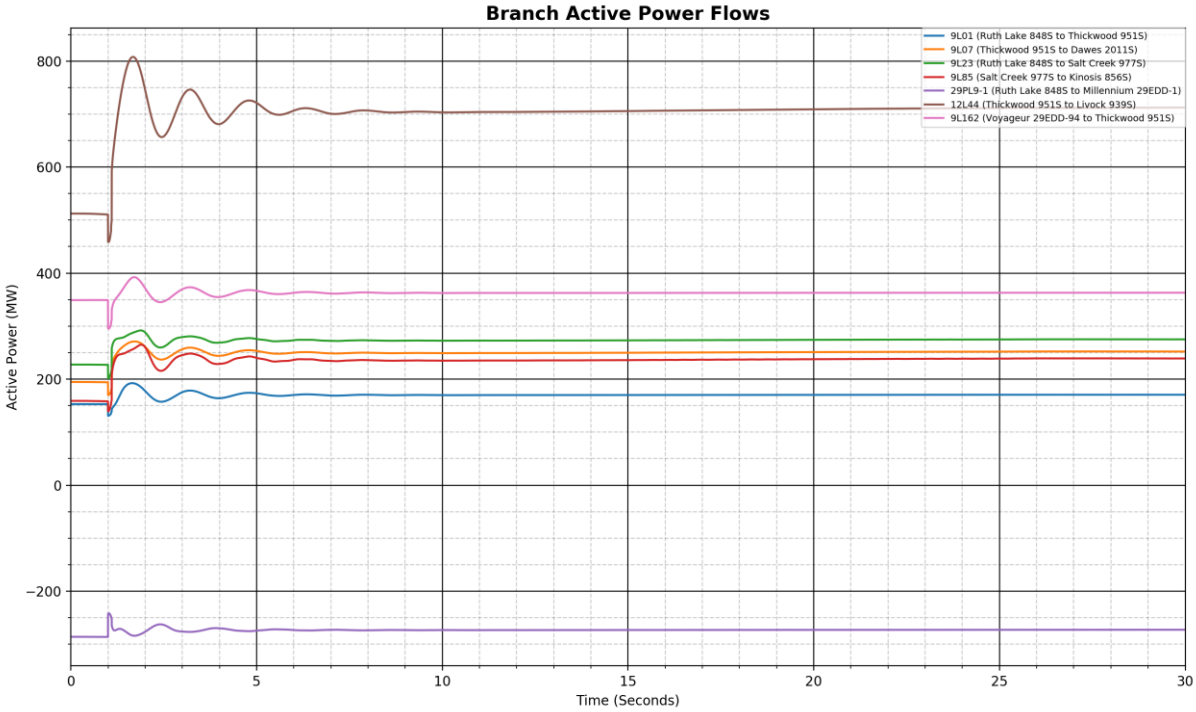

Suncor Generator Terminal Voltage
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7
Terminal Voltage (pu)
1.075
1.050
1.025
1.000
0.975
0.950
0.925
0.900
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.2
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.02
1.00
0.98
0.96
0.94
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

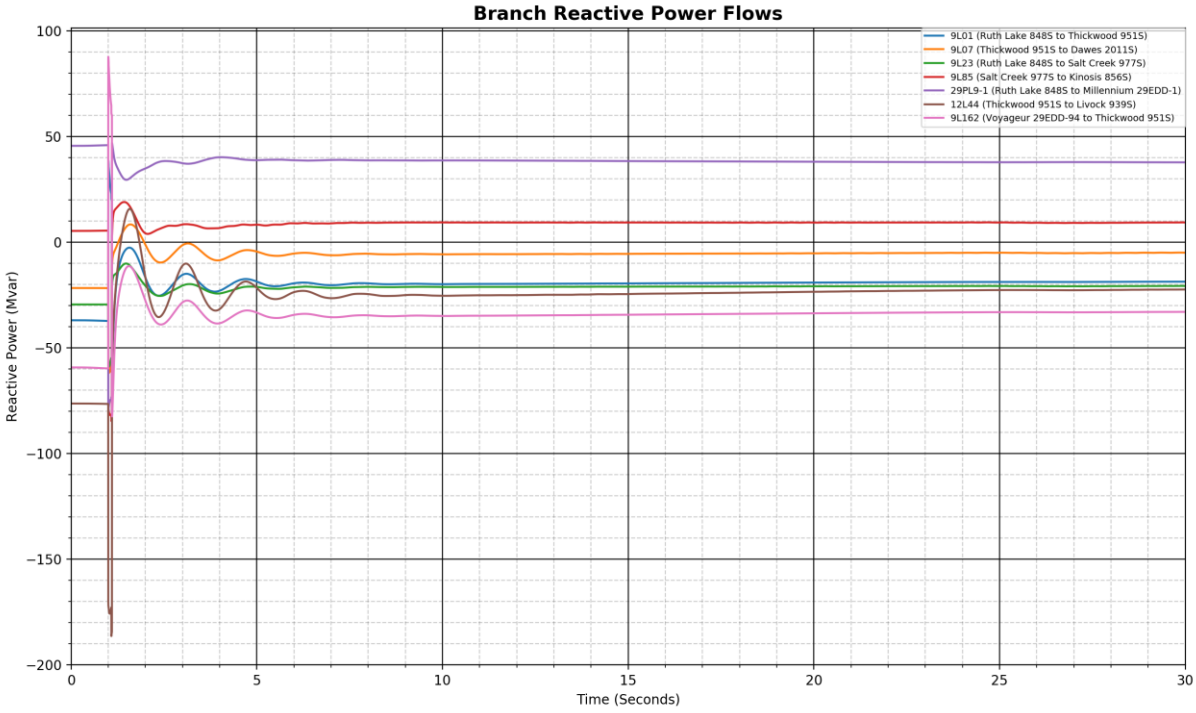
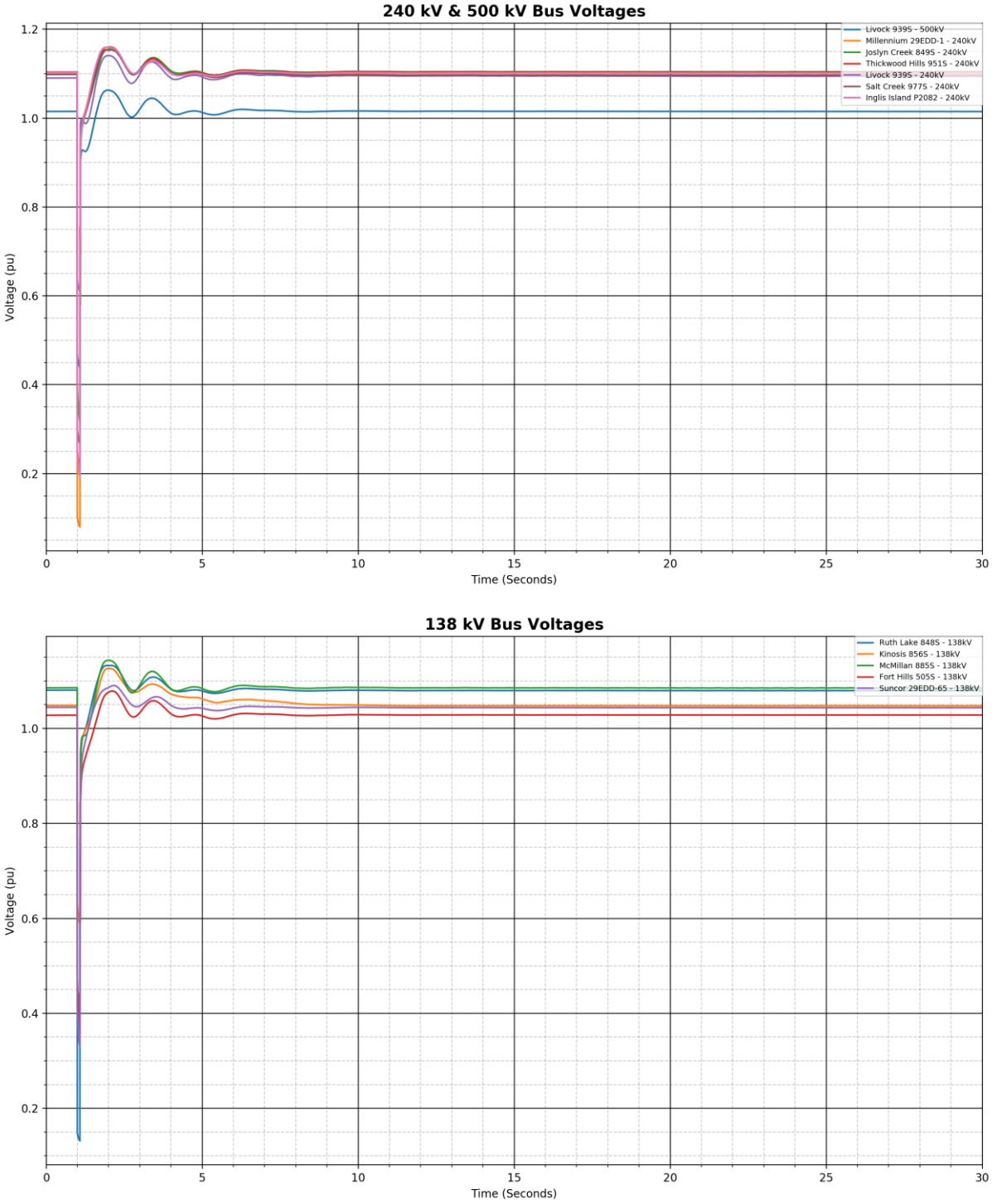
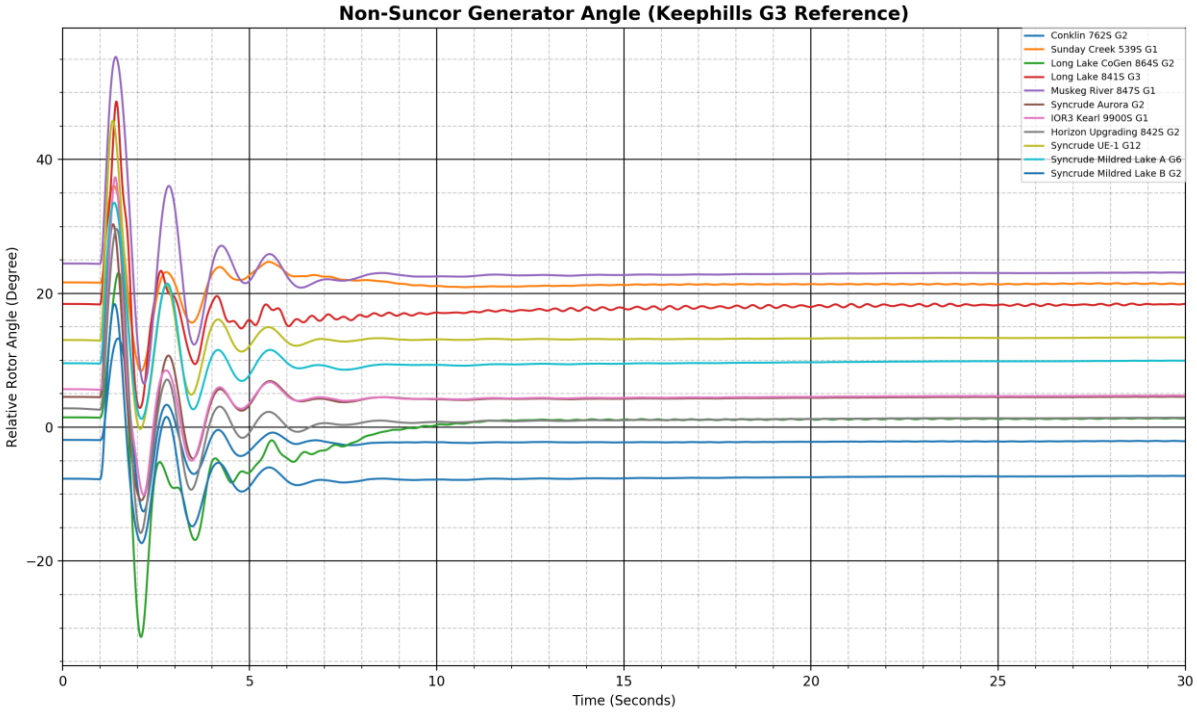
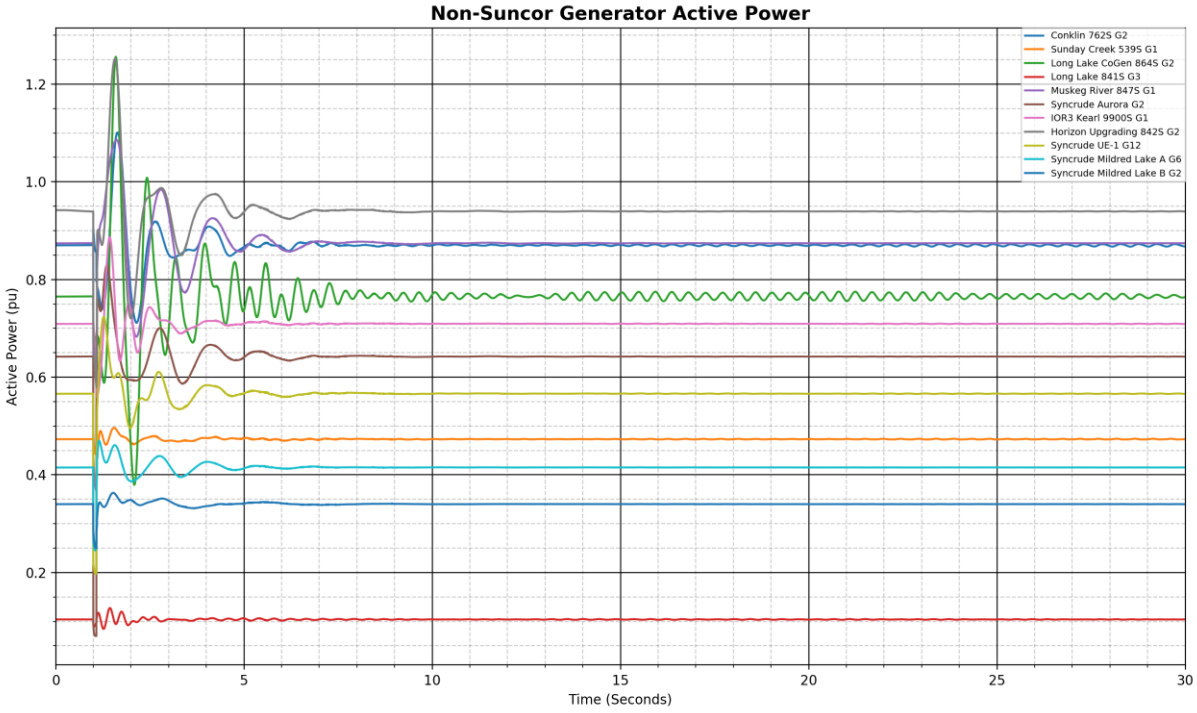
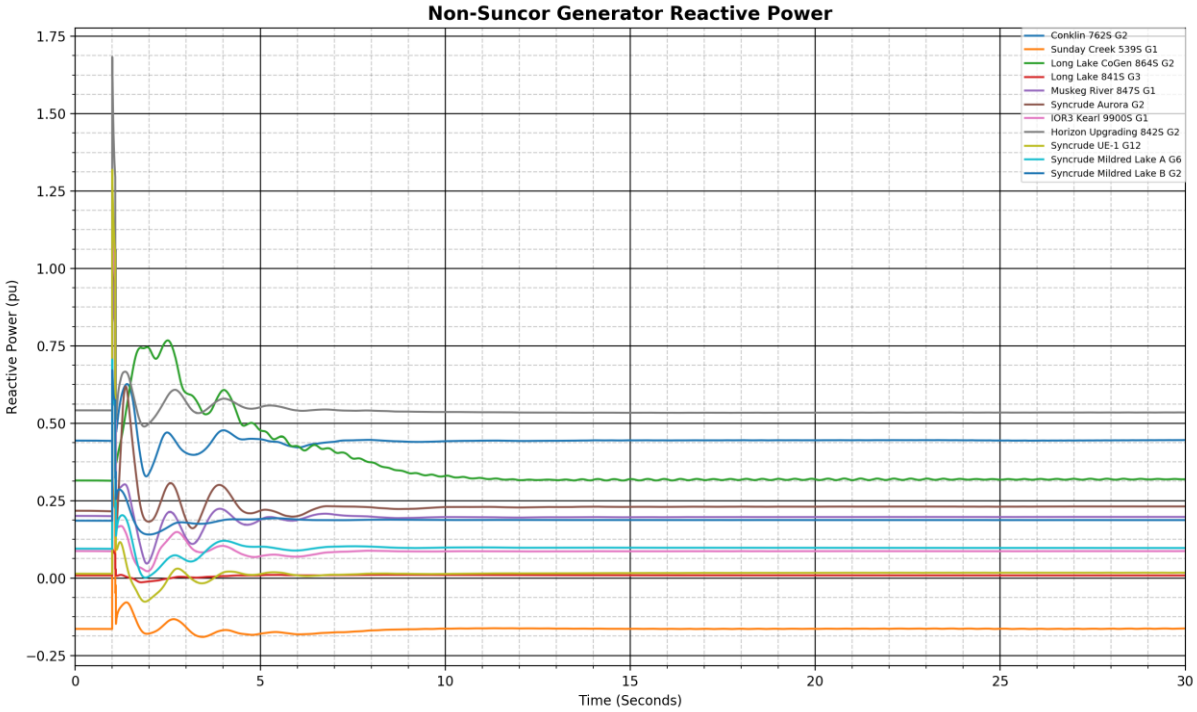

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
100
50
0
−50
−100
−150
−200
0
5
10
15
20
25
30
Time (Seconds)

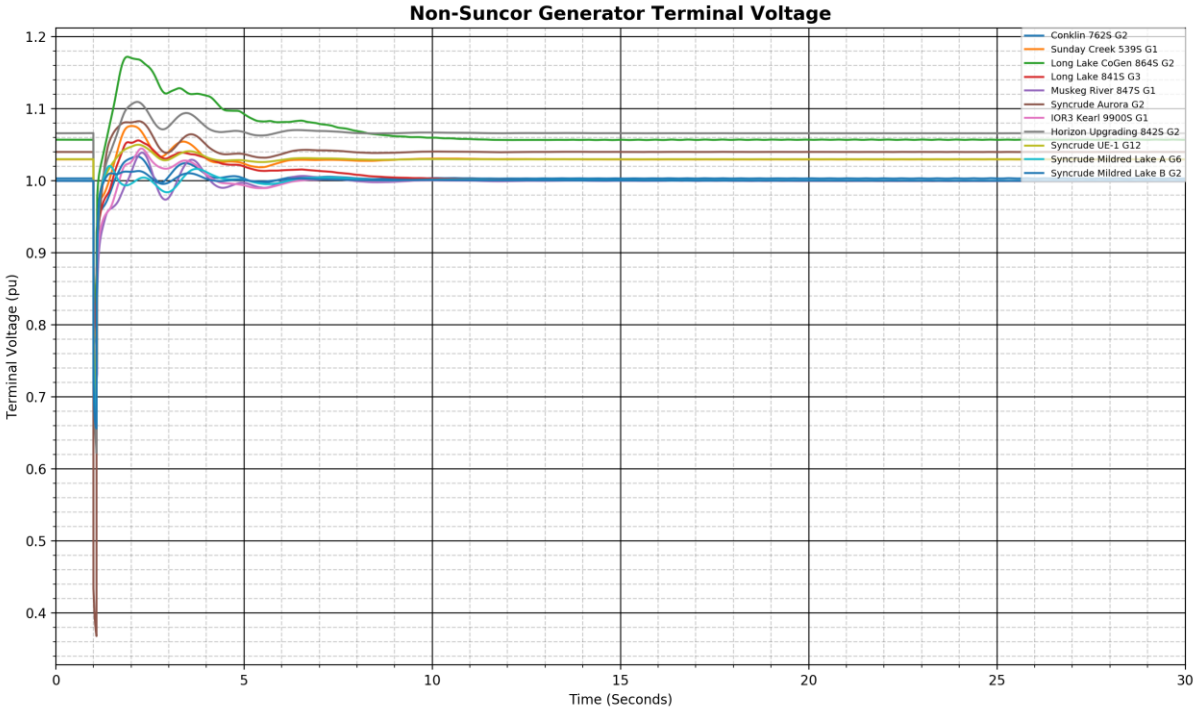
Figure A4-17: 9L58 (Ruth Lake 848S to Dover 888S): Fault at Ruth Lake 848S

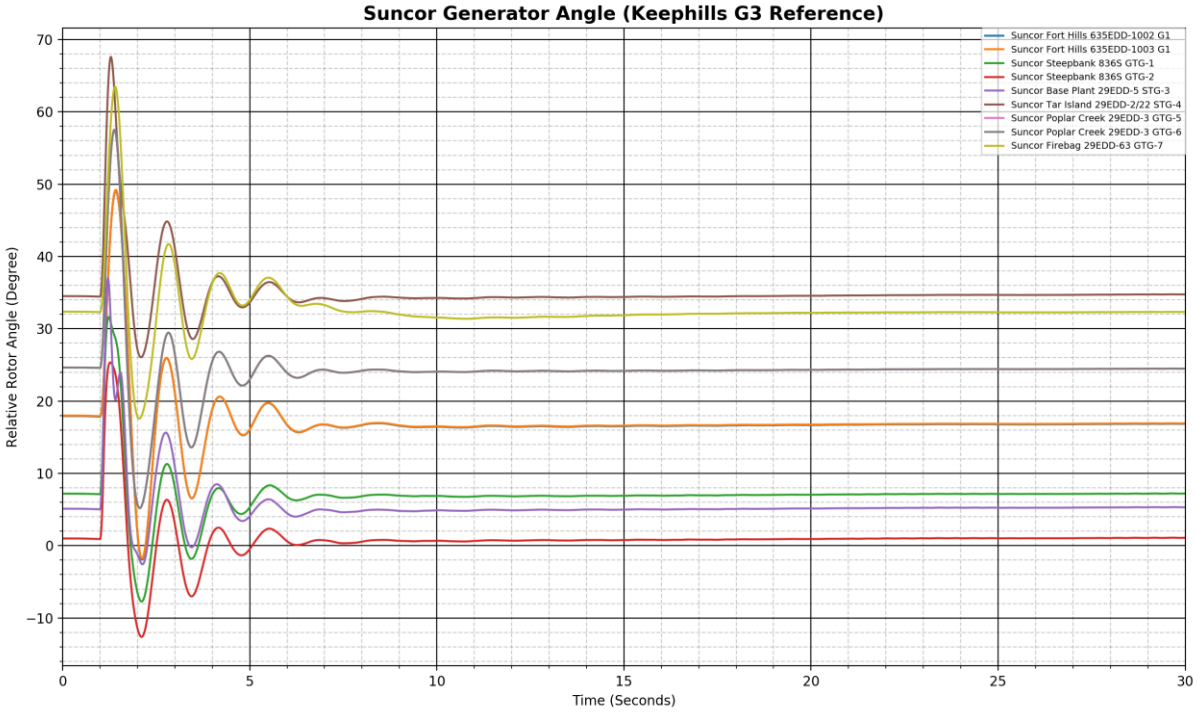


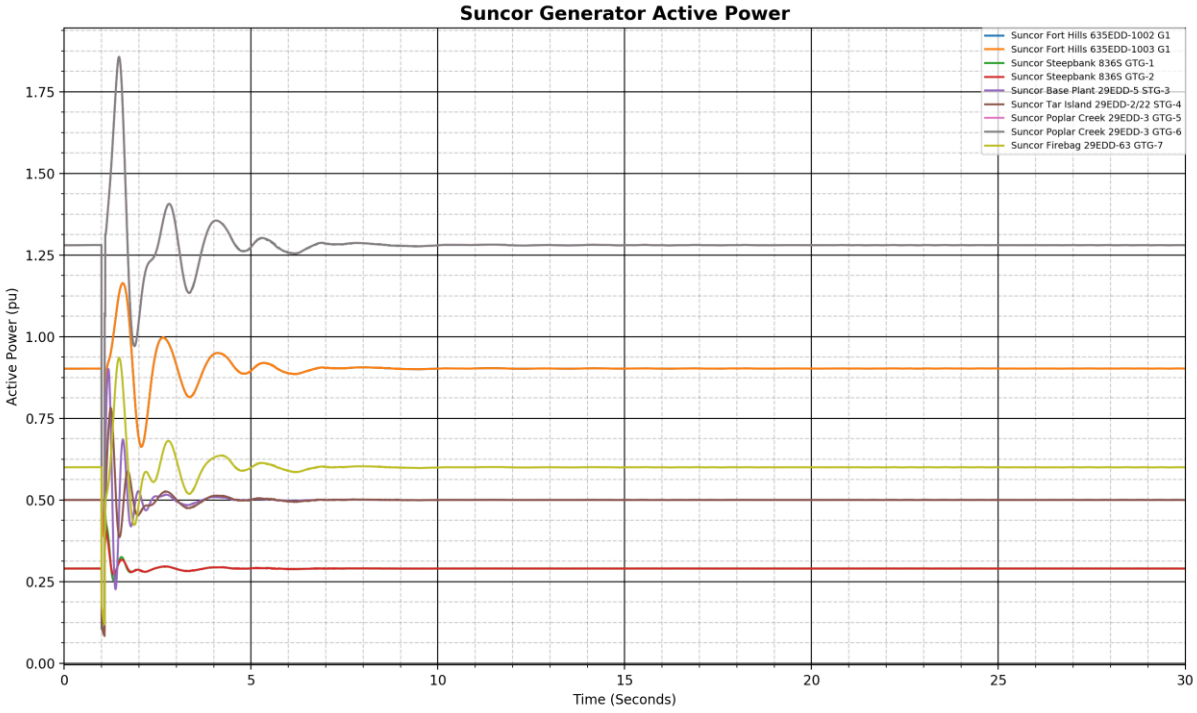

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

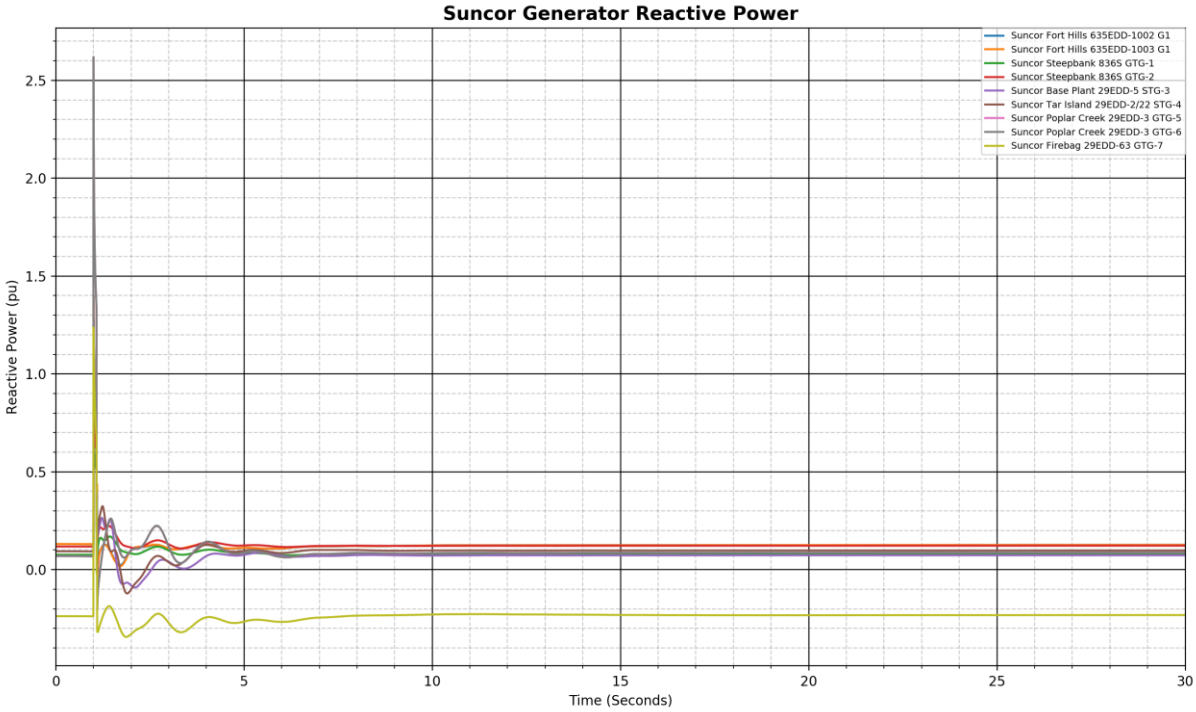

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

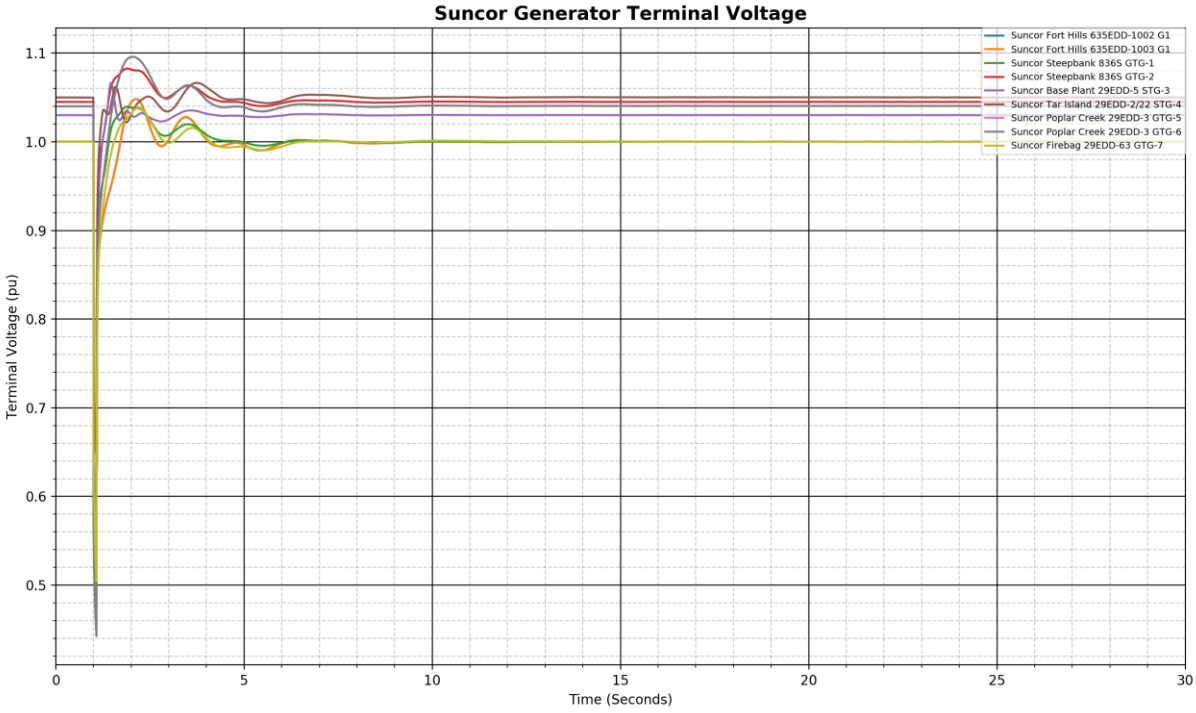

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

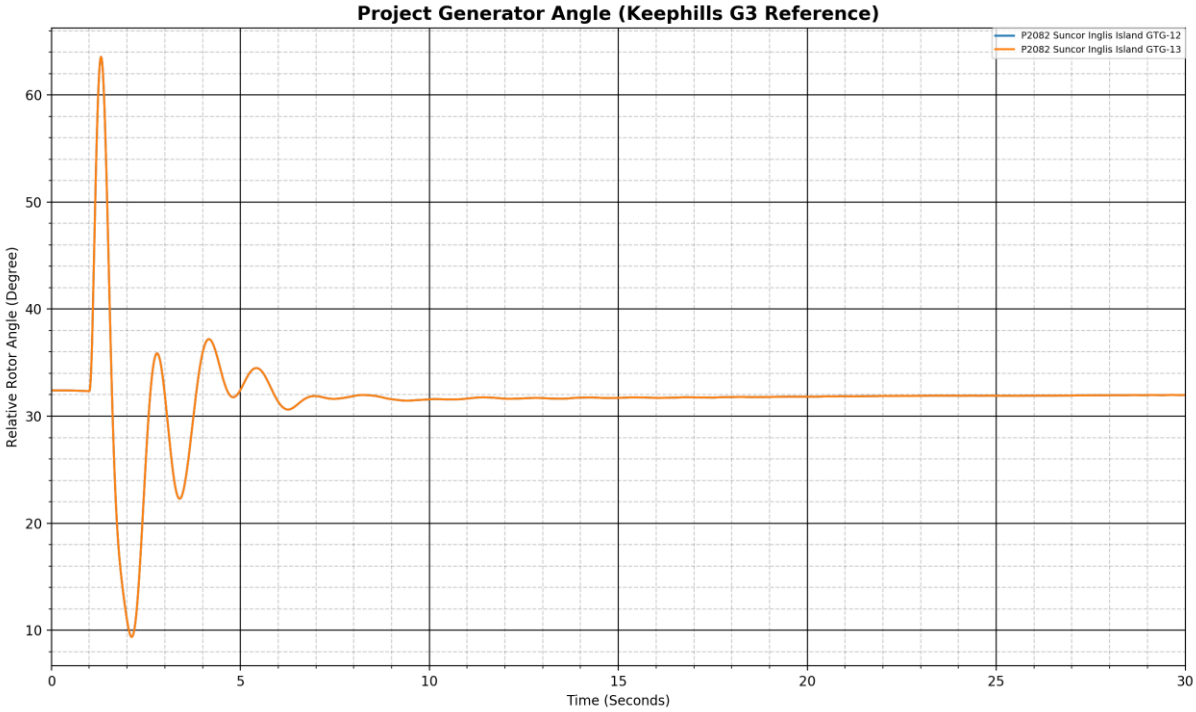

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

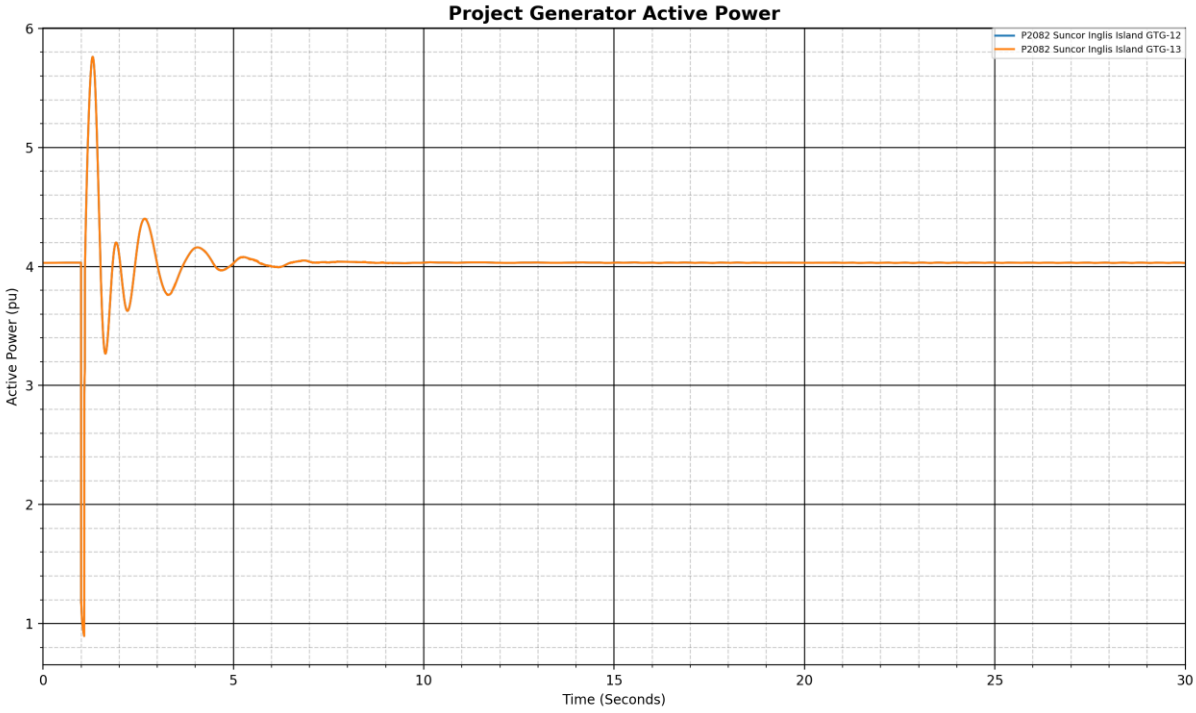

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

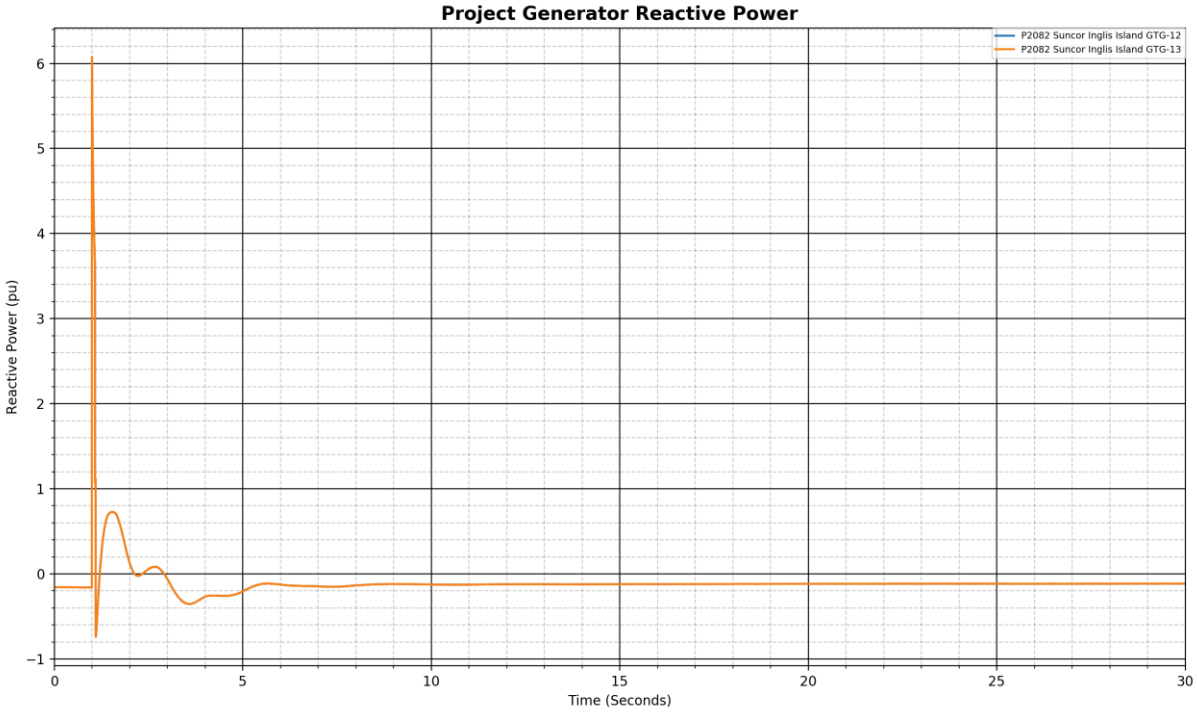

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

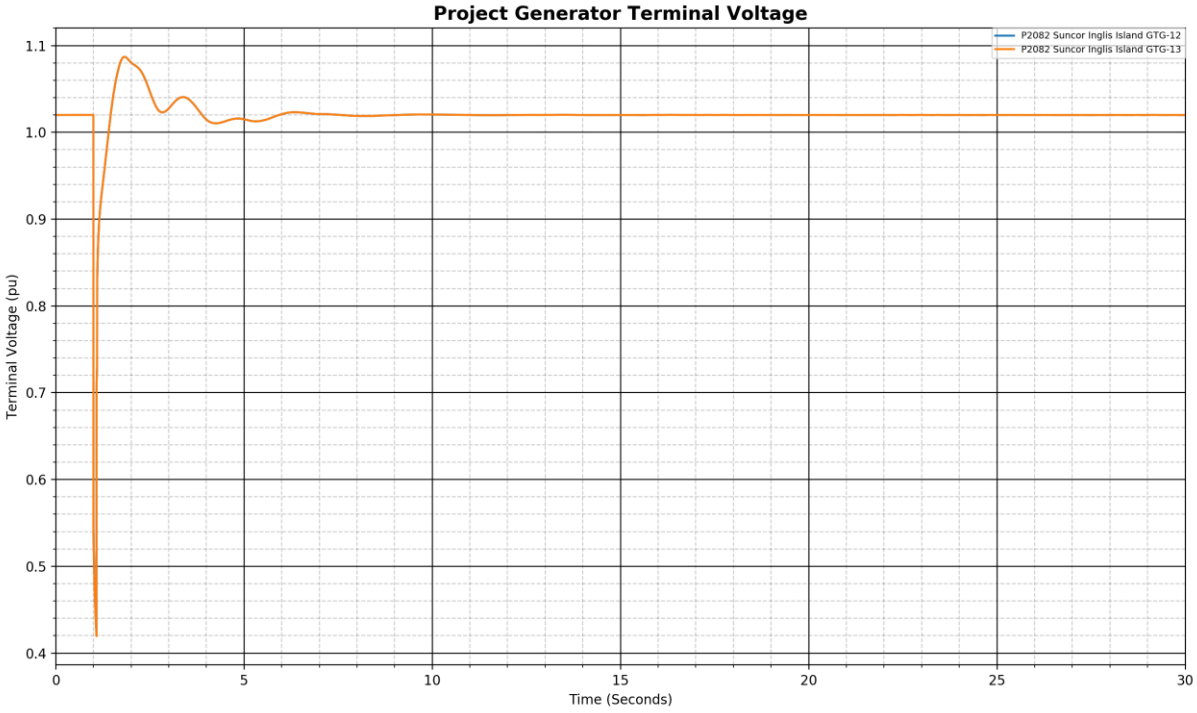

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

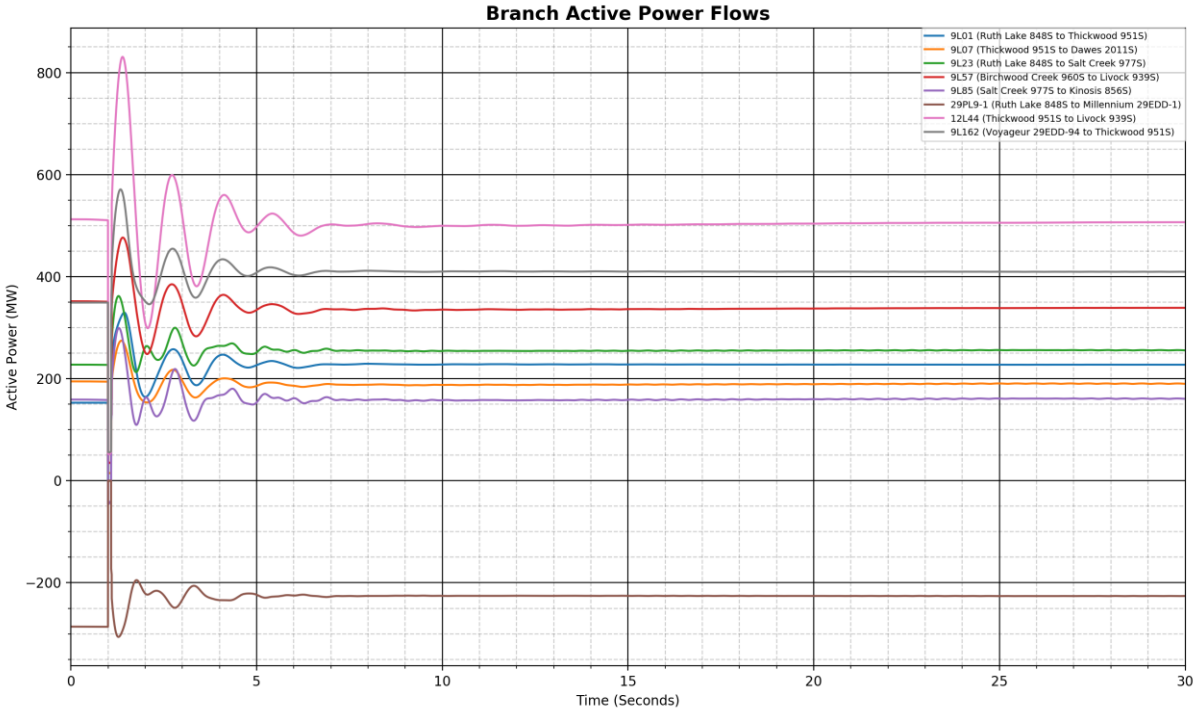

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
10
20
30
40
50
60
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
1
2
3
4
5
6
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

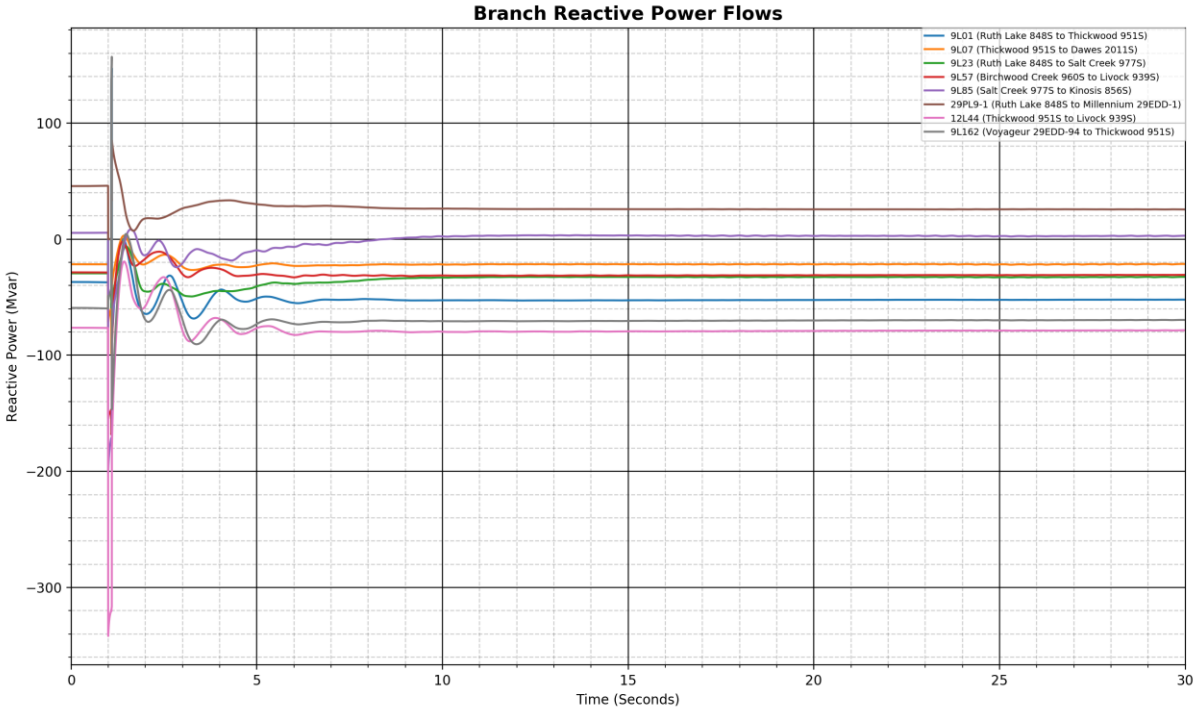
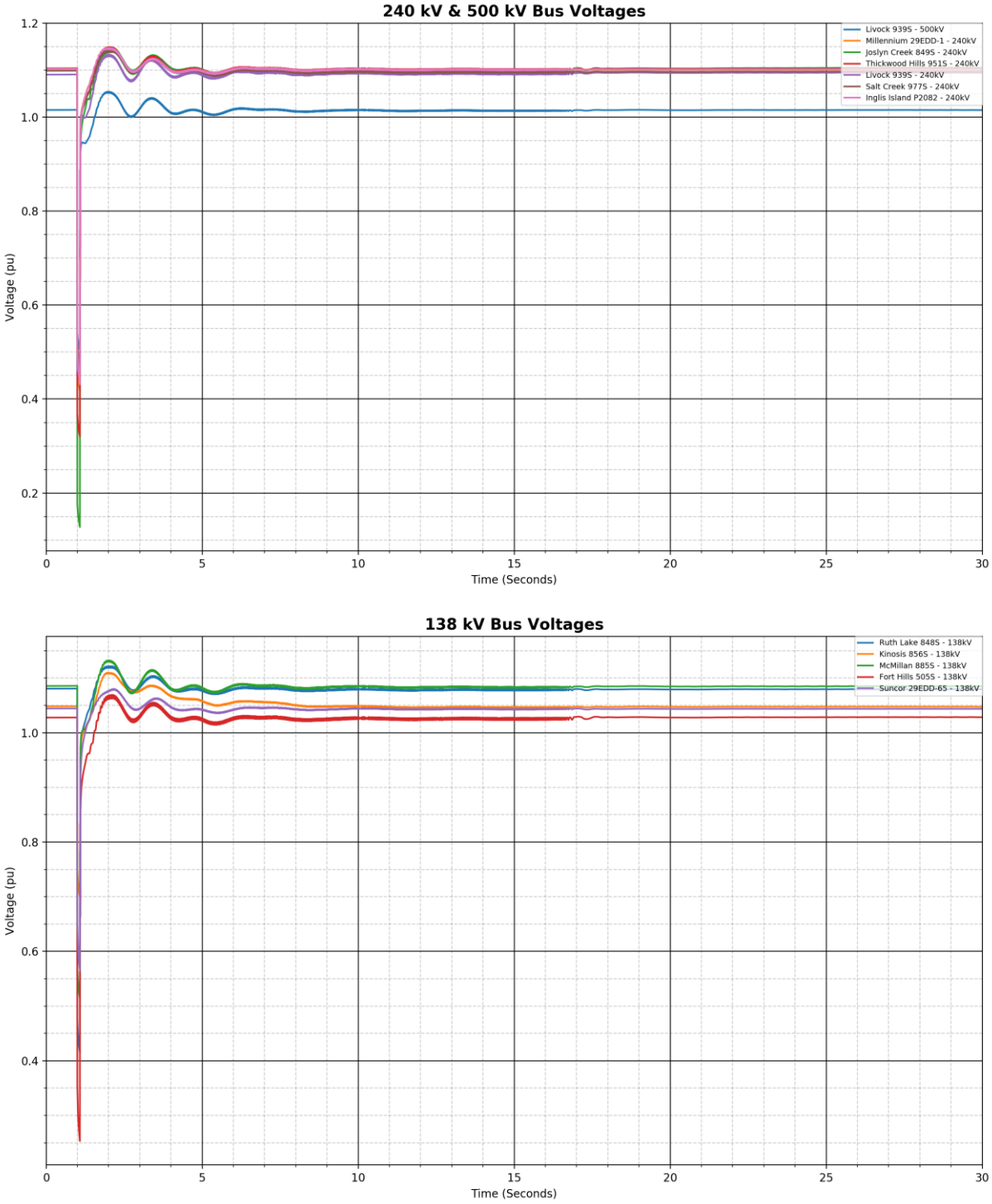
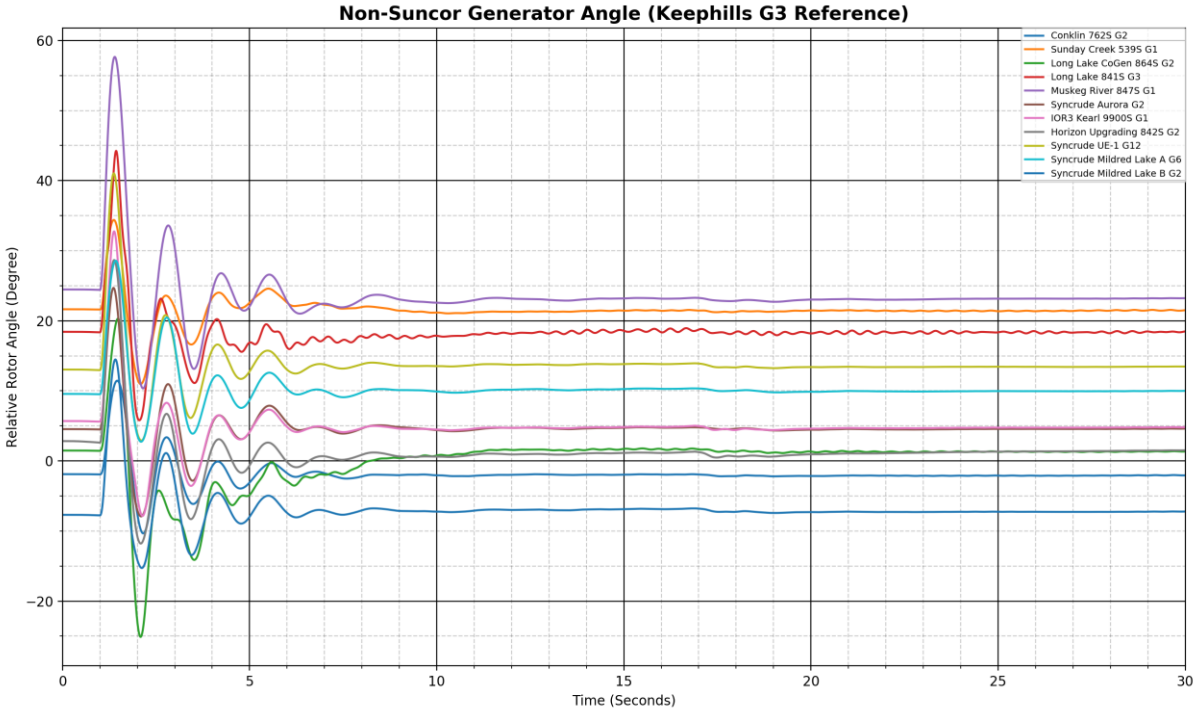
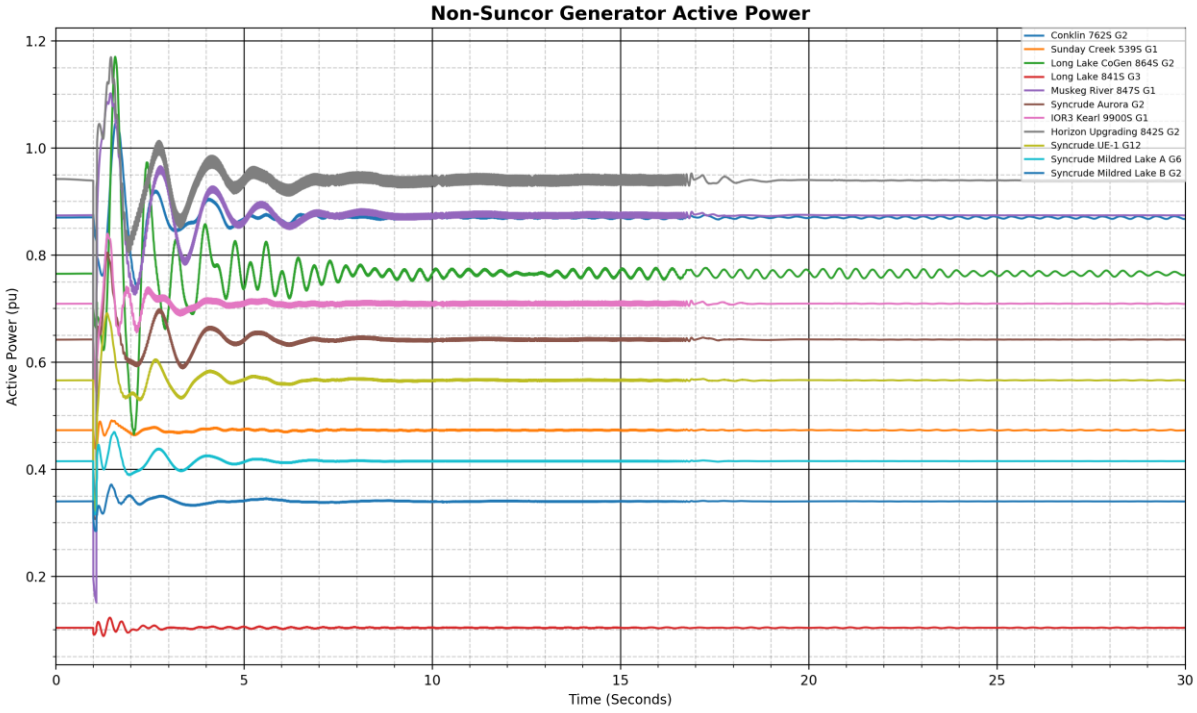
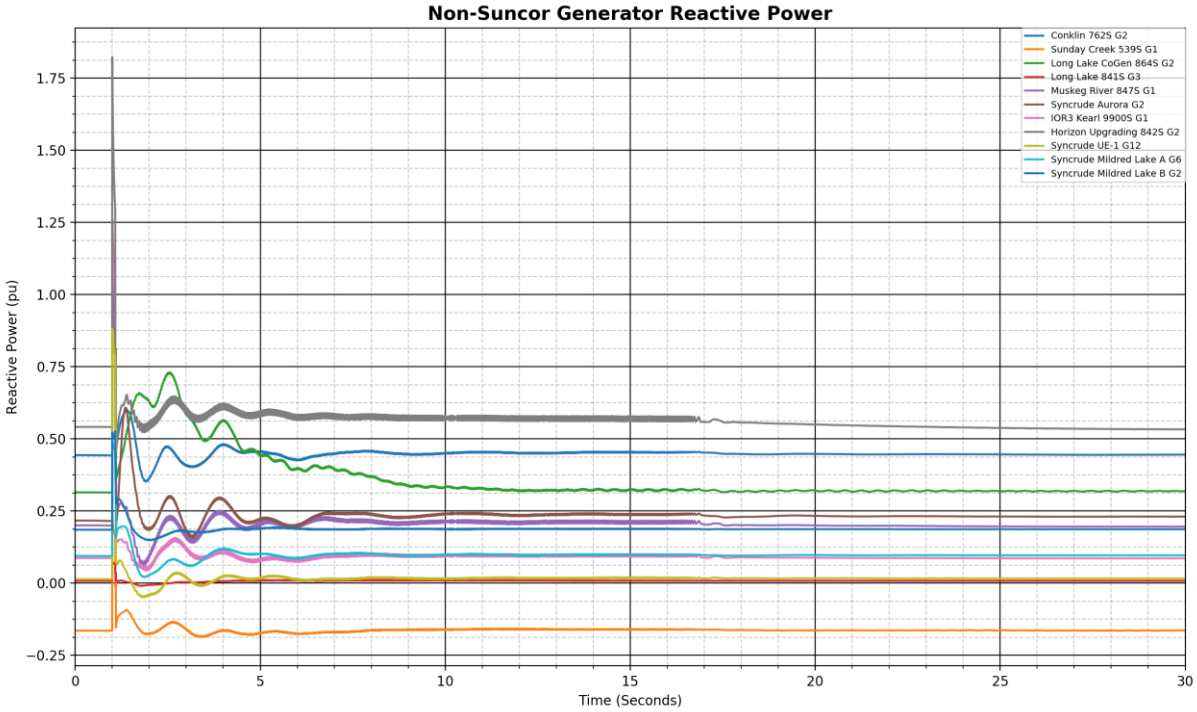

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

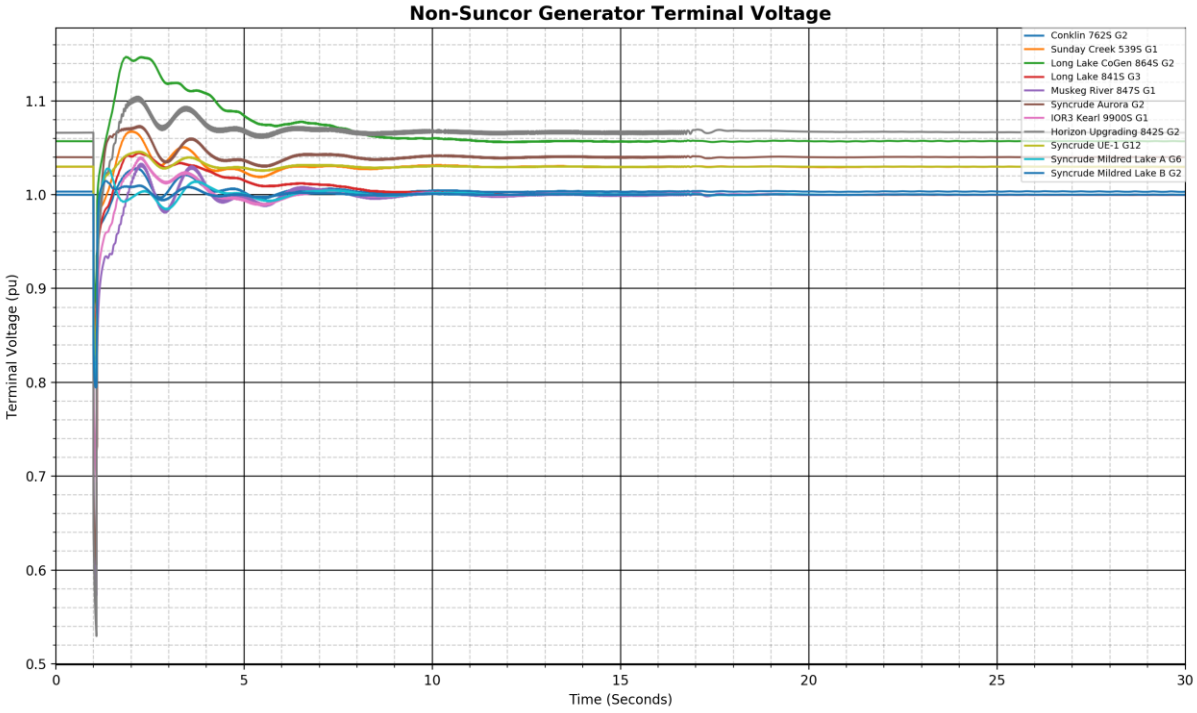
Figure A4-18: 9L58 (Ruth Lake 848S to Dover 888S): Fault at Dover 888S

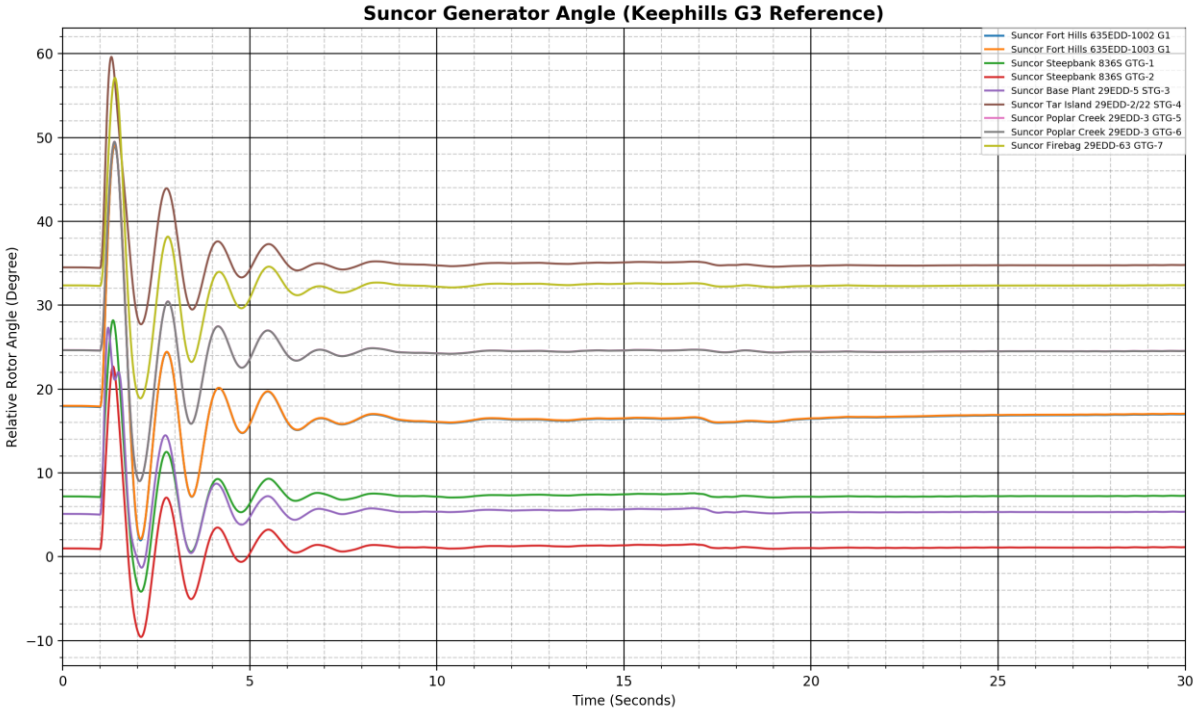


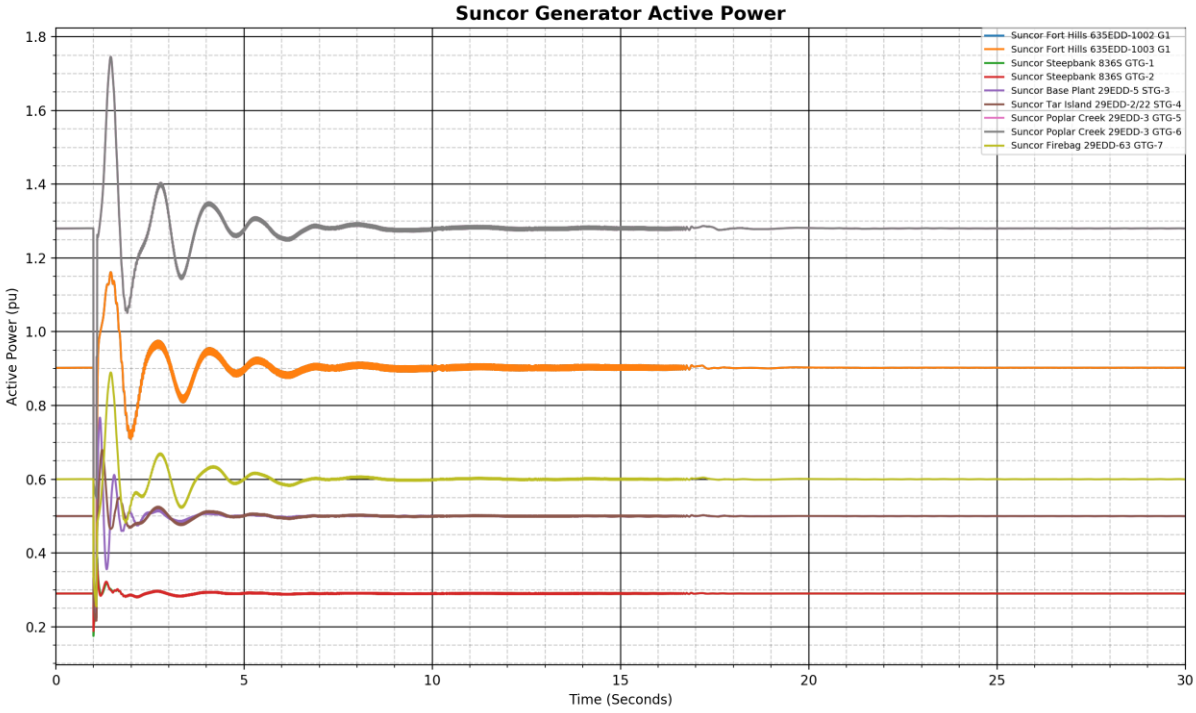

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

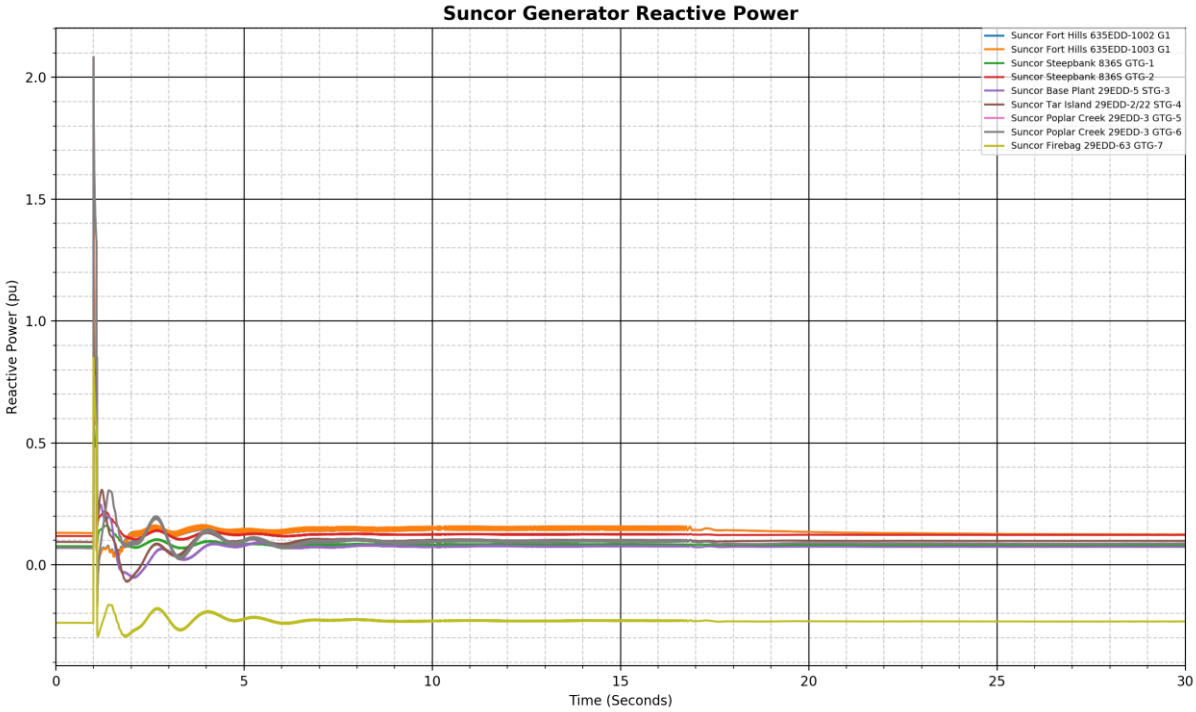

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

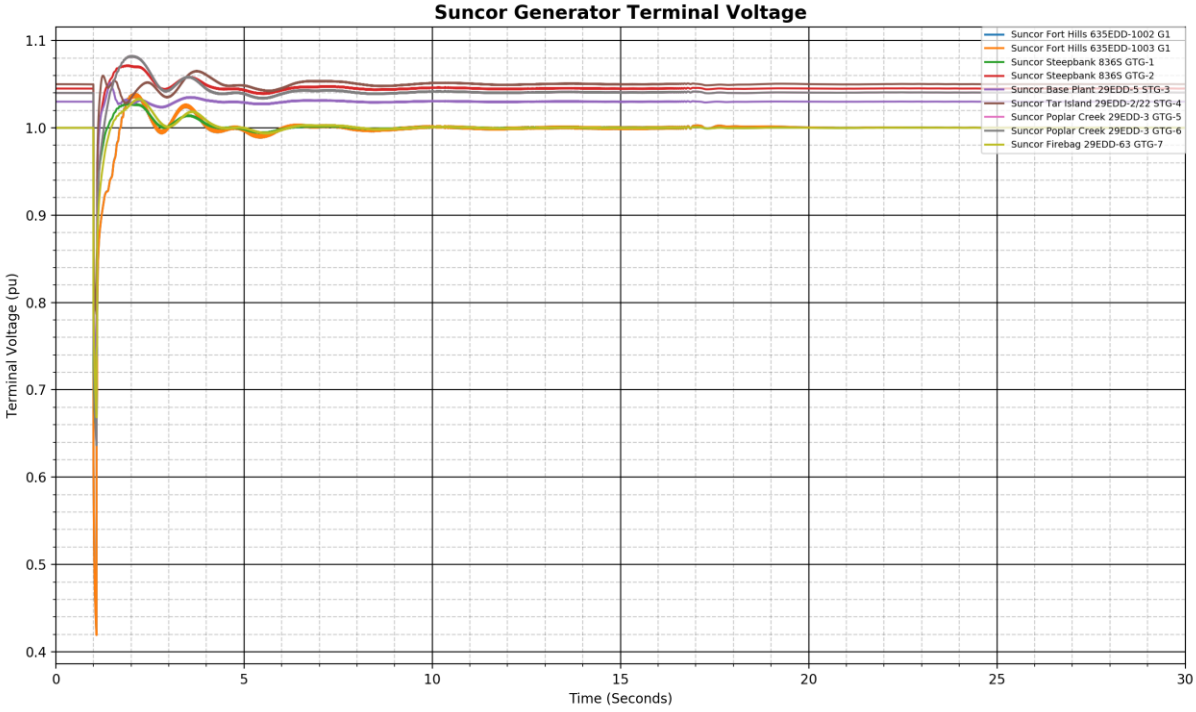

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

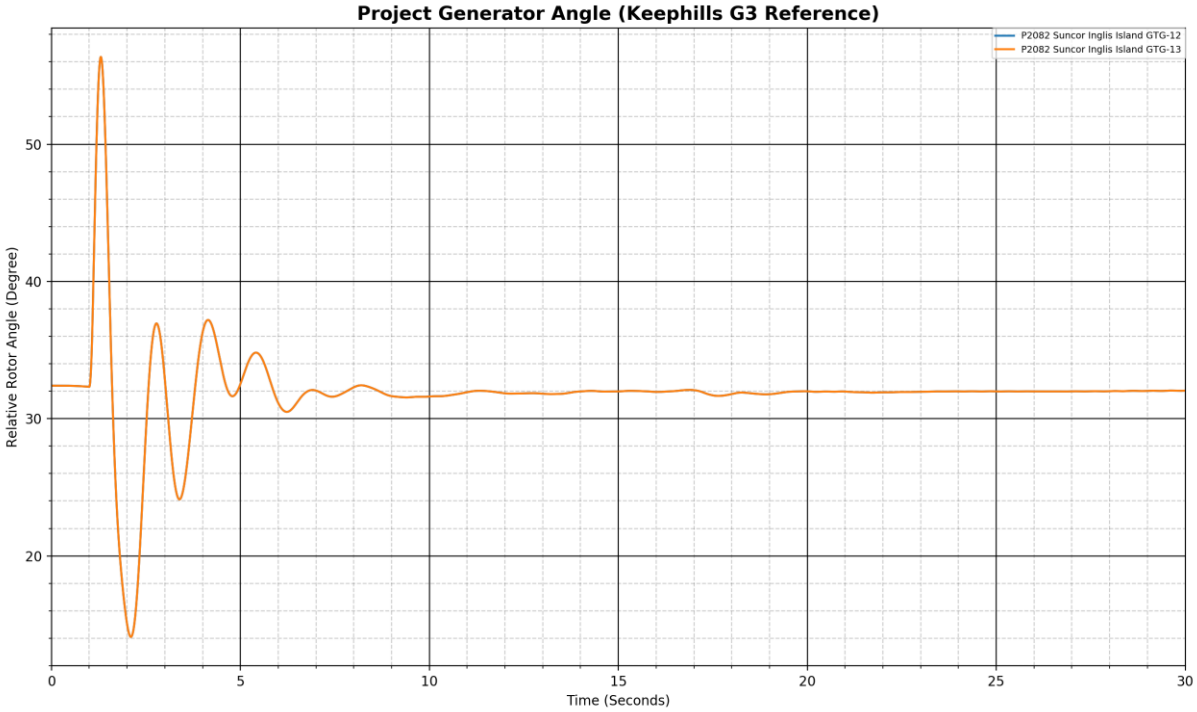

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

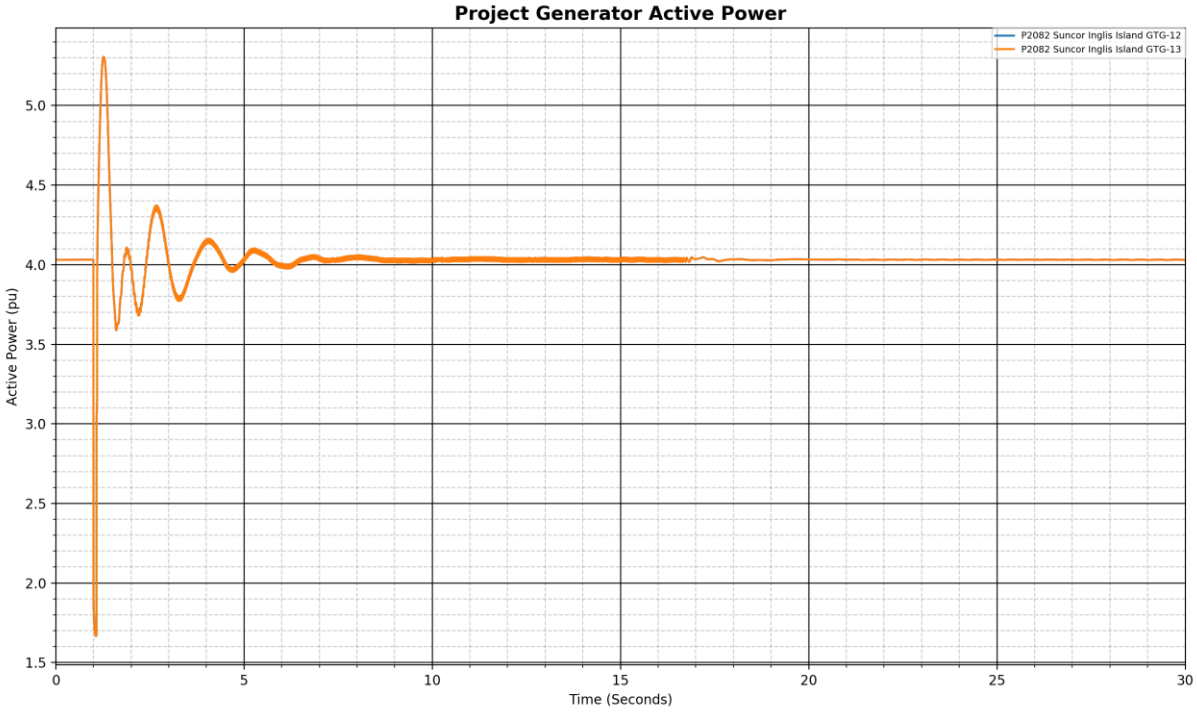

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

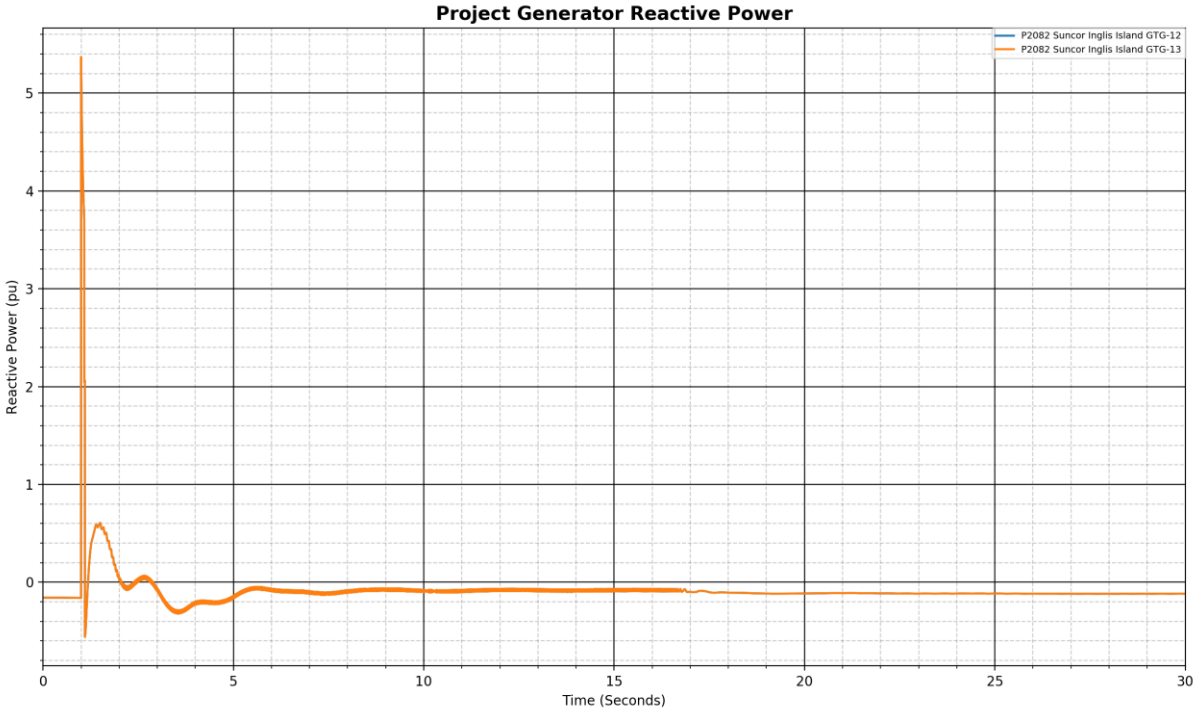

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

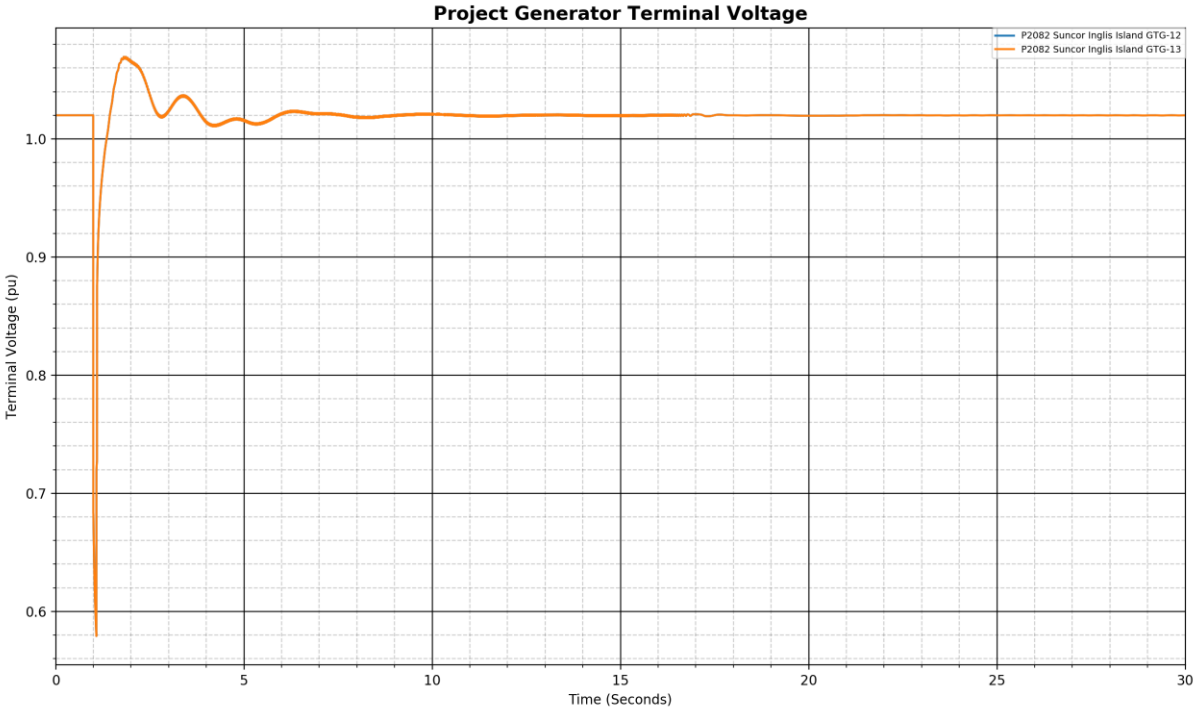

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

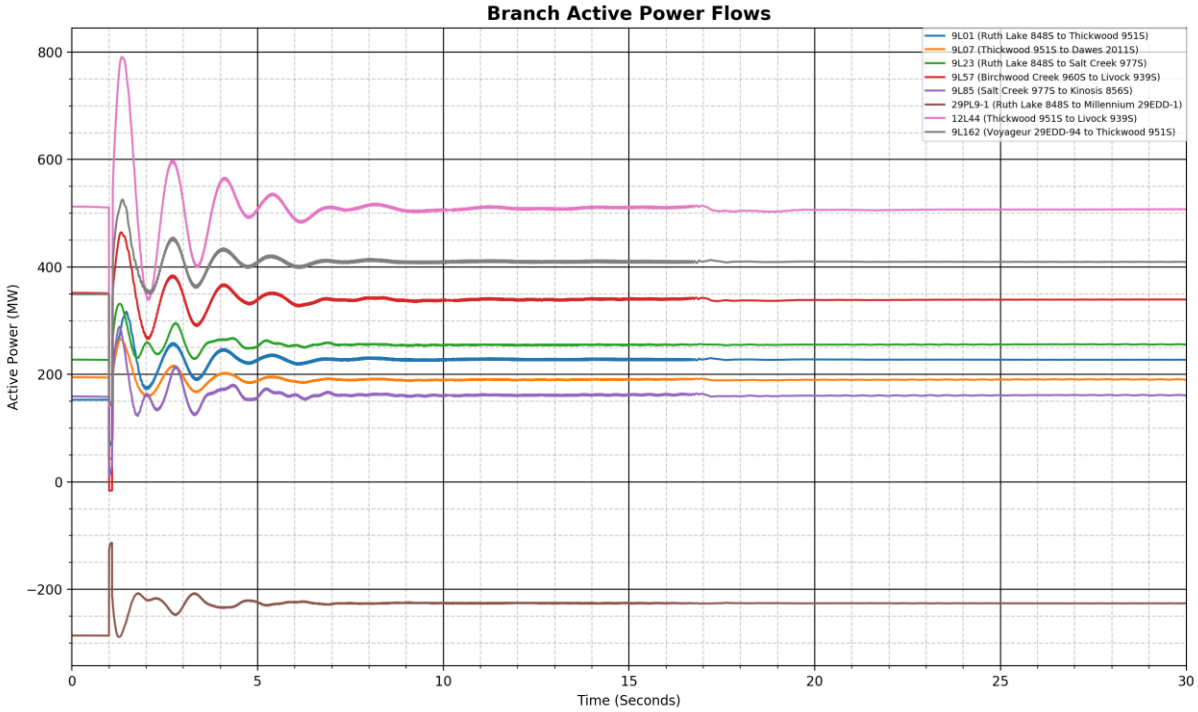

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
50
40
30
20
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.6
0.7
0.8
0.9
1.0
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

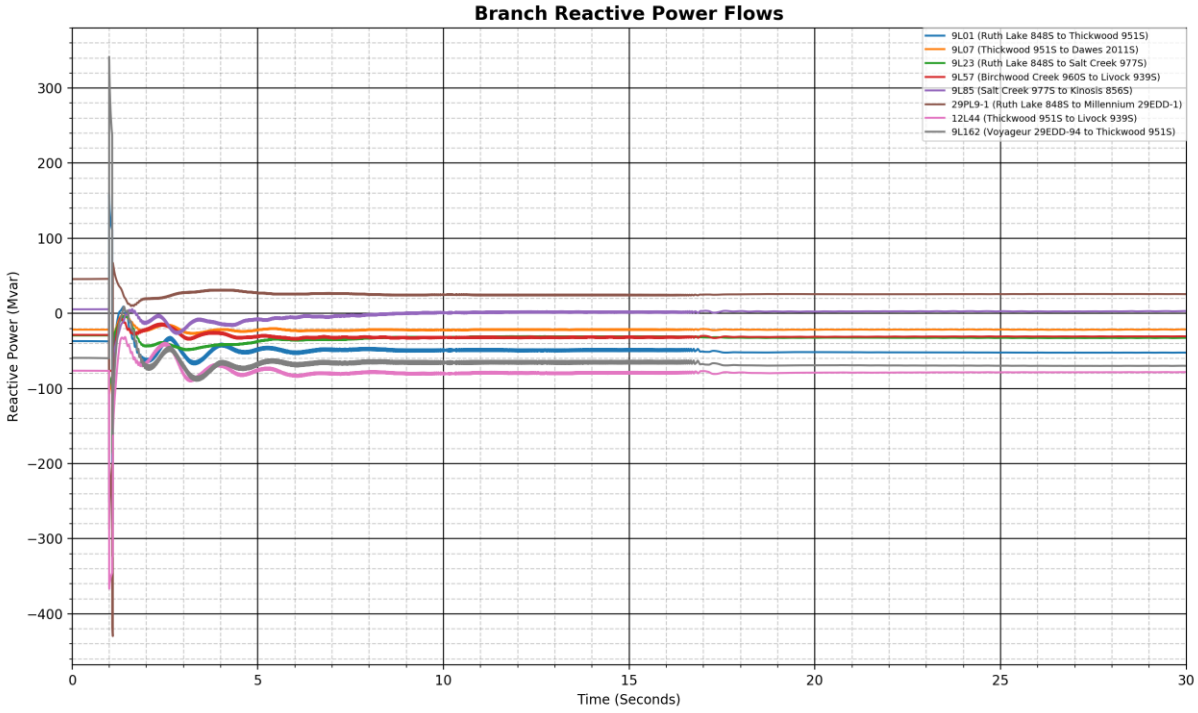
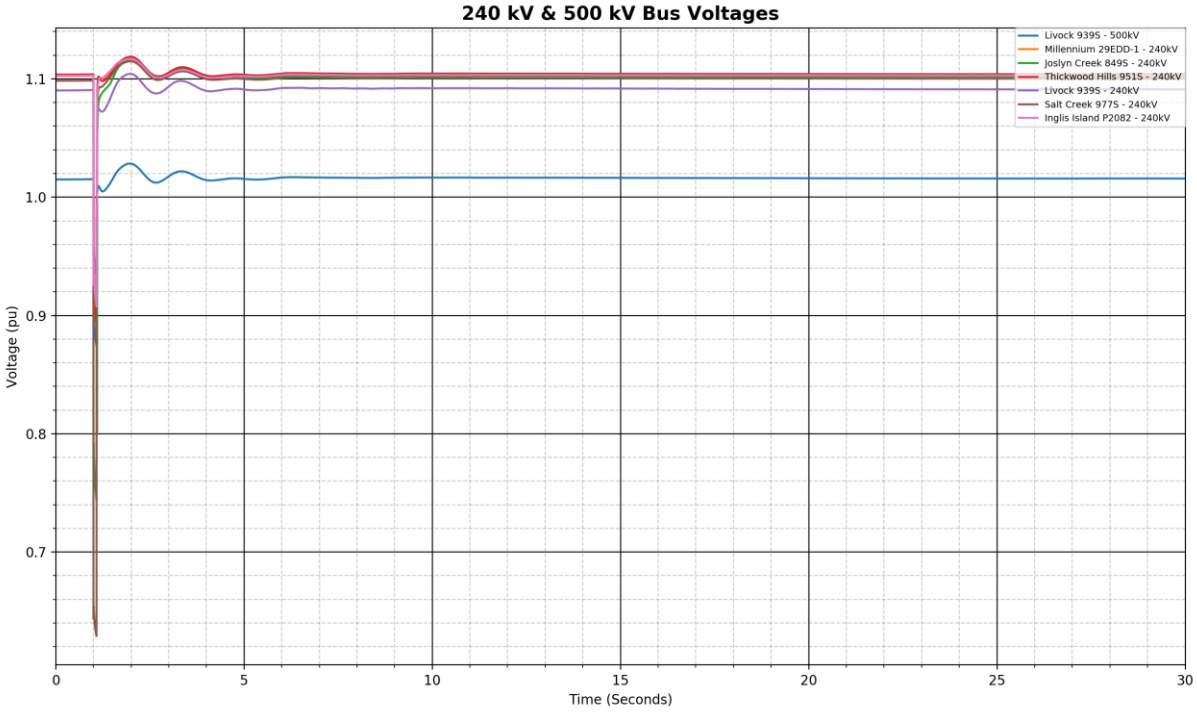
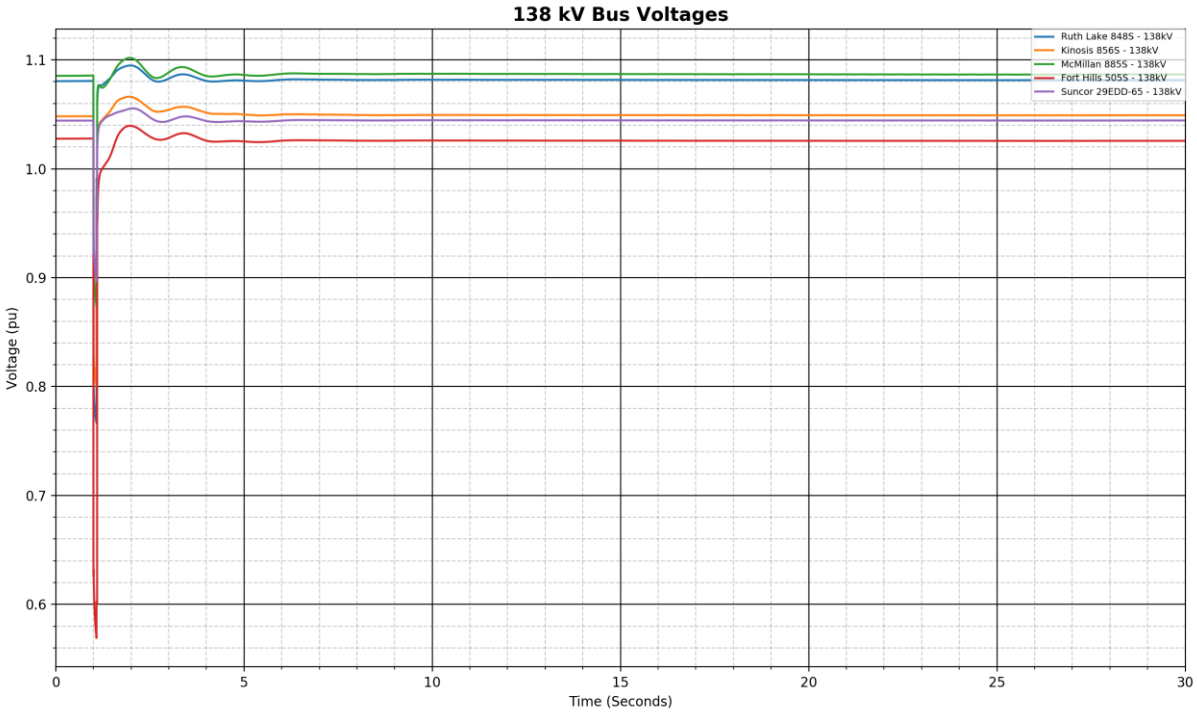
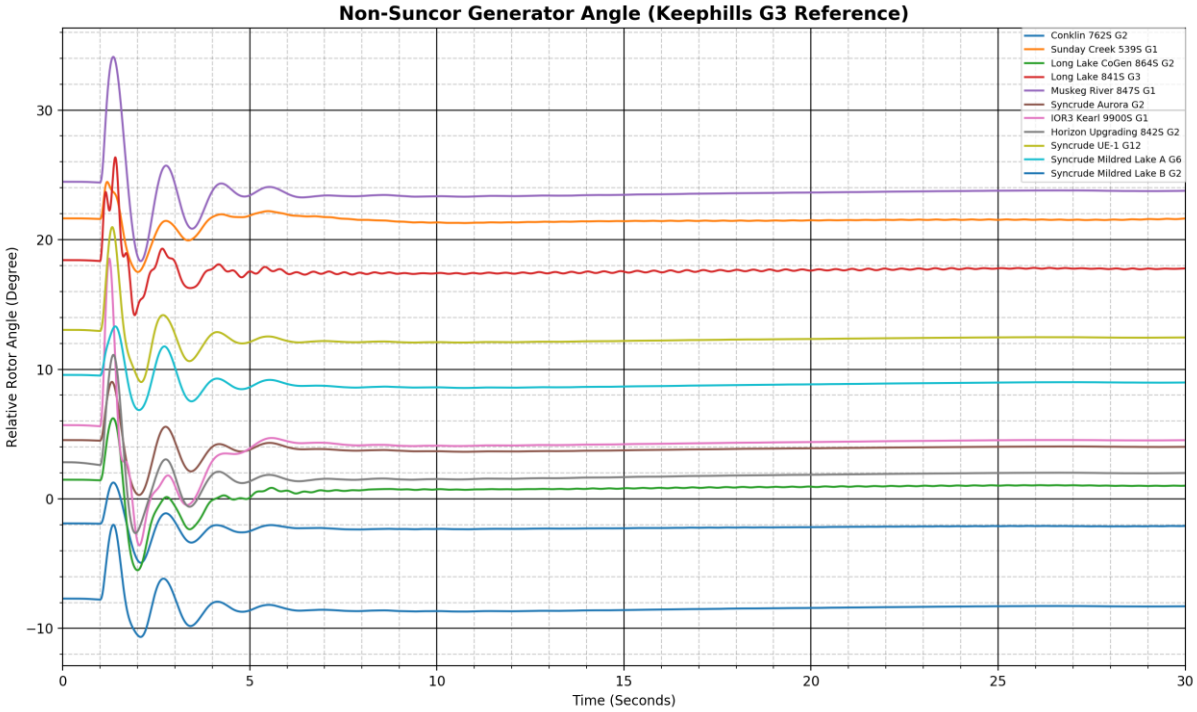
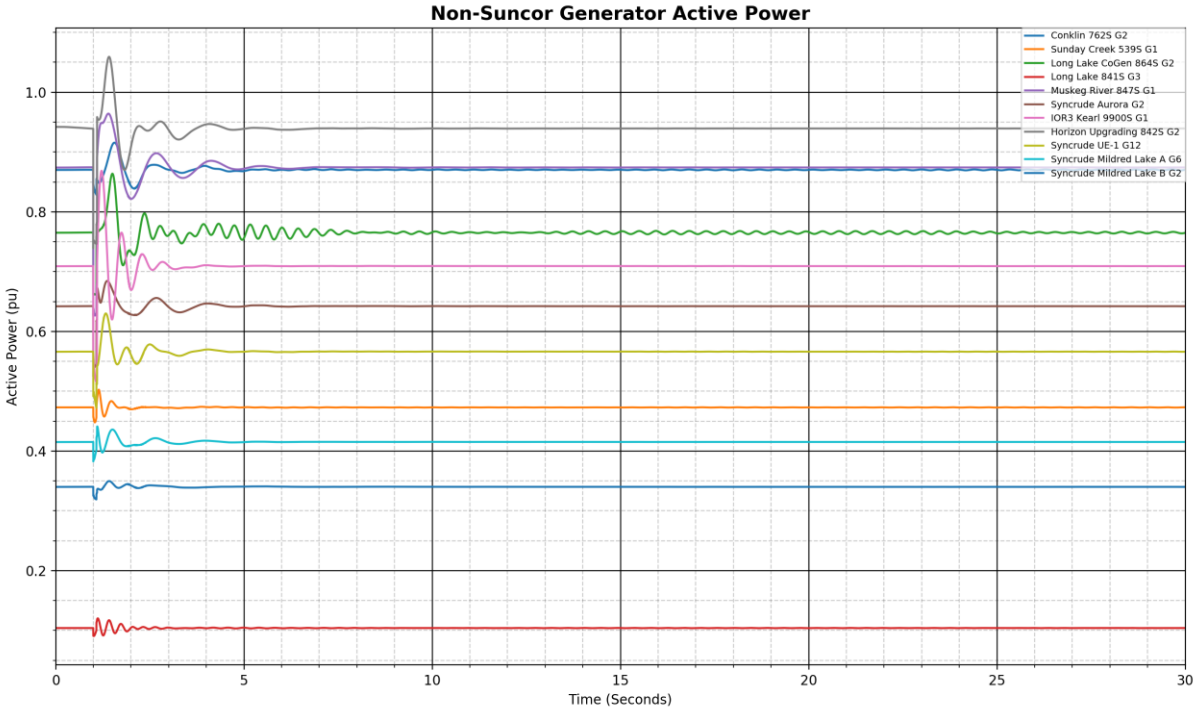

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

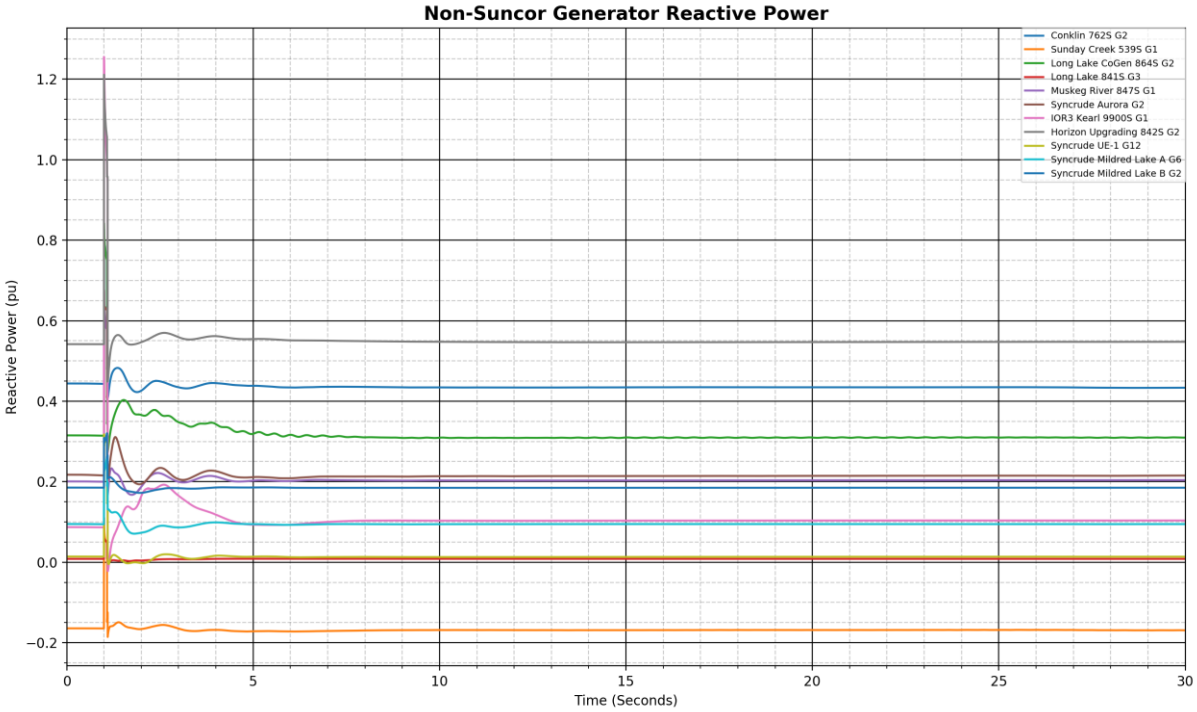
Figure A4-19: 9L69 (Black Fly 934S to McClelland 957S): Fault at Black Fly 934S

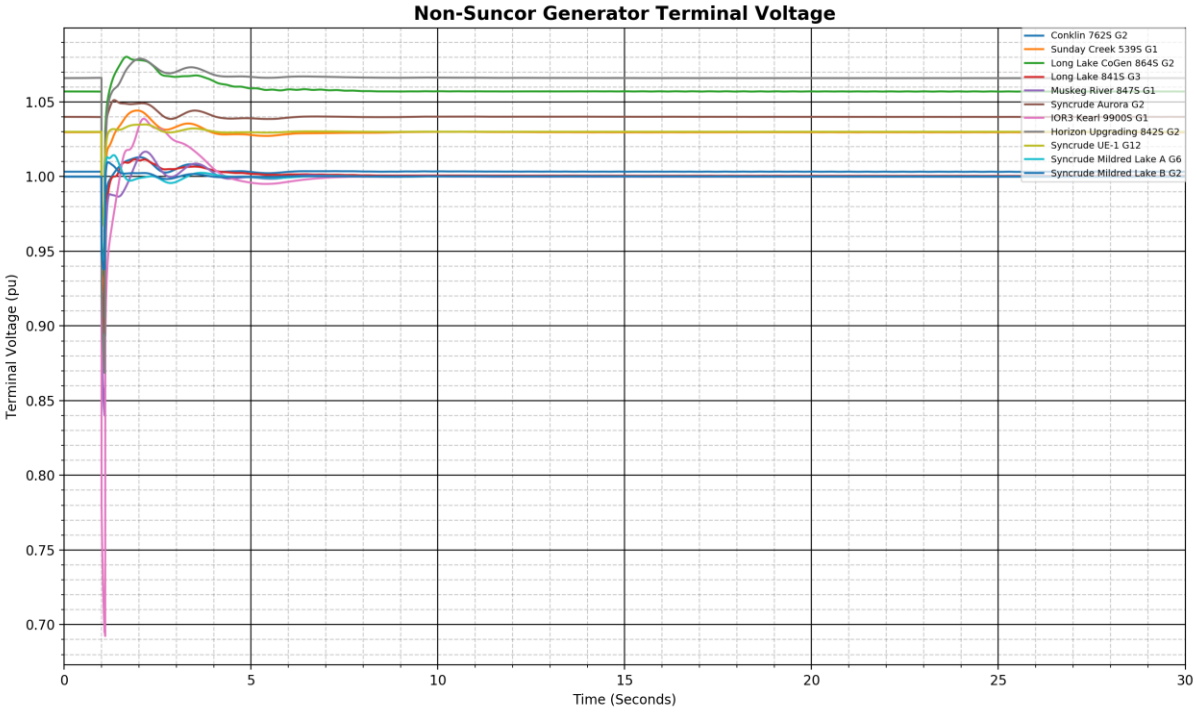


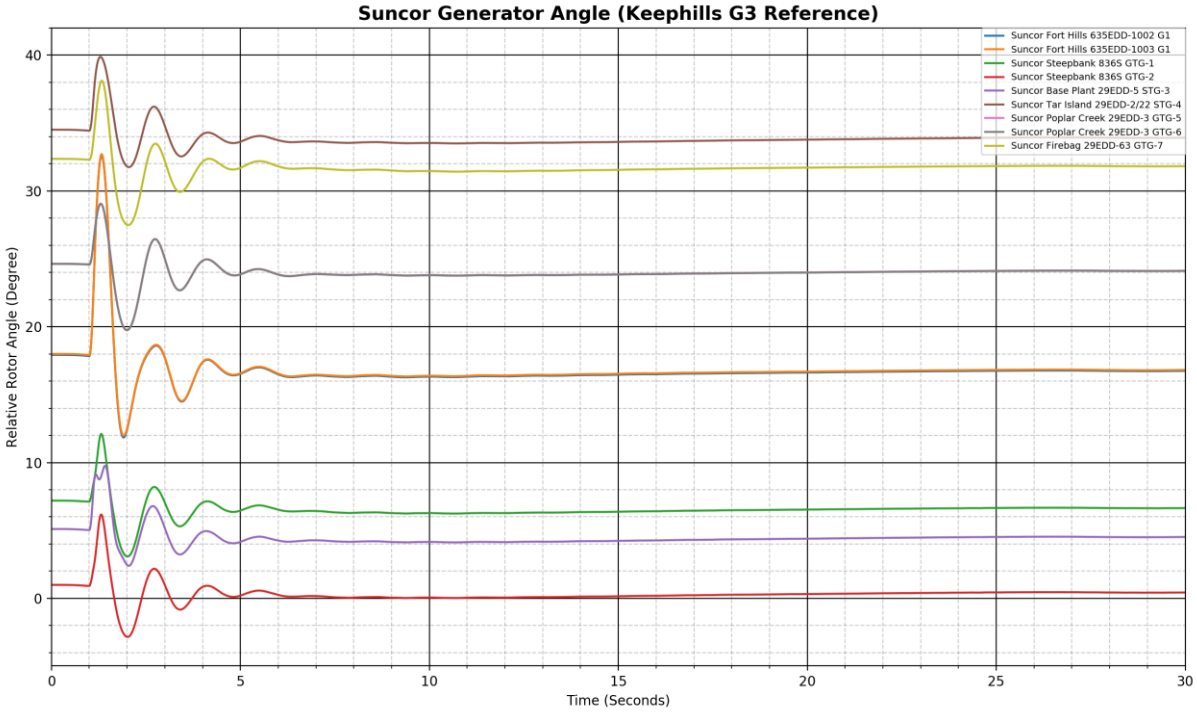


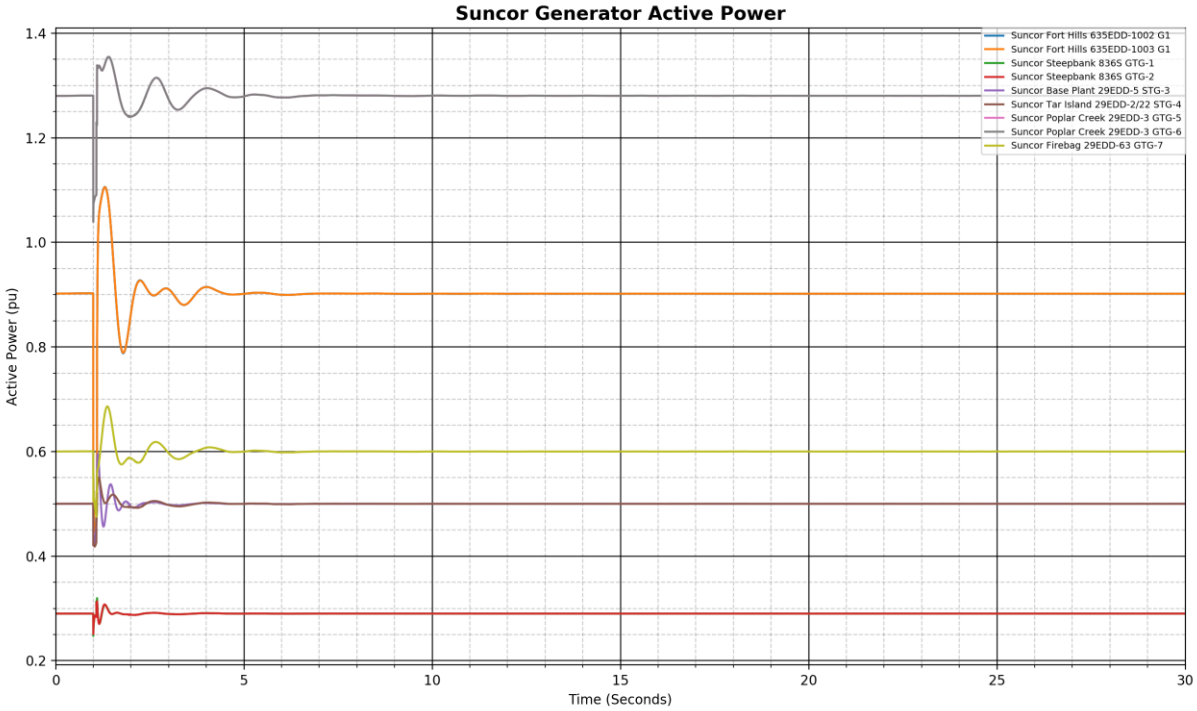

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

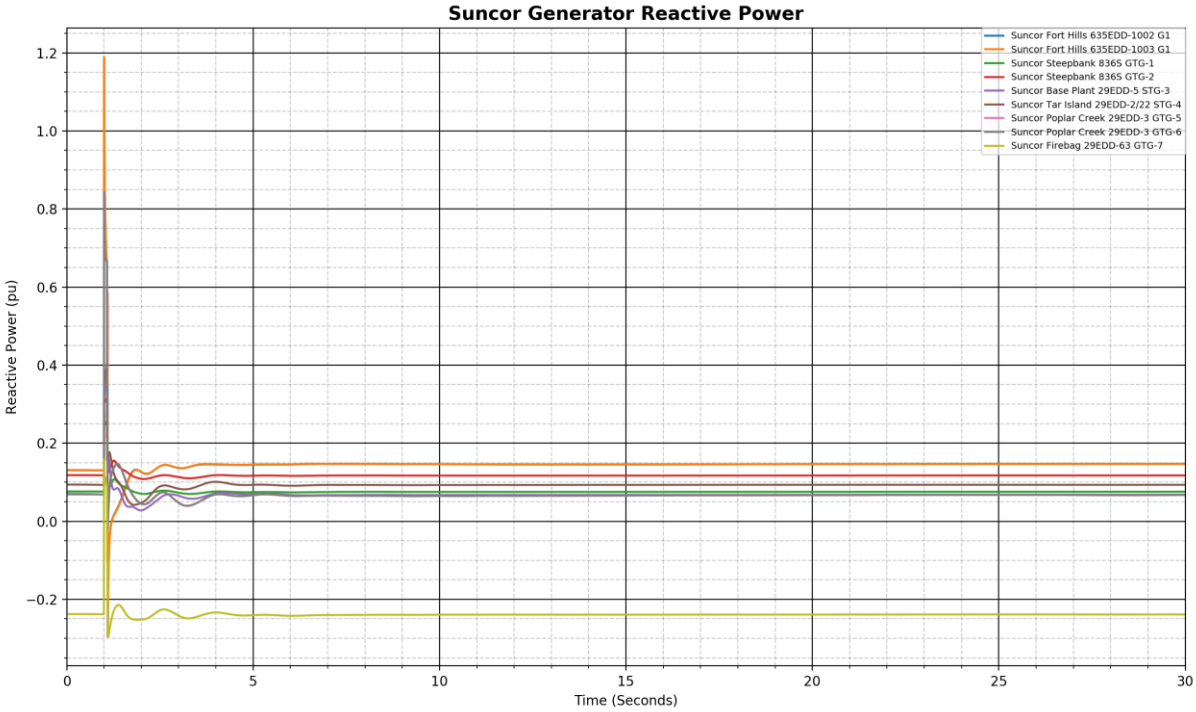

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

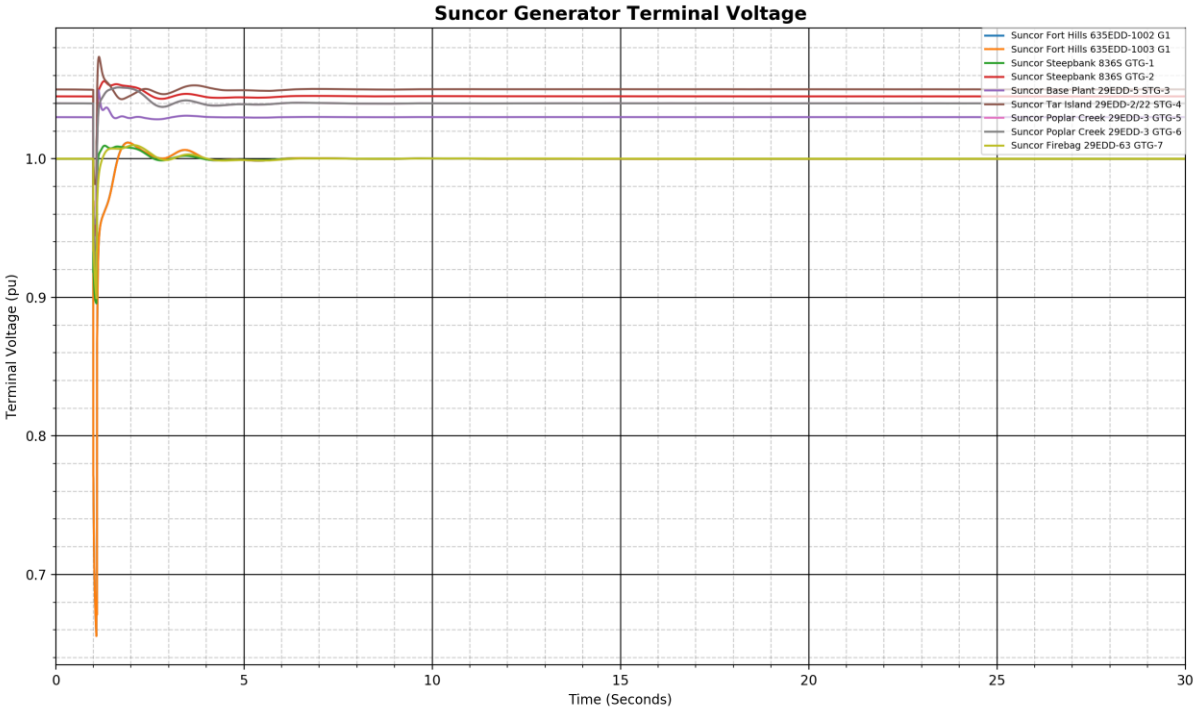

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

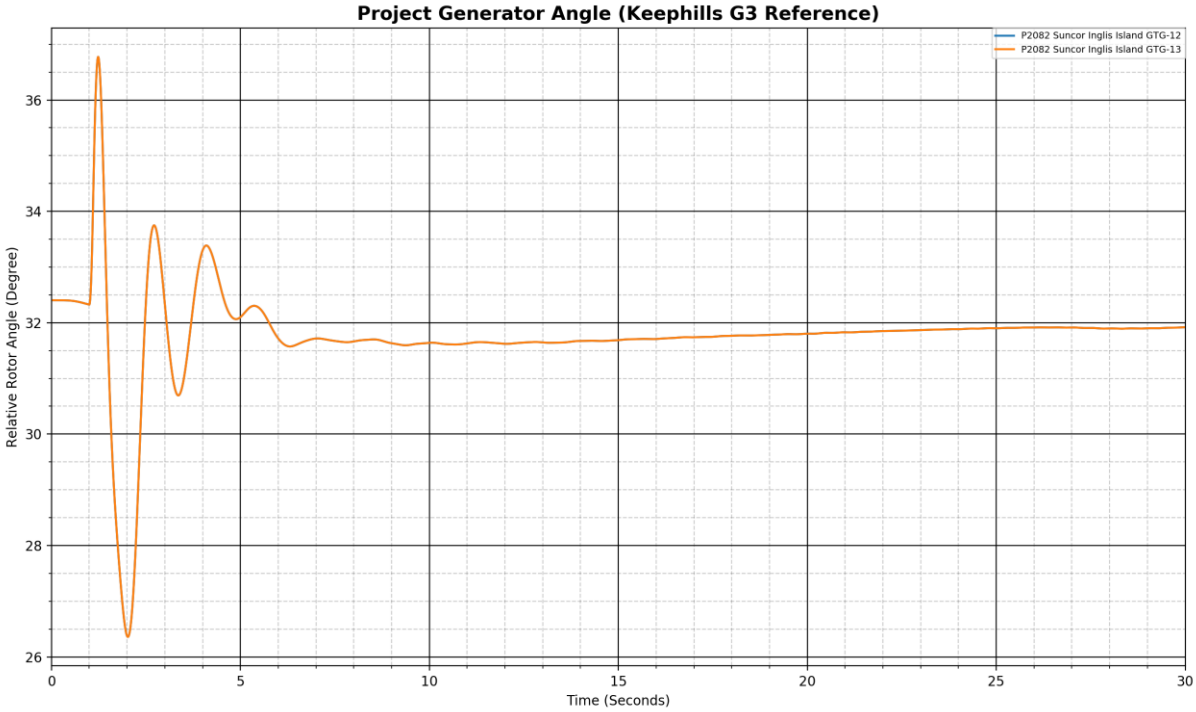

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

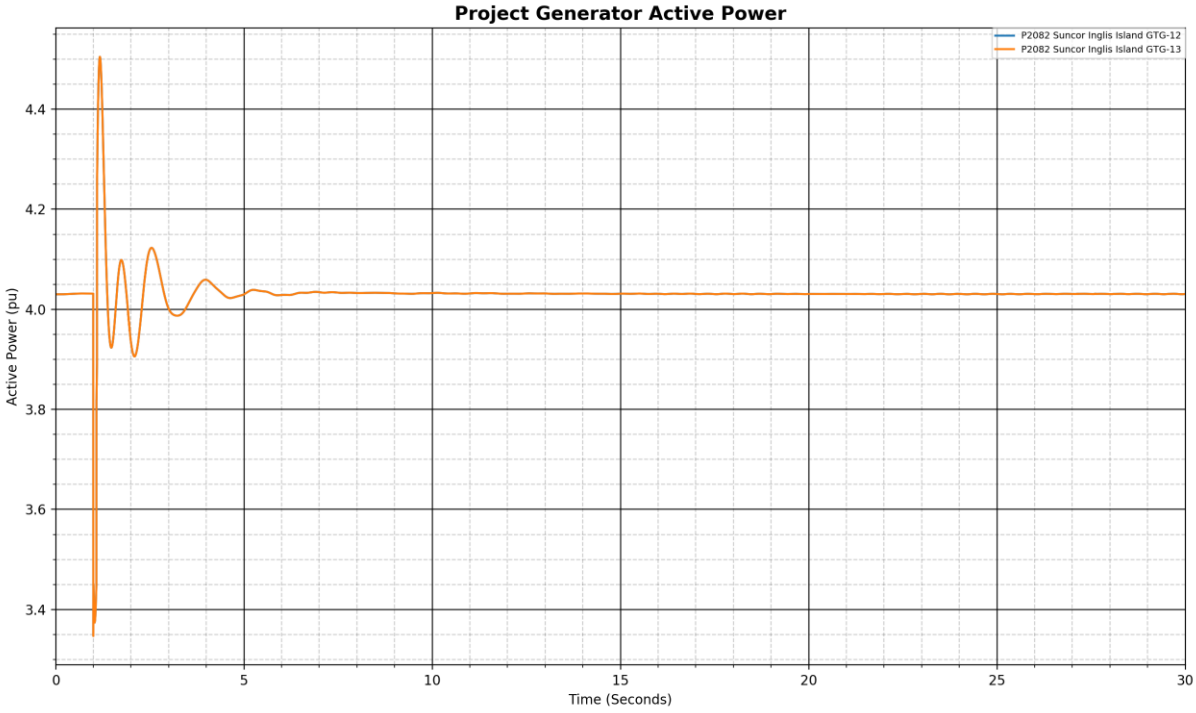

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

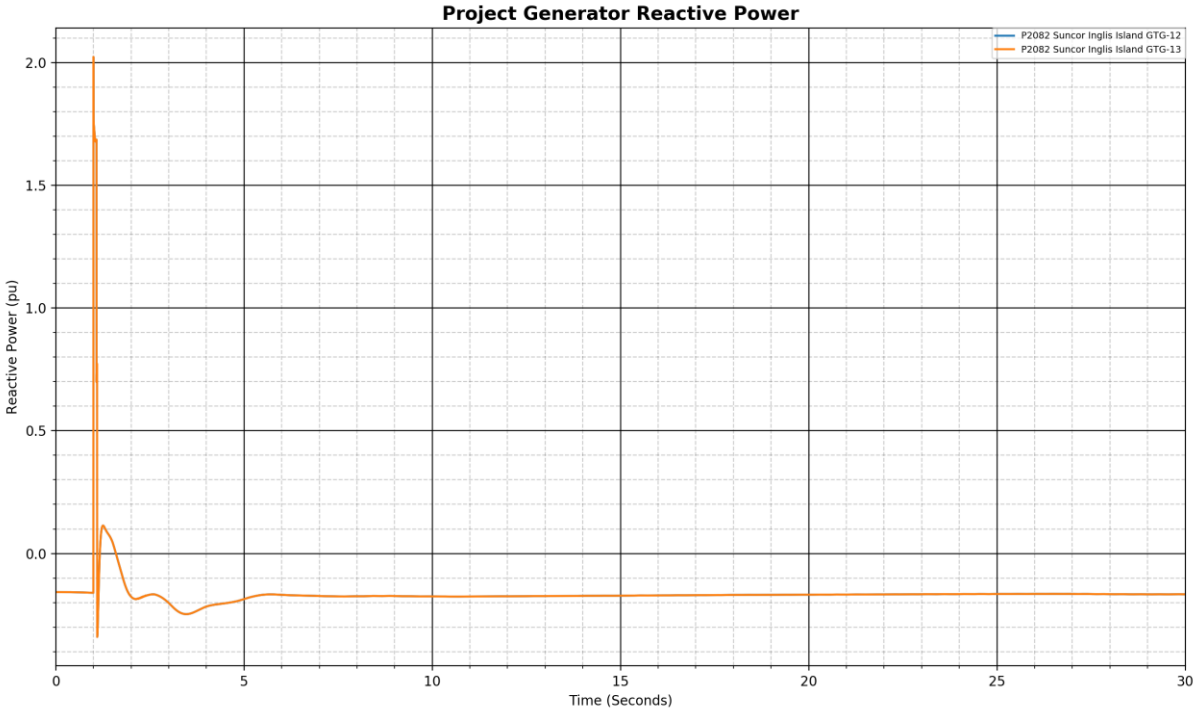

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

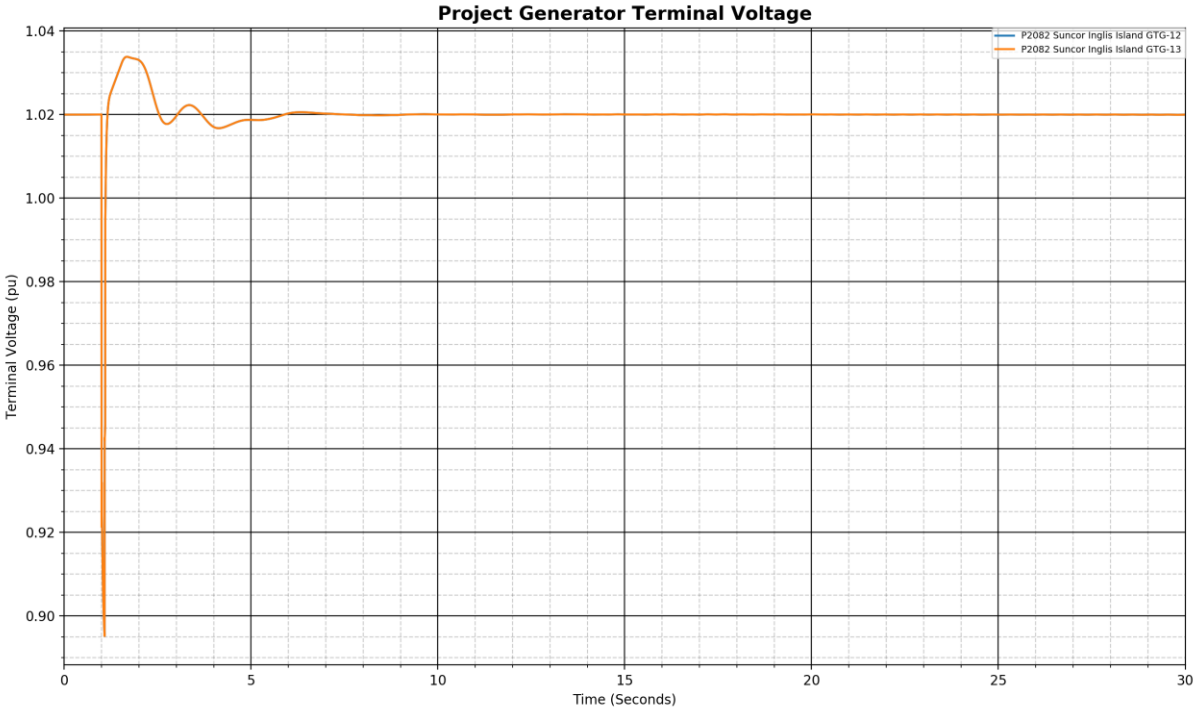

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

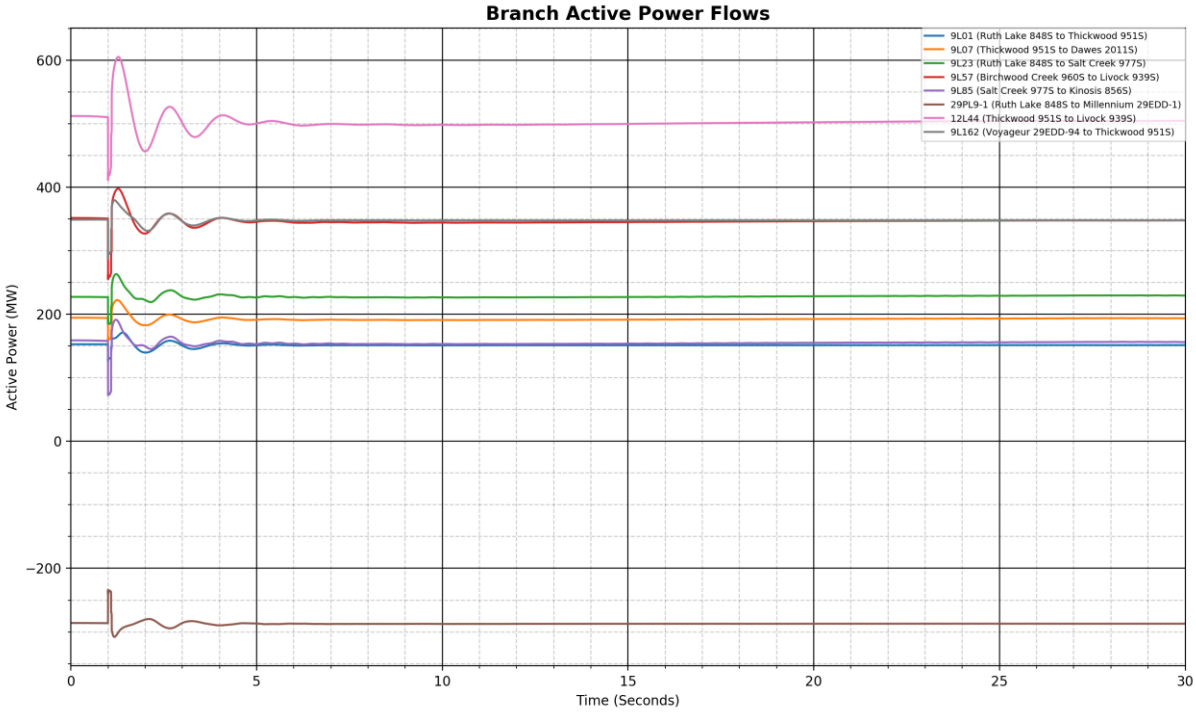

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
36
34
32
30
28
26
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.4
4.2
4.0
3.8
3.6
3.4
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

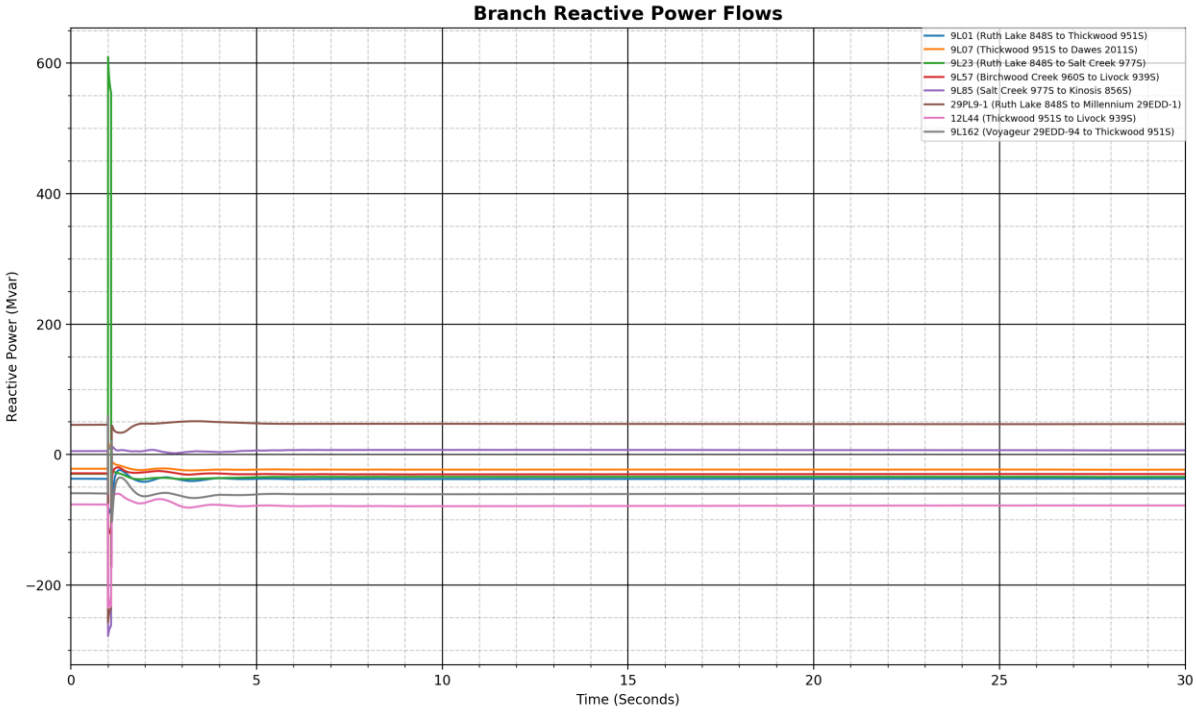
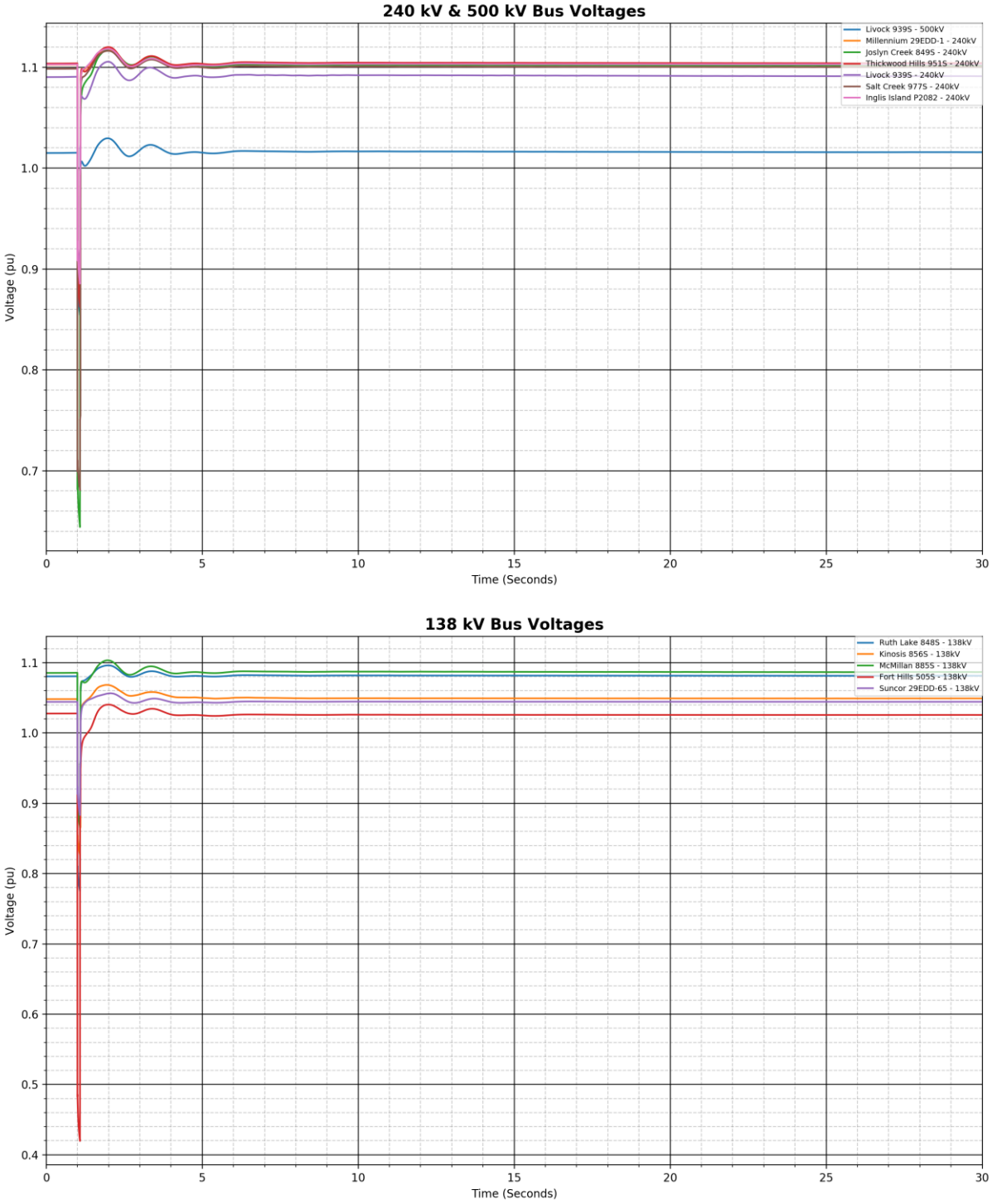
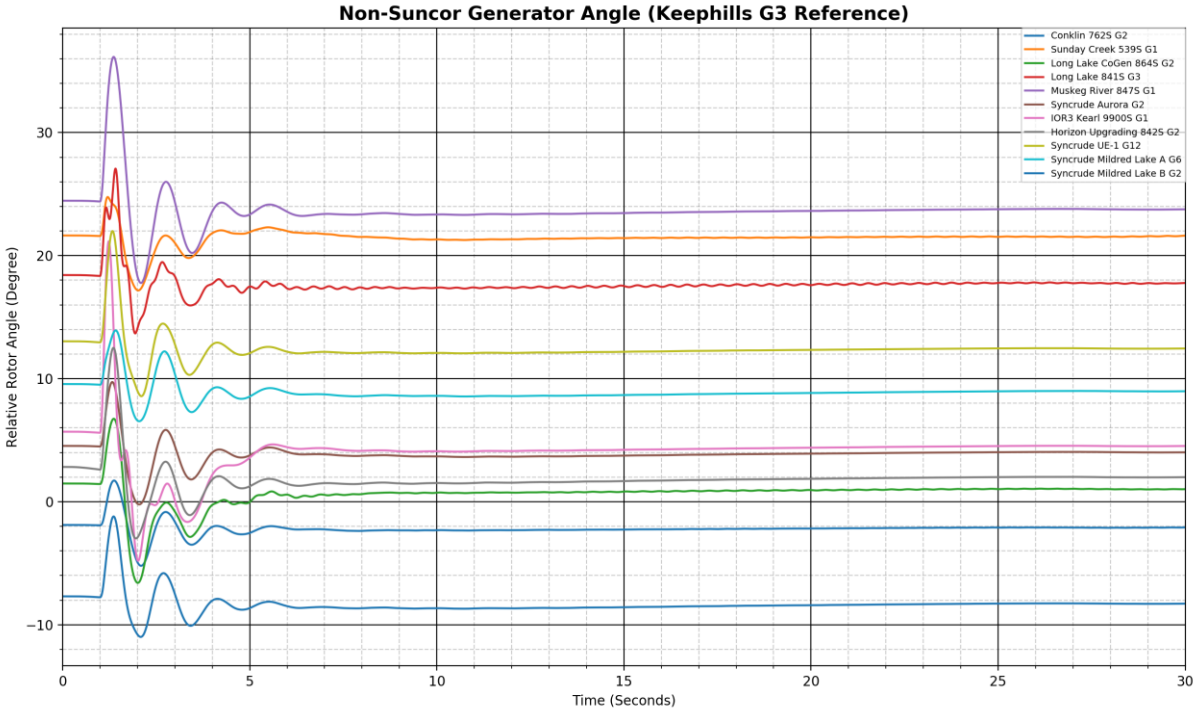
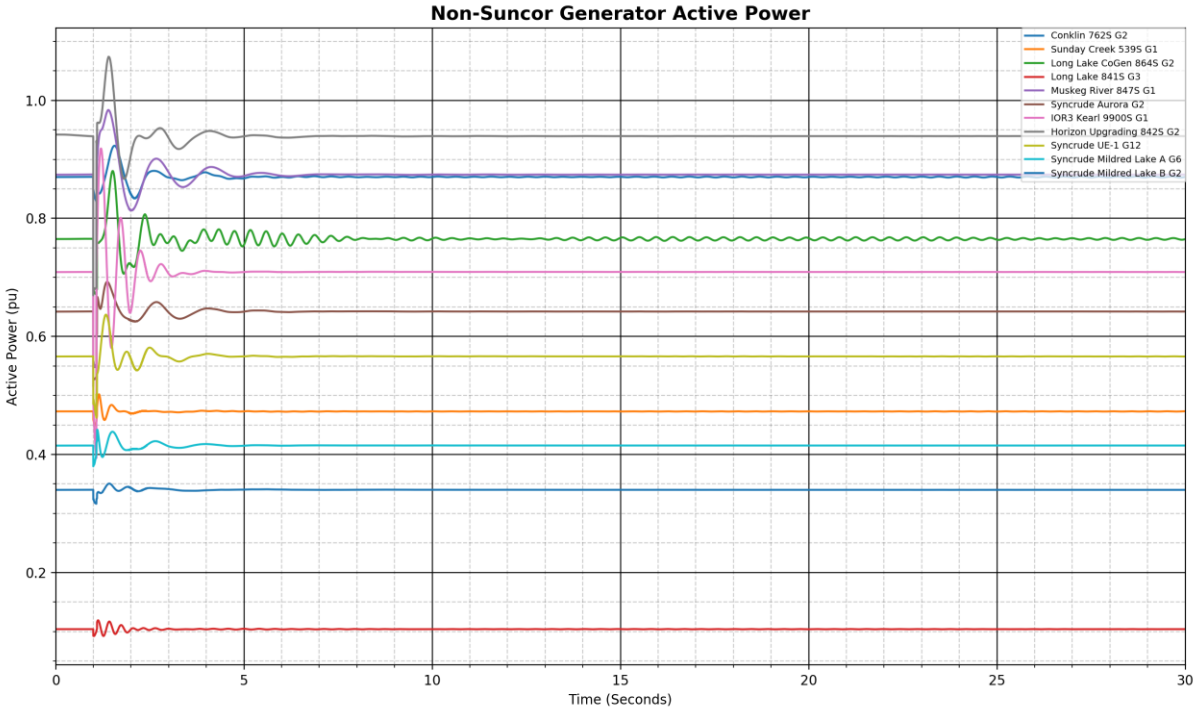
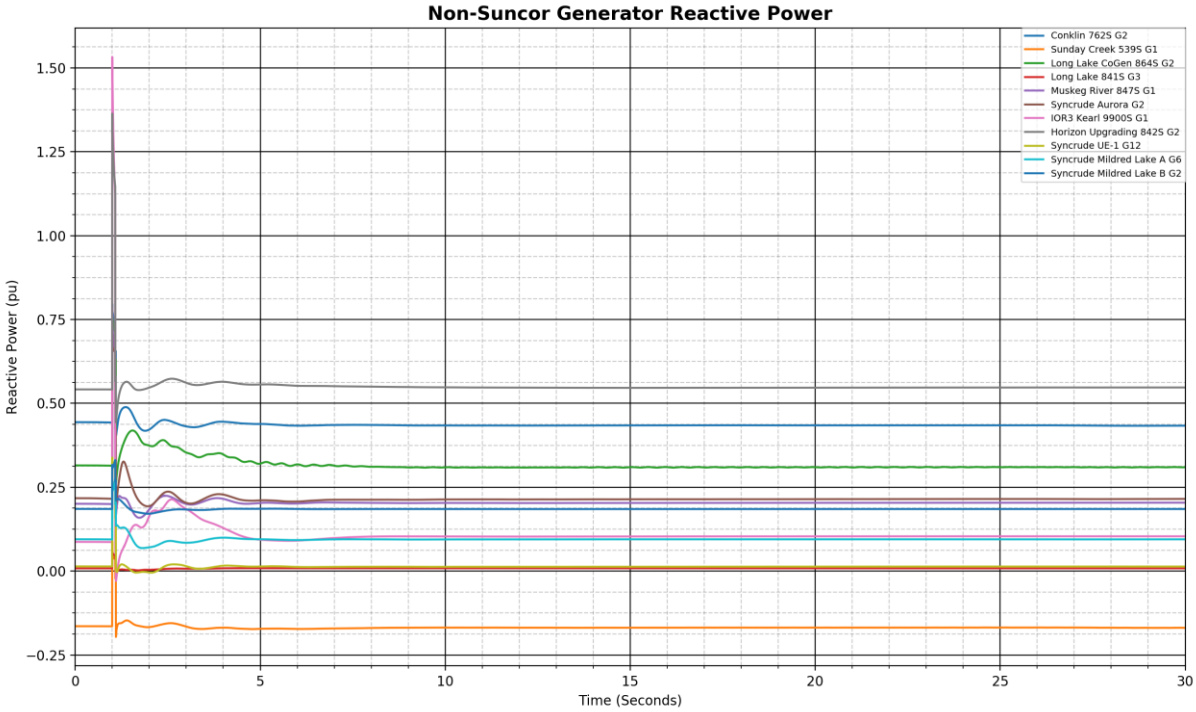

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

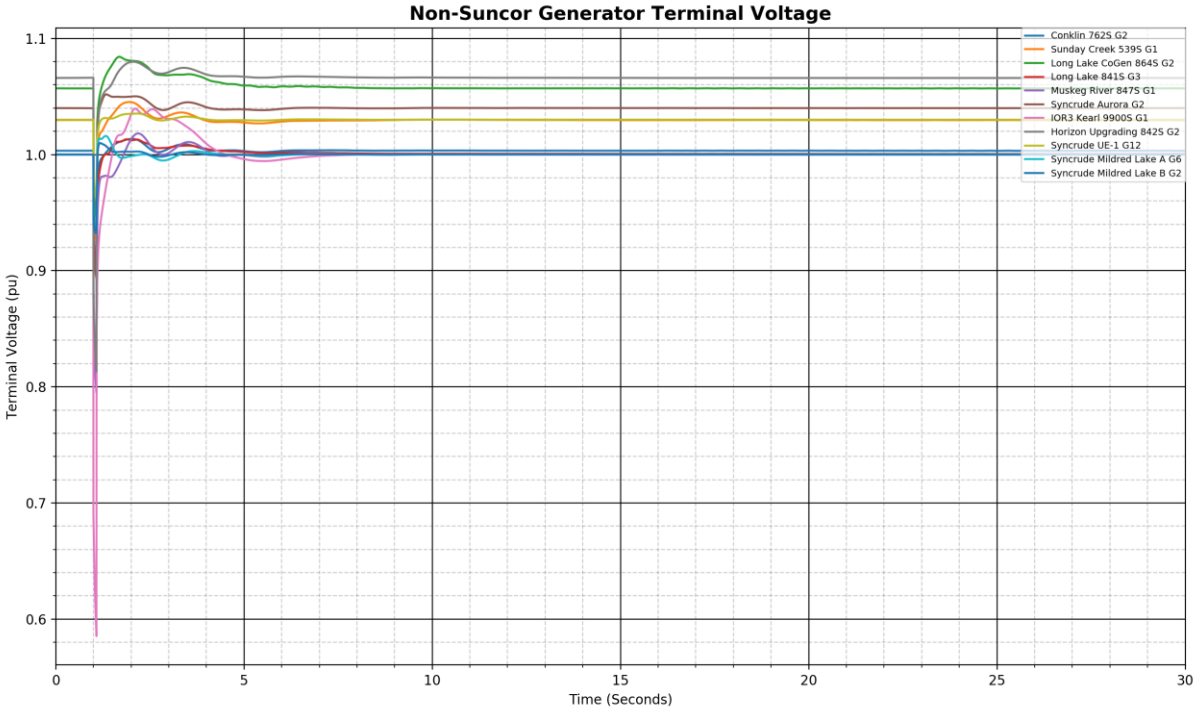
Figure A4-20: 9L69 (Black Fly 934S to McClelland 957S): Fault at McClelland 957S

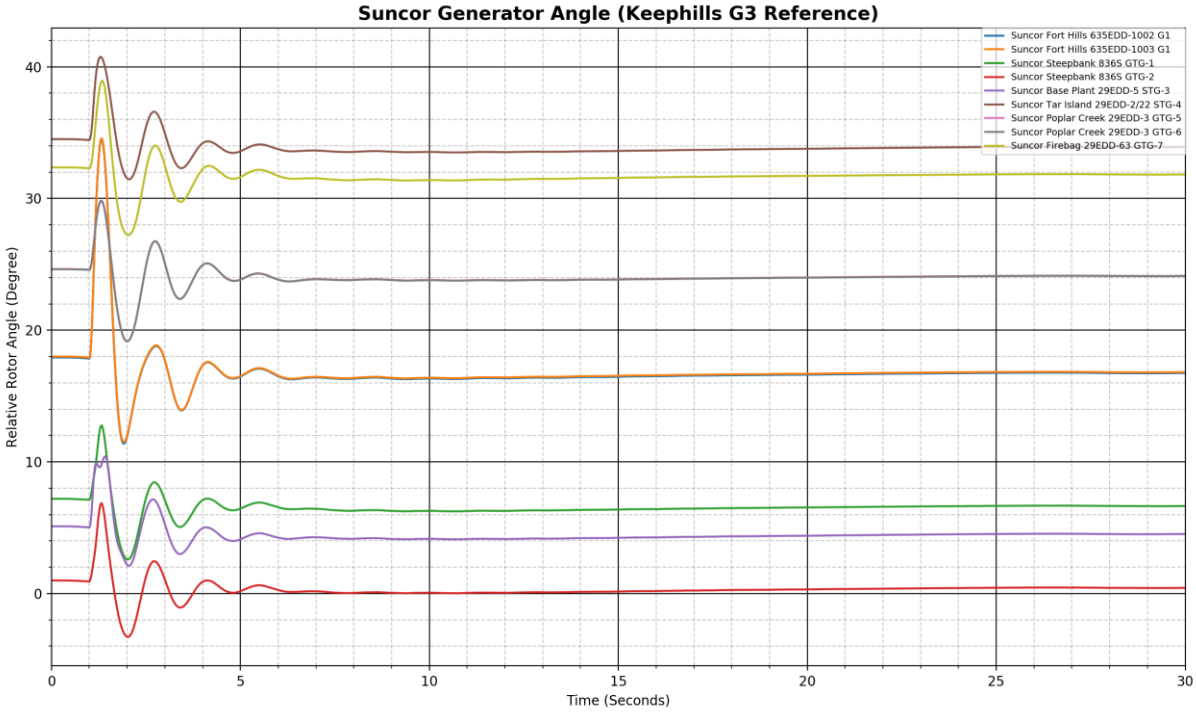


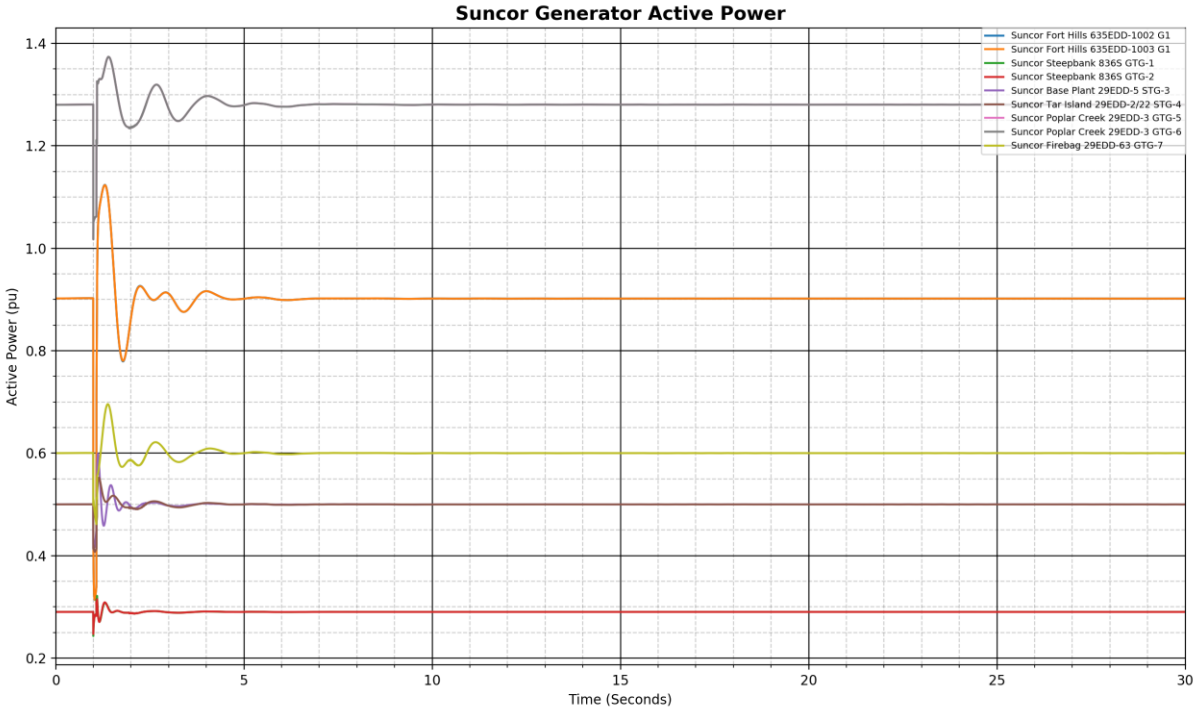

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

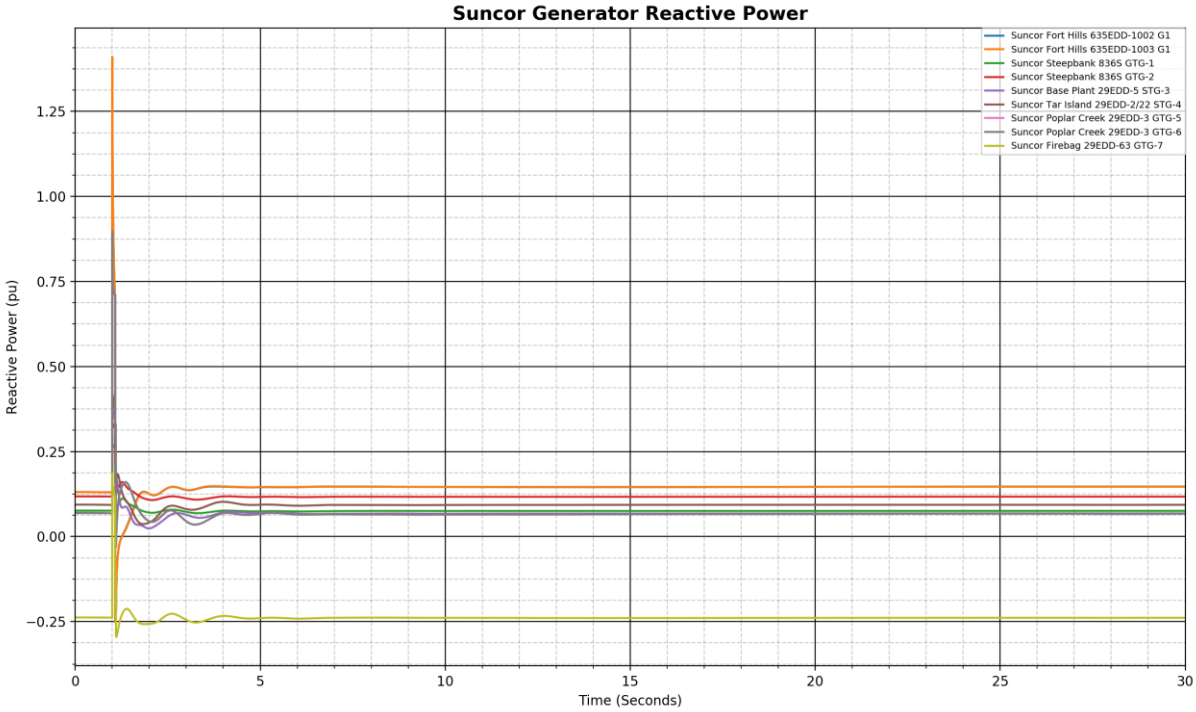

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

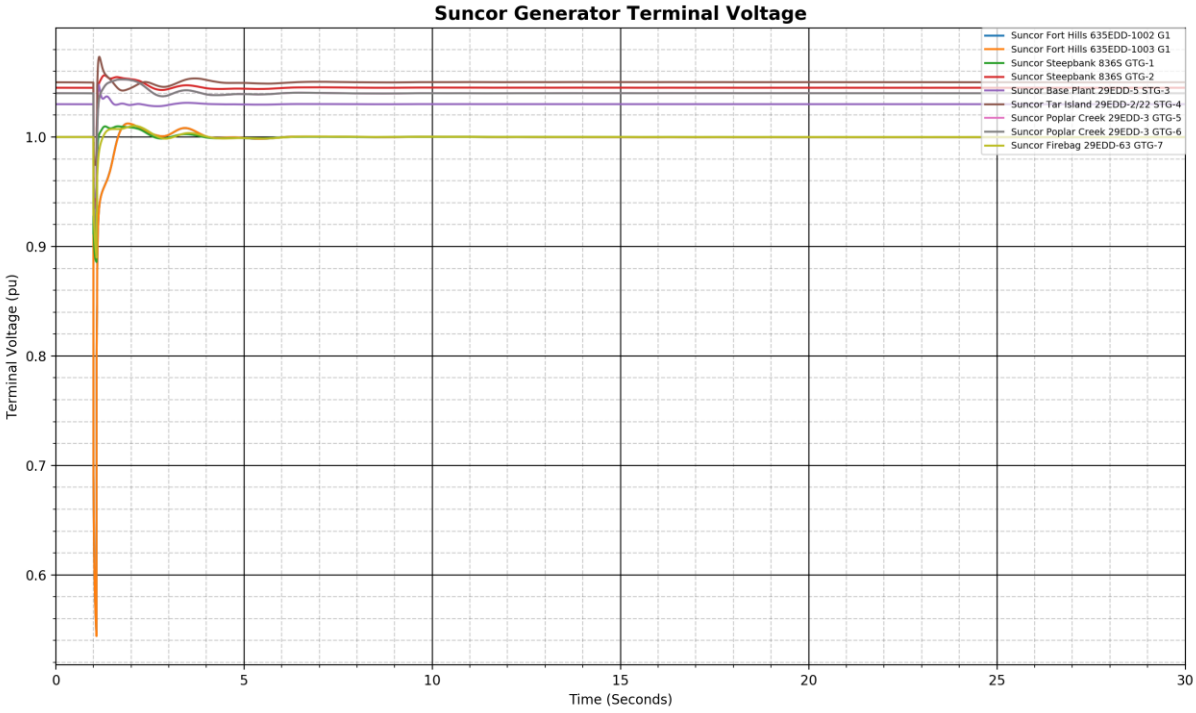

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

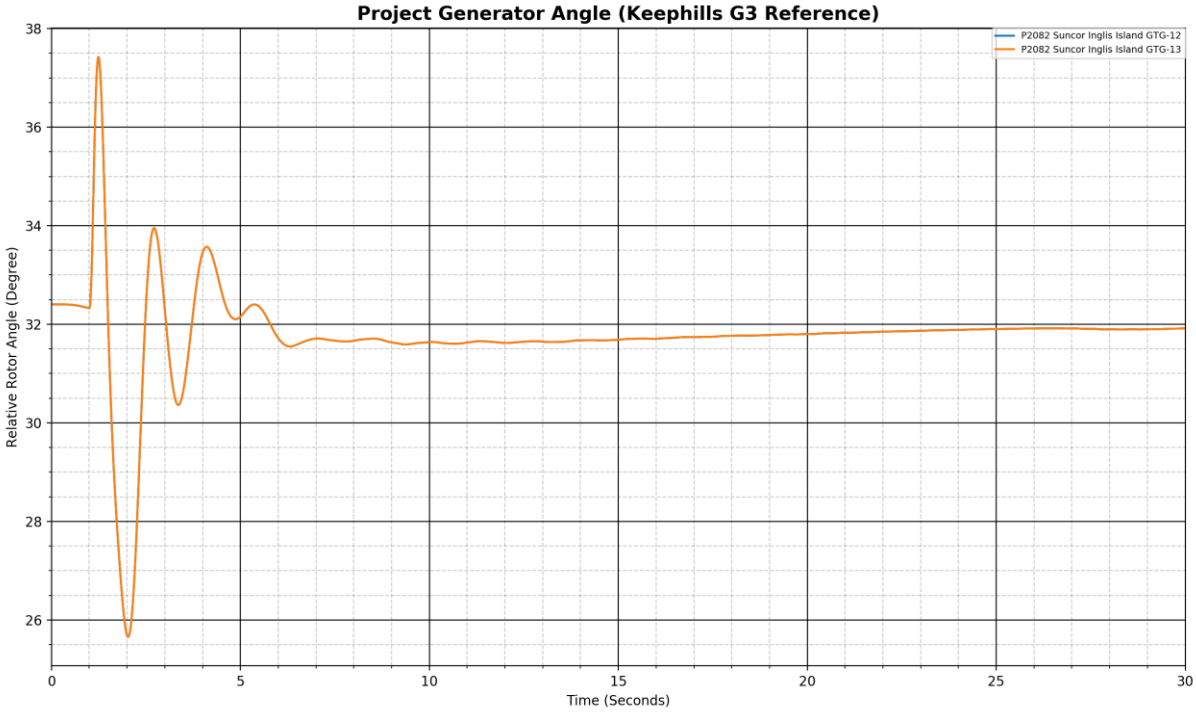

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

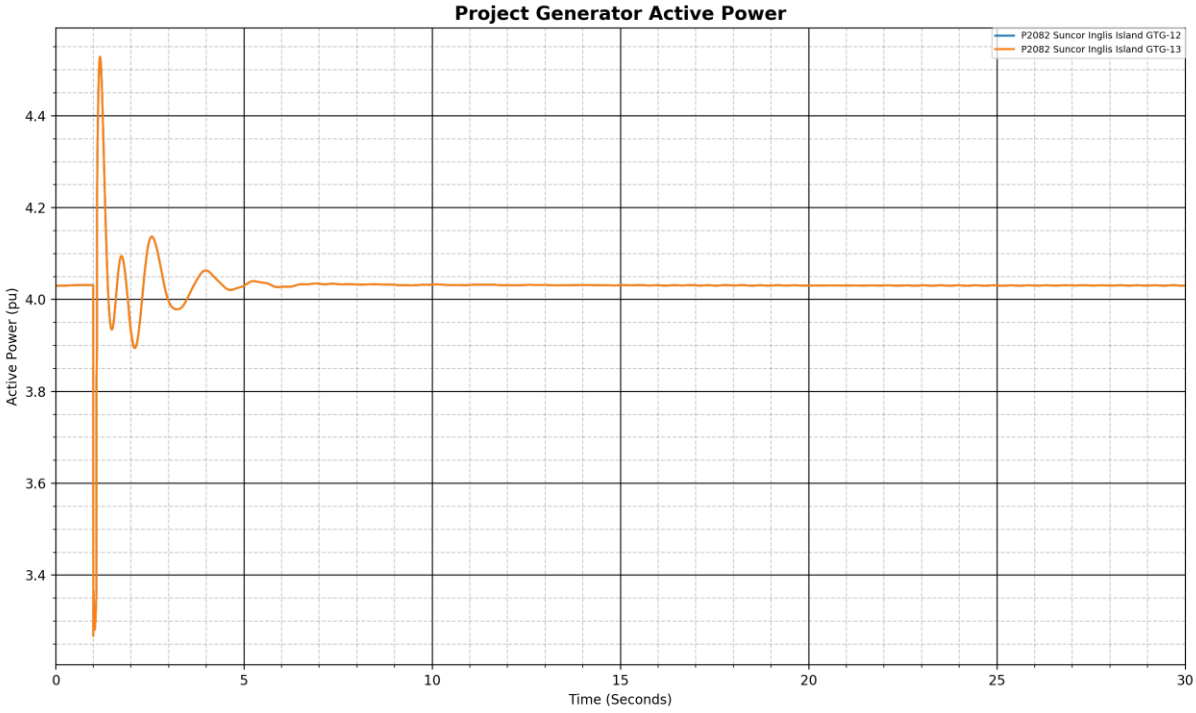

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

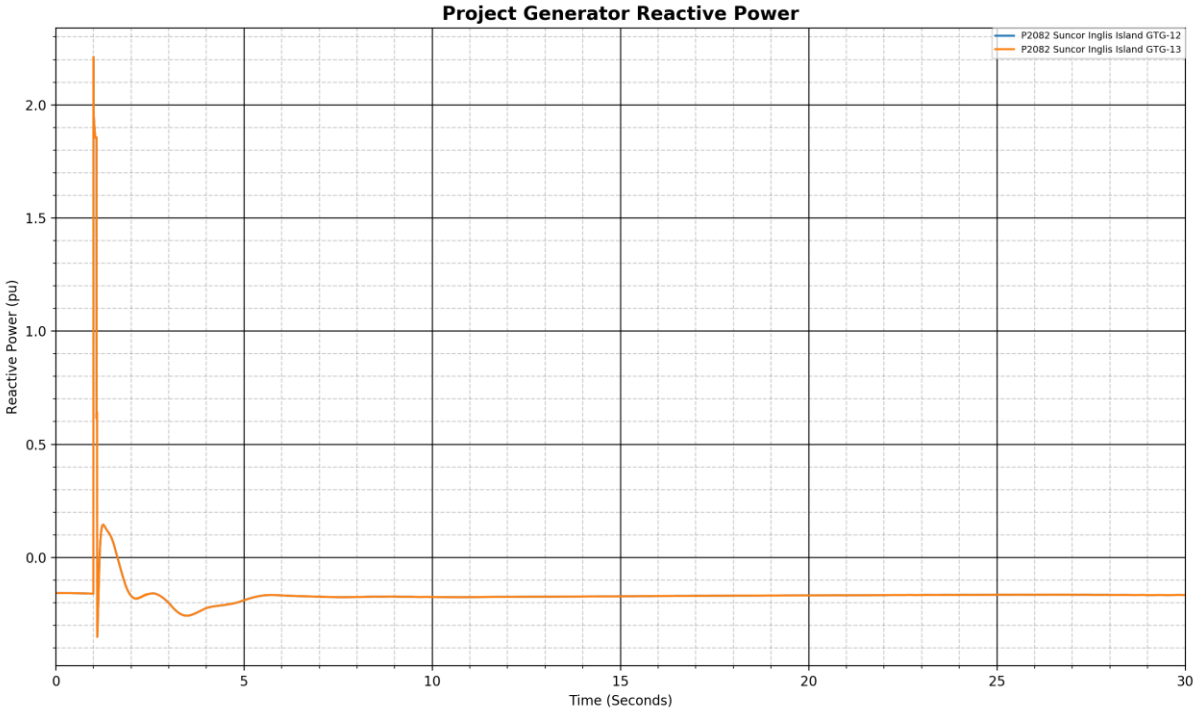

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

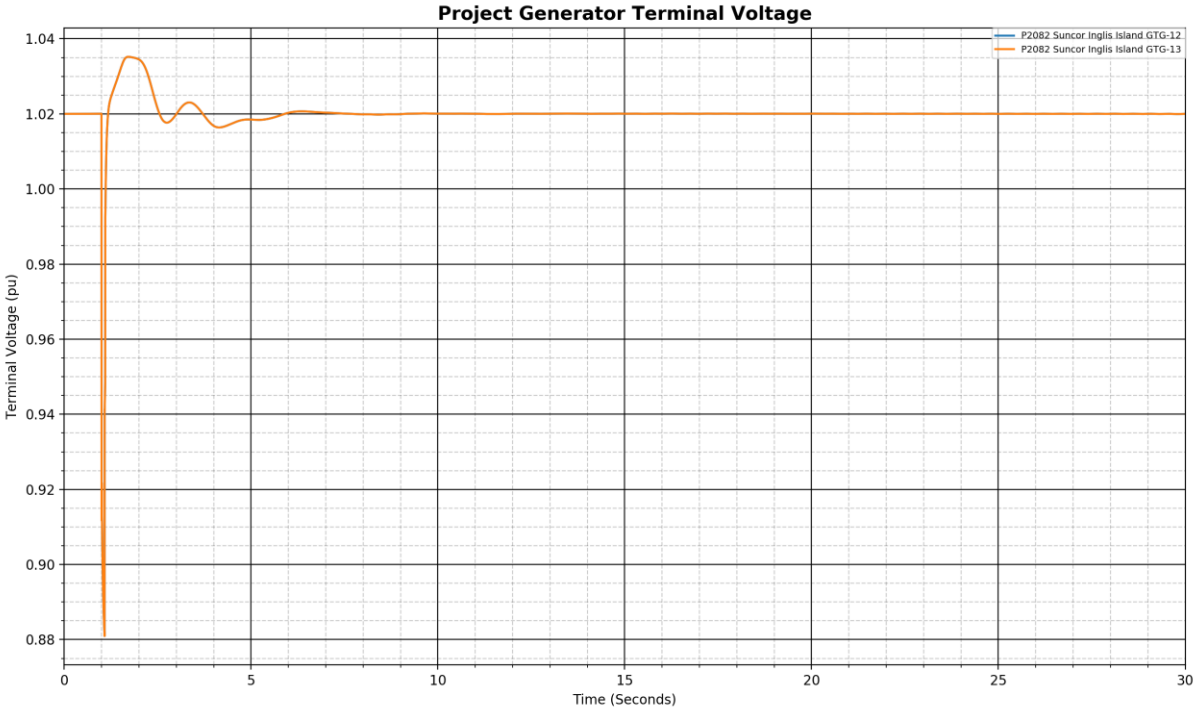

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

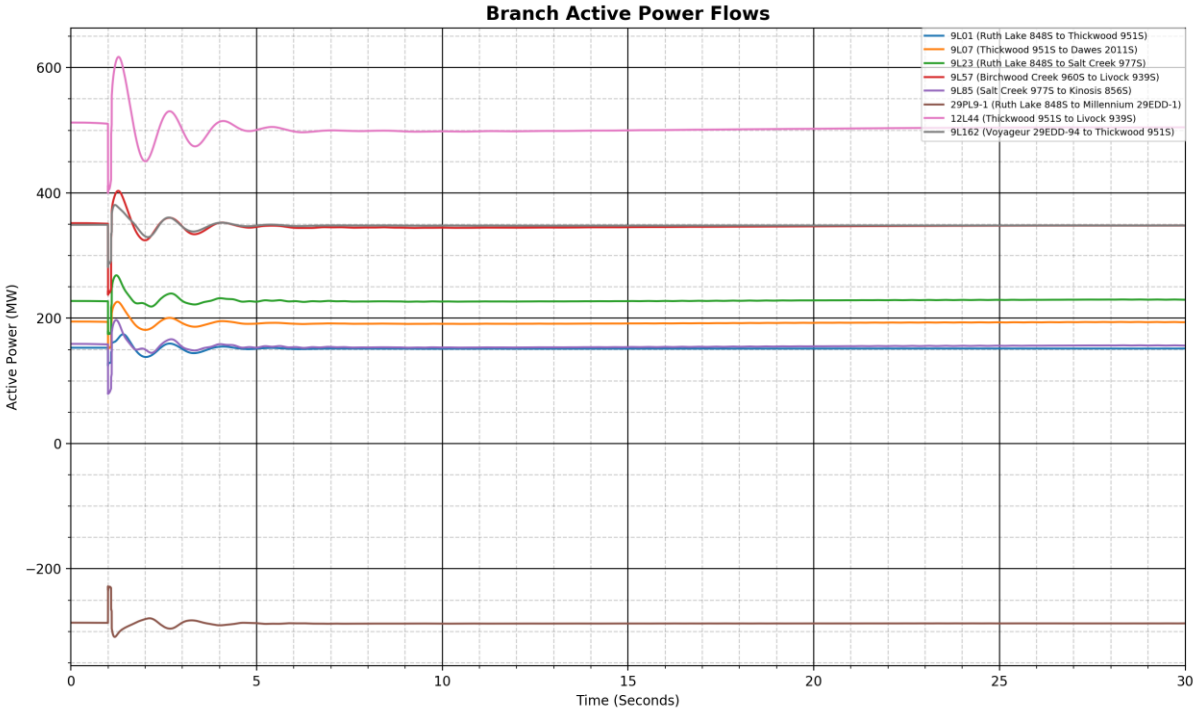

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
38
36
34
32
30
28
26
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.4
4.2
4.0
3.8
3.6
3.4
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

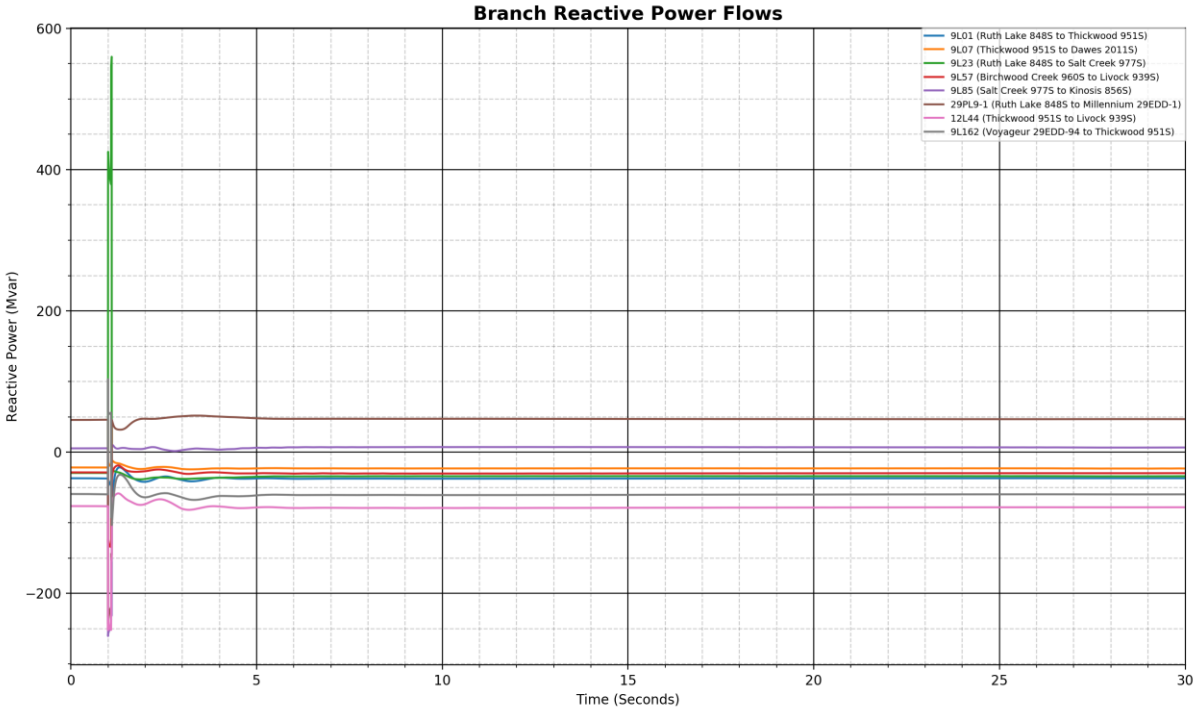
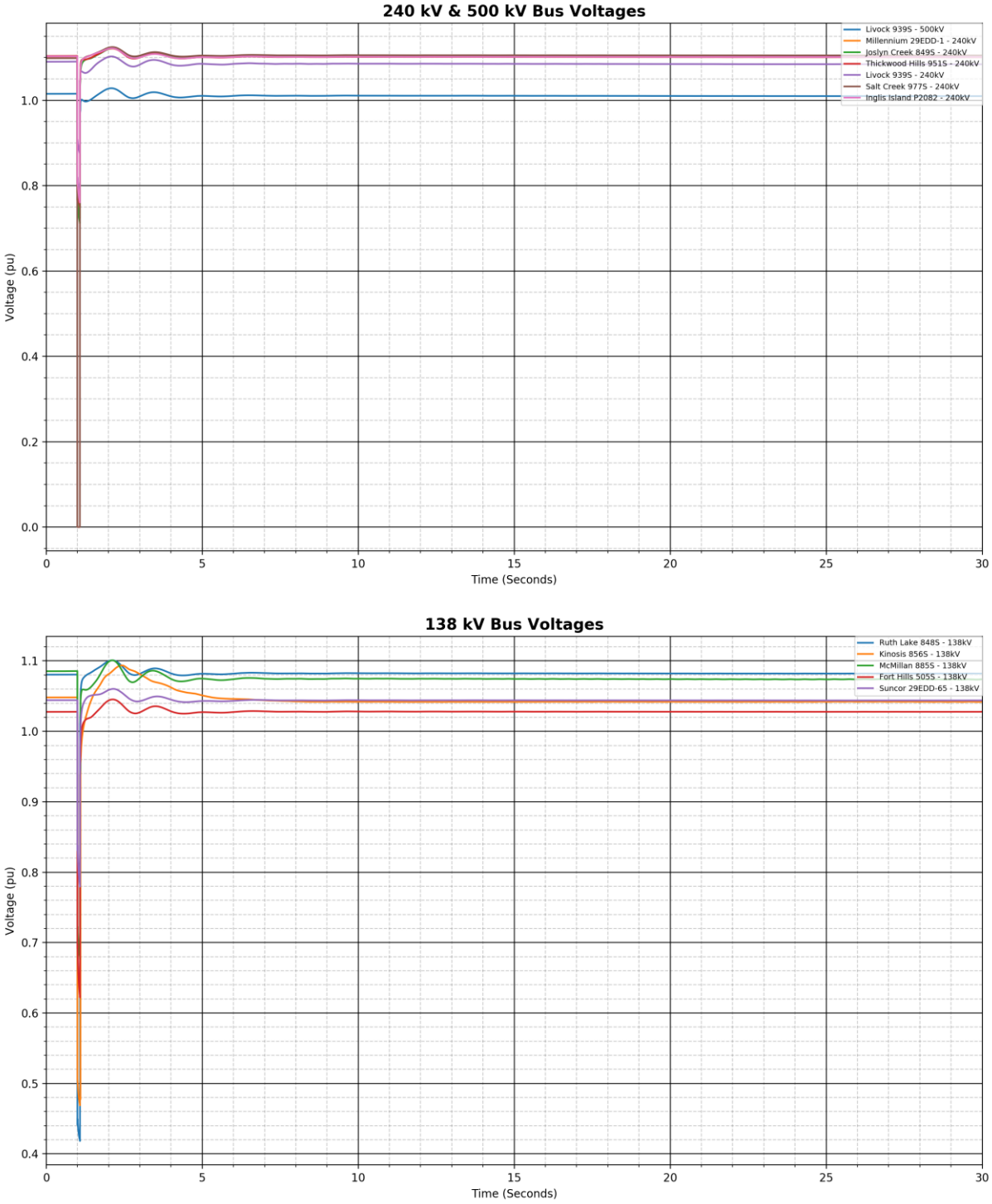
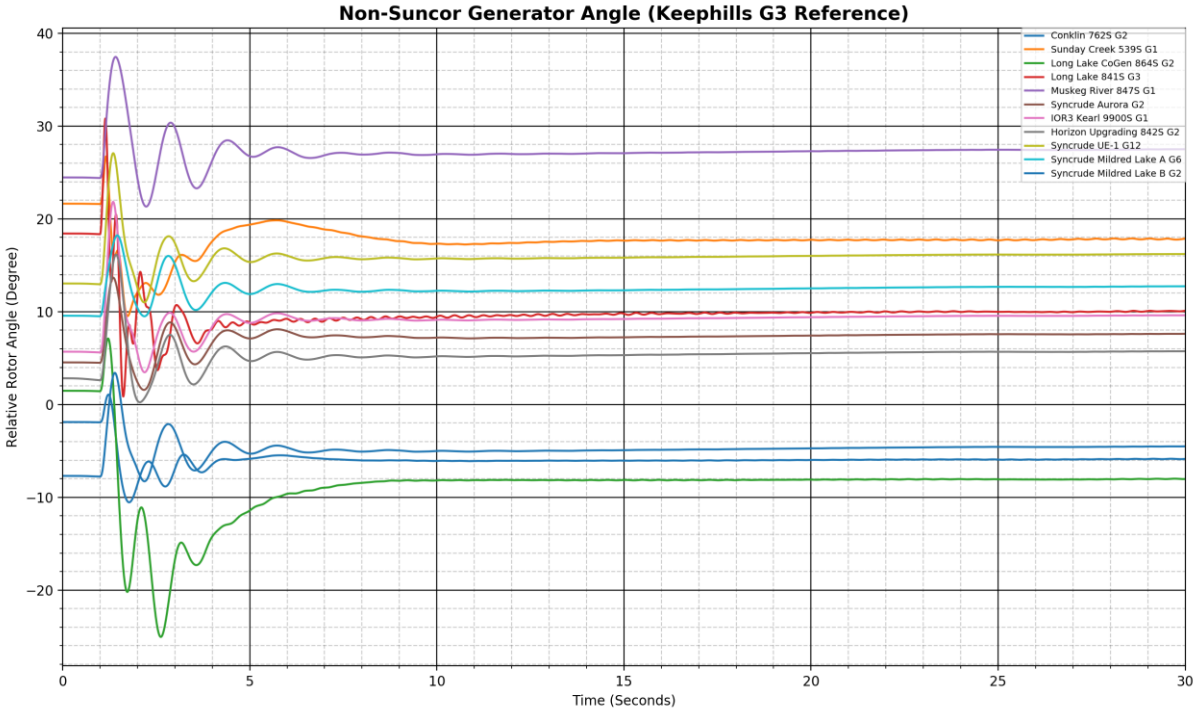
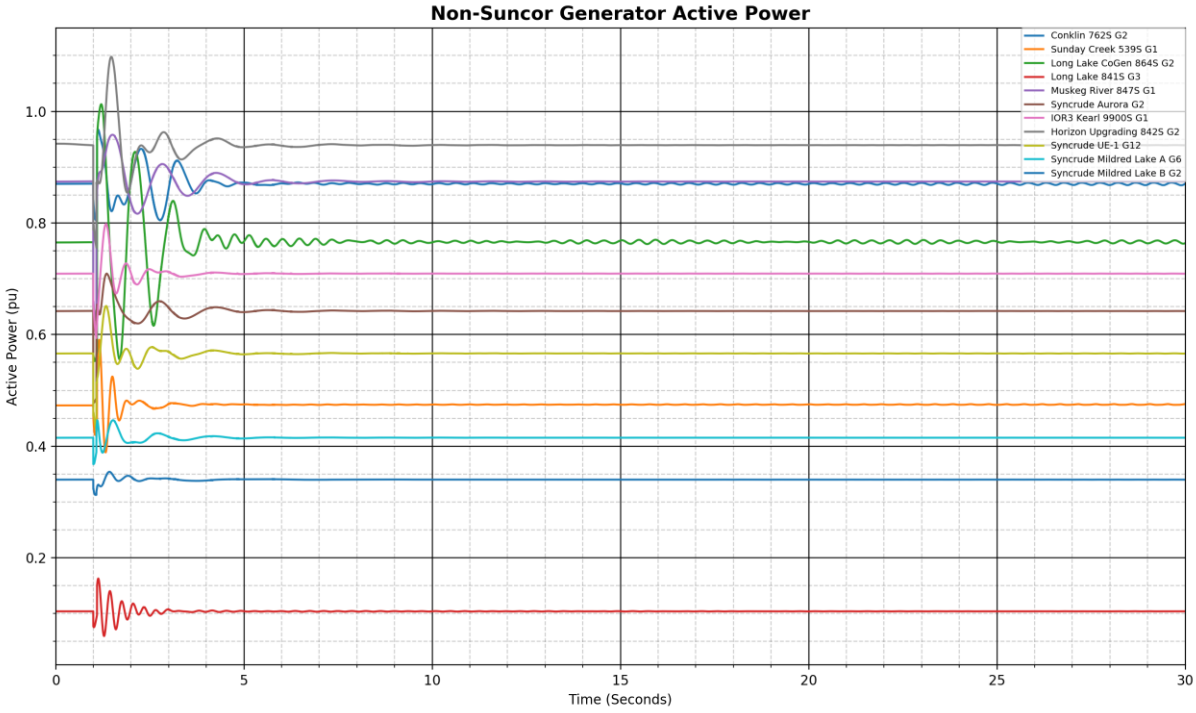
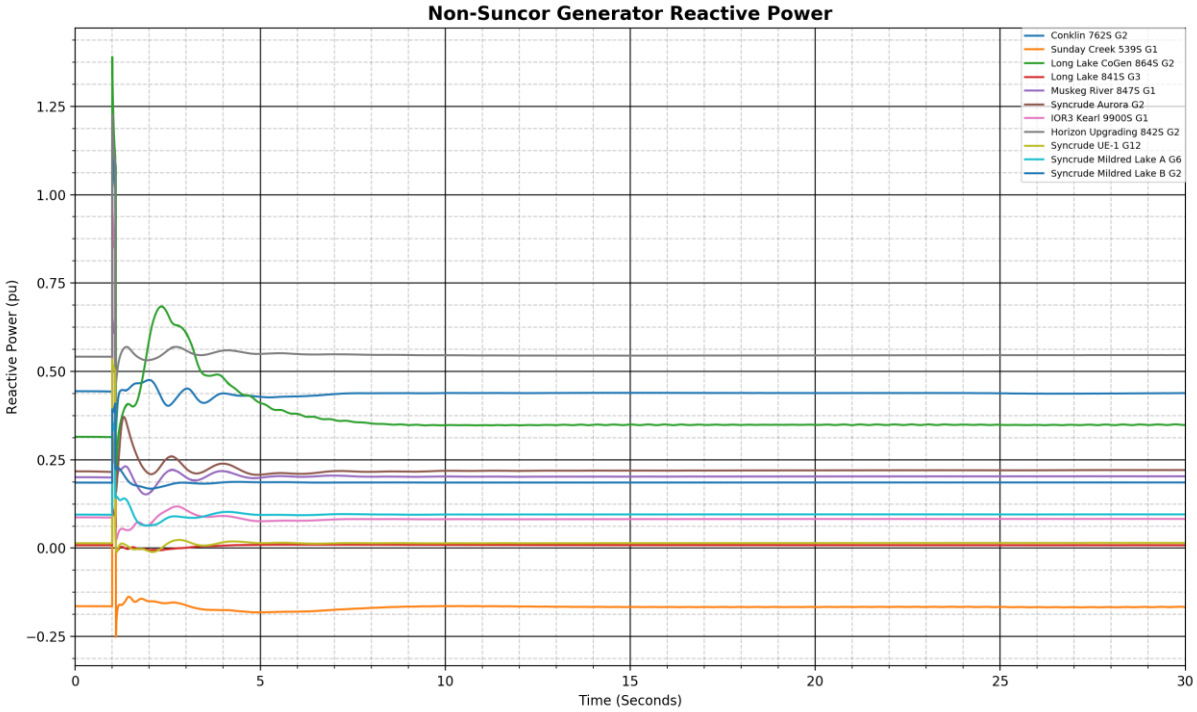

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

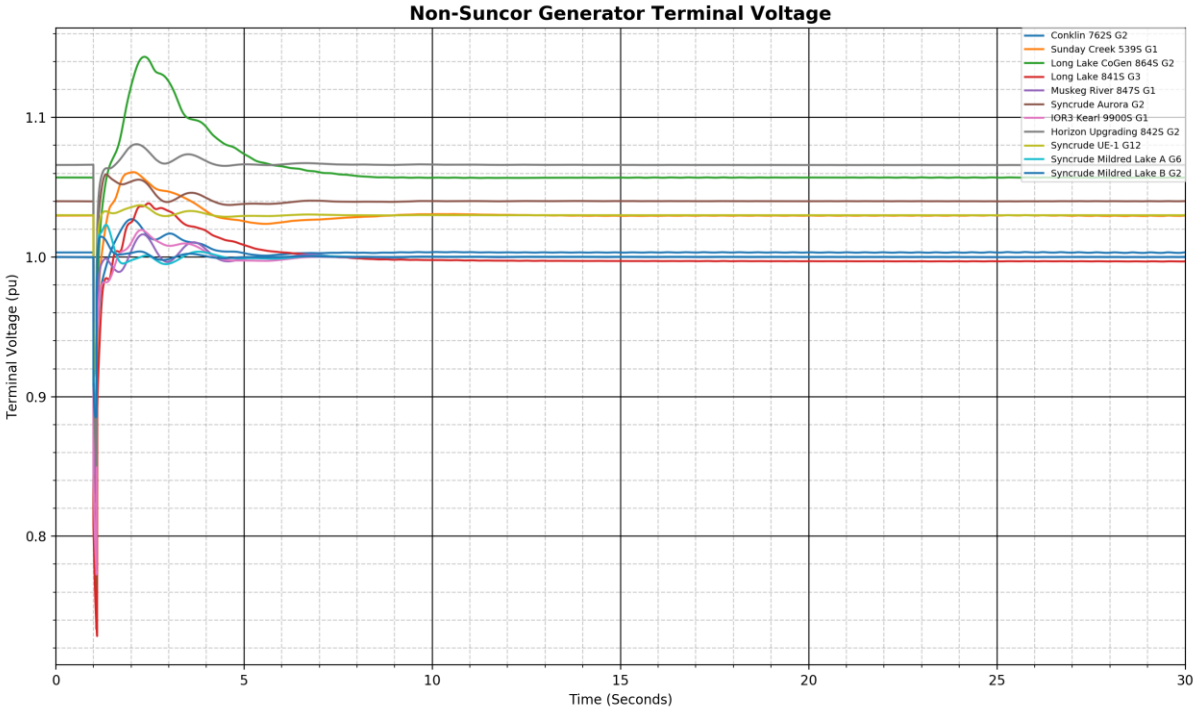
Figure A4-21: 9L85 (Salt Creek 977S to Kinosis 856S): Fault at Salt Creek 977S

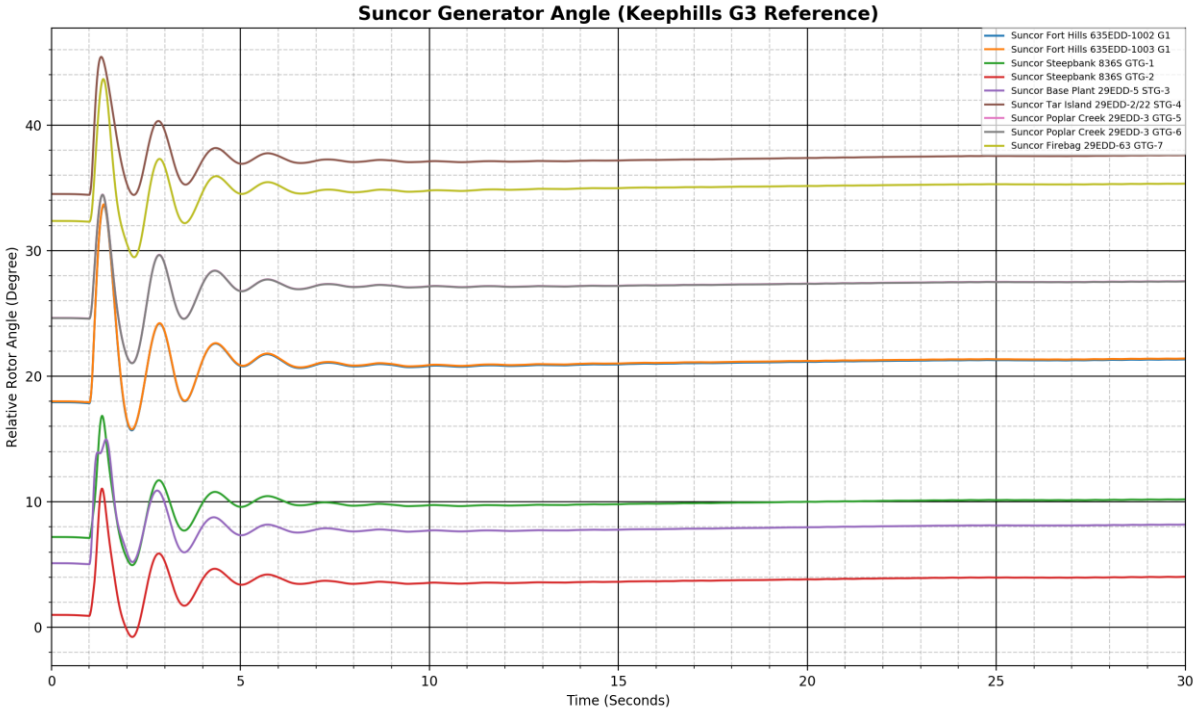


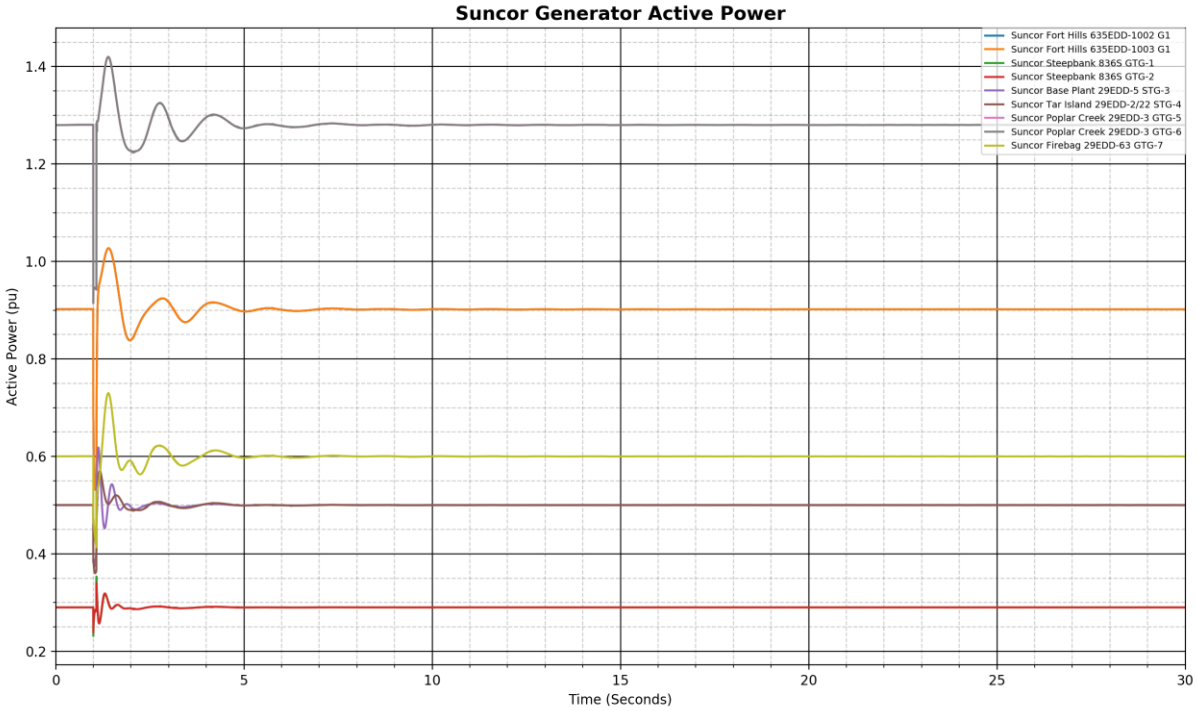

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

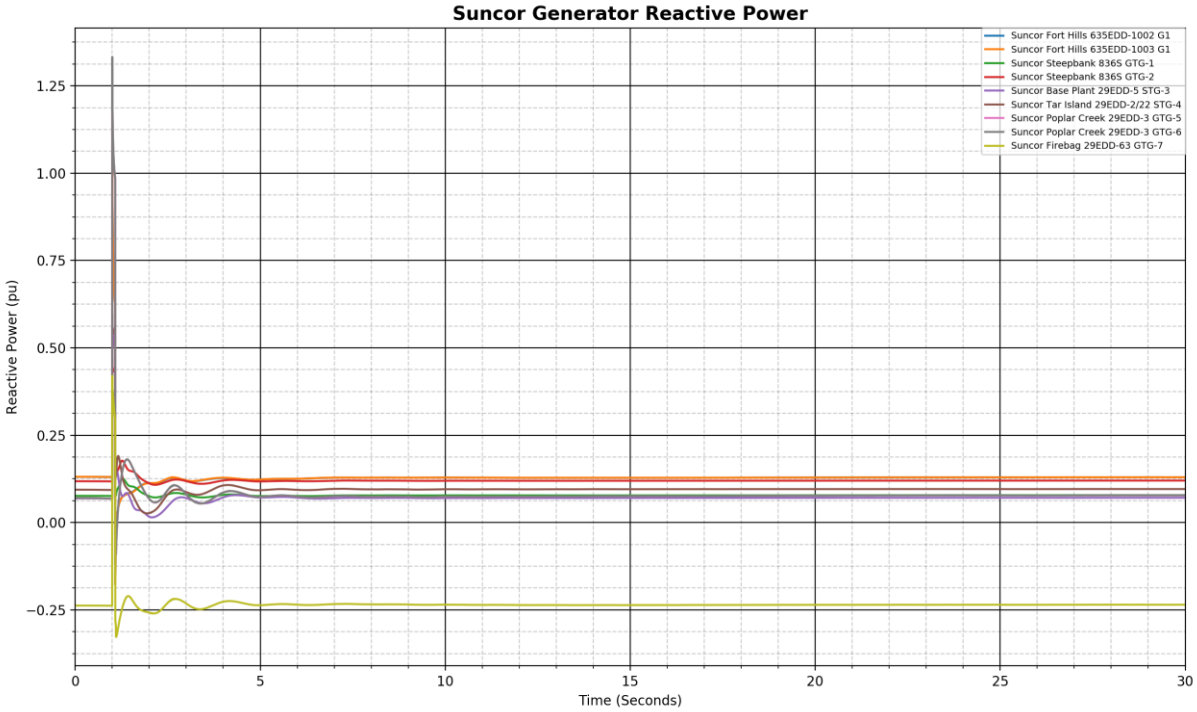

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

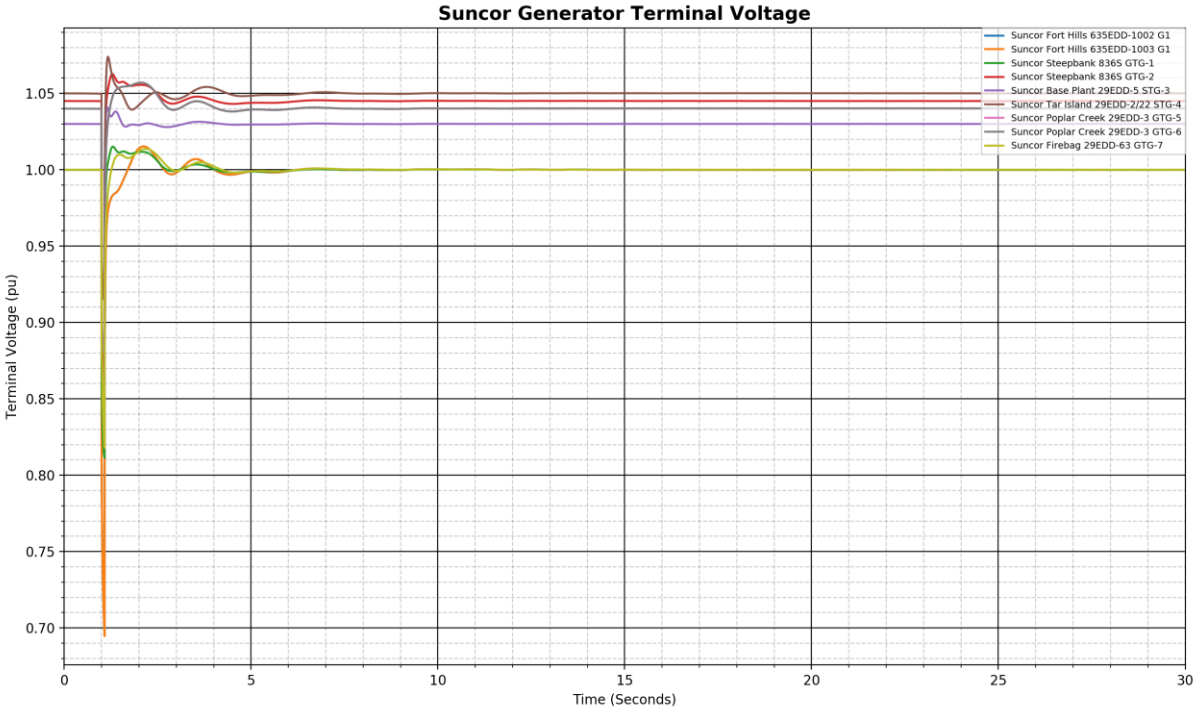

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

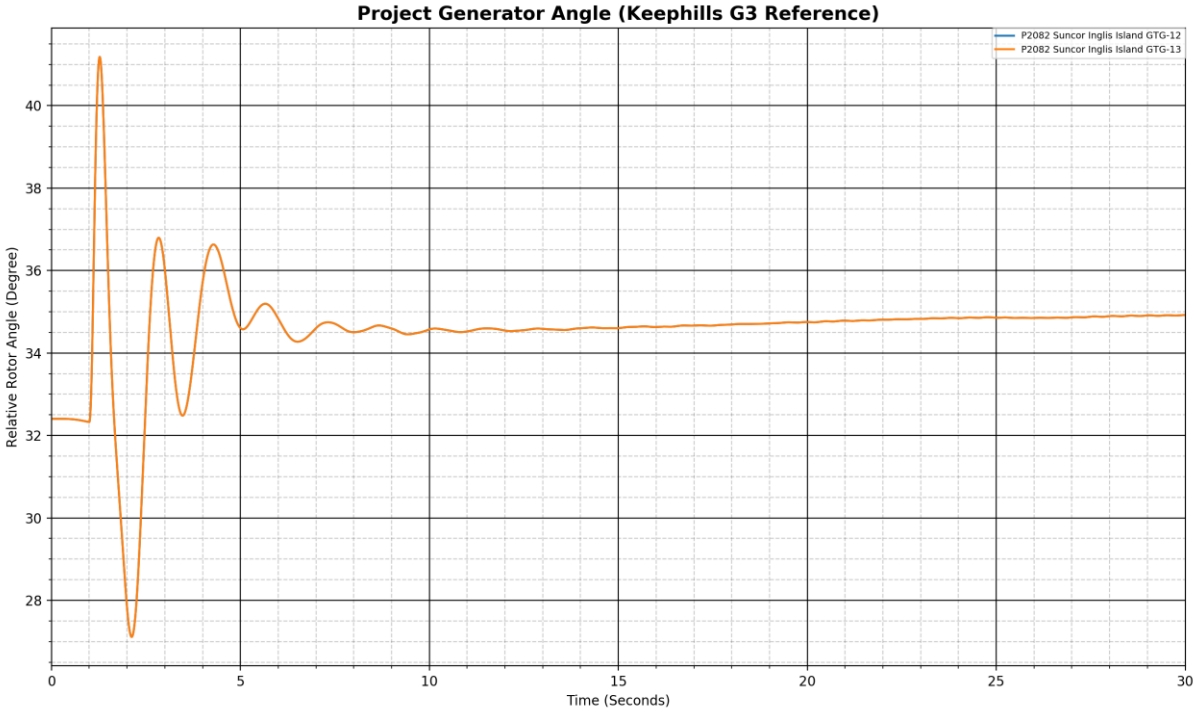

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

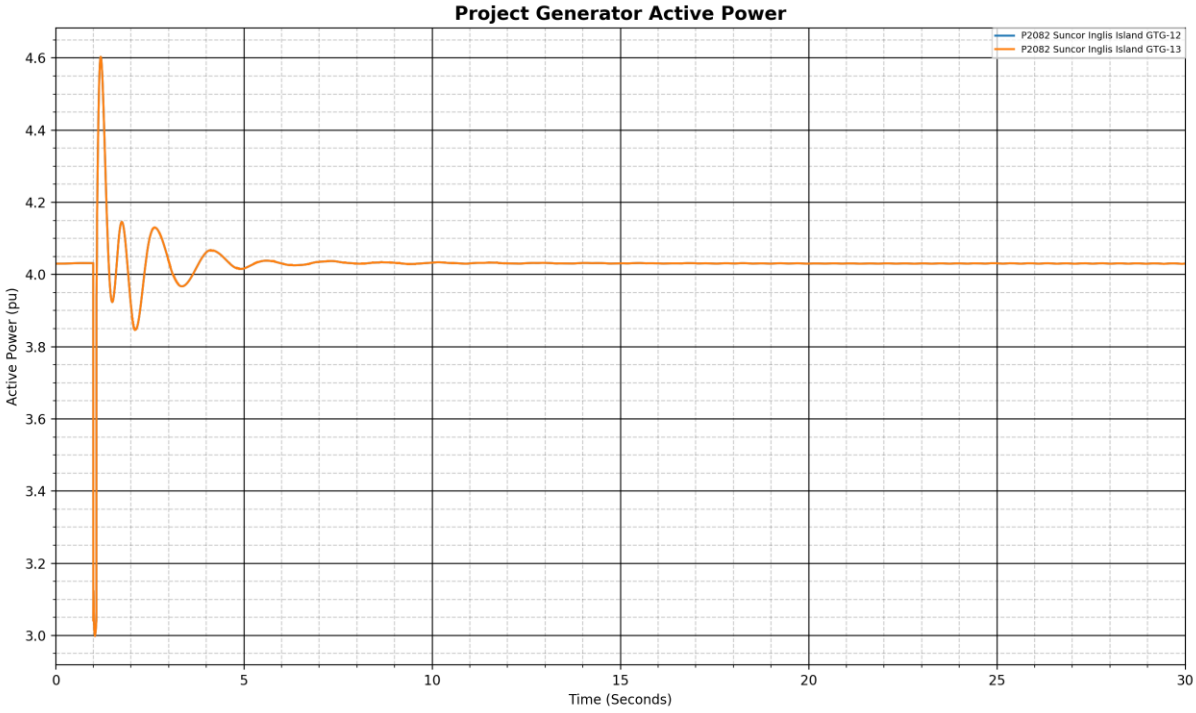

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

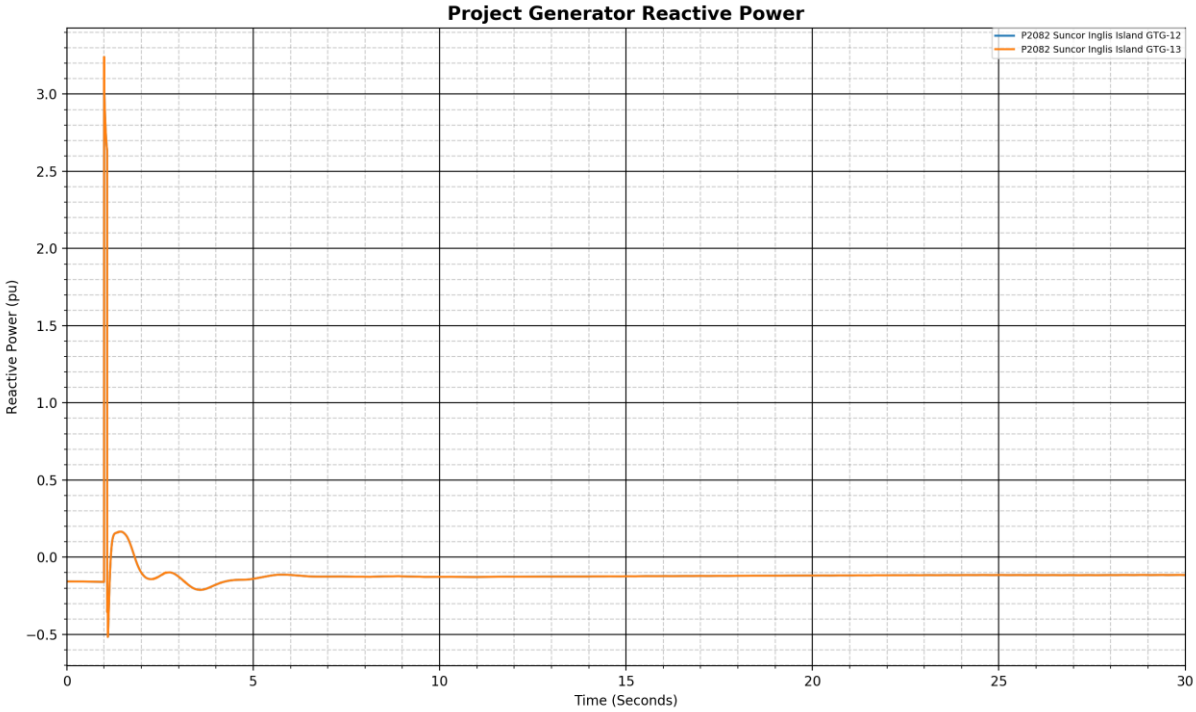

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

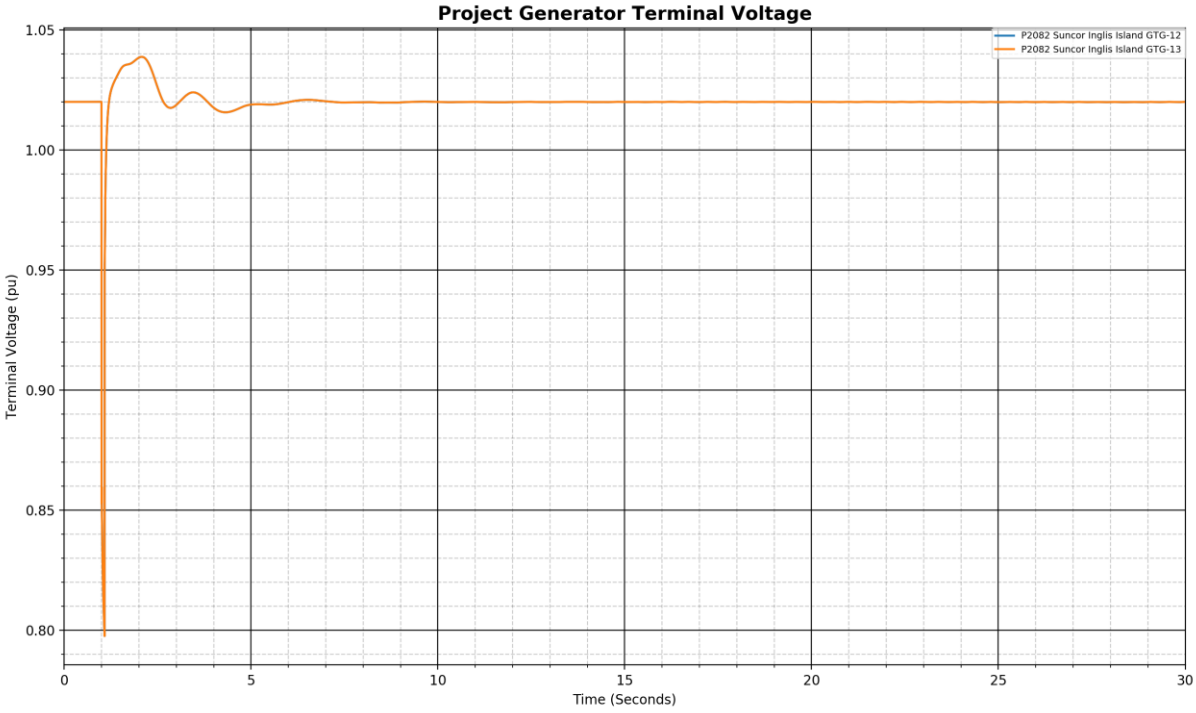

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

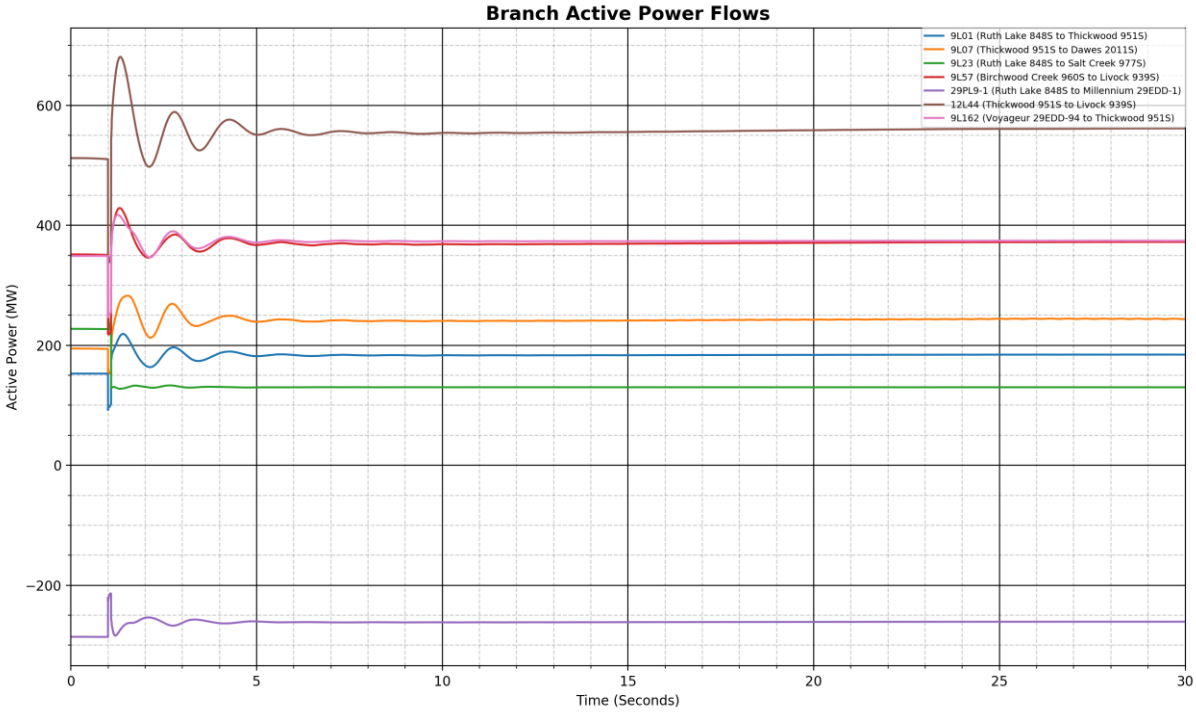

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
40
38
36
34
32
30
28
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

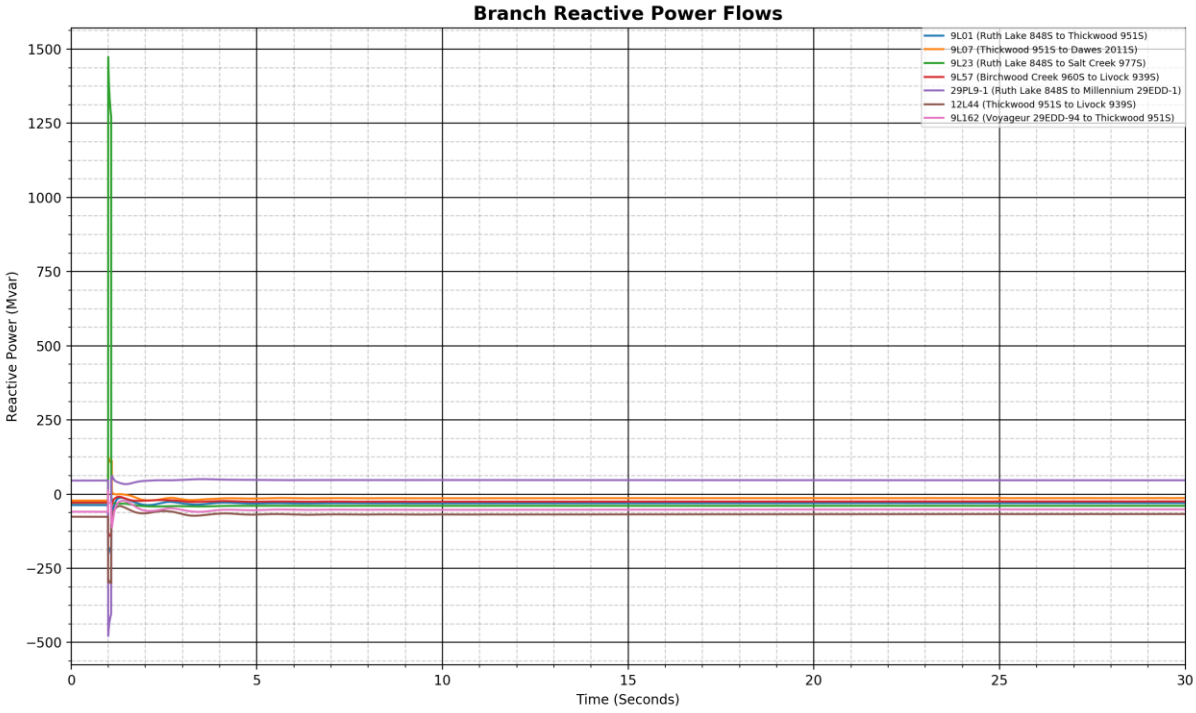
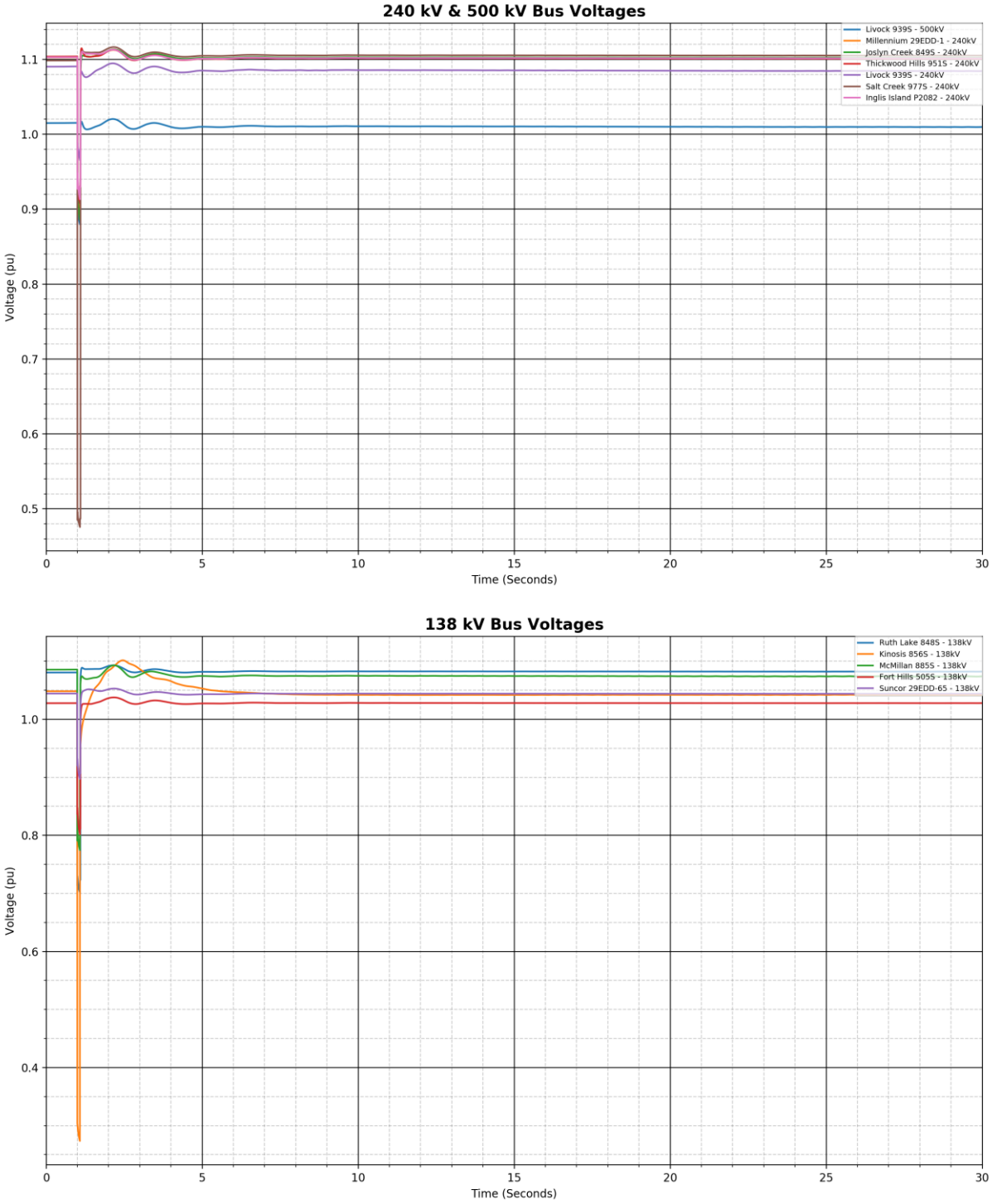
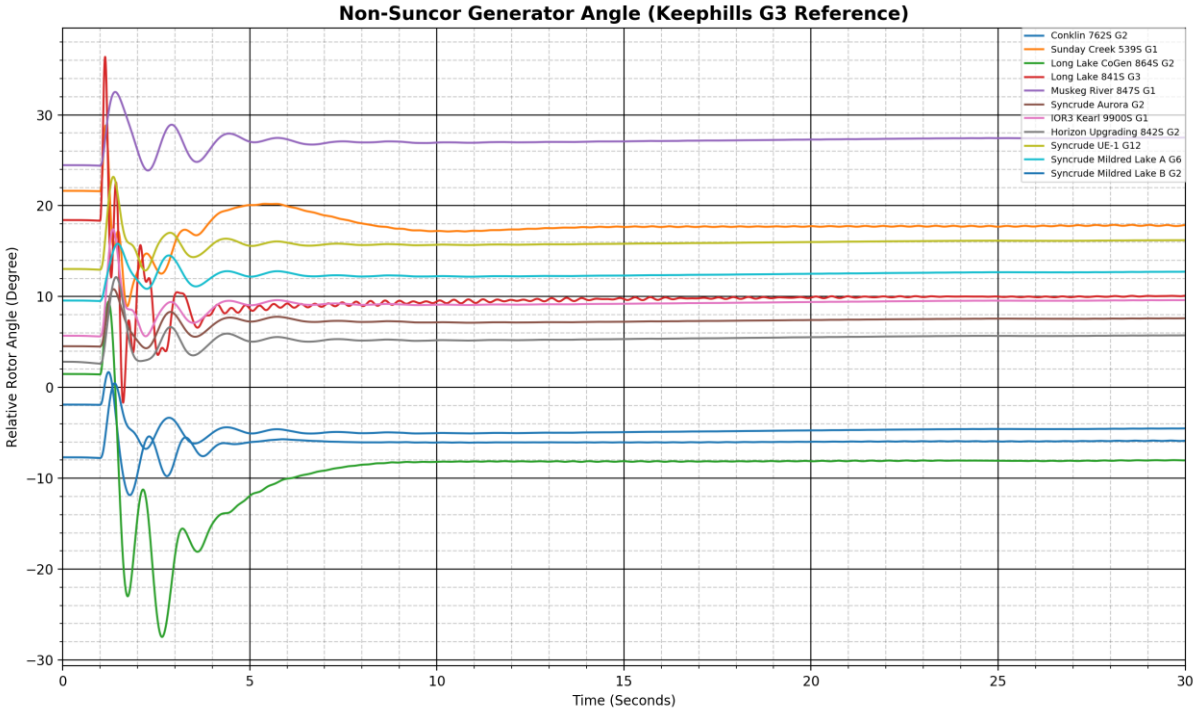
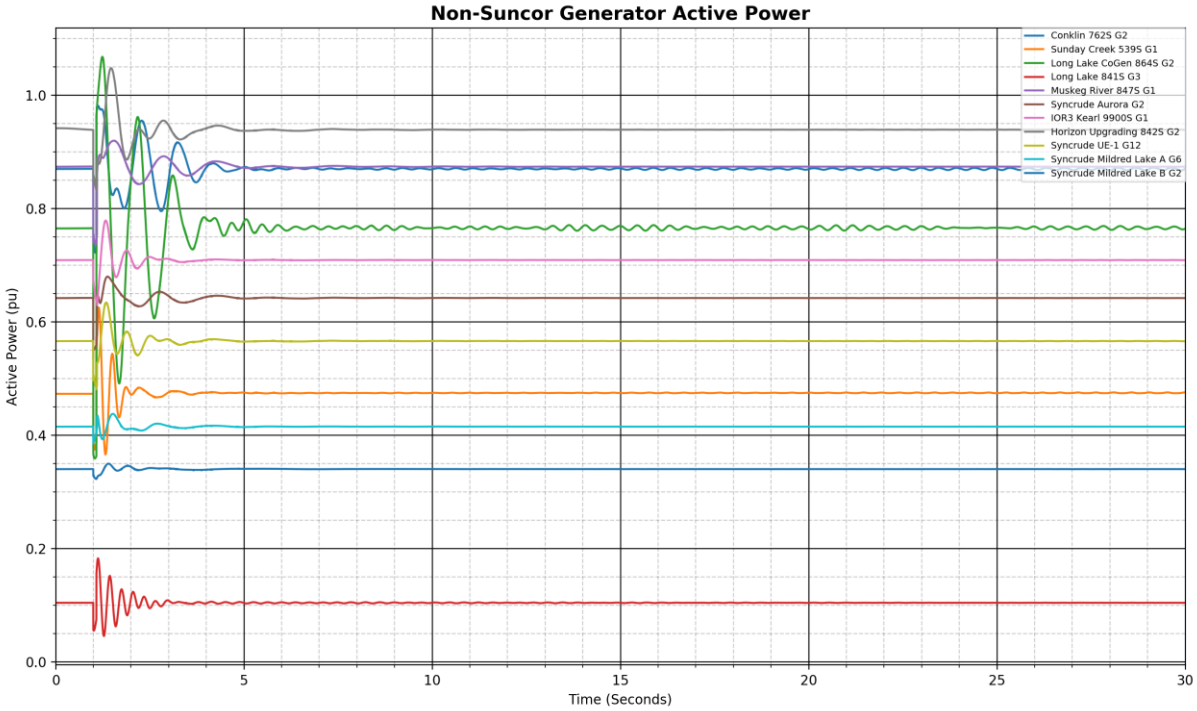
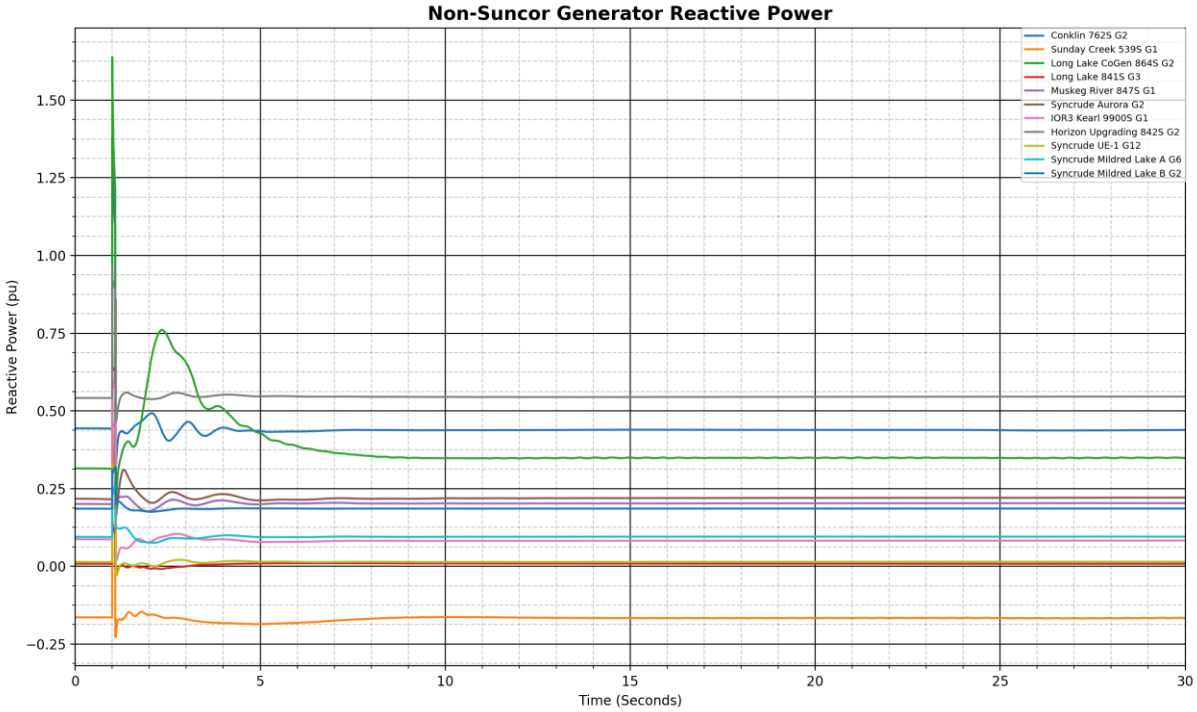

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
1500
1250
1000
750
500
250
0
−250
−500
0
5
10
15
20
25
30
Time (Seconds)

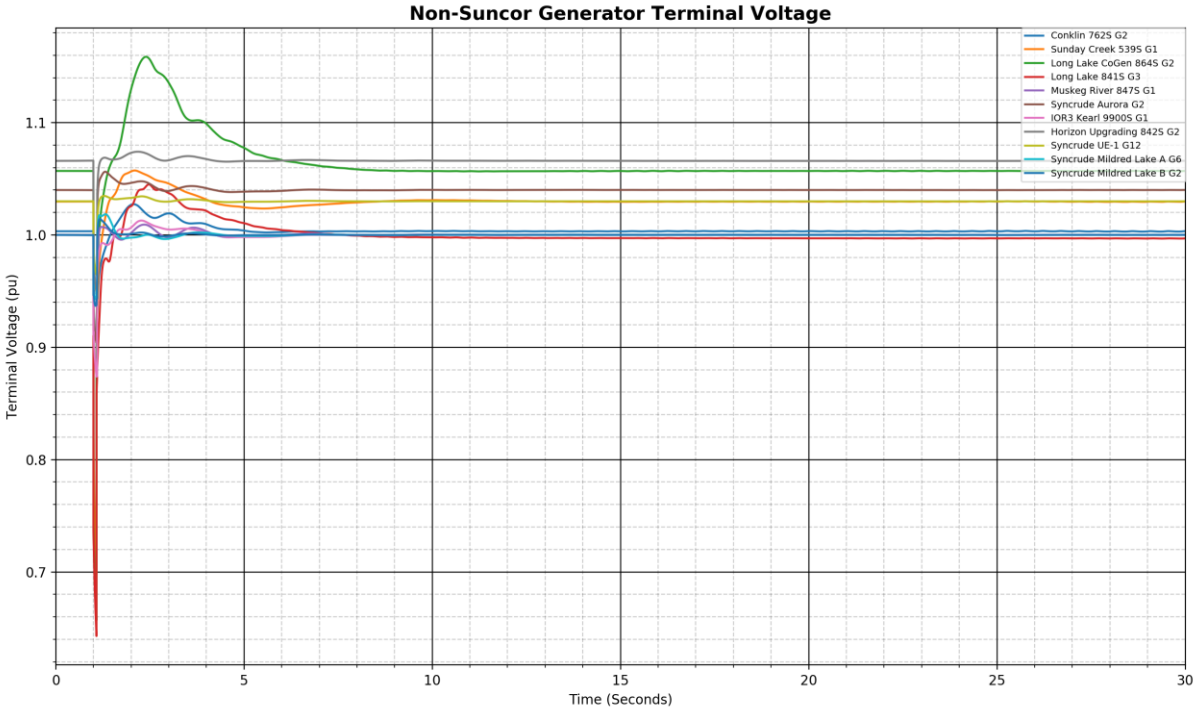
Figure A4-22: 9L85 (Salt Creek 977S to Kinosis 856S): Fault at Kinosis 856S

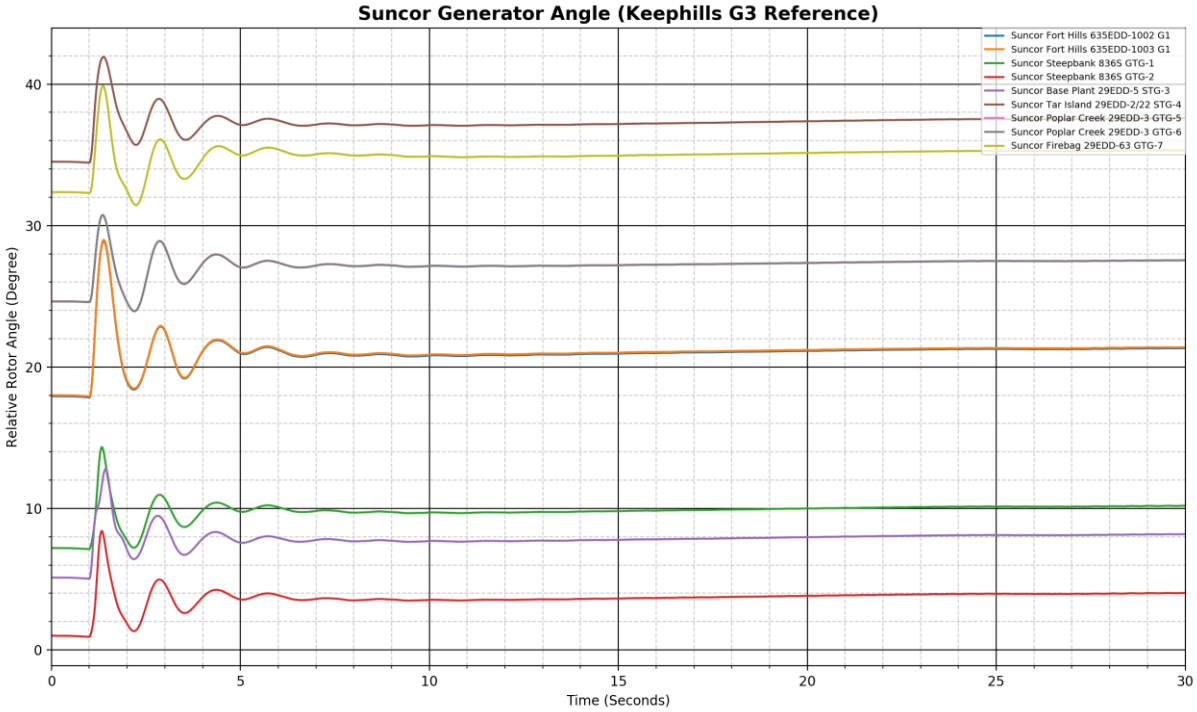


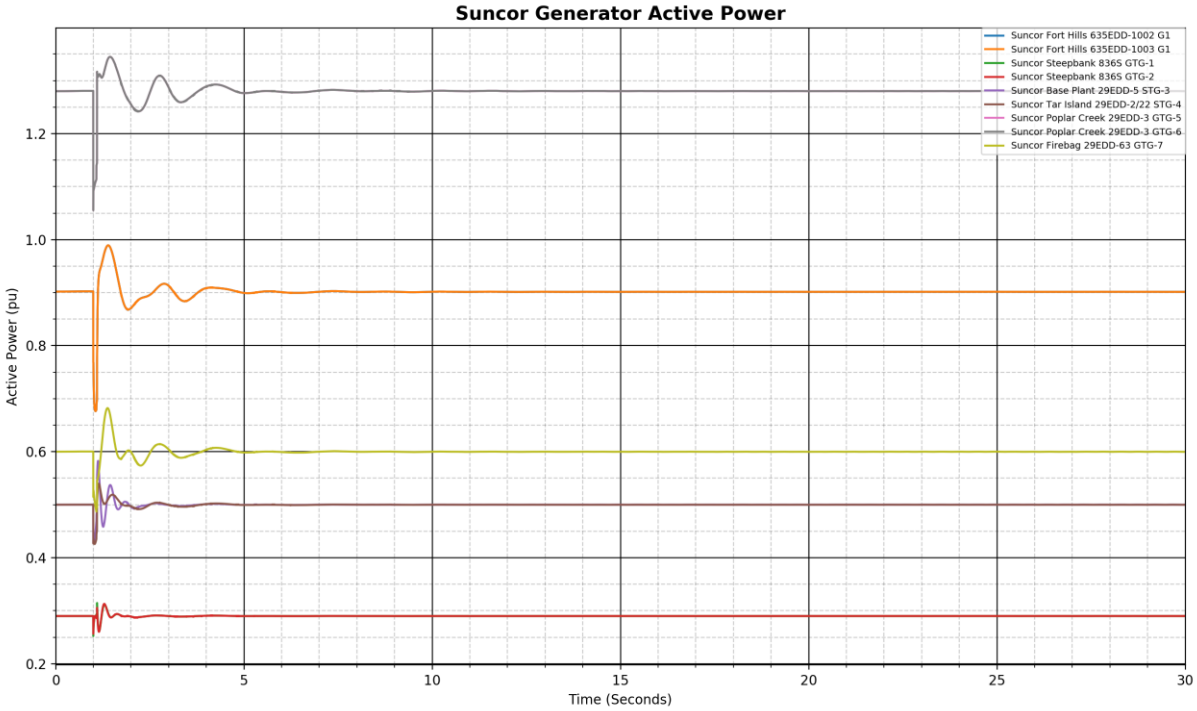

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

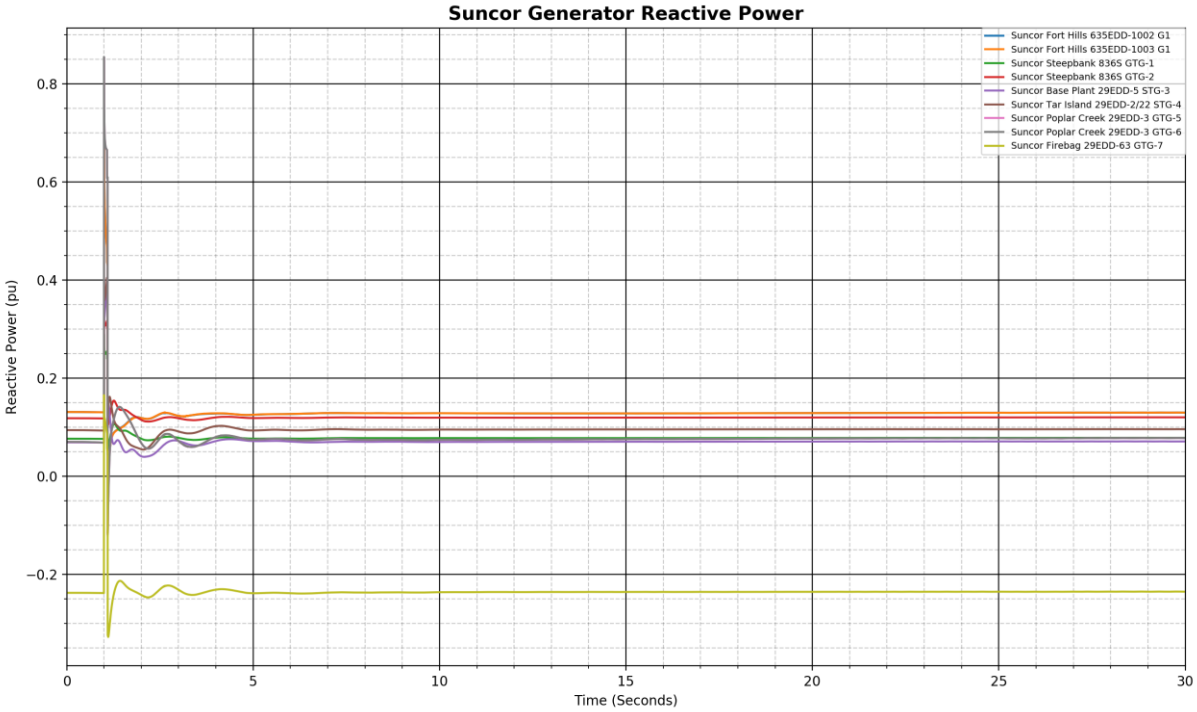

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

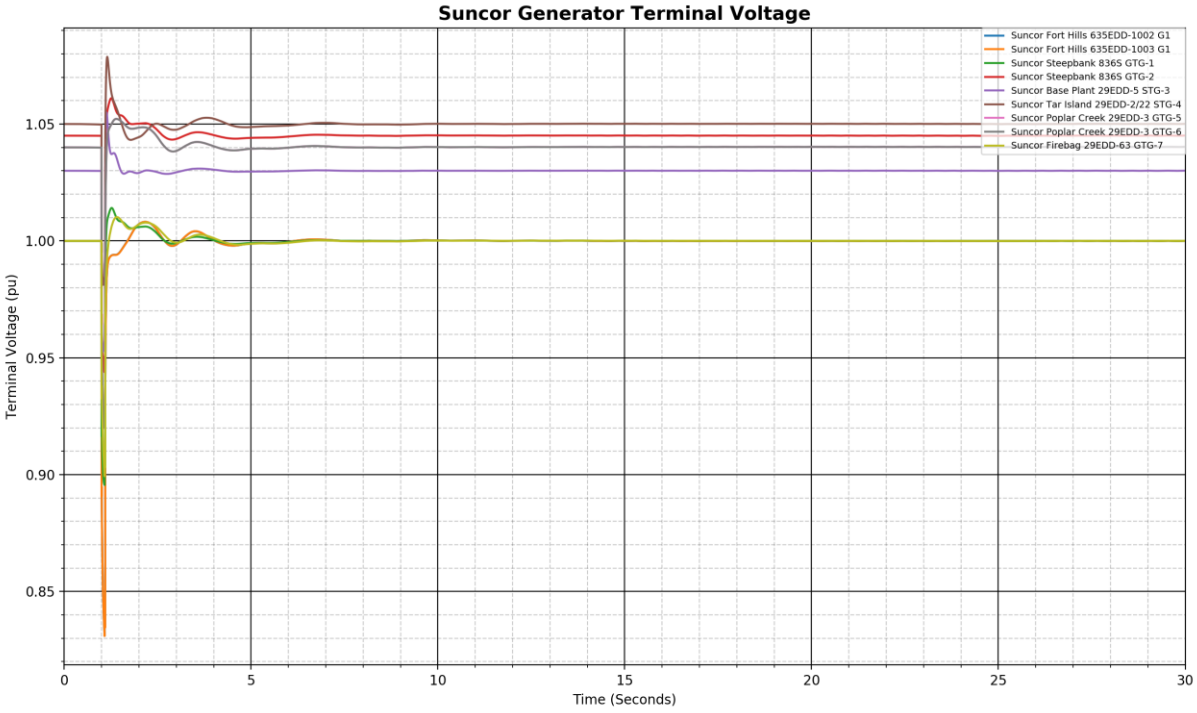

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

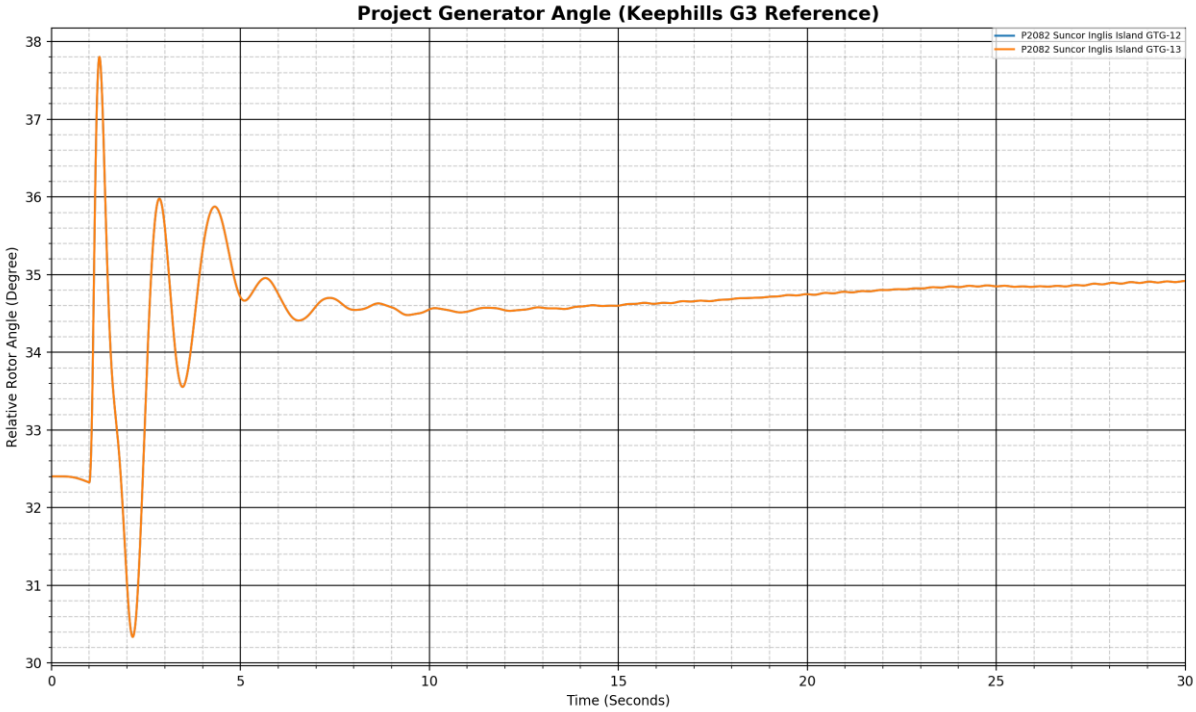

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

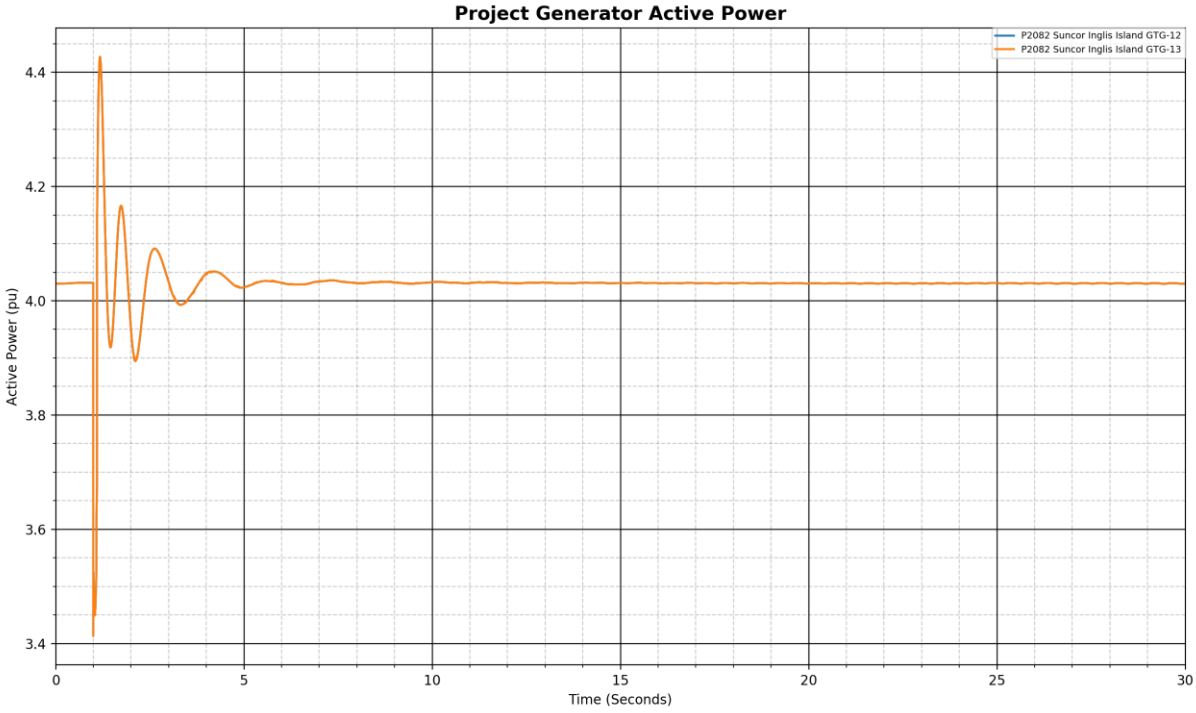

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

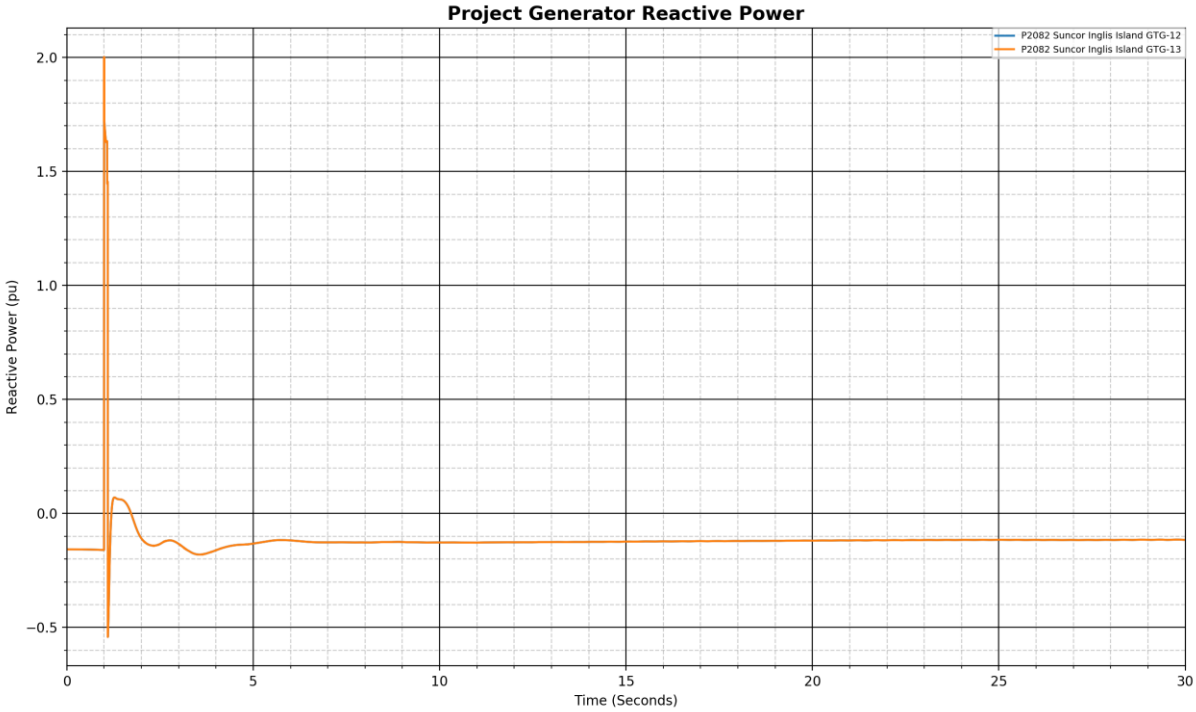

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

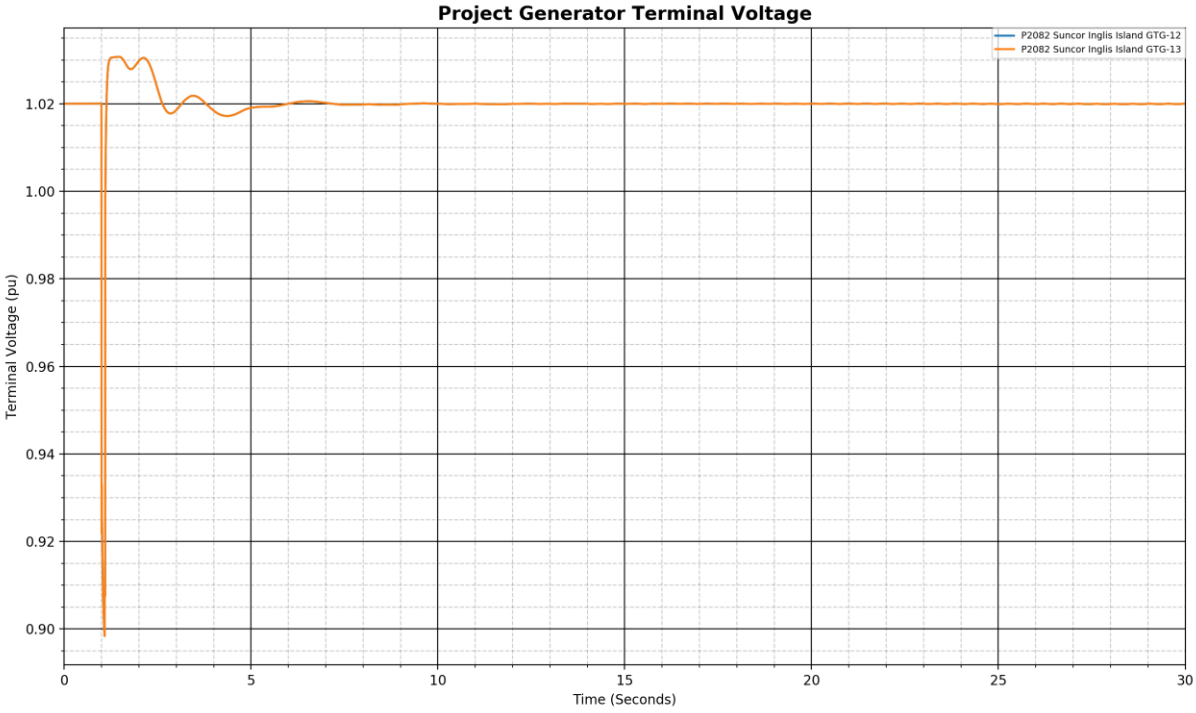

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

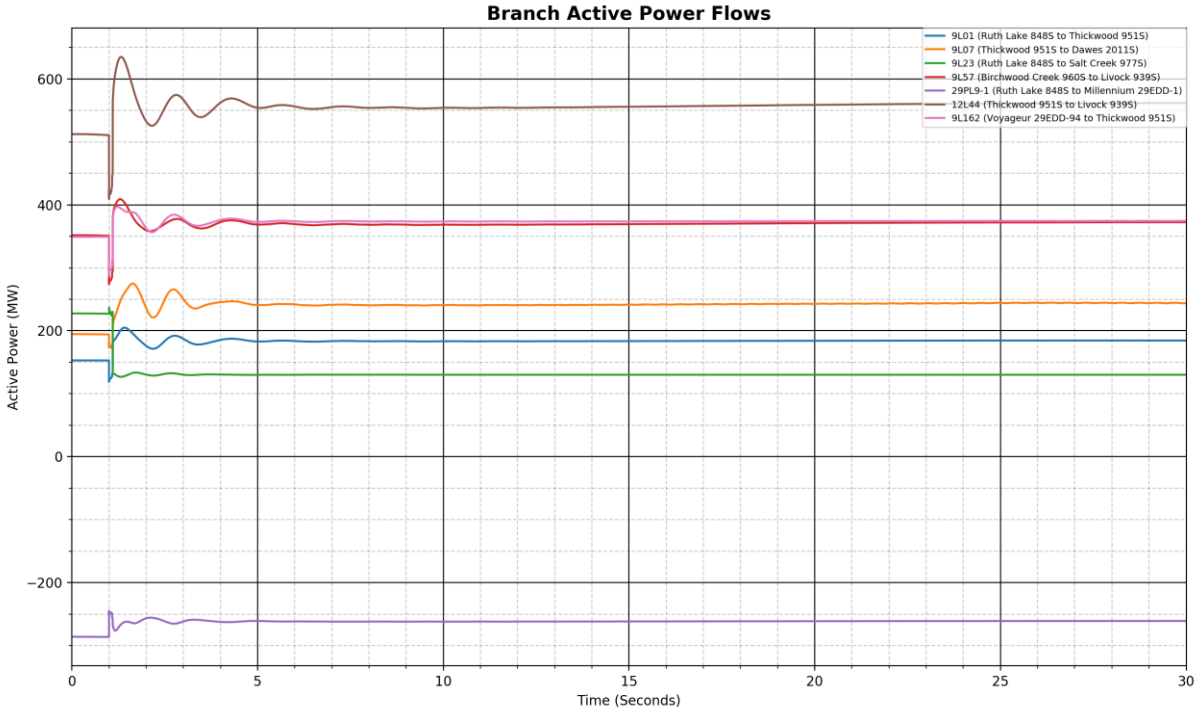

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
38
37
36
35
34
33
32
31
30
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.4
4.2
4.0
3.8
3.6
3.4
0
5
10
15
20
25
30
Time (Seconds)

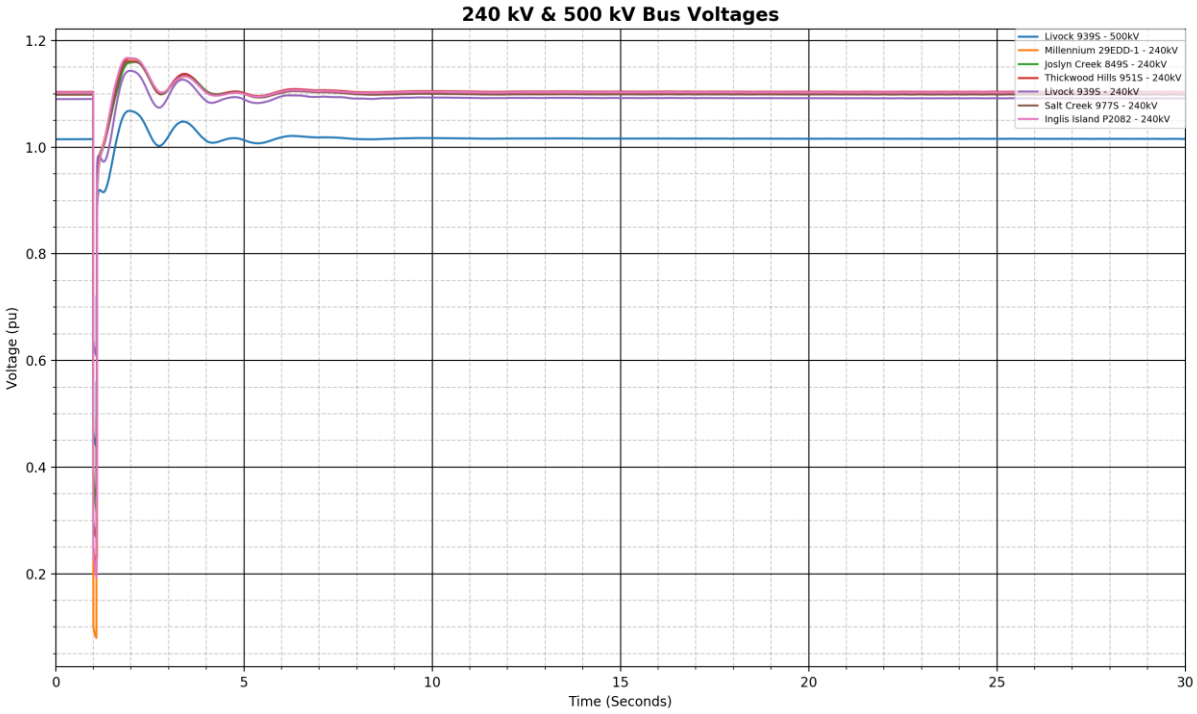

Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
Time (Seconds)

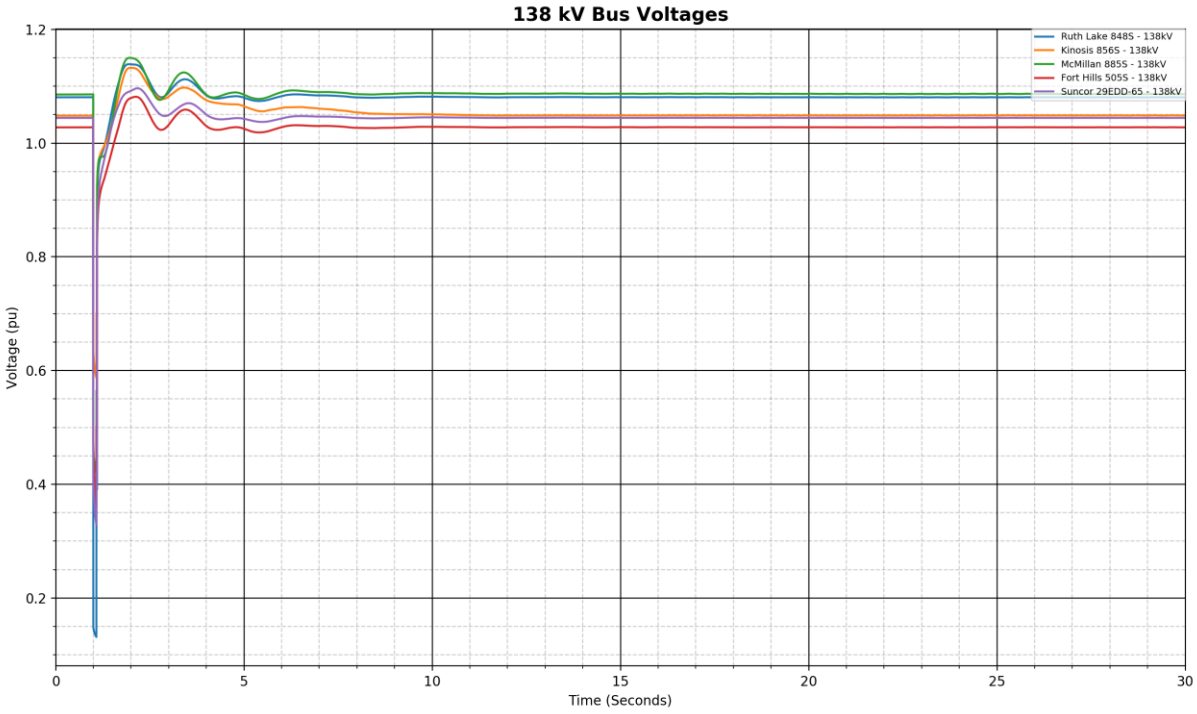

Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0
5
10
15
20
25
30
Time (Seconds)

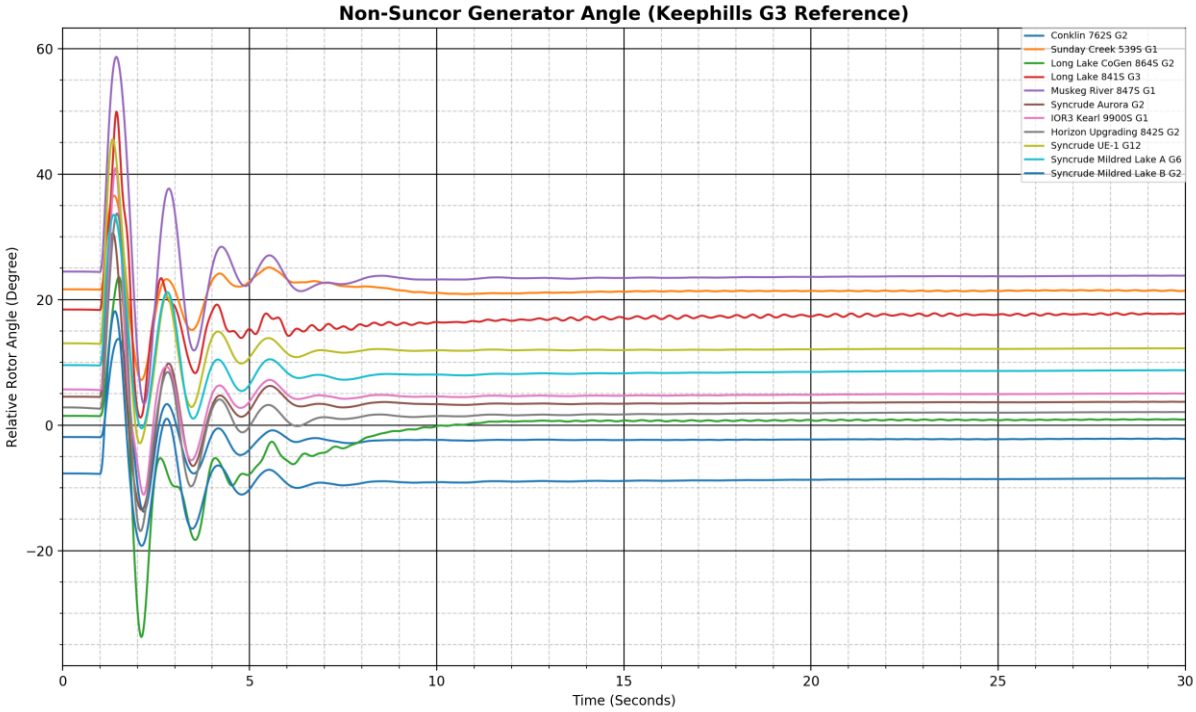

Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

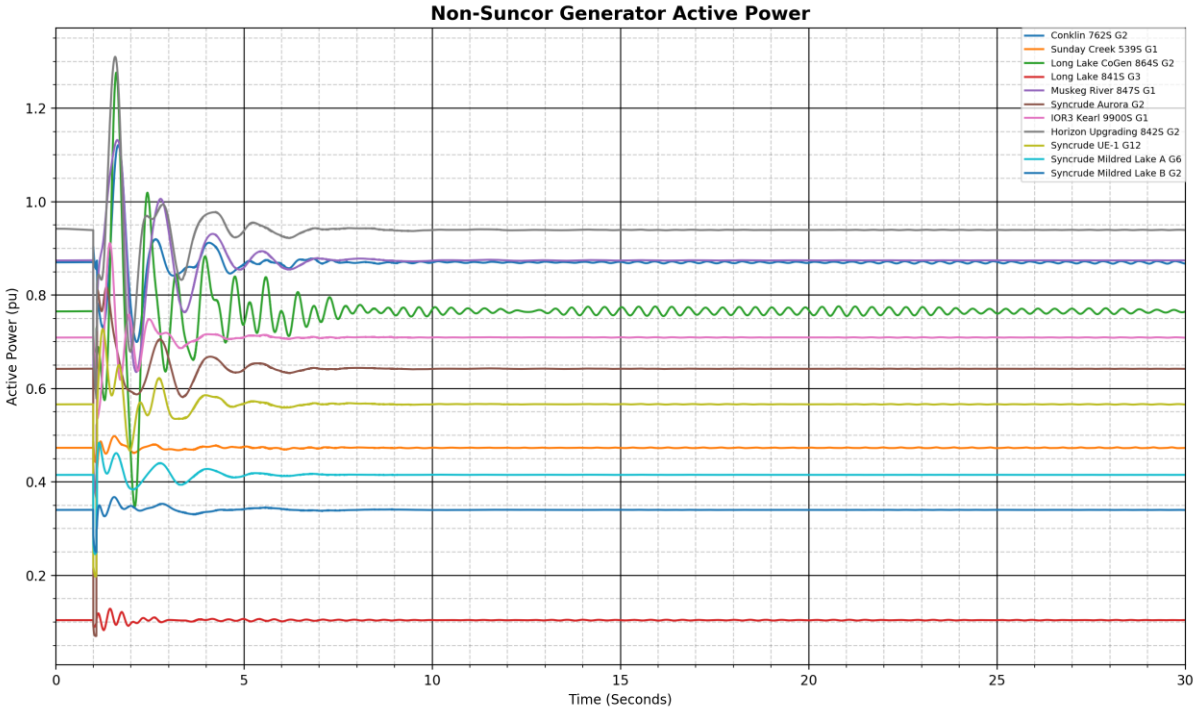
Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
1000
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

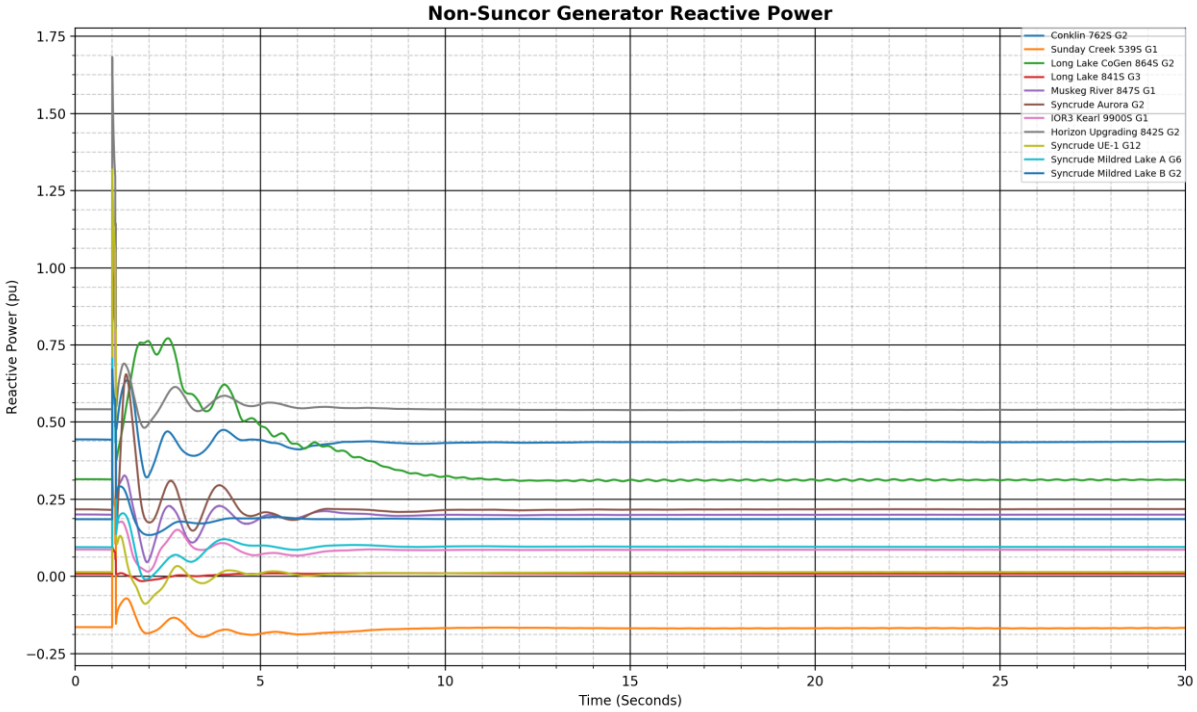
Figure A4-23: 29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1): Fault at Ruth Lake 848S

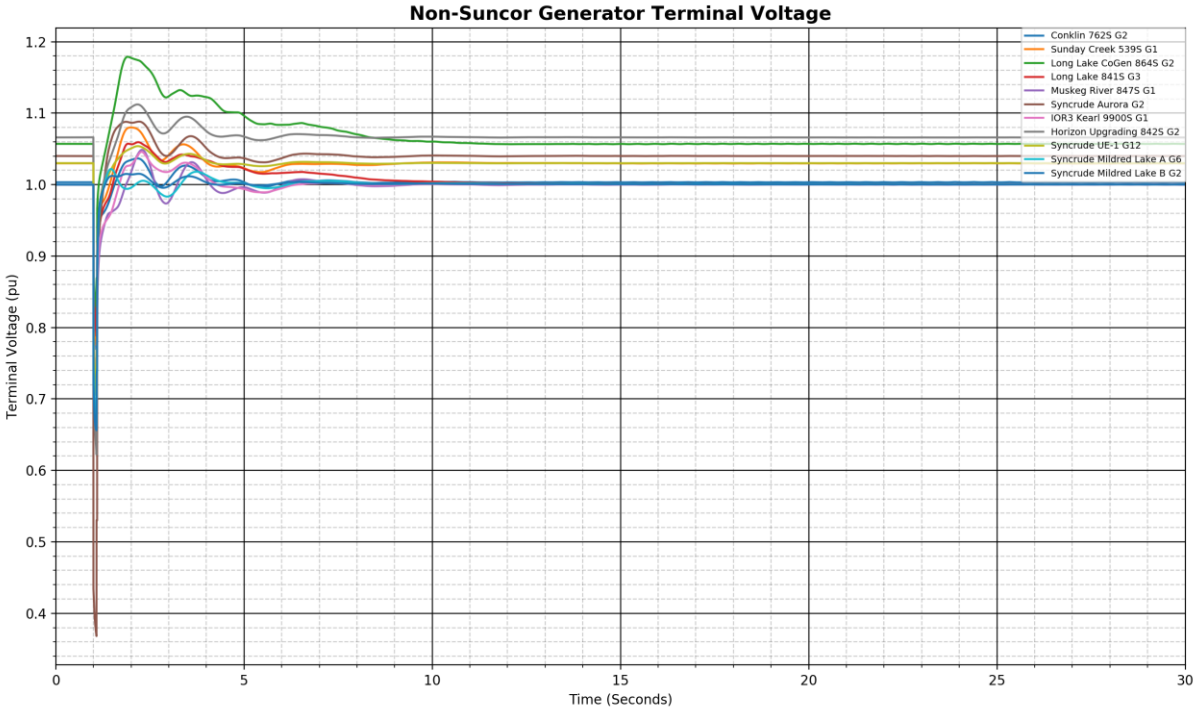


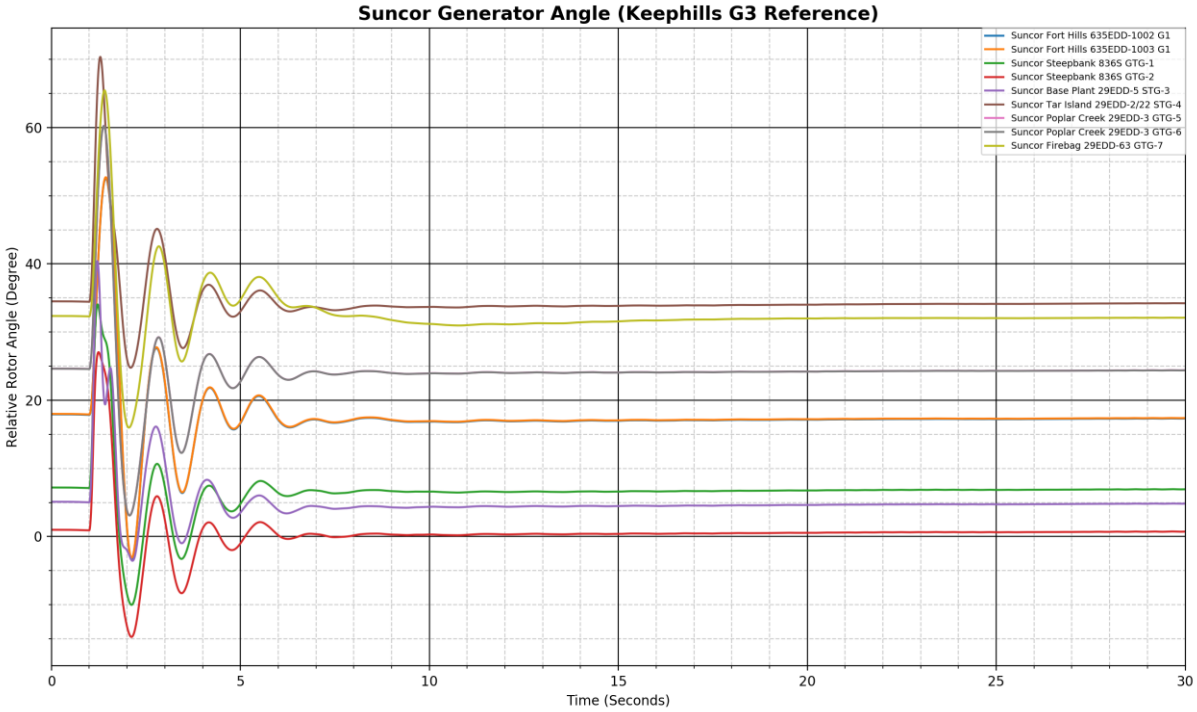


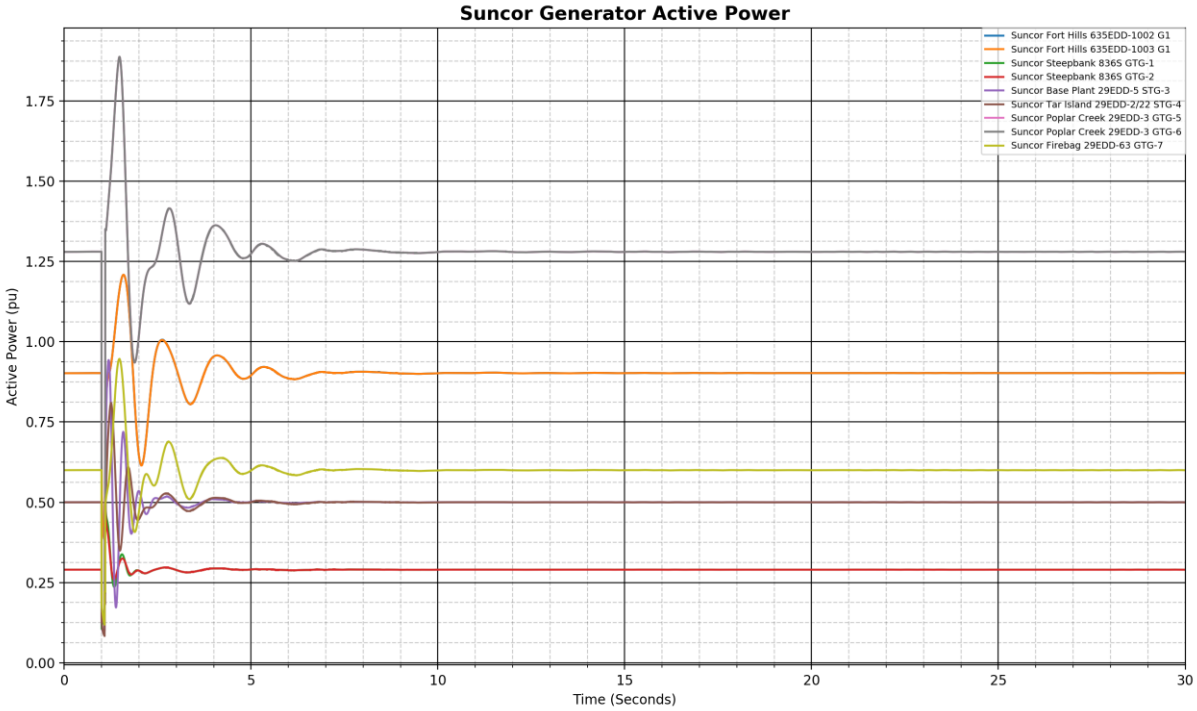

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

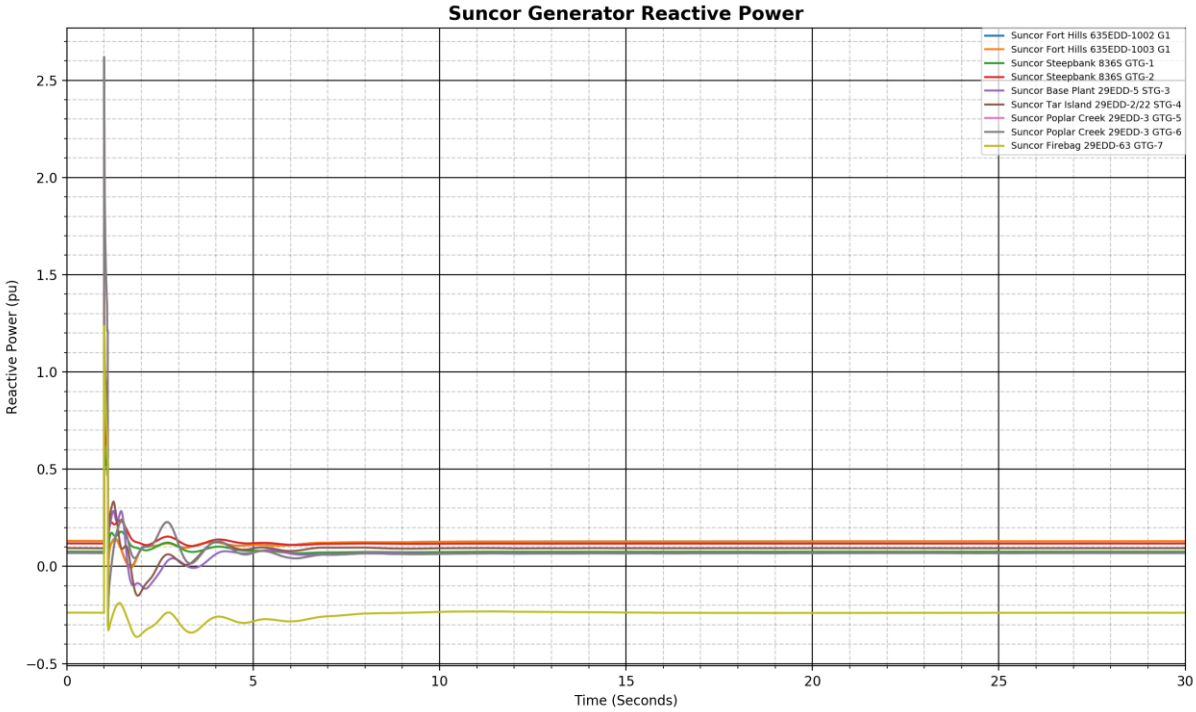

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

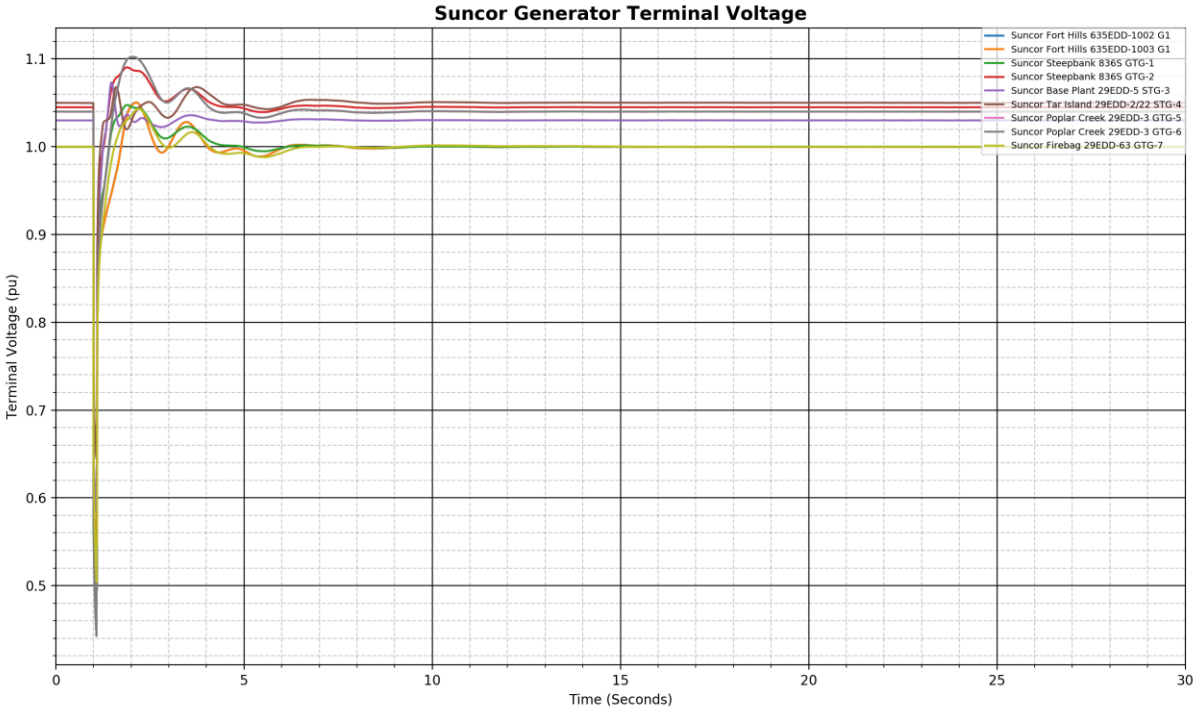

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

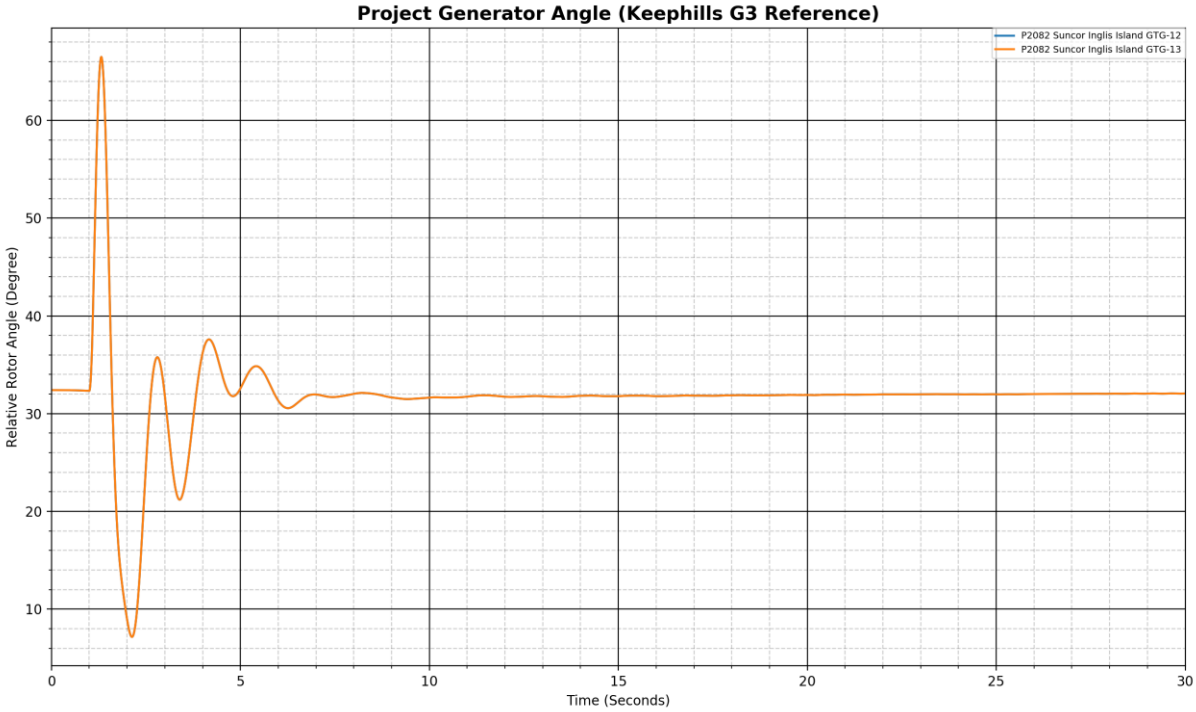

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

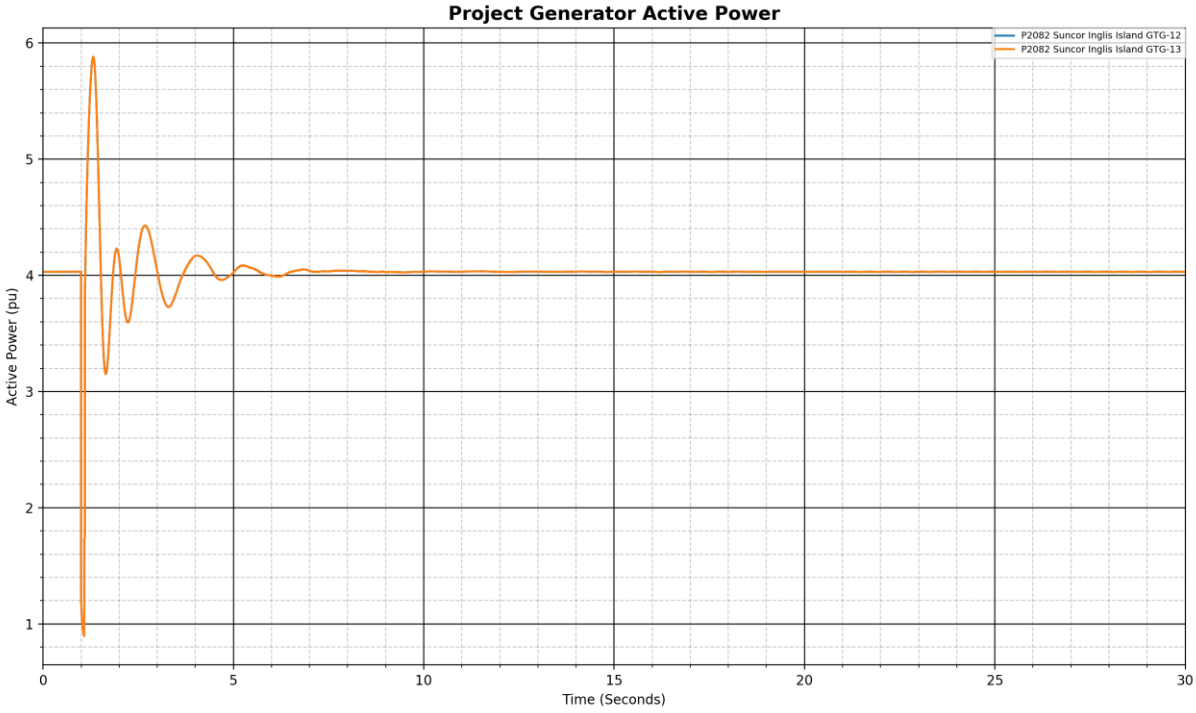

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

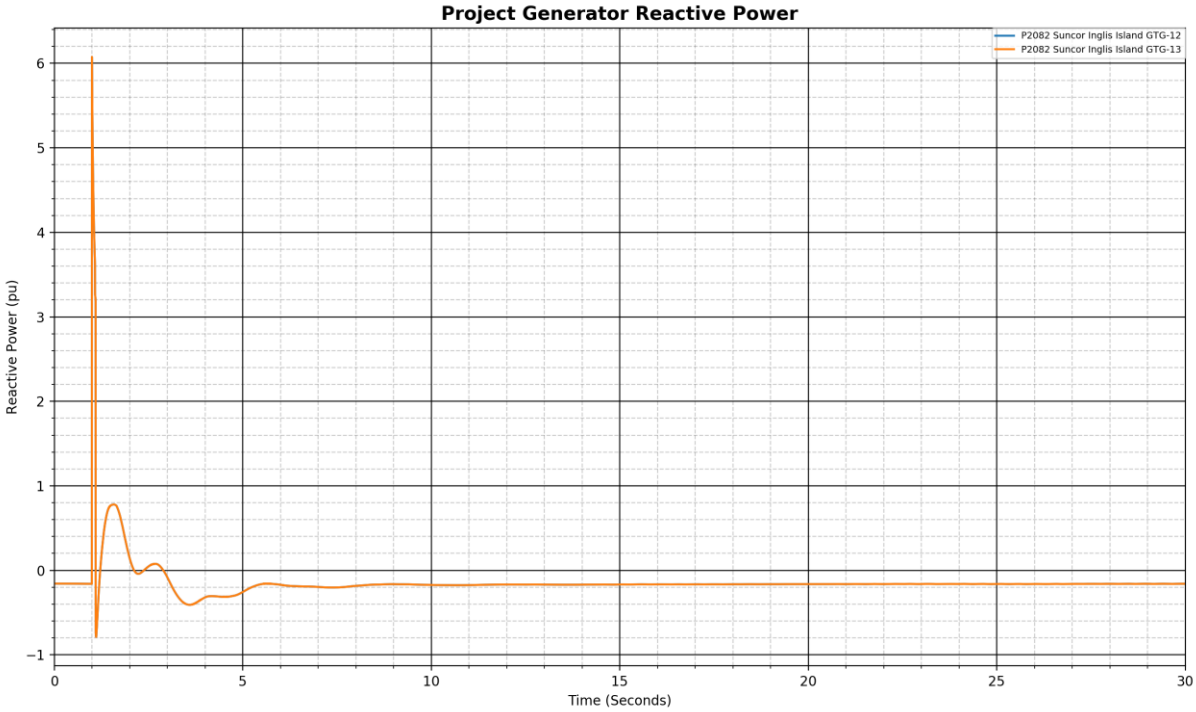

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

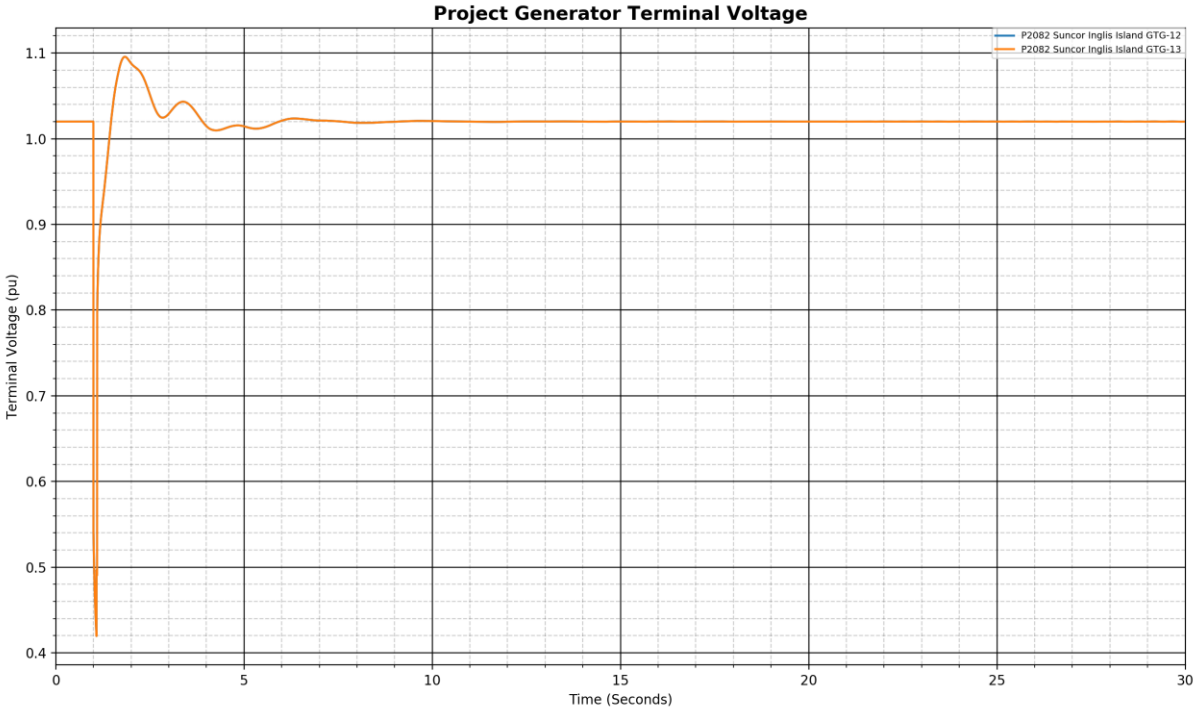

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

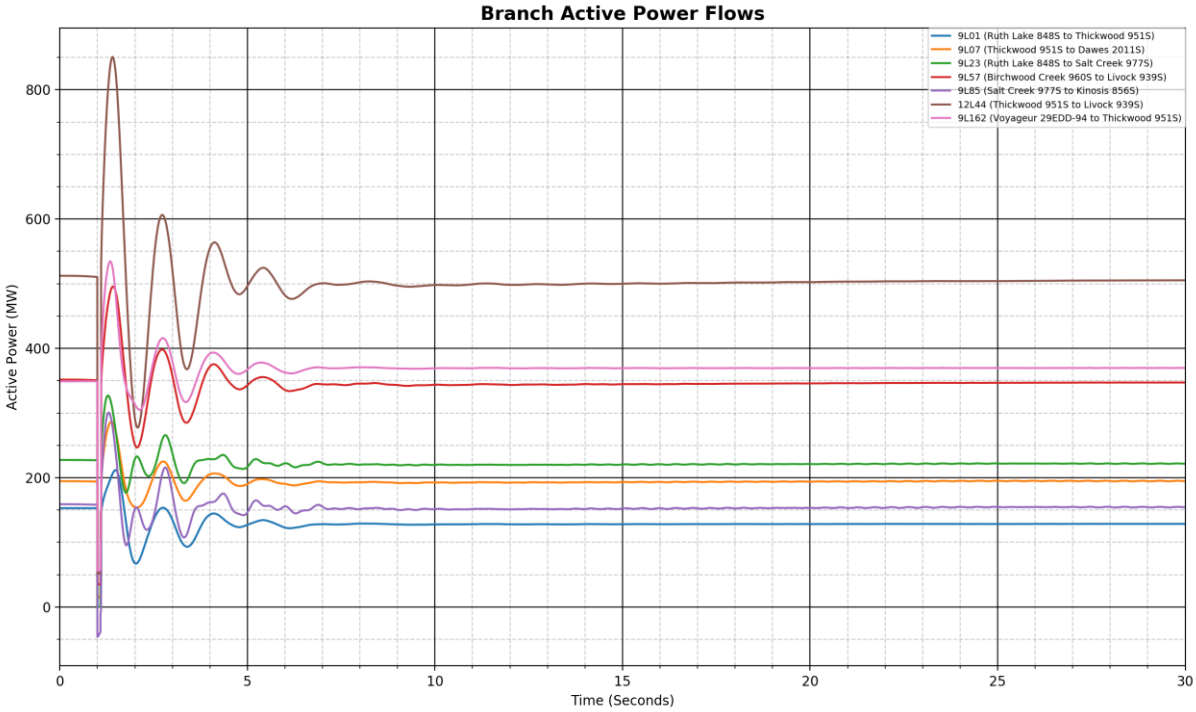

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

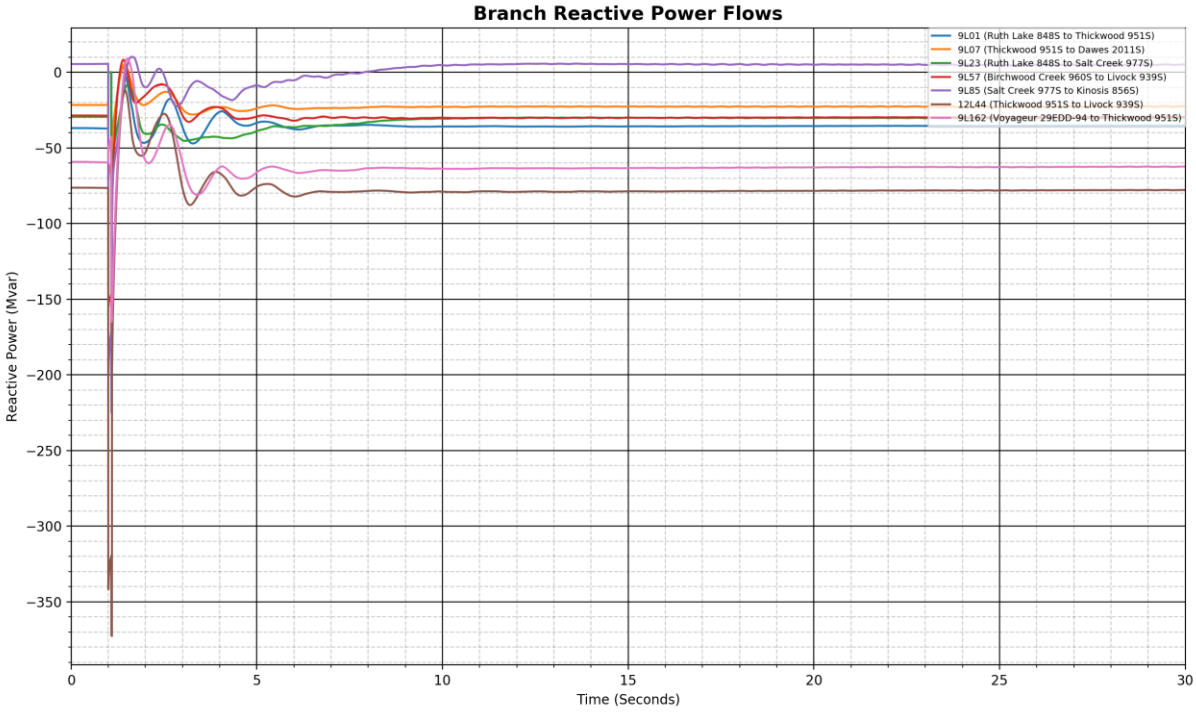
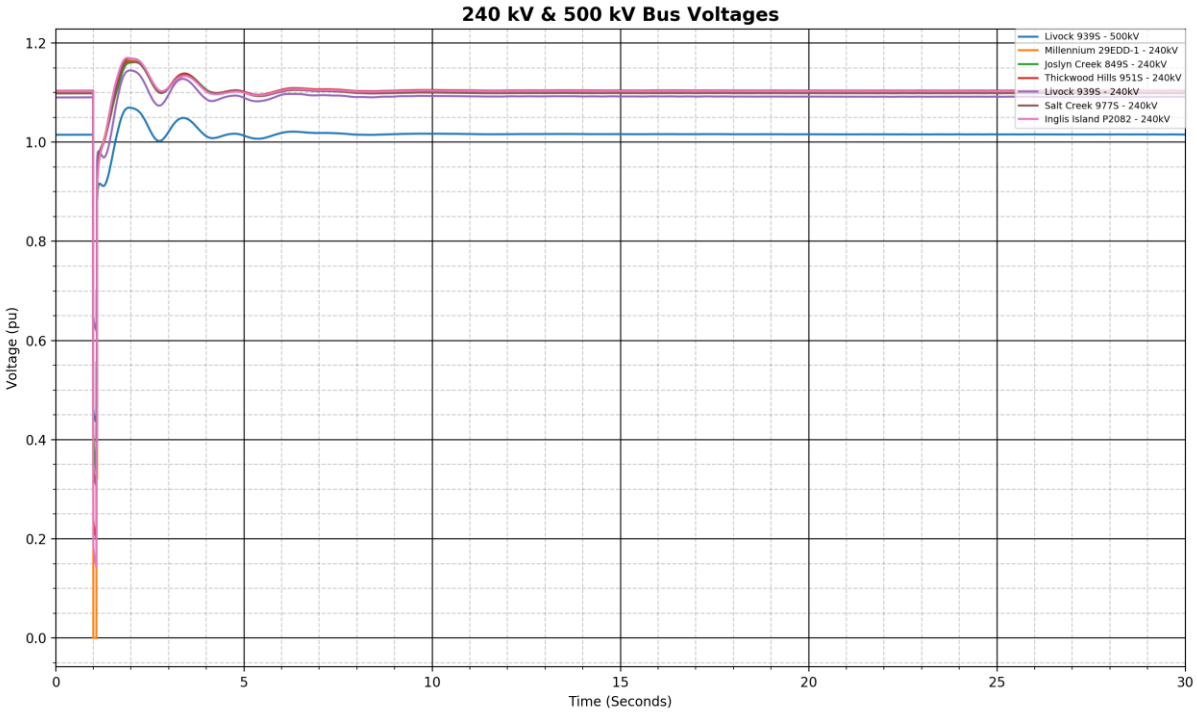
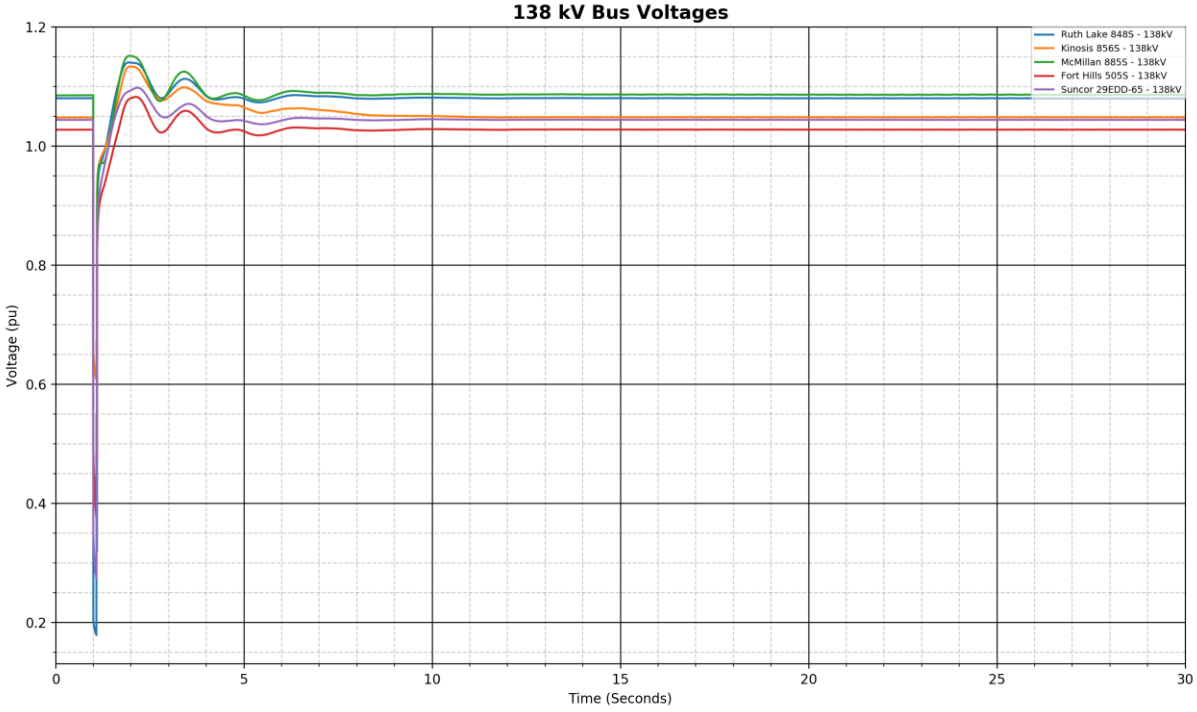
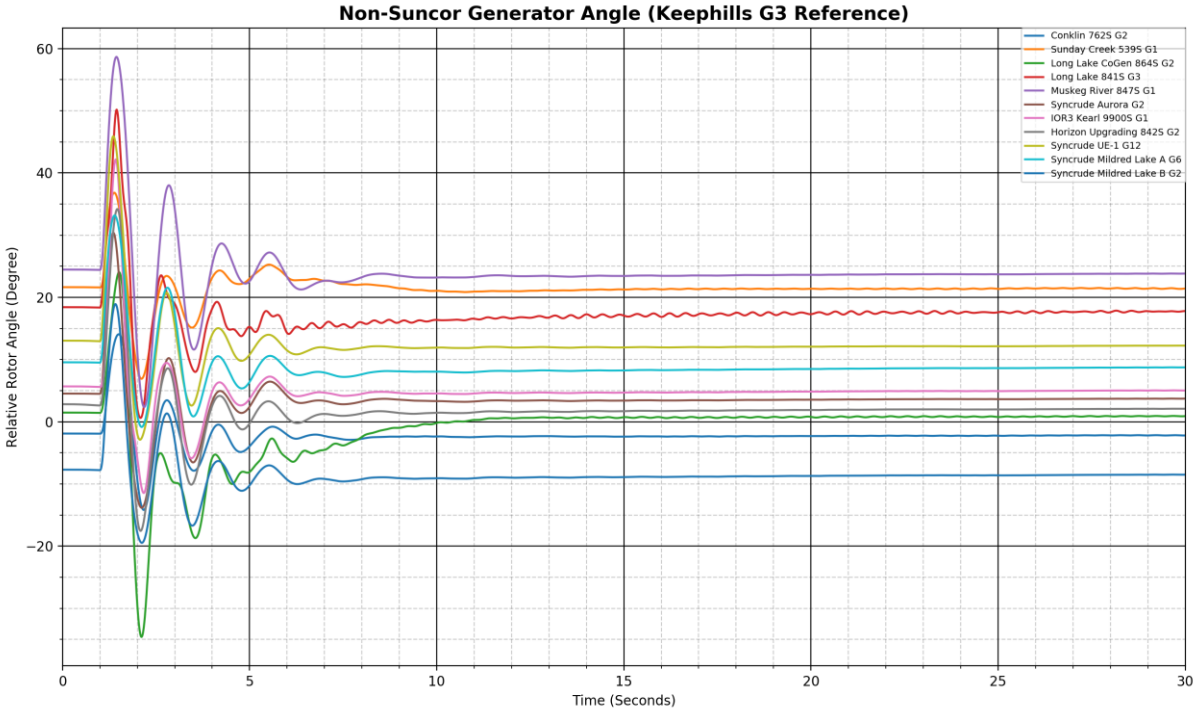
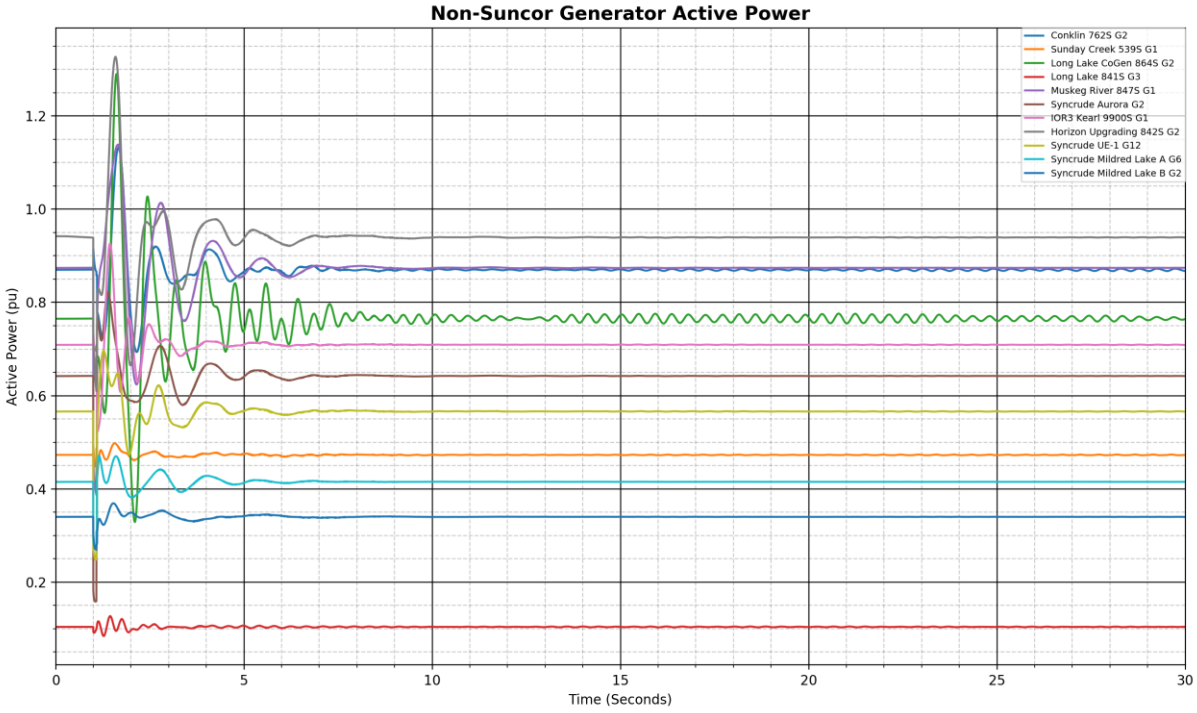

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

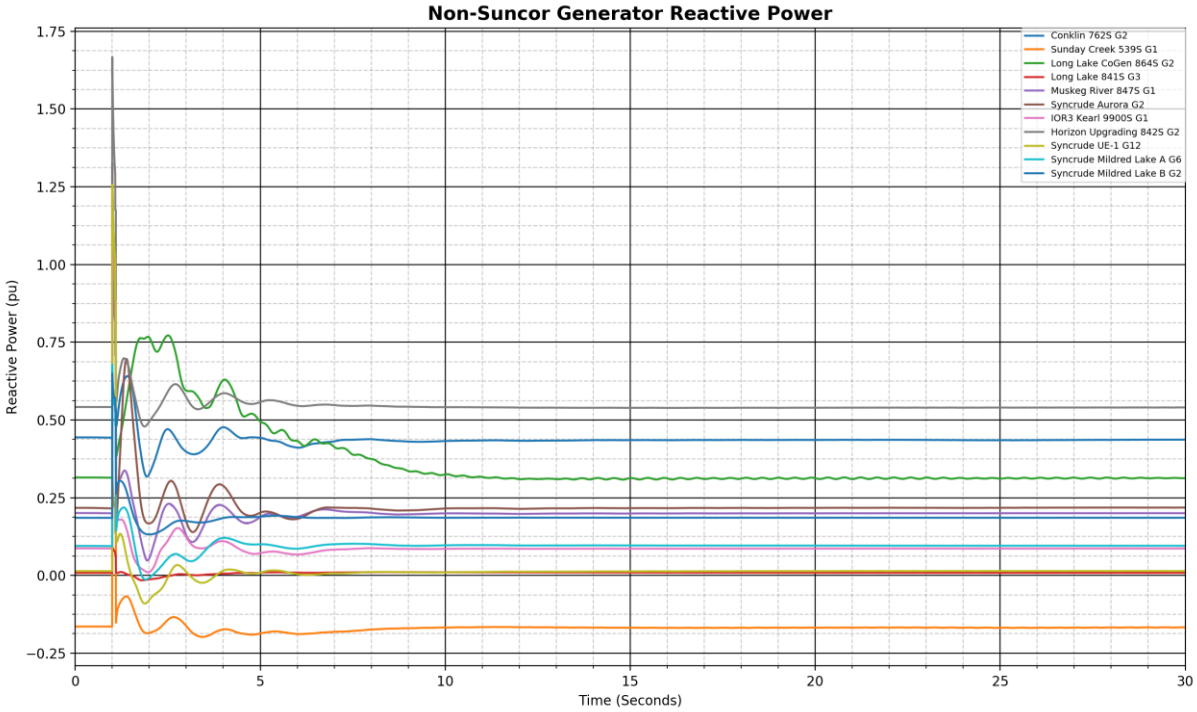
Figure A4-24: 29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1): Fault at Millennium 29EDD-1

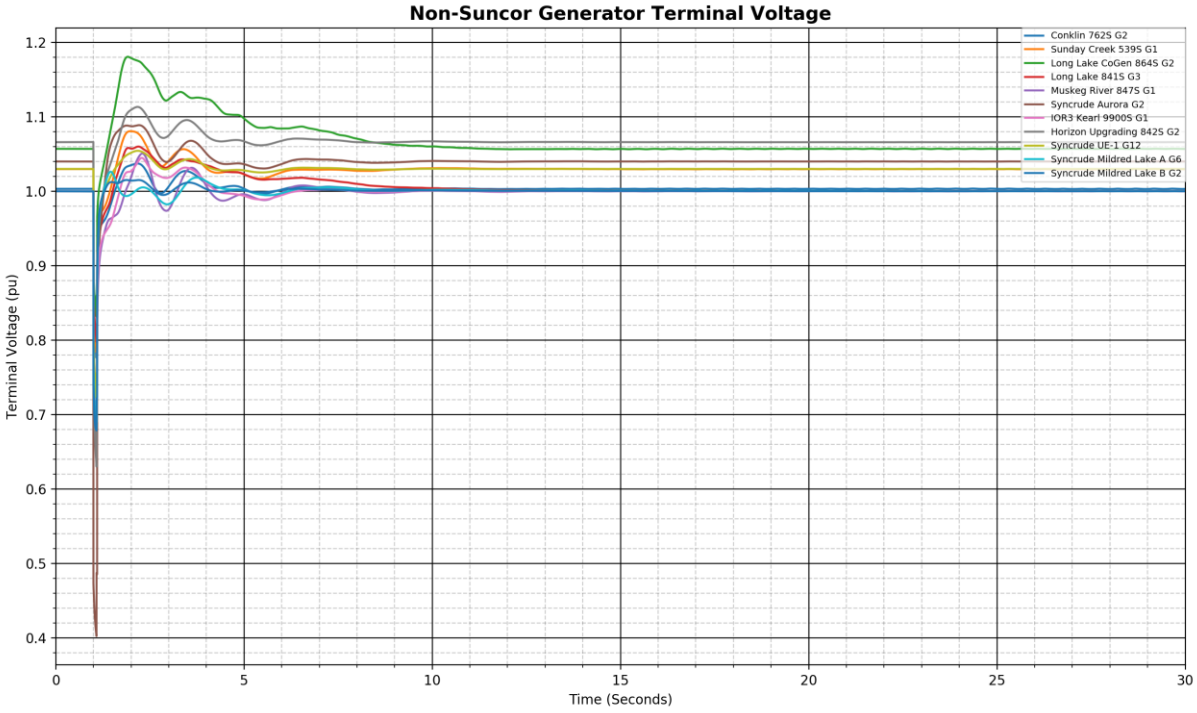


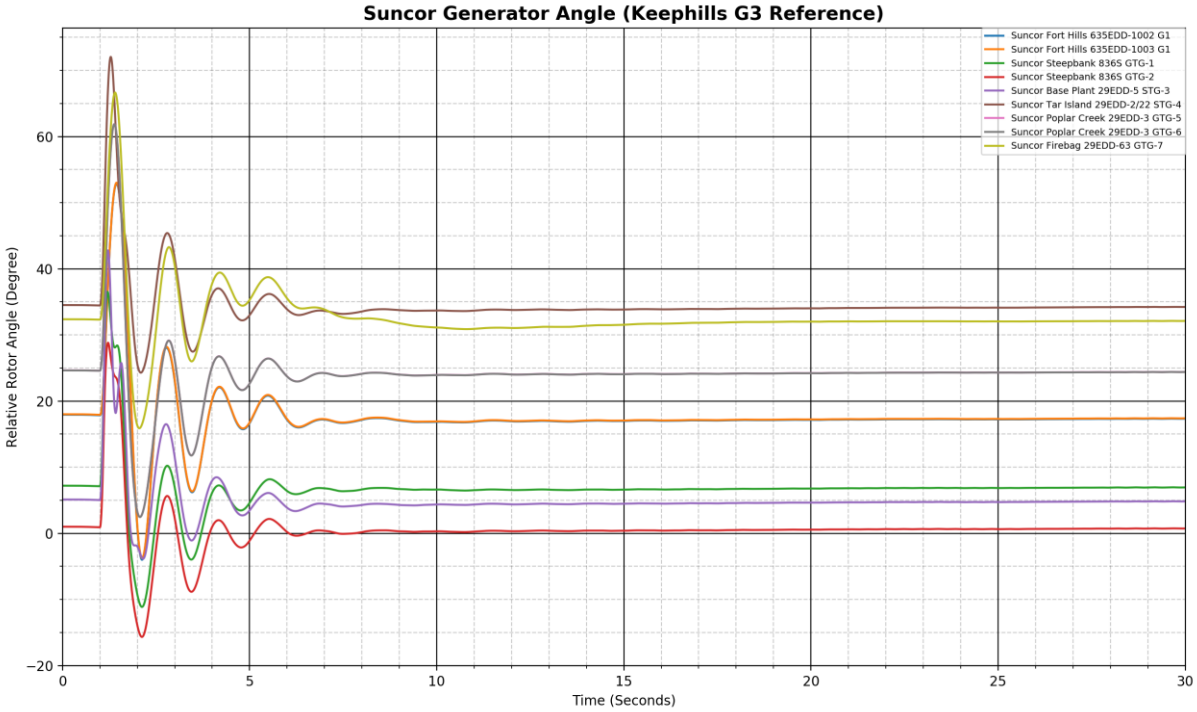


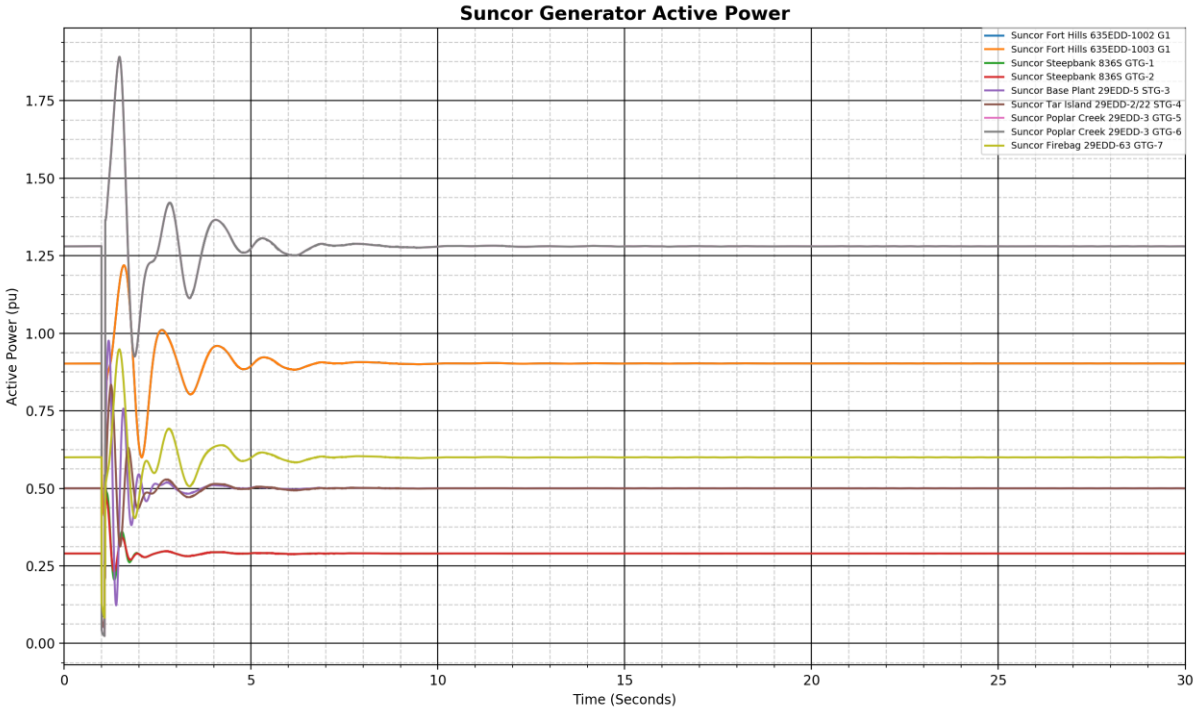

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

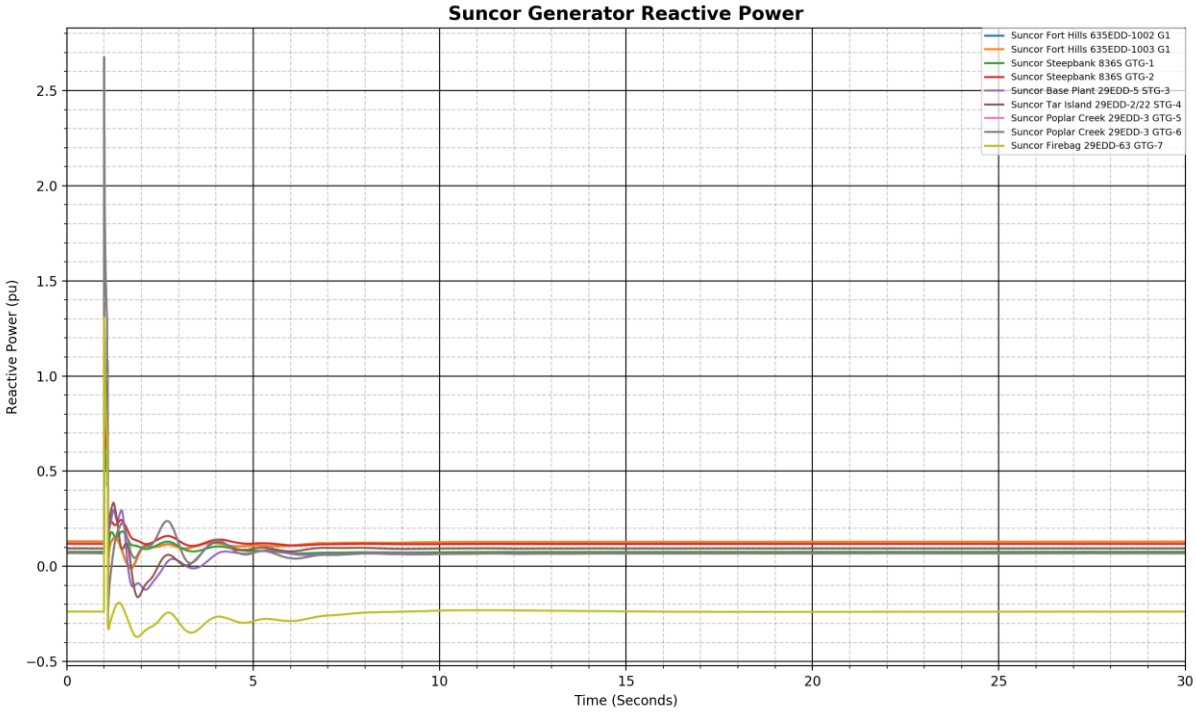

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

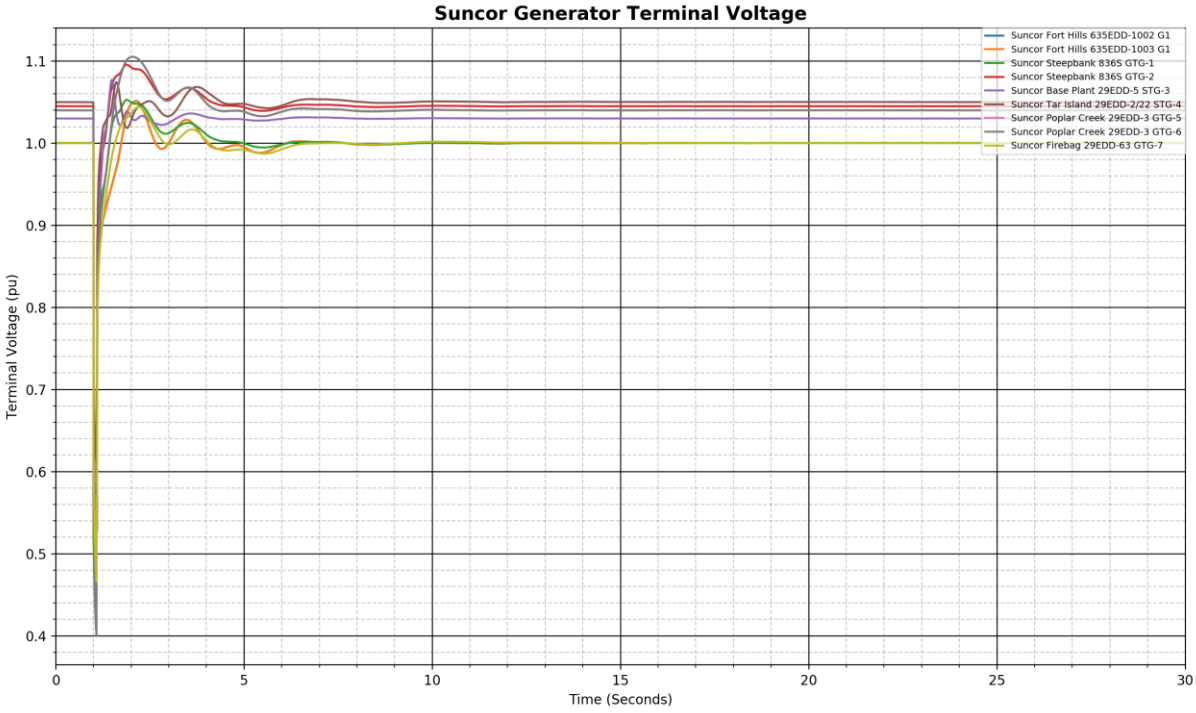

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

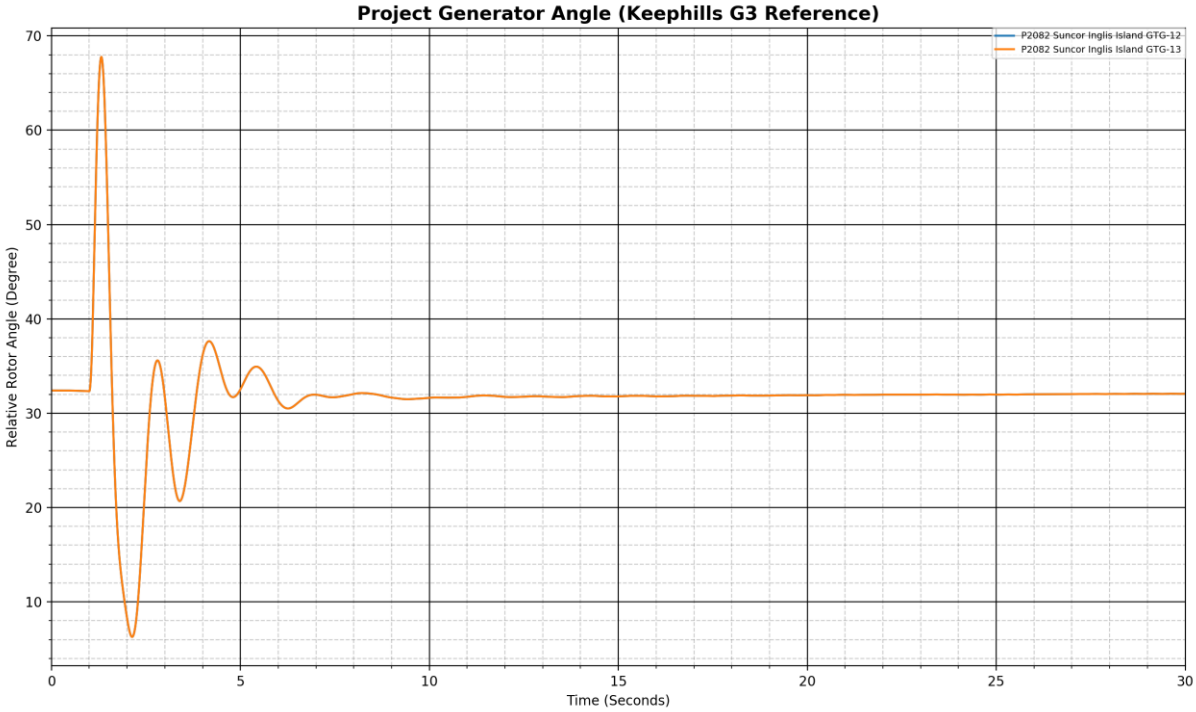

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

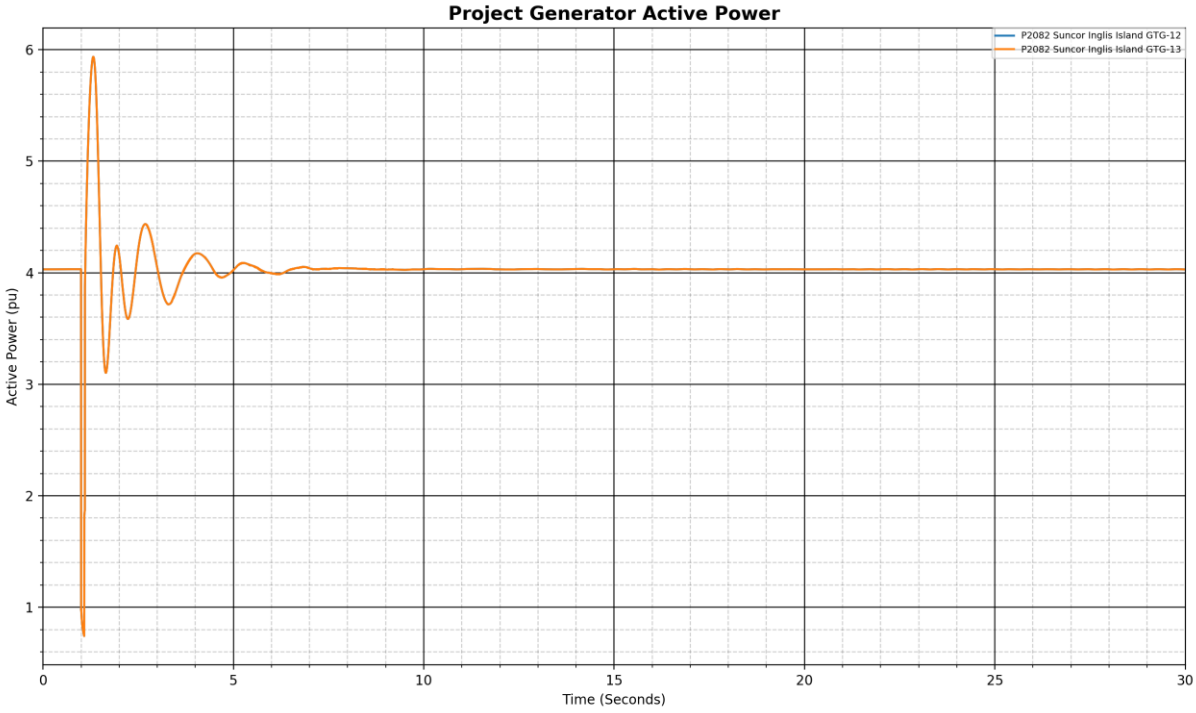

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

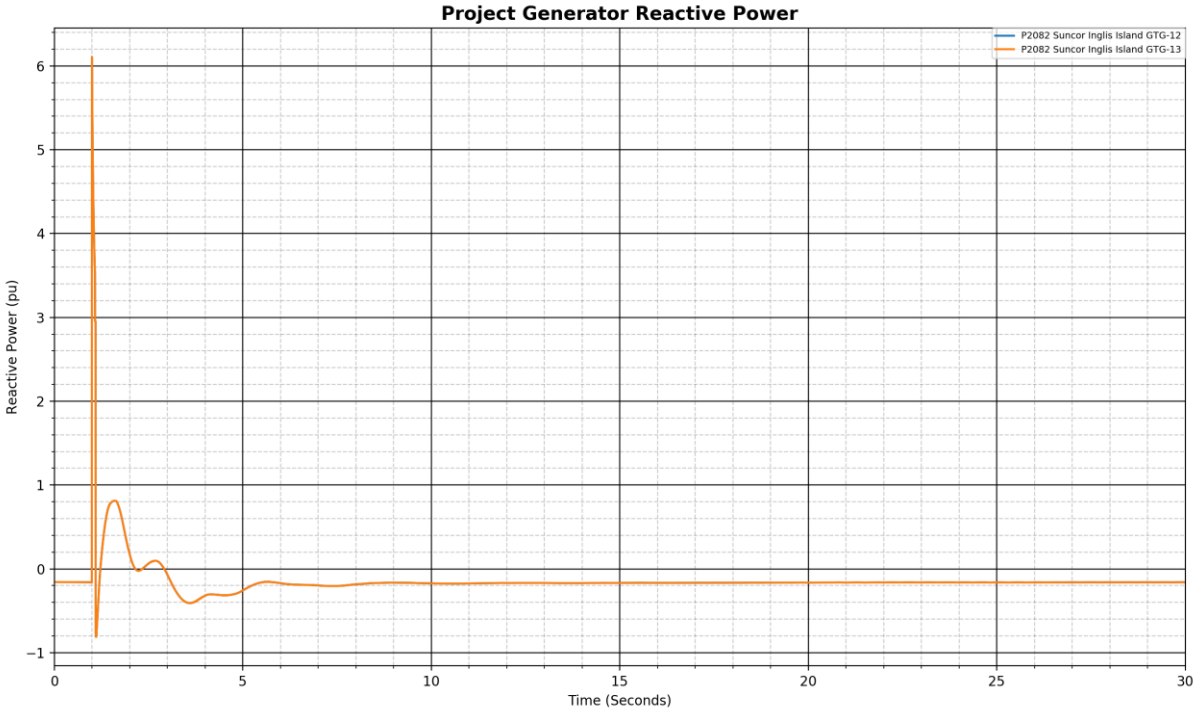

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

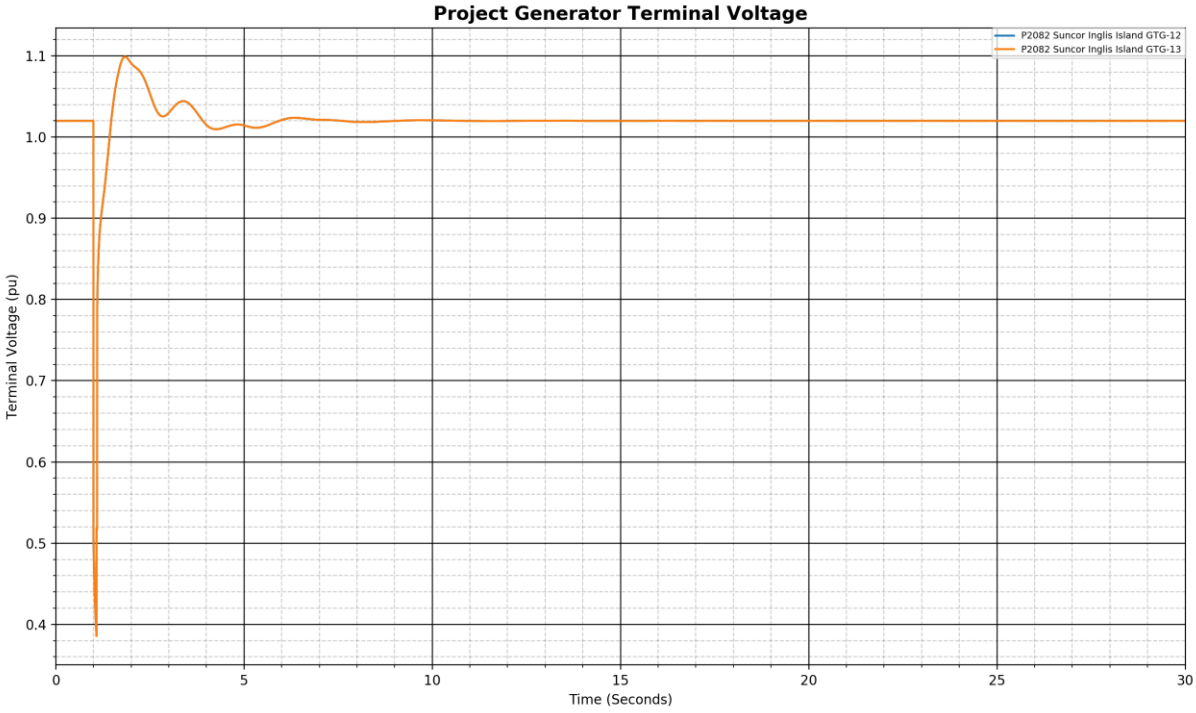

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

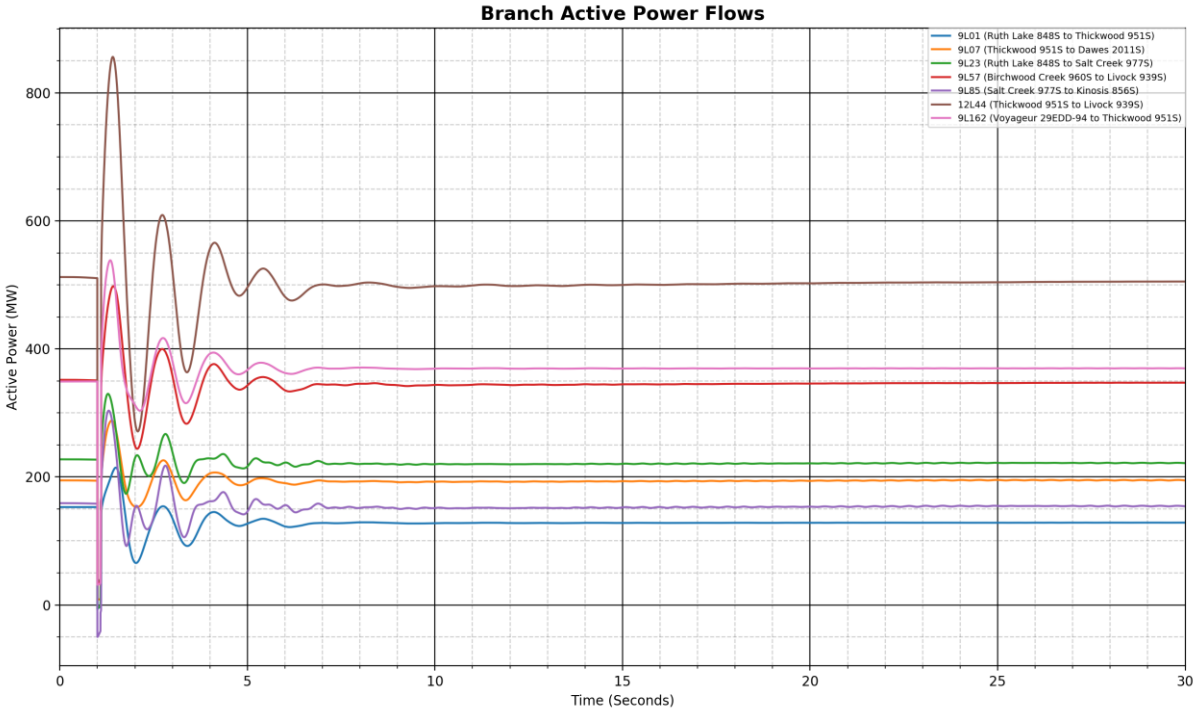

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
70
60
50
40
30
20
10
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
6
5
4
3
2
1
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

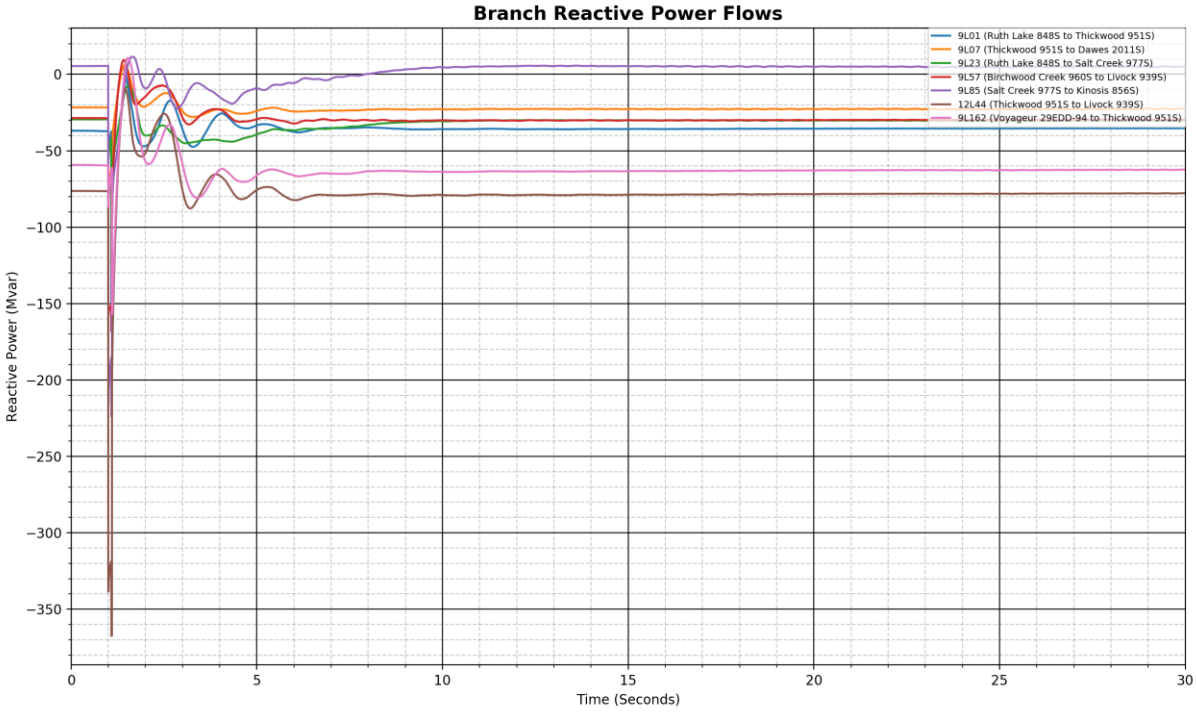
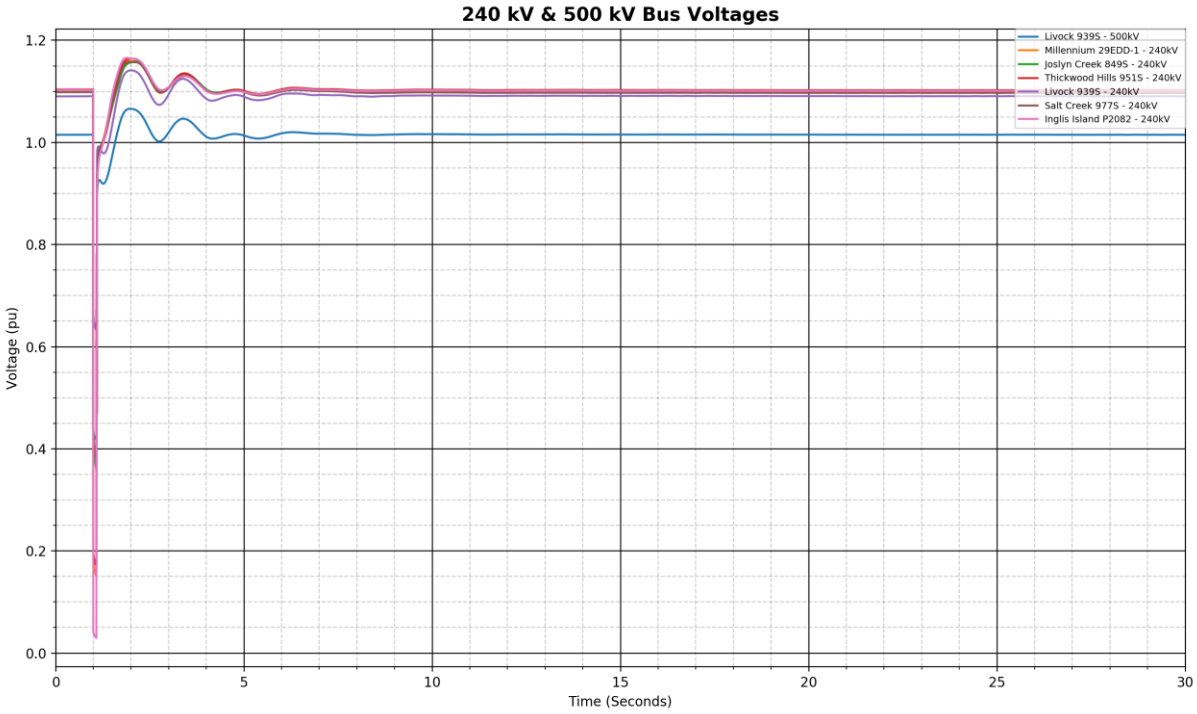
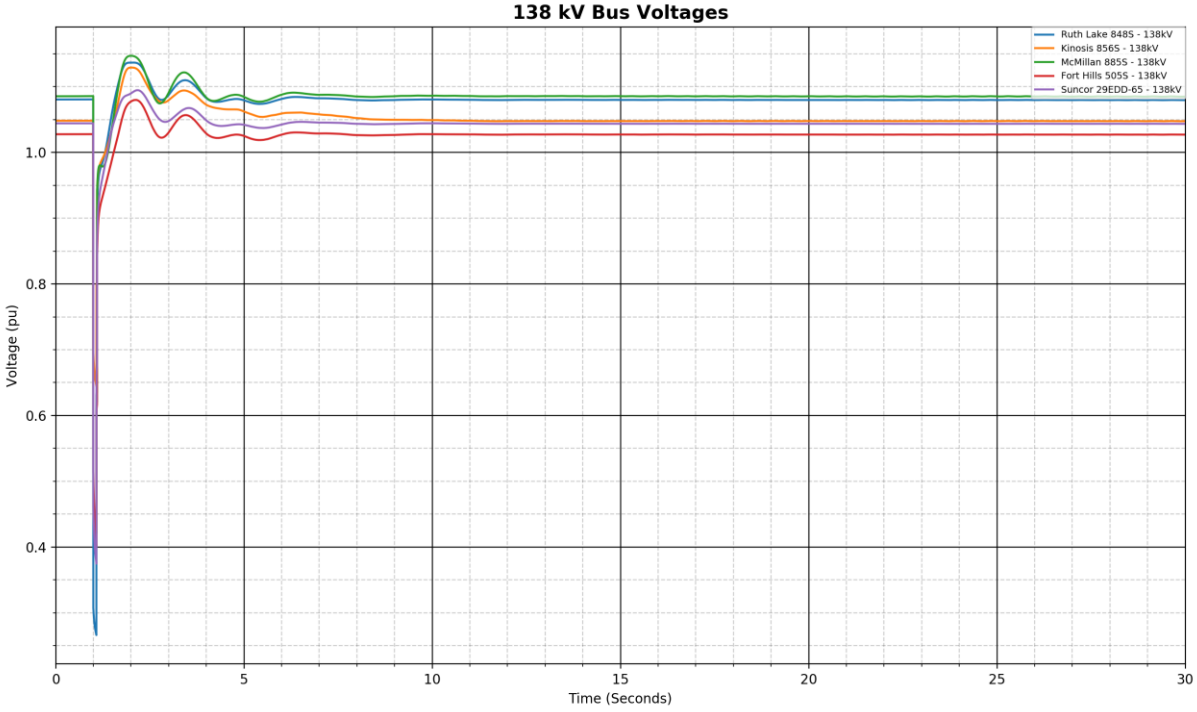
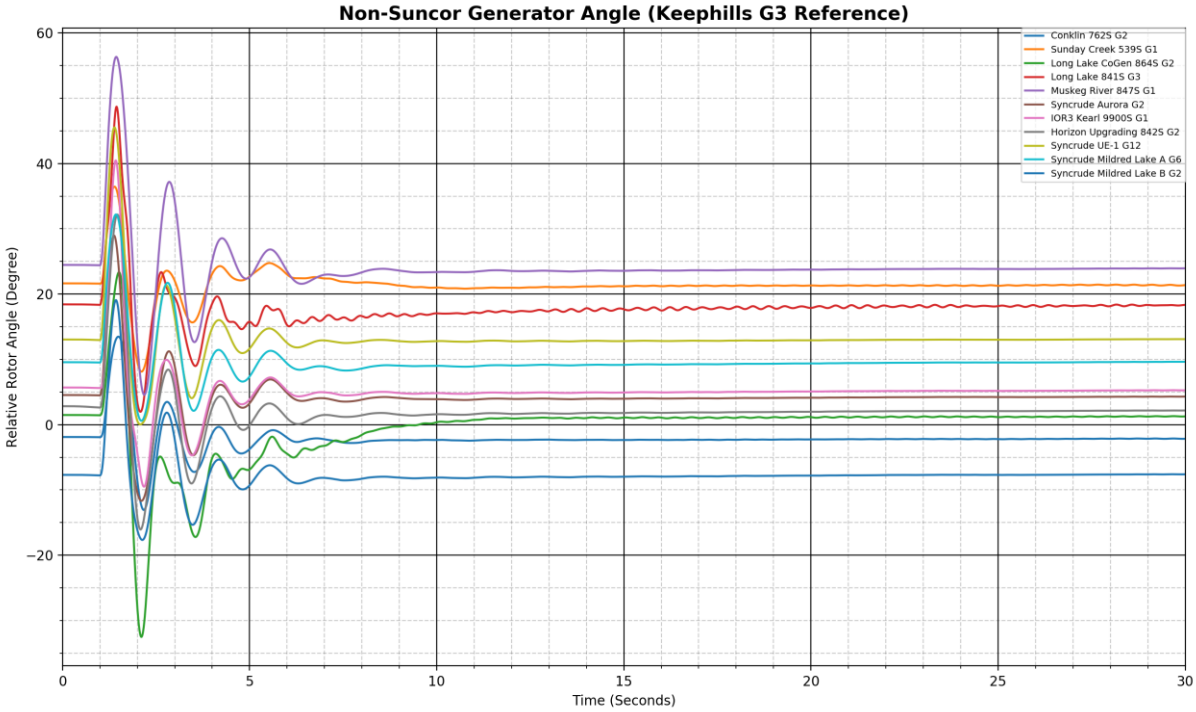
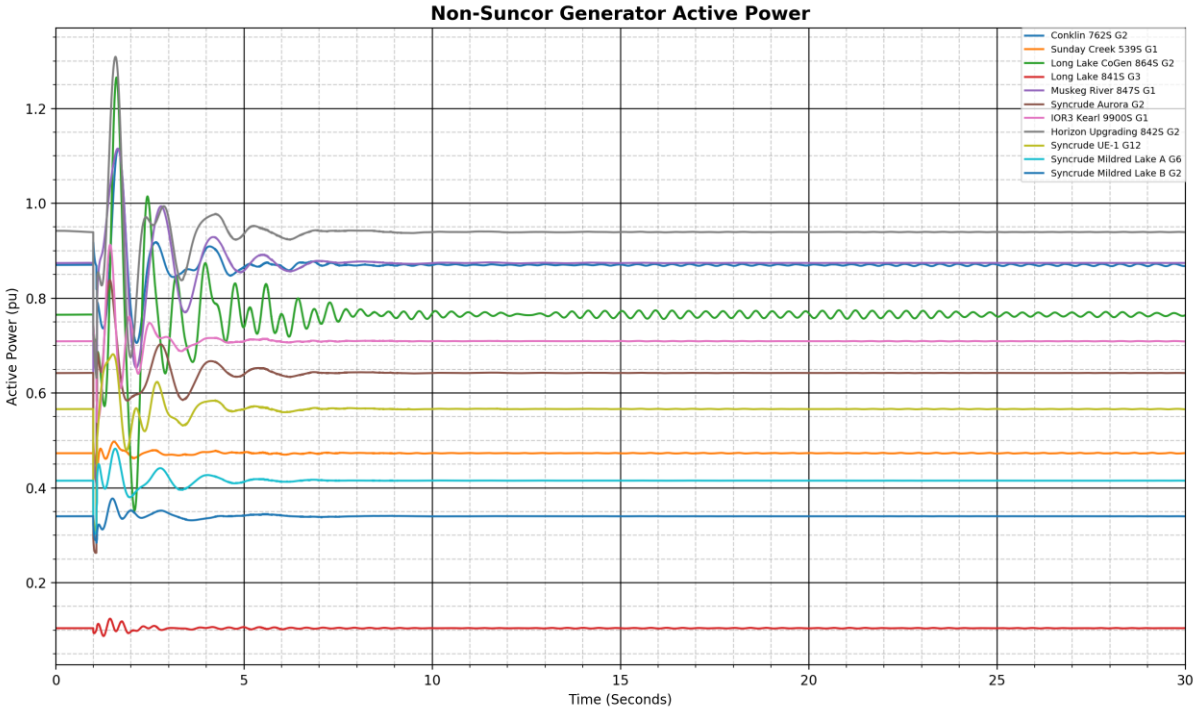

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

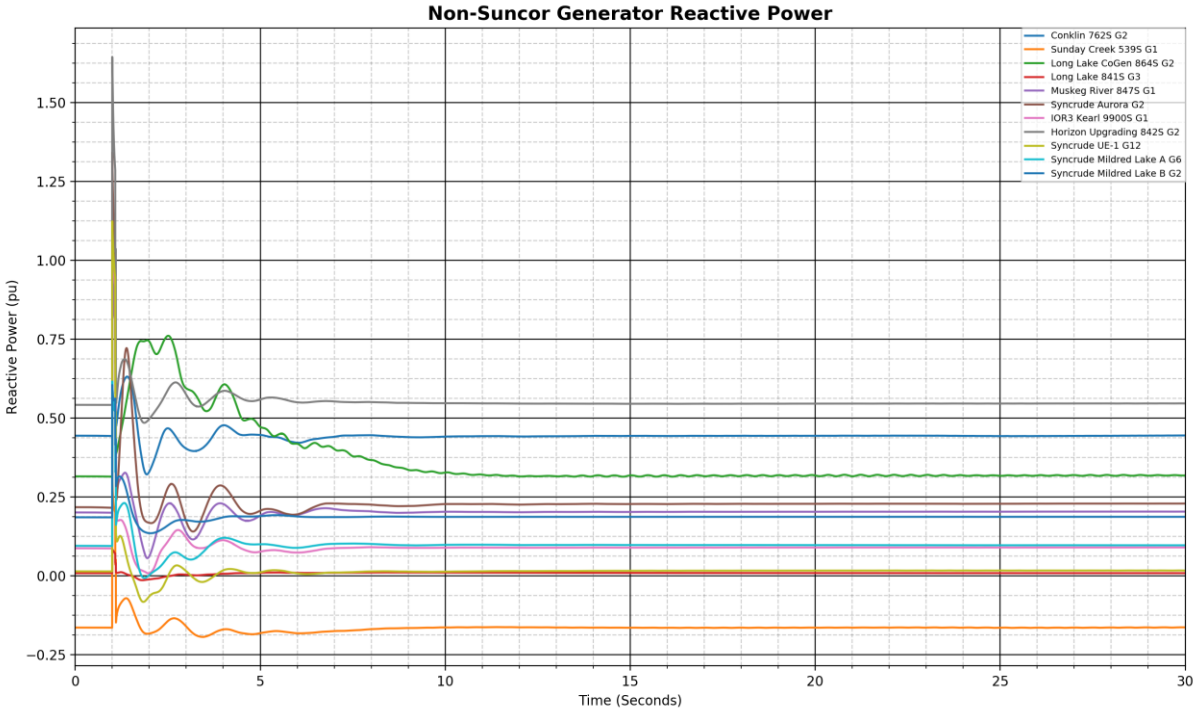
Figure A4-25: 9L162 (Voyageur 29EDD-94 to Thickwood Hills 951S): Fault at Voyageur 29EDD-94

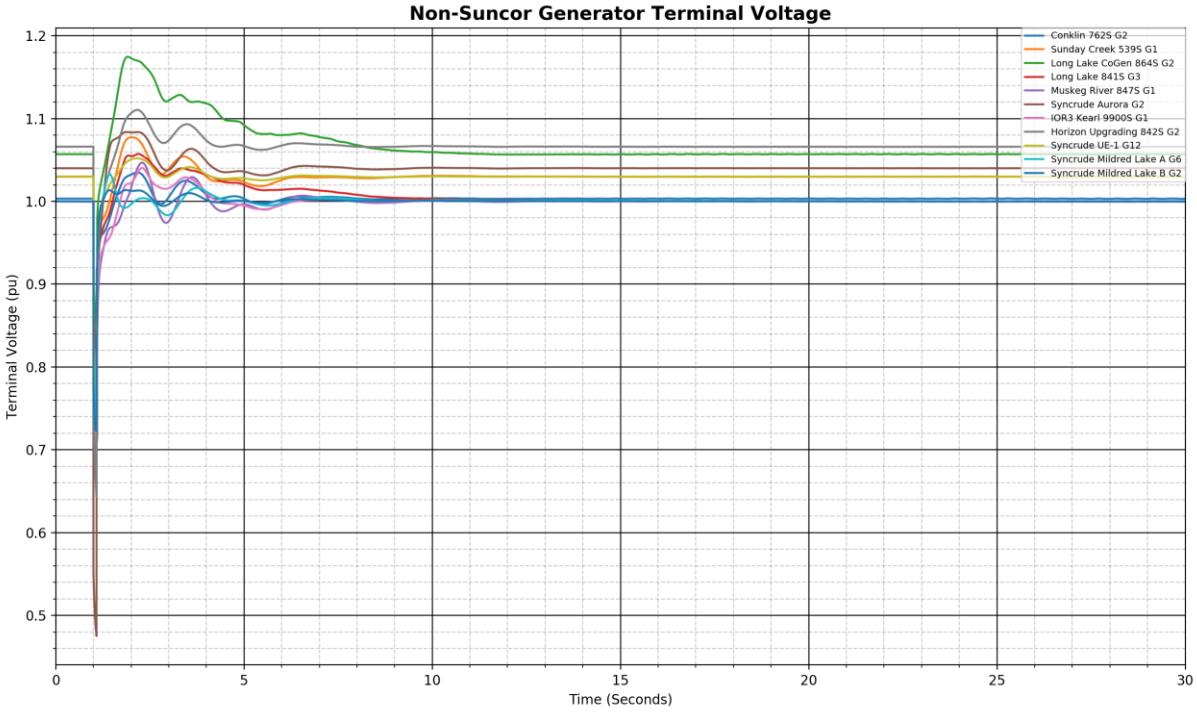


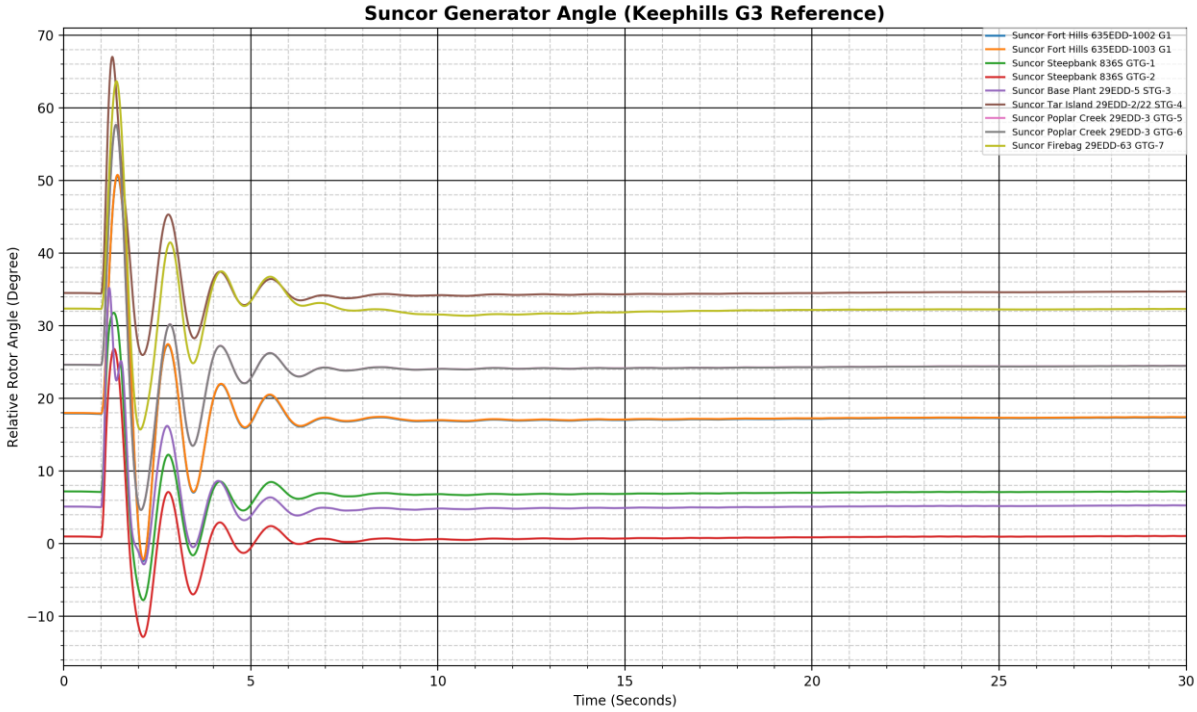


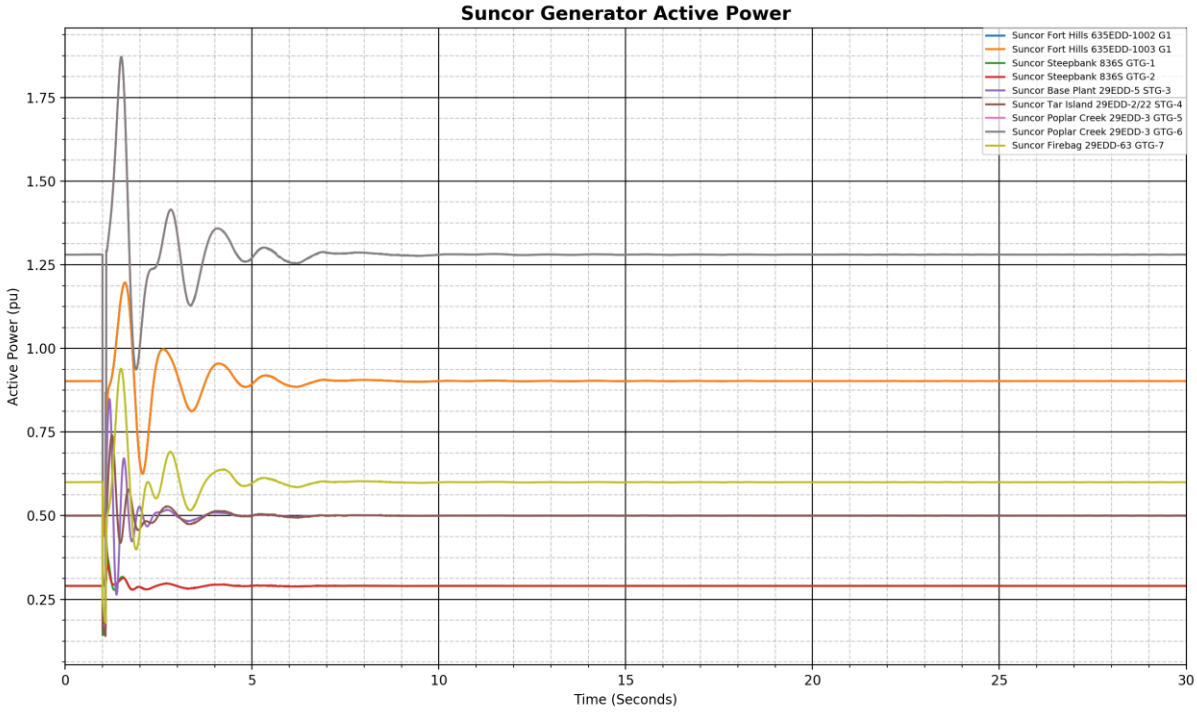

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

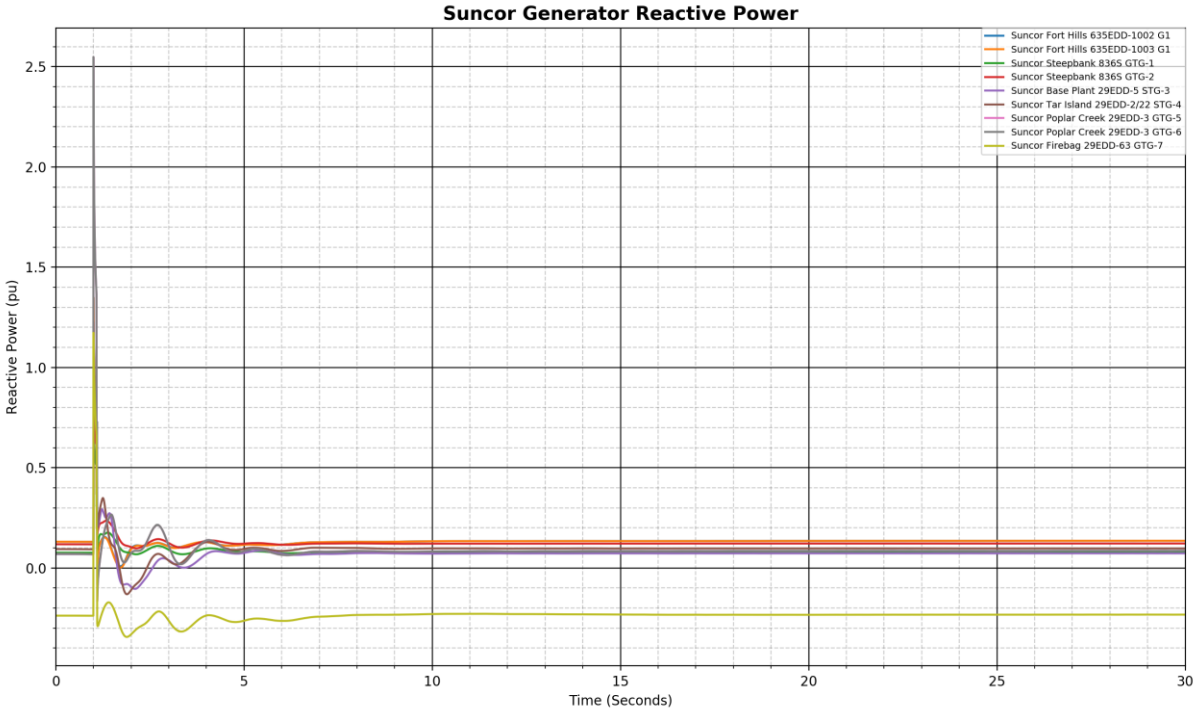

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

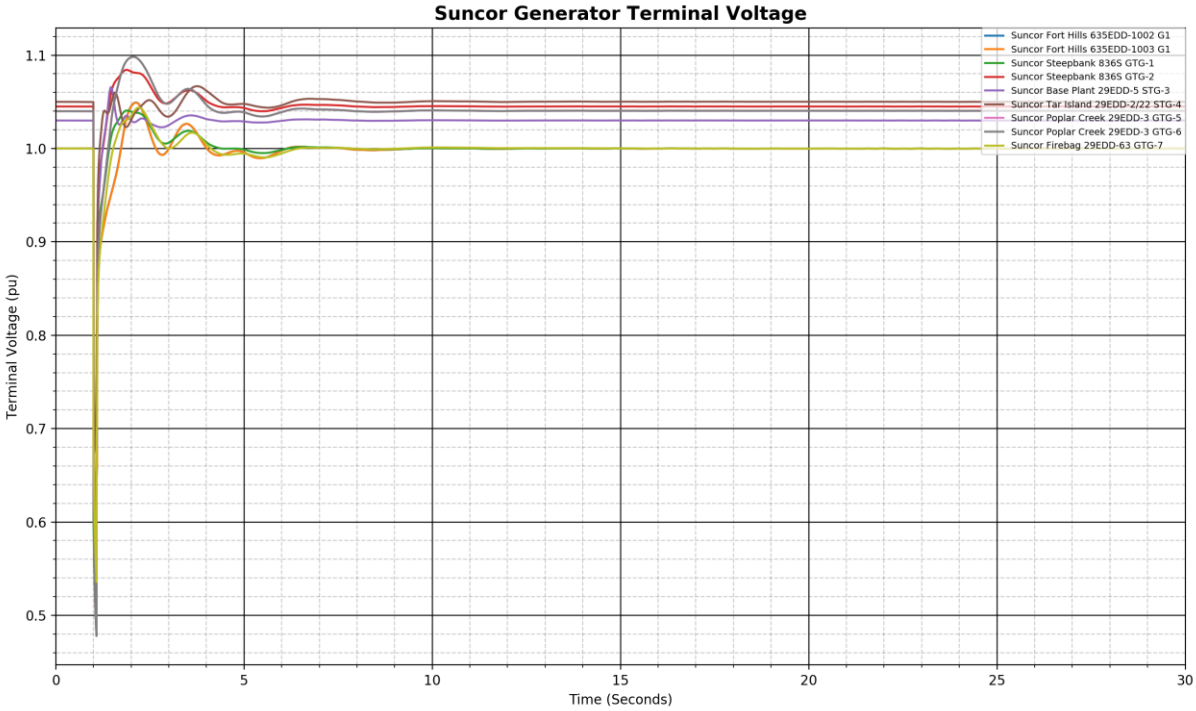

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

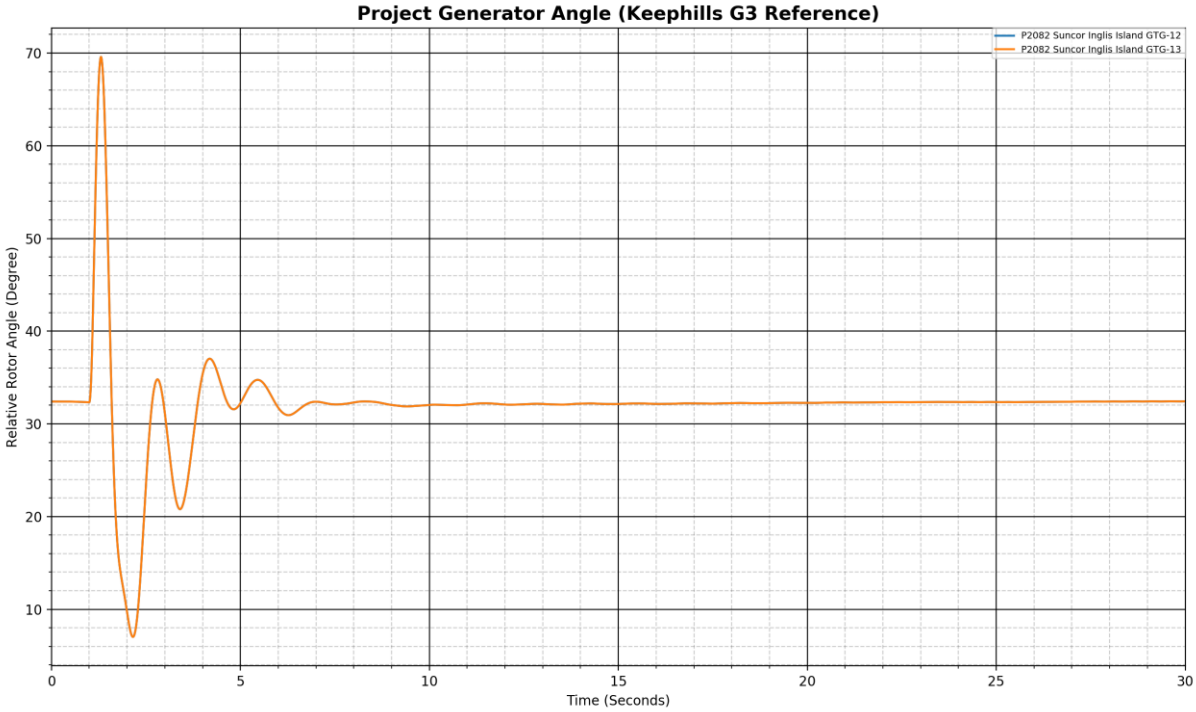

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

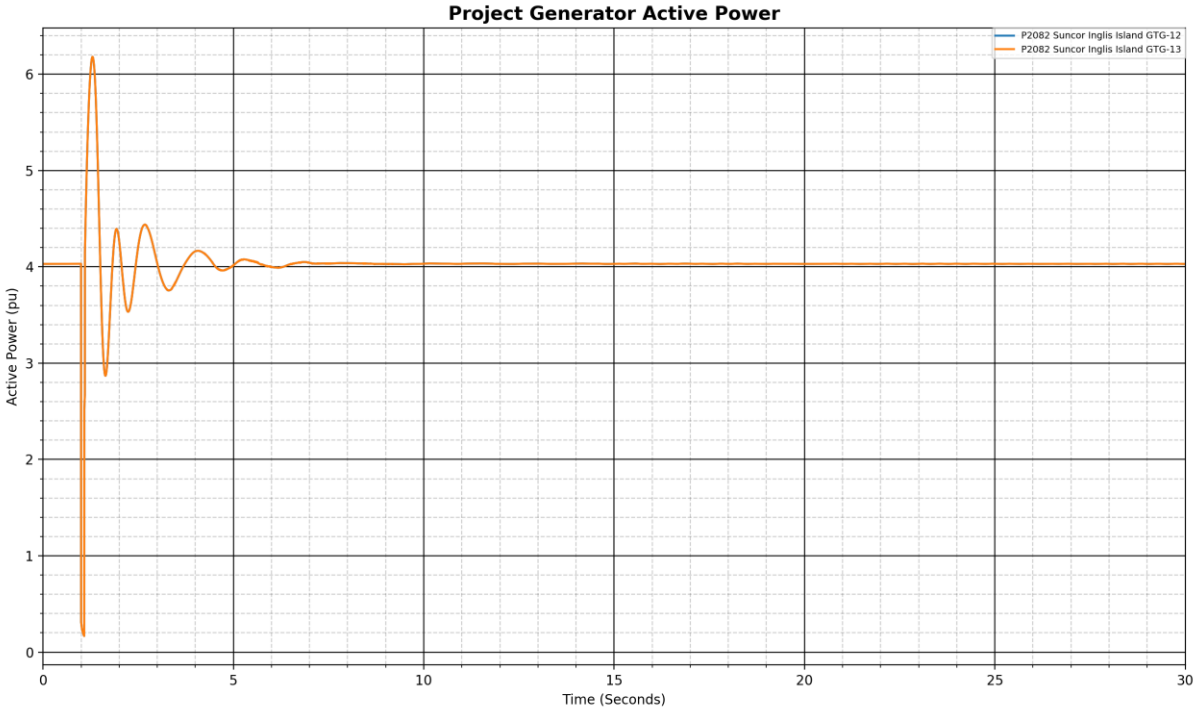

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

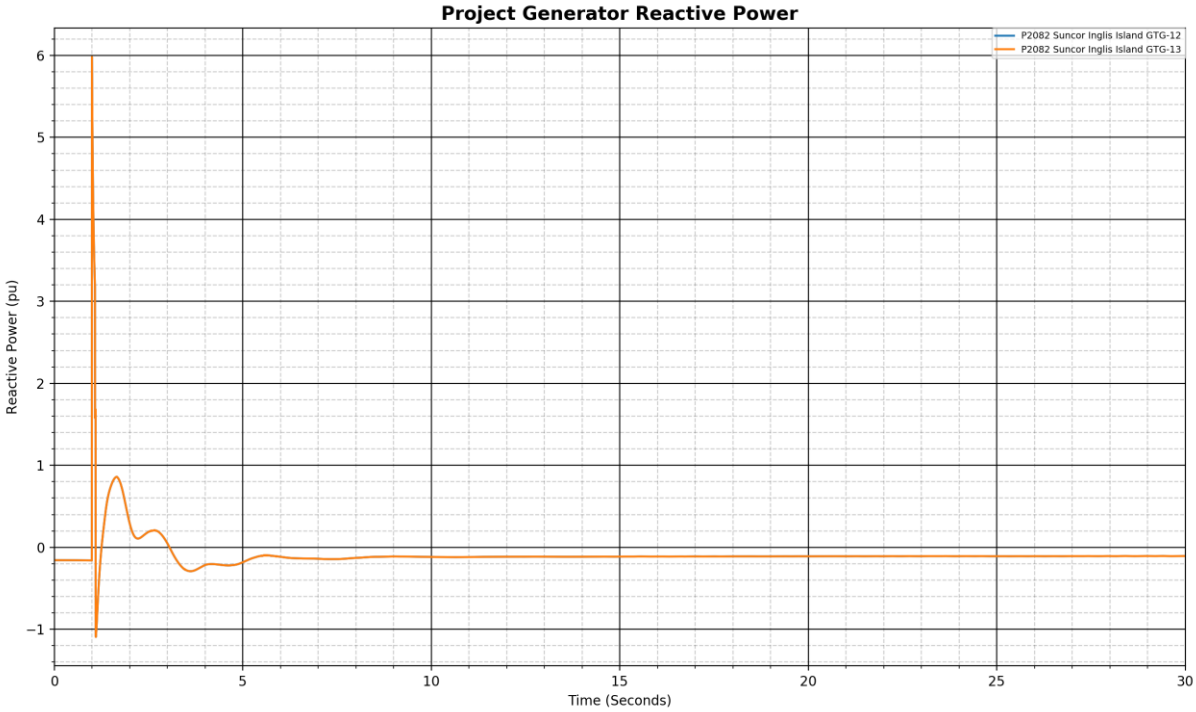

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

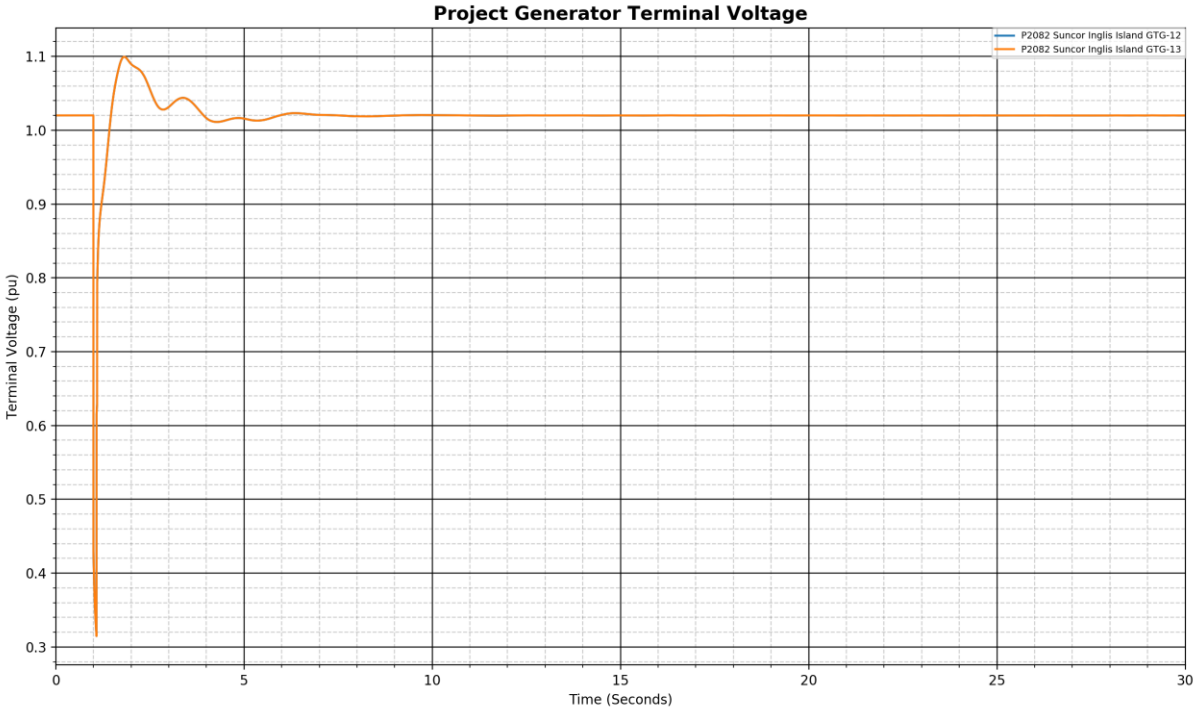

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

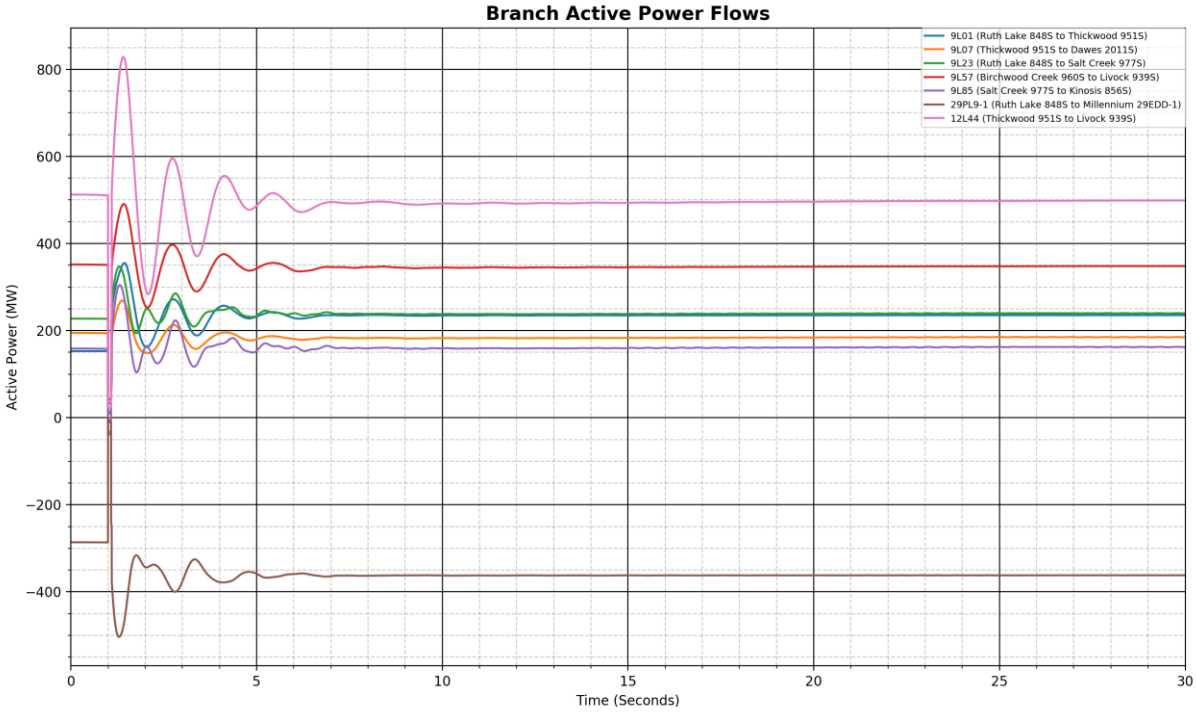

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
70
60
50
40
30
20
10
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
6
5
4
3
2
1
0
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Active Power (MW)
800
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

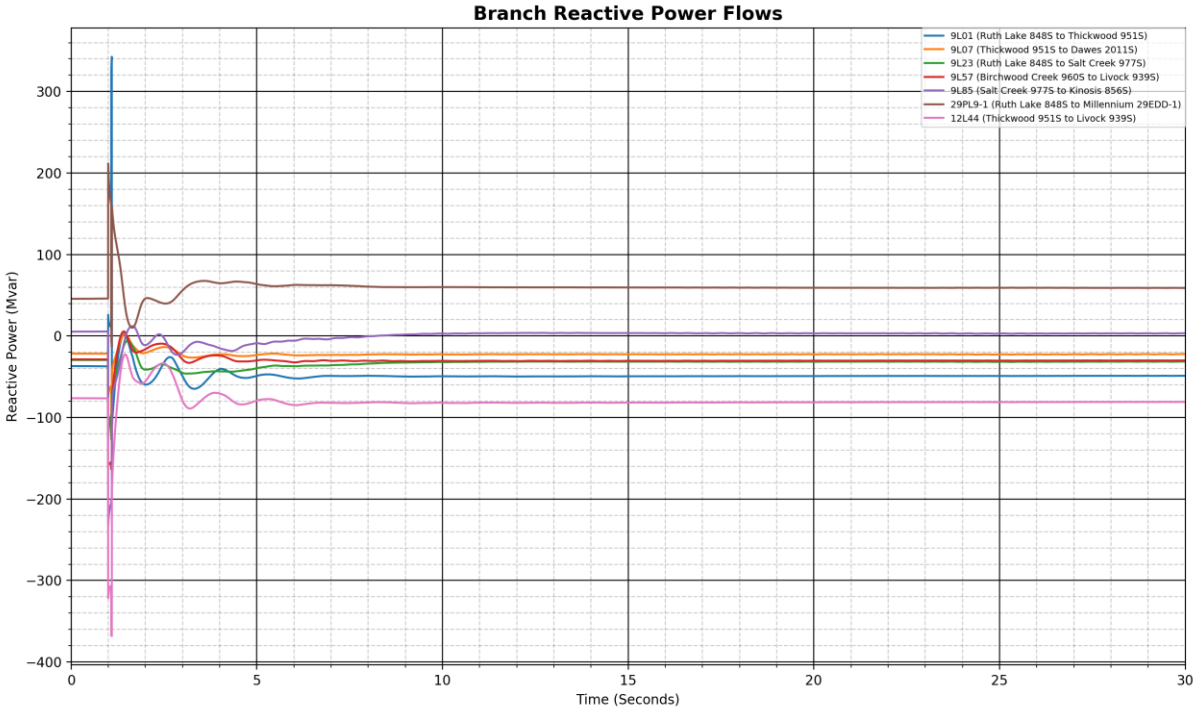
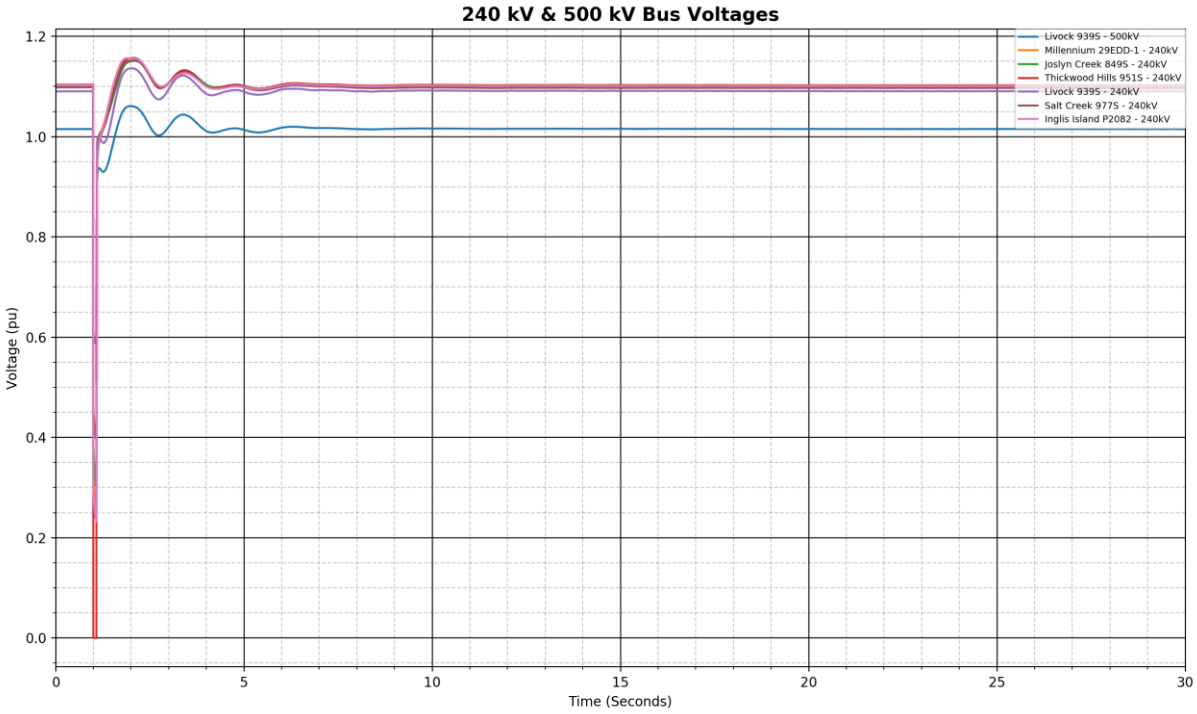
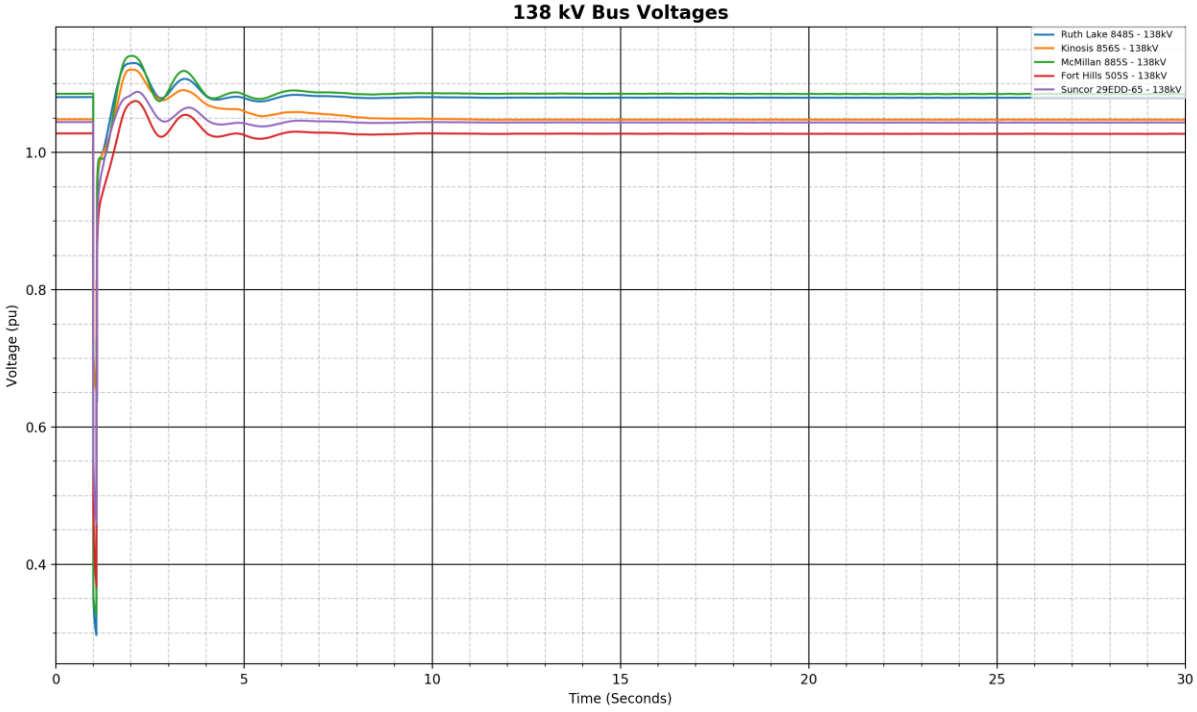
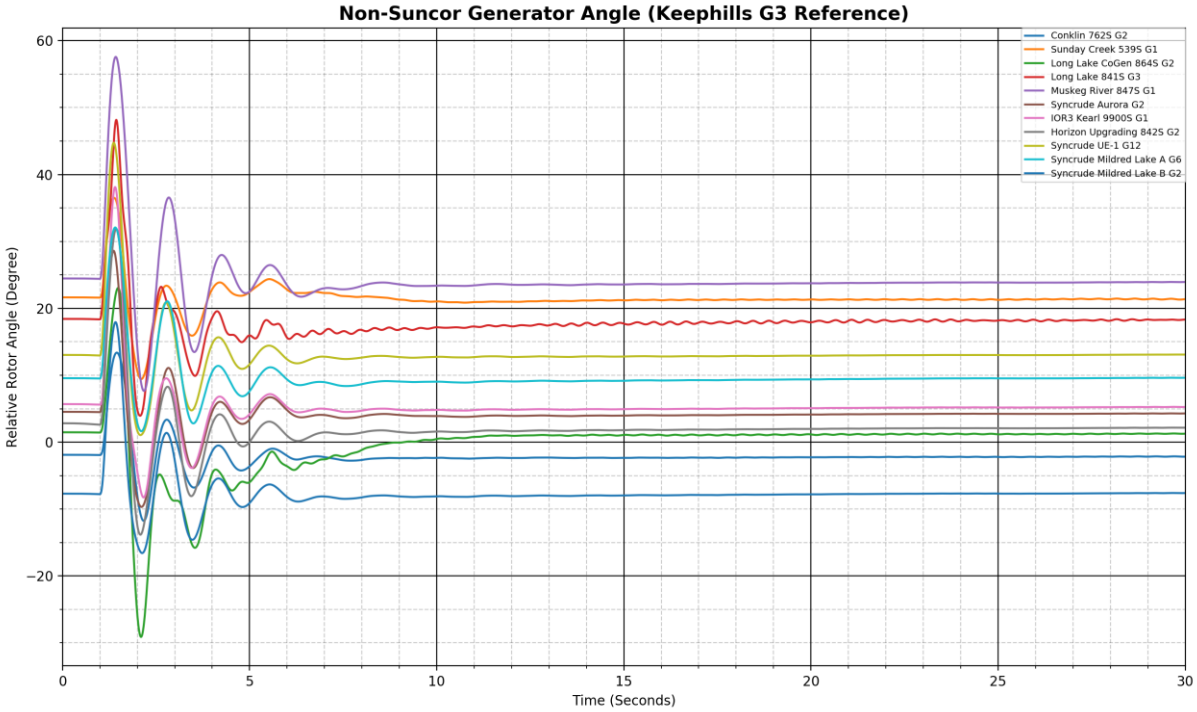
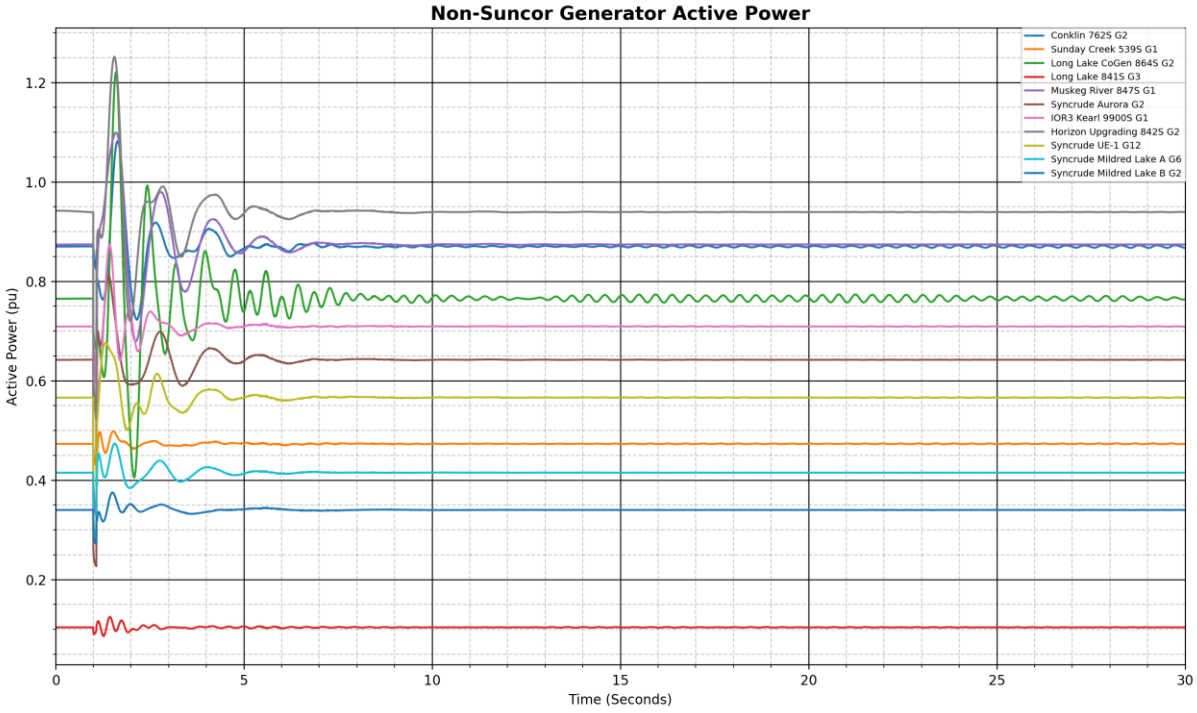

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

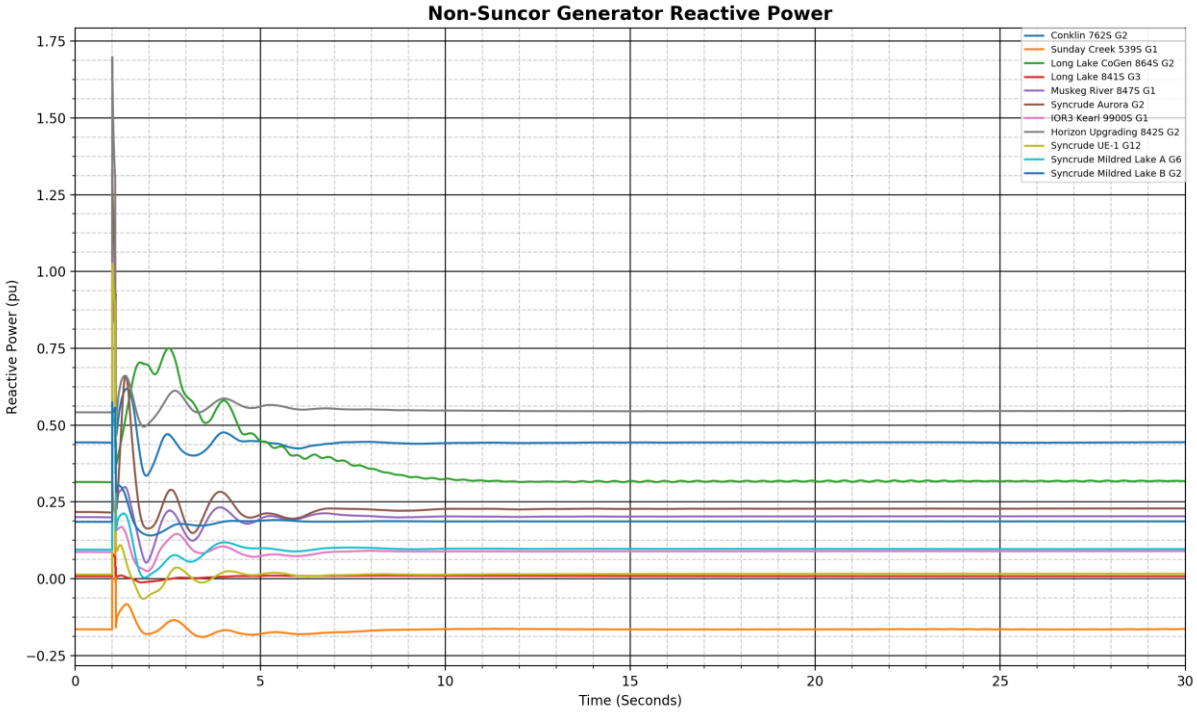
Figure A4-26: 9L162 (Voyageur 29EDD-94 to Thickwood Hills 951S): Fault at Thickwood Hills 951S

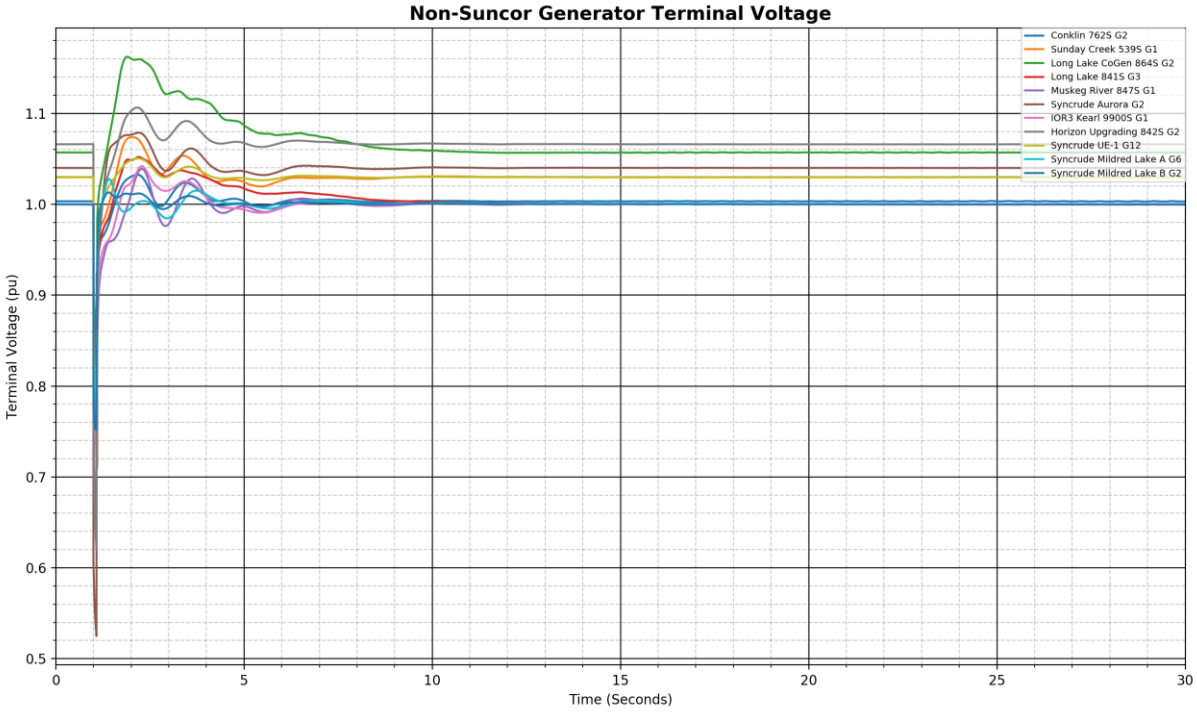


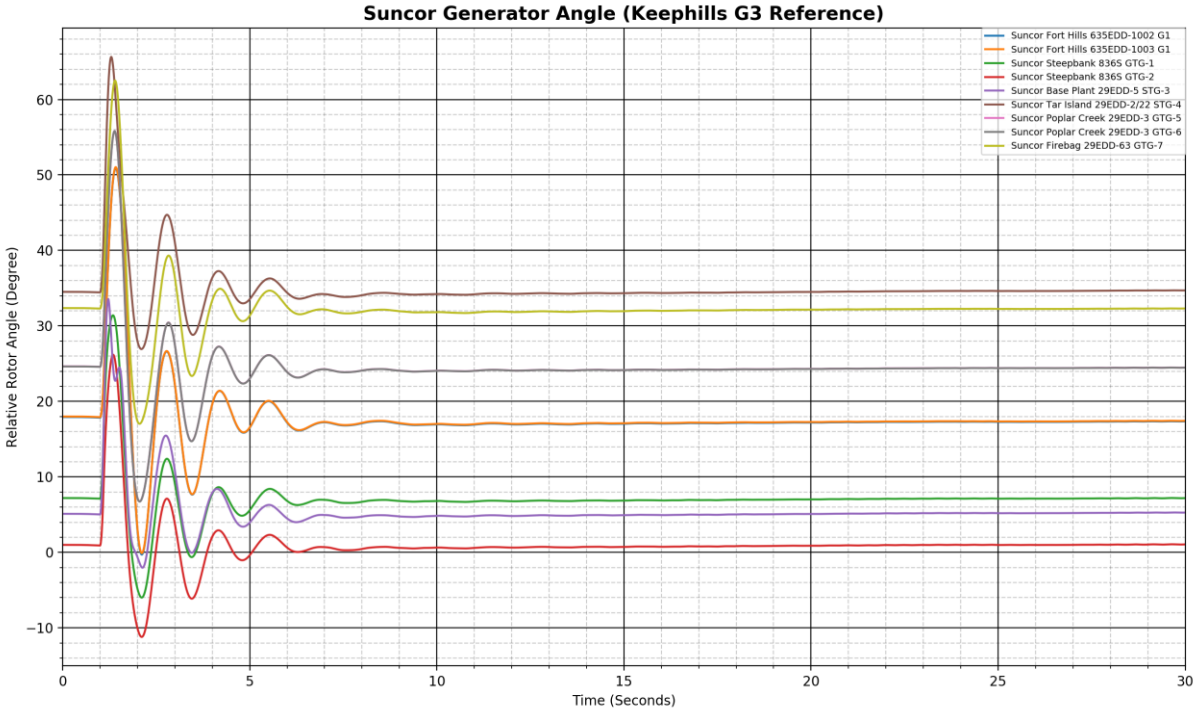


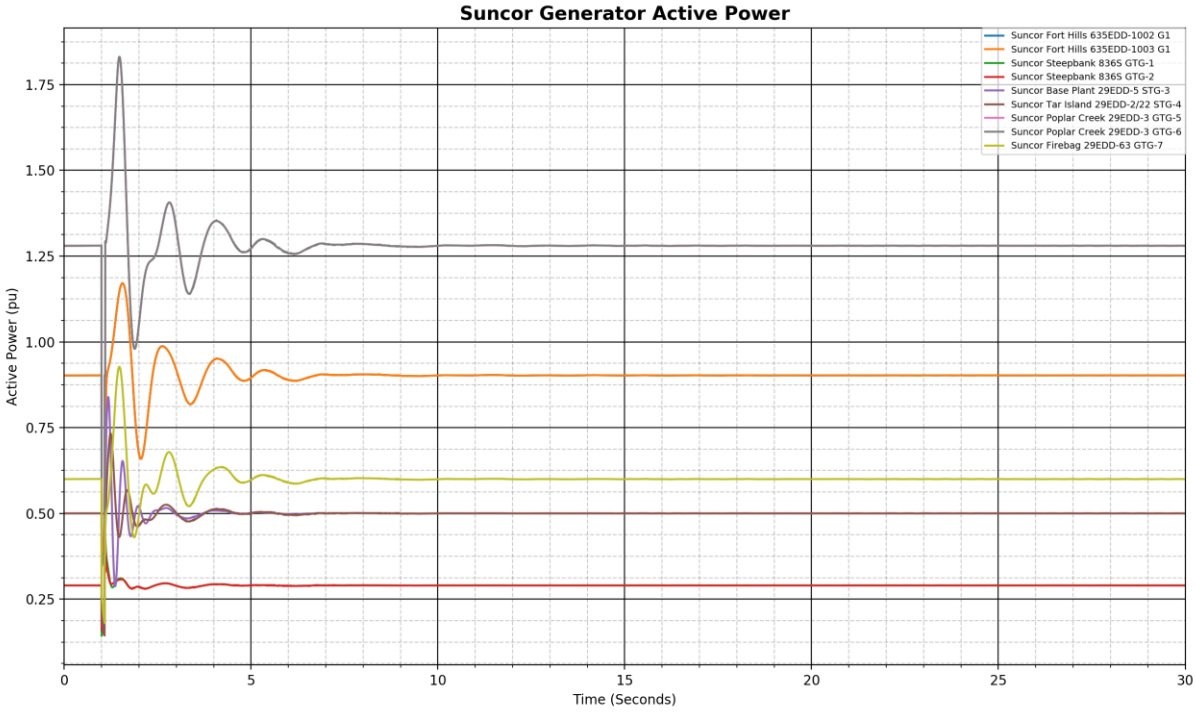

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

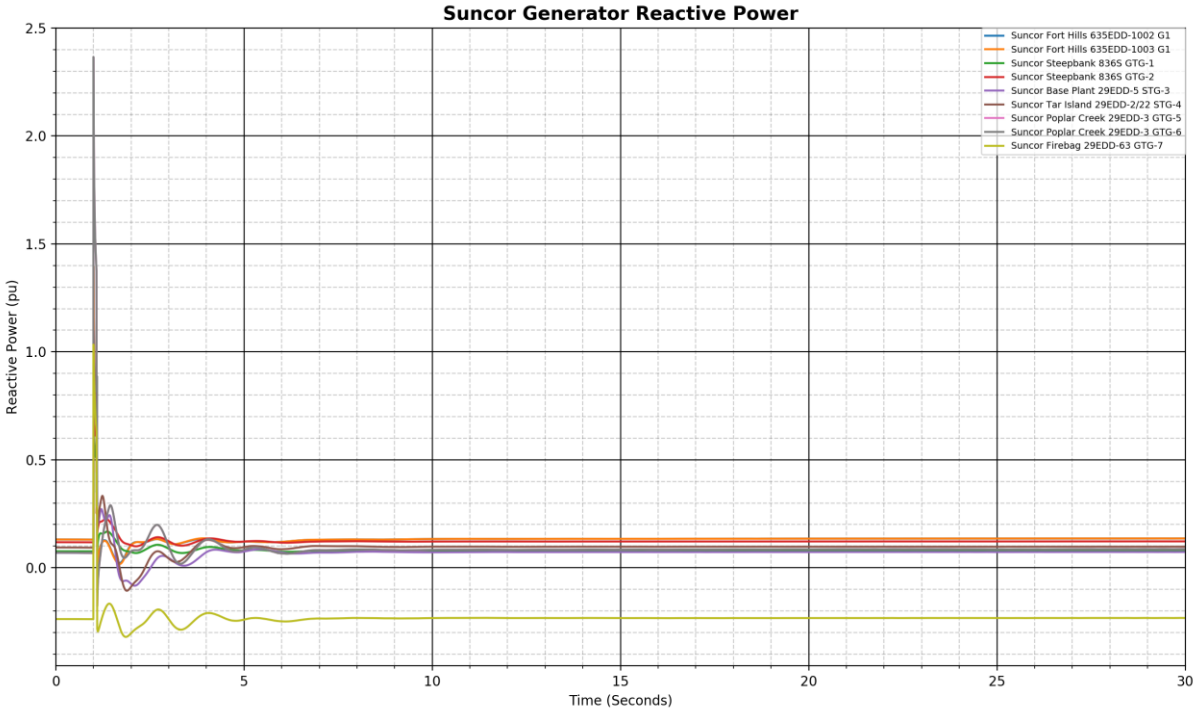

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

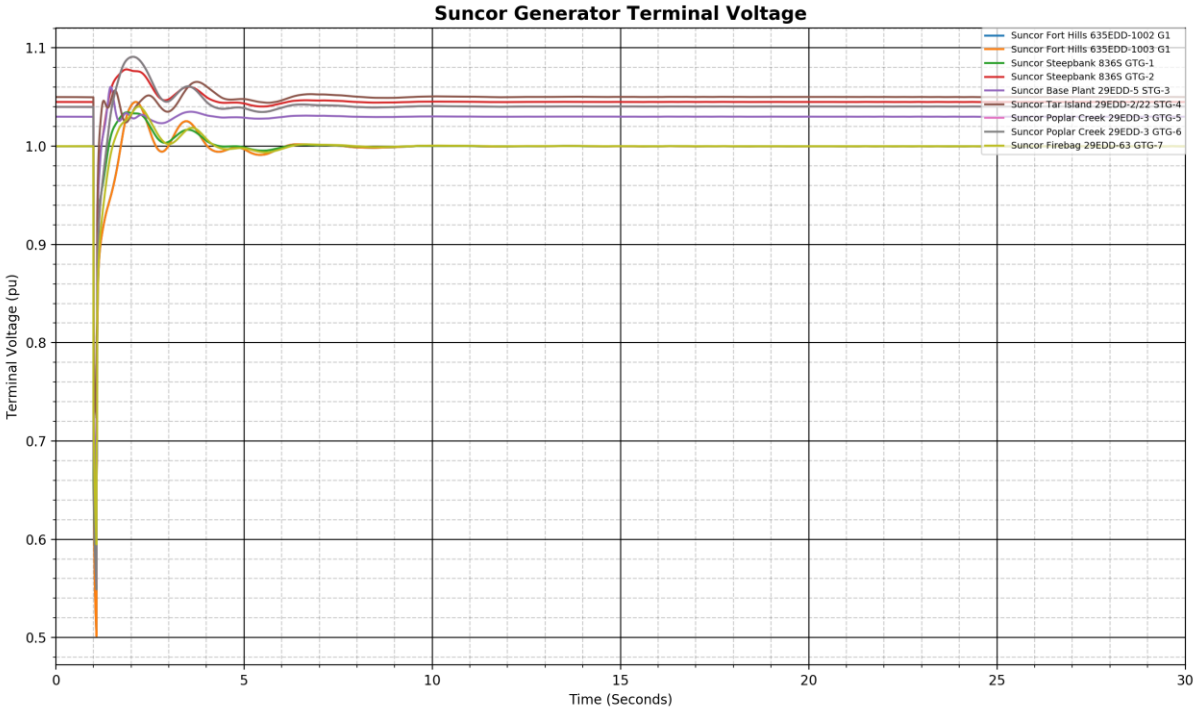

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

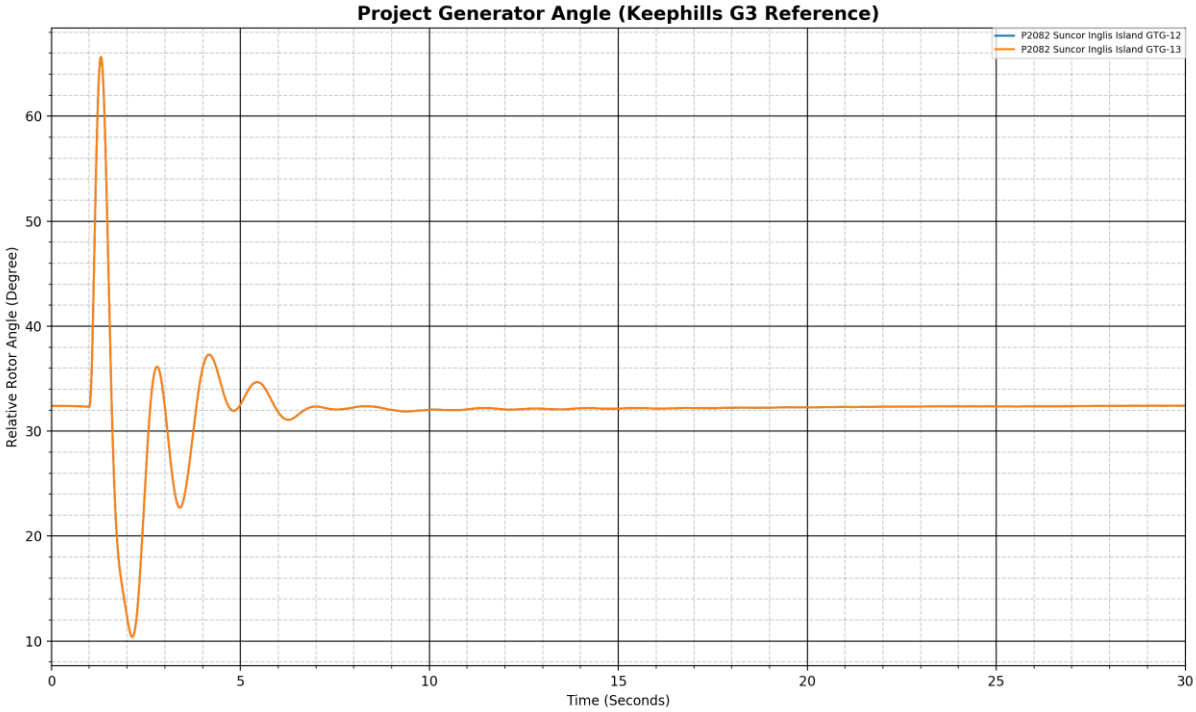

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

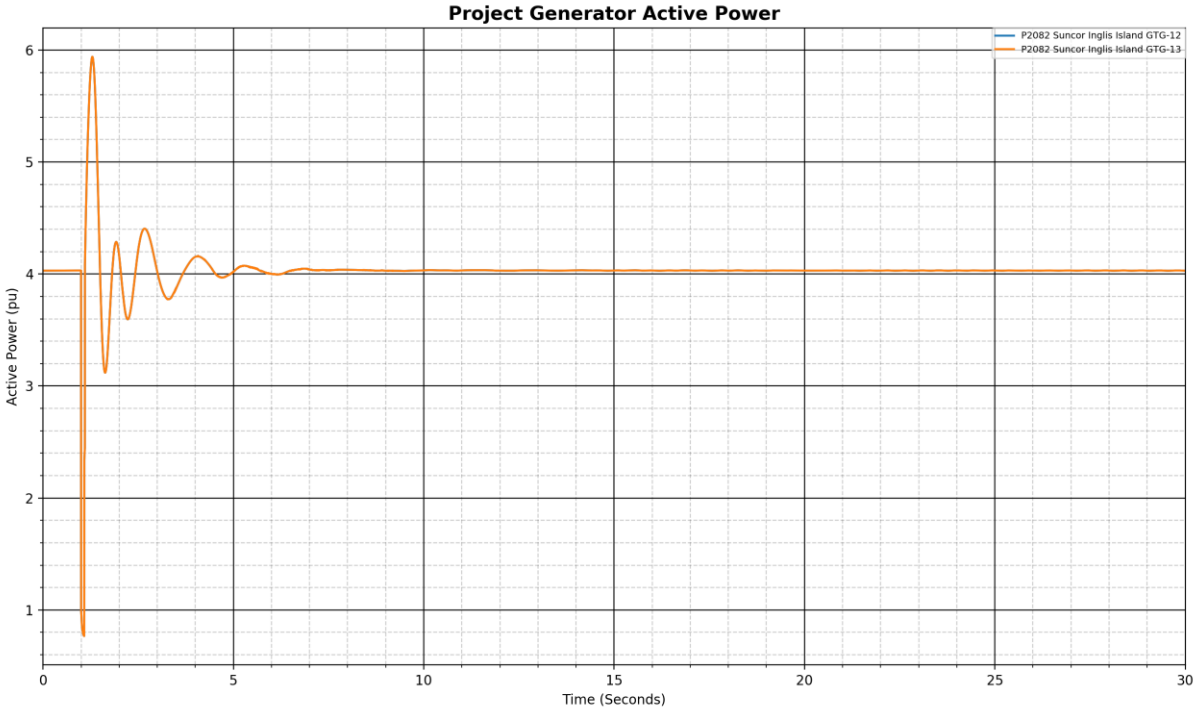

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

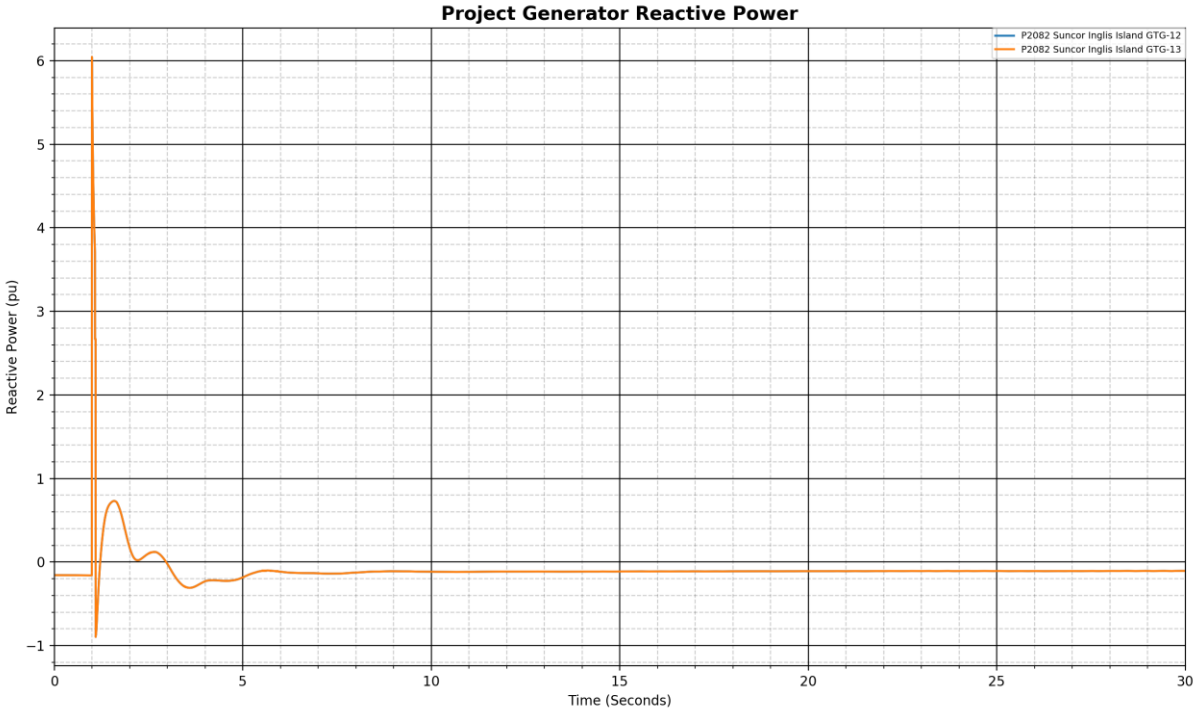

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

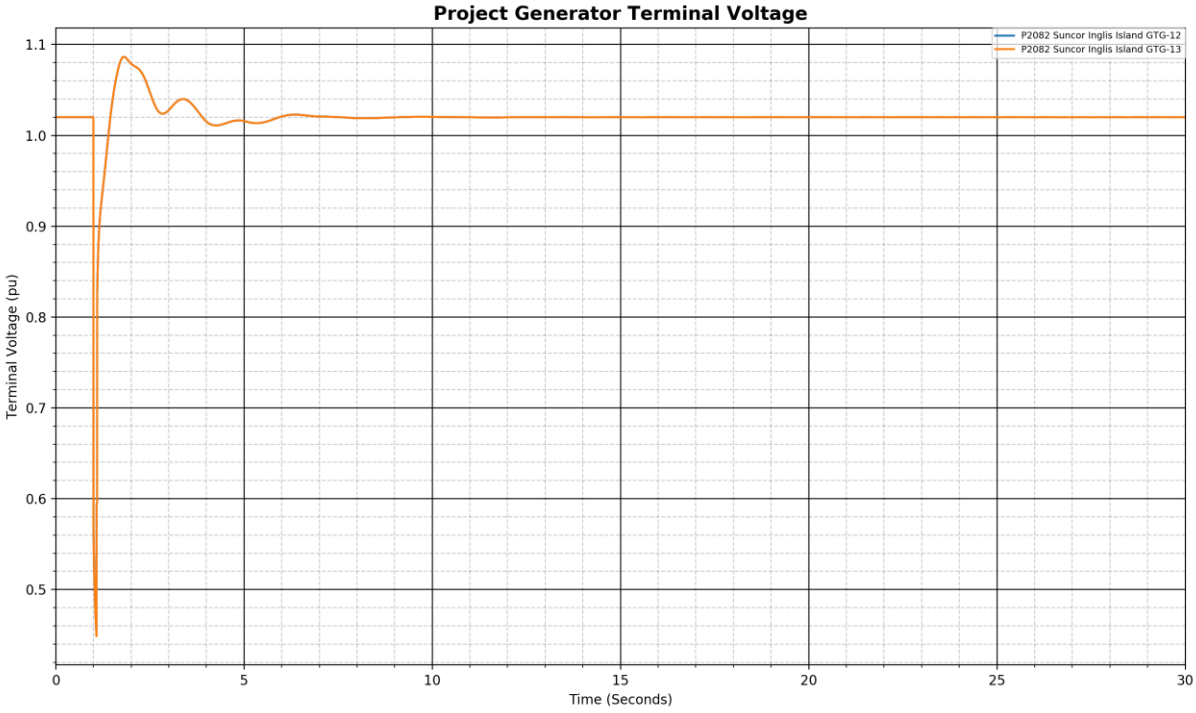

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

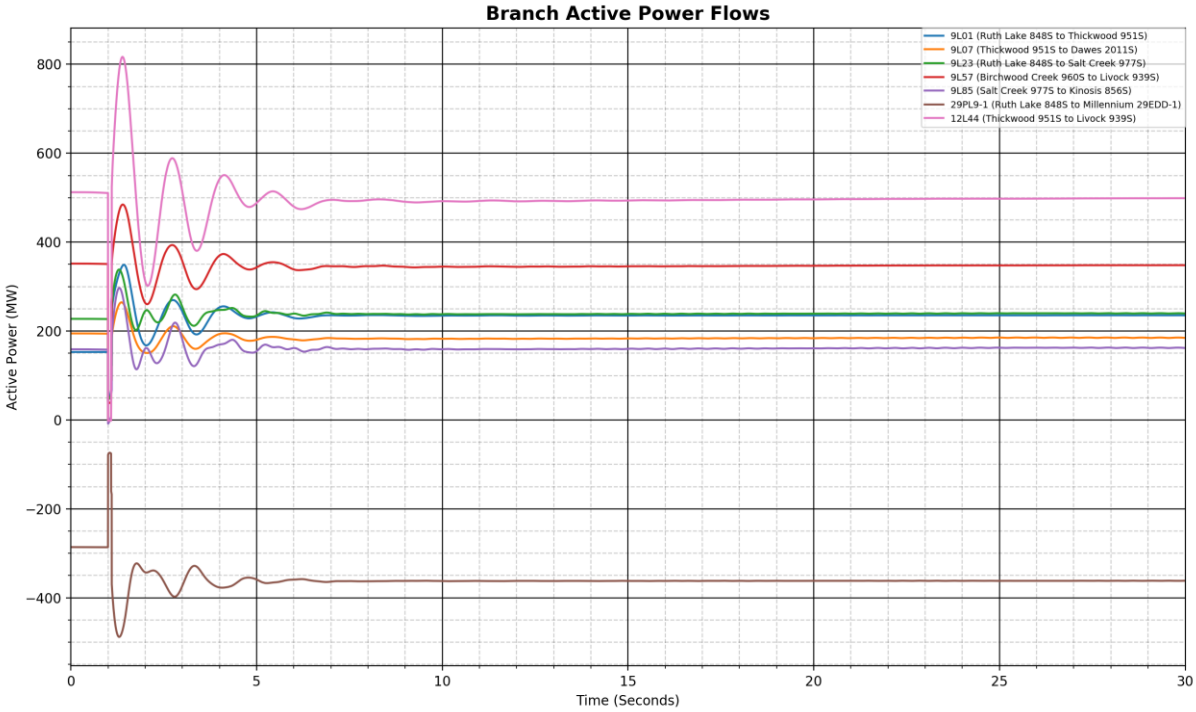

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

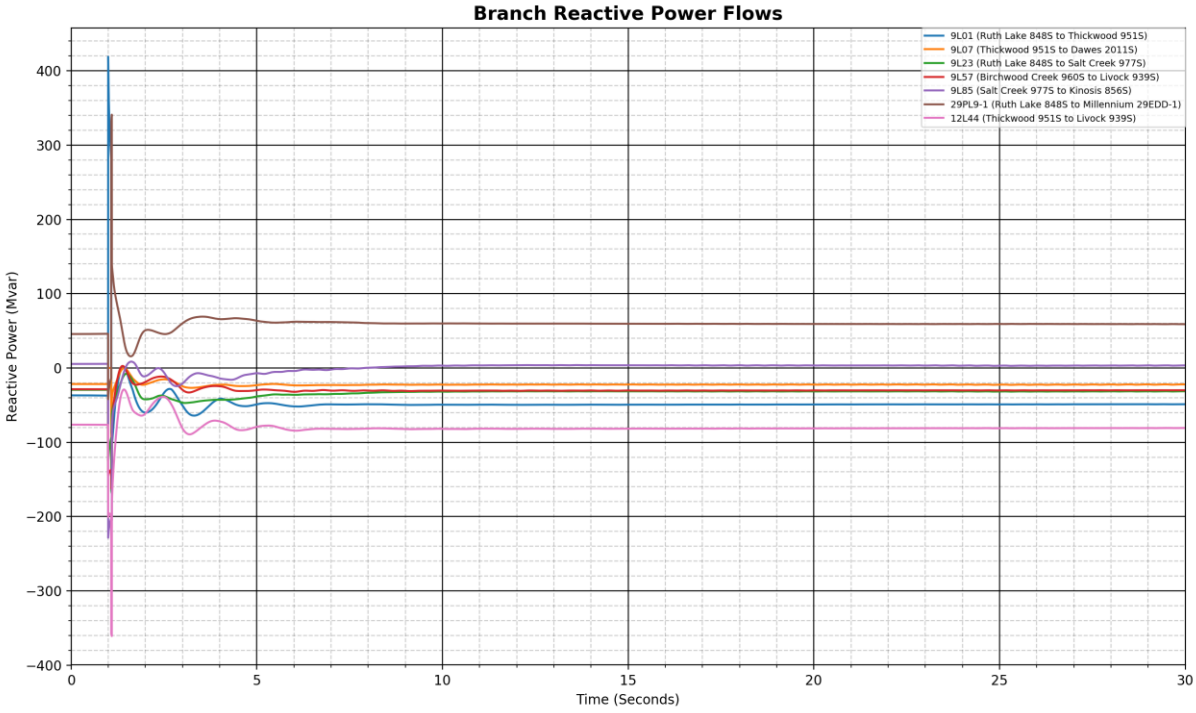

Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)

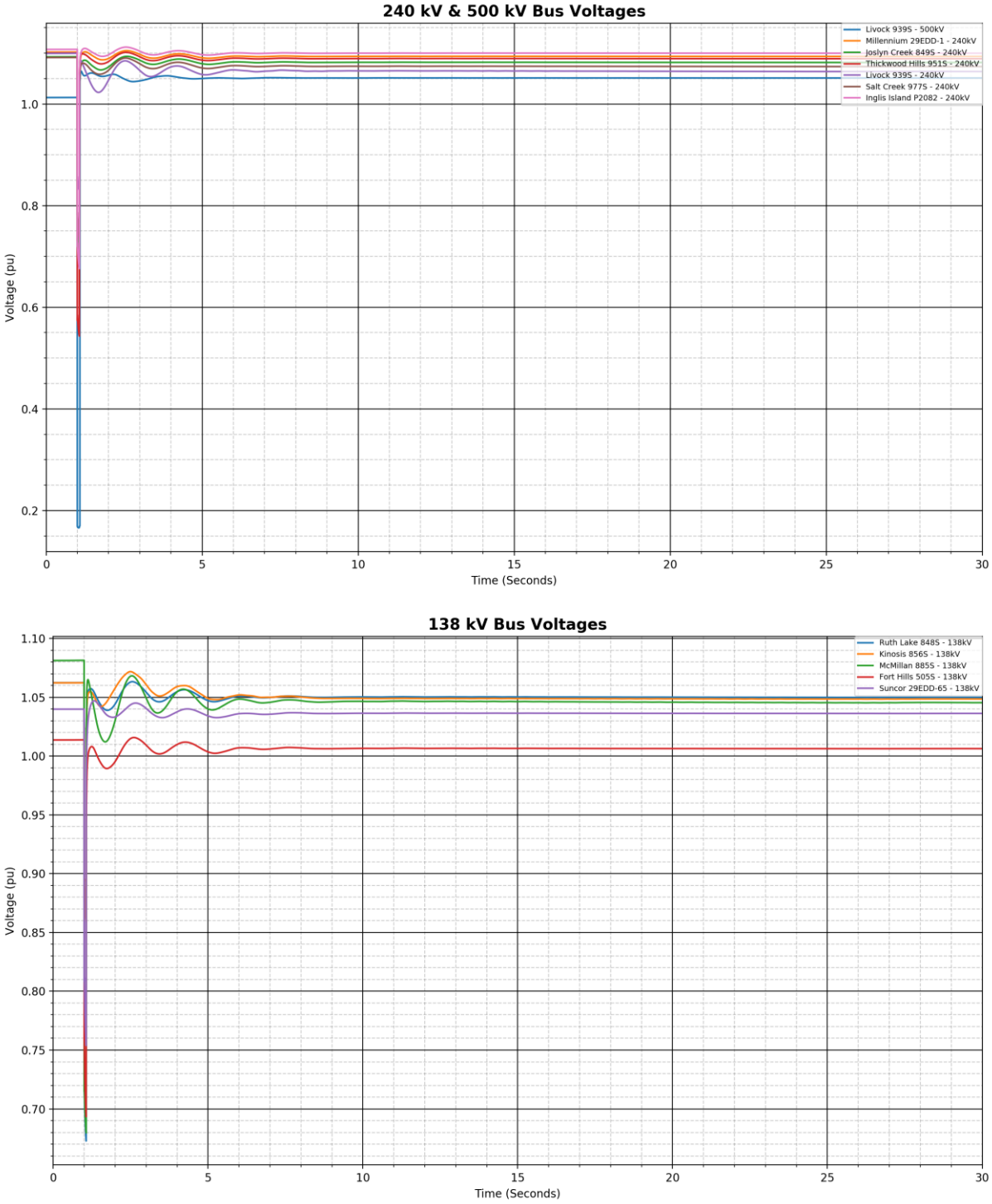

Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)

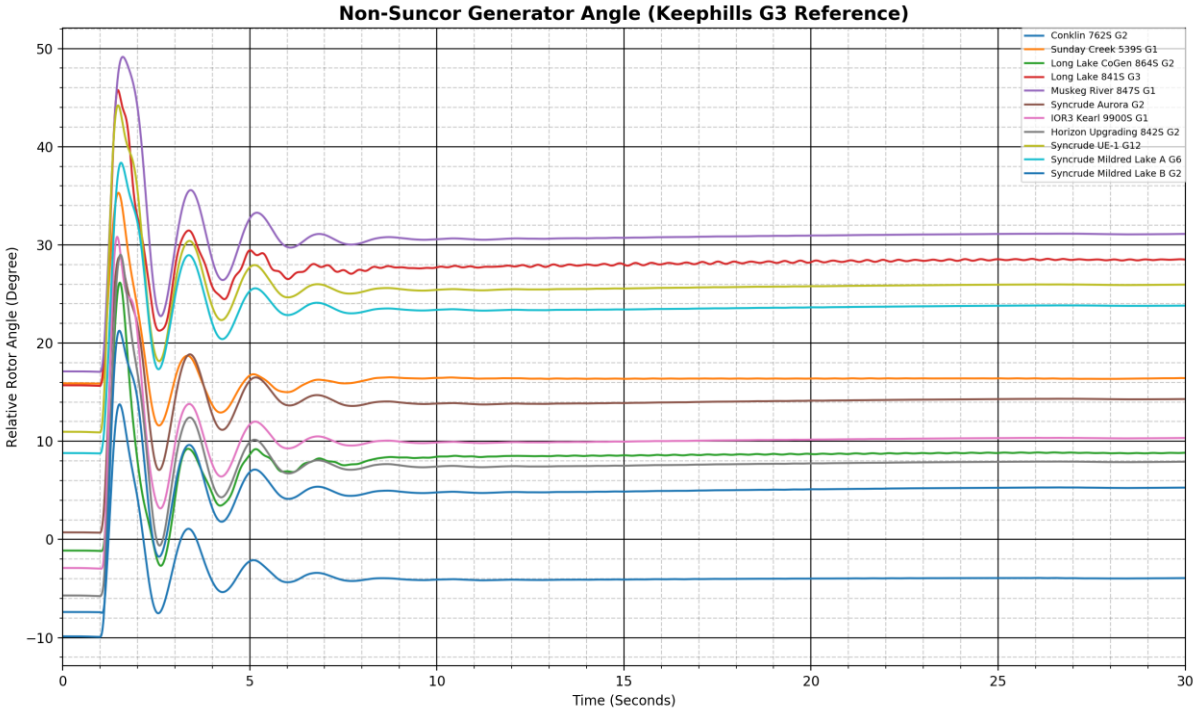

Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Active Power (MW)
Time (Seconds)

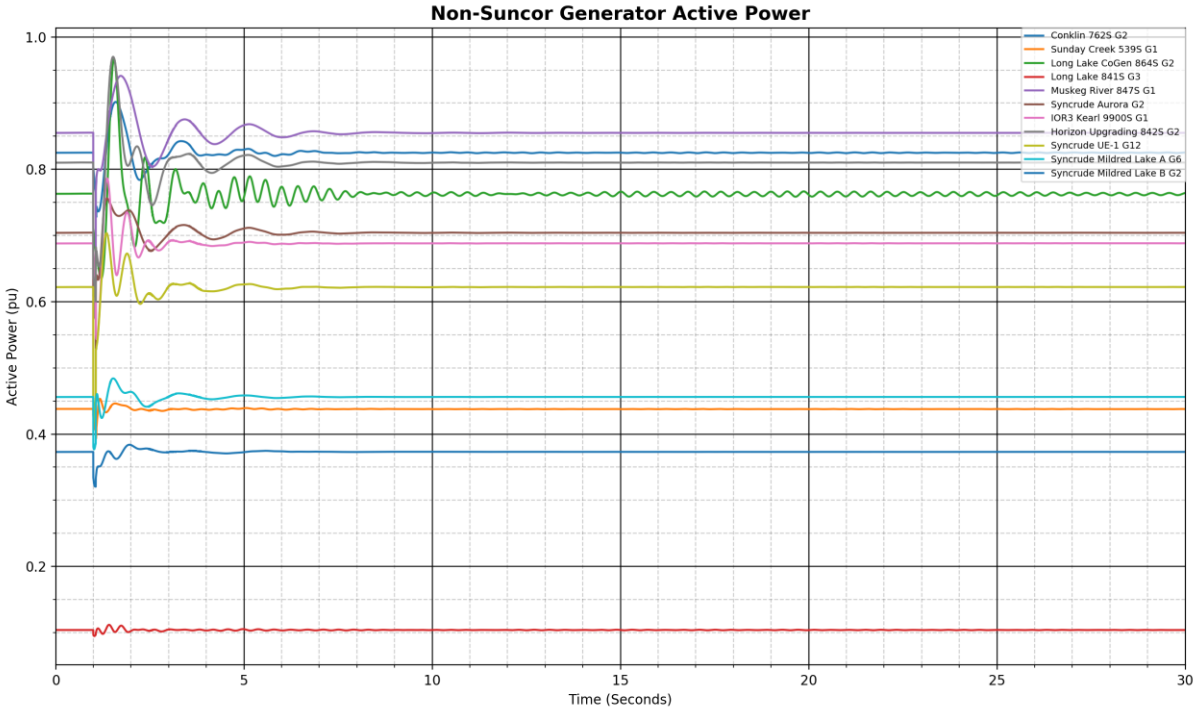

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Reactive Power (Mvar)
Time (Seconds)

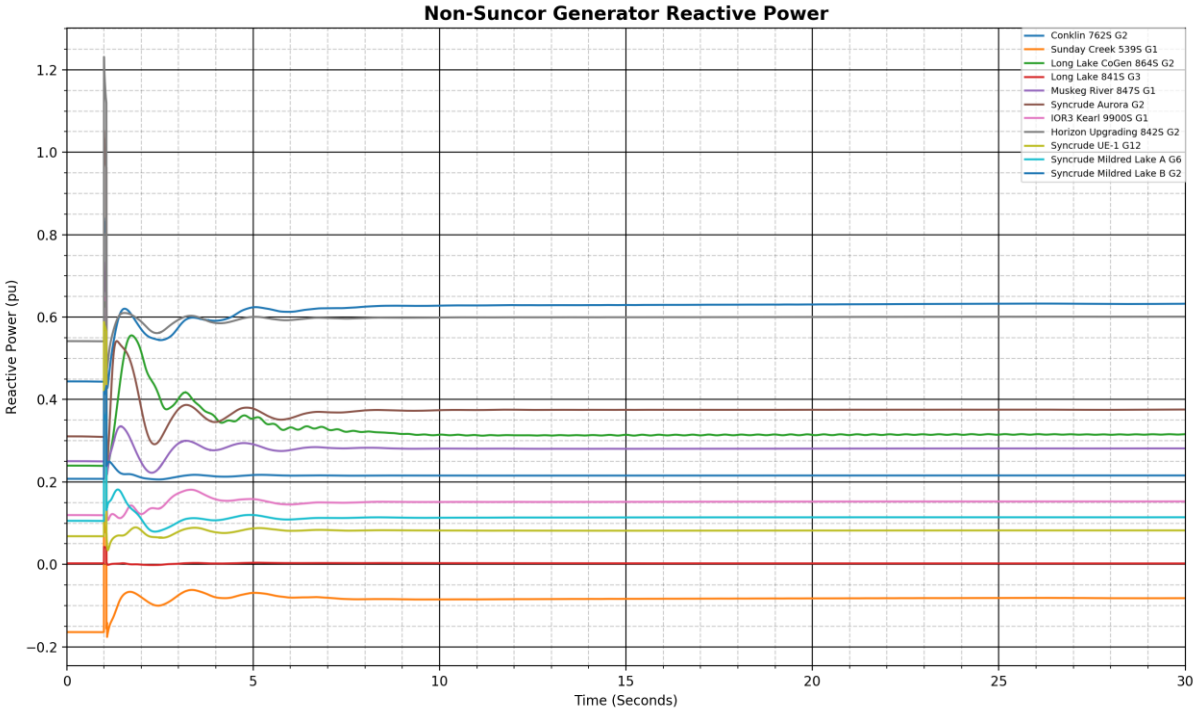
2. Stability Results 2023 Summer Peak

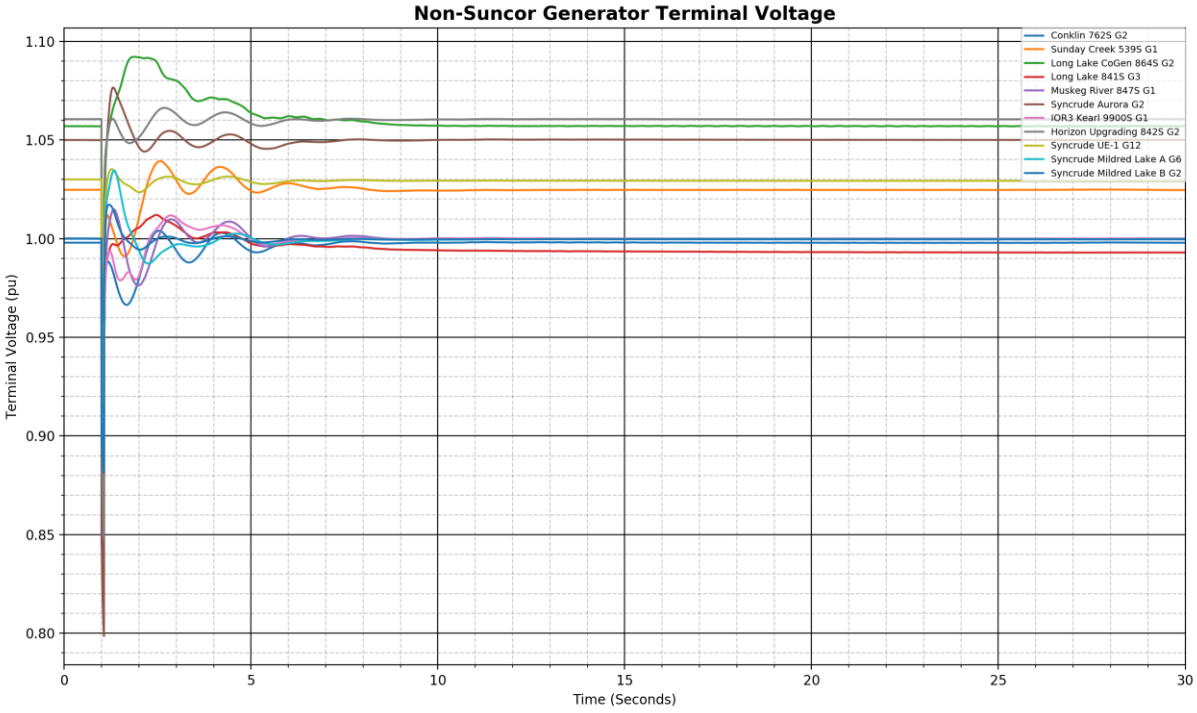
Figure A4-27: 12L44 (Thickwood Hills 951S to Livock 939S): Fault at Thickwood Hills 951S

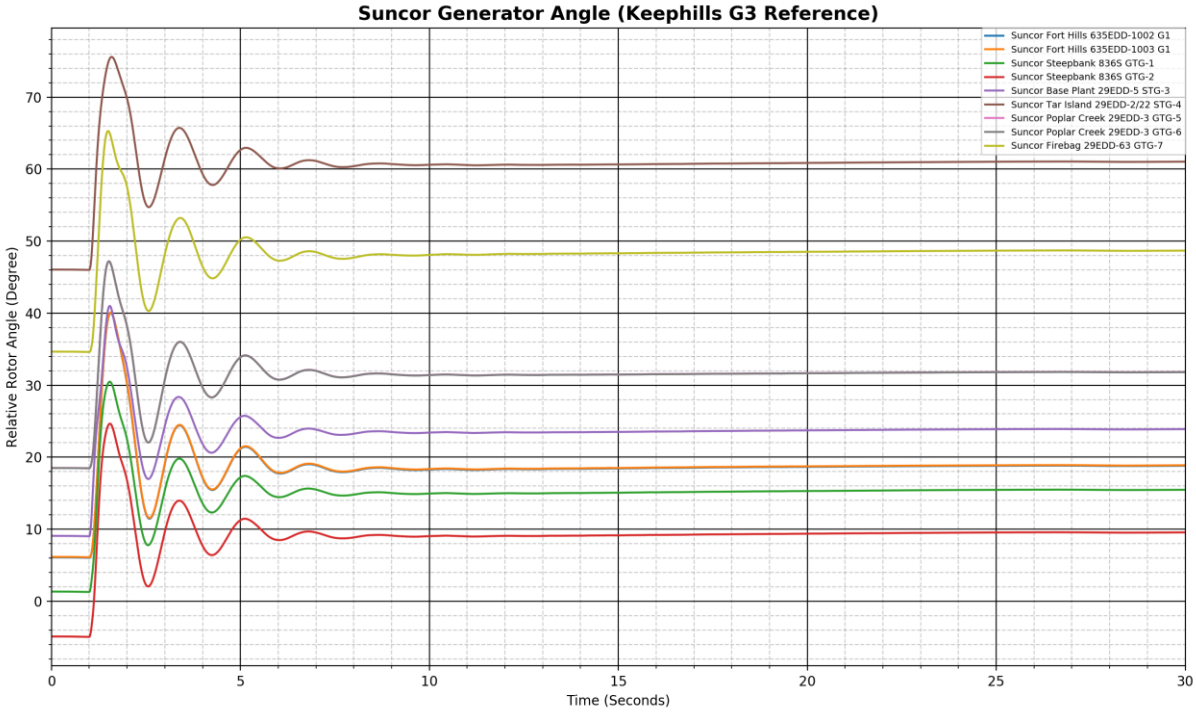


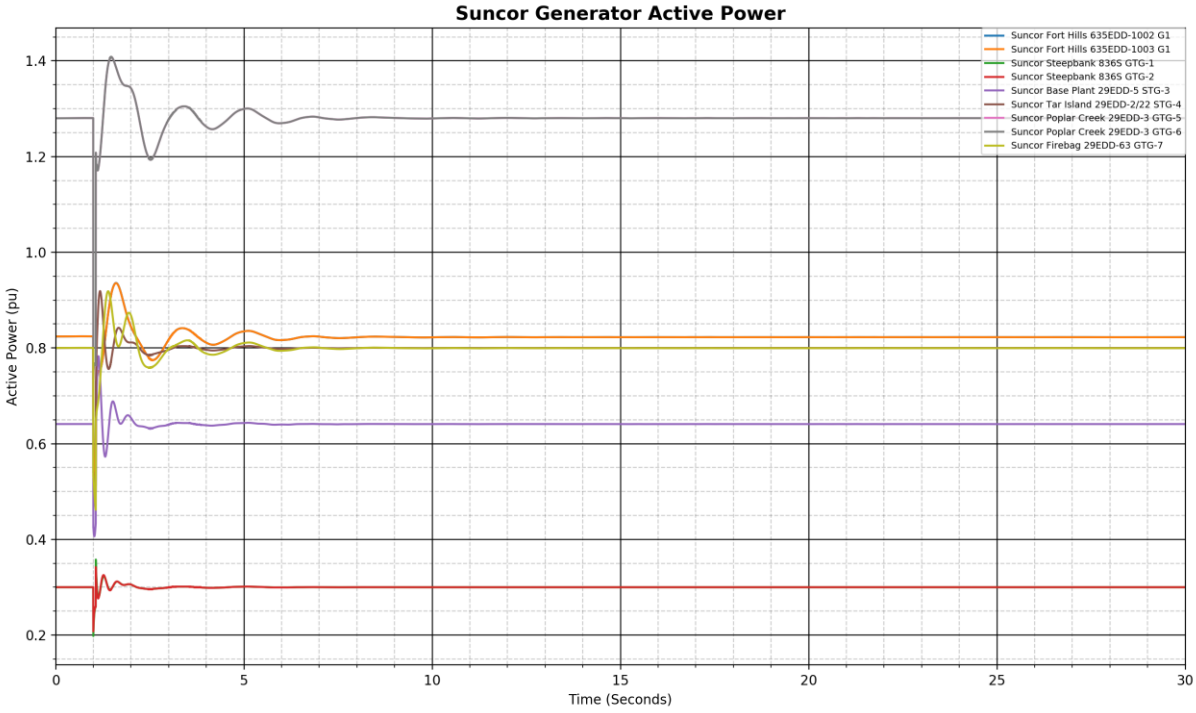

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

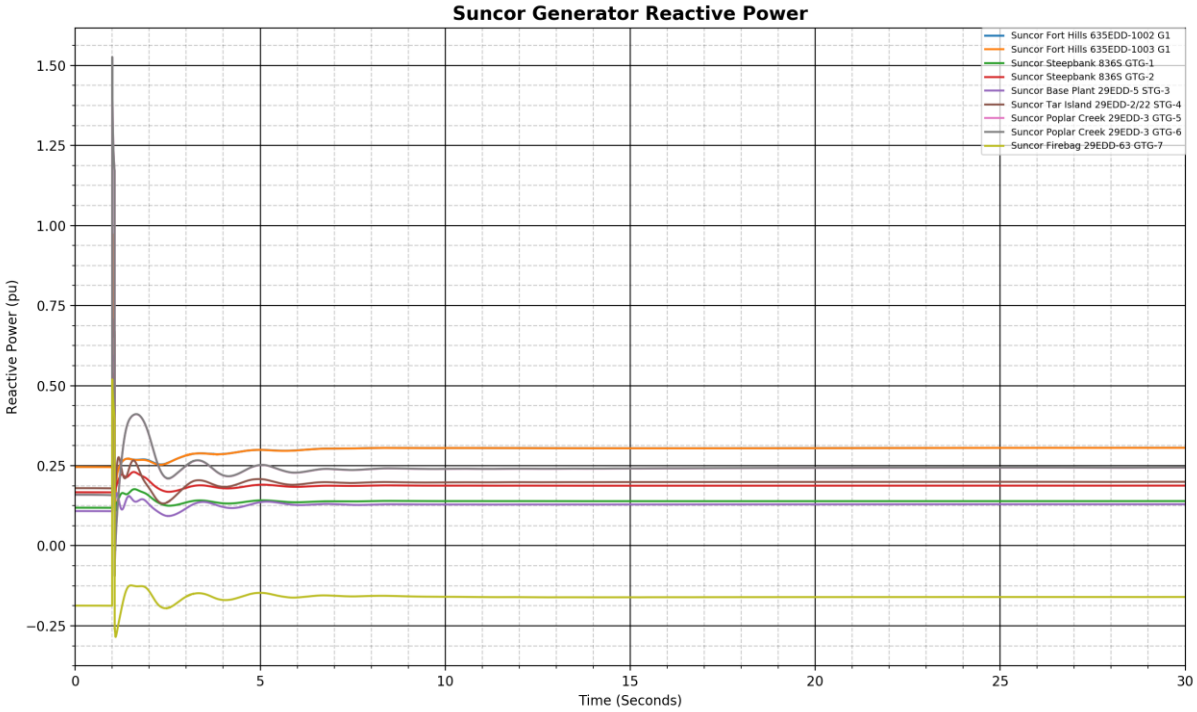

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

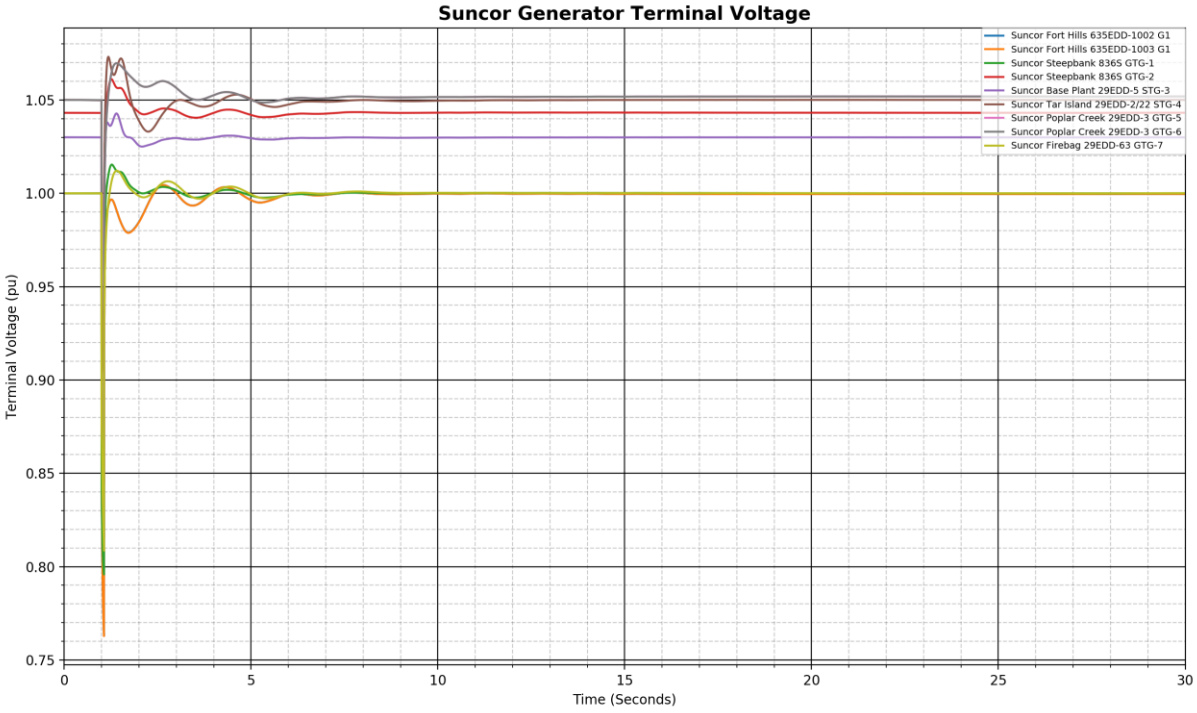

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

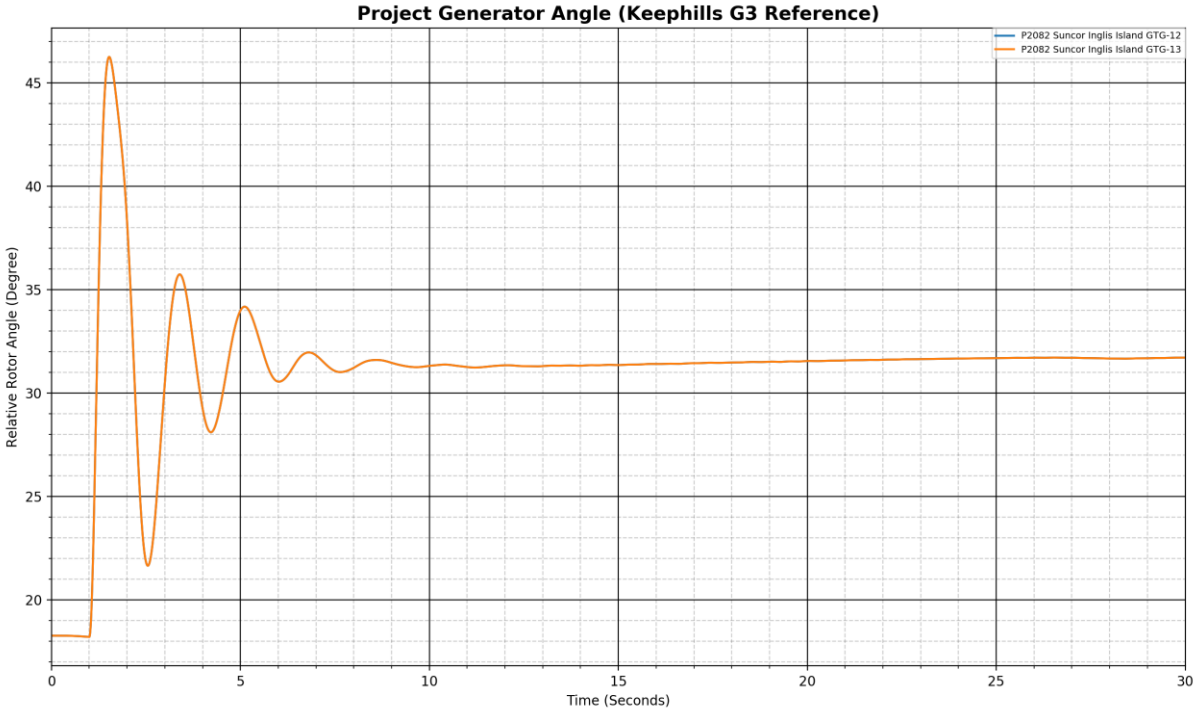

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

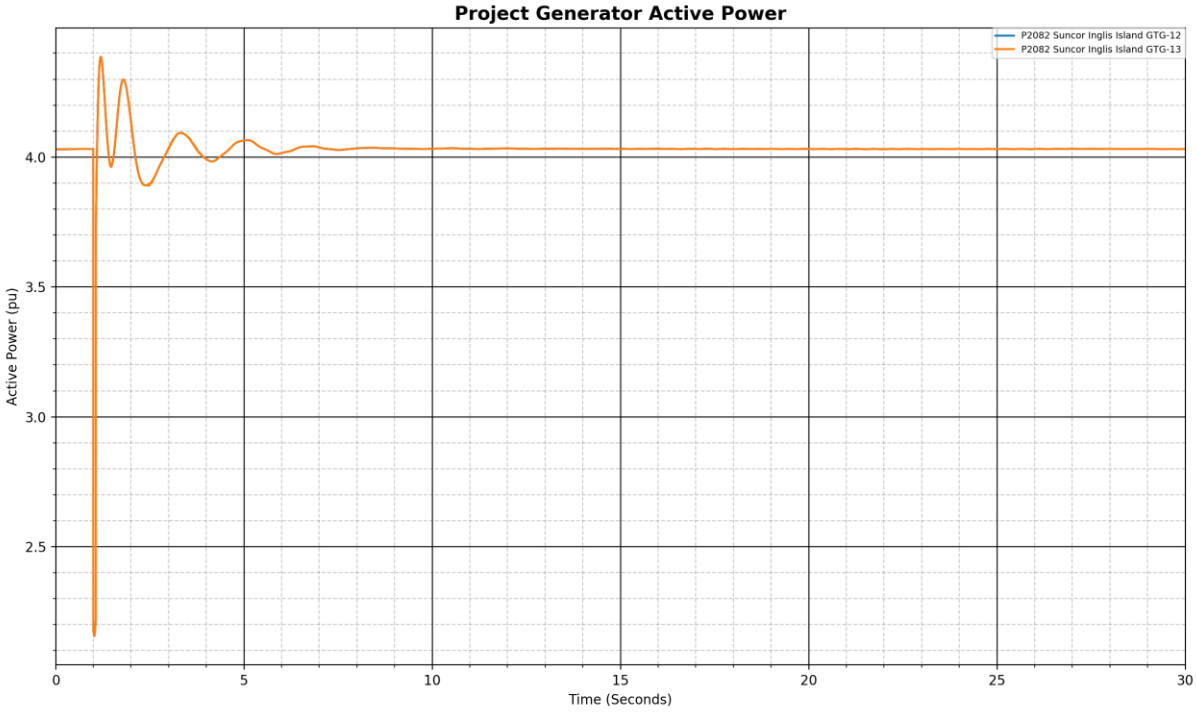

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

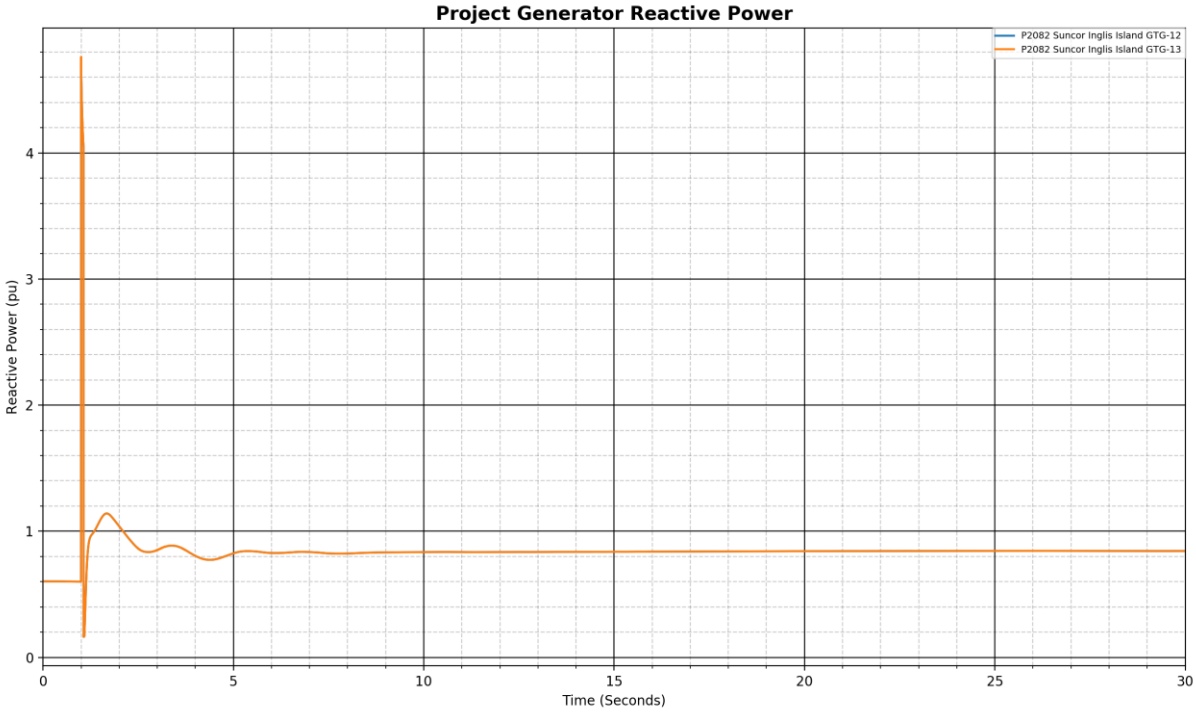

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

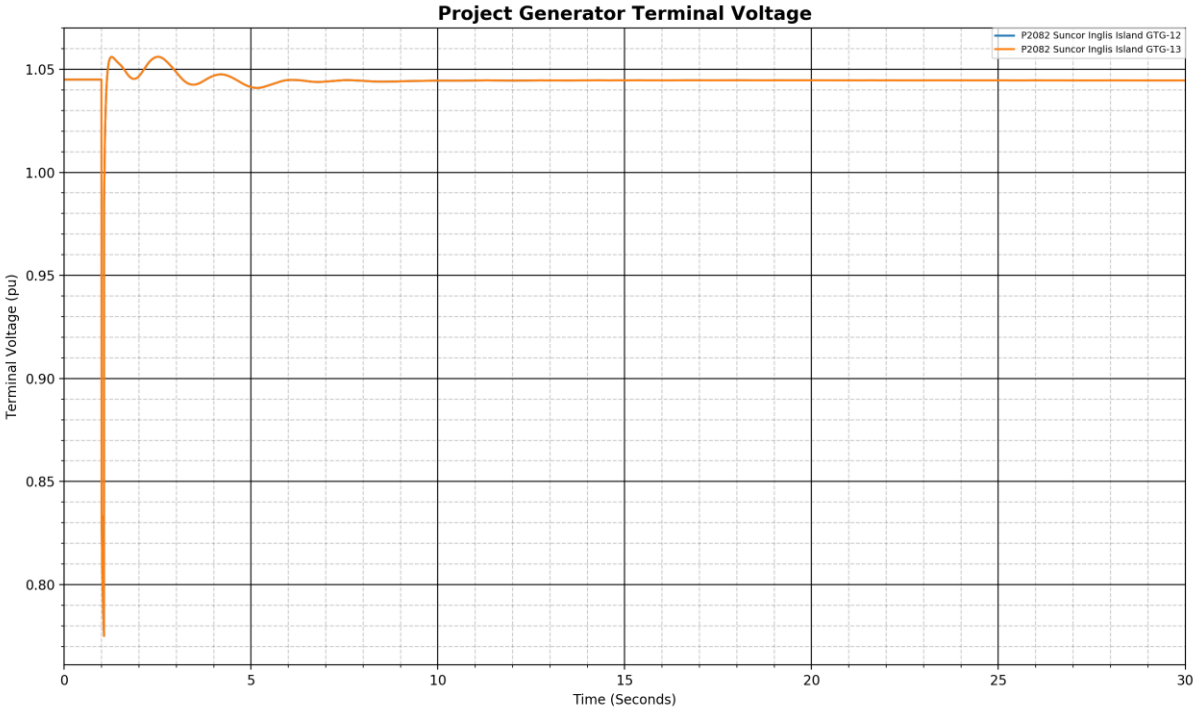

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

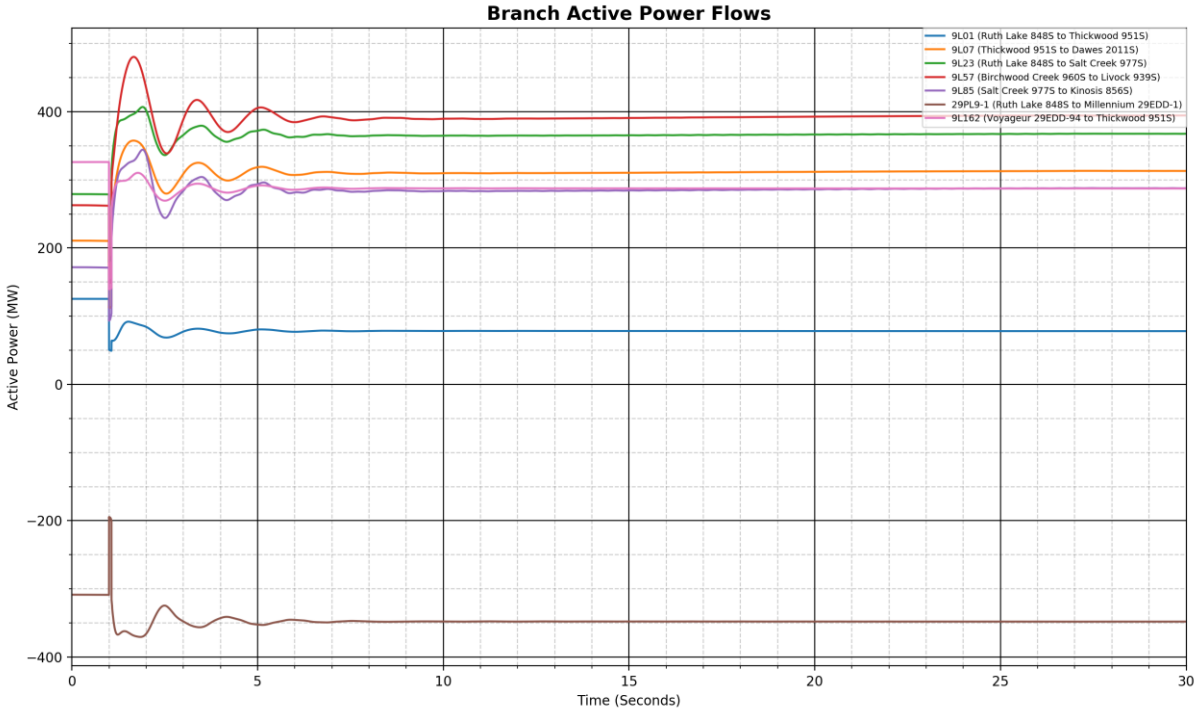

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
45
40
35
30
25
20
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.0
3.5
3.0
2.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

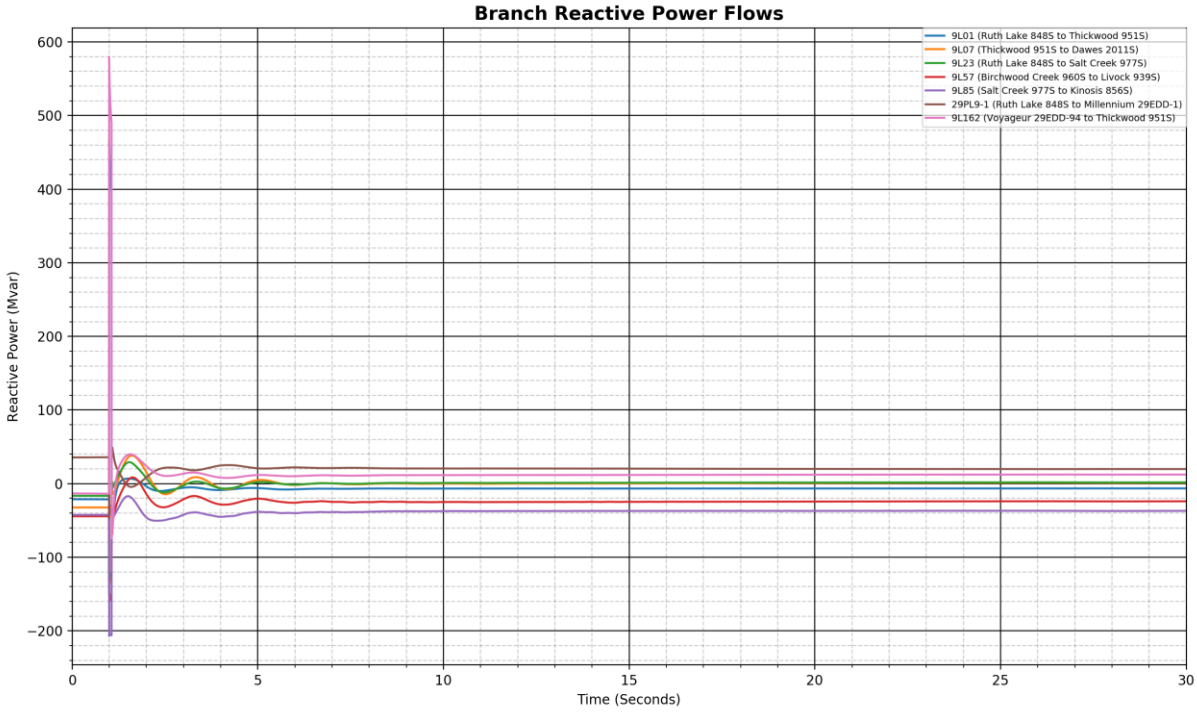
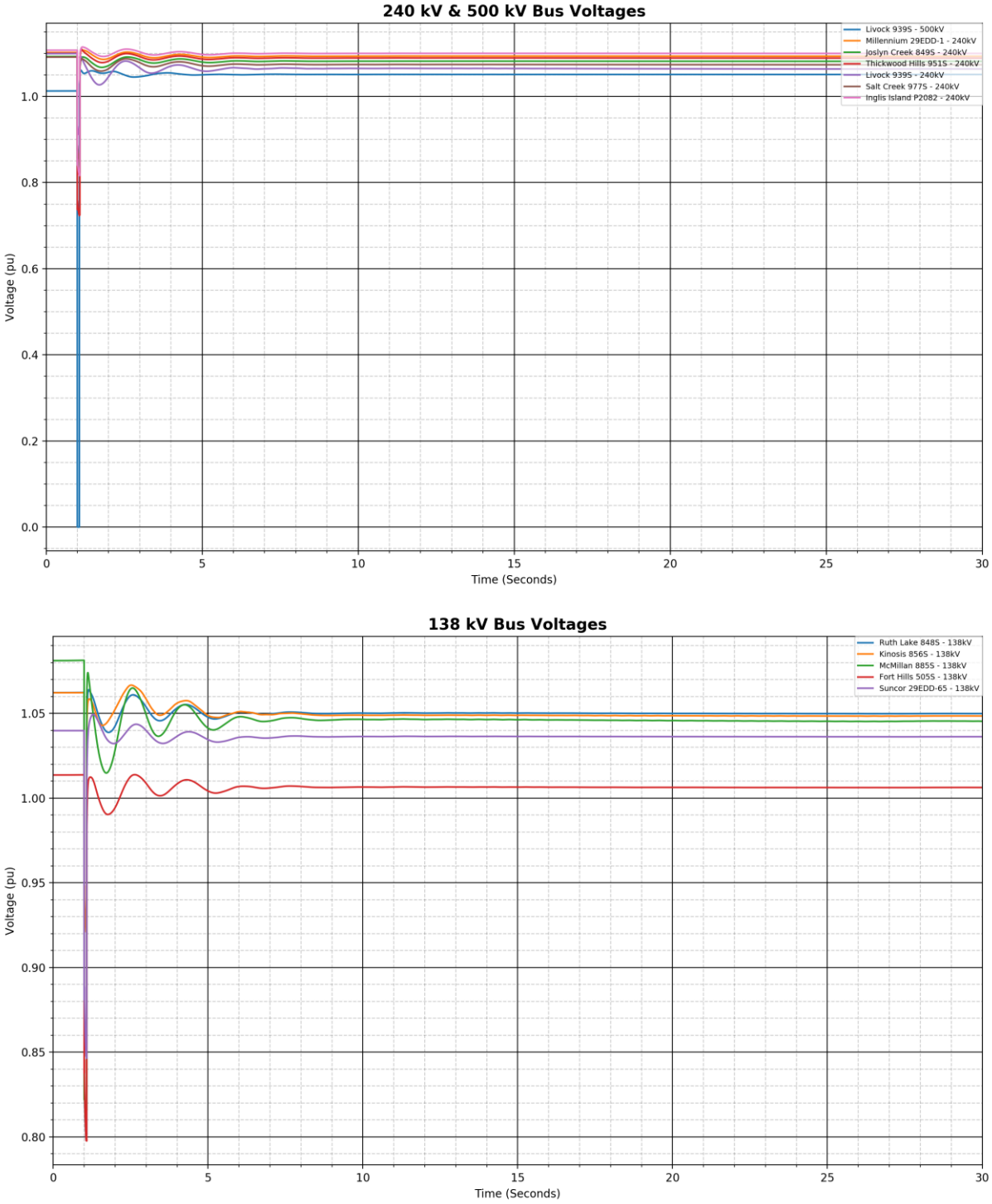
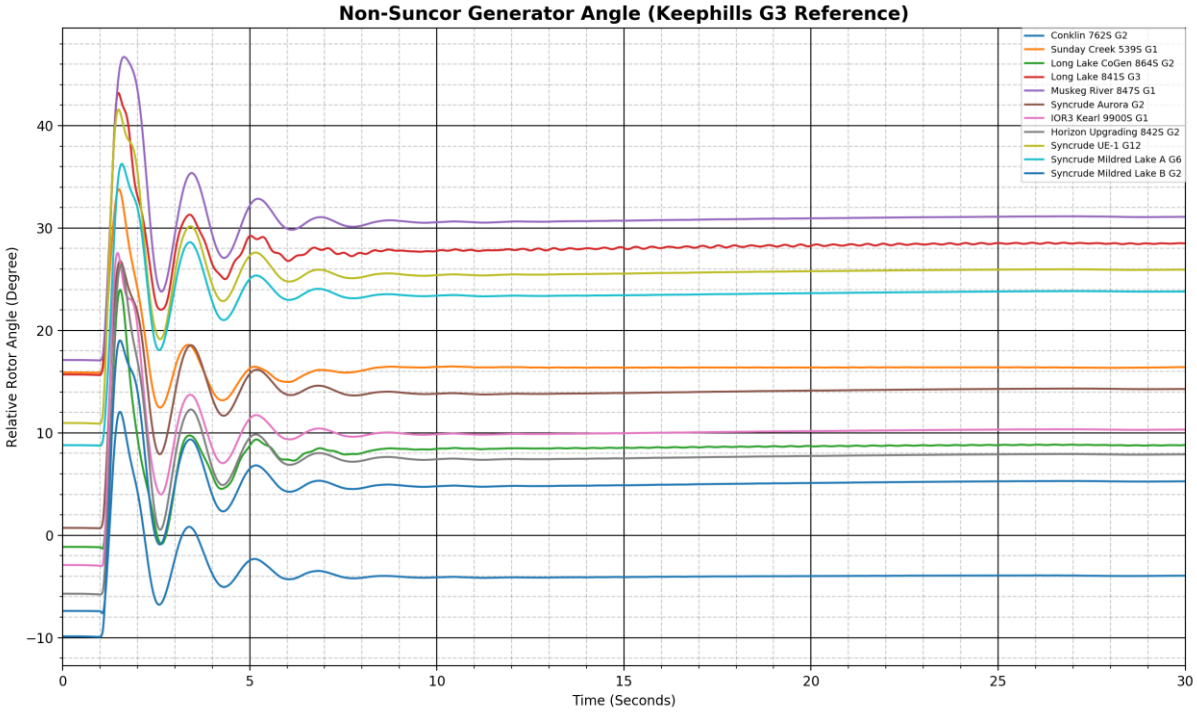
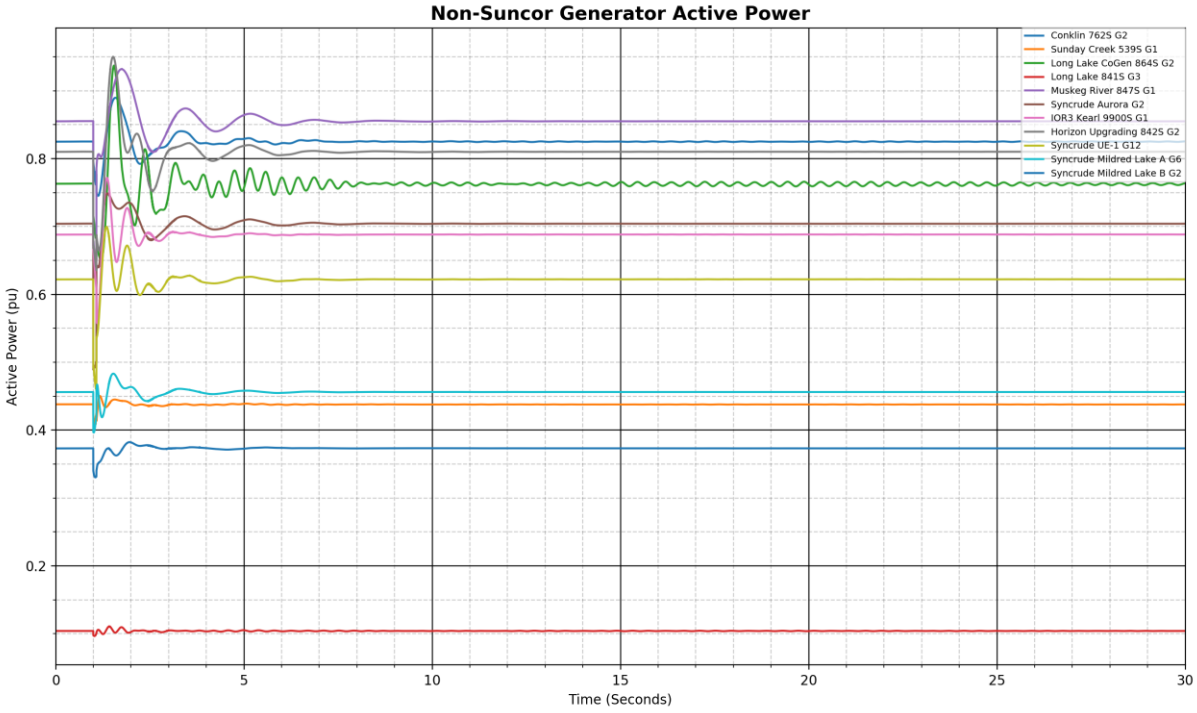
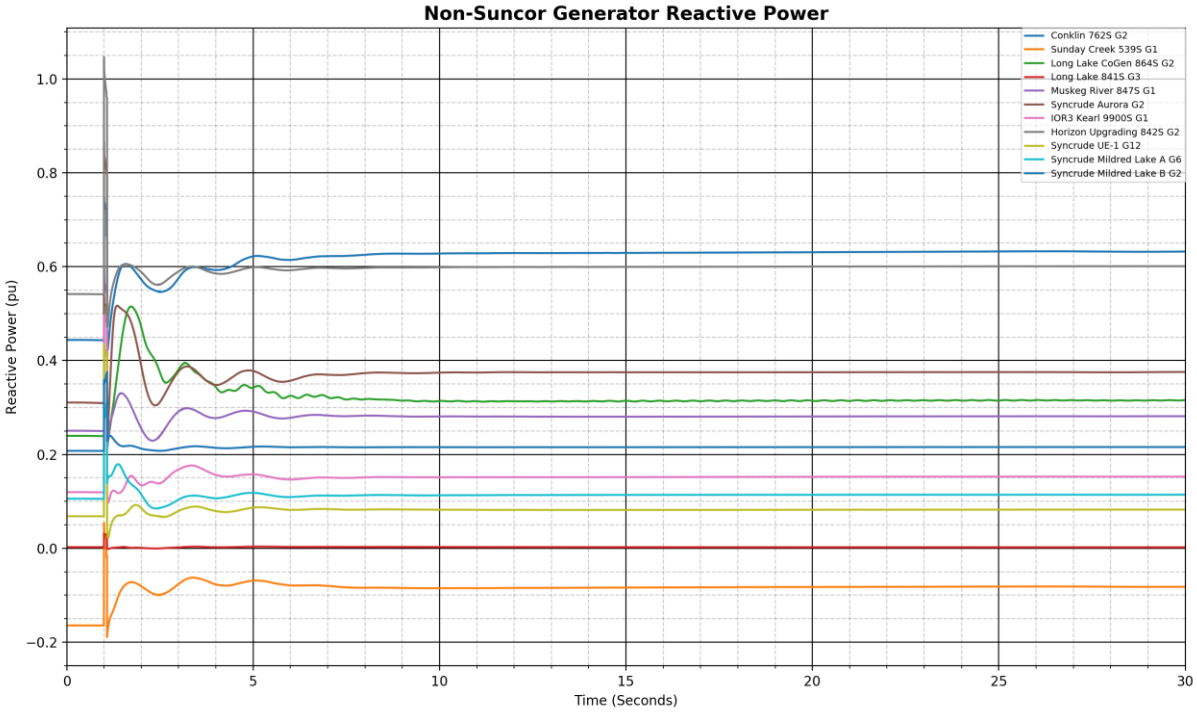

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
600
500
400
300
200
100
0
−100
−200
0
5
10
15
20
25
30
Time (Seconds)

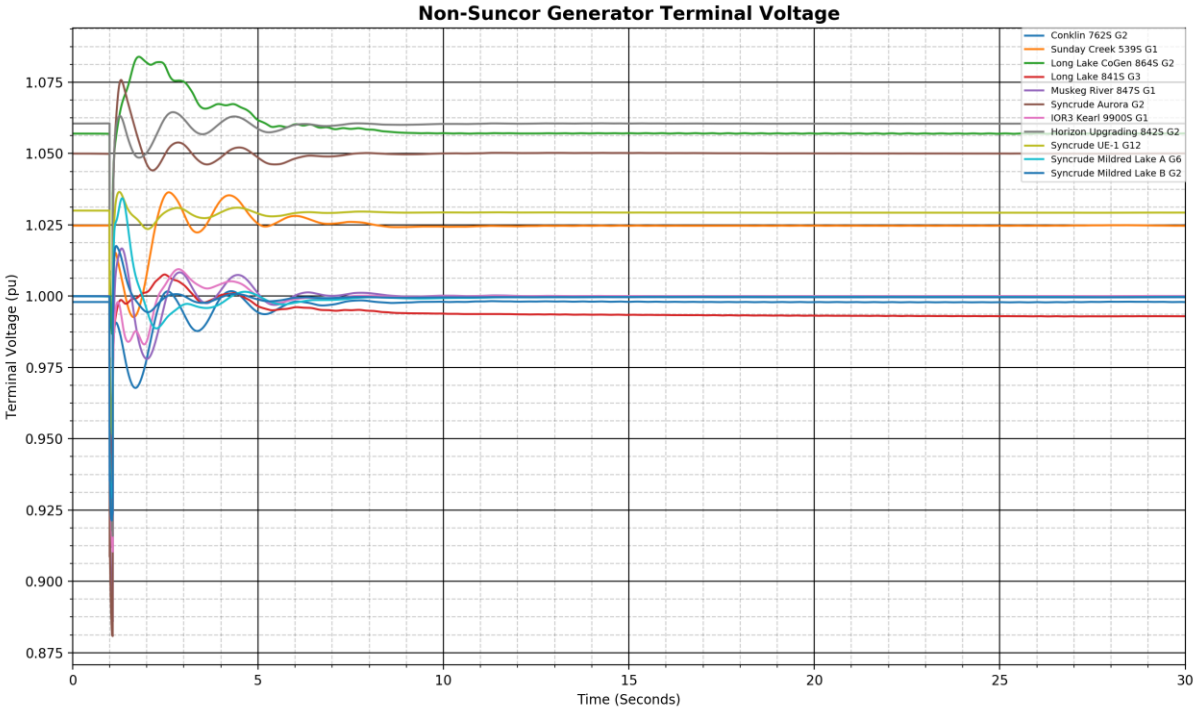
Figure A4-28: 12L44 (Thickwood Hills 951S to Livock 939S): Fault at Livock 939S

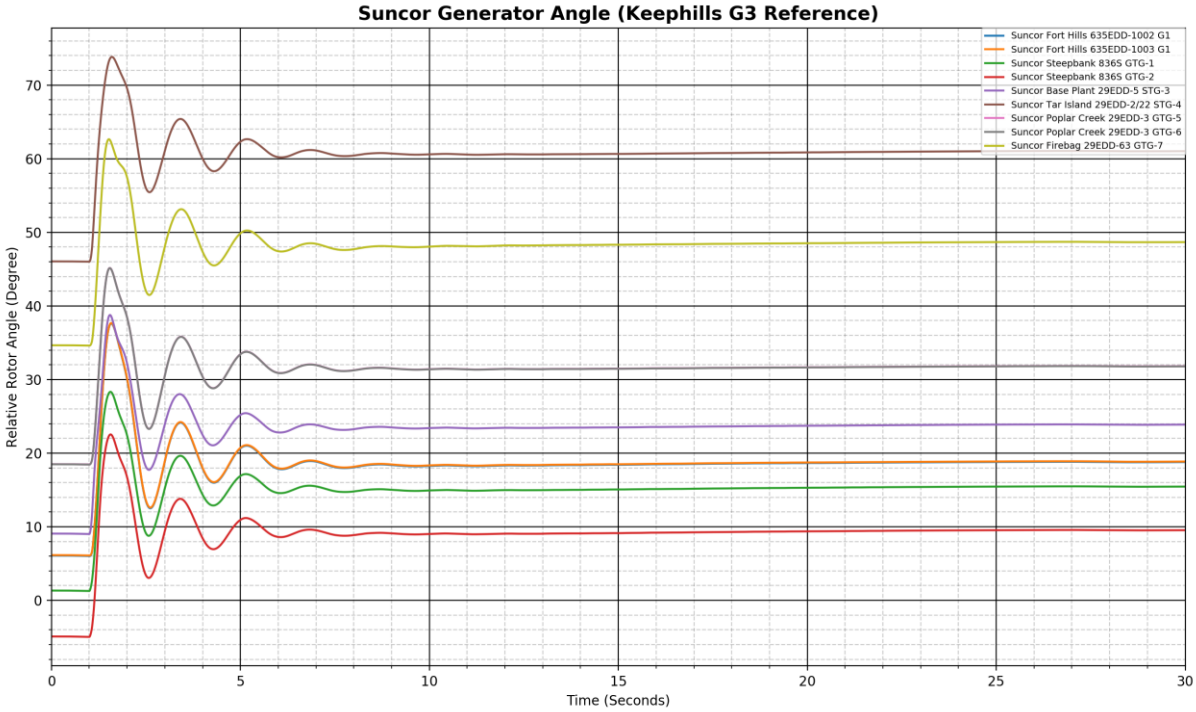


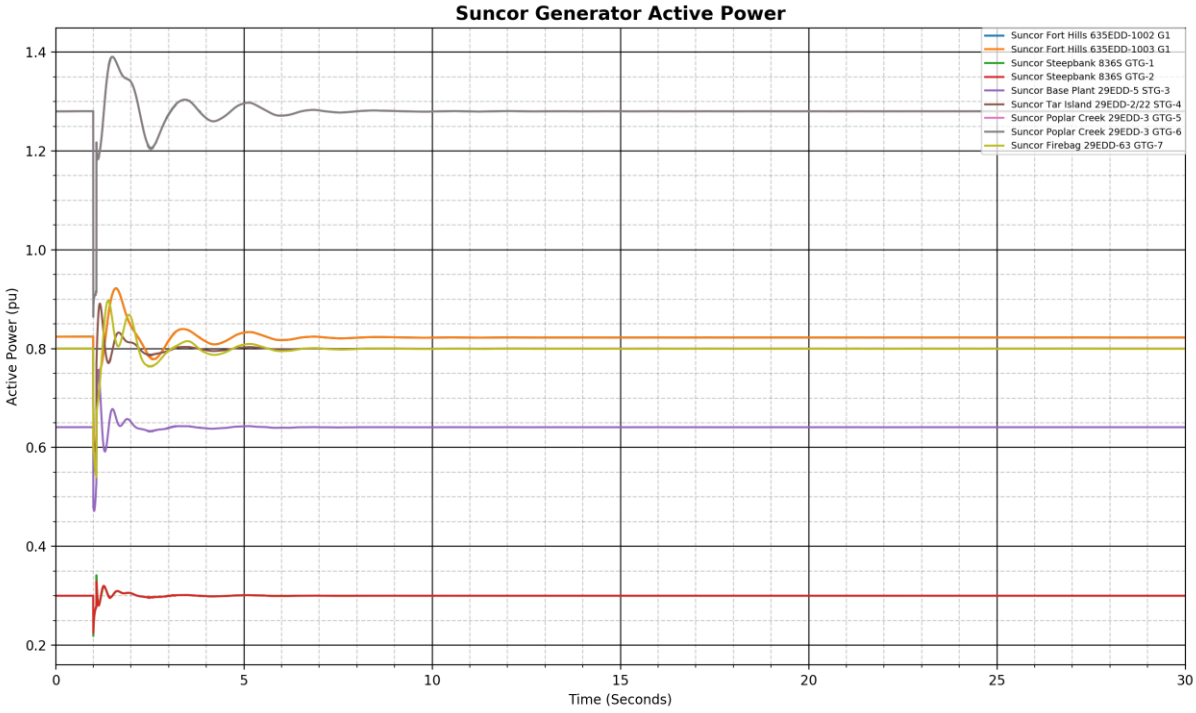

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

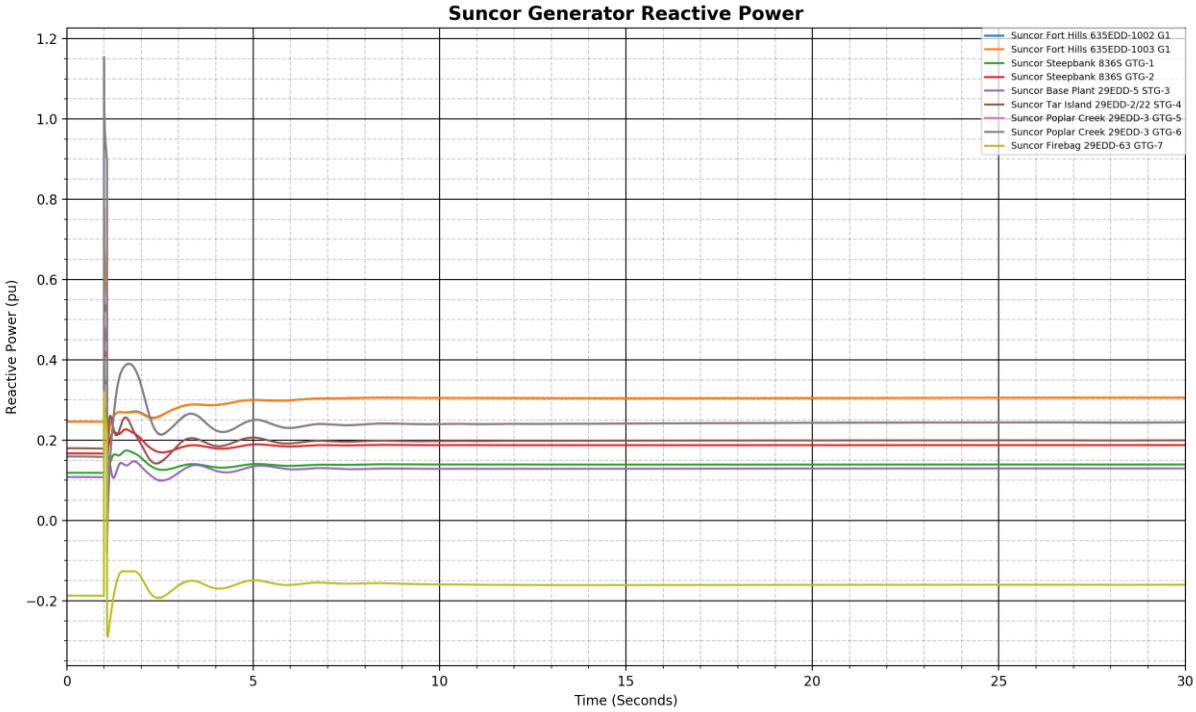

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

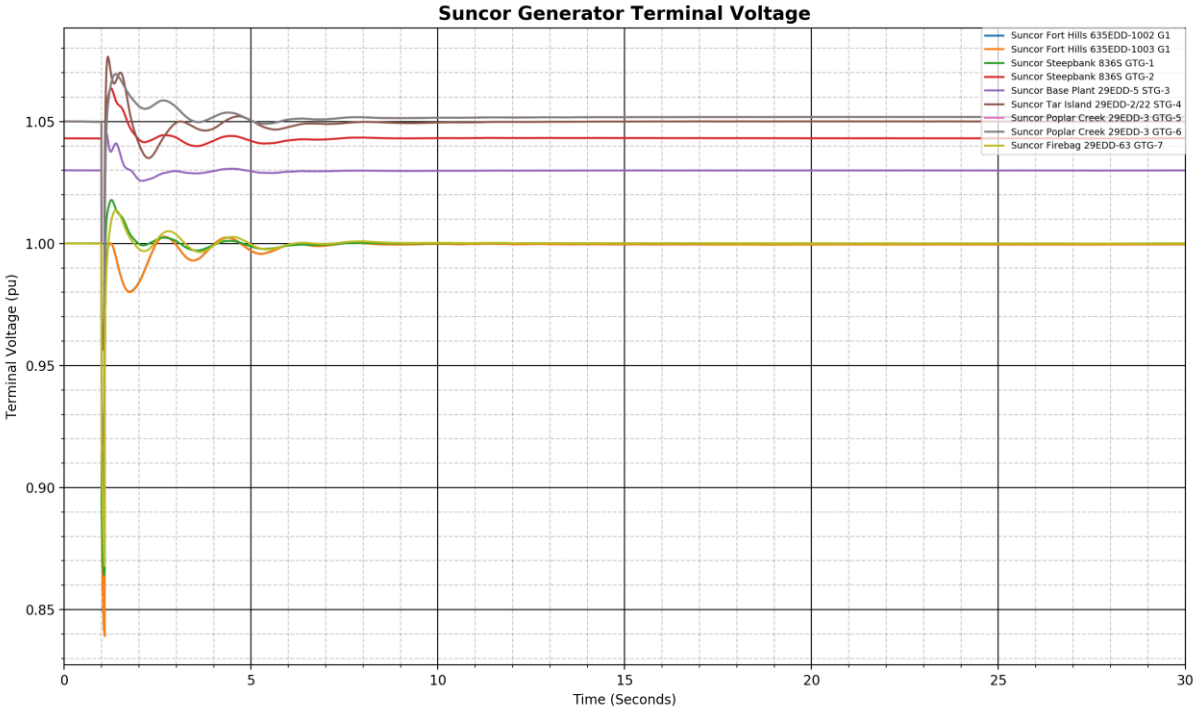

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

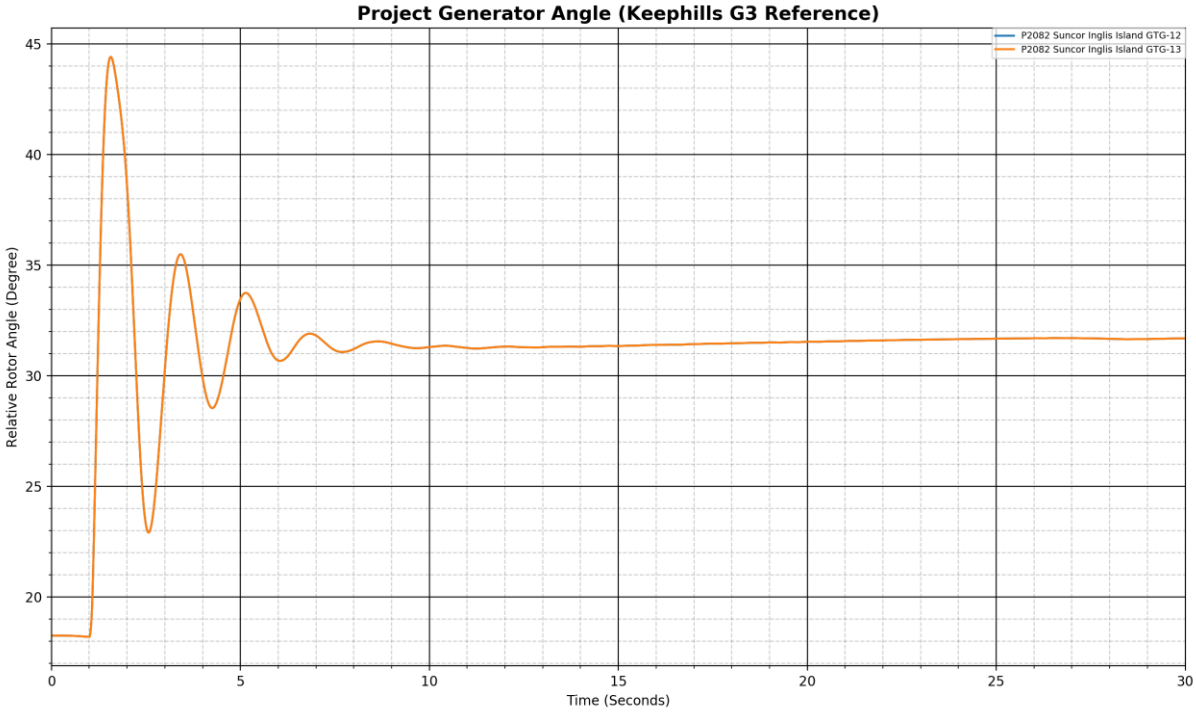

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

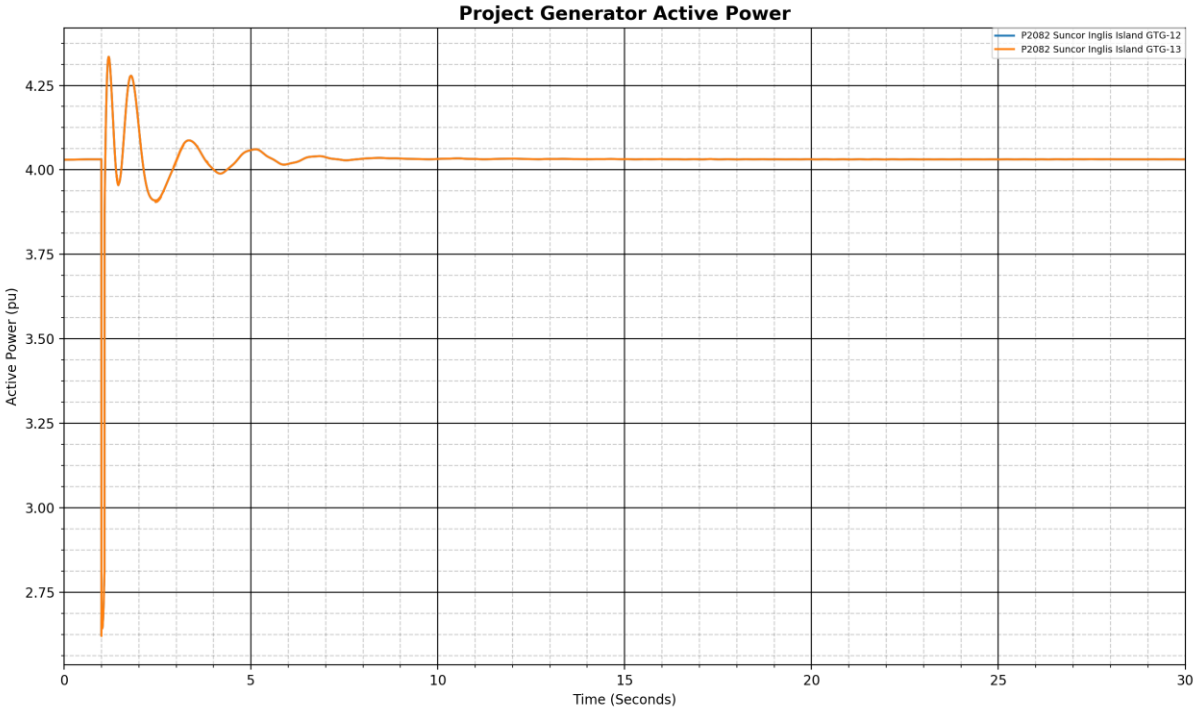

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

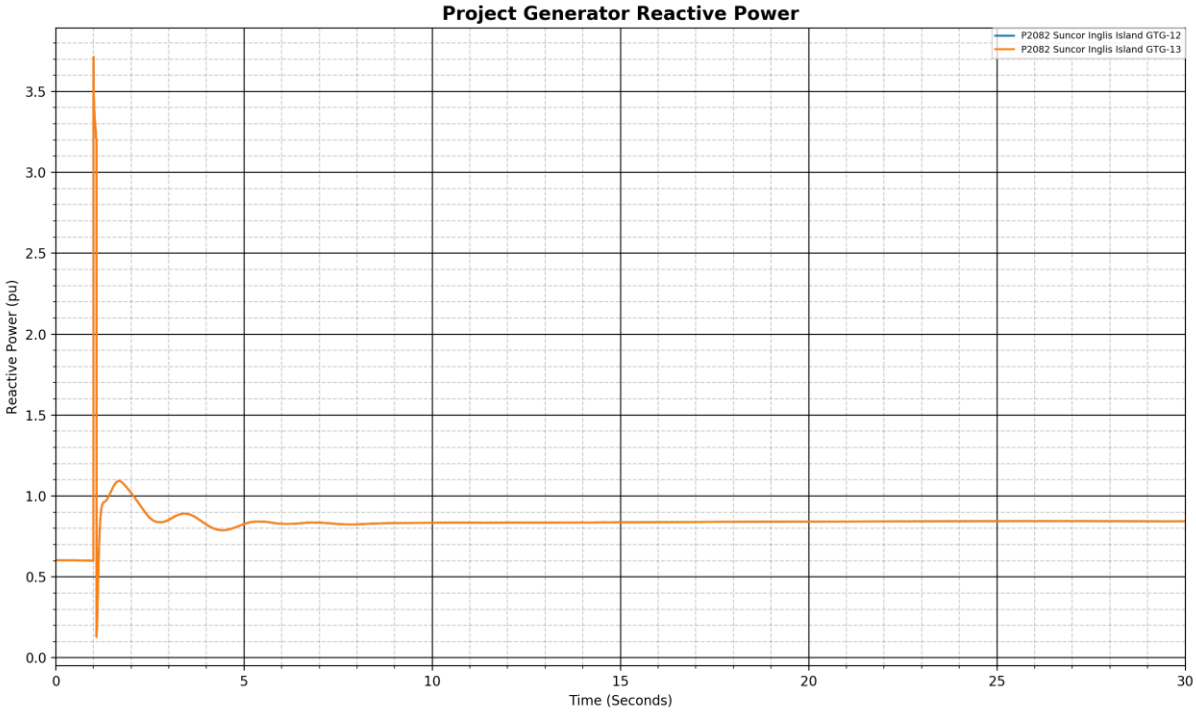

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

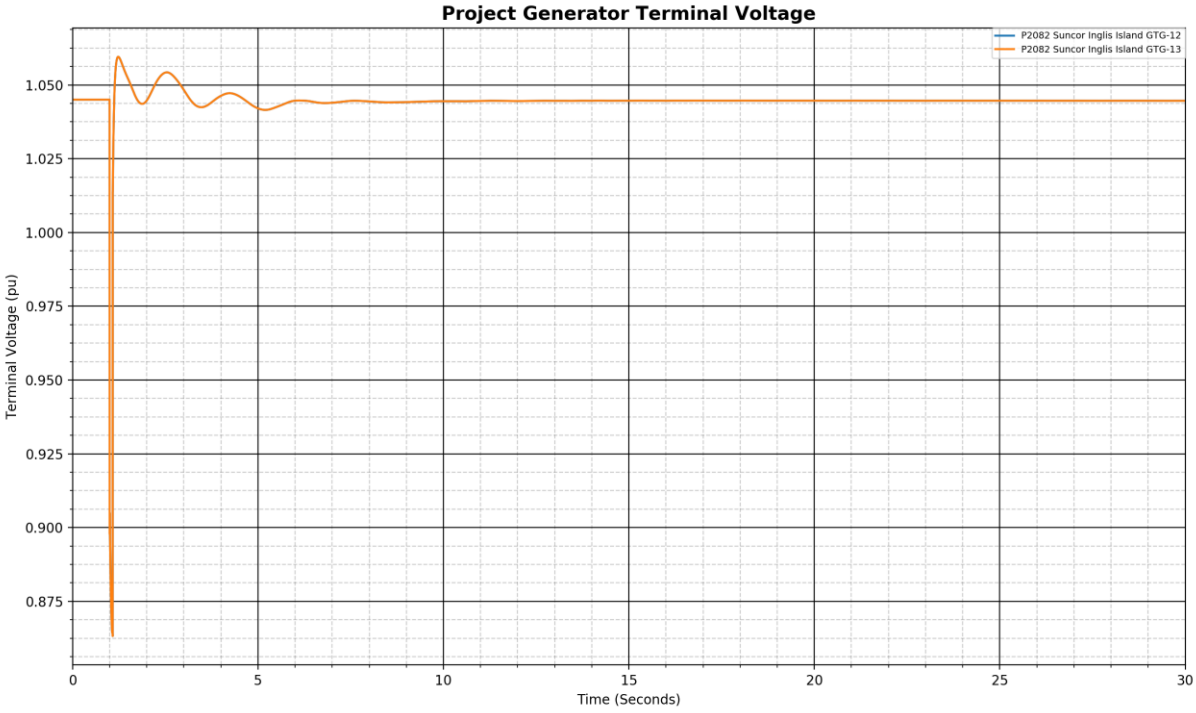

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

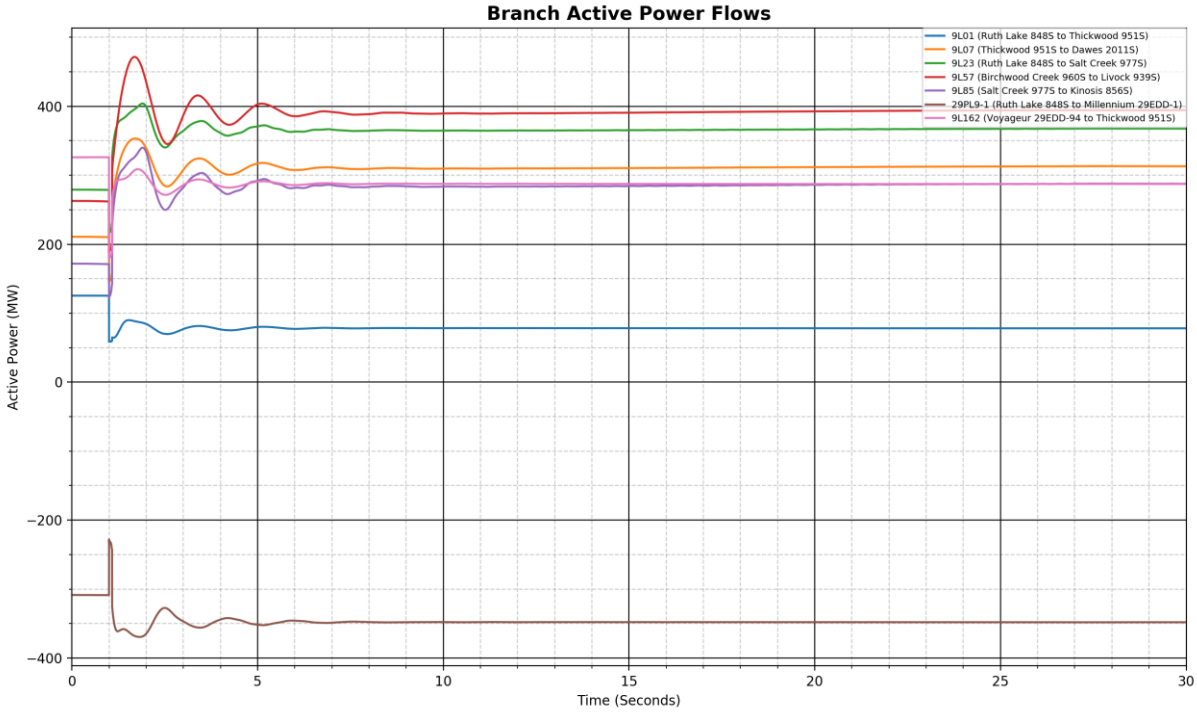

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
45
40
35
30
25
20
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.25
4.00
3.75
3.50
3.25
3.00
2.75
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.875
0.900
0.925
0.950
0.975
1.000
1.025
1.050
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

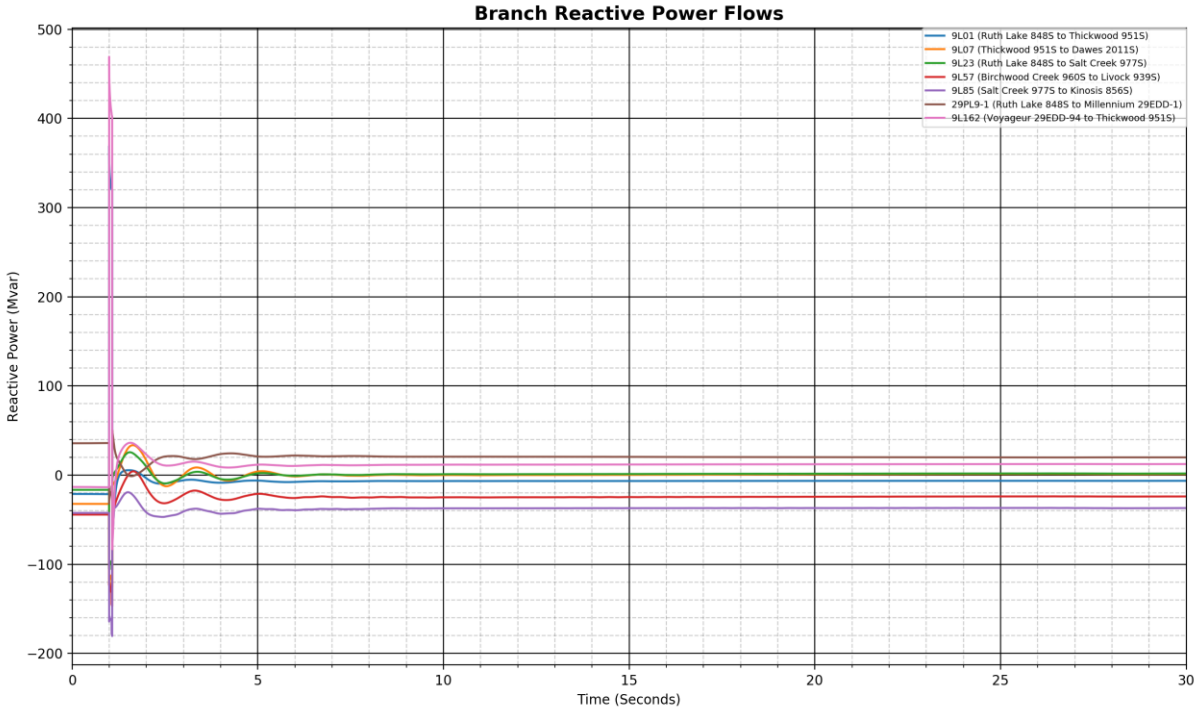
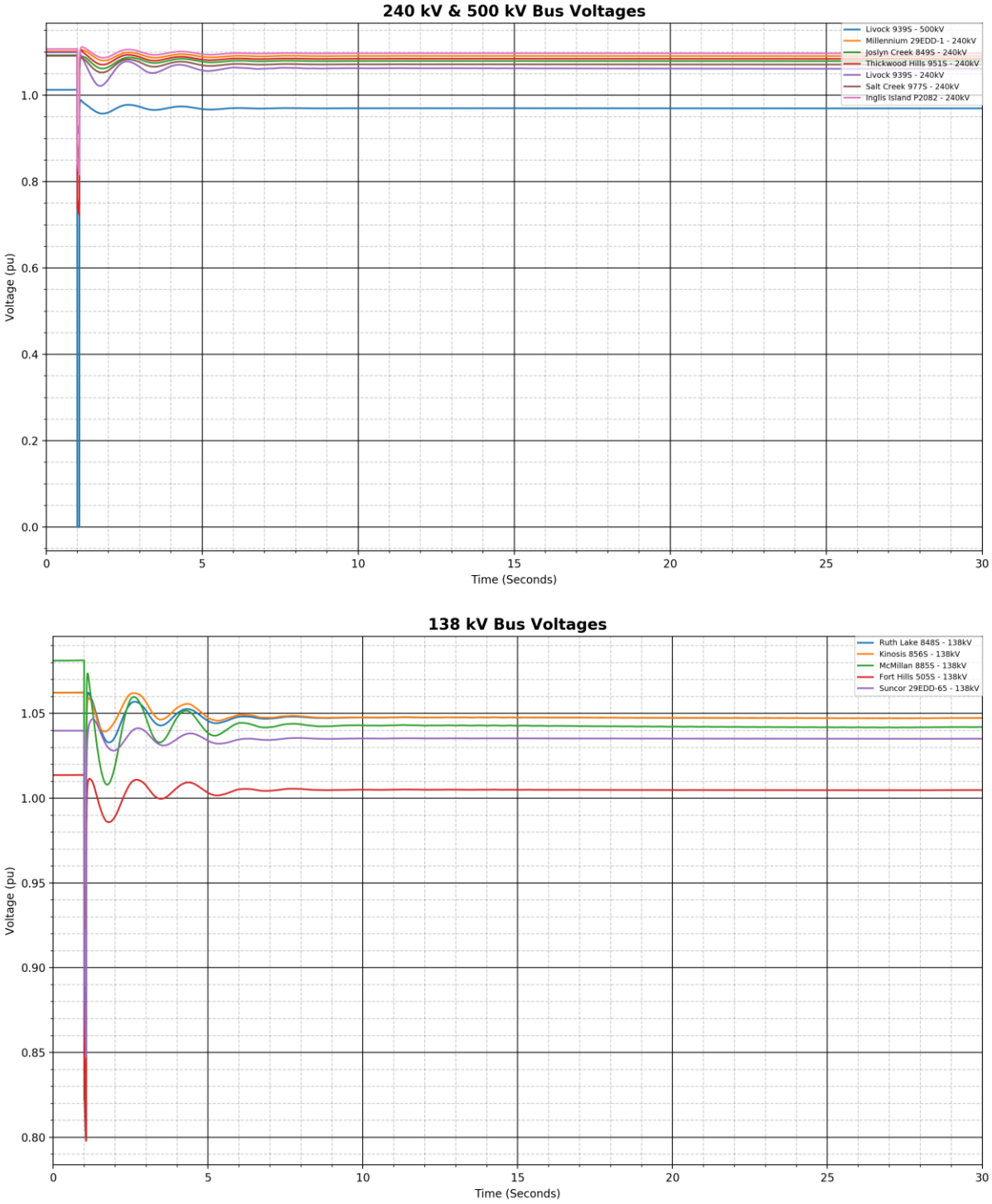
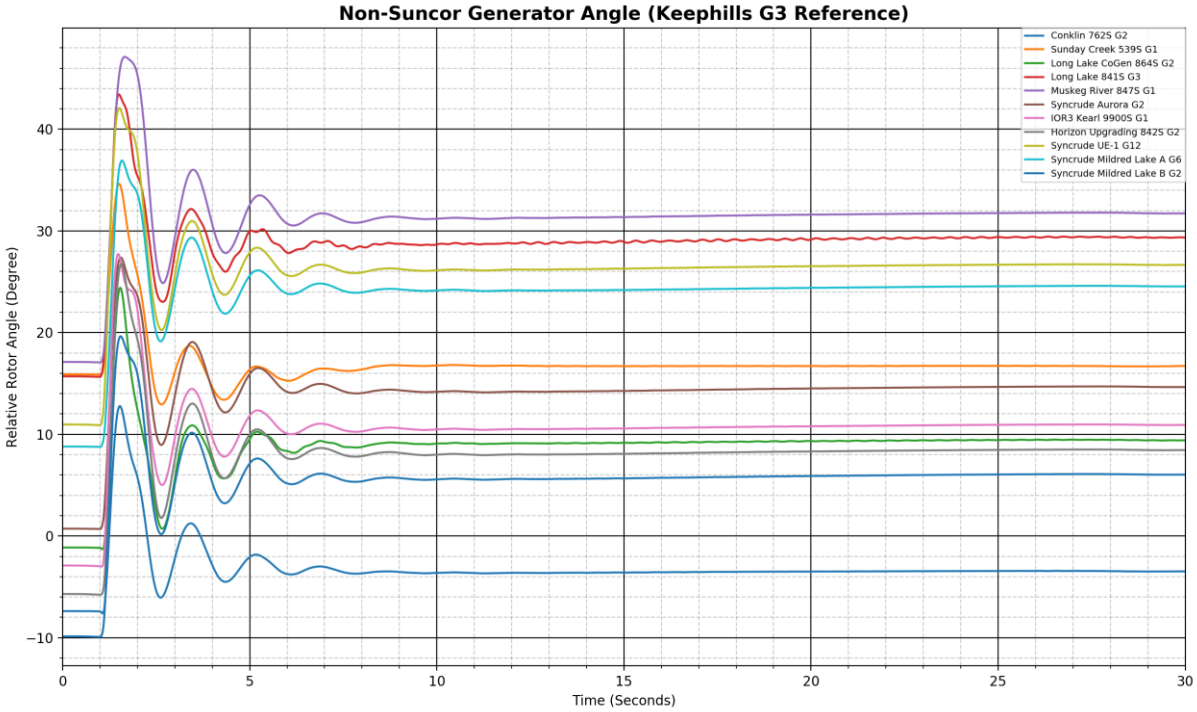
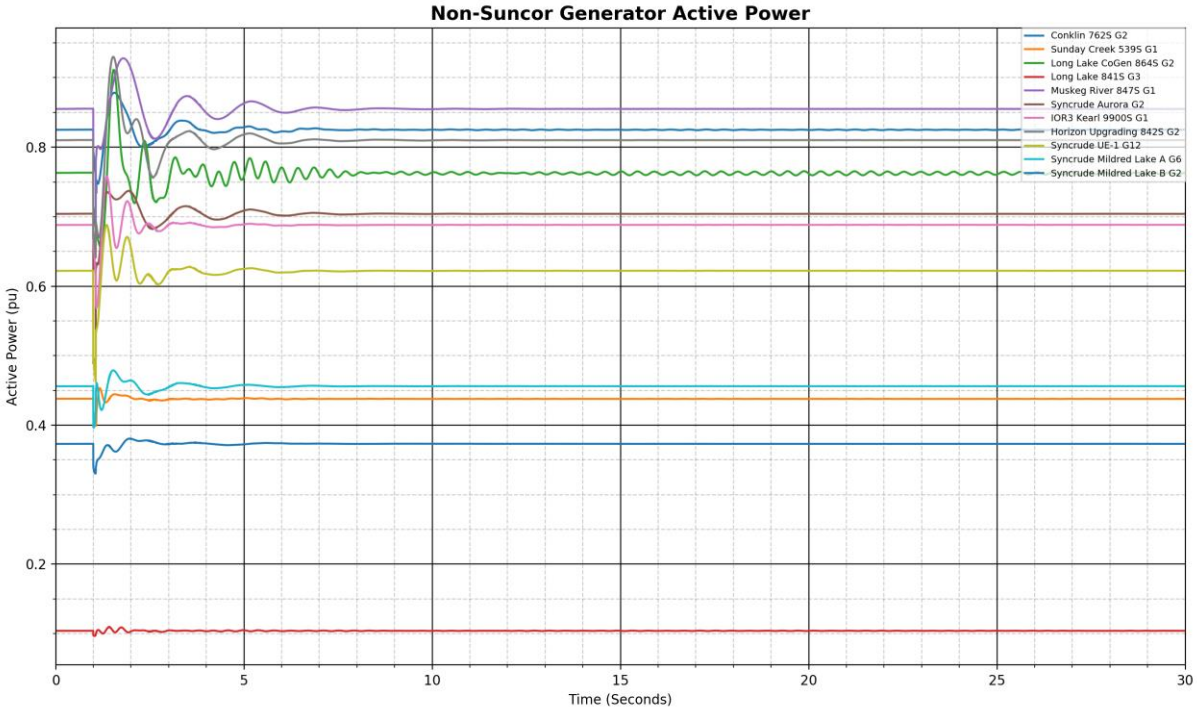
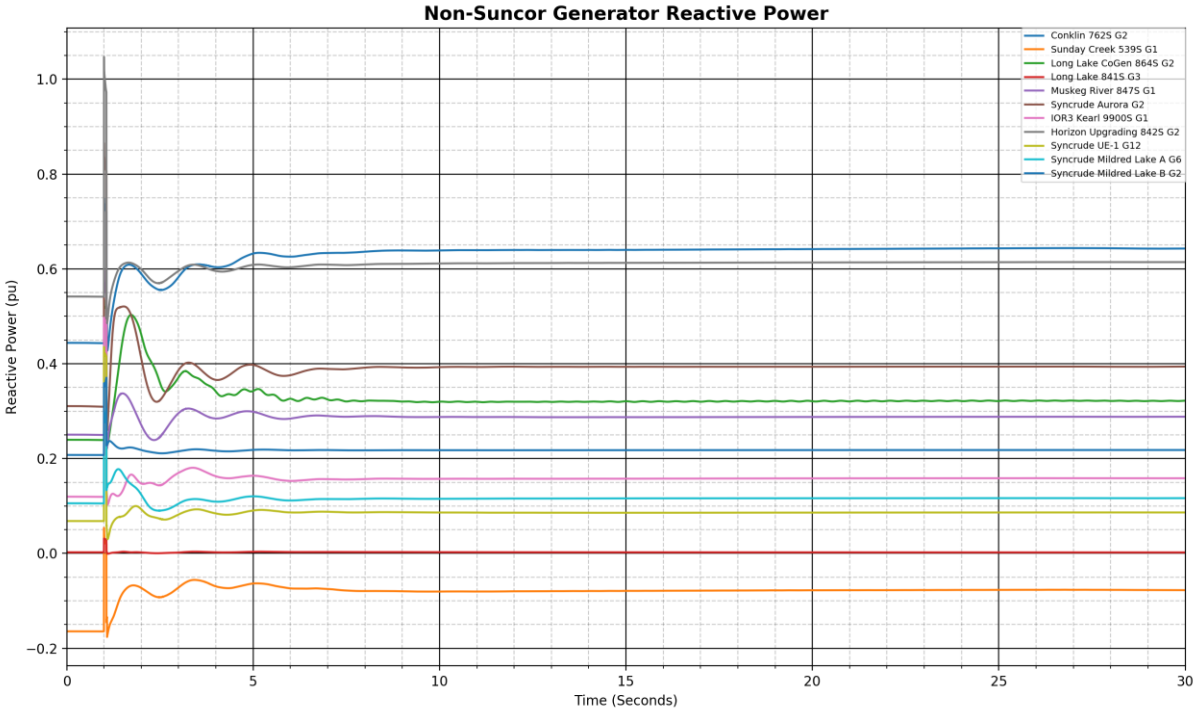

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

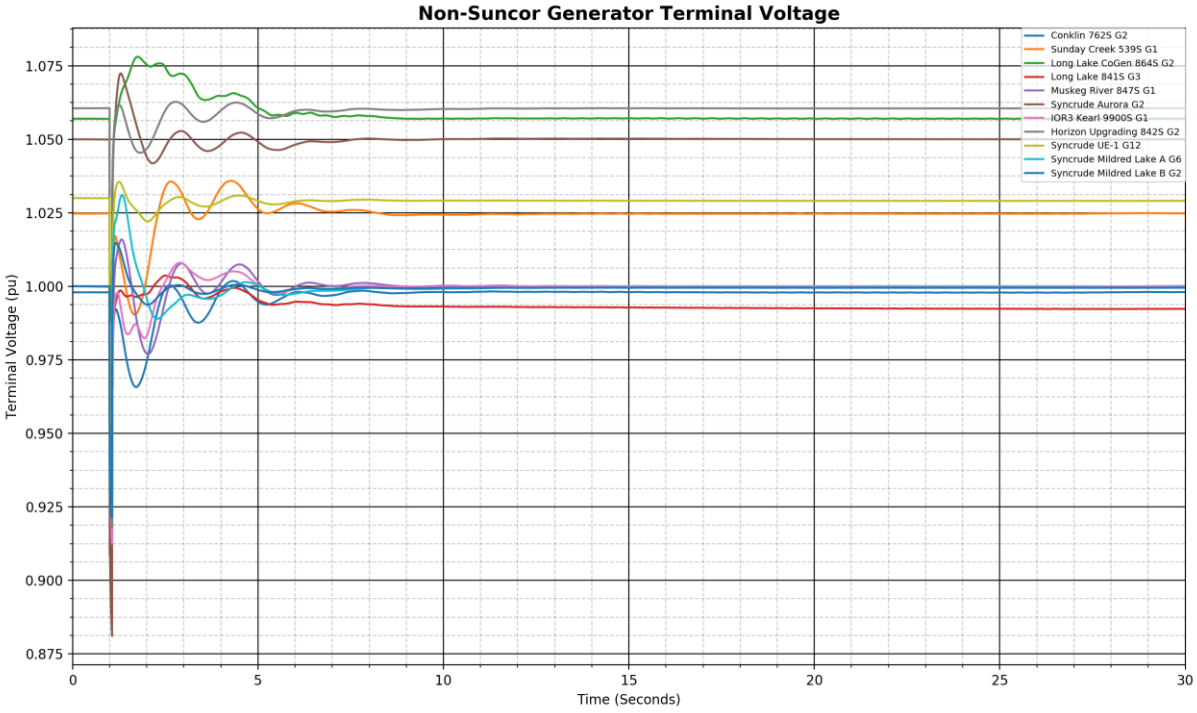
Figure A4-29: 12L41 (Livock 939S to Sunnybrook 510S): Fault at Livock 939S

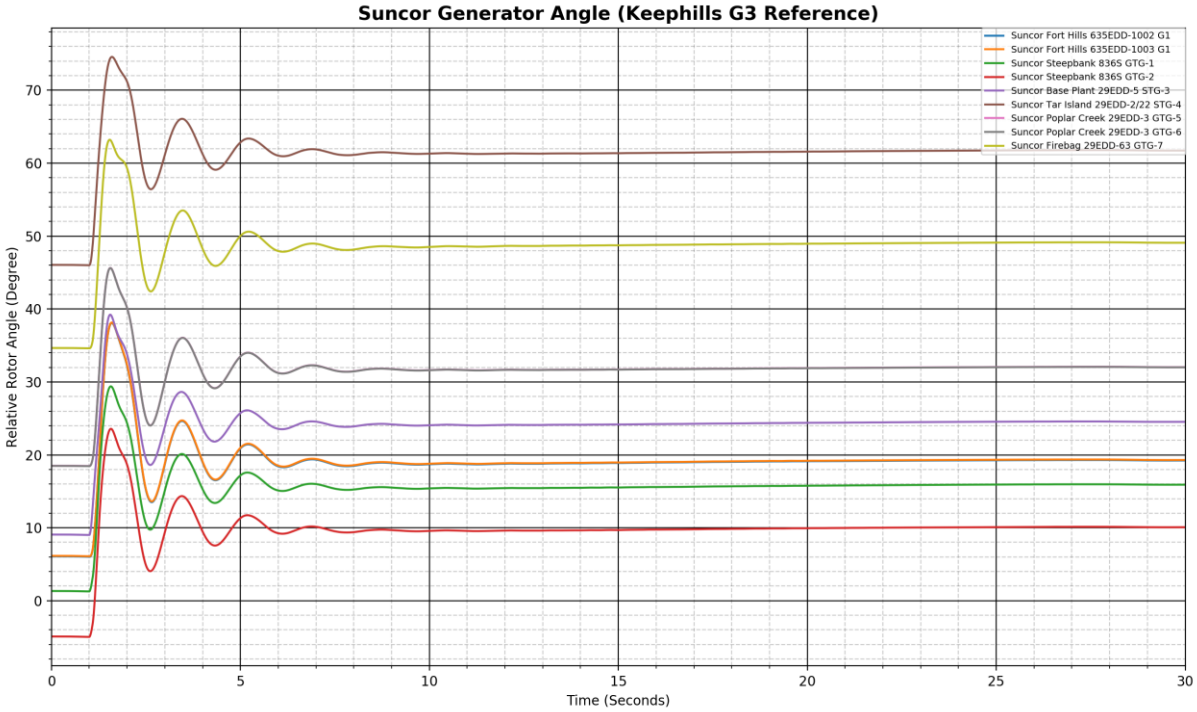


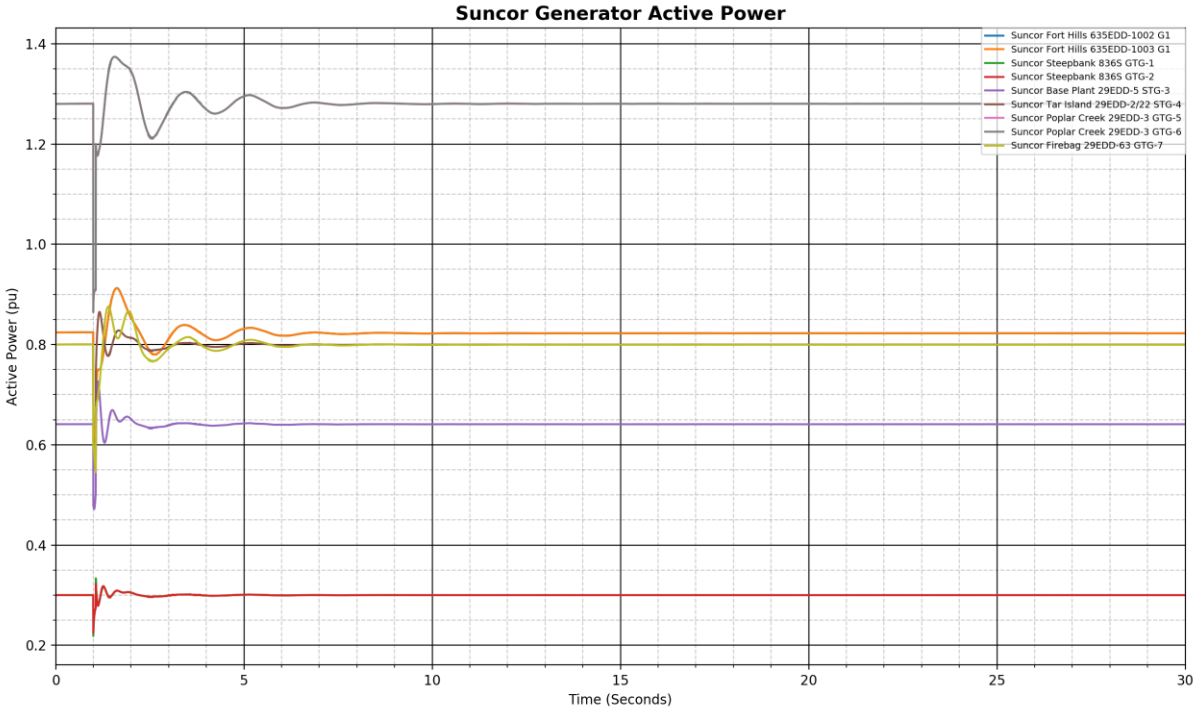

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

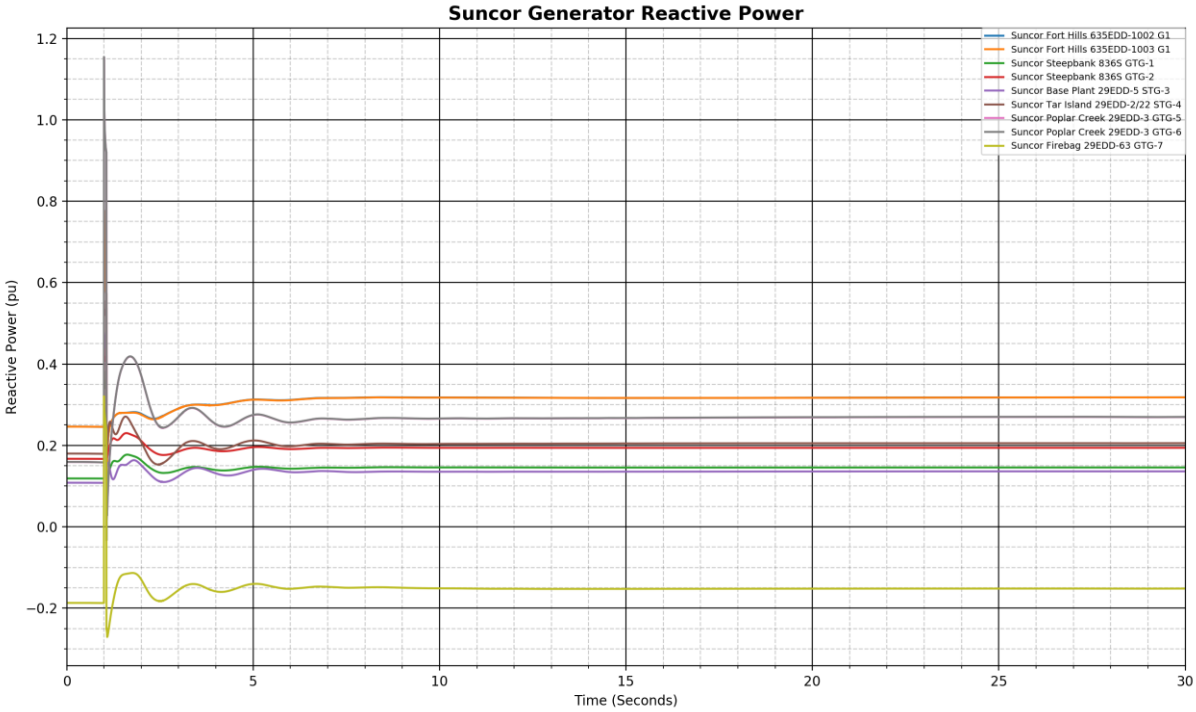

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

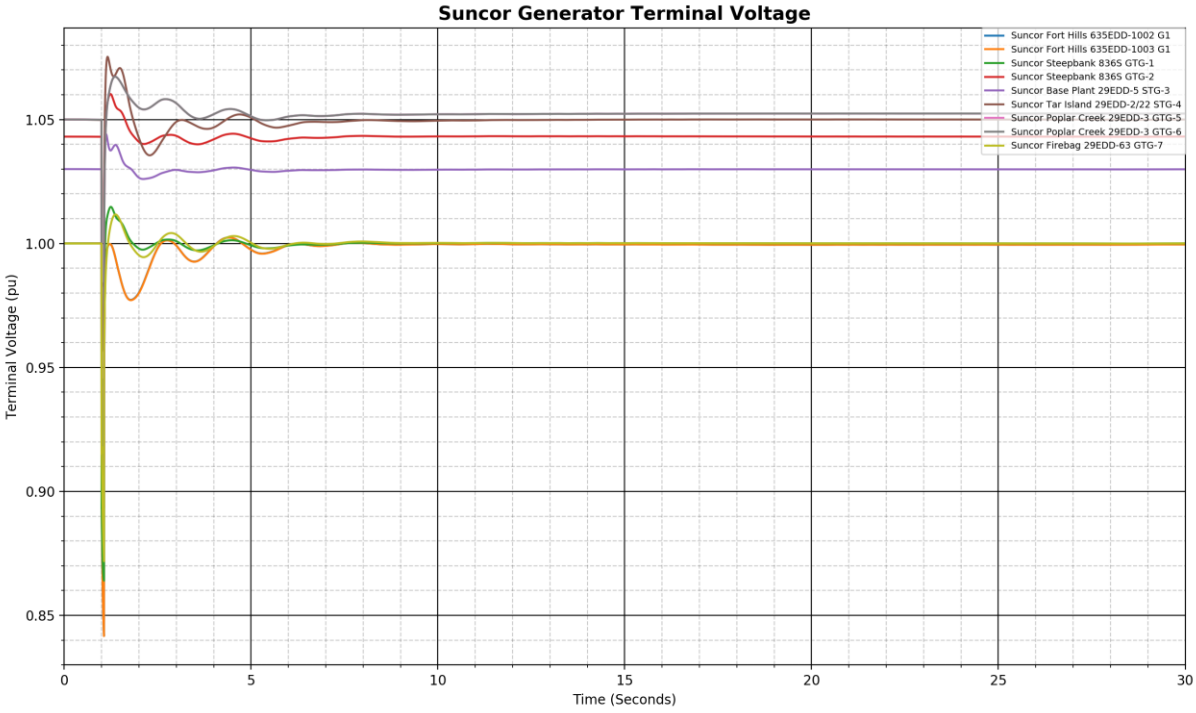

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

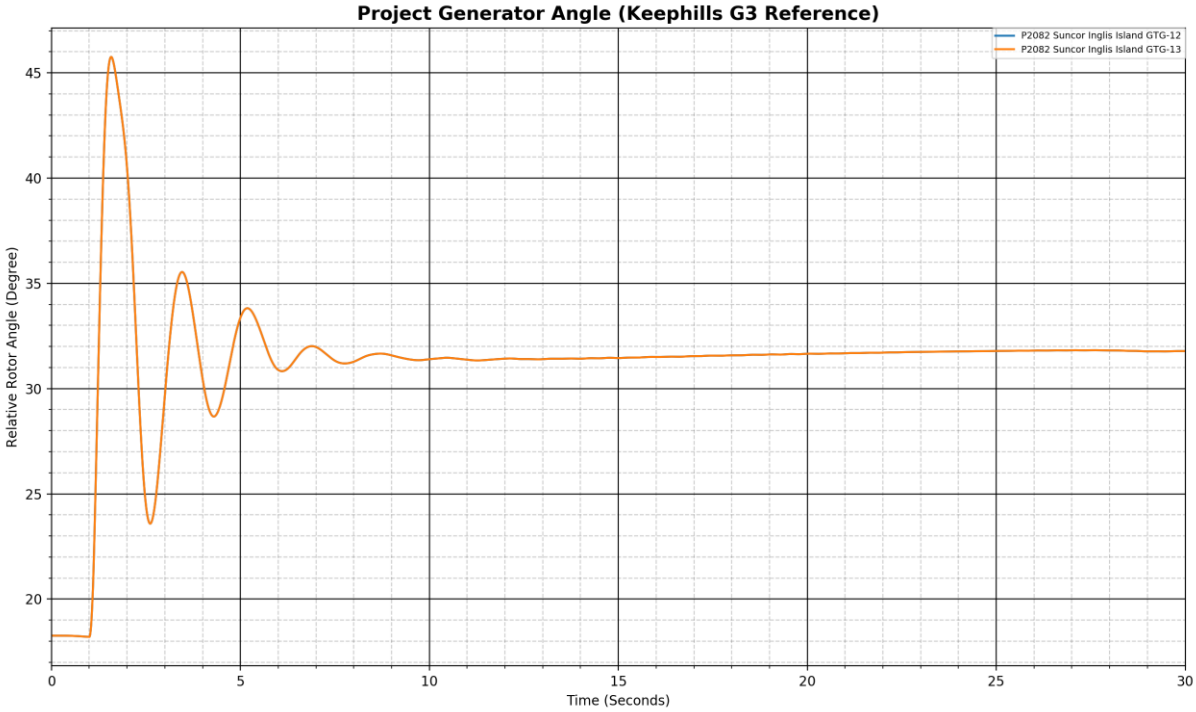

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

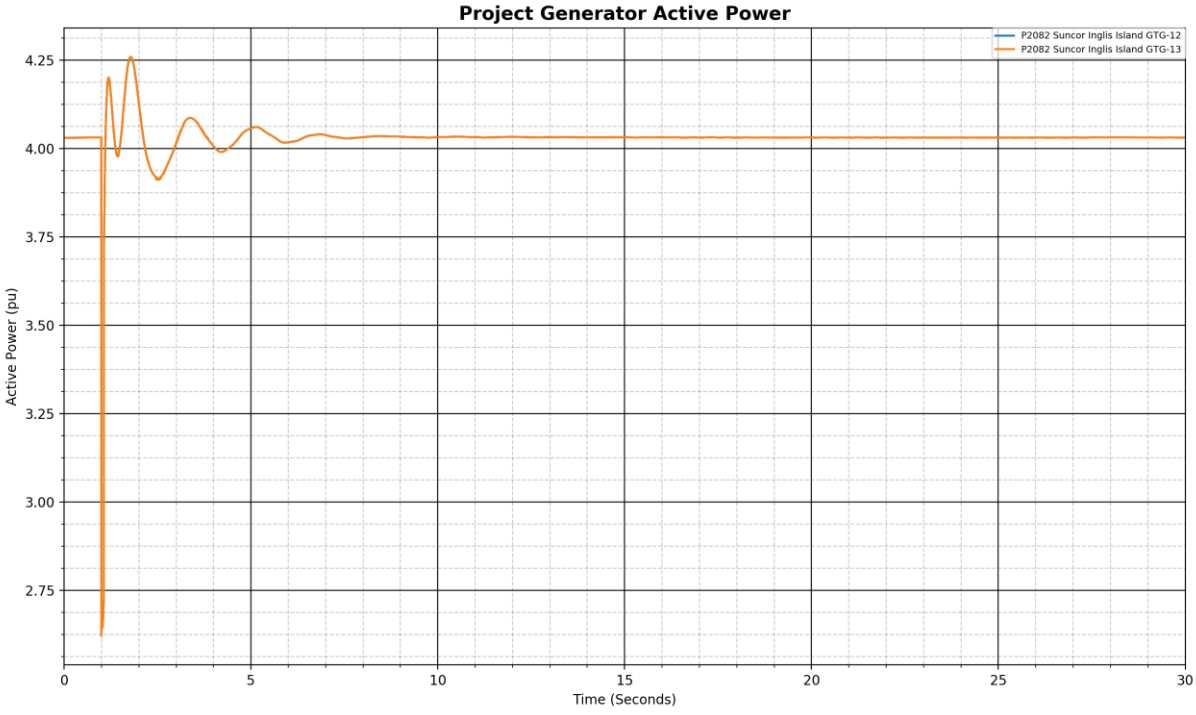

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

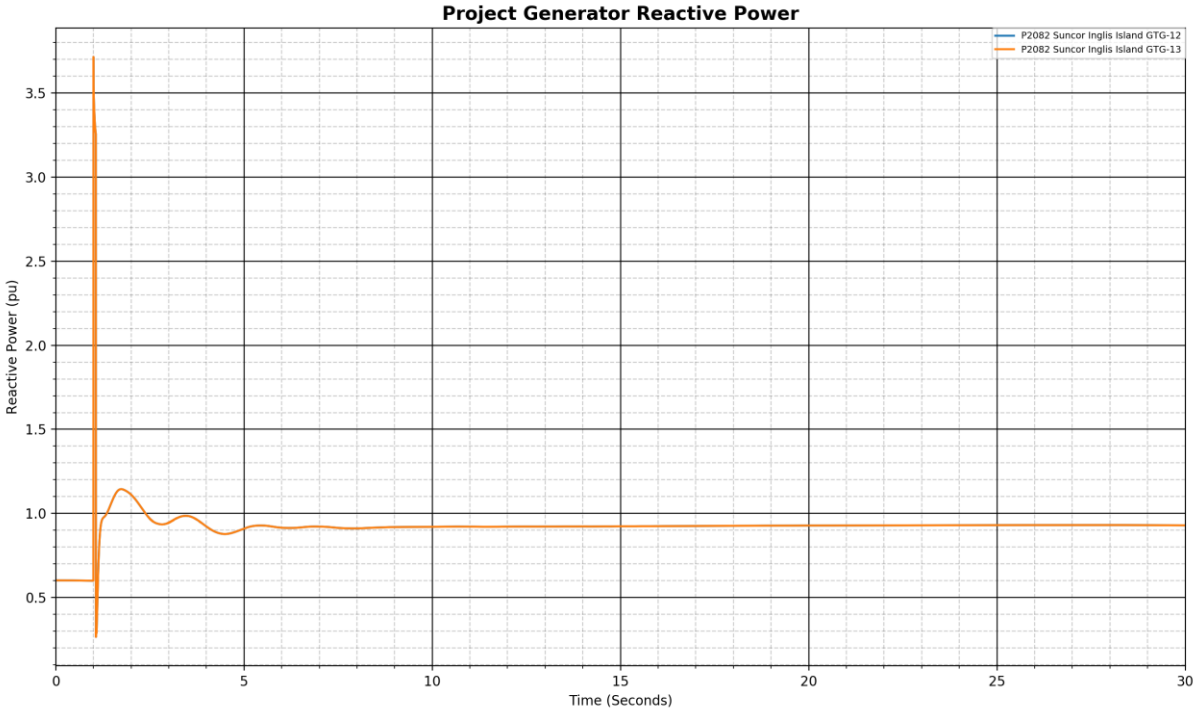

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

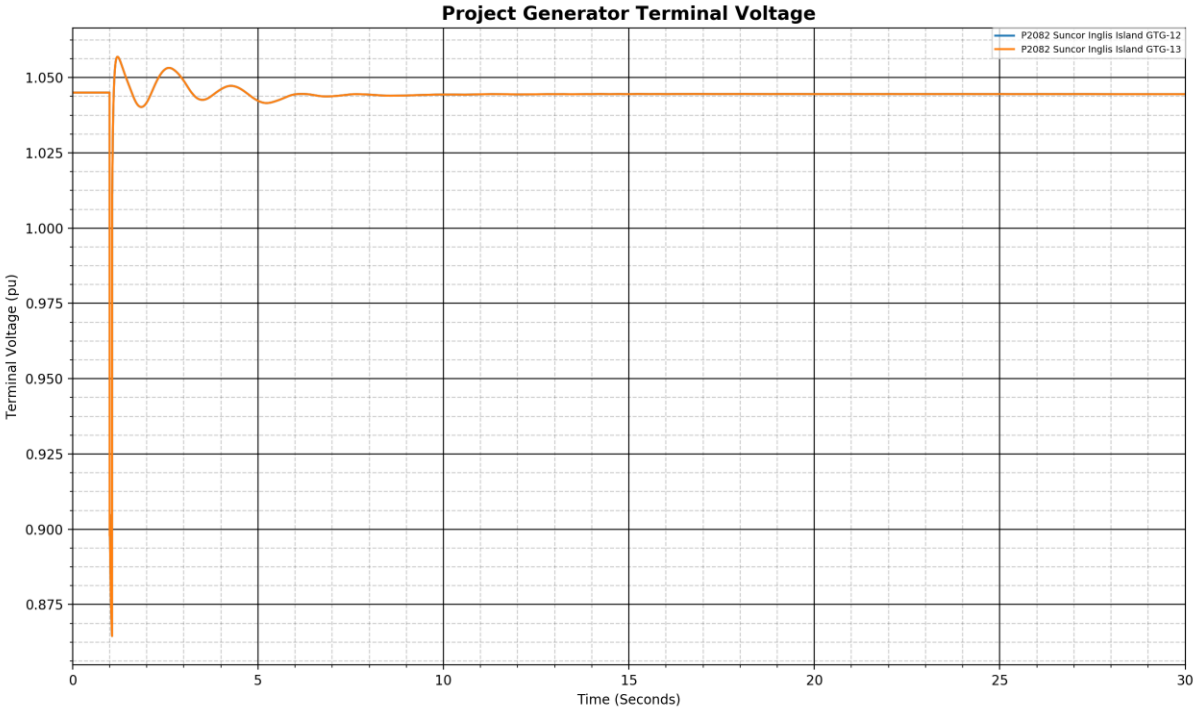

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

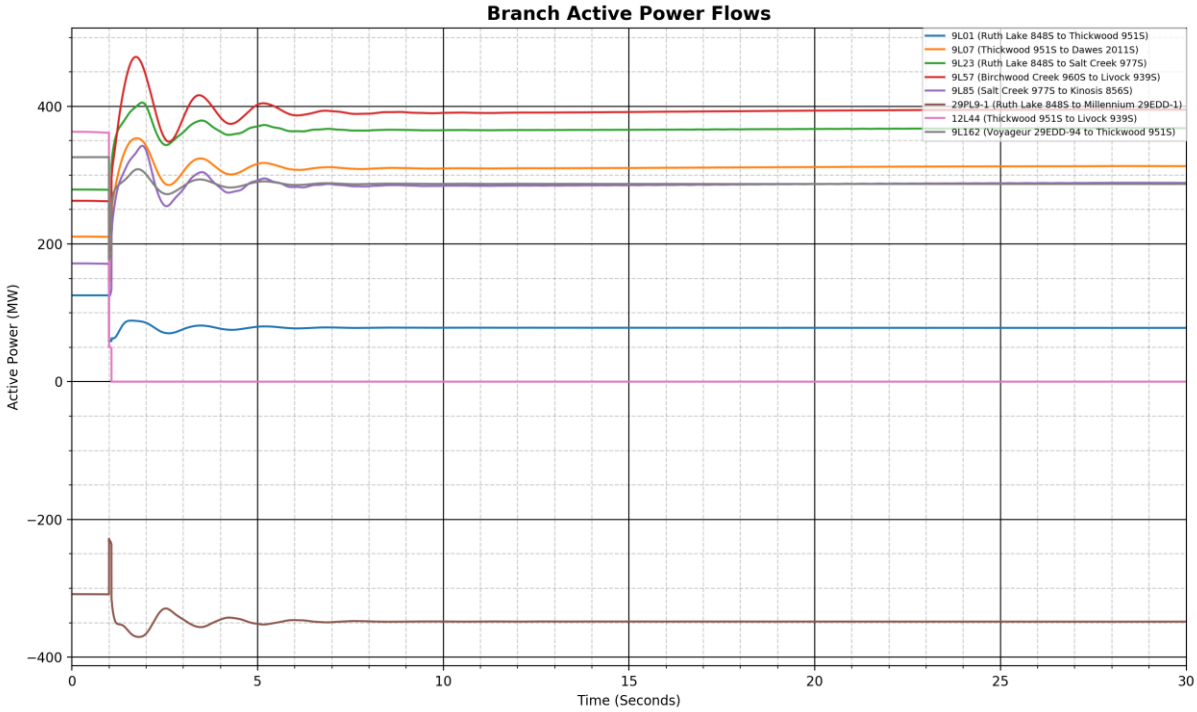

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
45
40
35
30
25
20
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.25
4.00
3.75
3.50
3.25
3.00
2.75
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.050
1.025
1.000
0.975
0.950
0.925
0.900
0.875
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

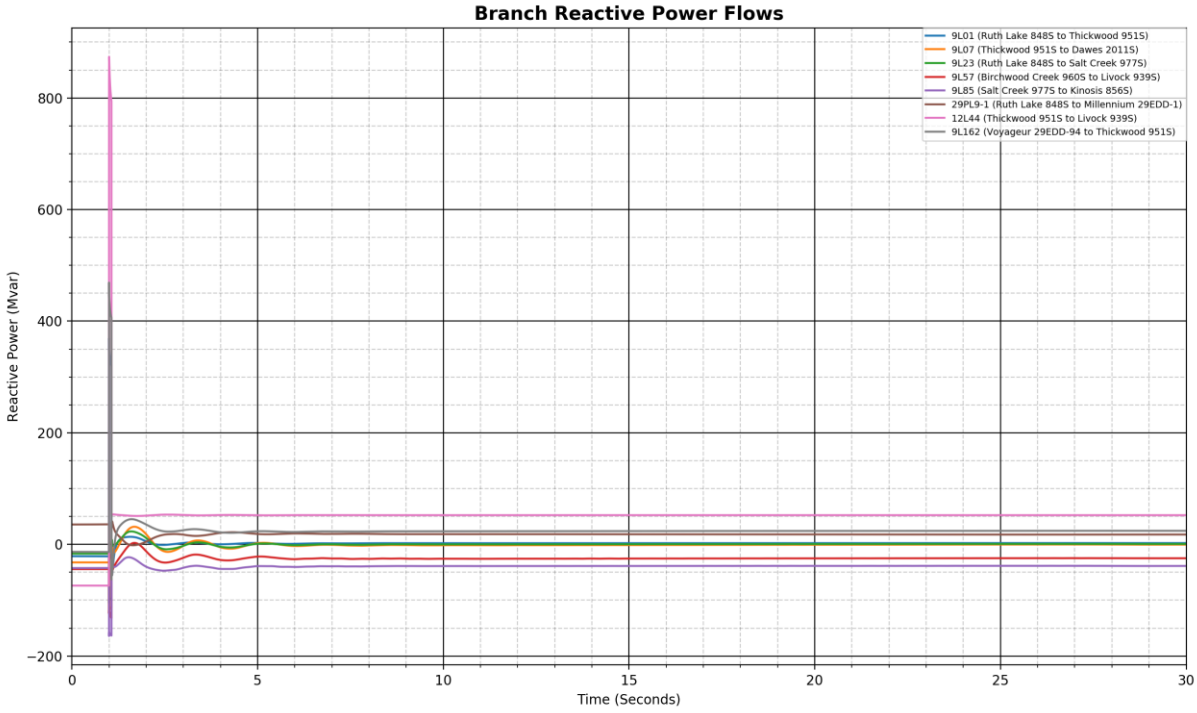
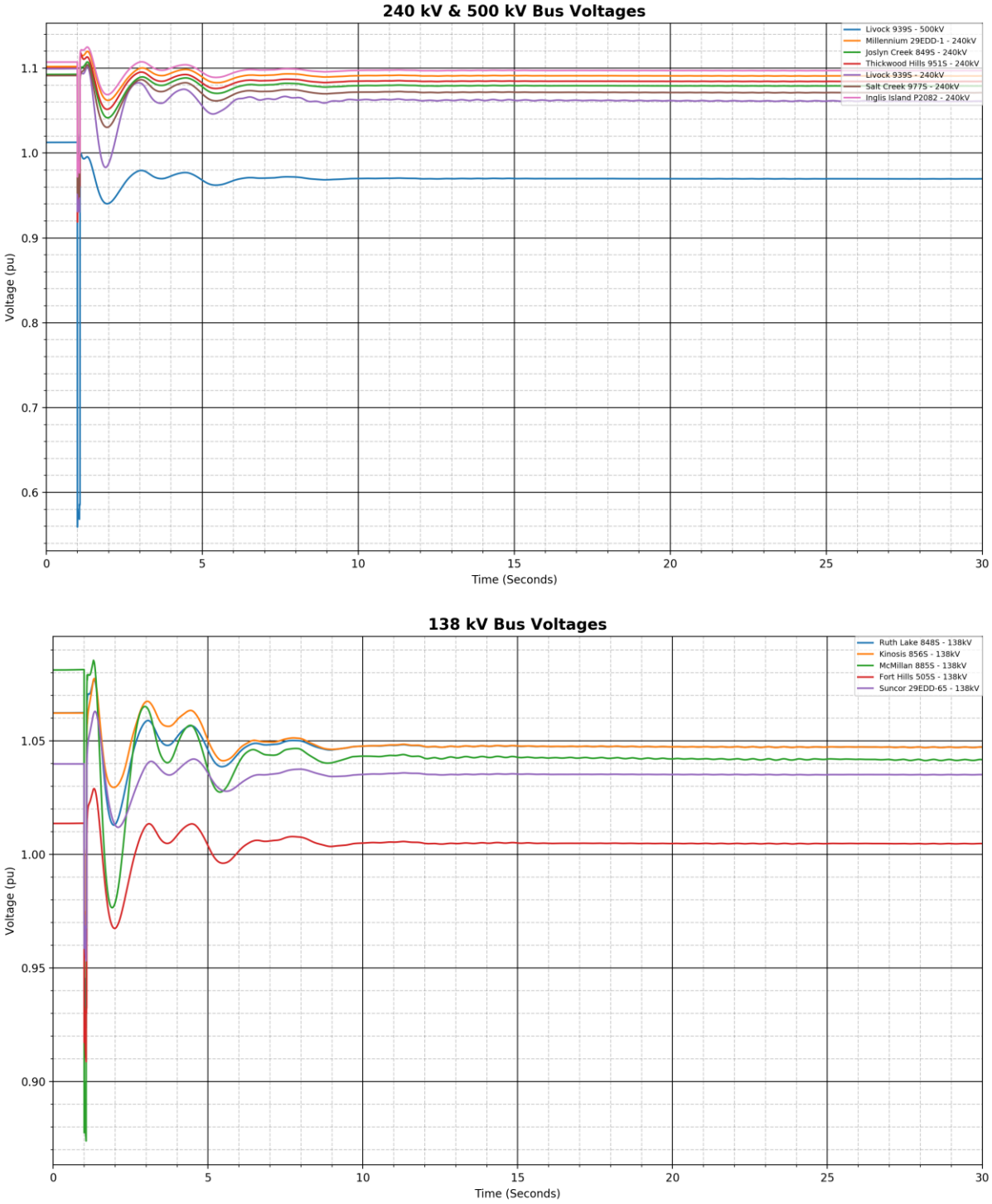
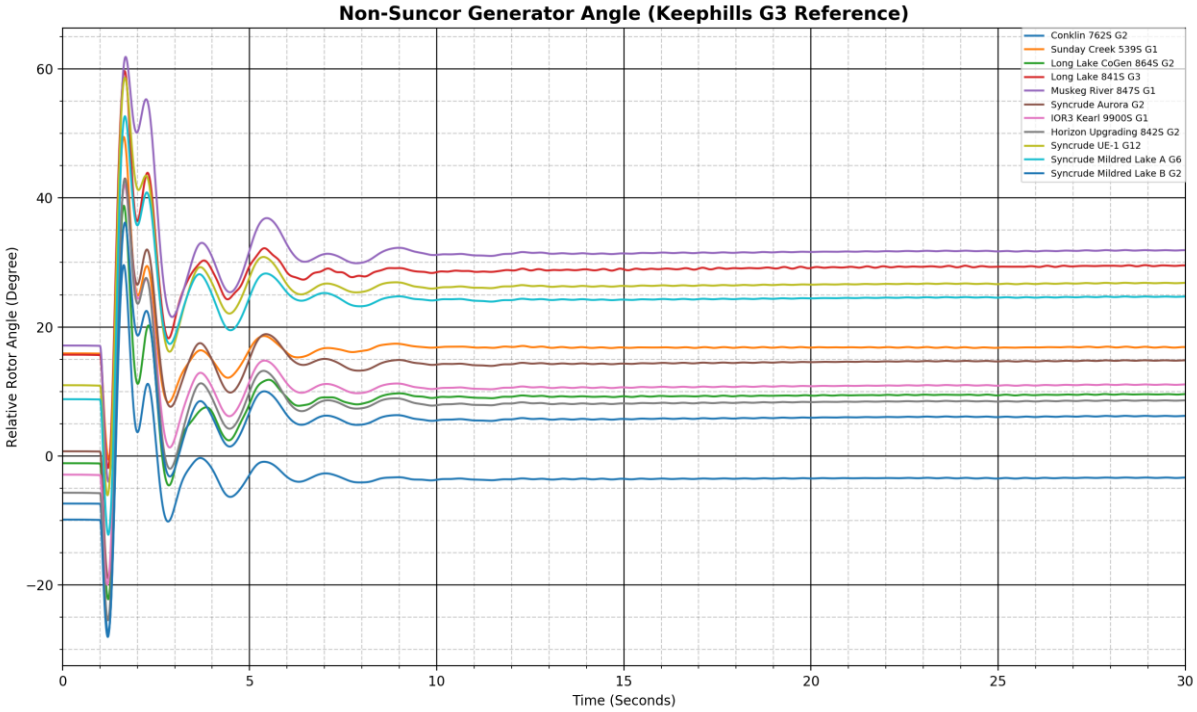
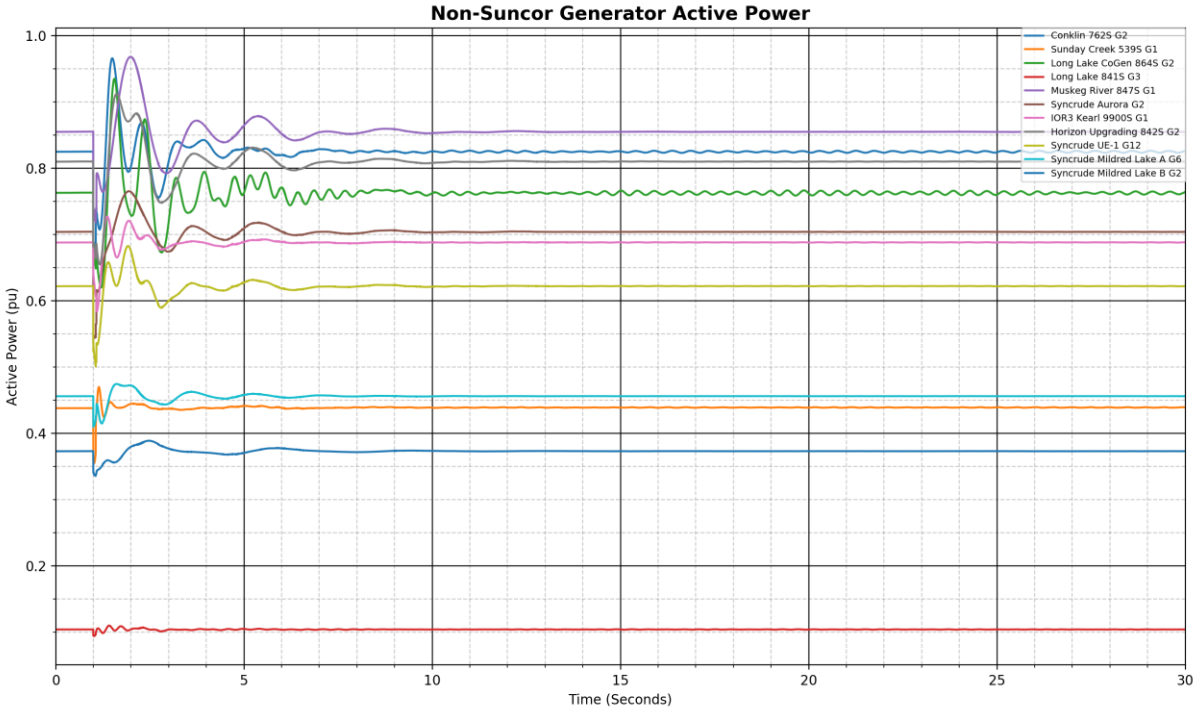
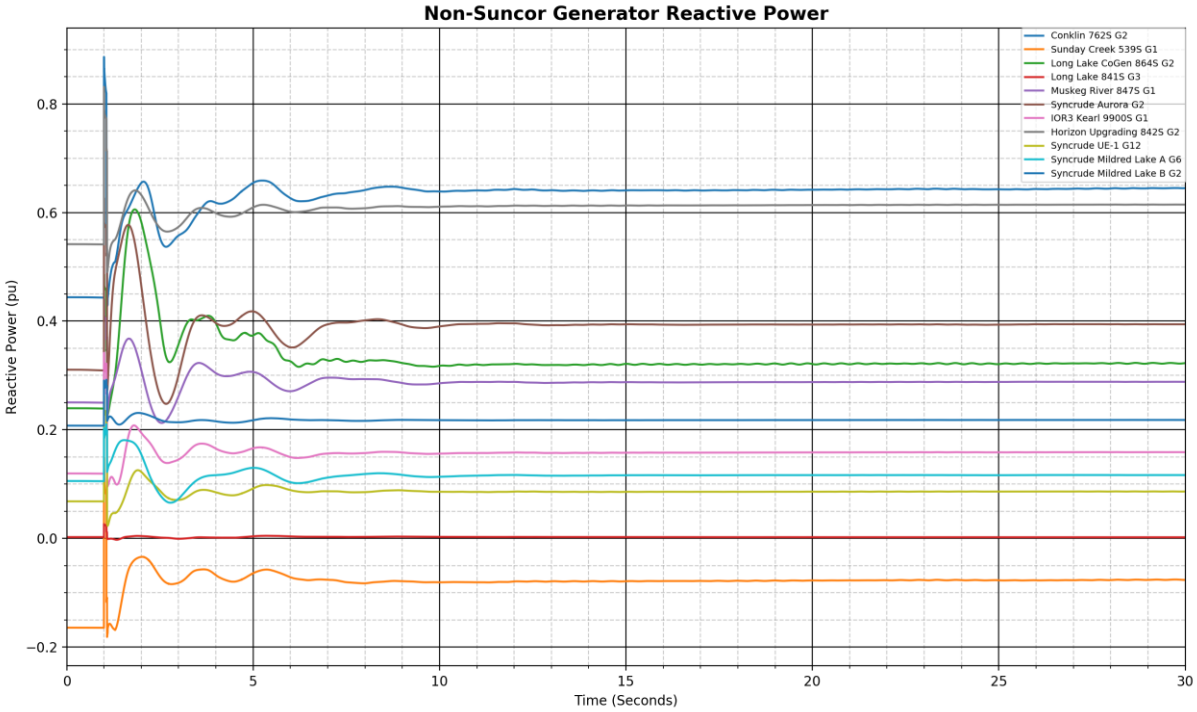

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

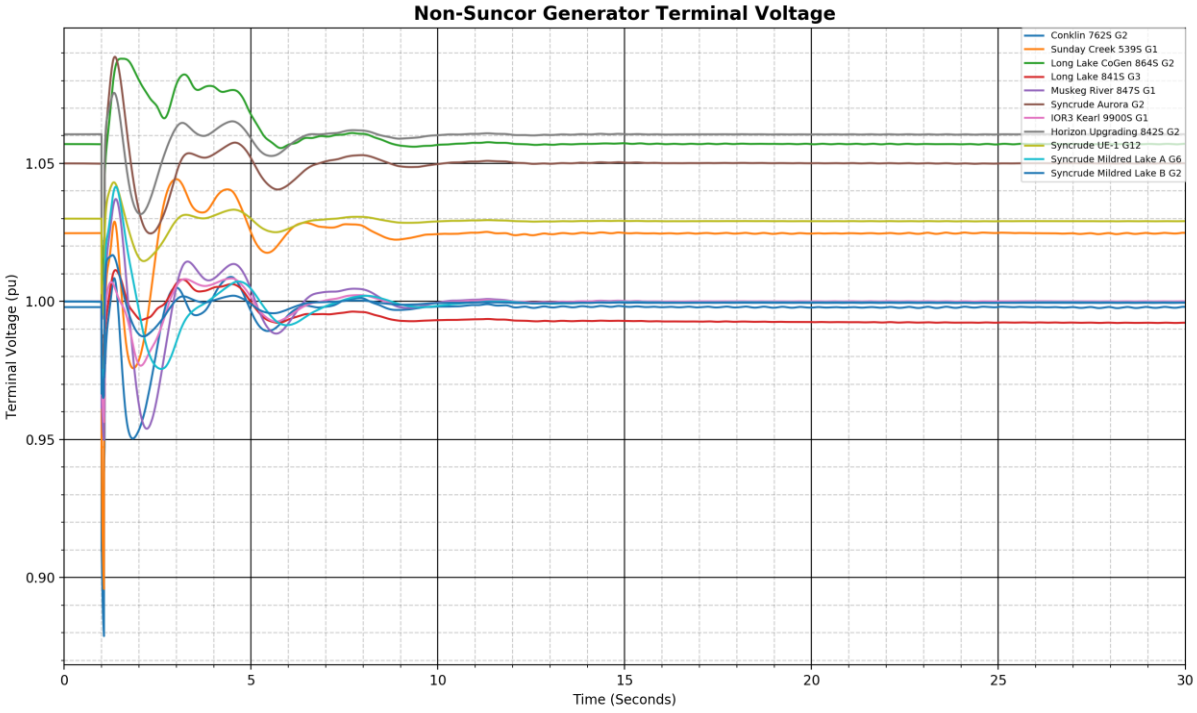
Figure A4-30: 12L41 (Livock 939S to Sunnybrook 510S): Fault at Sunnybrook 510S

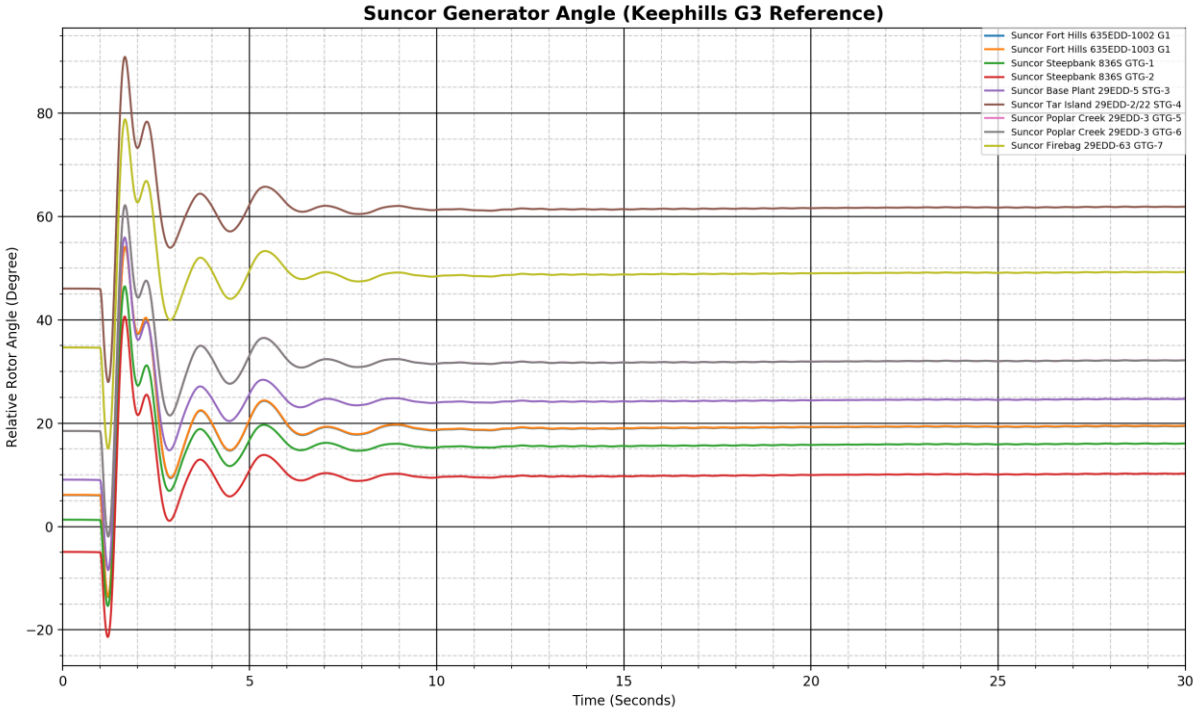


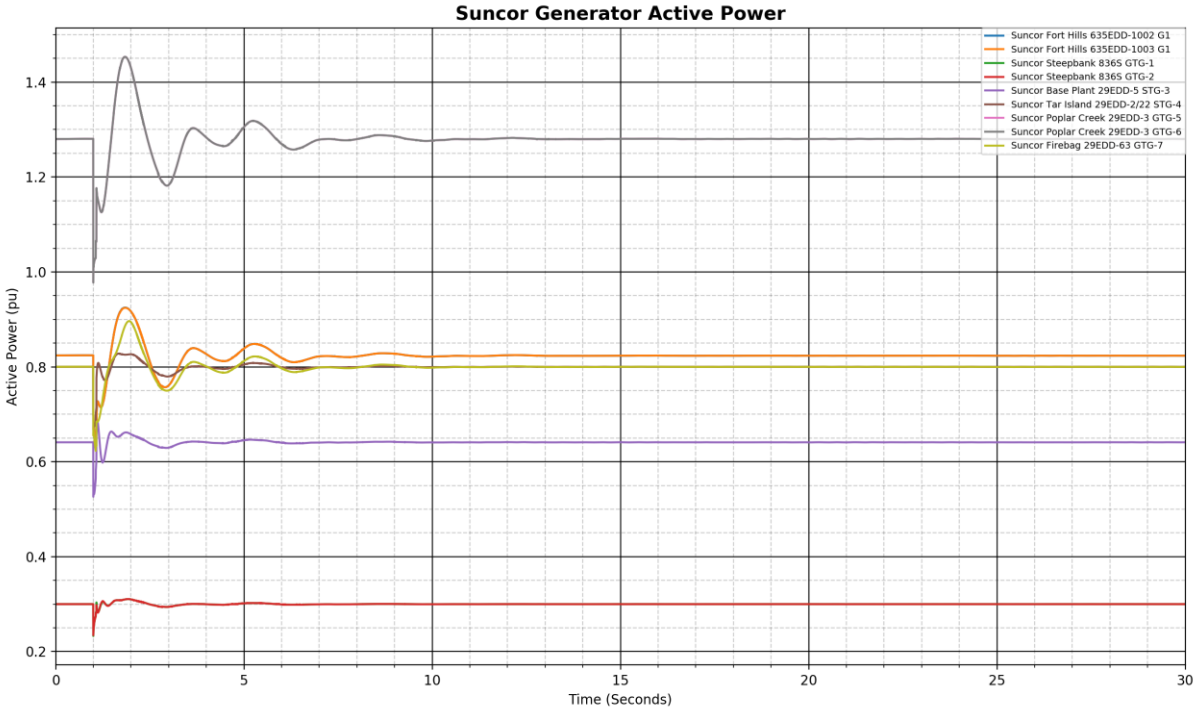

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

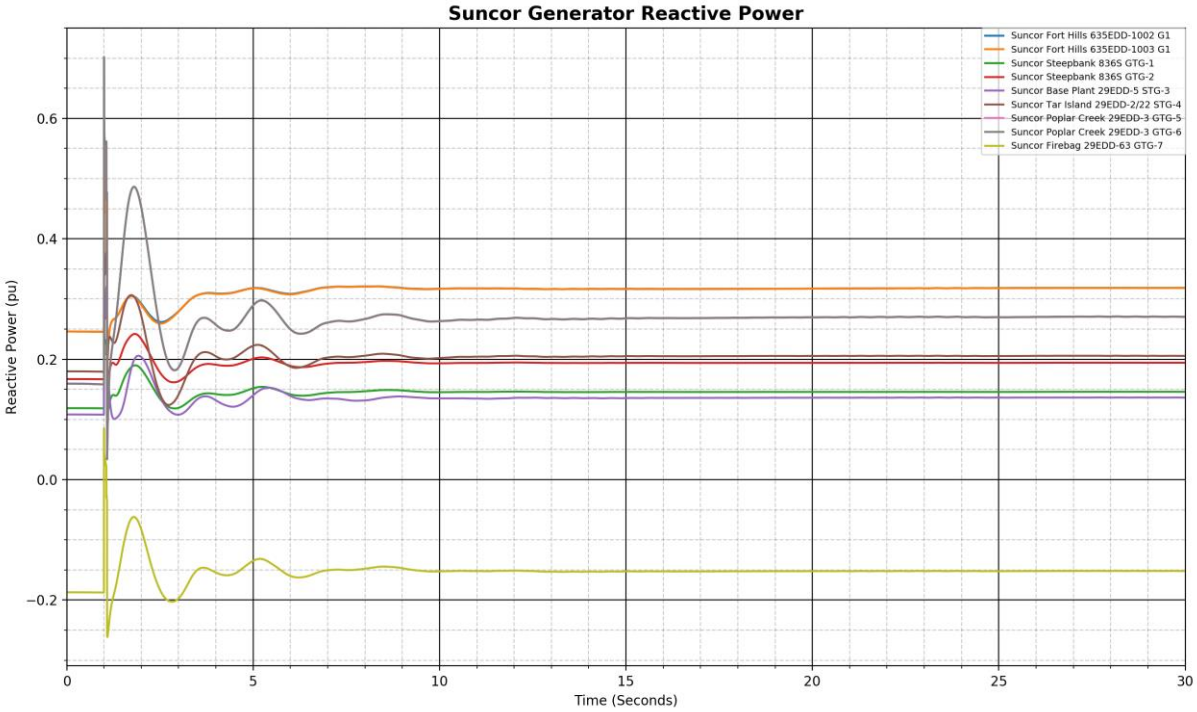

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

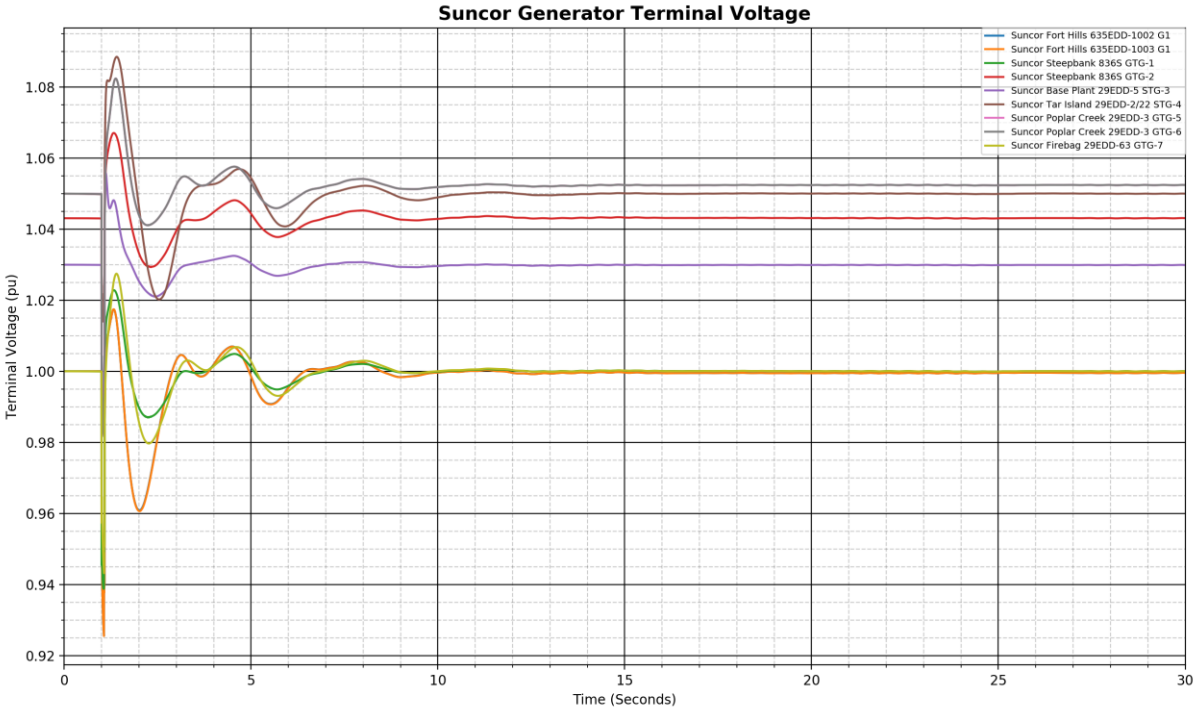

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

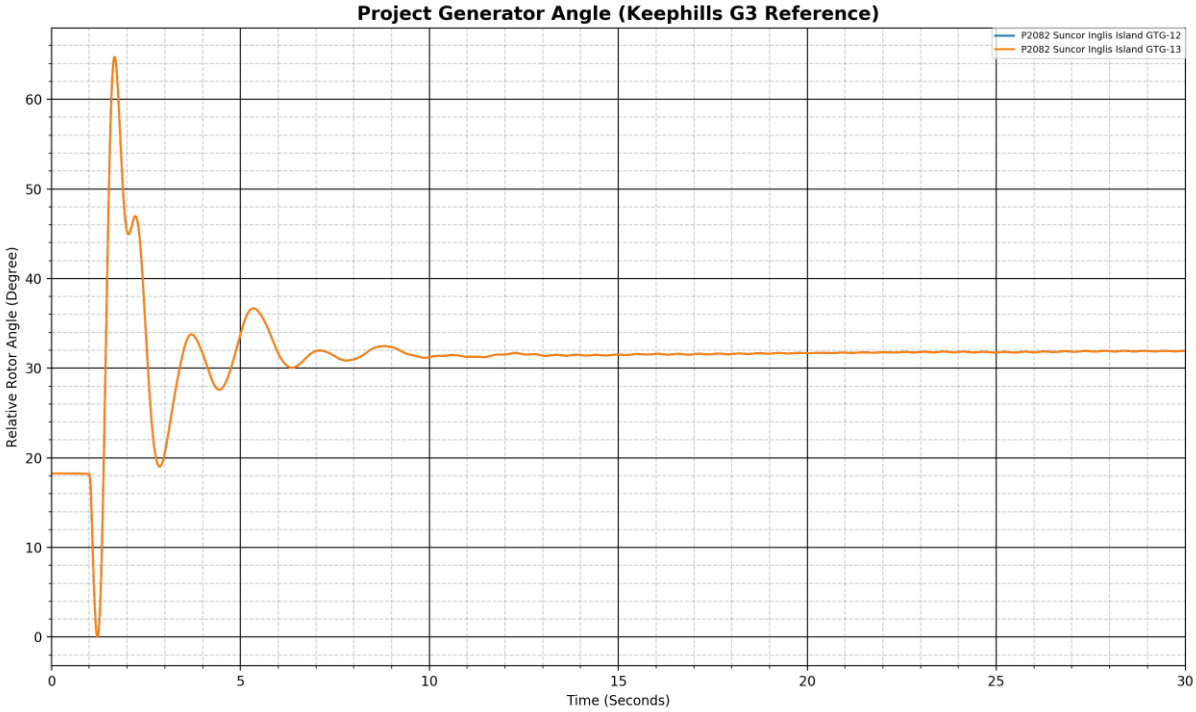

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

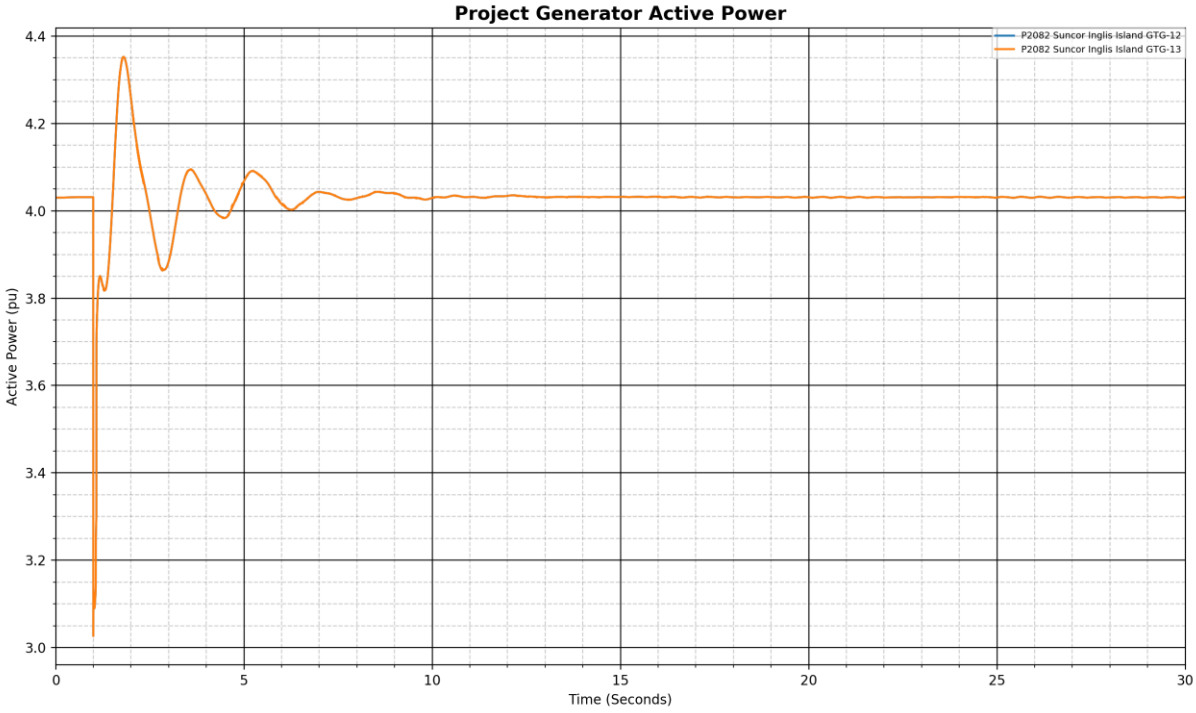

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

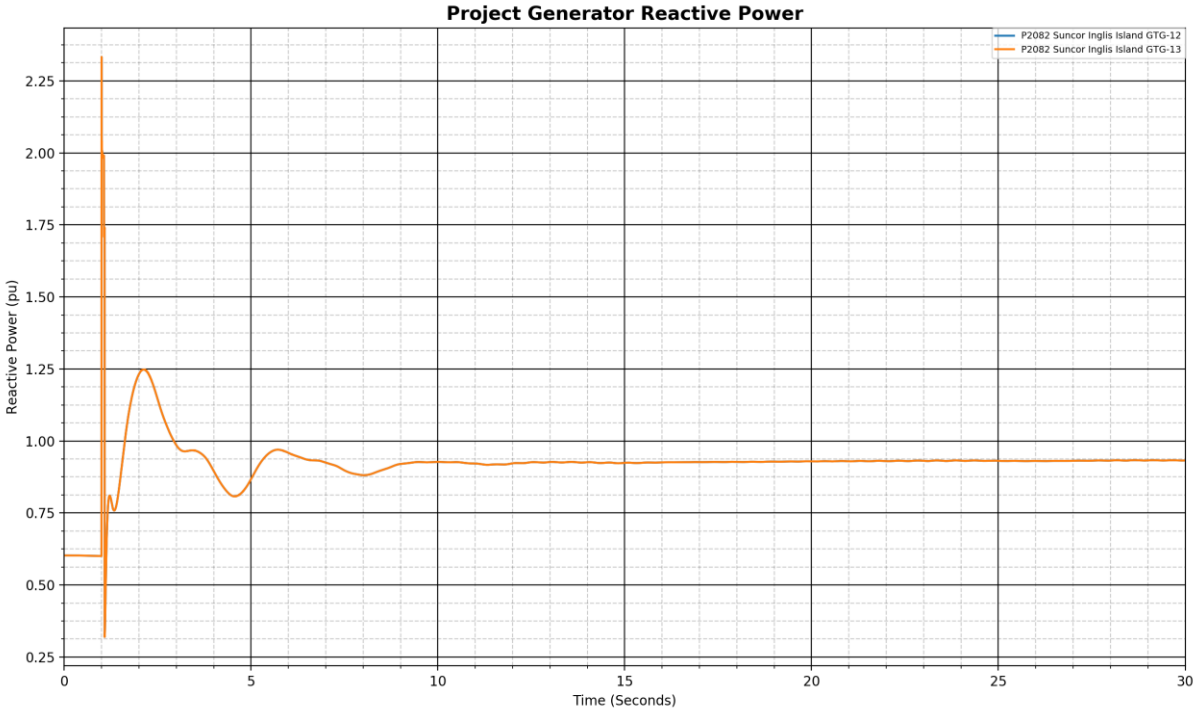

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

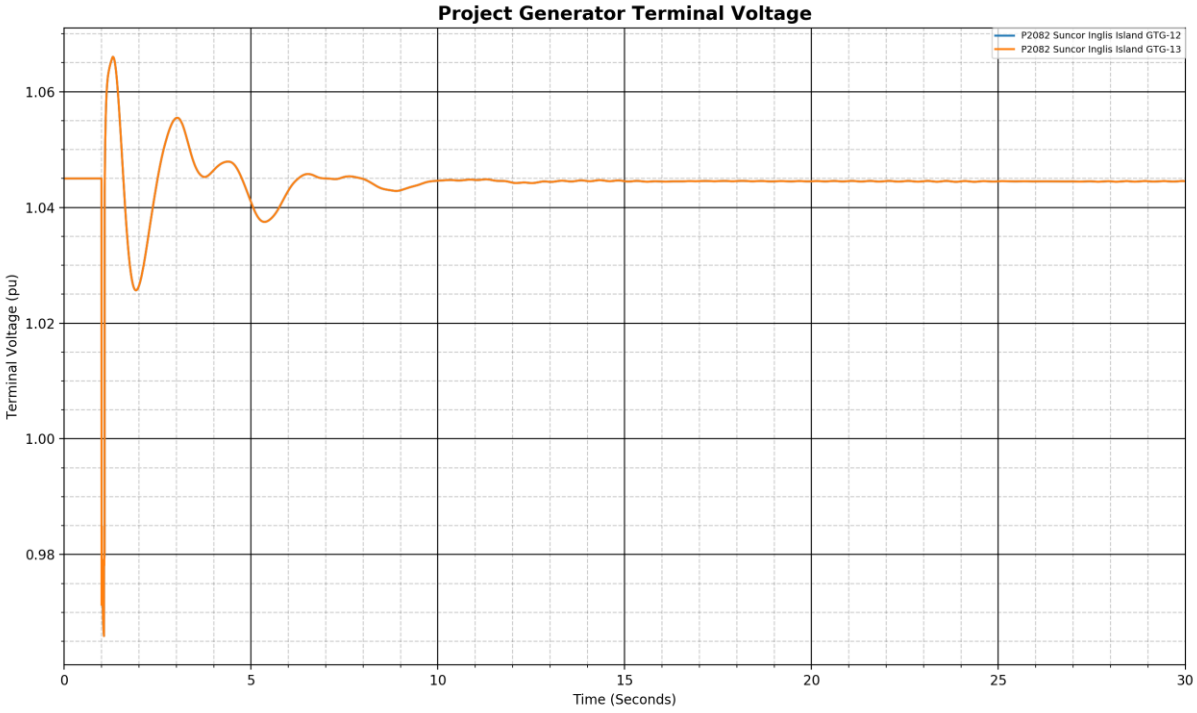

Suncor Generator Reactive Power
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7
Reactive Power (pu)
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
Time (Seconds)

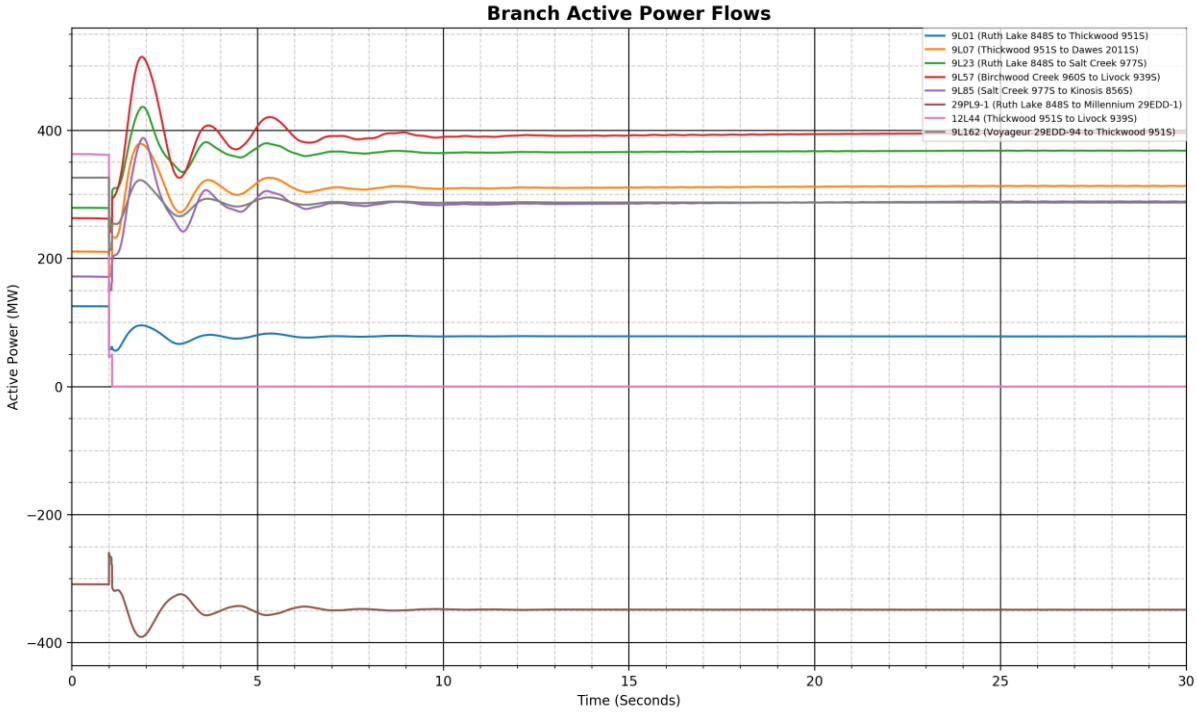

Suncor Generator Terminal Voltage
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7
Terminal Voltage (pu)
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
0
10
20
30
40
50
60
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

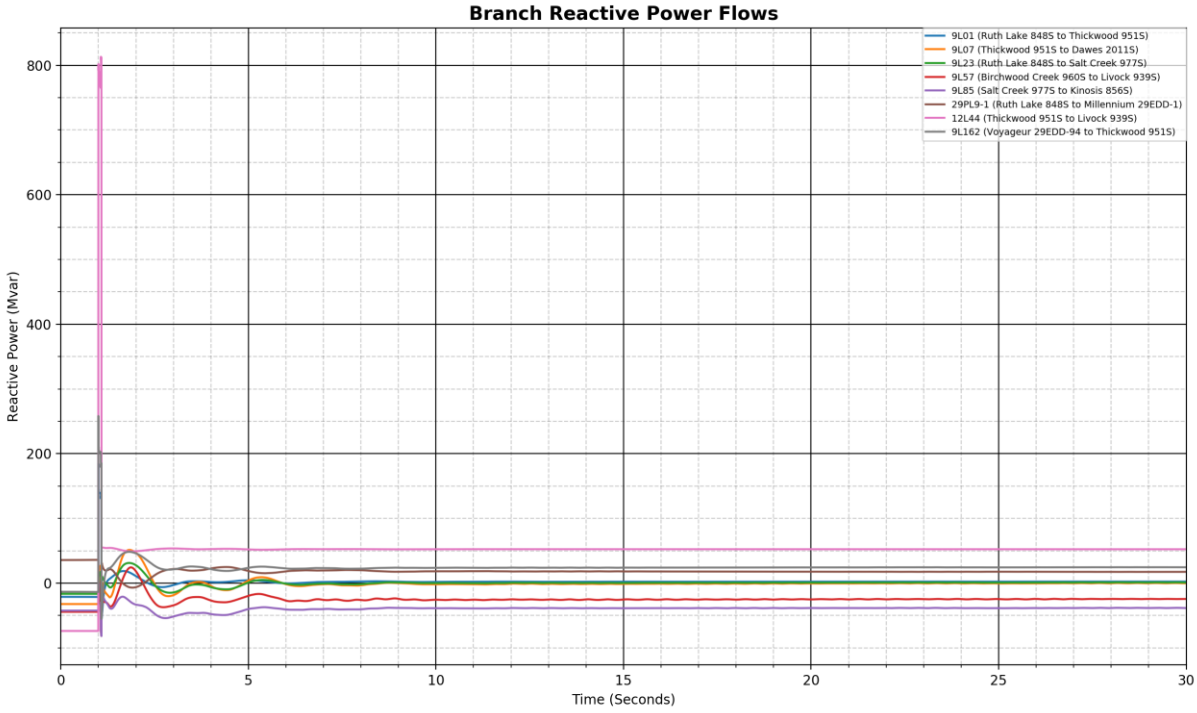
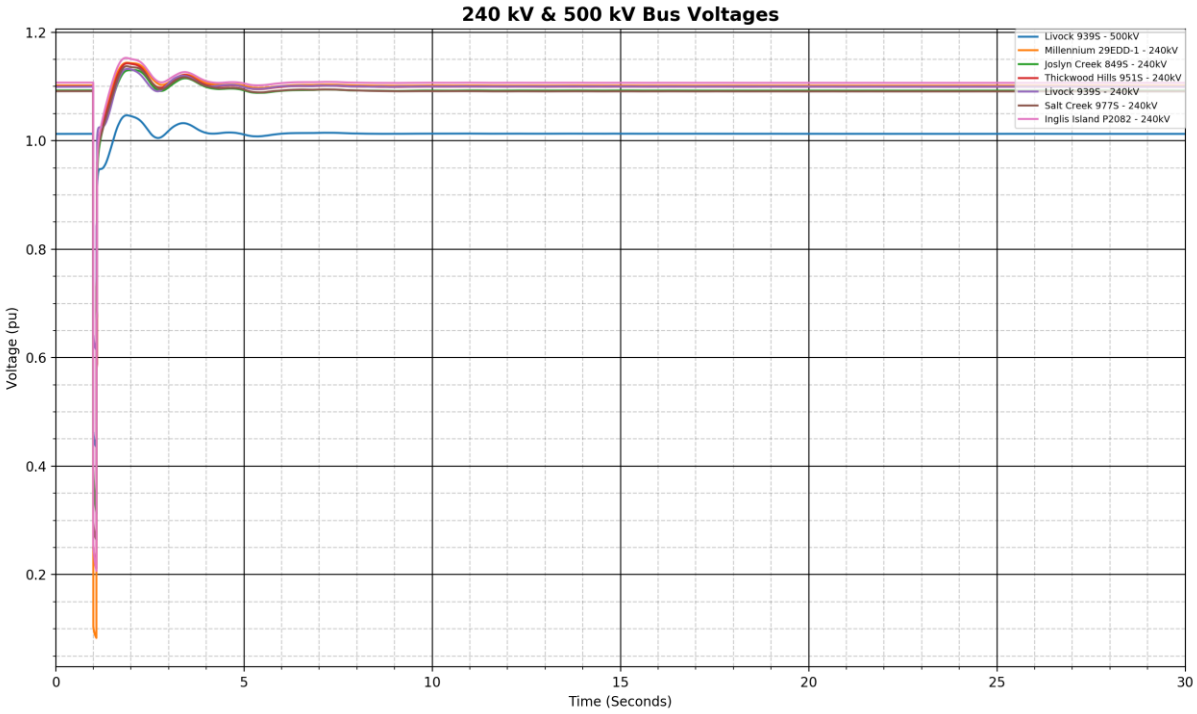
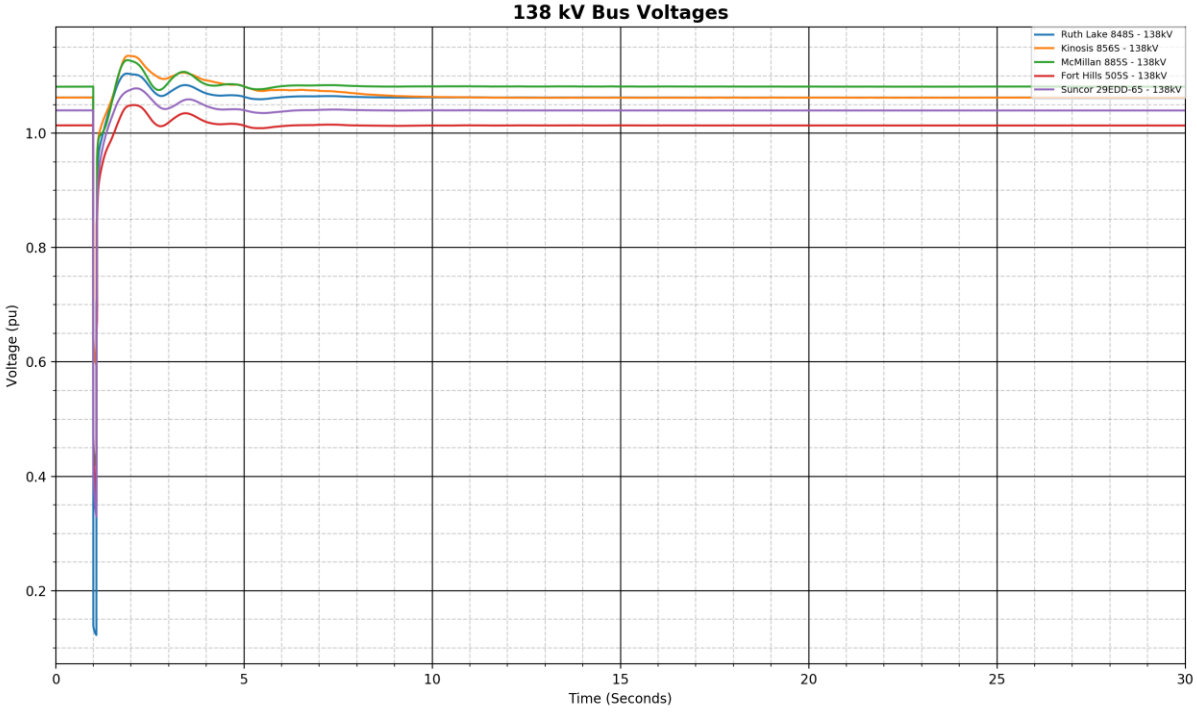
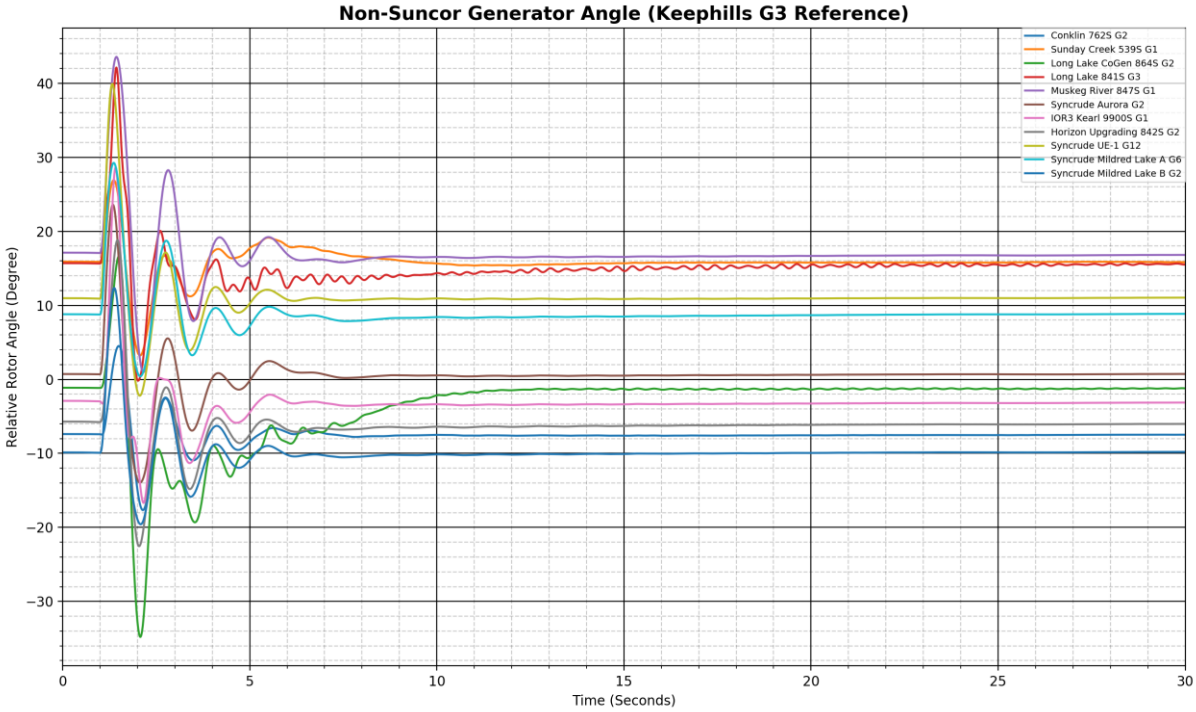
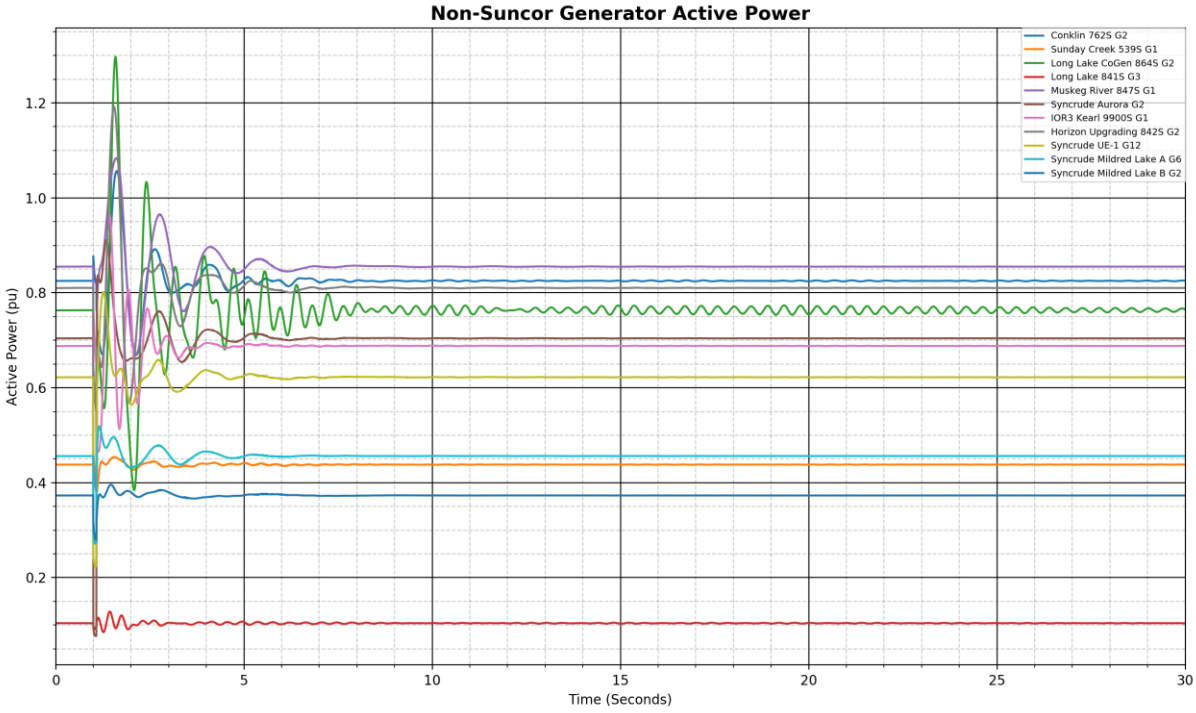

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
800
600
400
200
0
0
5
10
15
20
25
30
Time (Seconds)

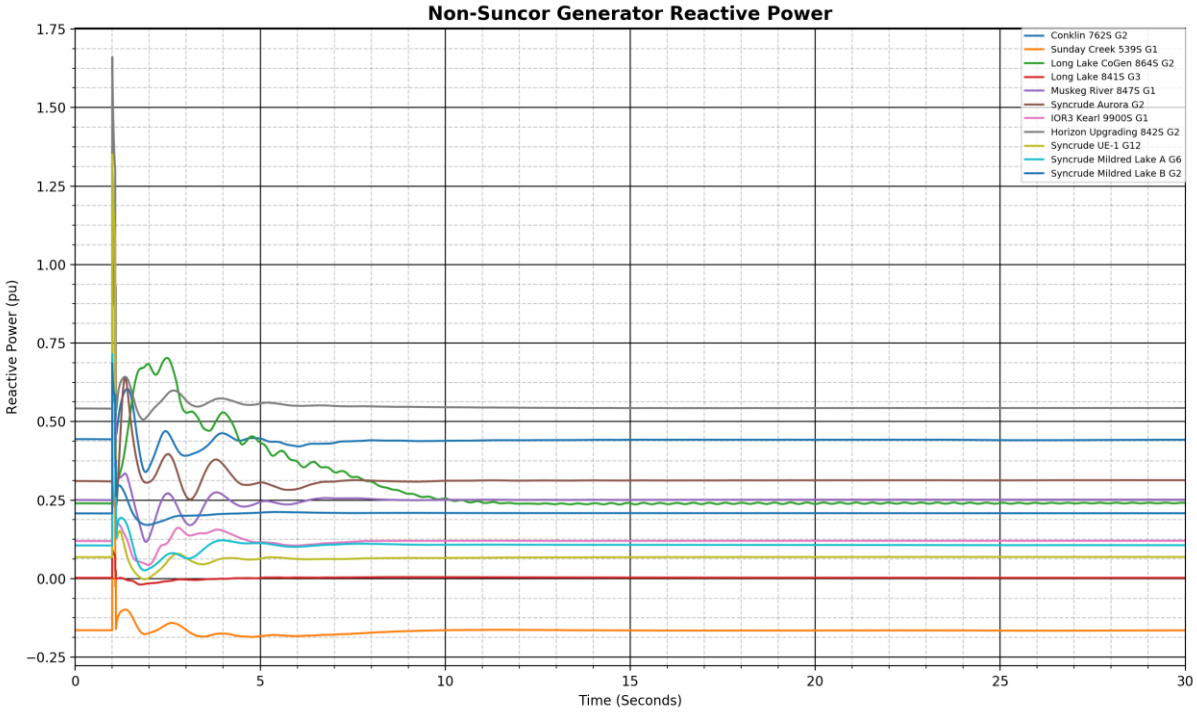
Figure A4-31: 9L01 (Ruth Lake 848S to Thickwood Hills 951S): Fault at Ruth Lake 848S

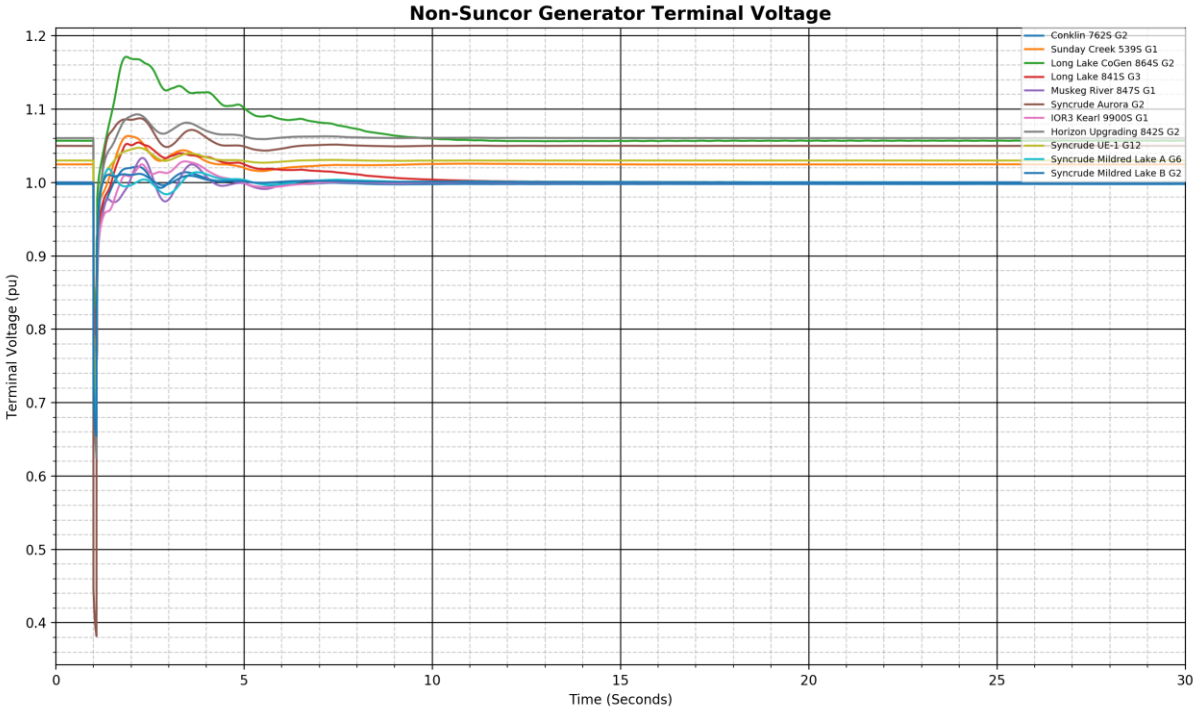


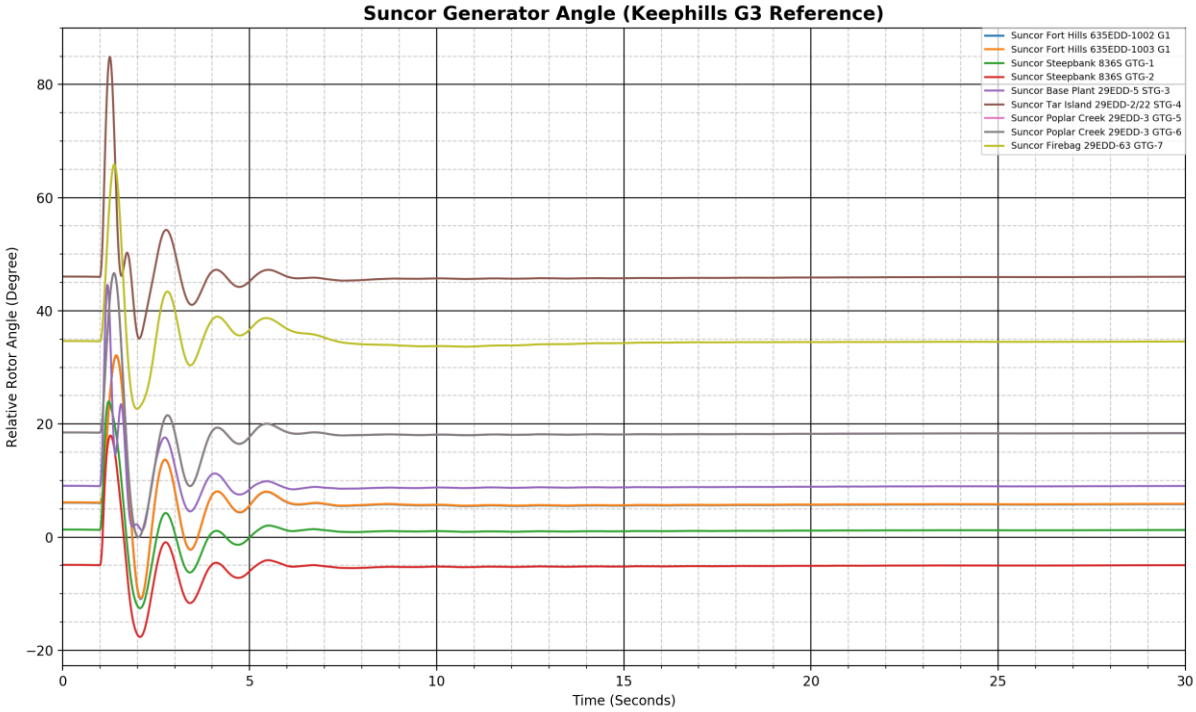


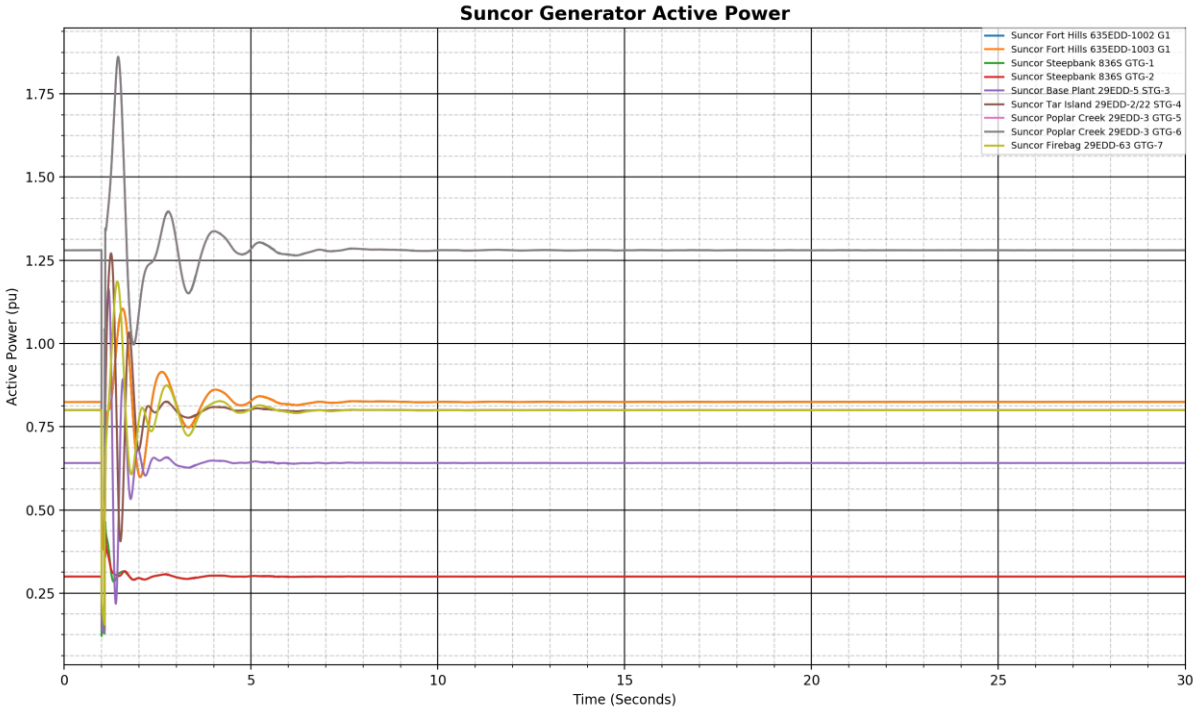

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

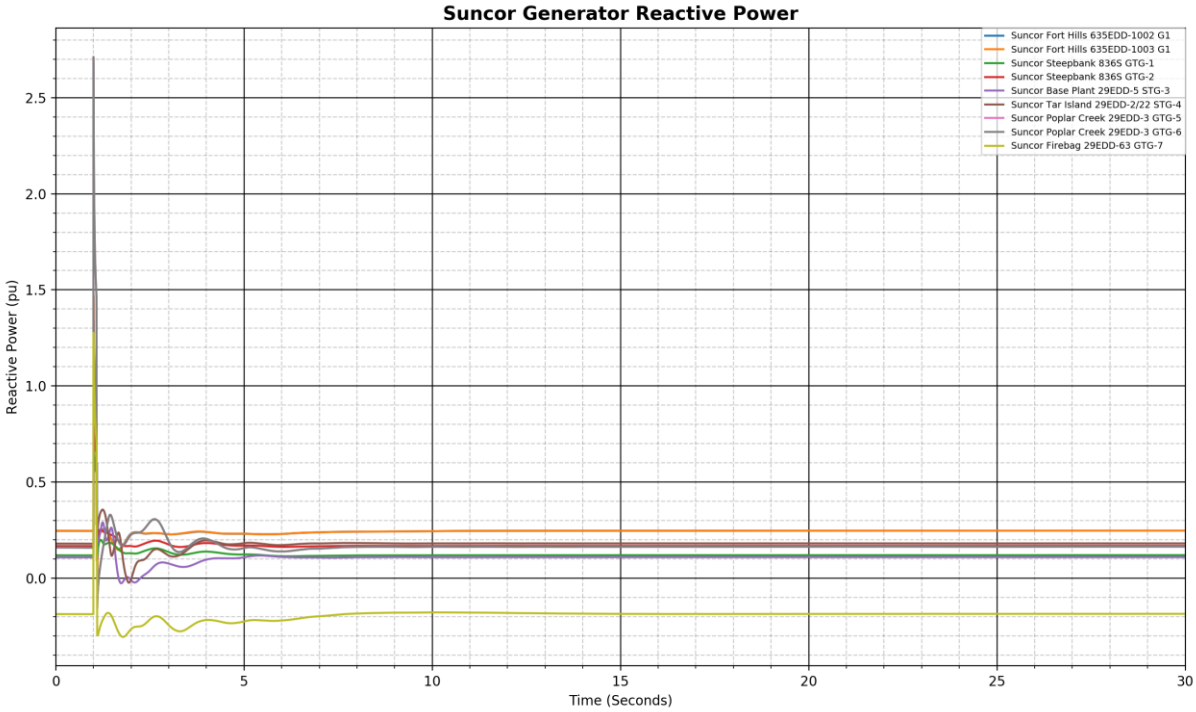

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

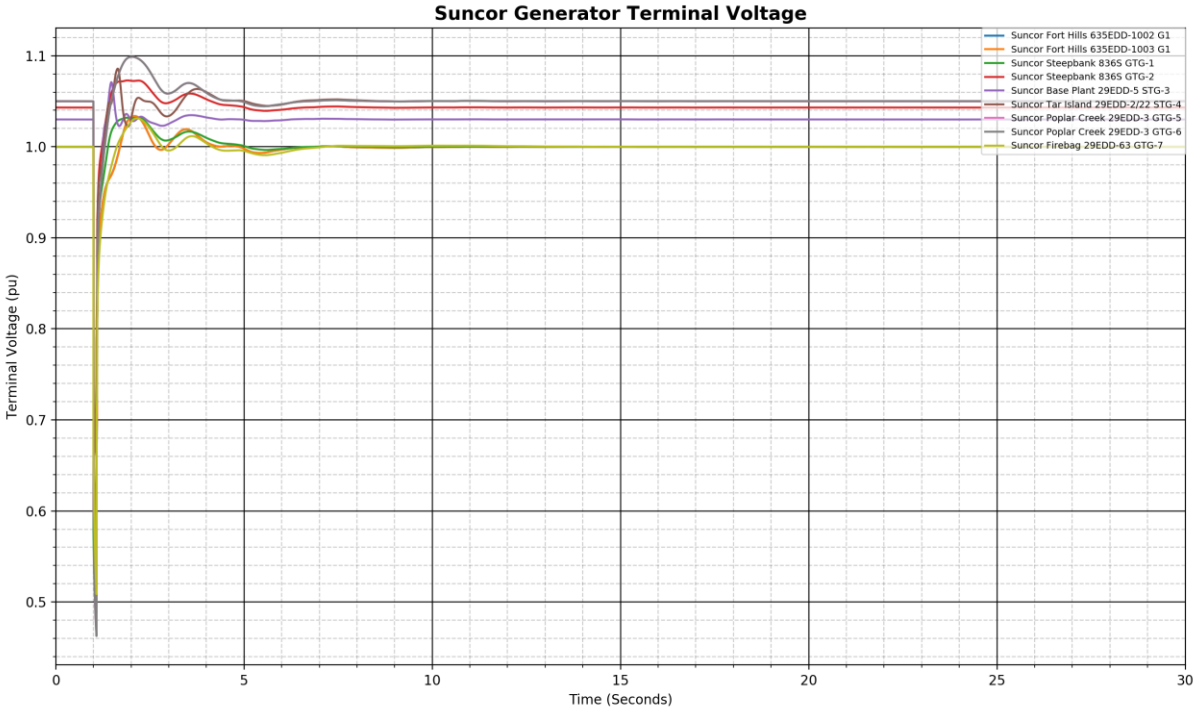

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

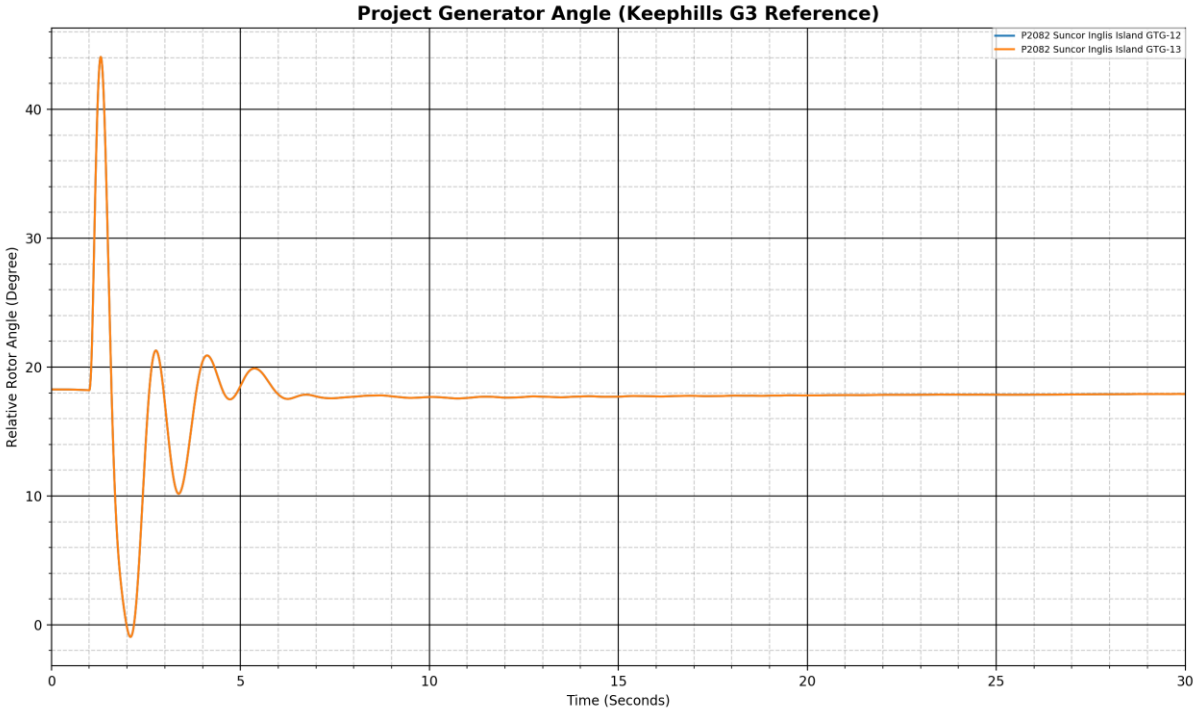

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

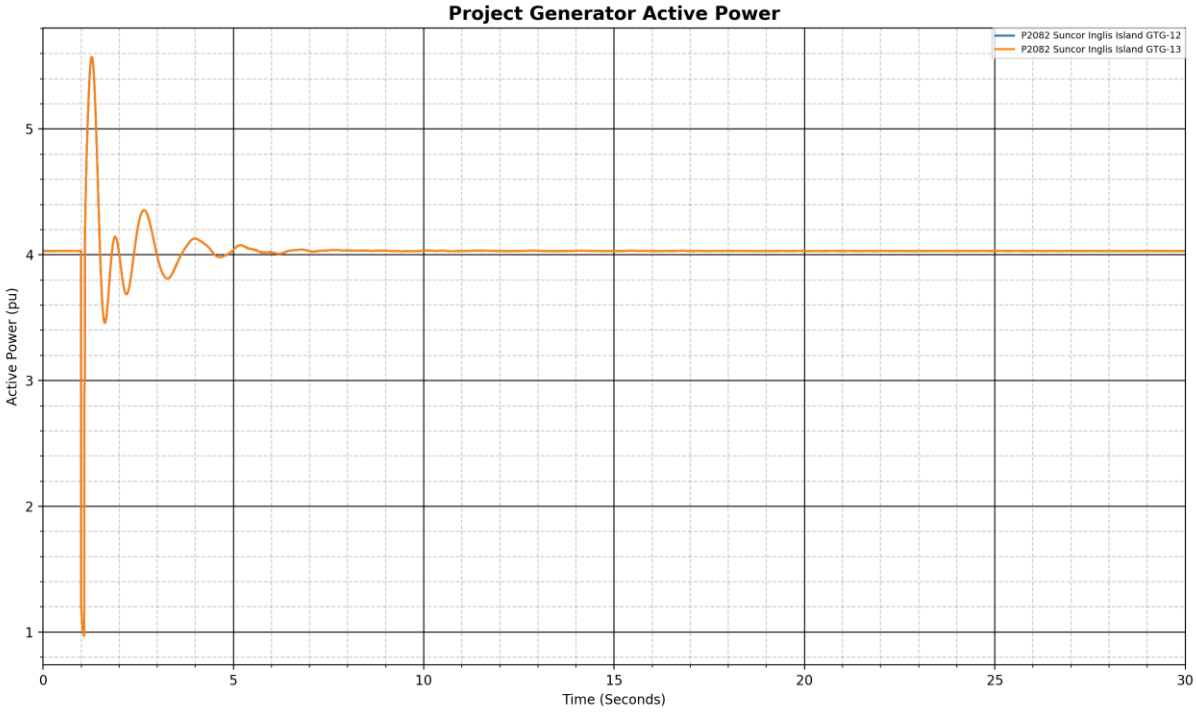

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

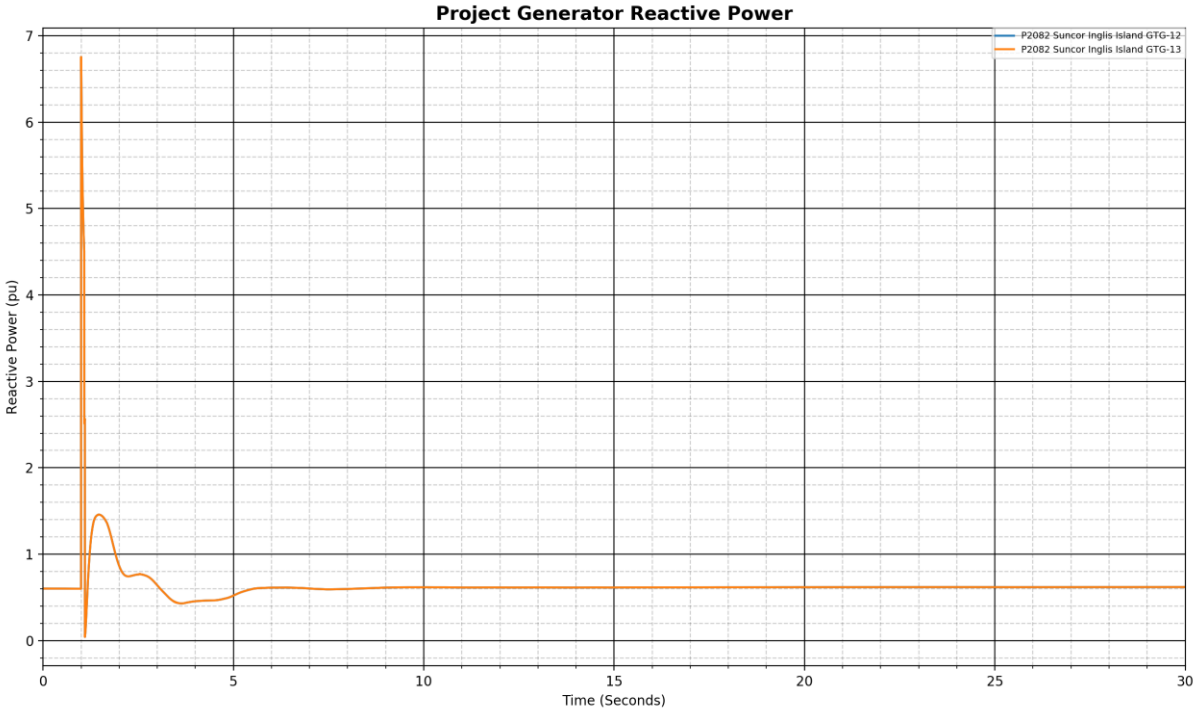

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

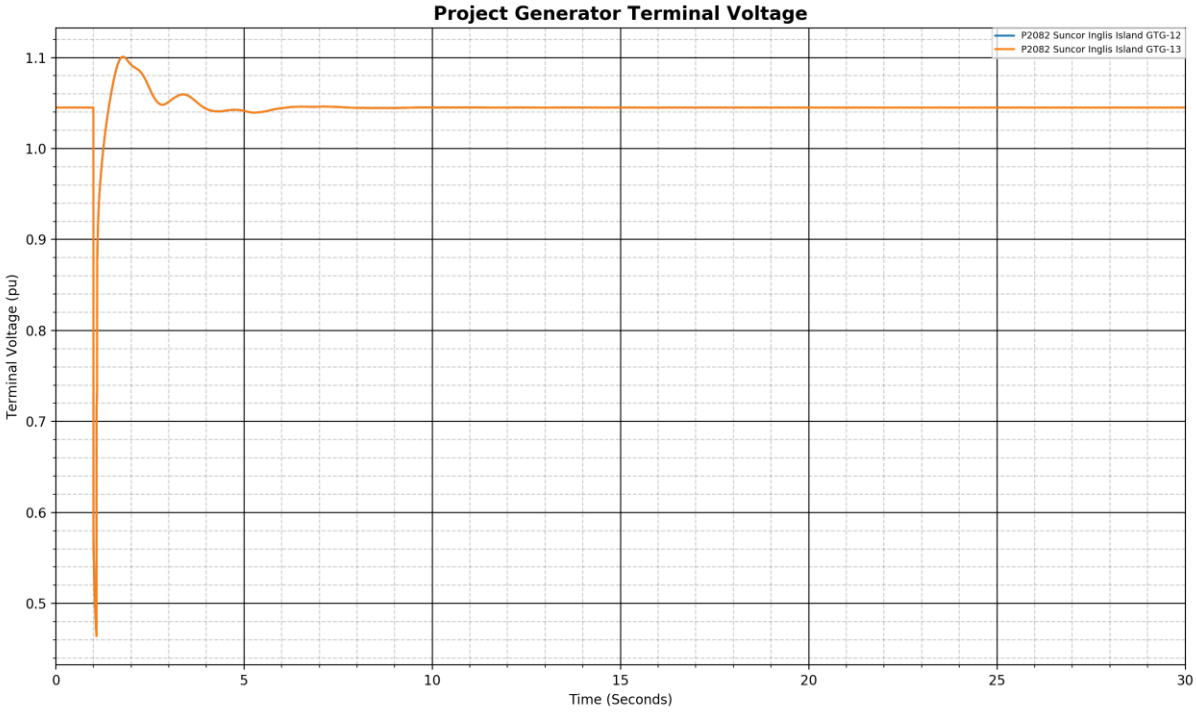

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

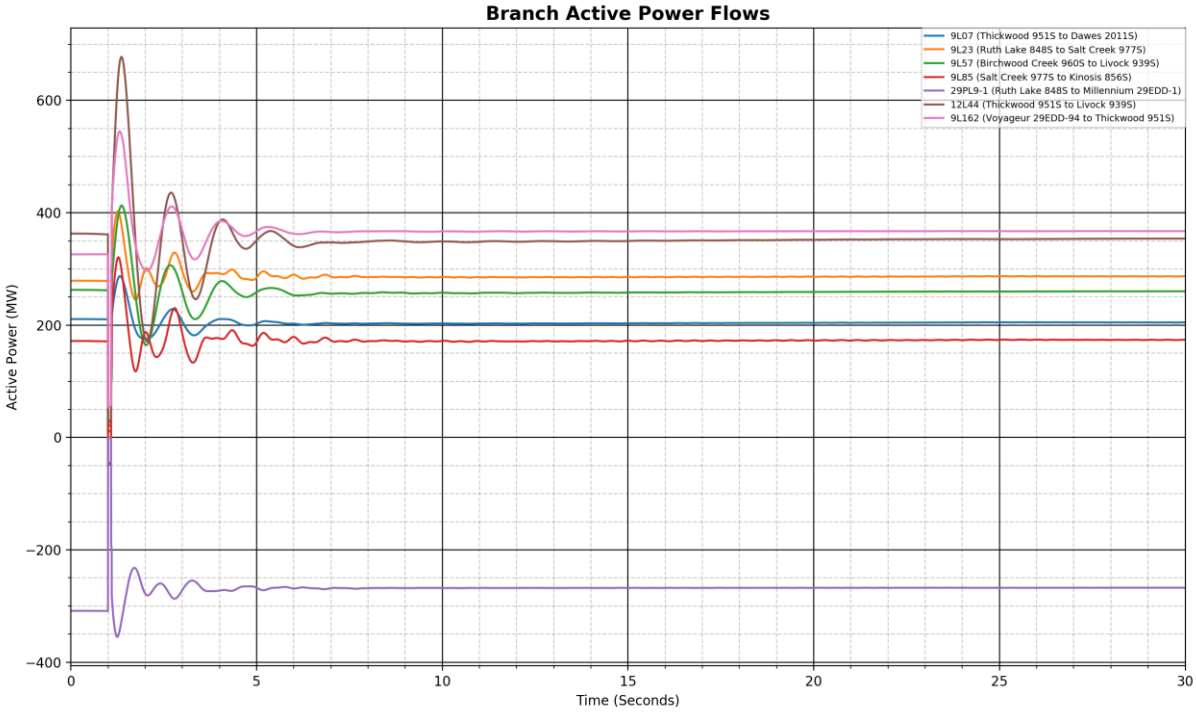

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
0
10
20
30
40
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
1
2
3
4
5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

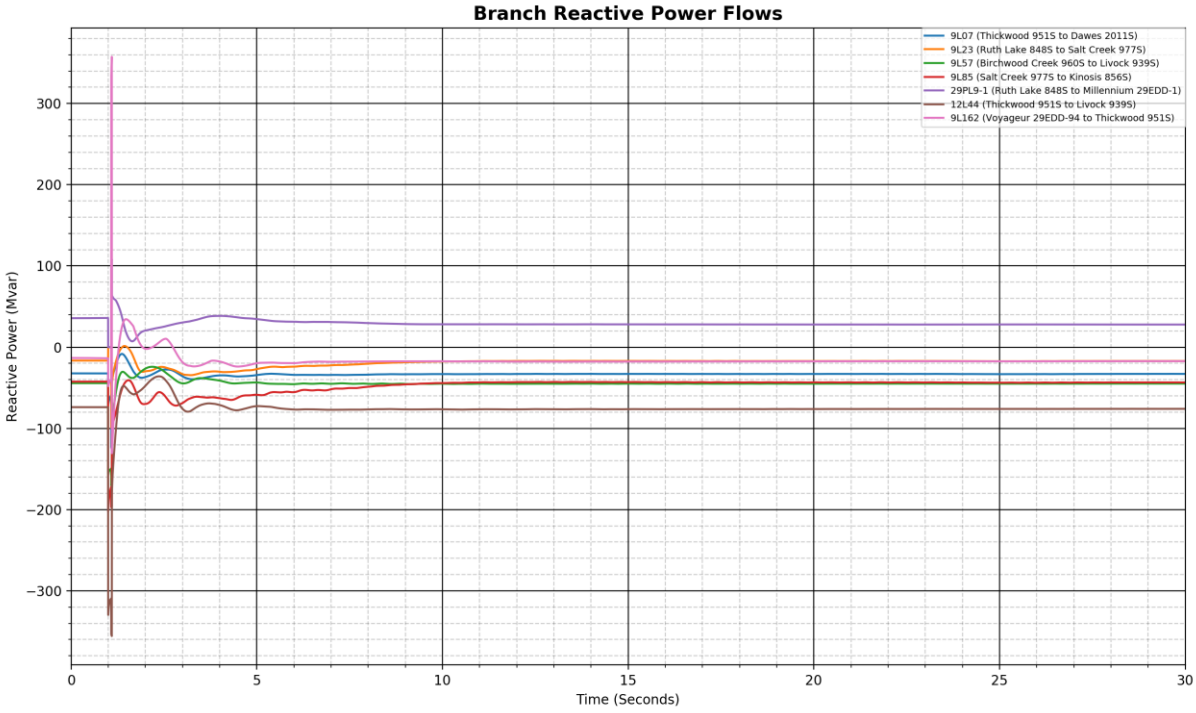
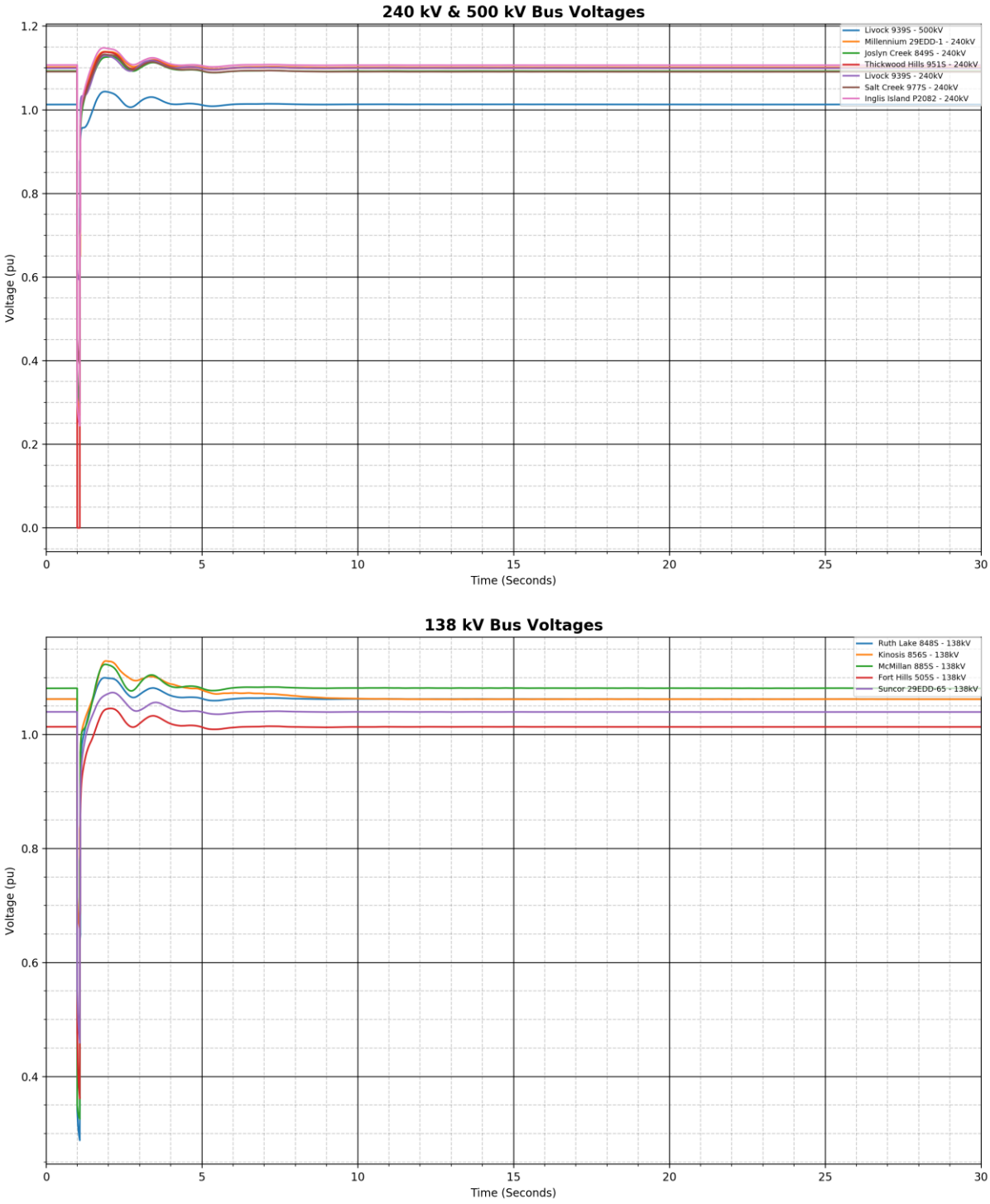
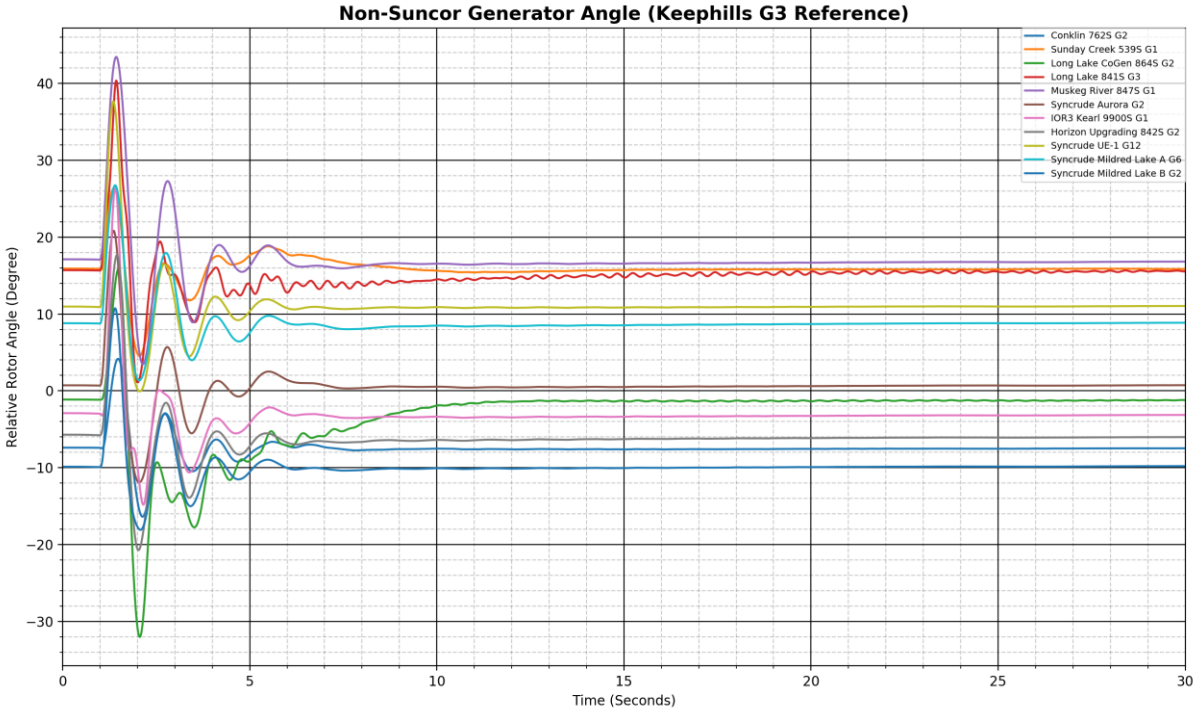
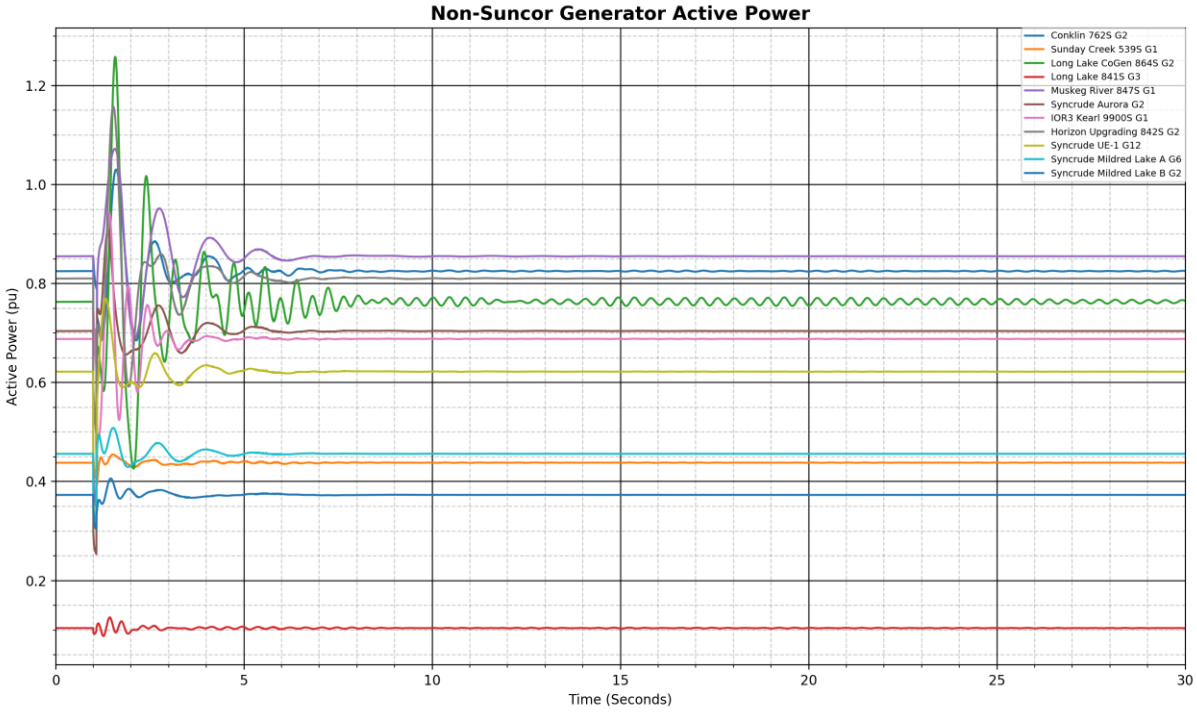
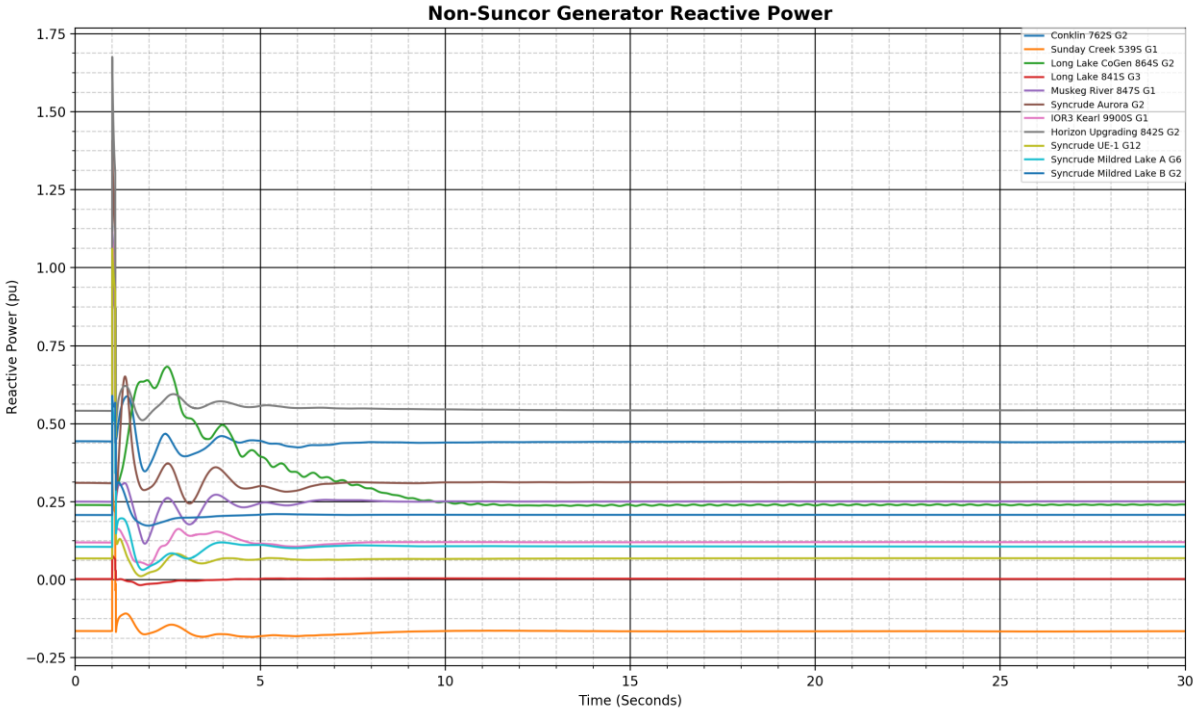

Branch Reactive Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

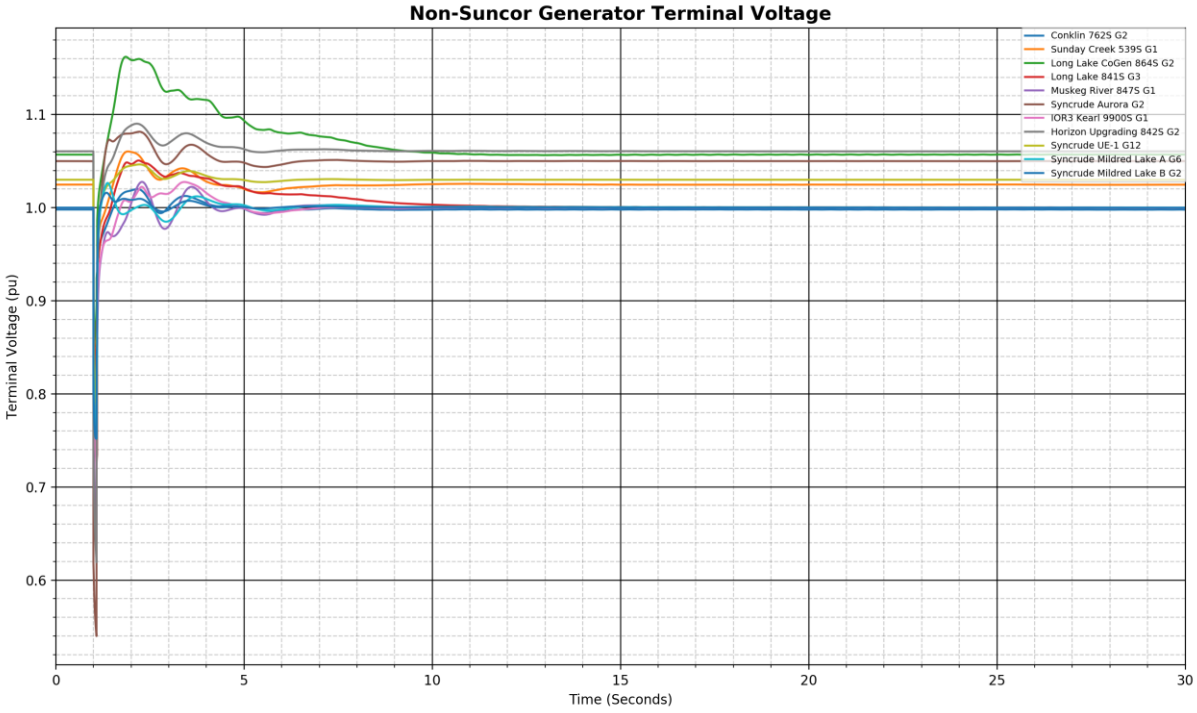
Figure A4-32: 9L01 (Ruth Lake 848S to Thickwood Hills 951S): Fault at Thickwood Hills 951S

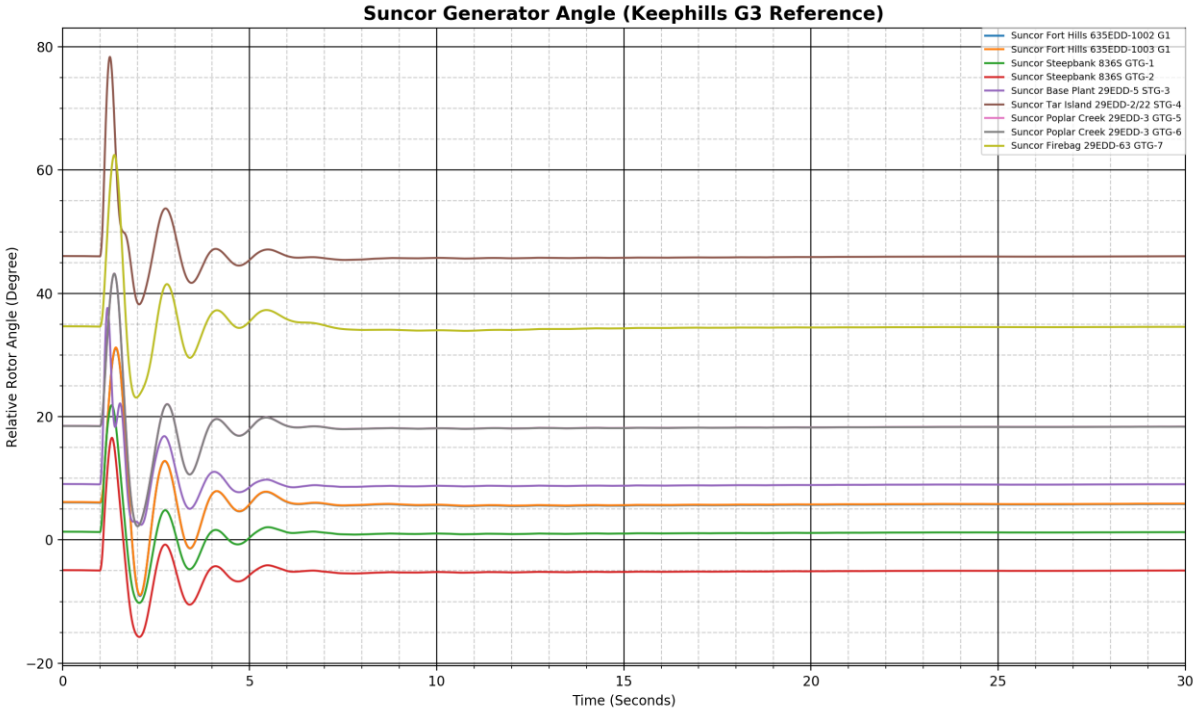


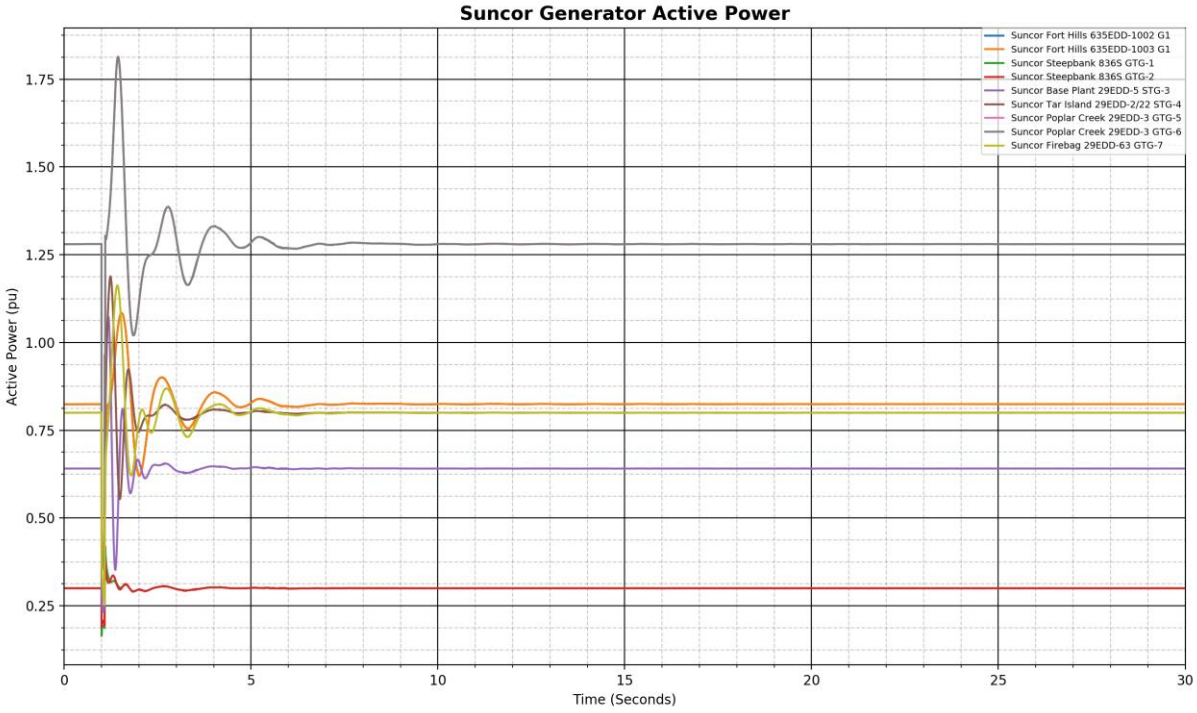

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

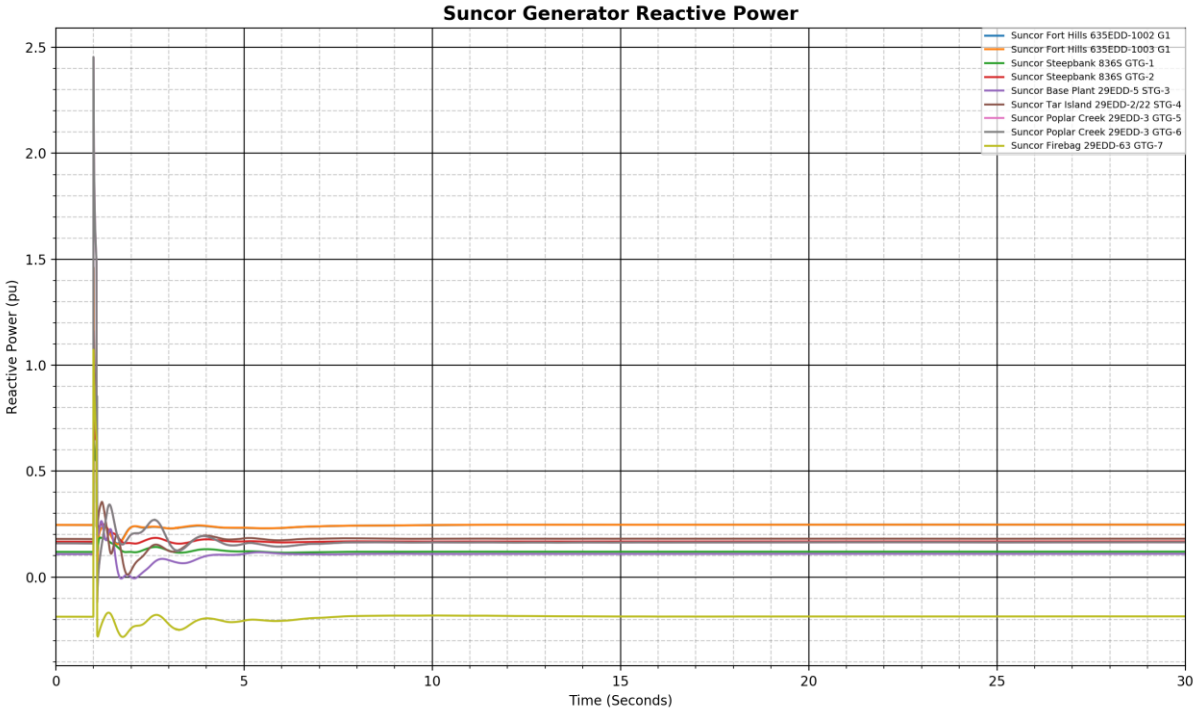

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

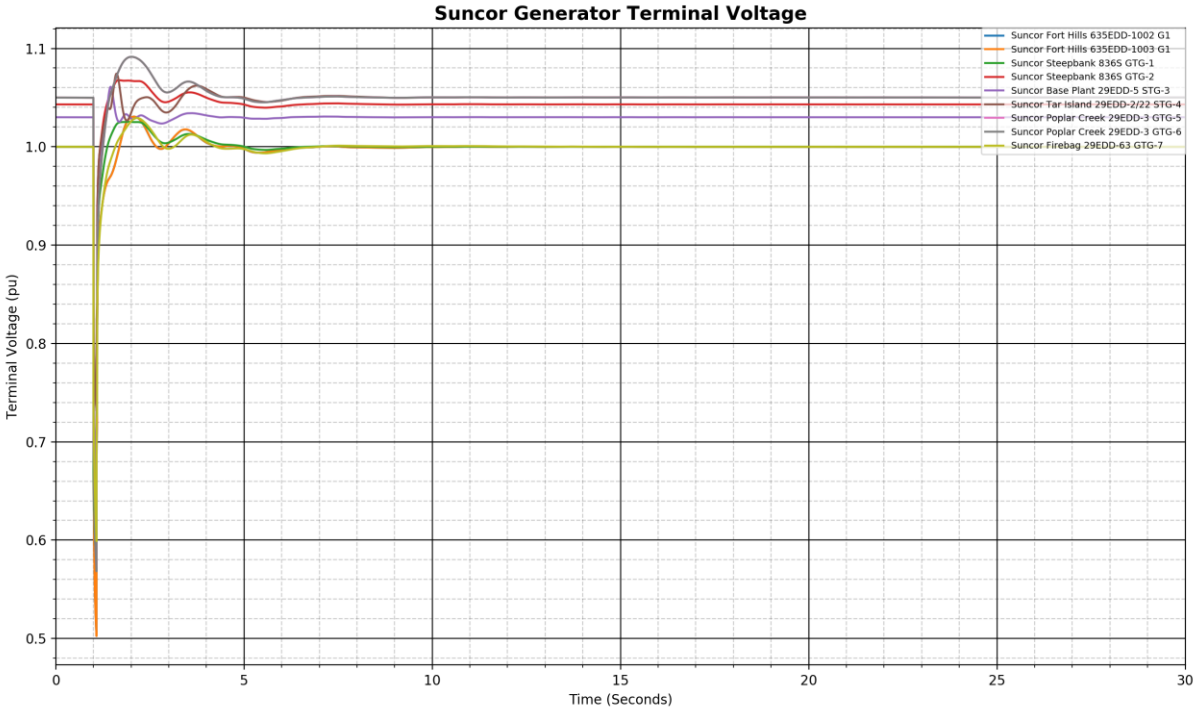

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

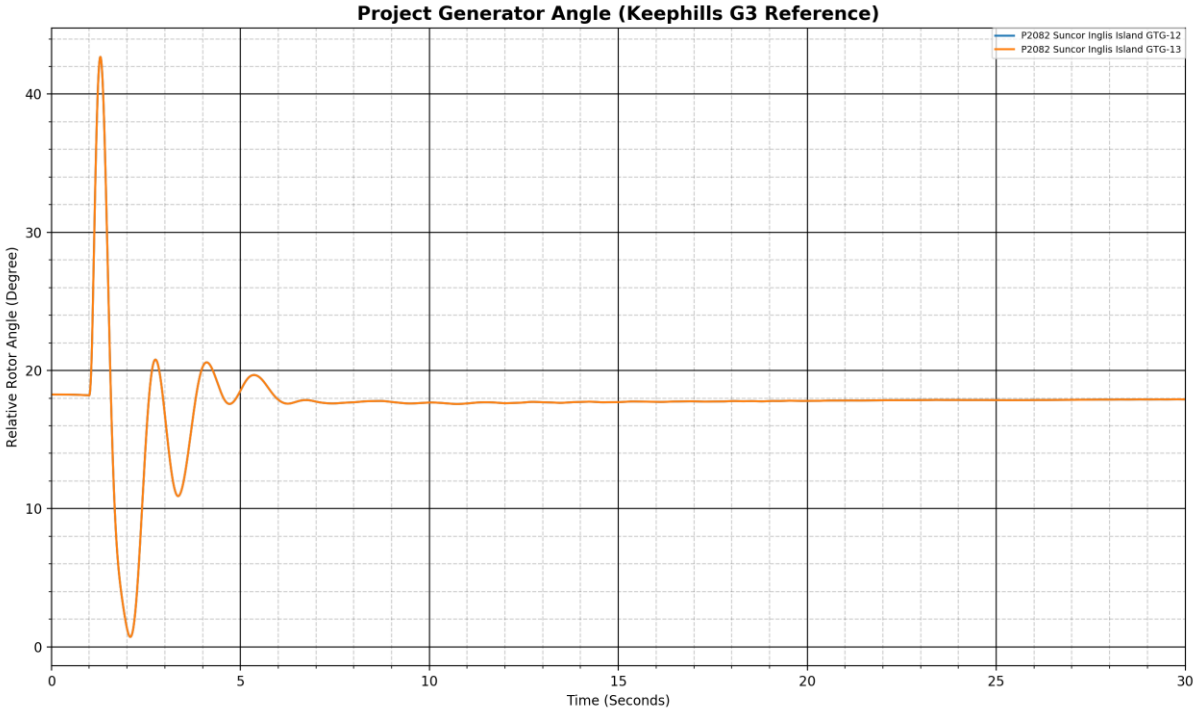

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

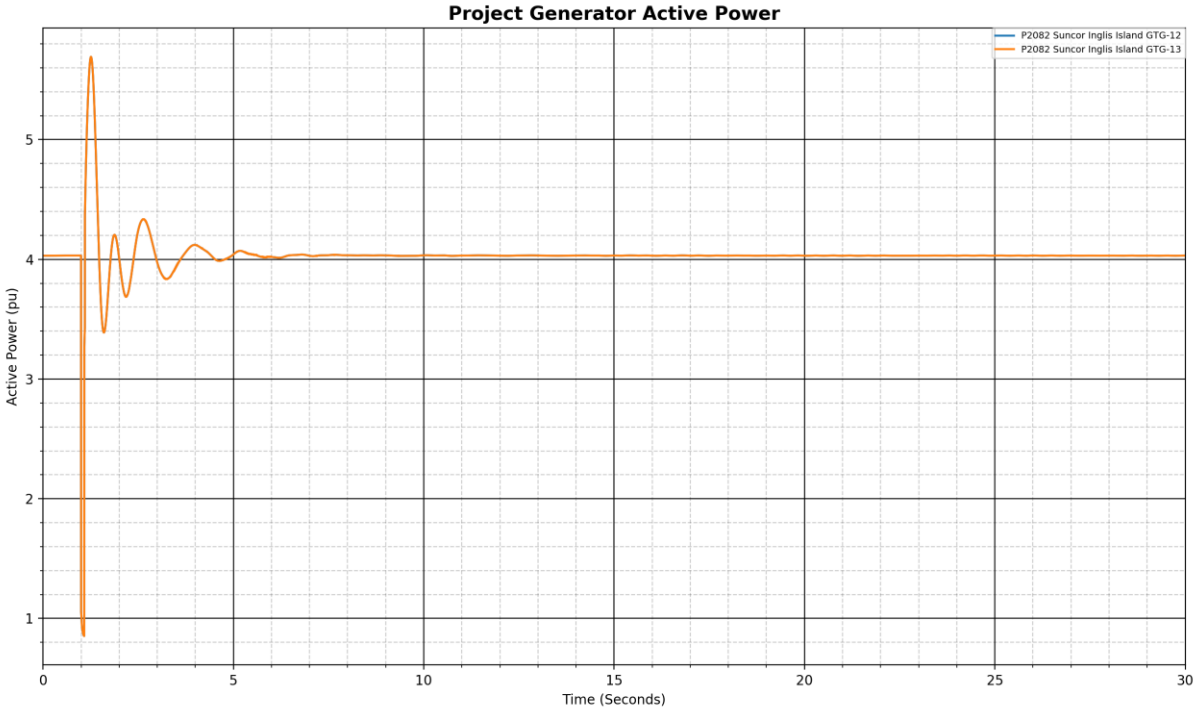

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

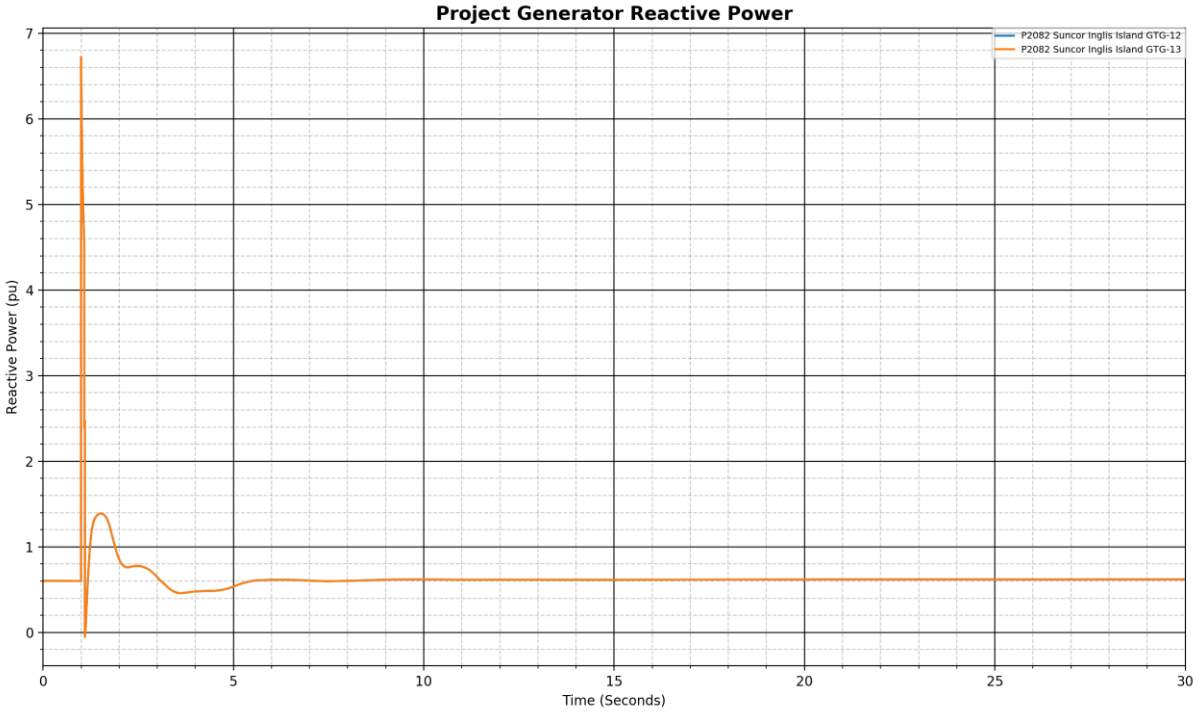

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

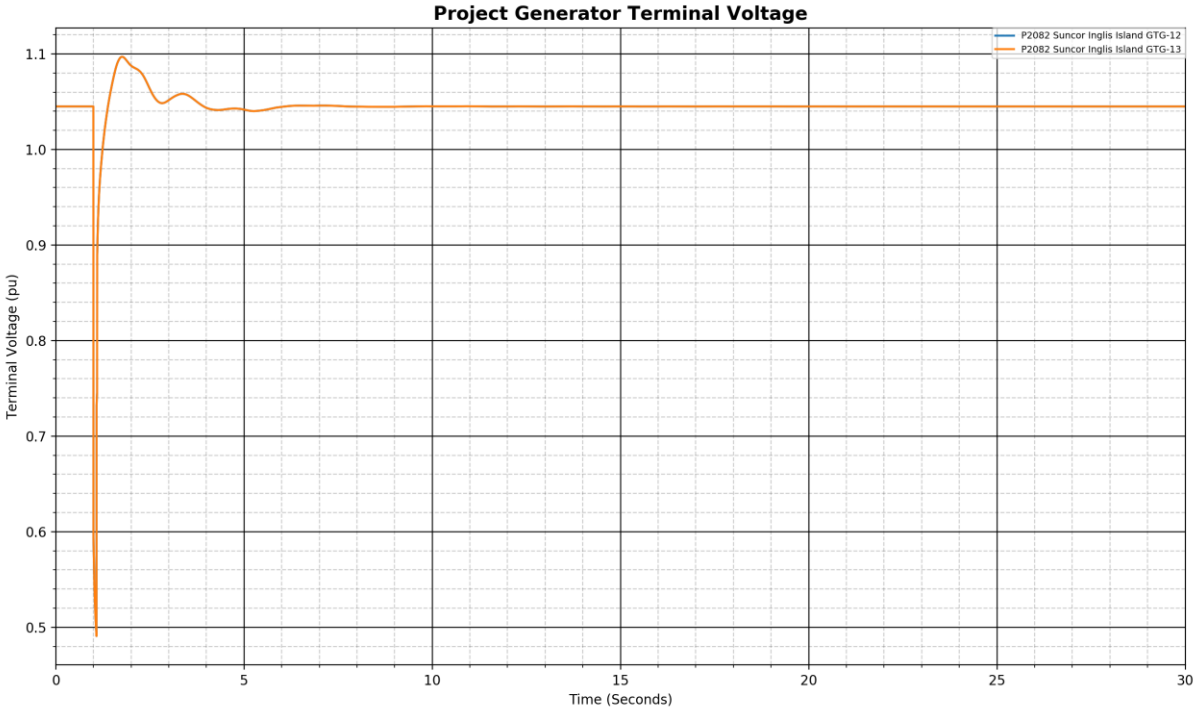

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

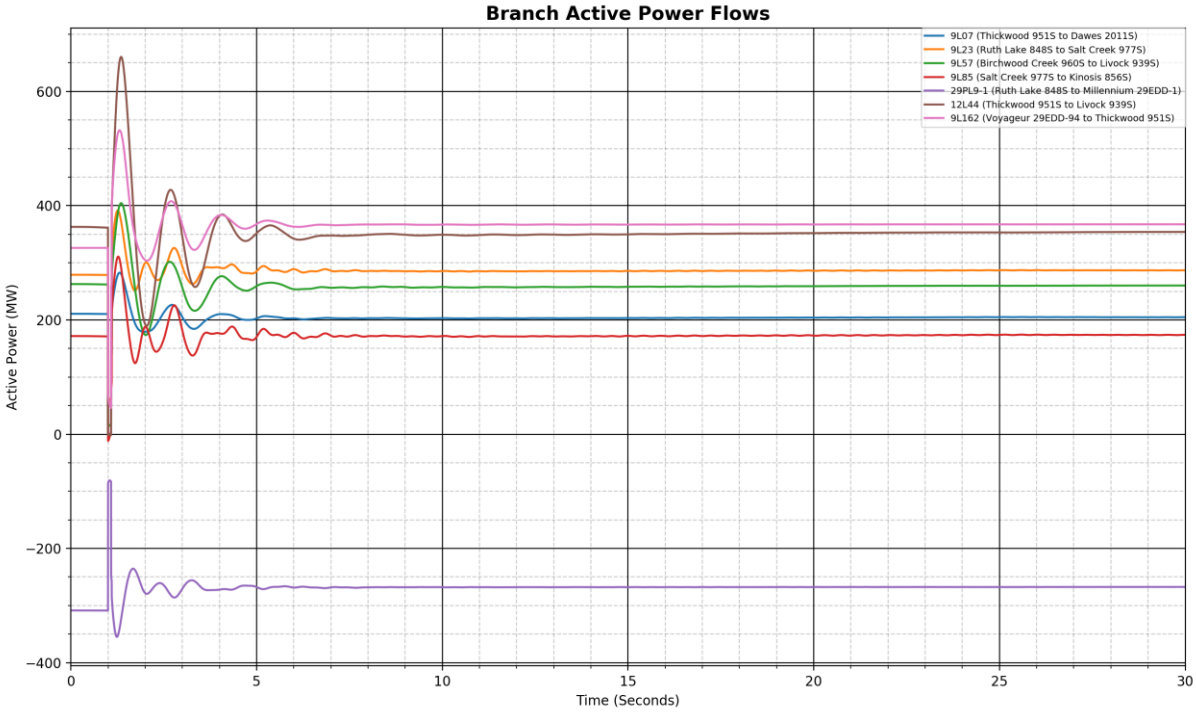

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
0
10
20
30
40
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
1
2
3
4
5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

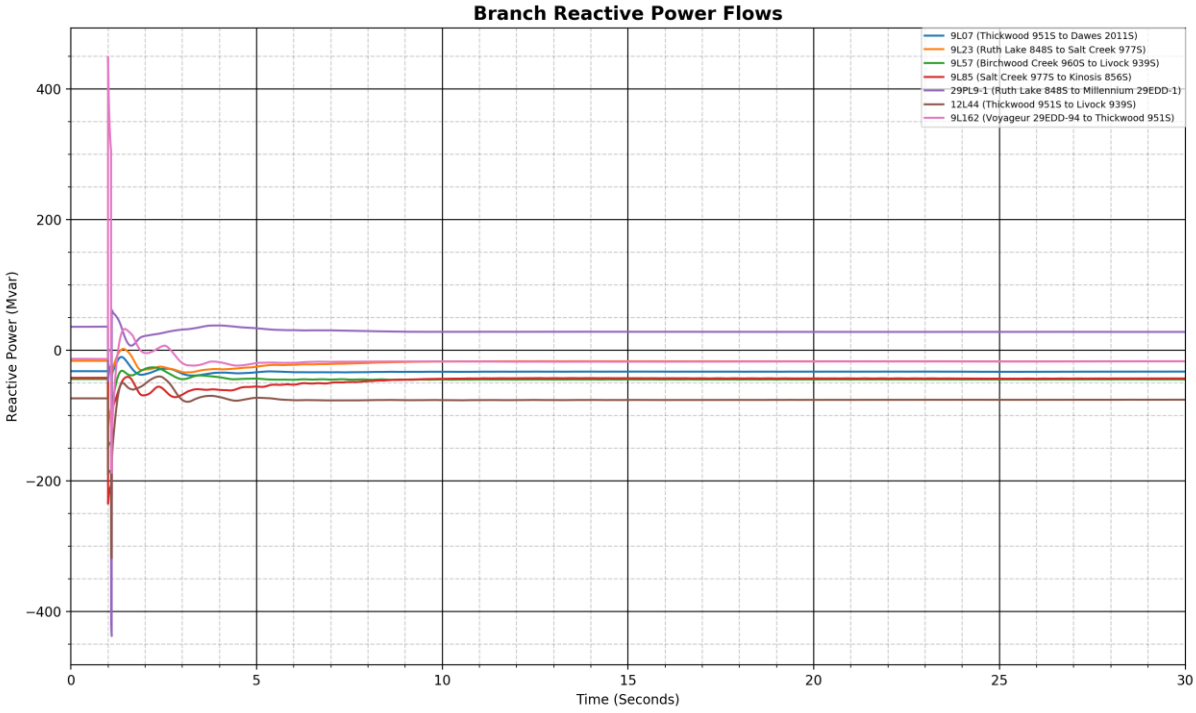
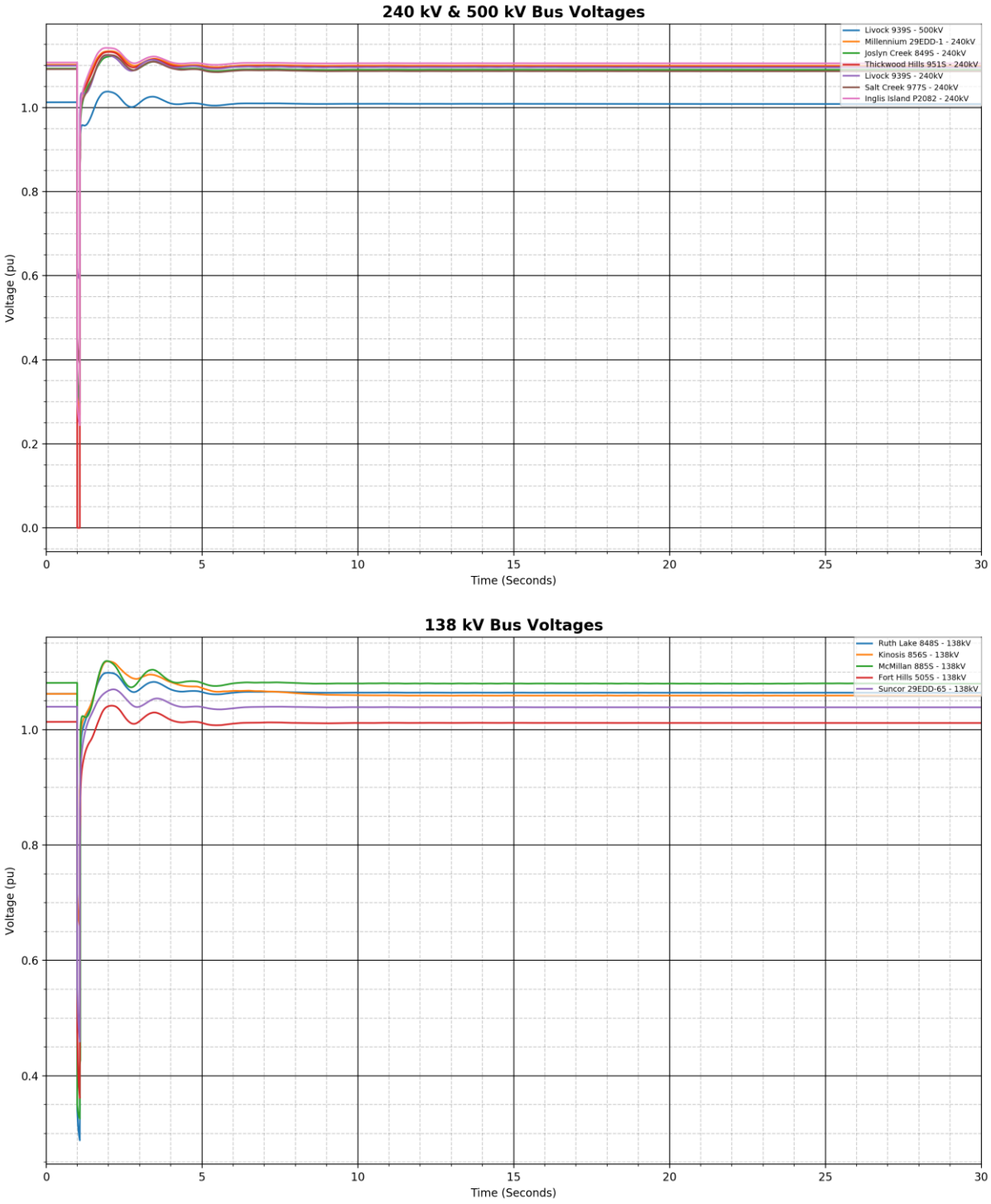
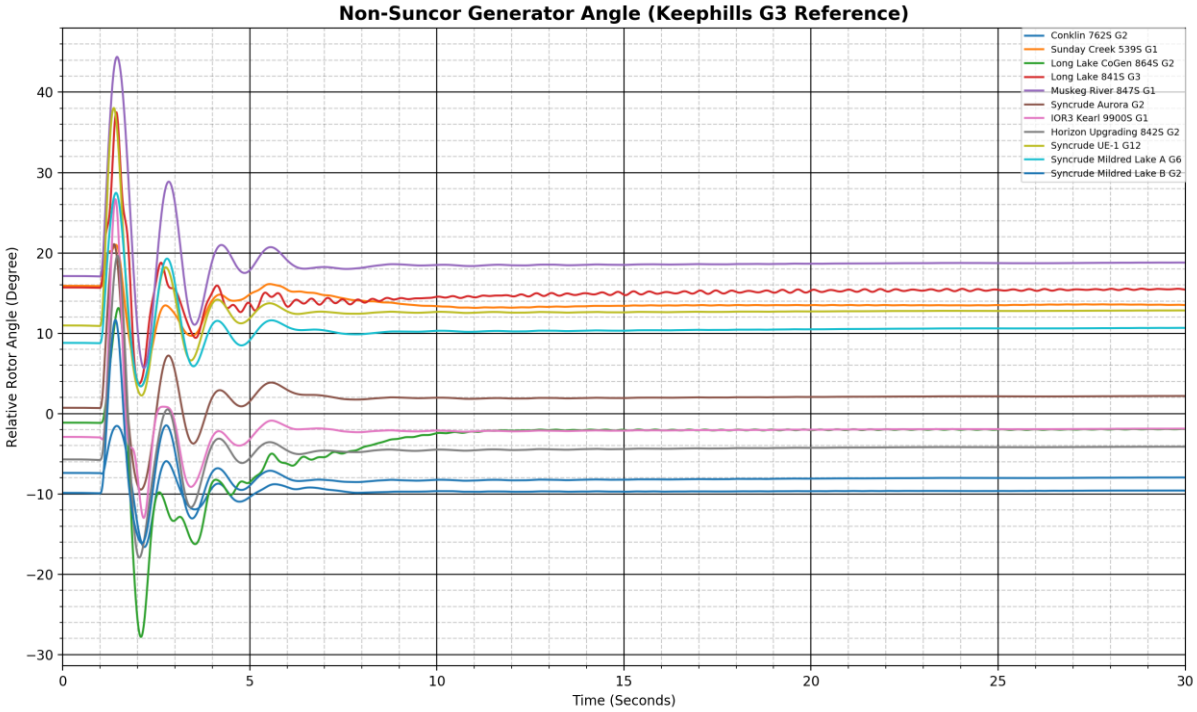
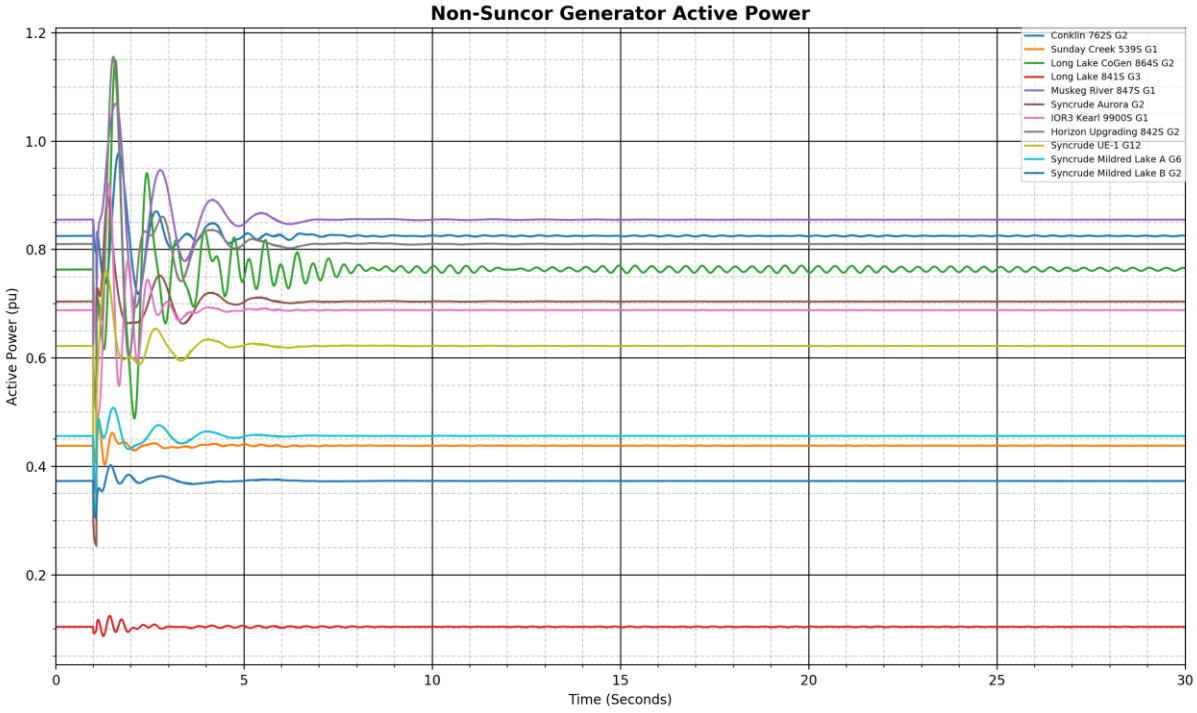
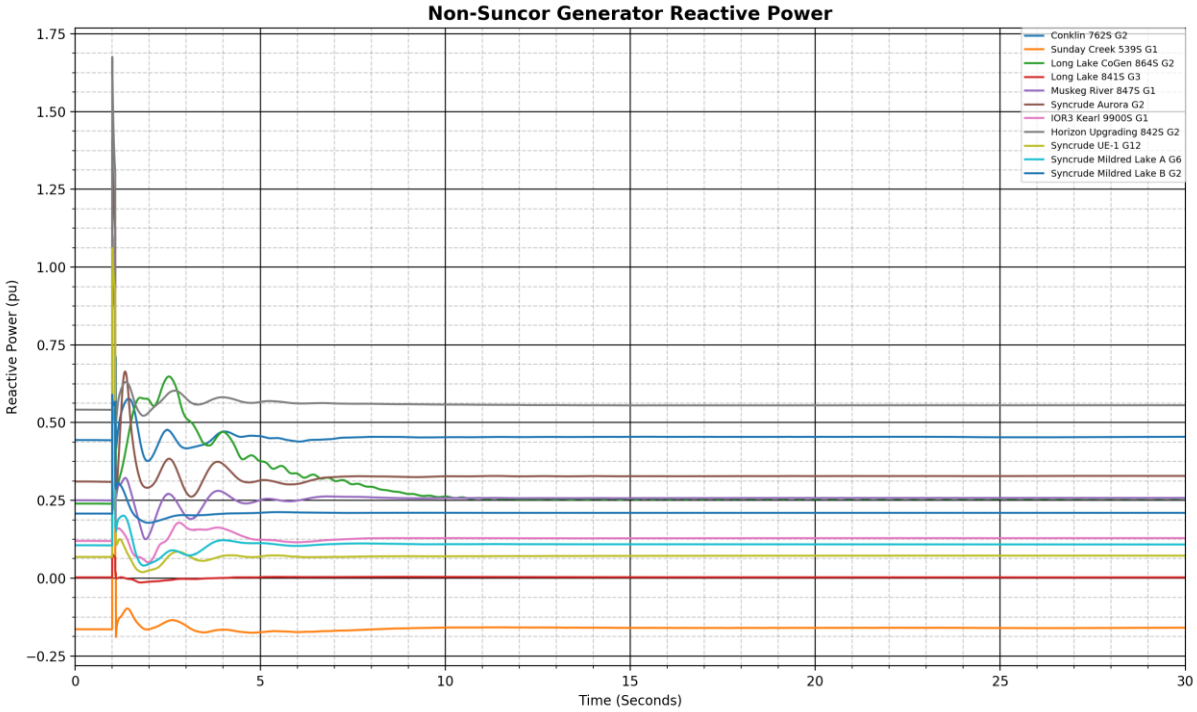

Branch Reactive Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

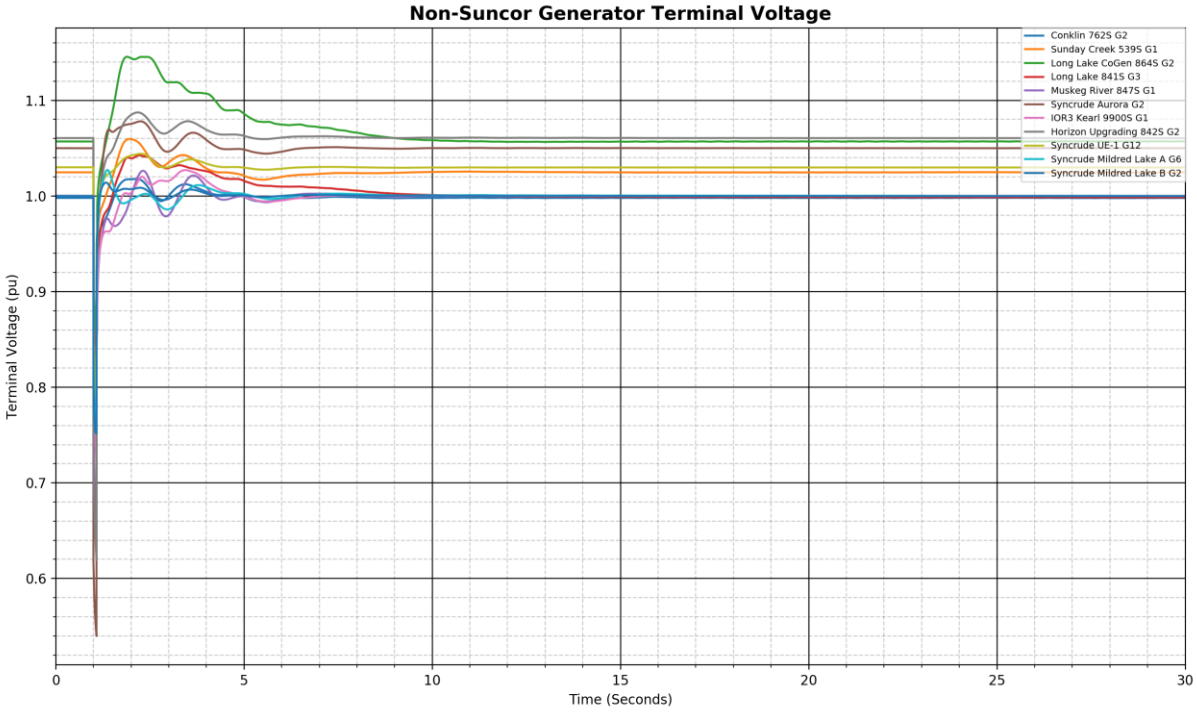
Figure A4-33: 9L07 (Thickwood Hills 951S to Dawes 2011S): Fault at Thickwood Hills 951S

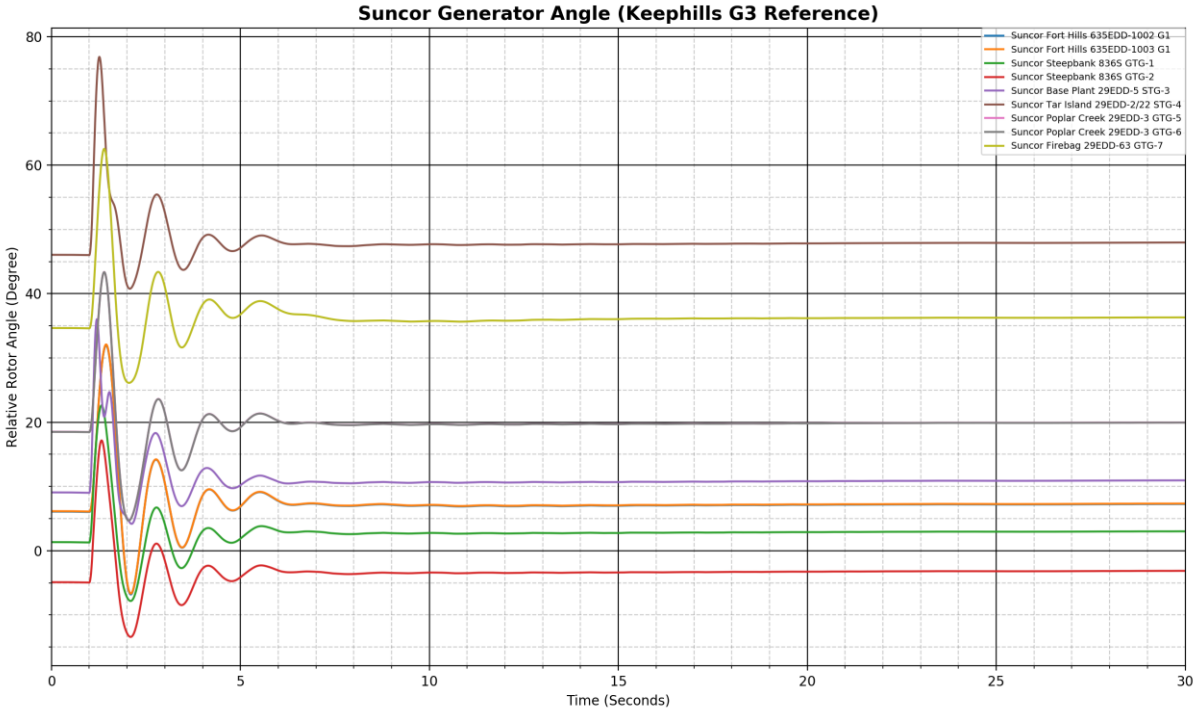


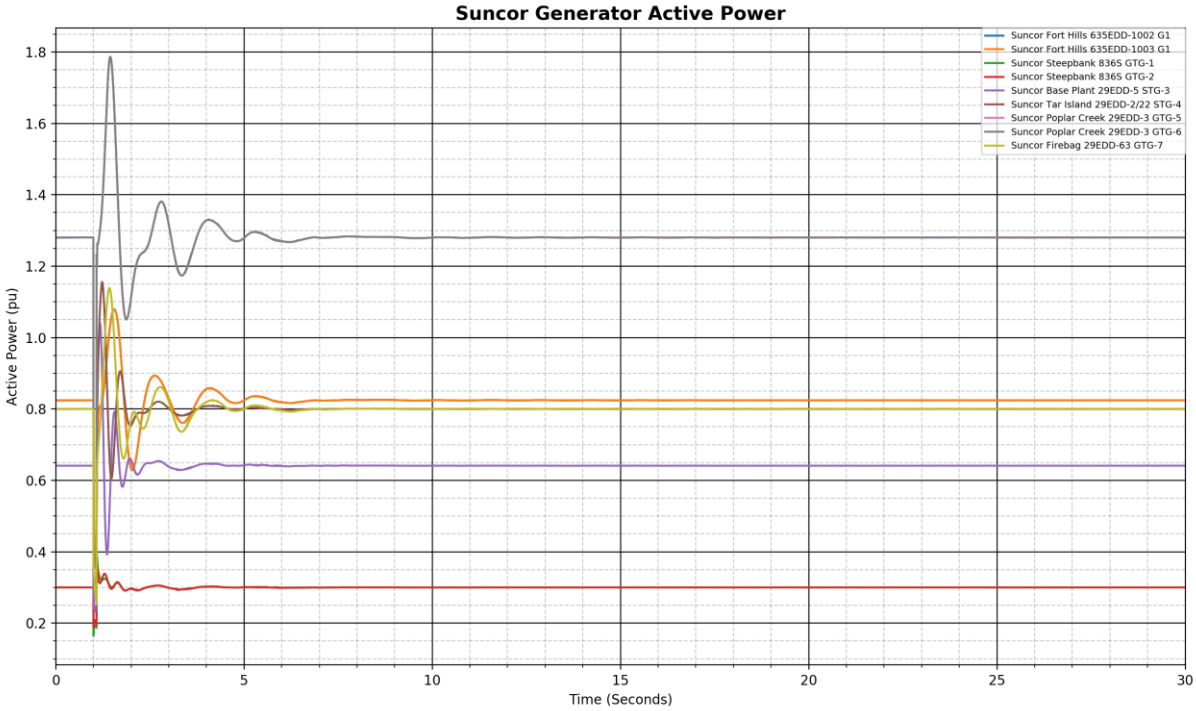

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

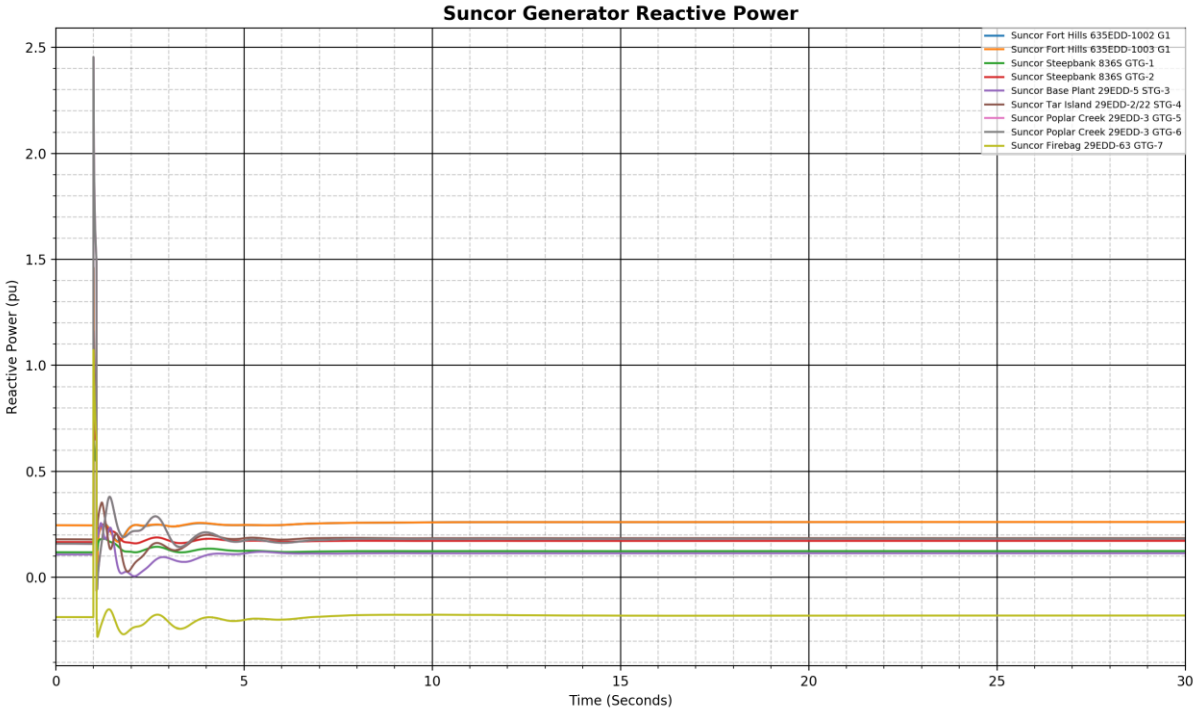

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

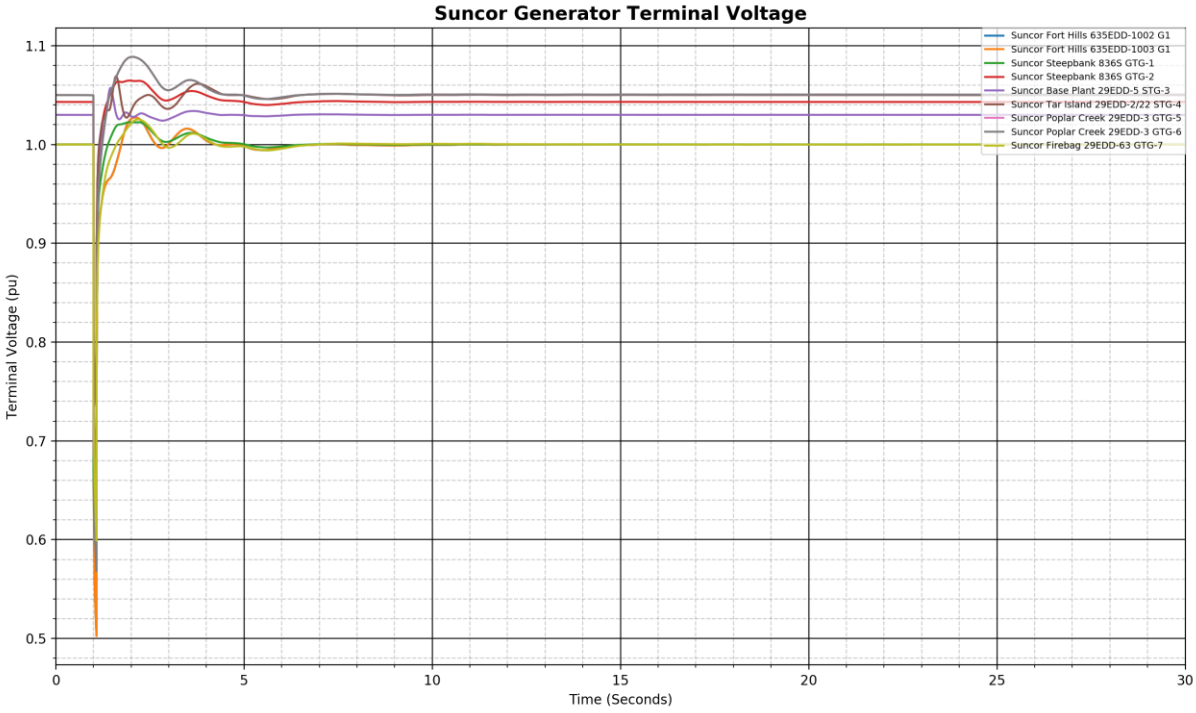

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

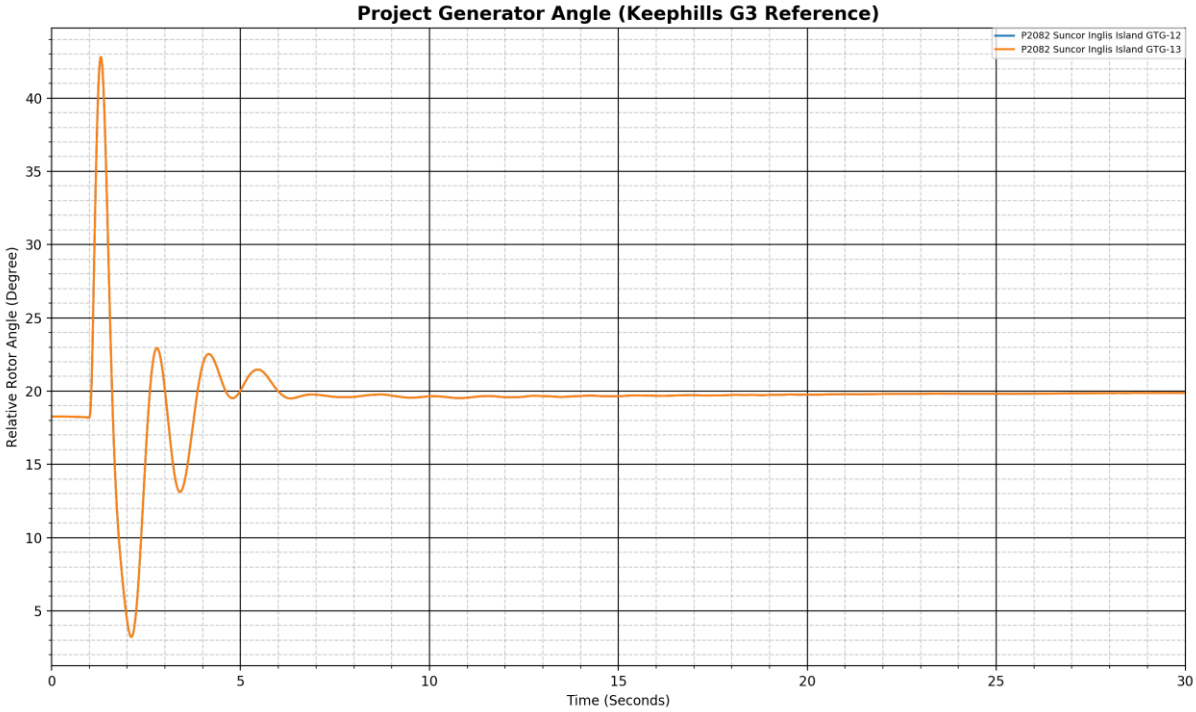

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

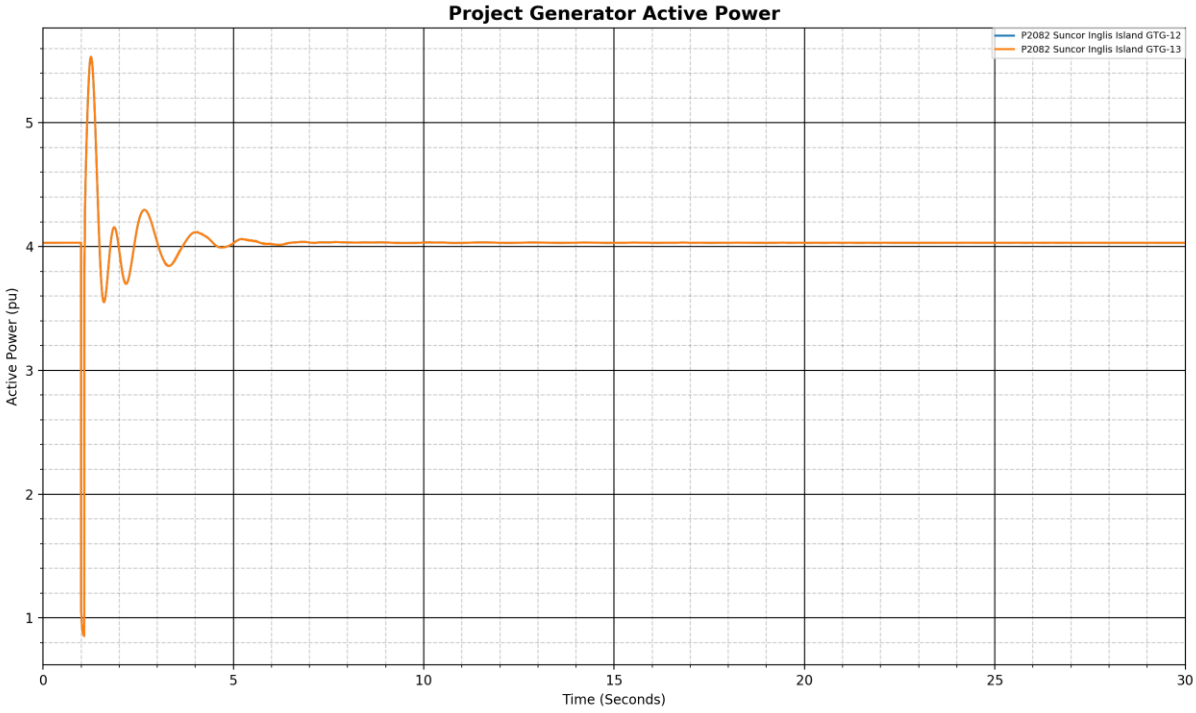

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

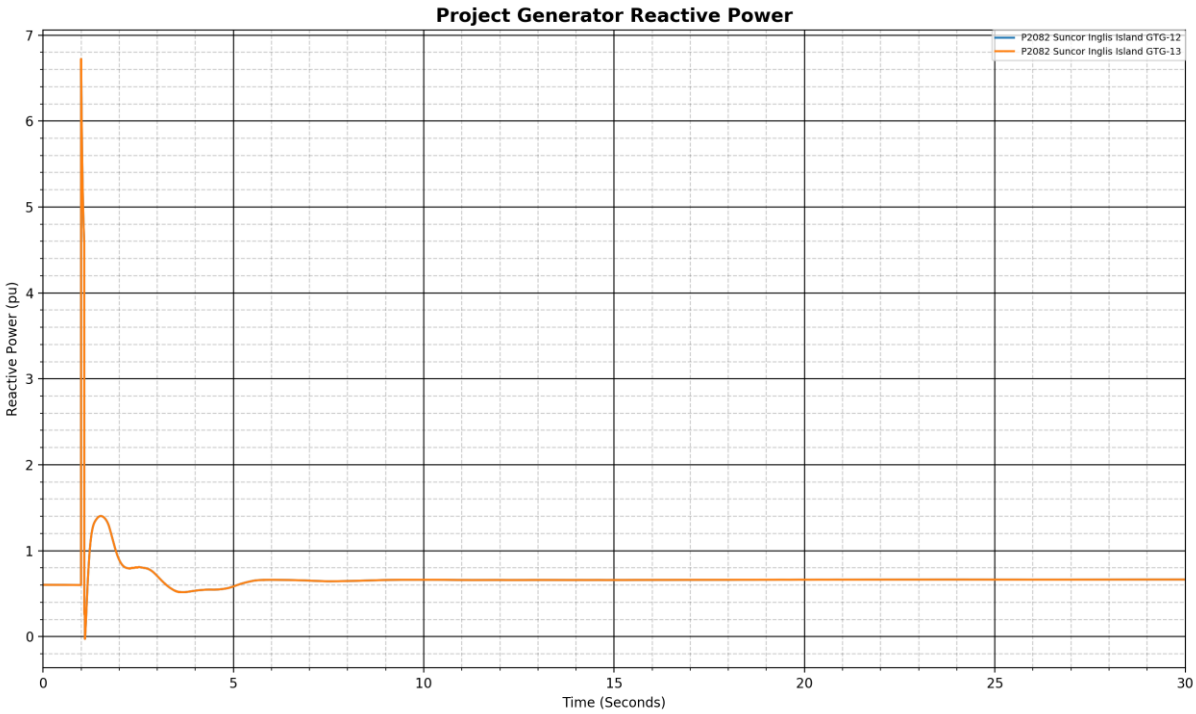

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

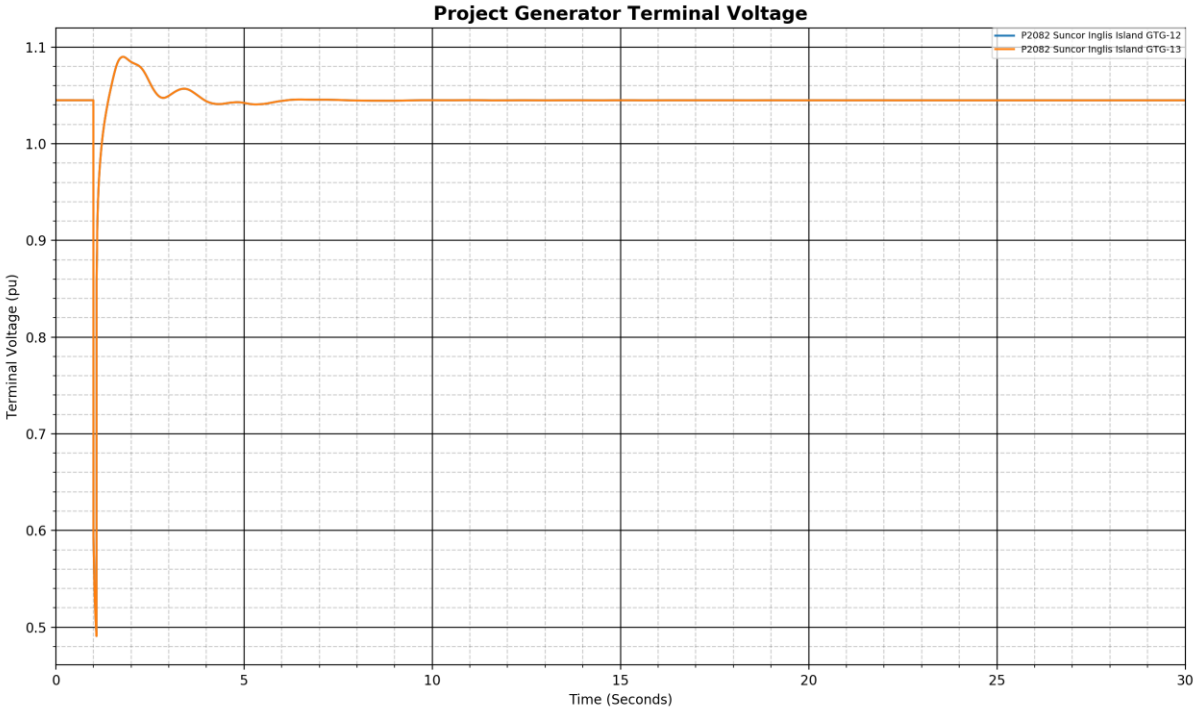

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

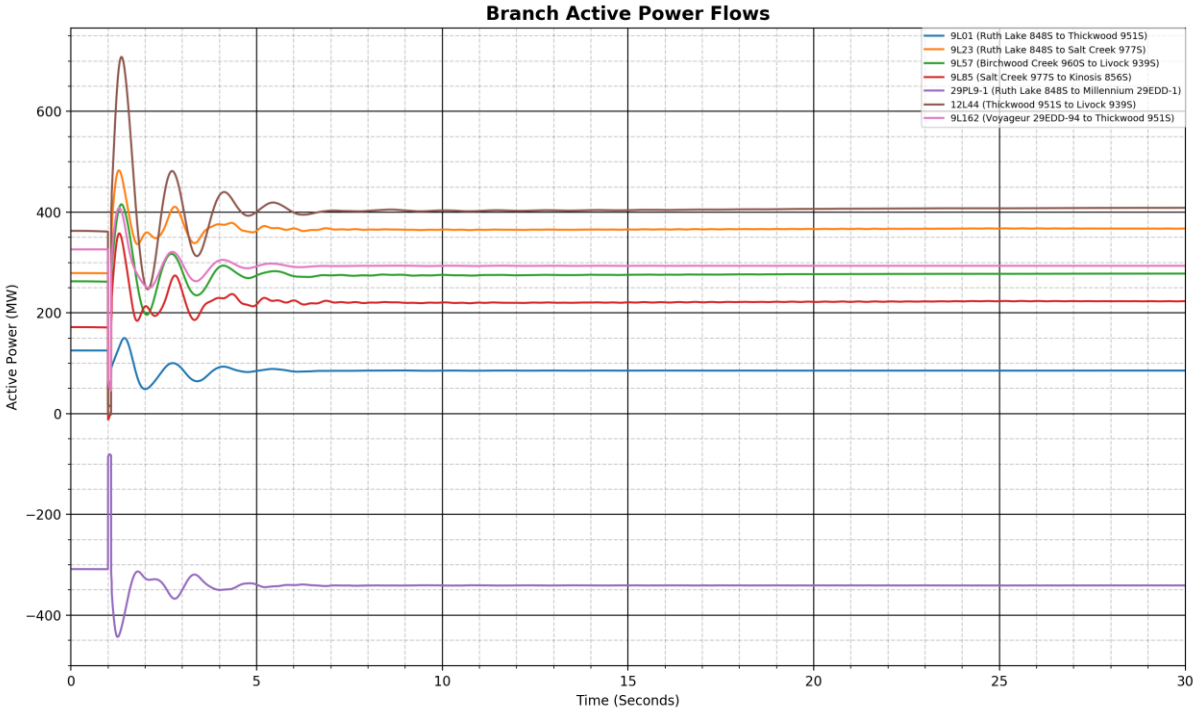

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
0
5
10
15
20
25
30
35
40


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

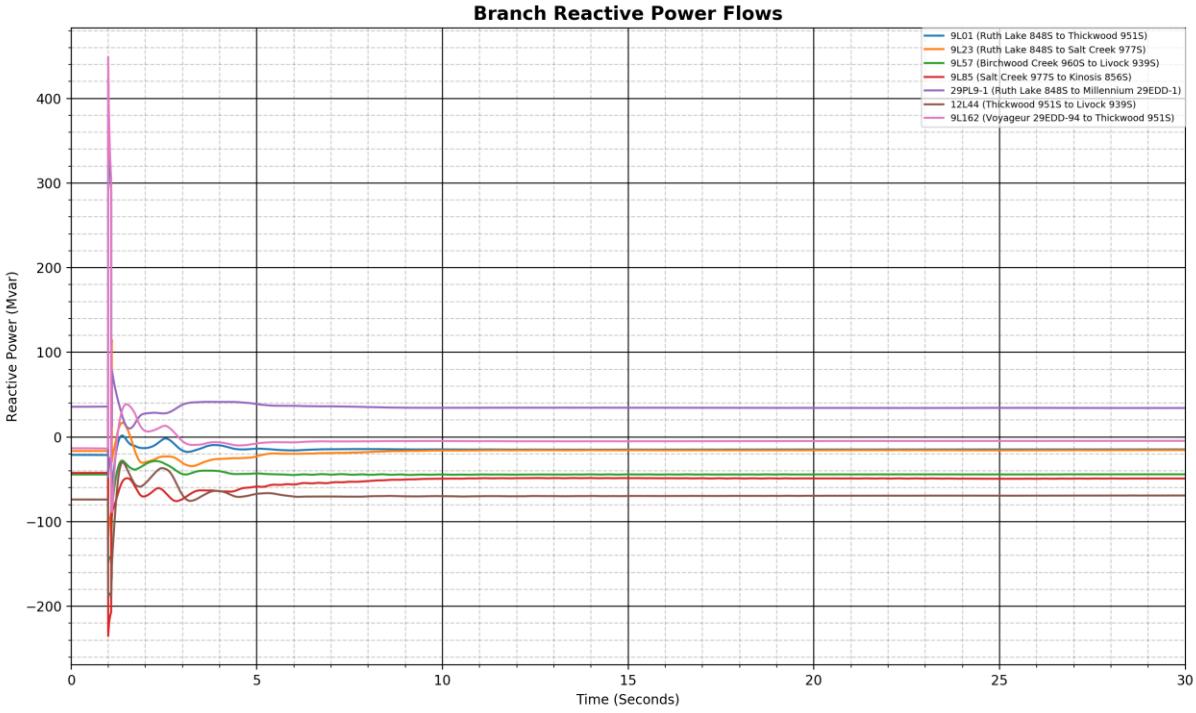
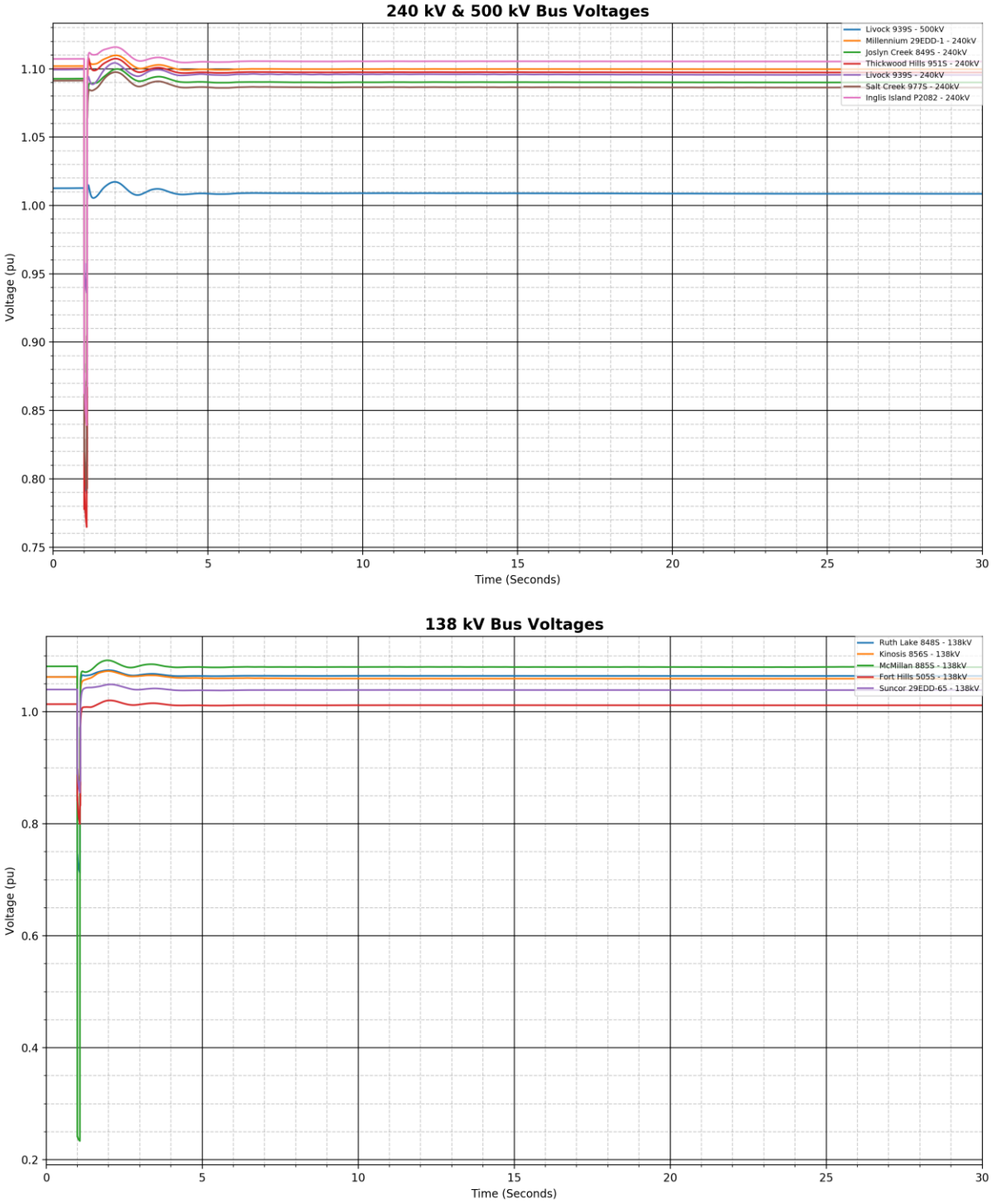
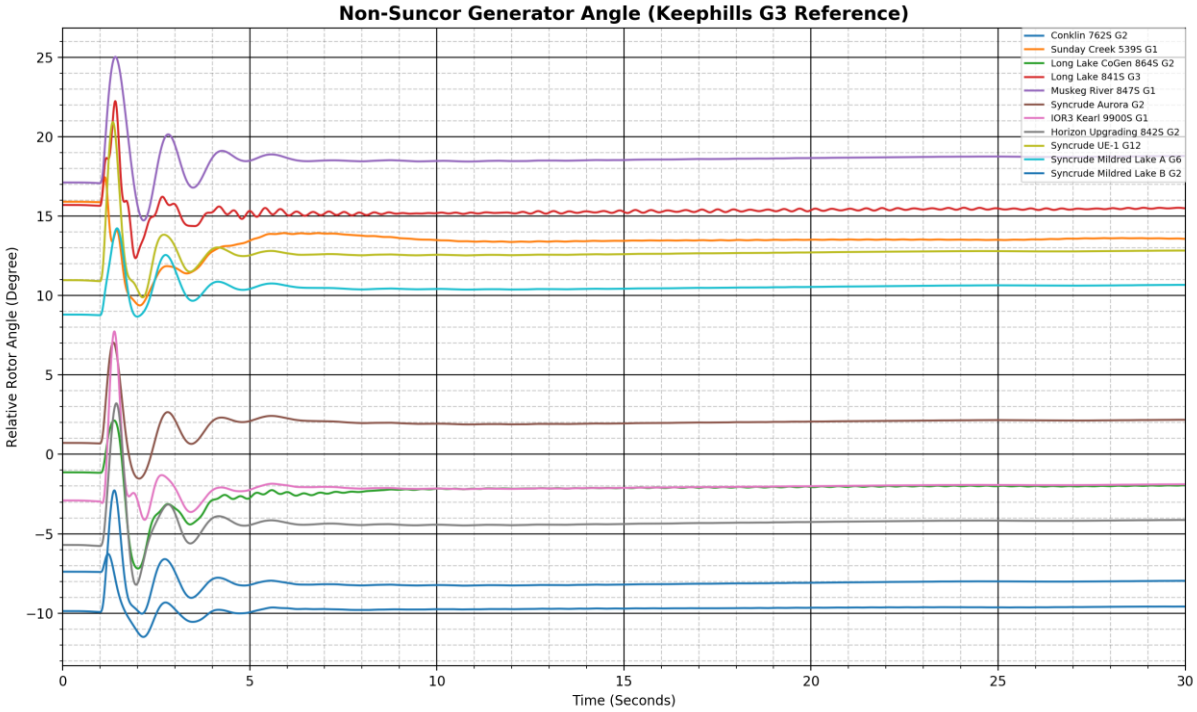
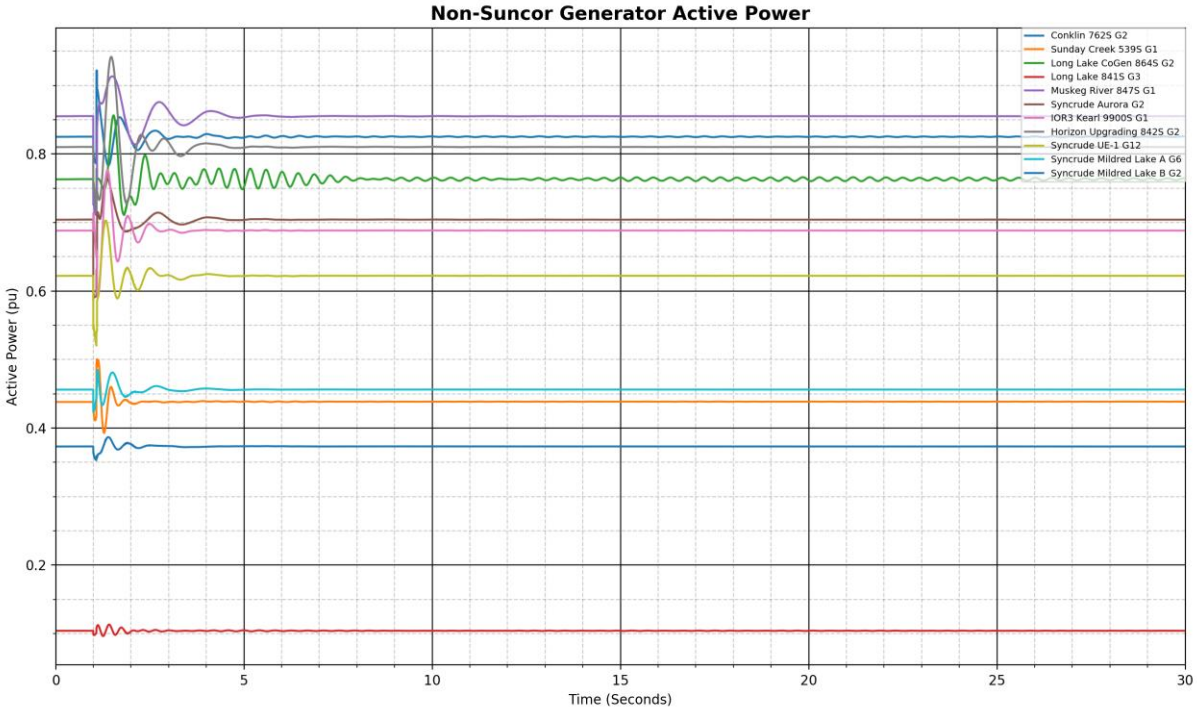
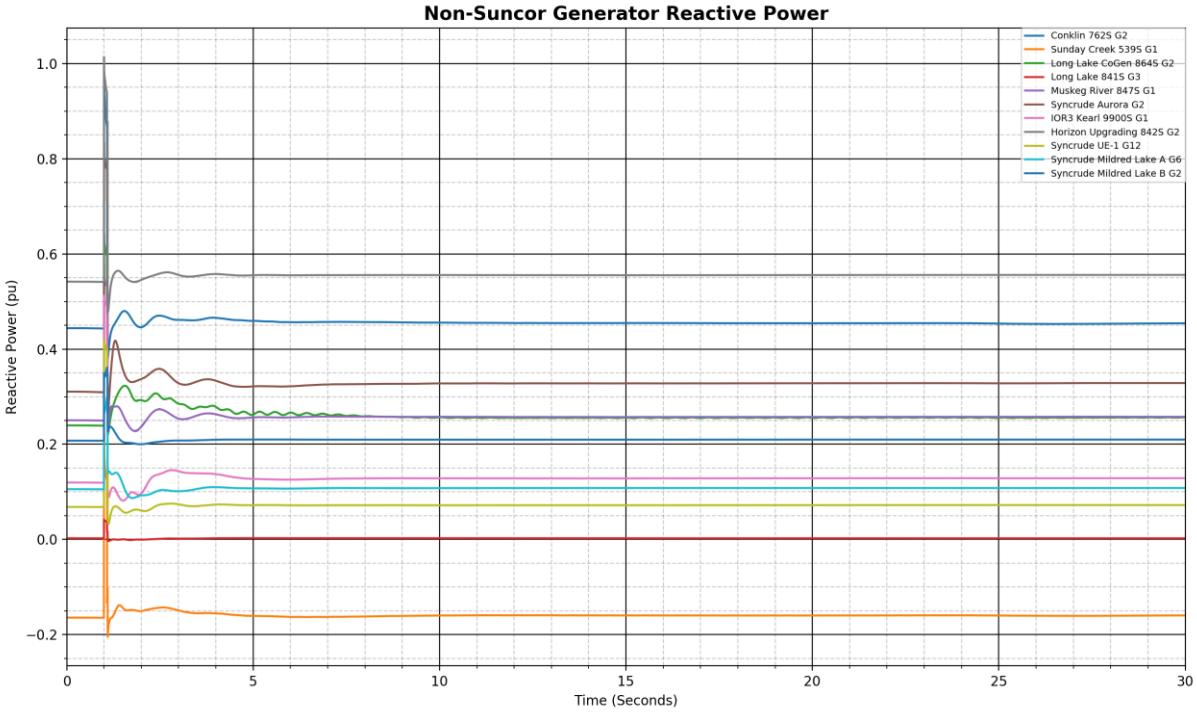

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
0
5
10
15
20
25
30
Time (Seconds)

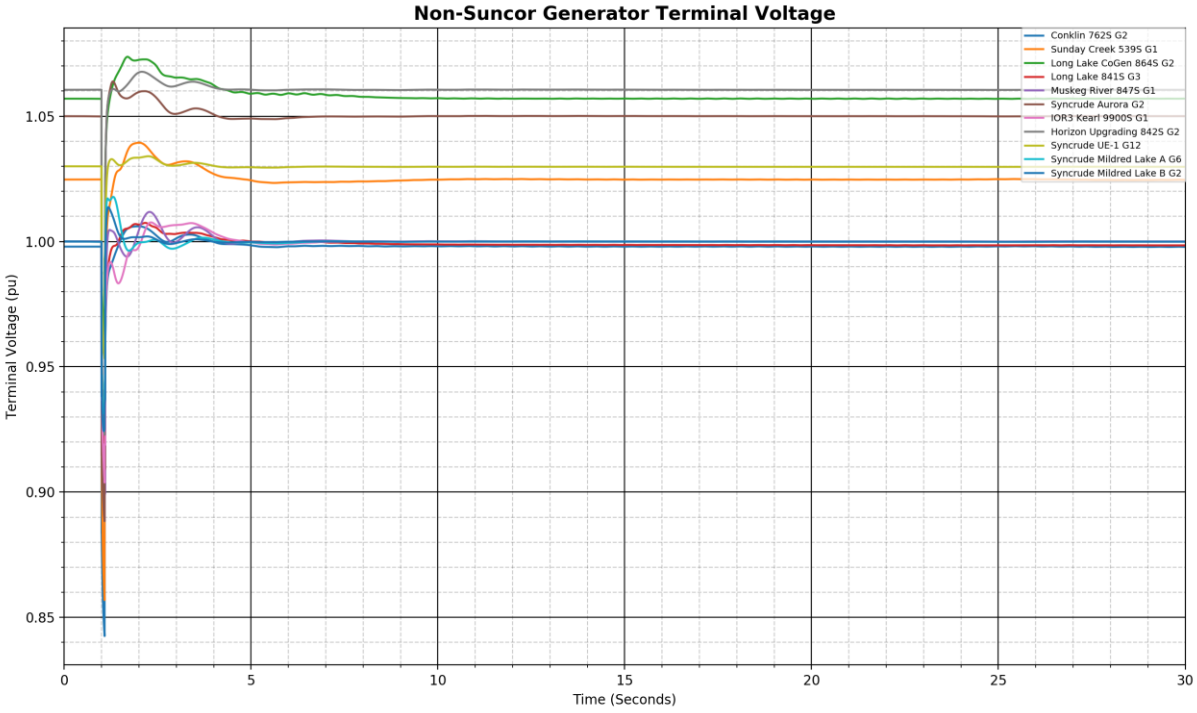
Figure A4-34: 9L07 (Thickwood Hills 951S to Dawes 2011S): Fault at Dawes 2011S

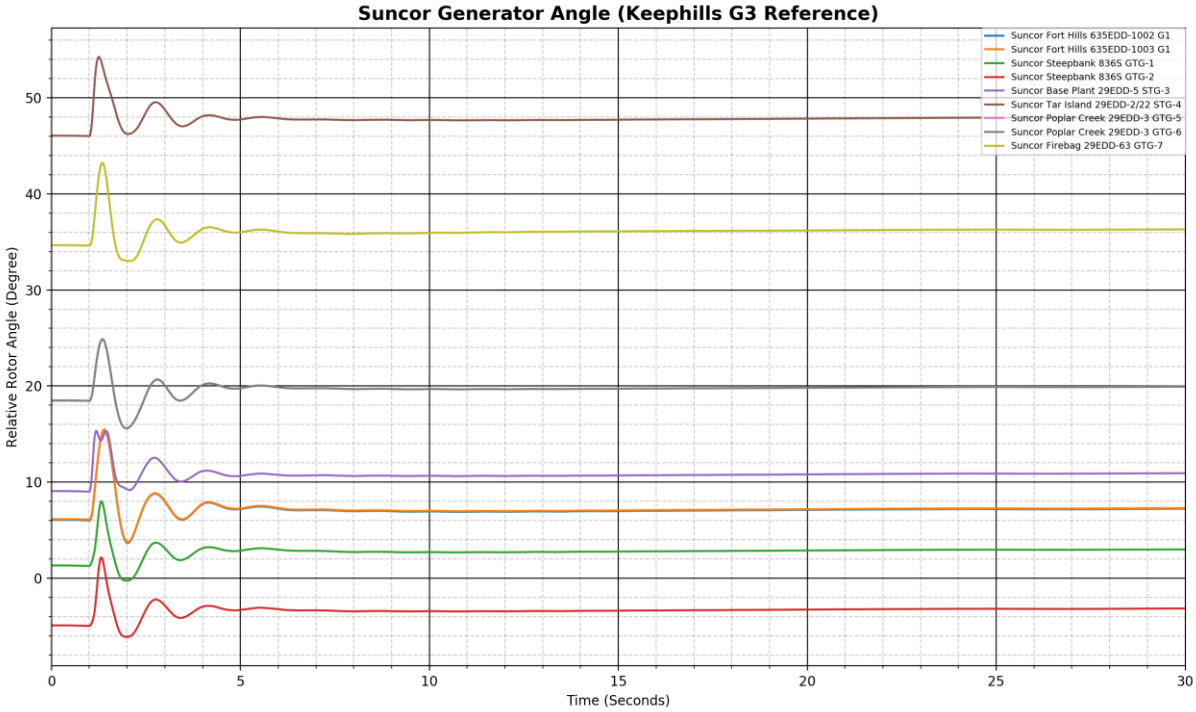


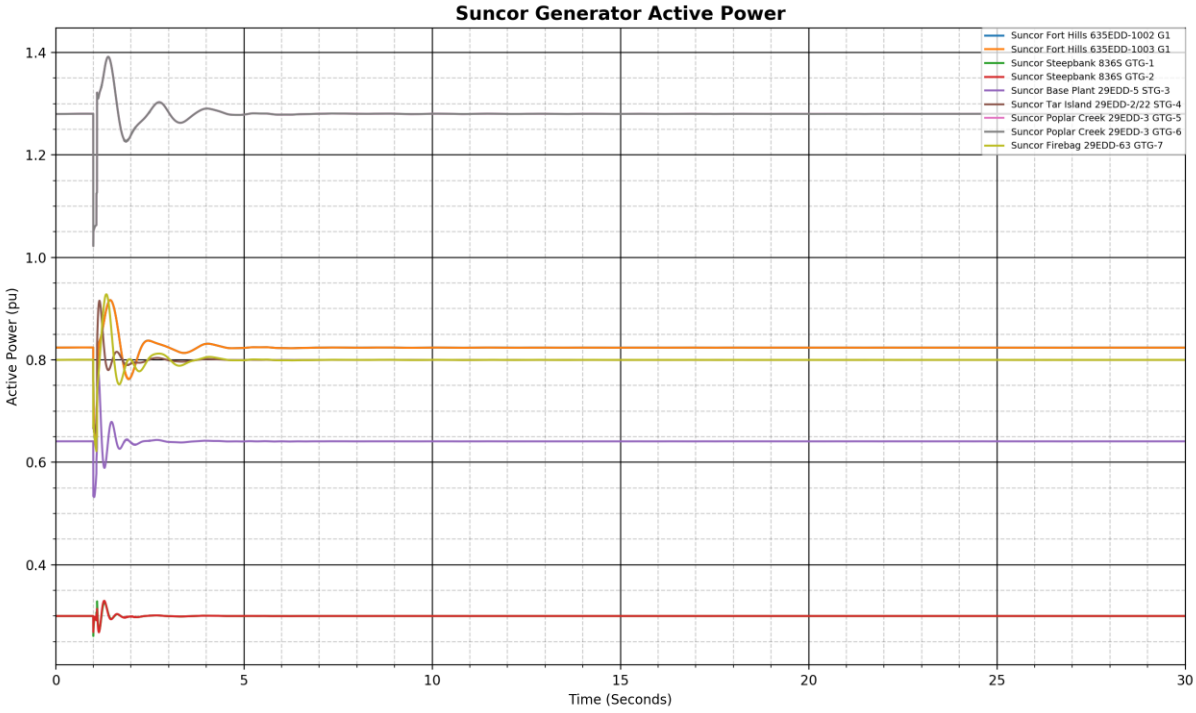

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

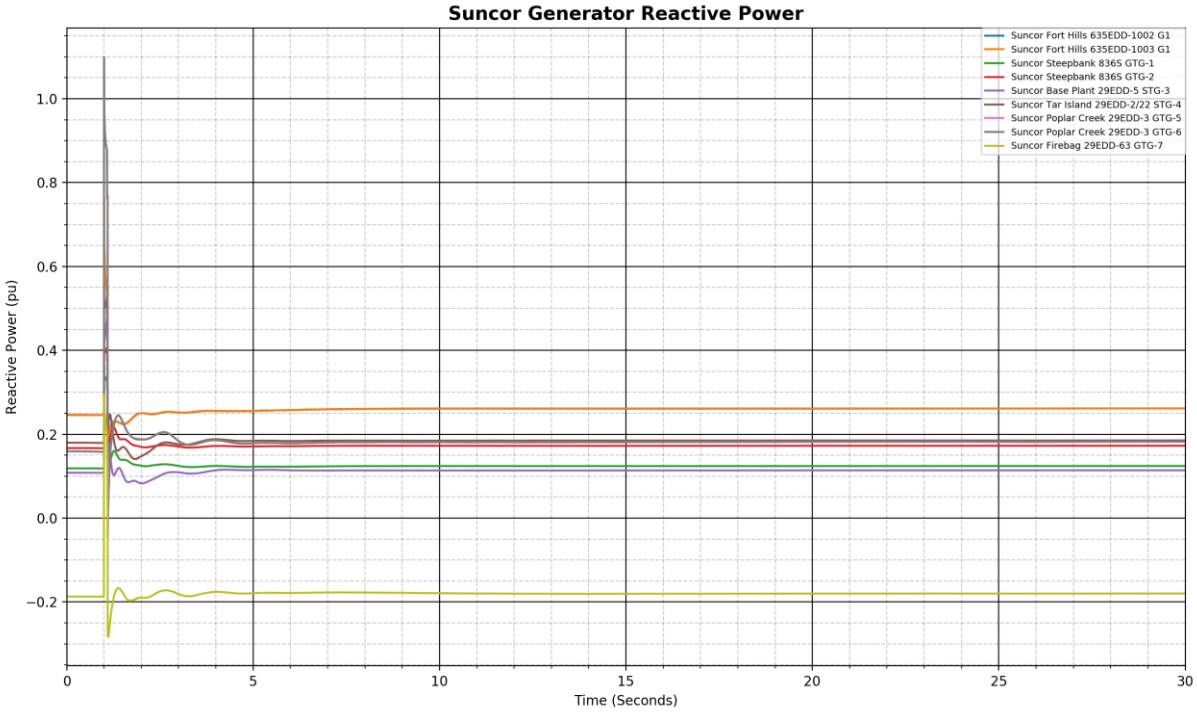

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

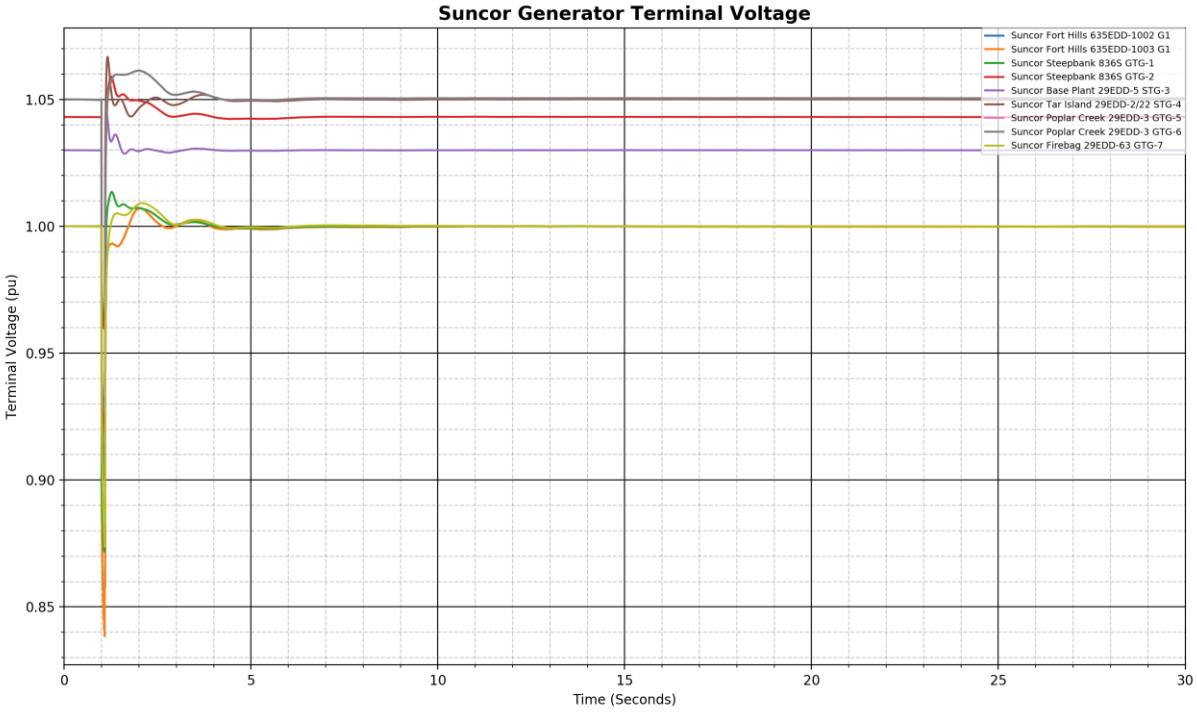

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

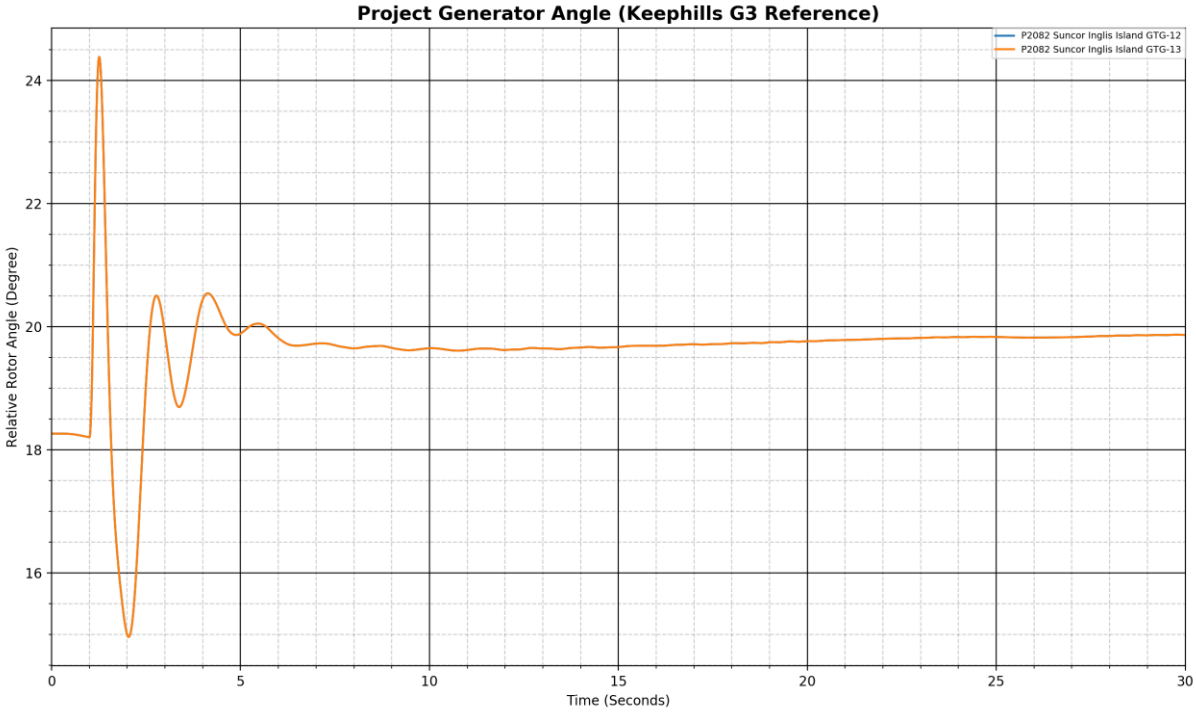

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

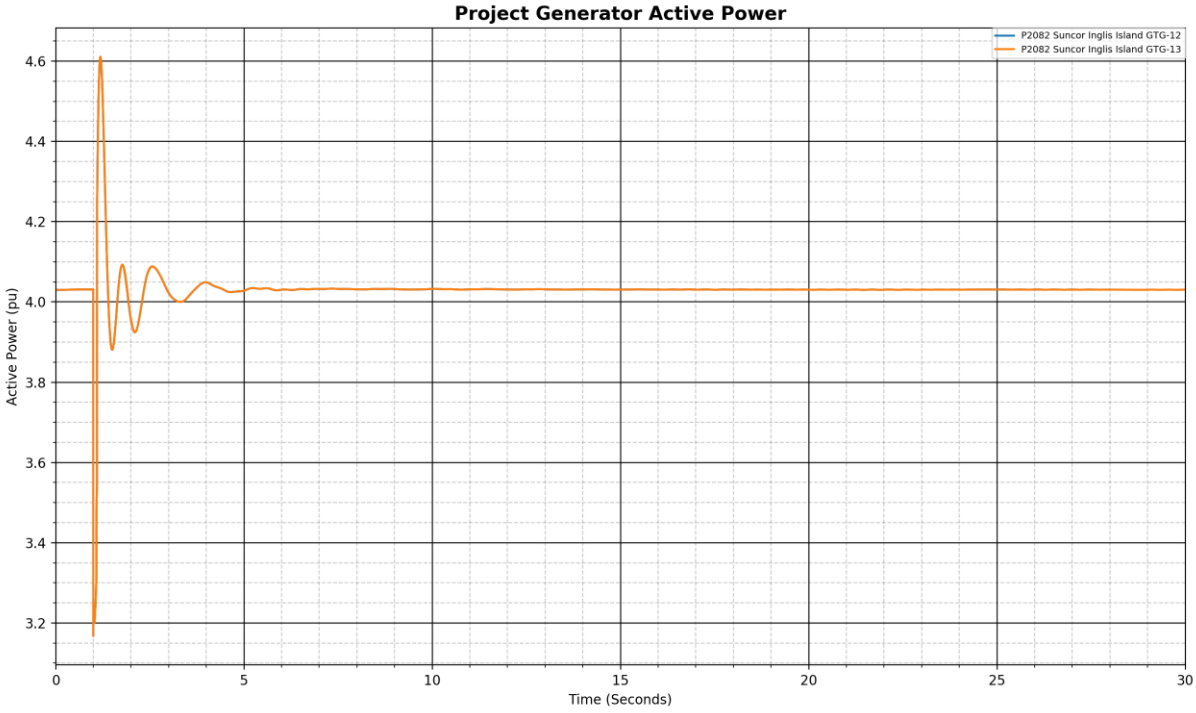

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

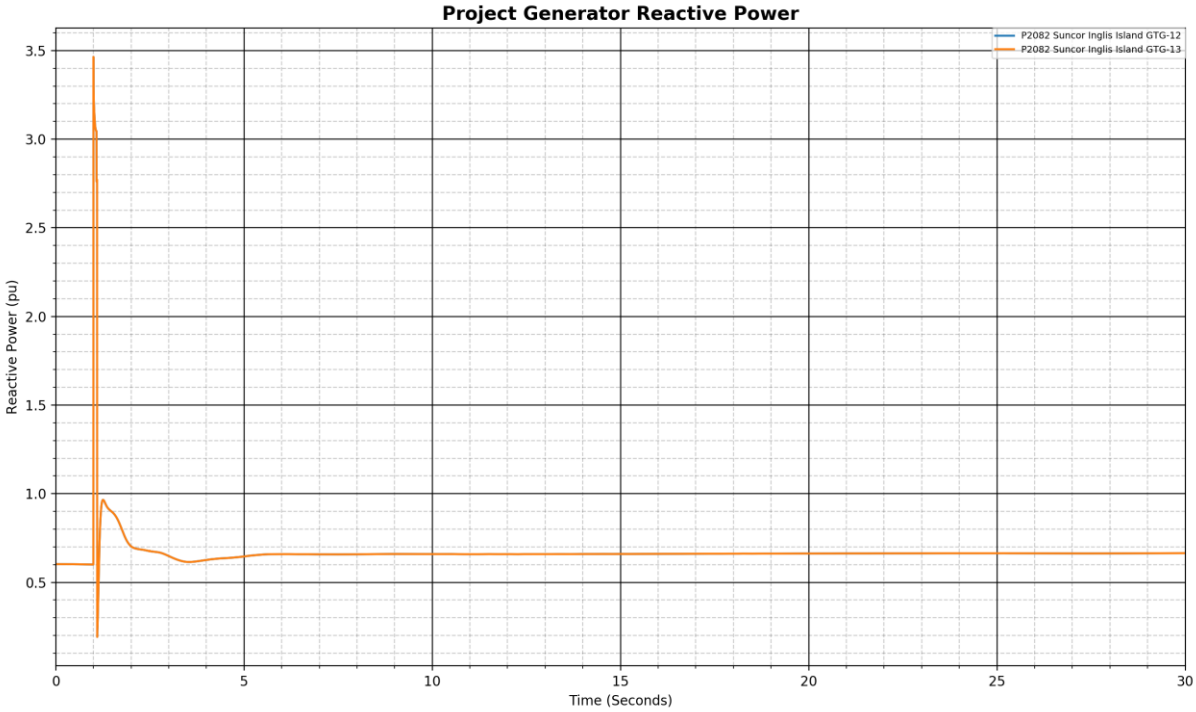

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

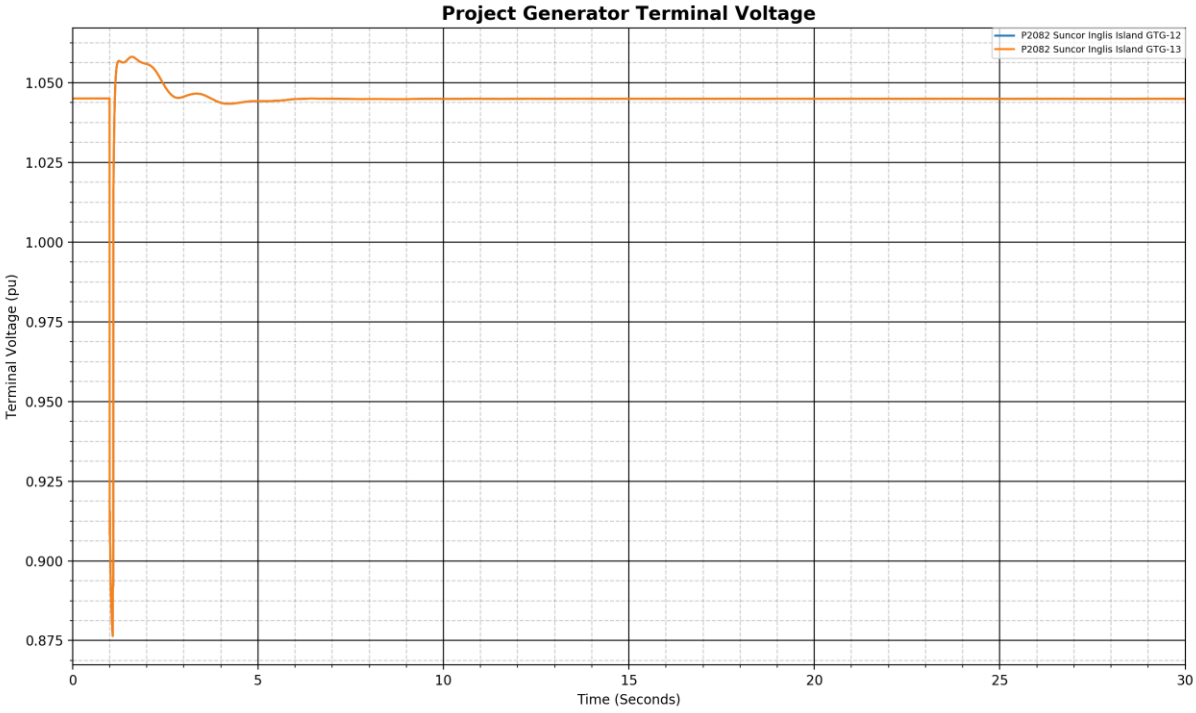

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

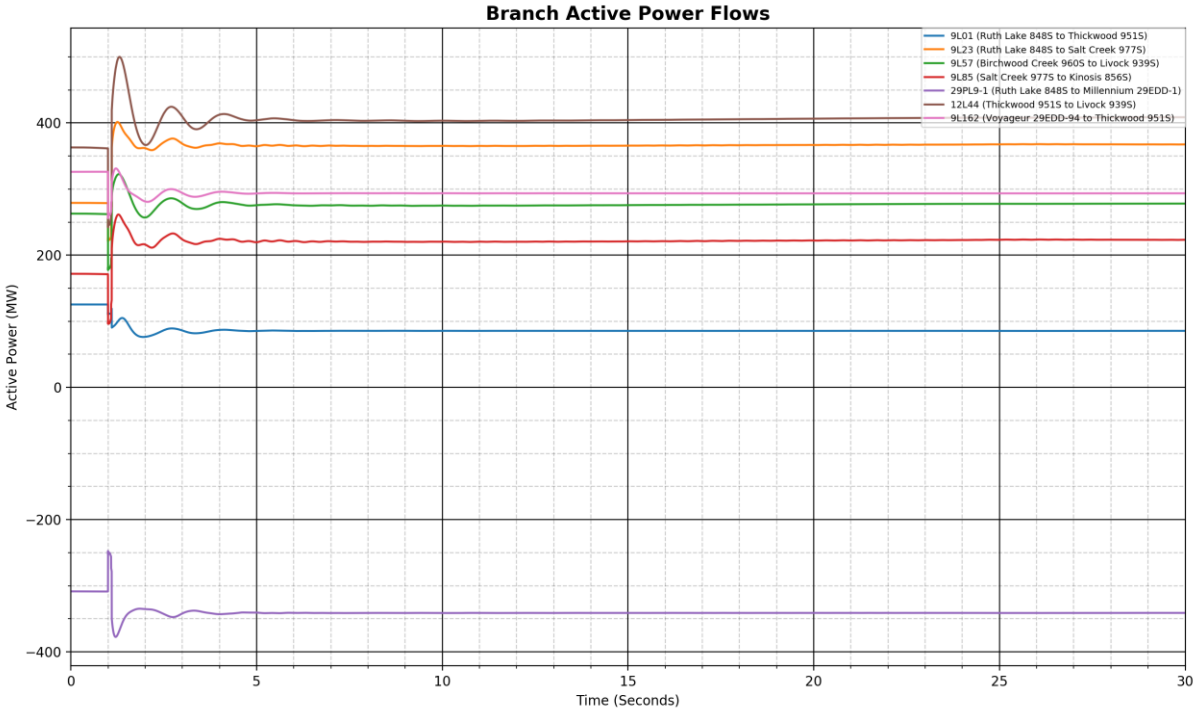

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
24
22
20
18
16
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.050
1.025
1.000
0.975
0.950
0.925
0.900
0.875
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

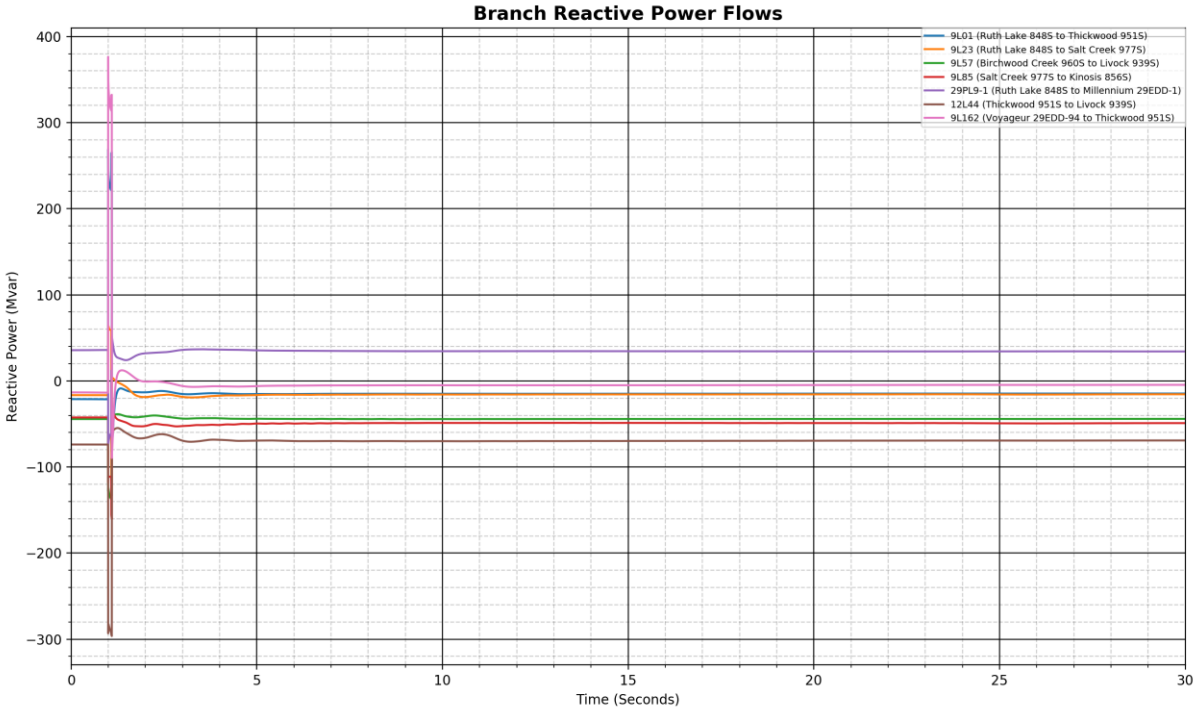
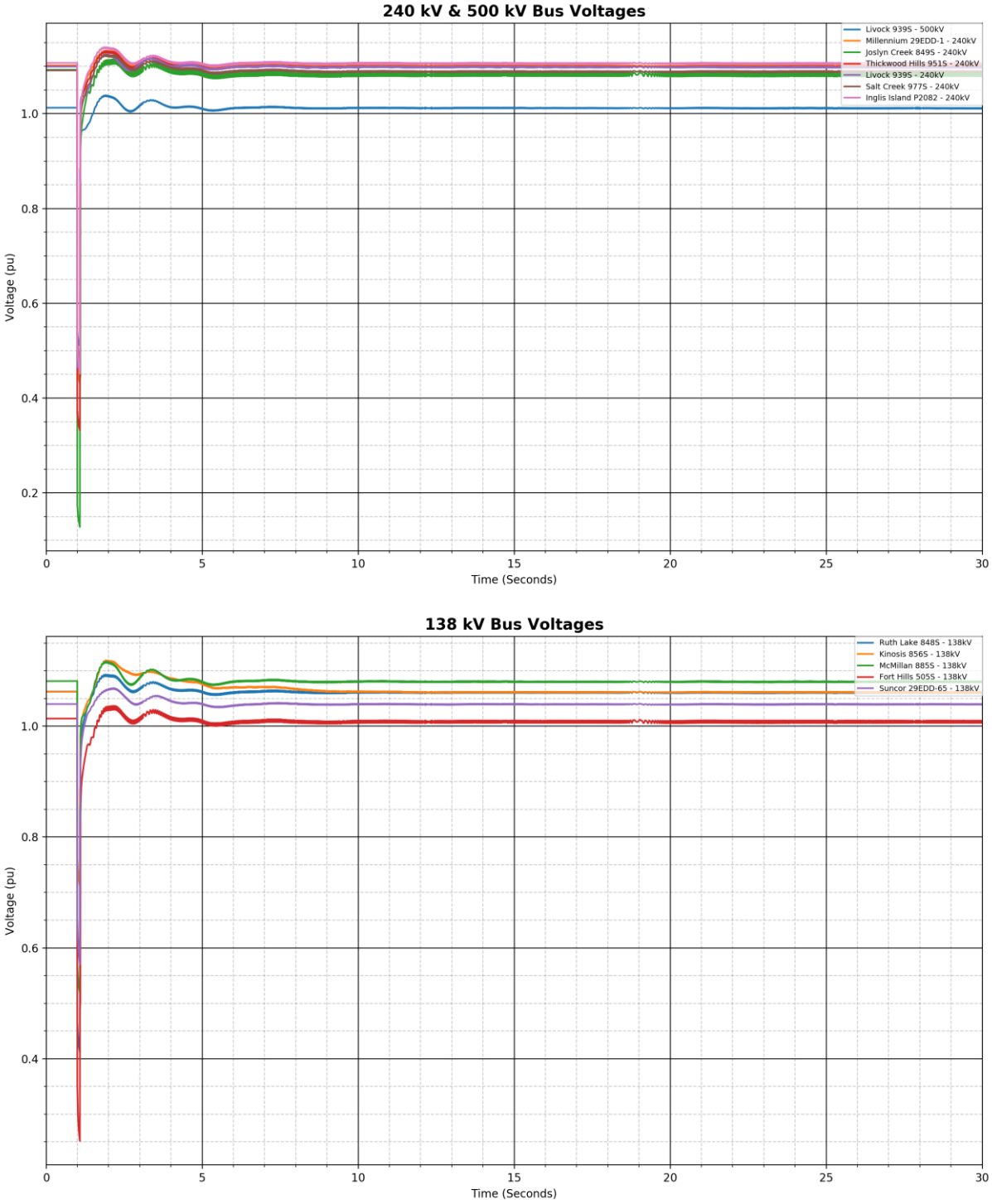
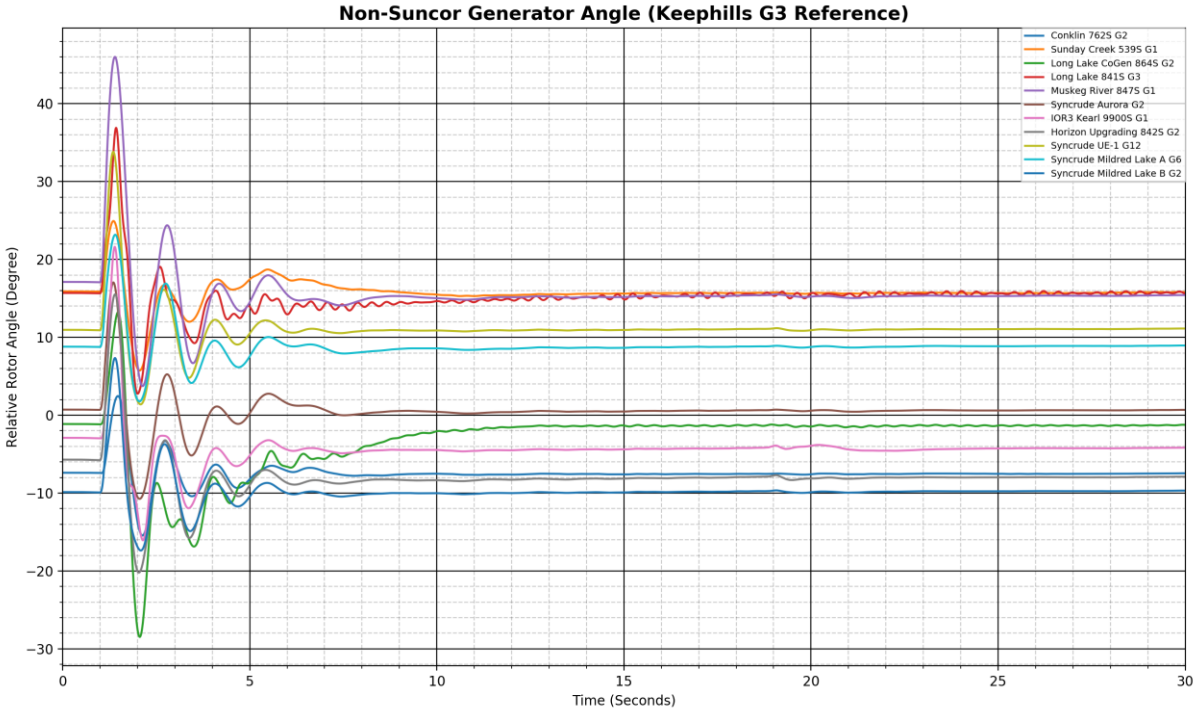
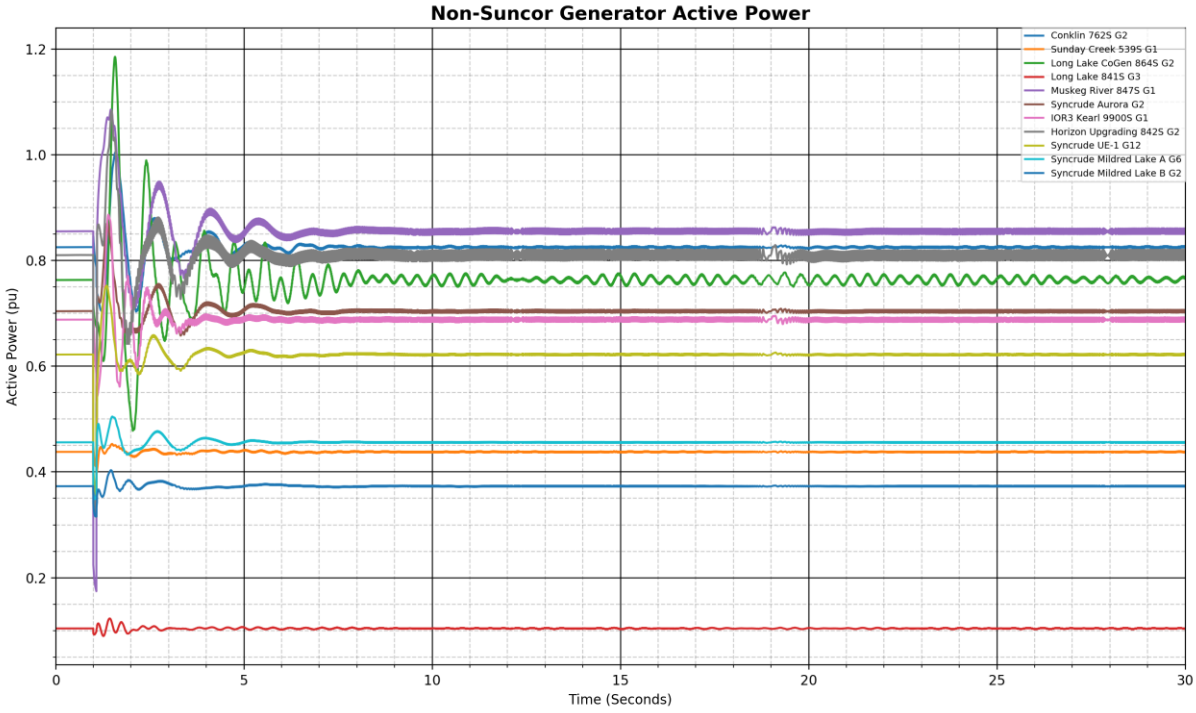
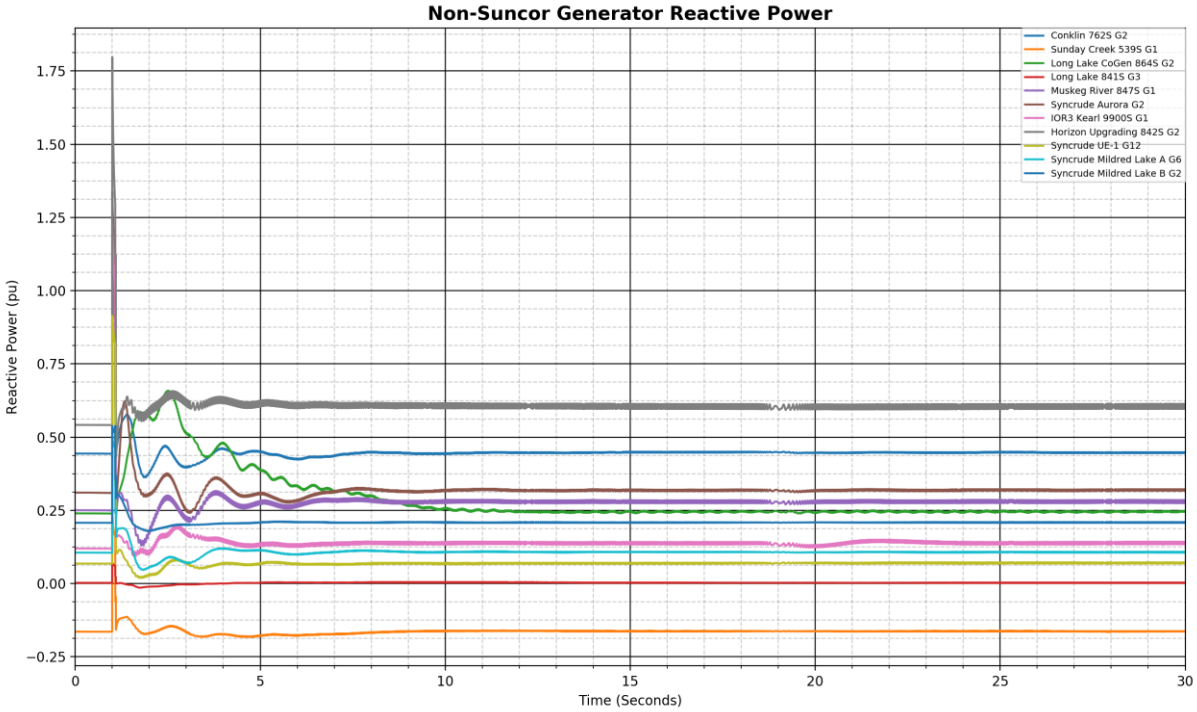

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

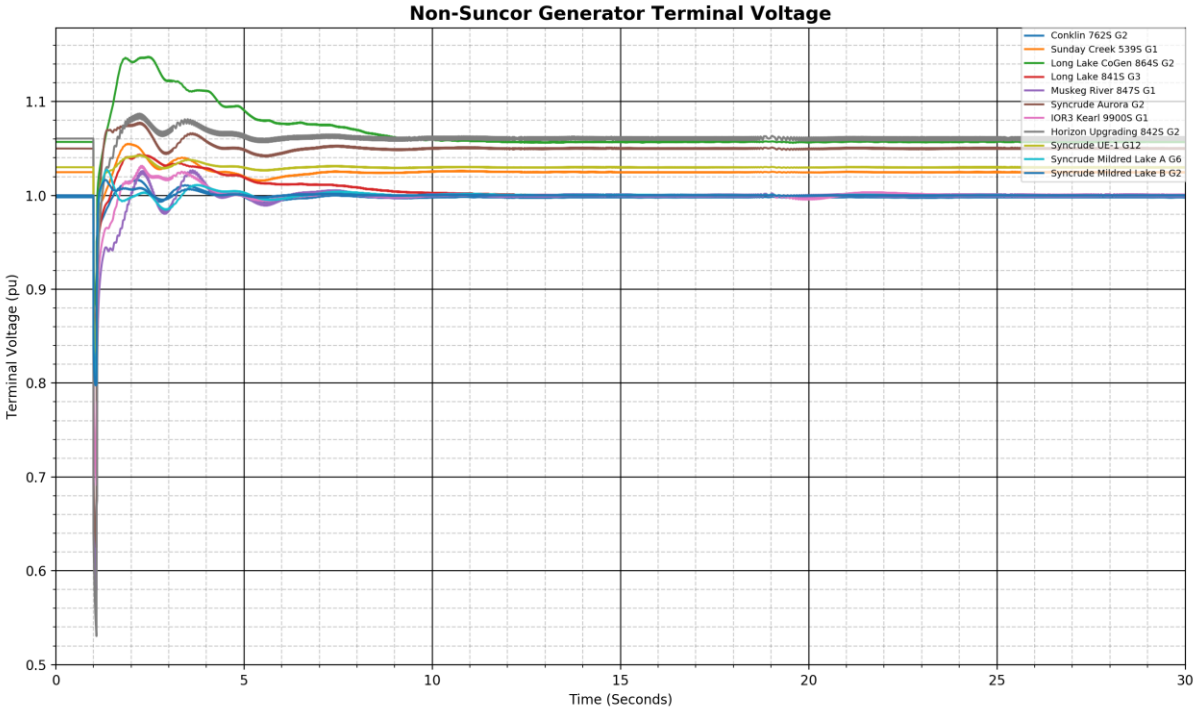
Figure A4-35: 9L08 (Dover 888S to Joslyn Creek 849S): Fault at Dover 888S

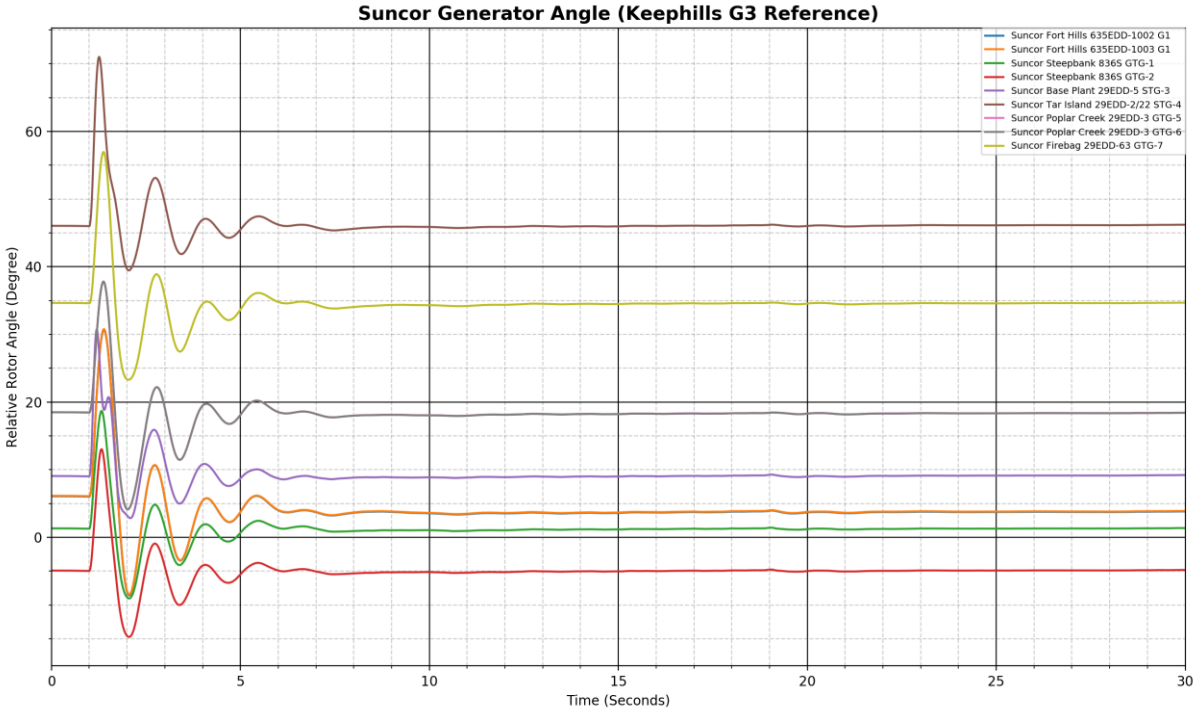


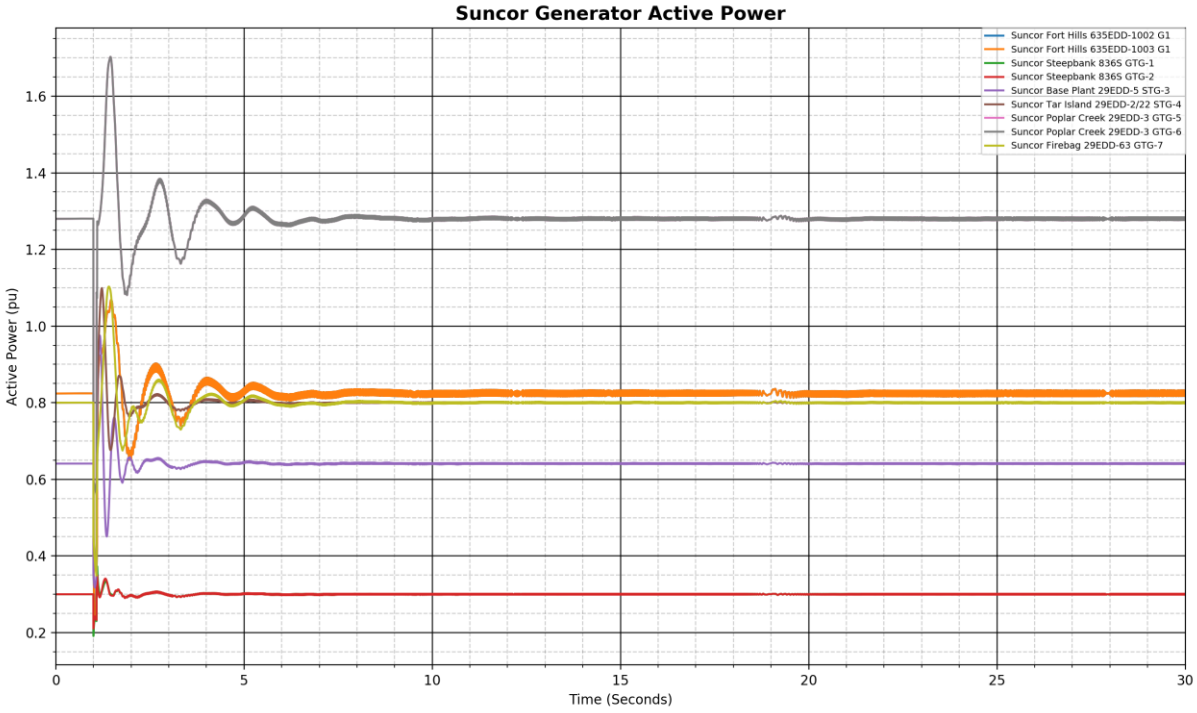

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

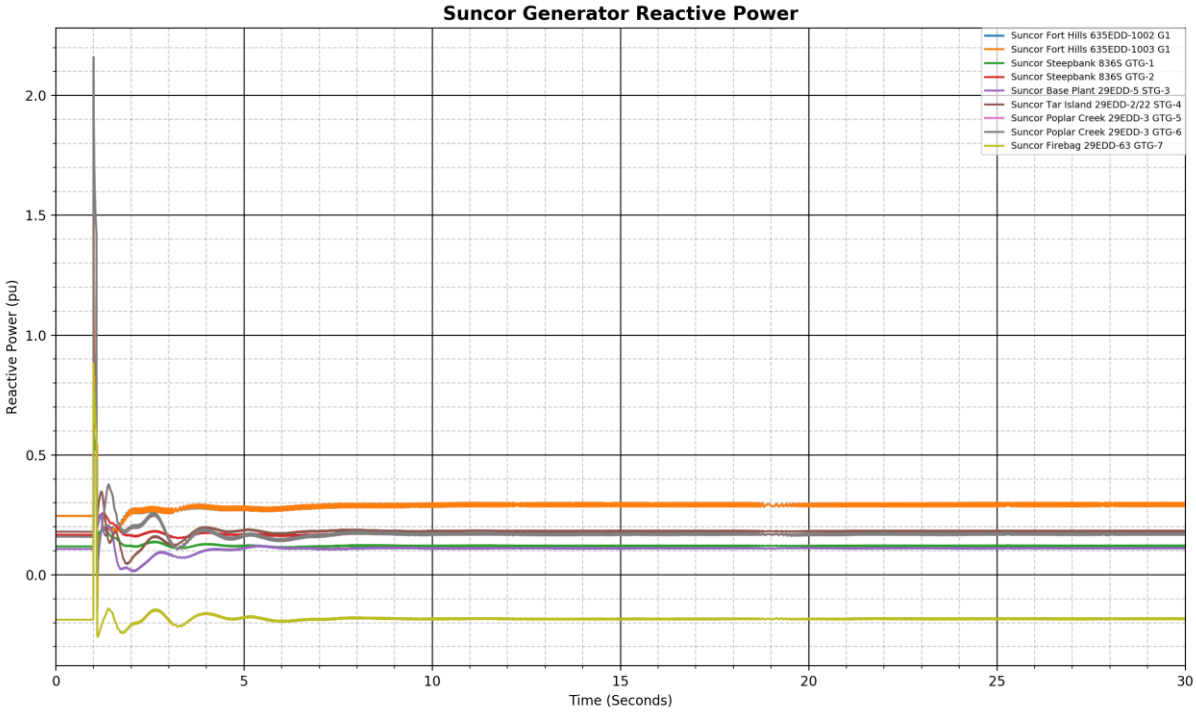

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

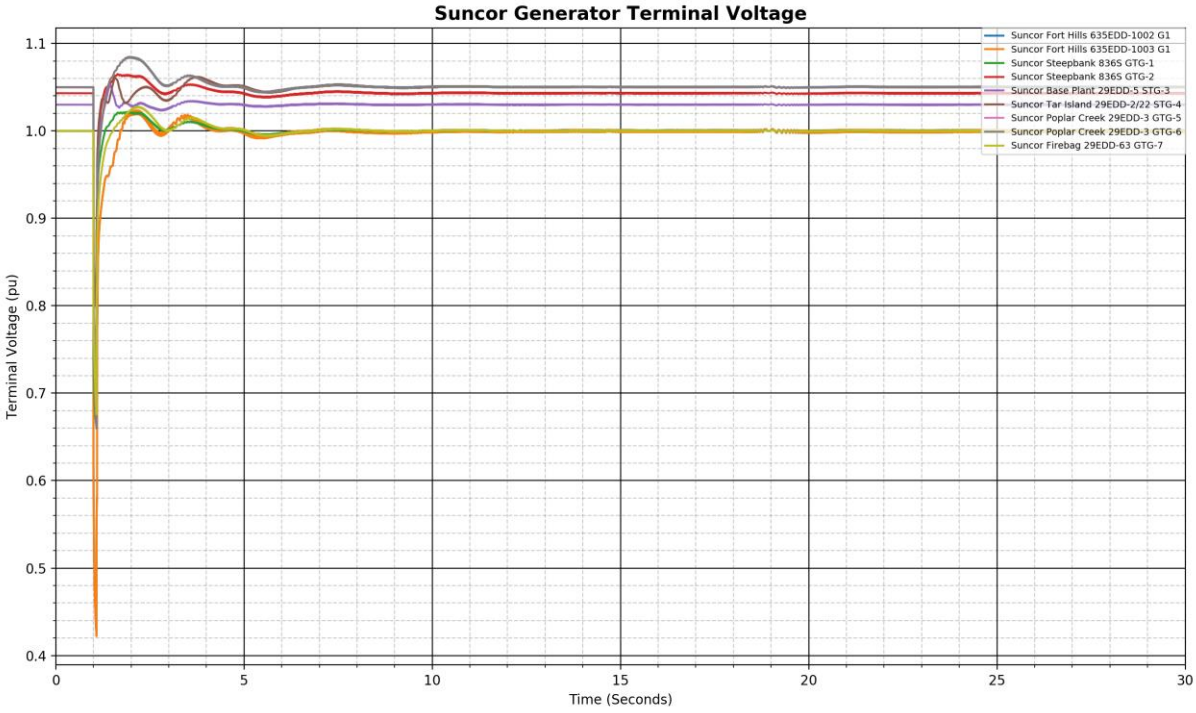

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

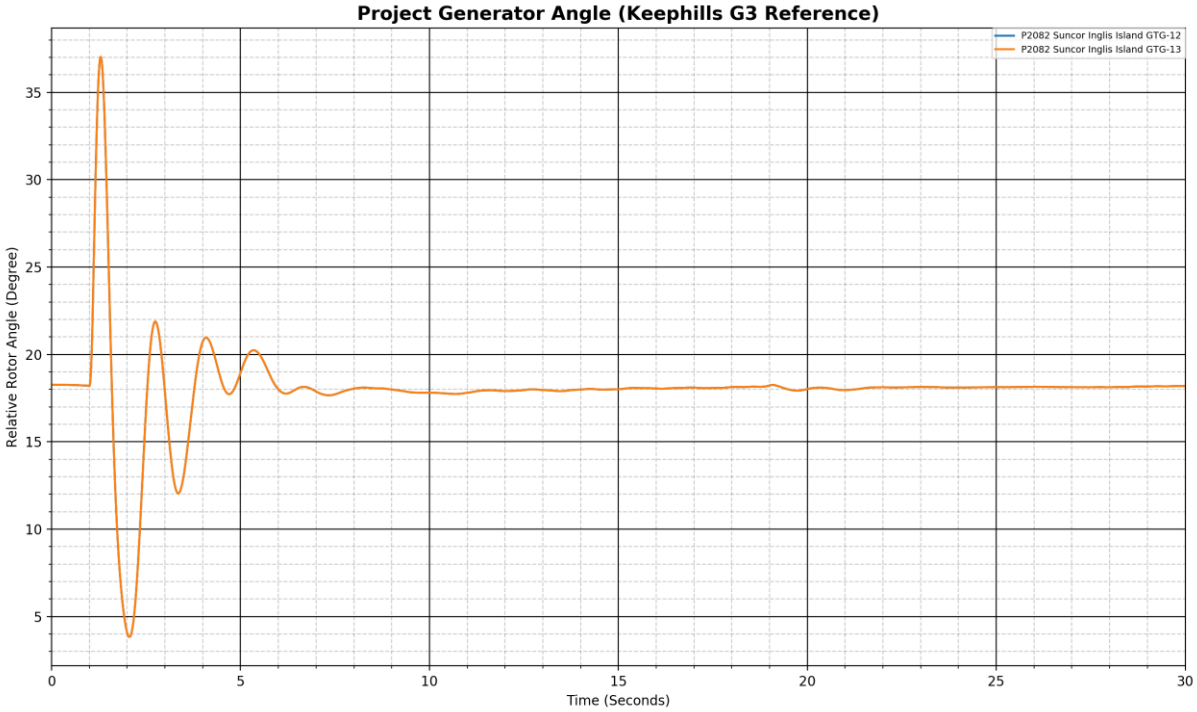

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

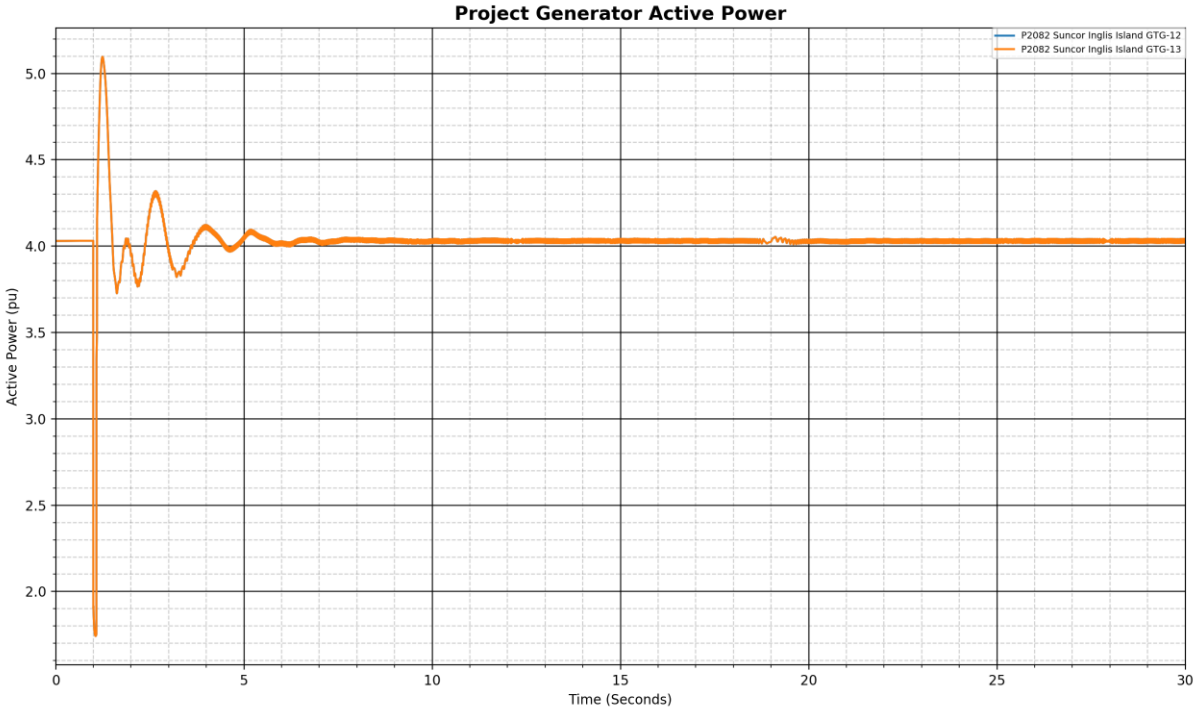

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

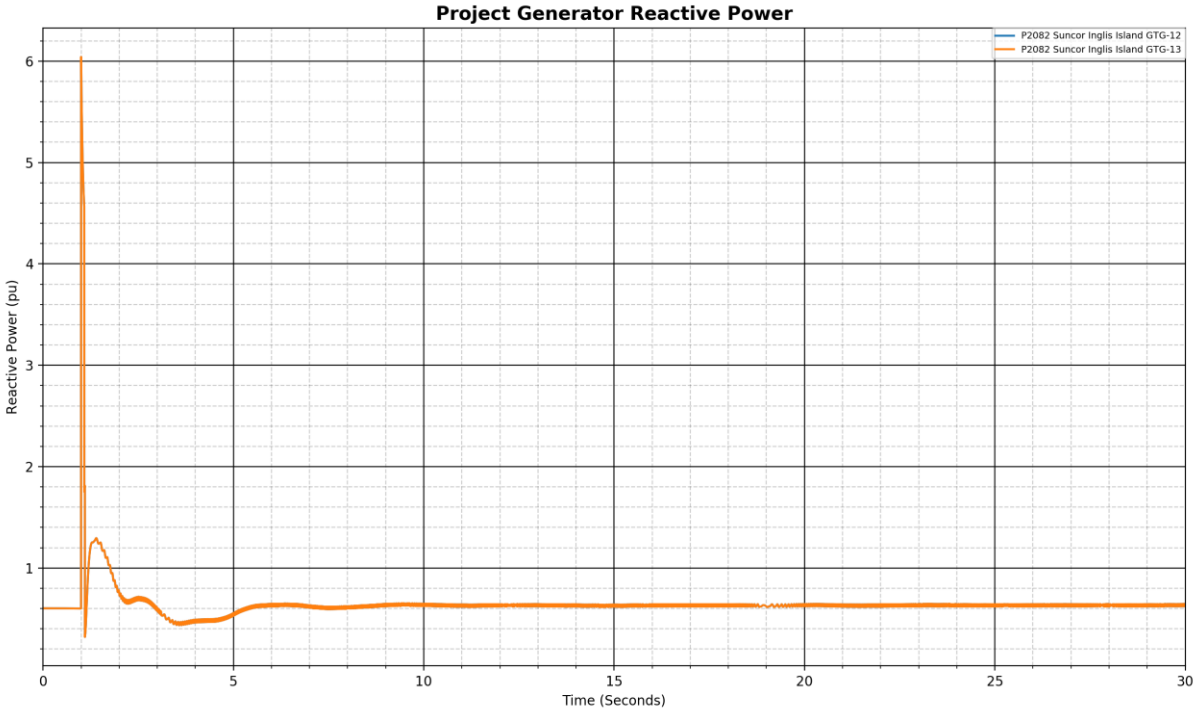

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

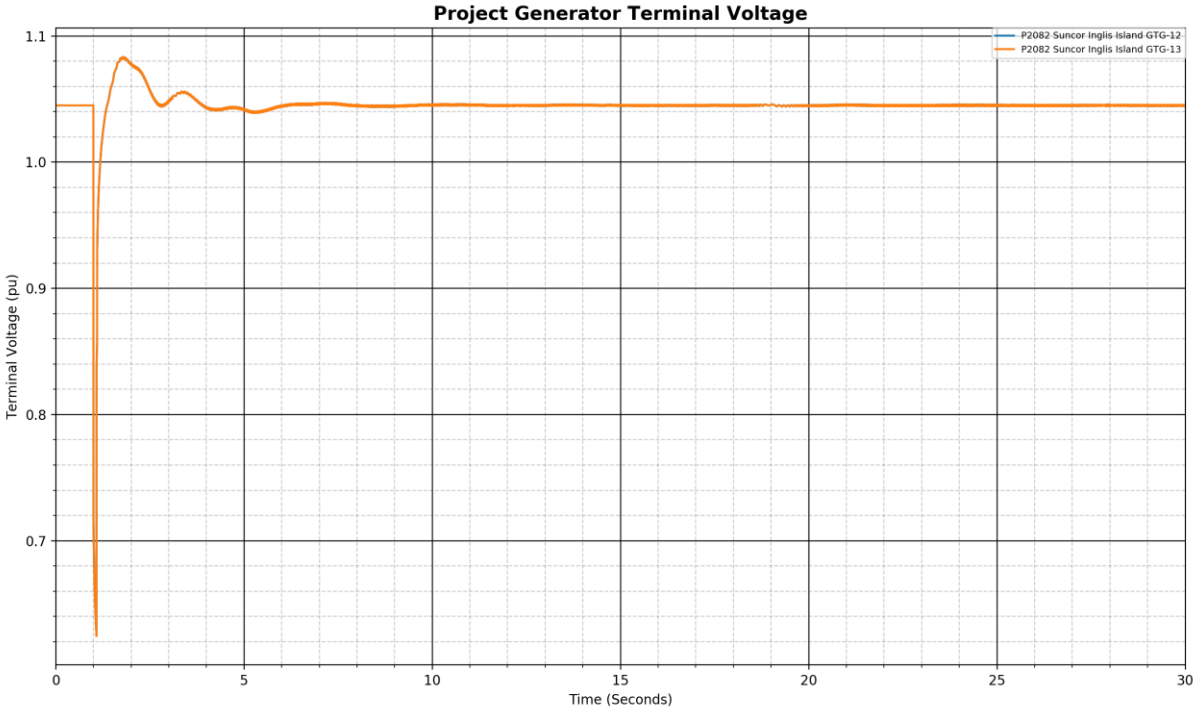

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

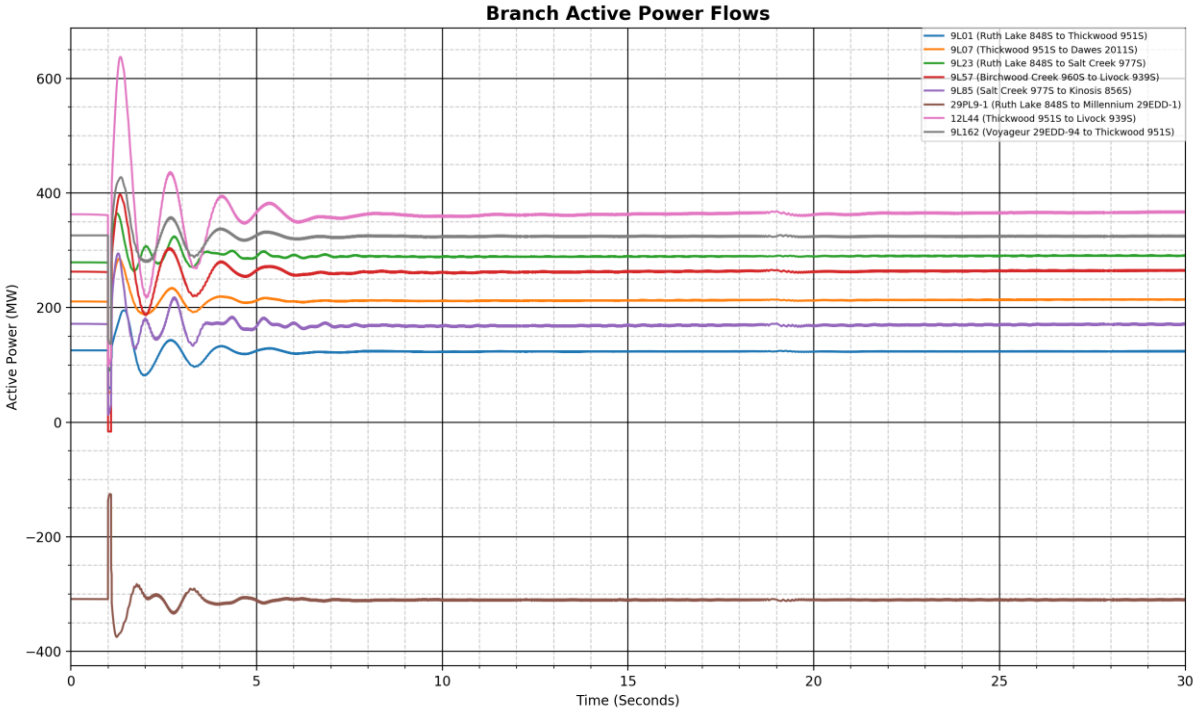

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
5
10
15
20
25
30
1
2
3
4
5
6


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0
5
10
15
20
25
30
0.7
0.8
0.9
1.0
1.1


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

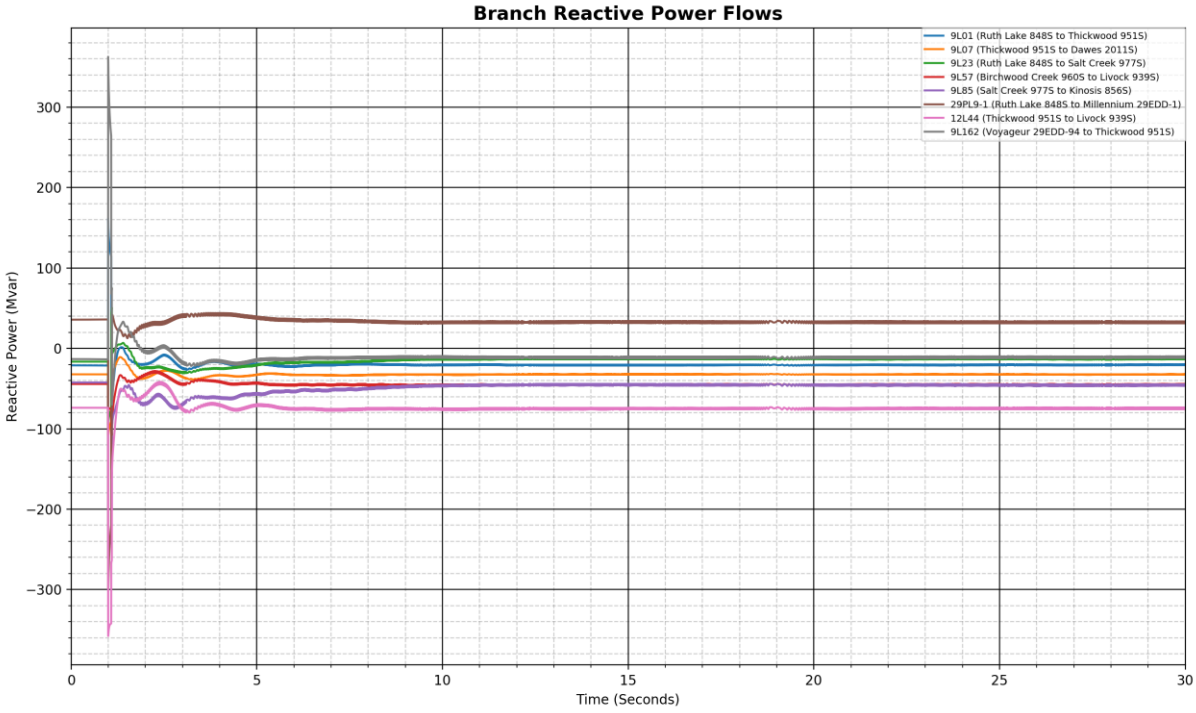
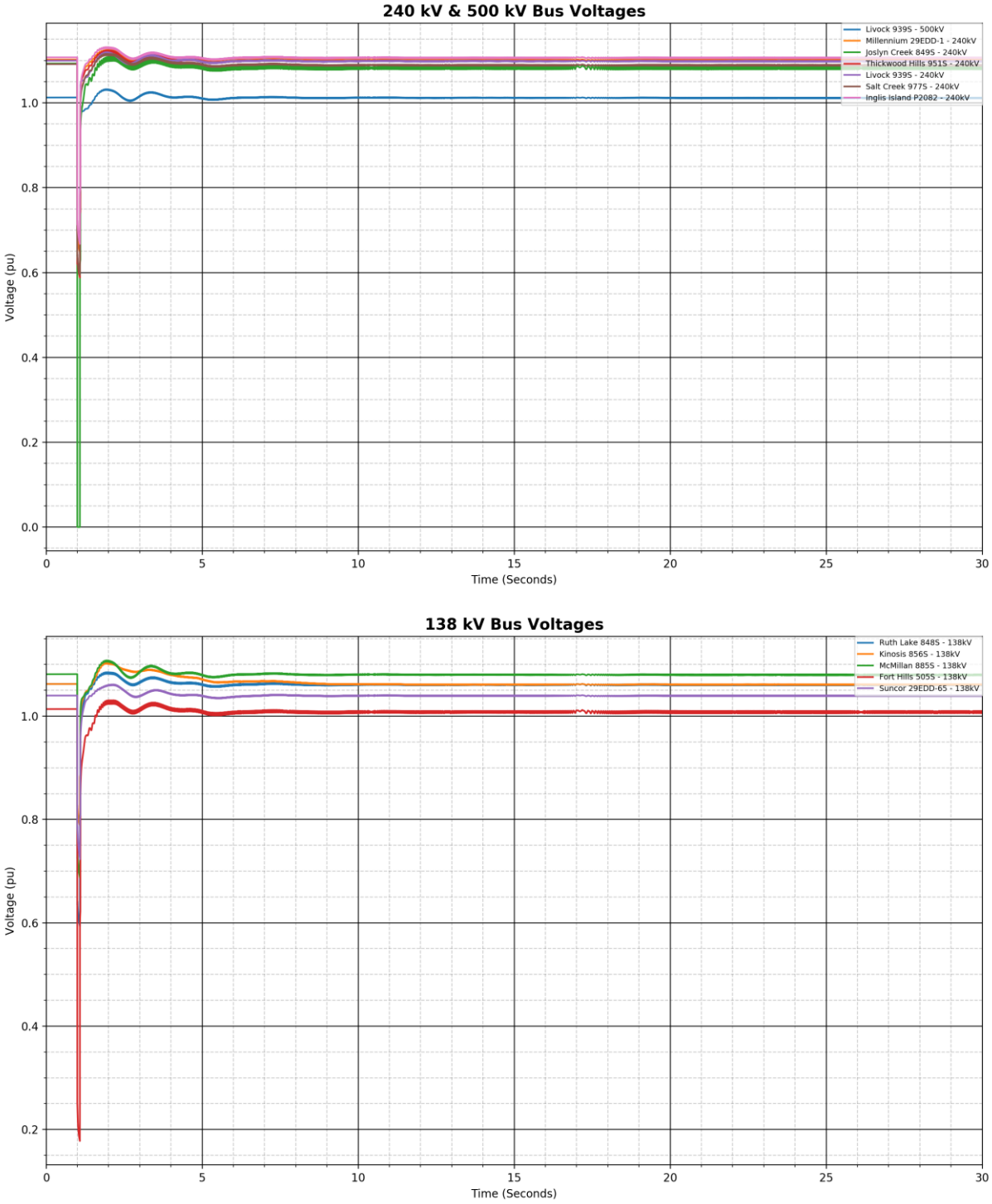
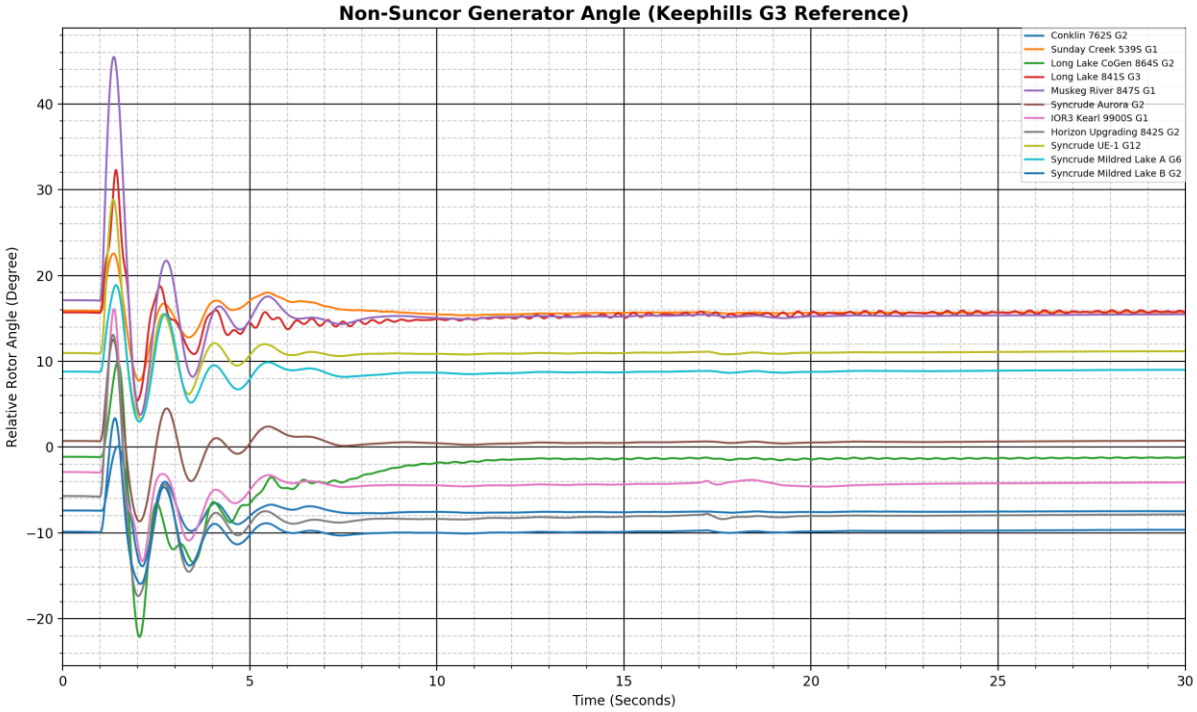
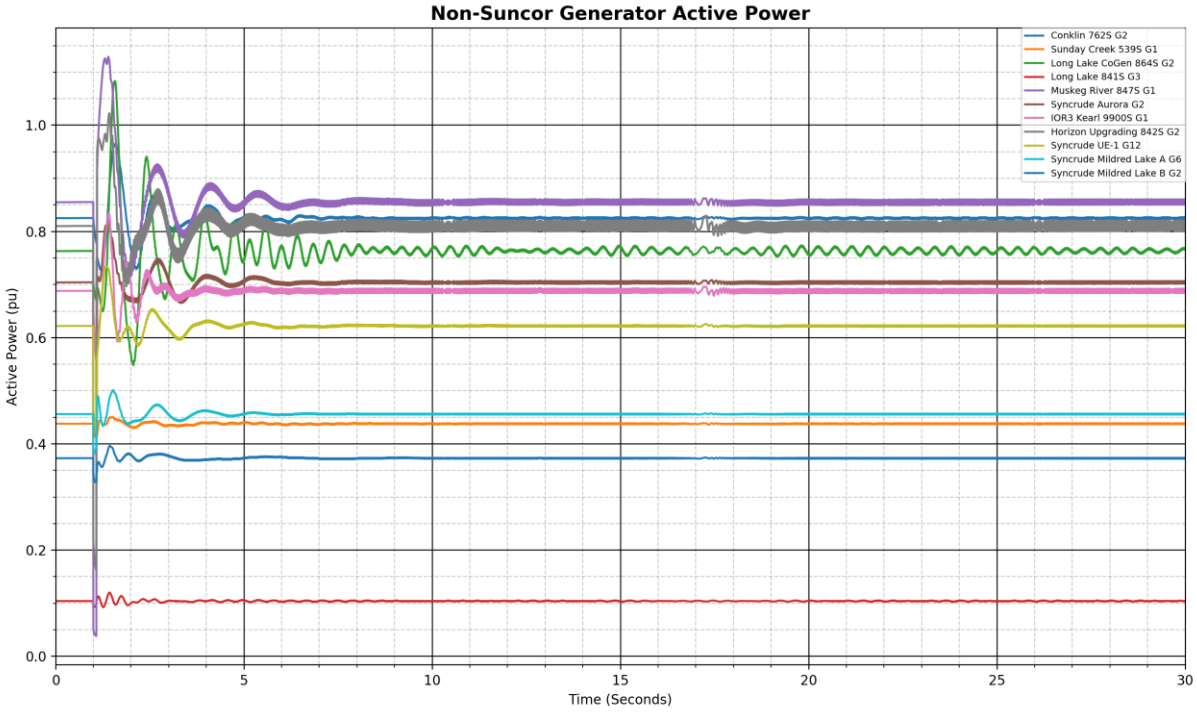
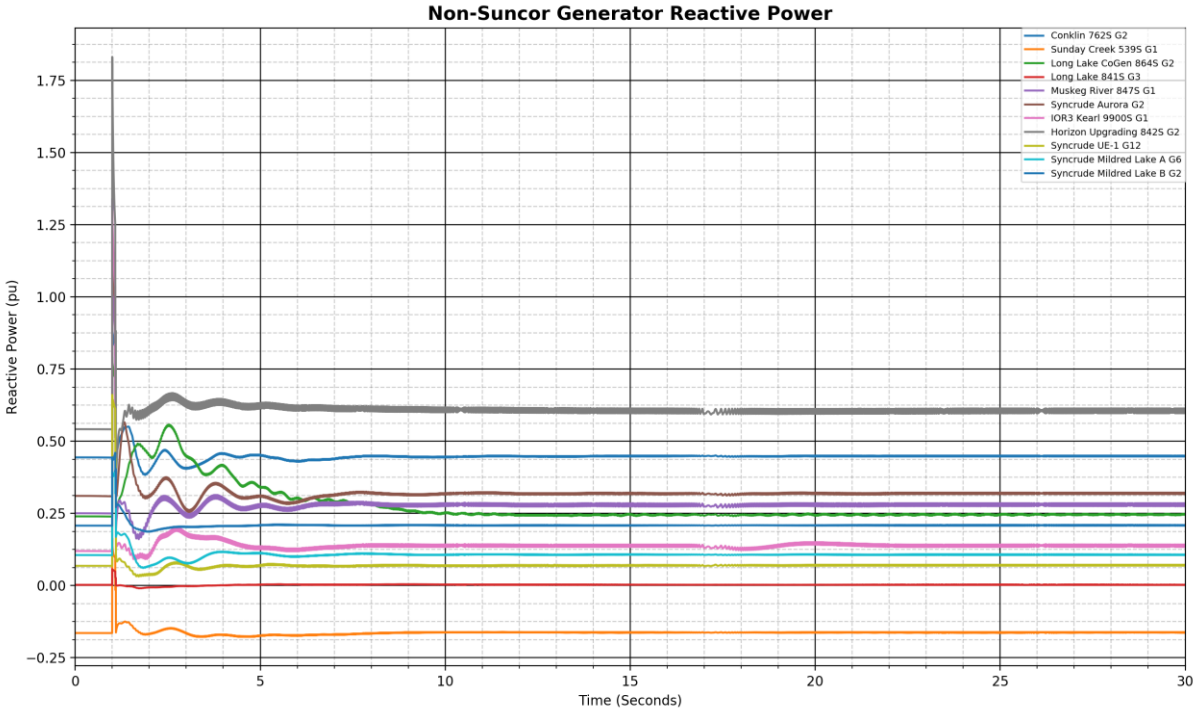

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

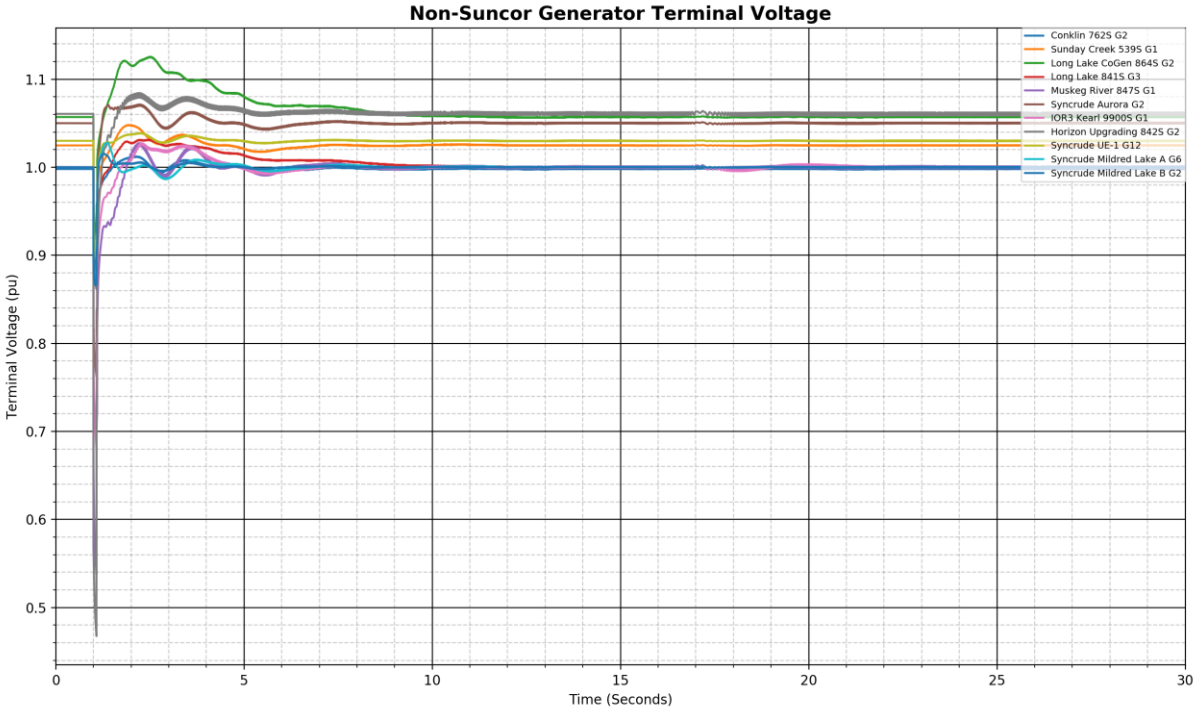
Figure A4-36: 9L08 (Dover 888S to Joslyn Creek 849S): Fault at Joslyn Creek 849S

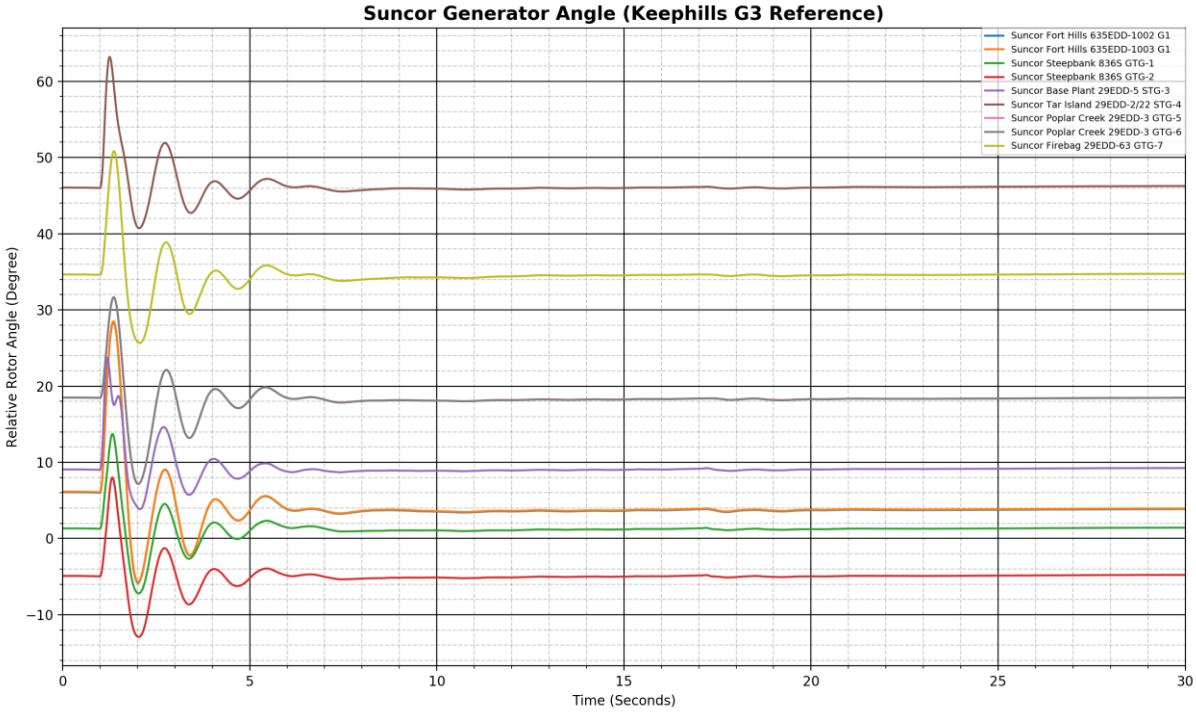


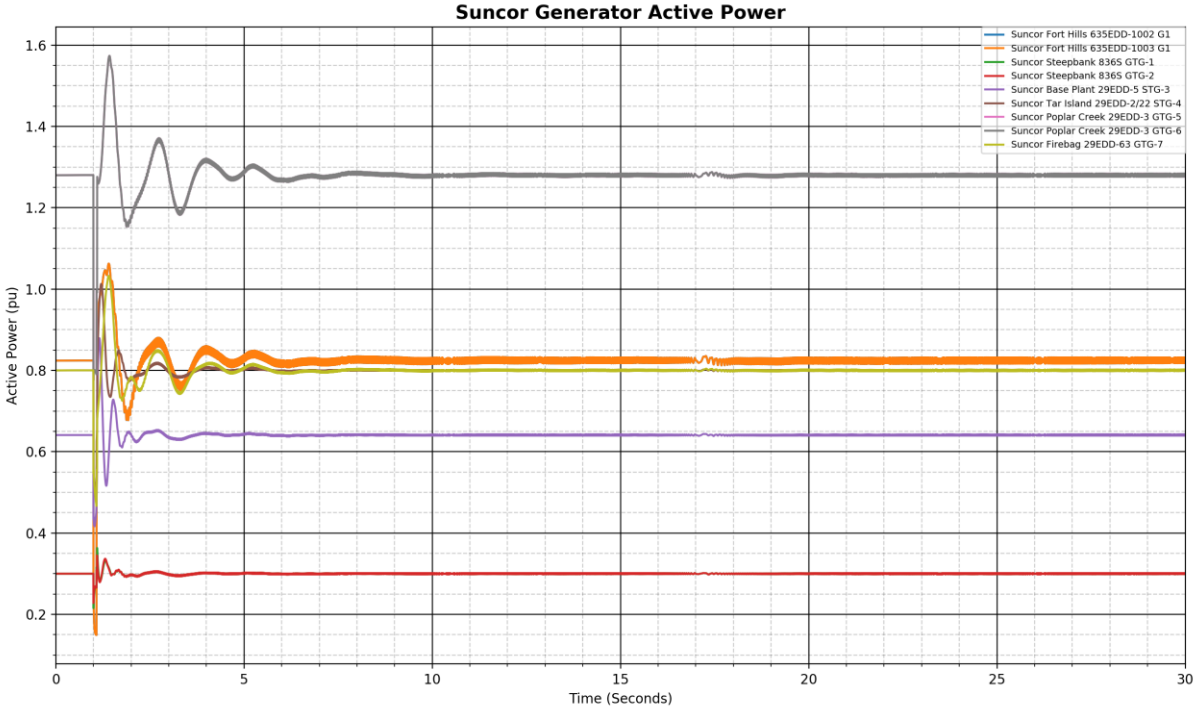

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

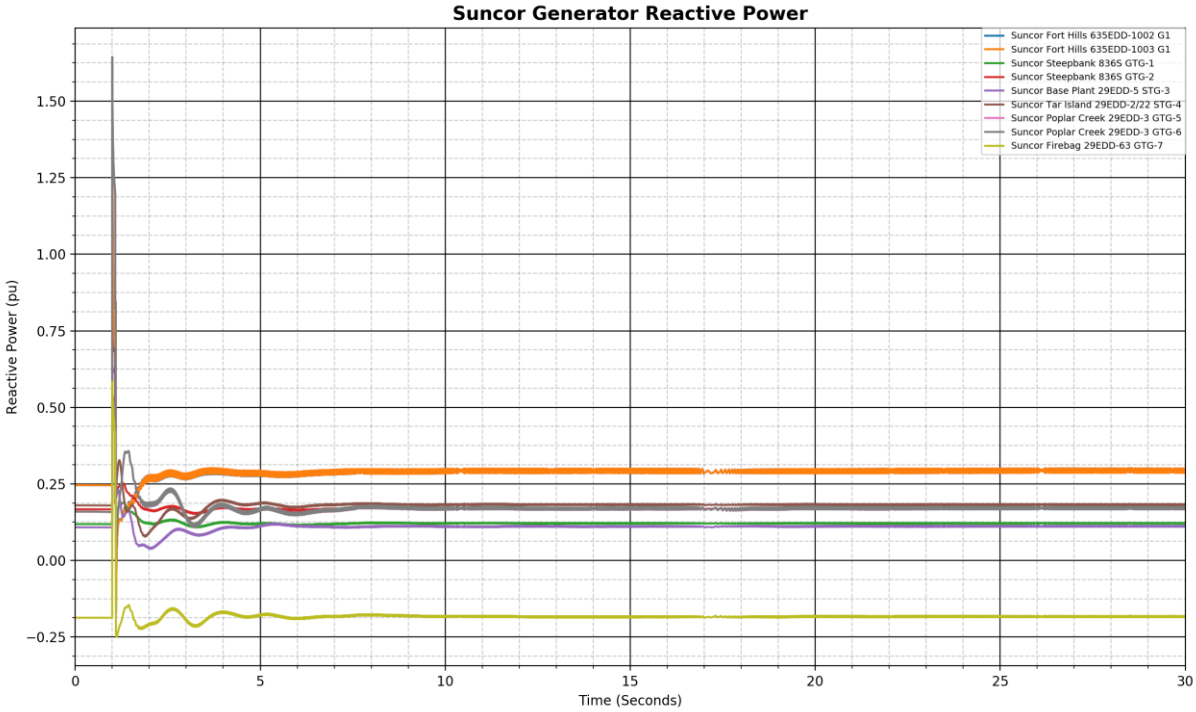

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

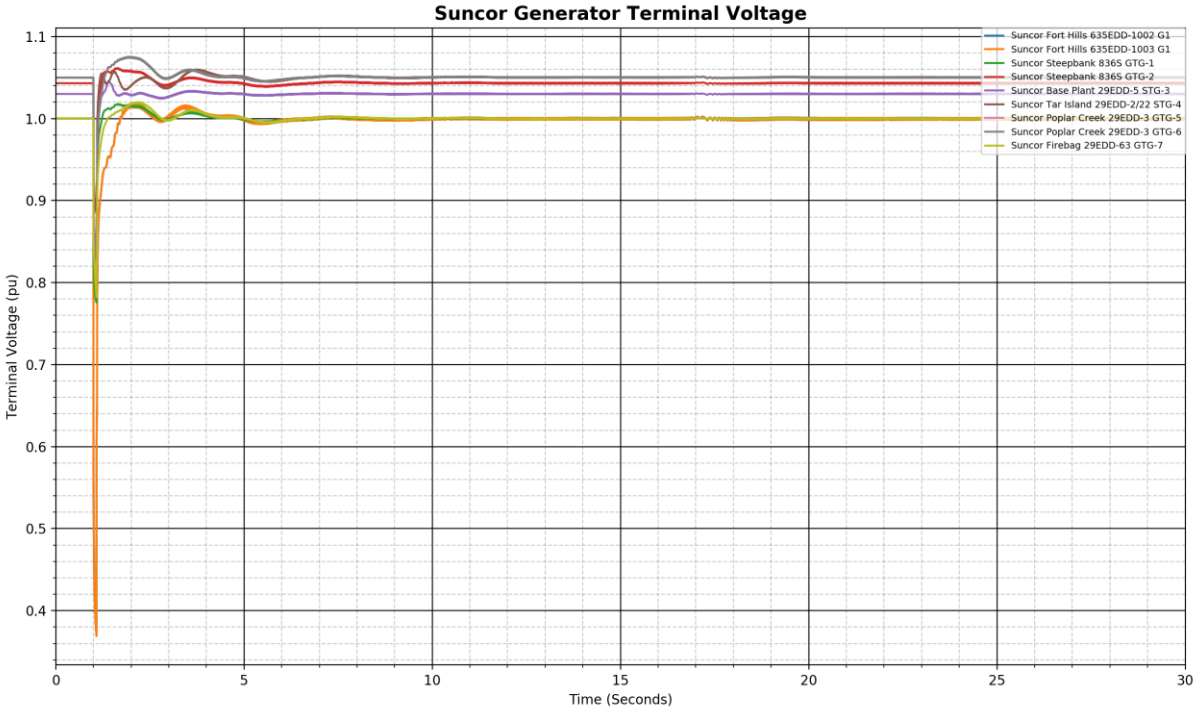

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

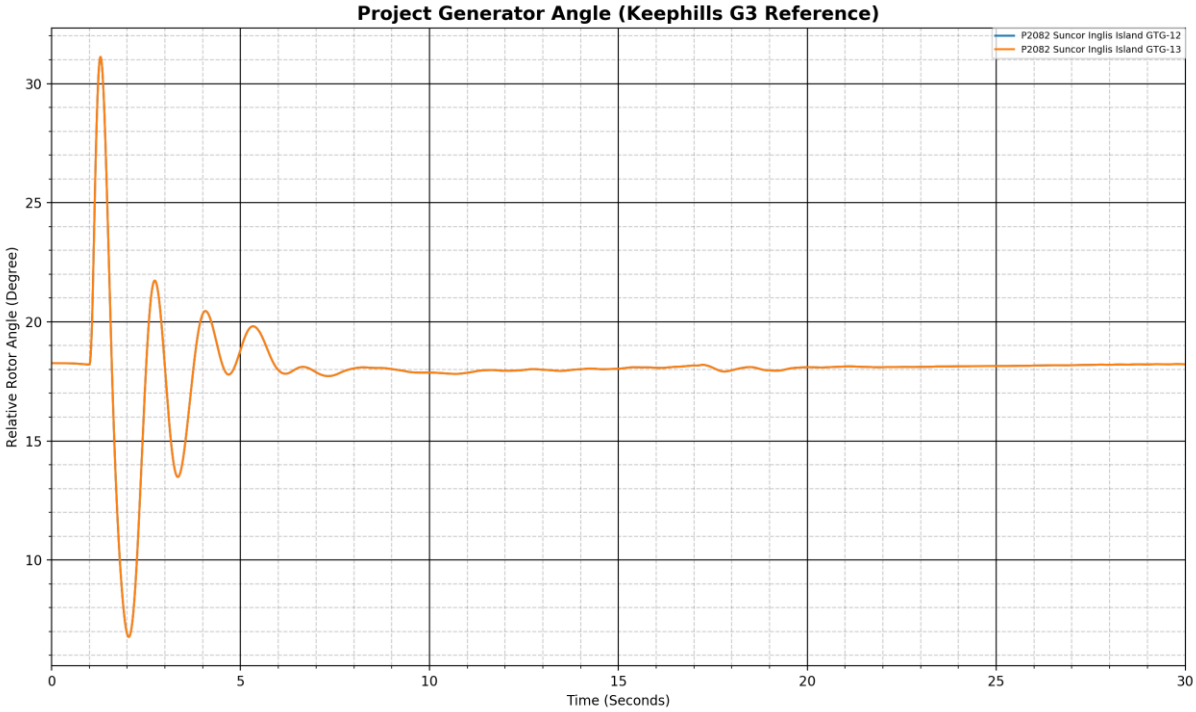

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

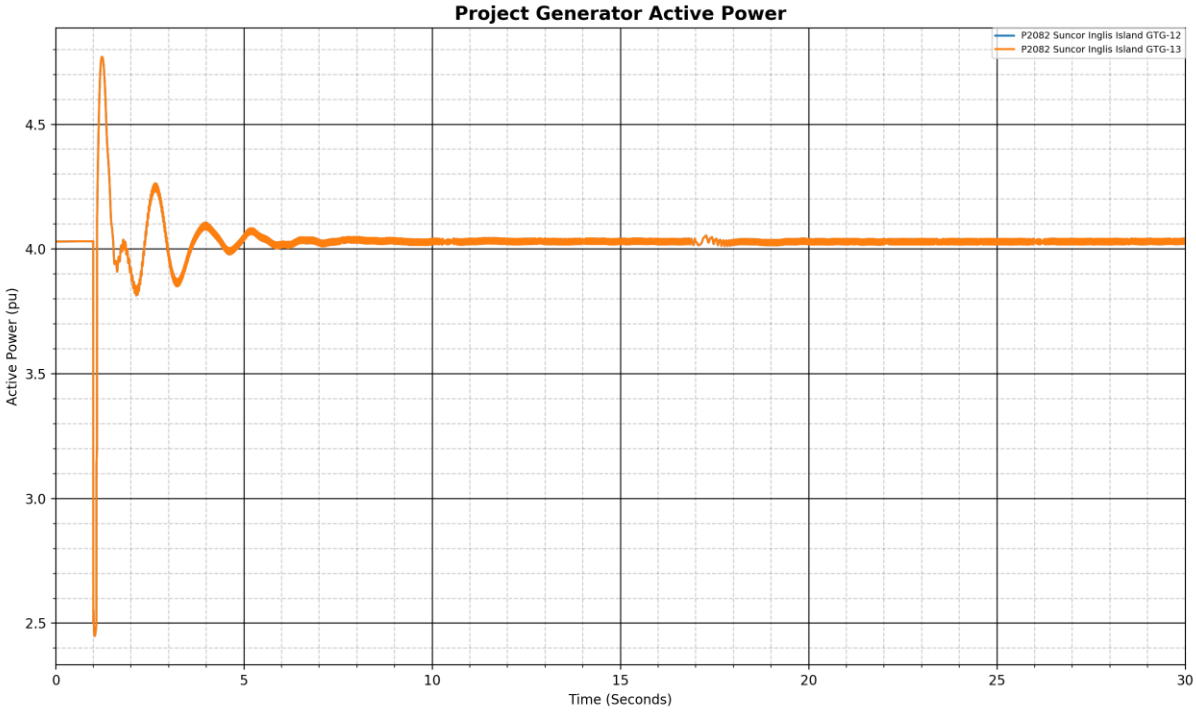

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

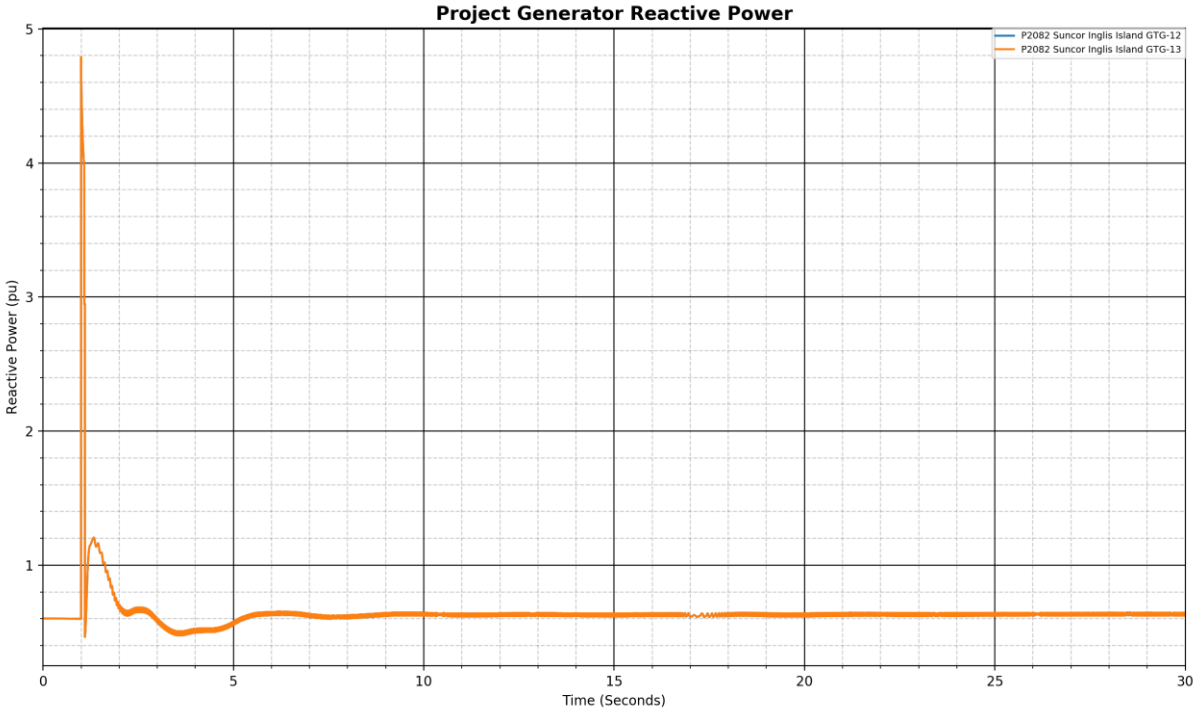

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

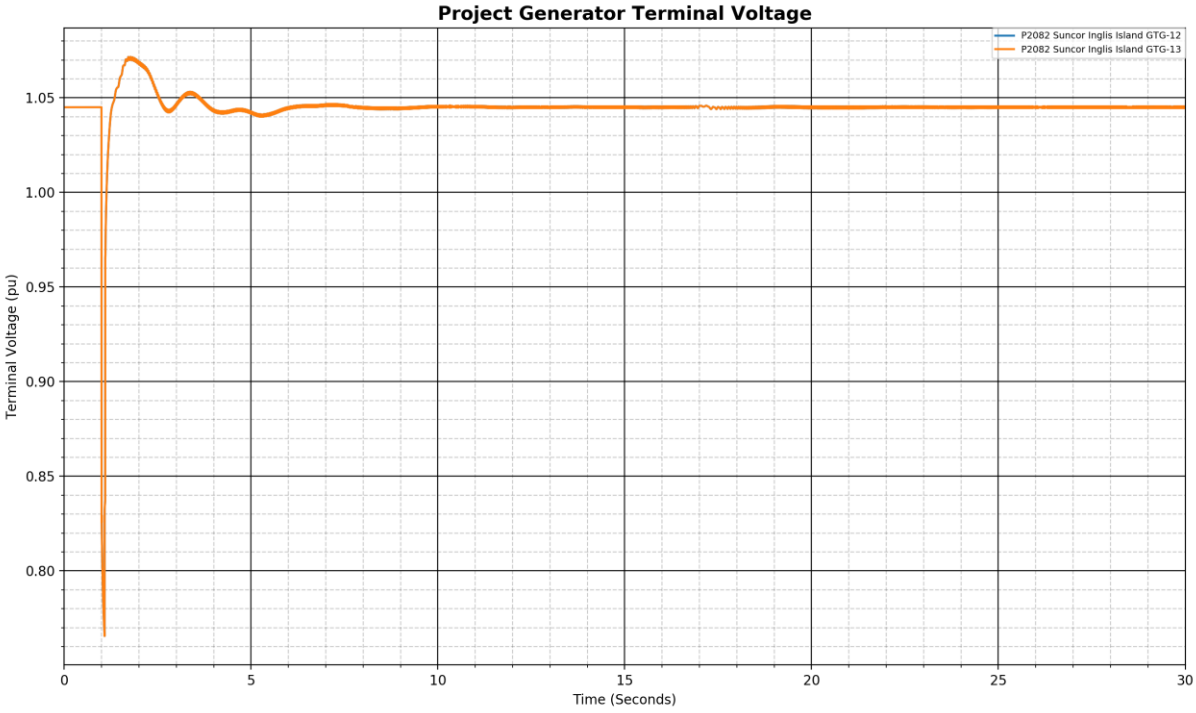

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

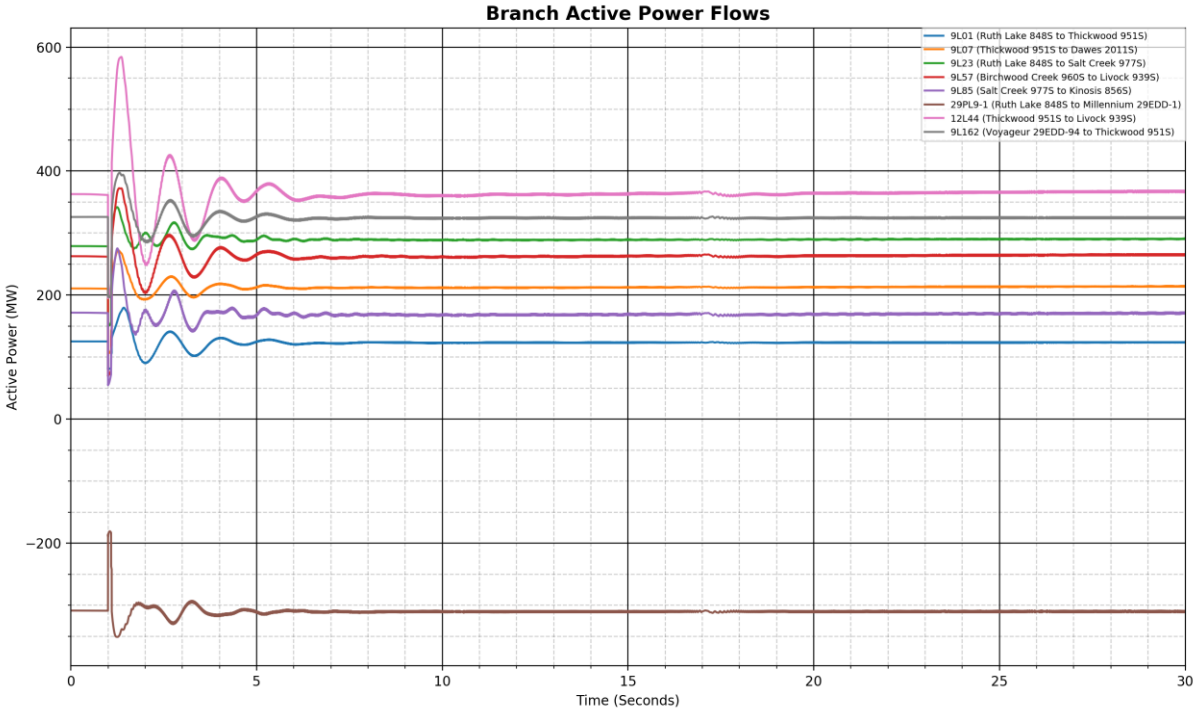

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
25
20
15
10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.5
4.0
3.5
3.0
2.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
5
10
15
20
25
30
1
2
3
4
5


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0
5
10
15
20
25
30
0.80
0.85
0.90
0.95
1.00
1.05


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

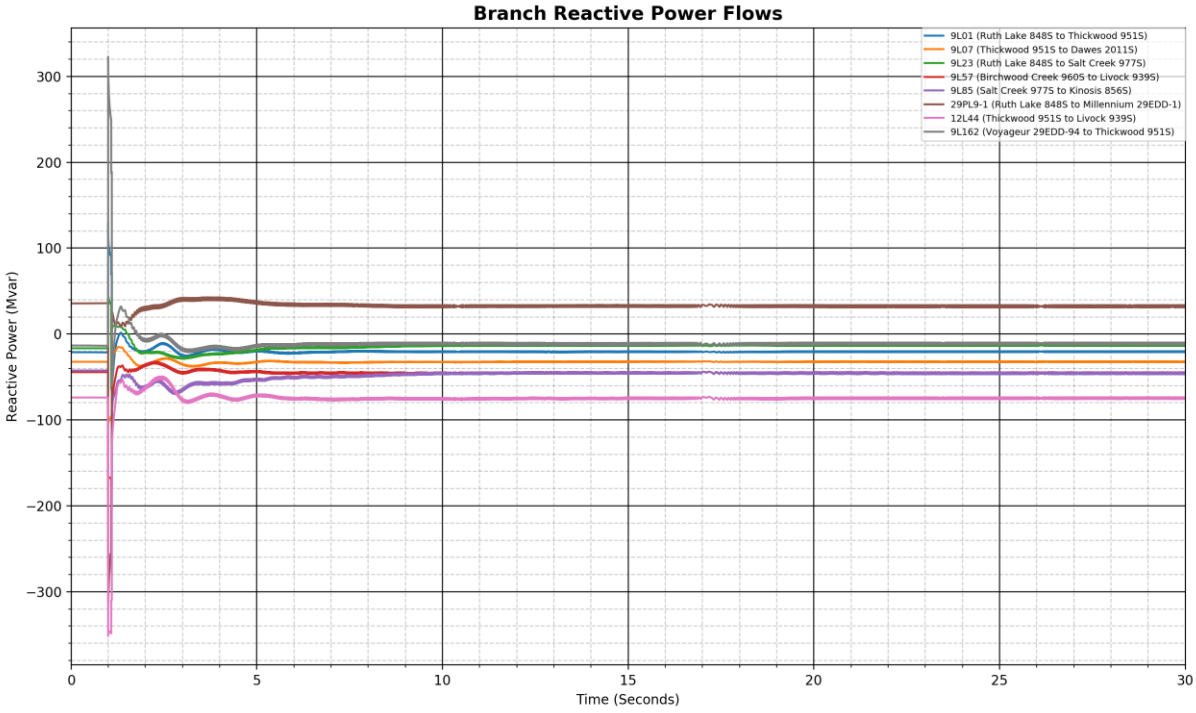
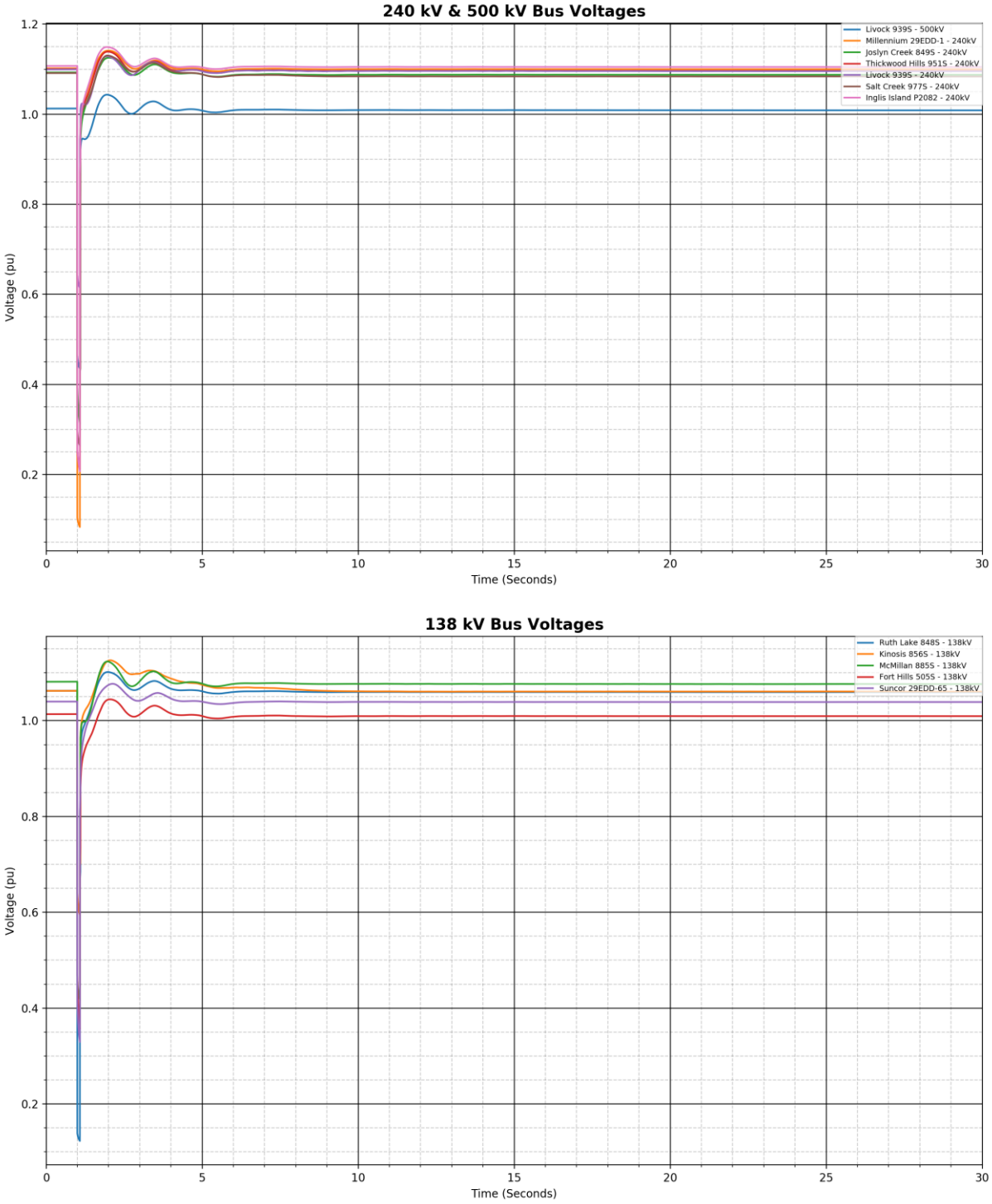
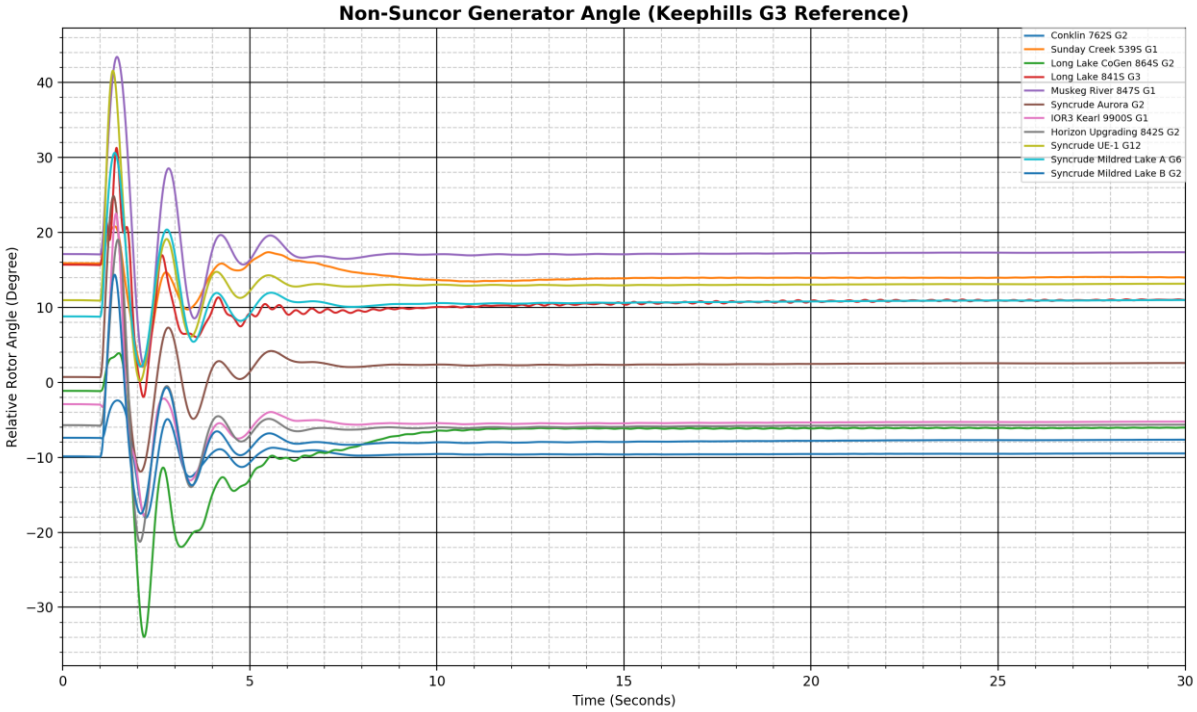
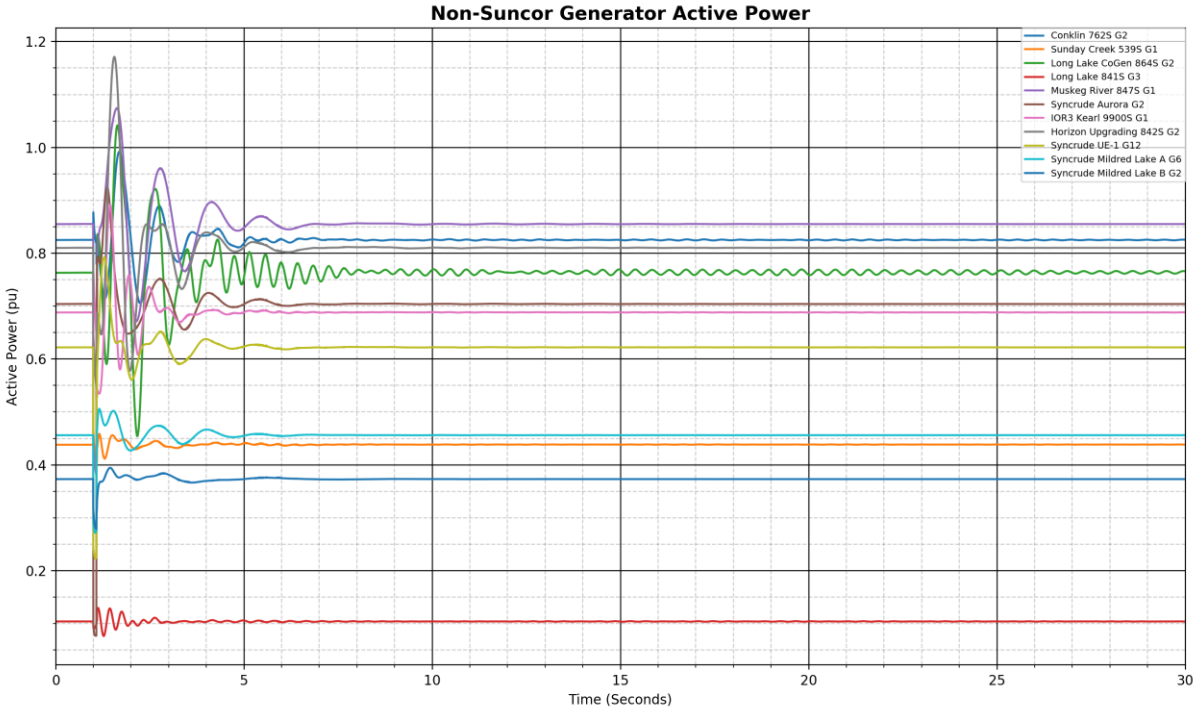
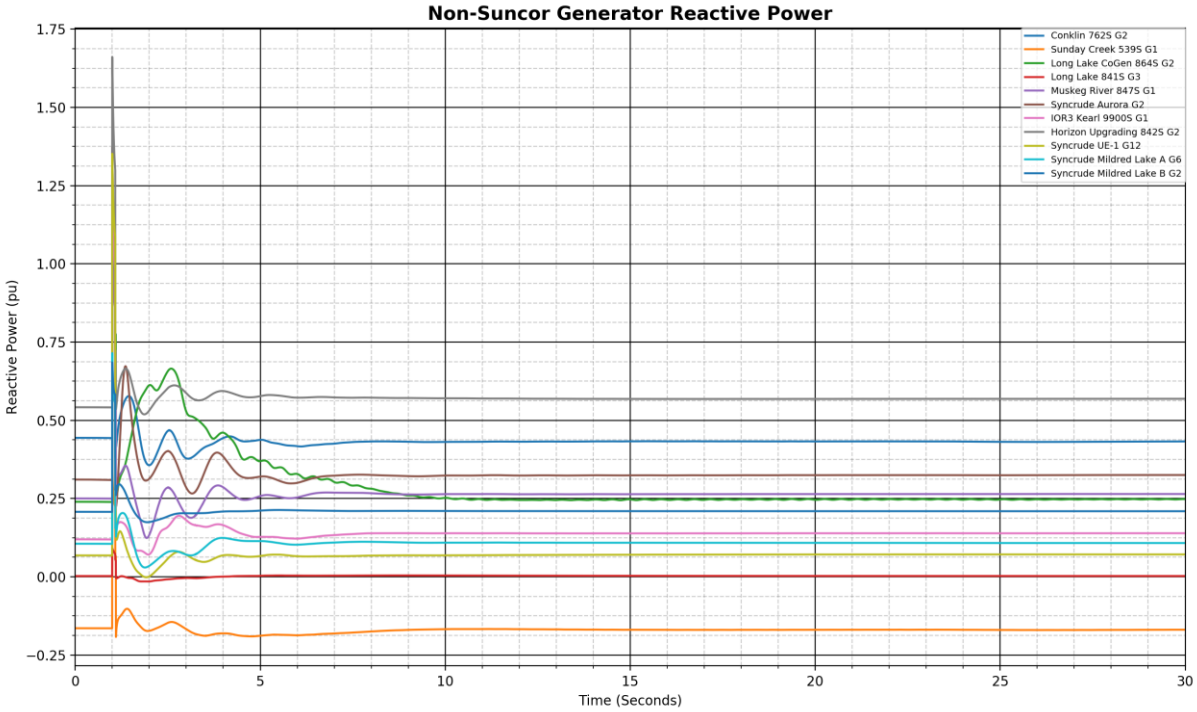

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

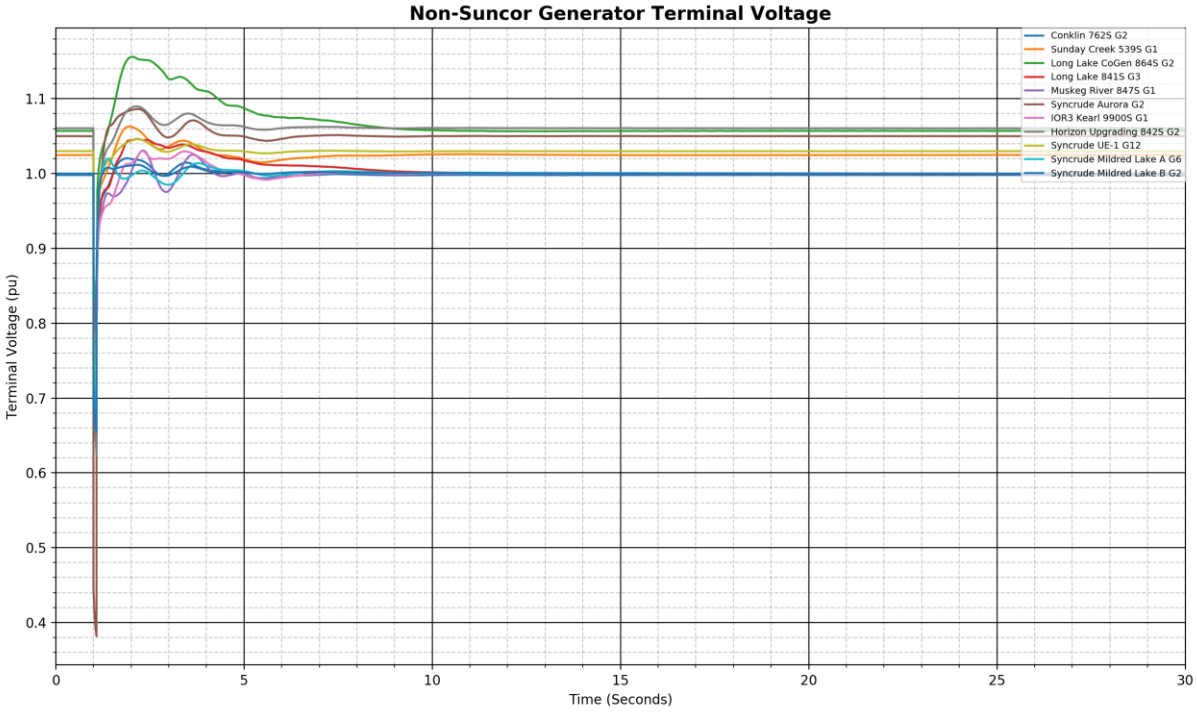
Figure A4-37: 9L23 (Ruth Lake 848S to Salt Creek 977S): Fault at Ruth Lake 848S

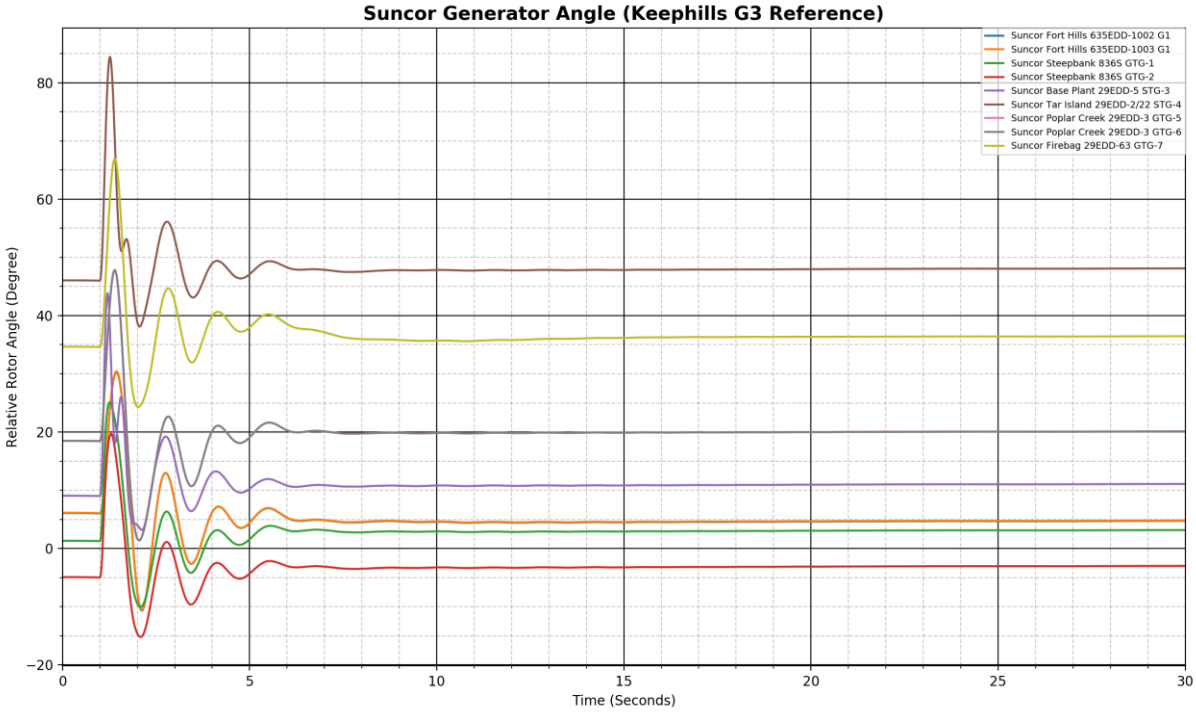


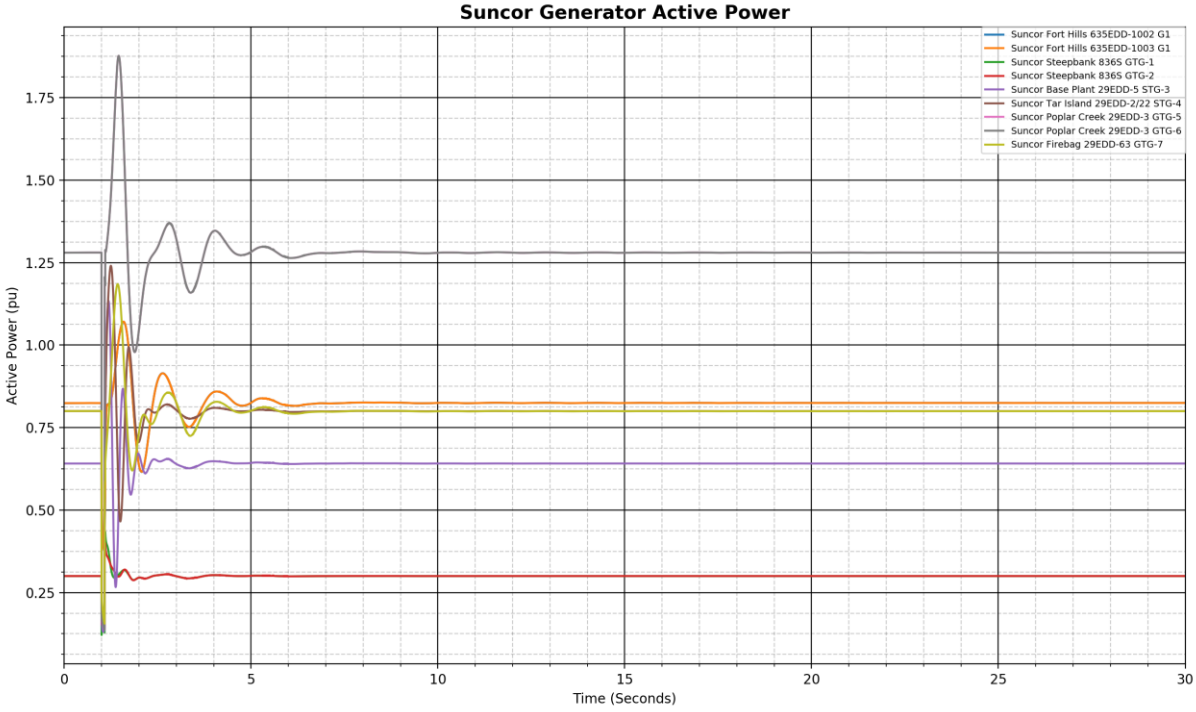

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

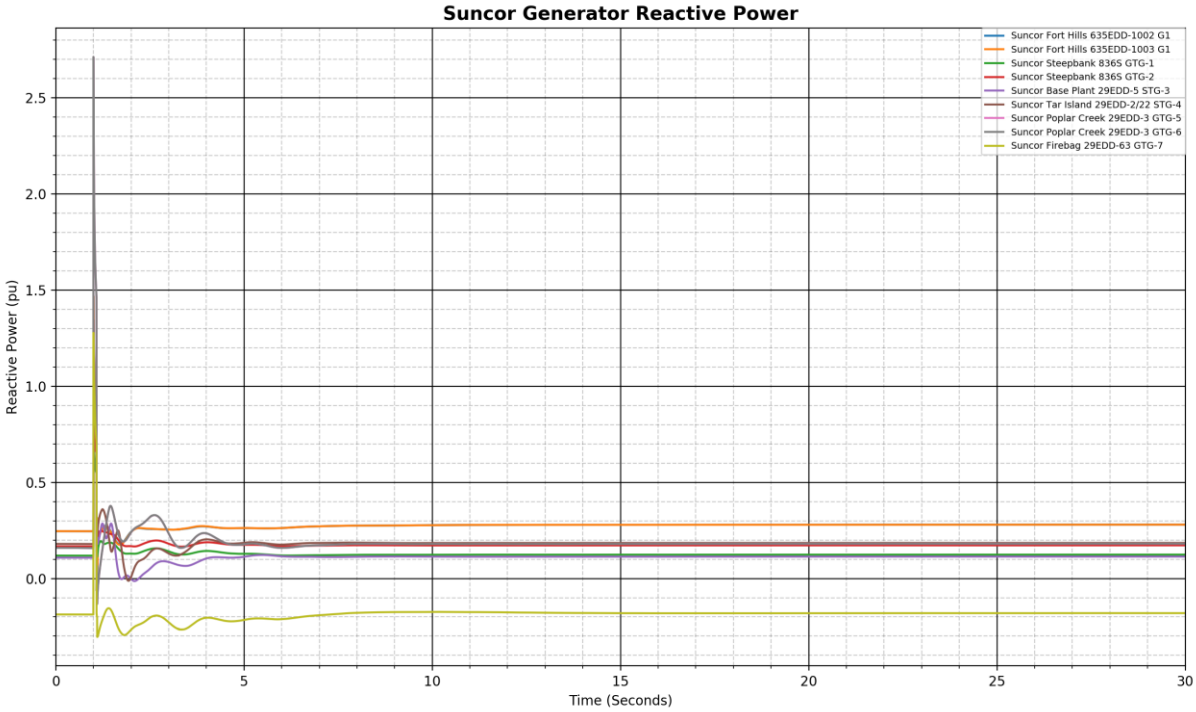

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

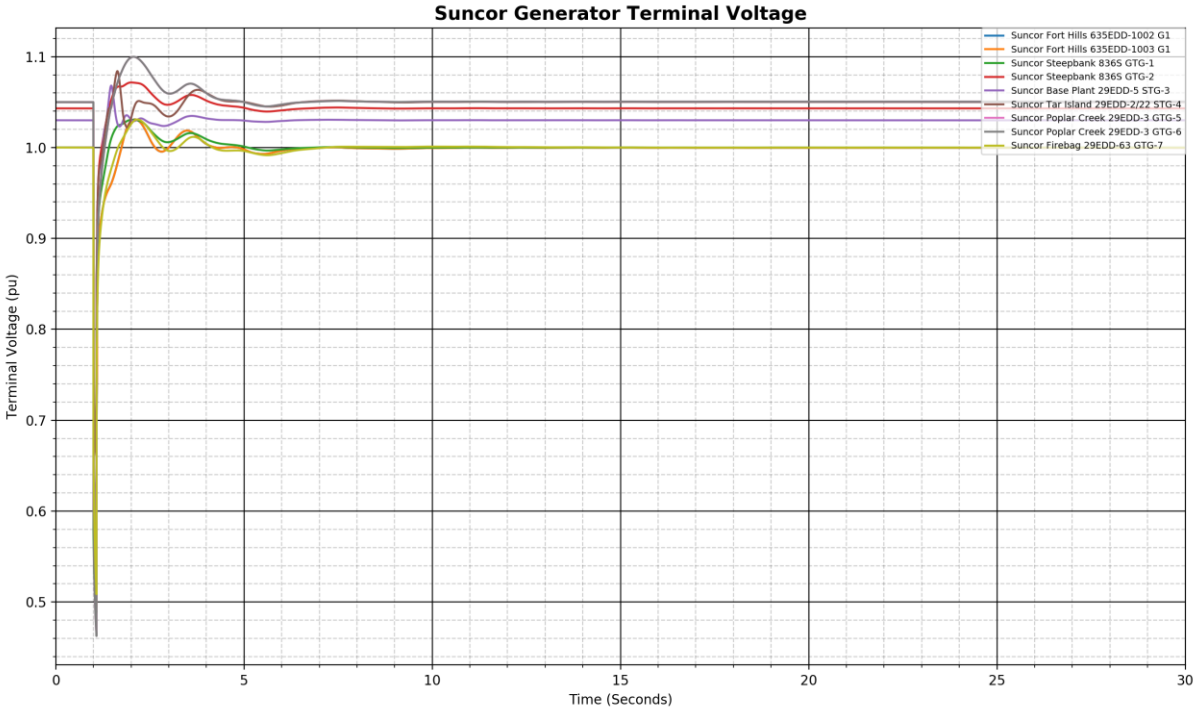

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

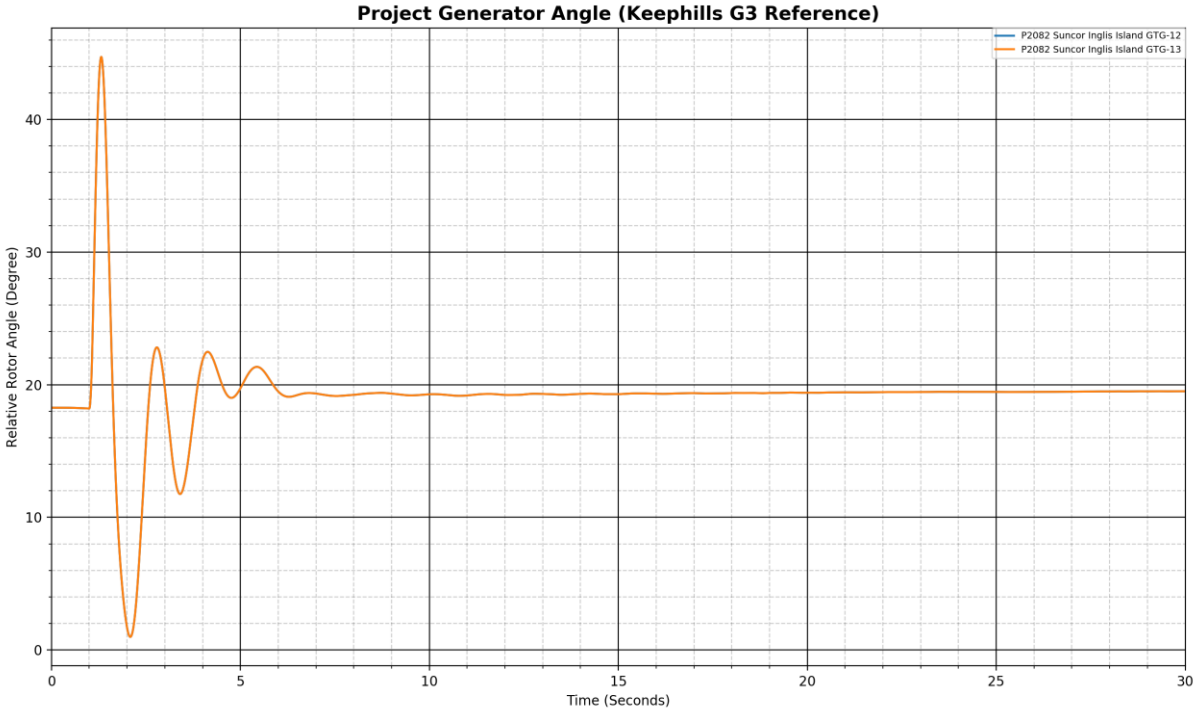

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

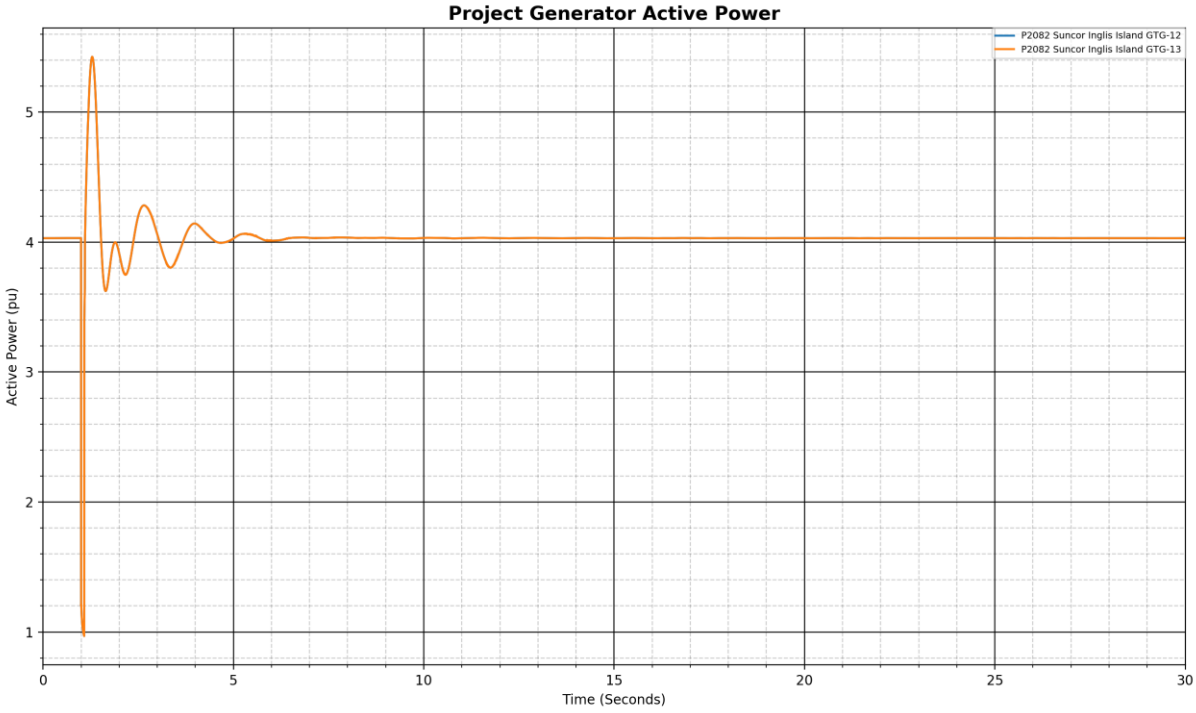

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

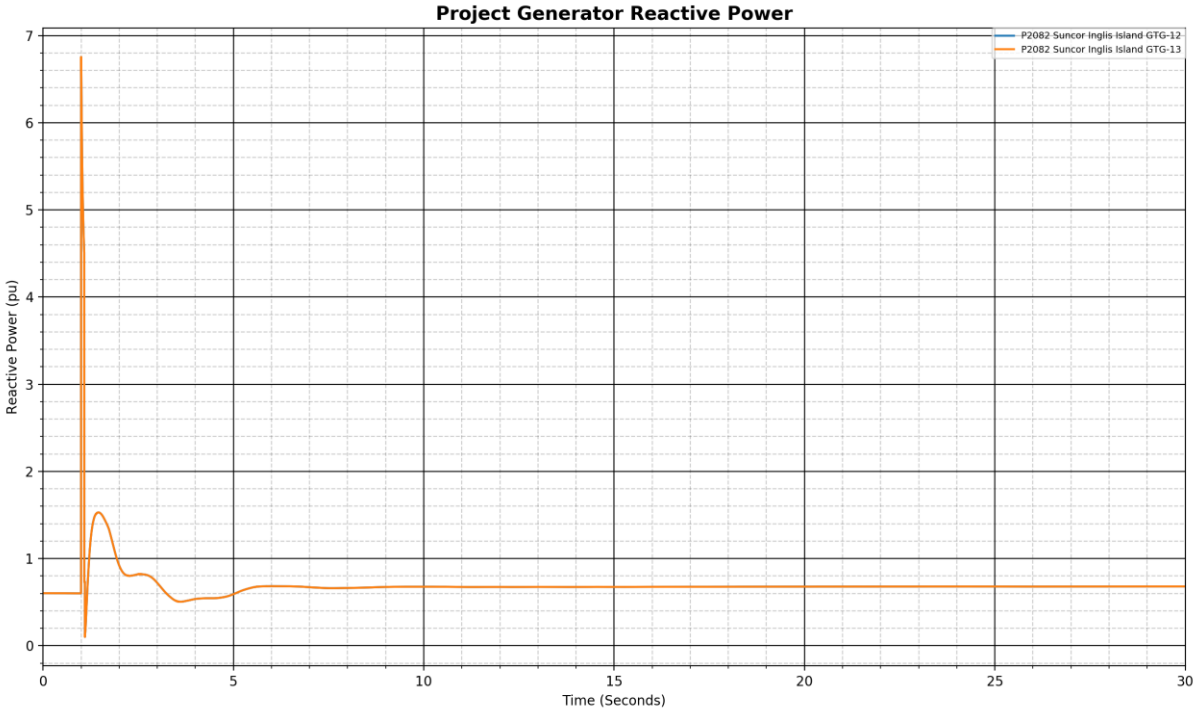

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

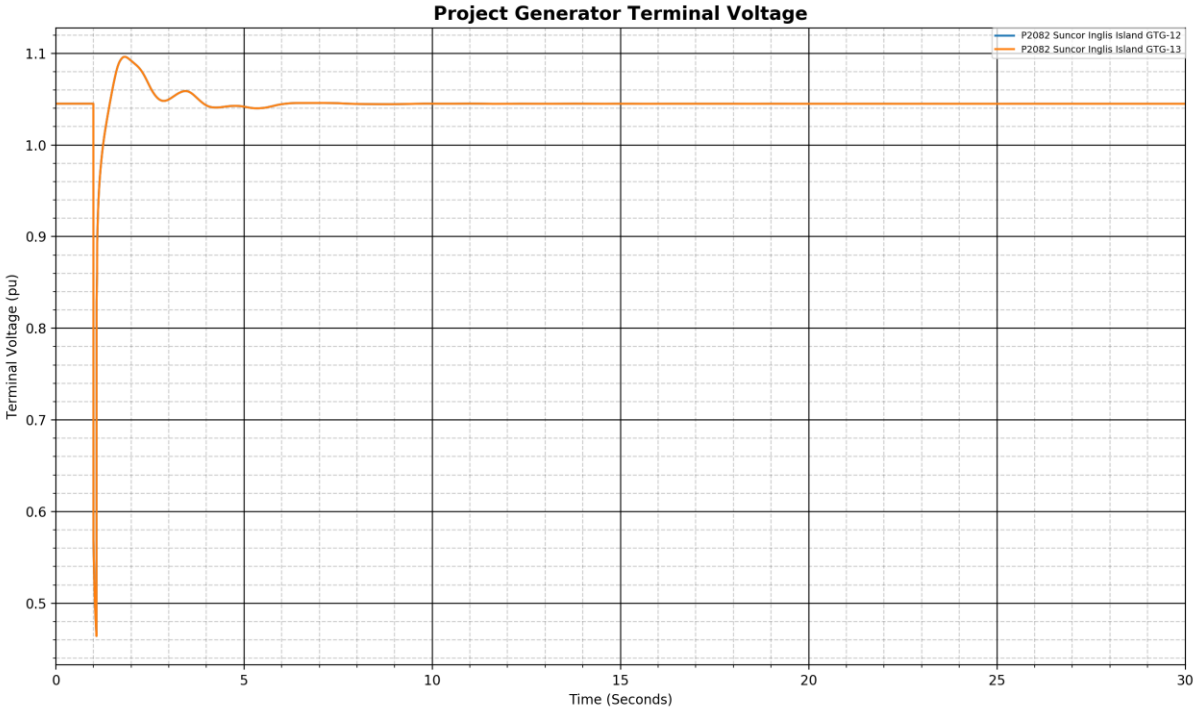

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

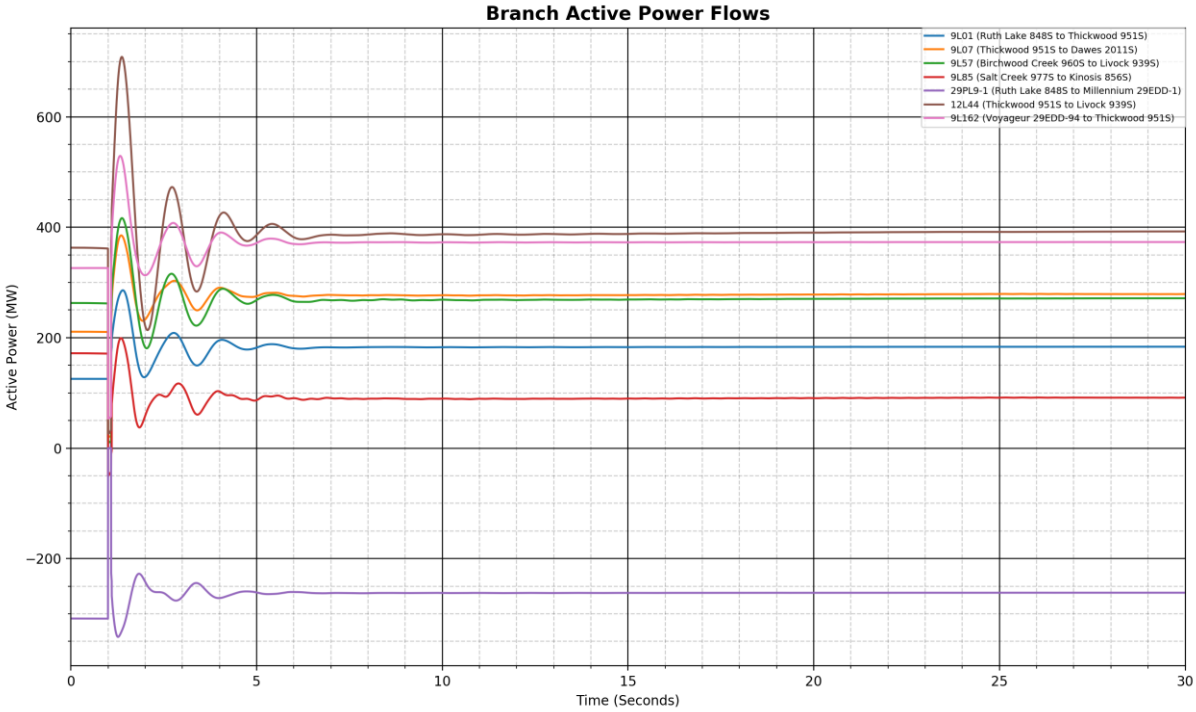

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
0
10
20
30
40
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

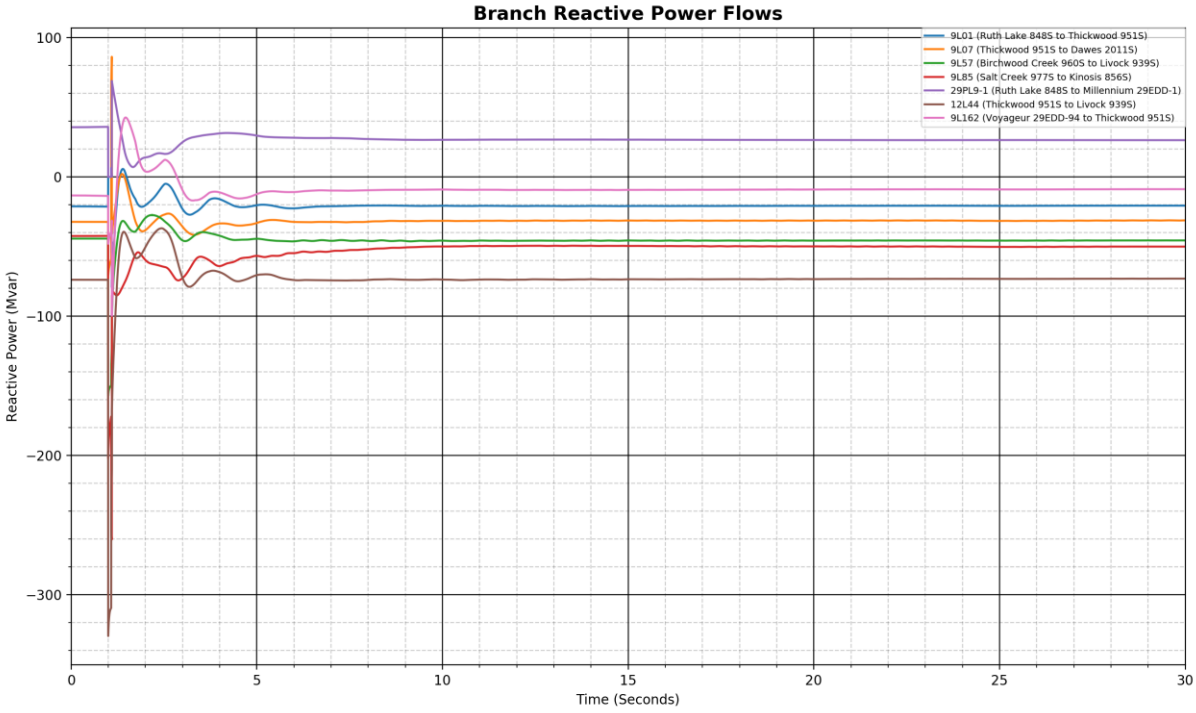
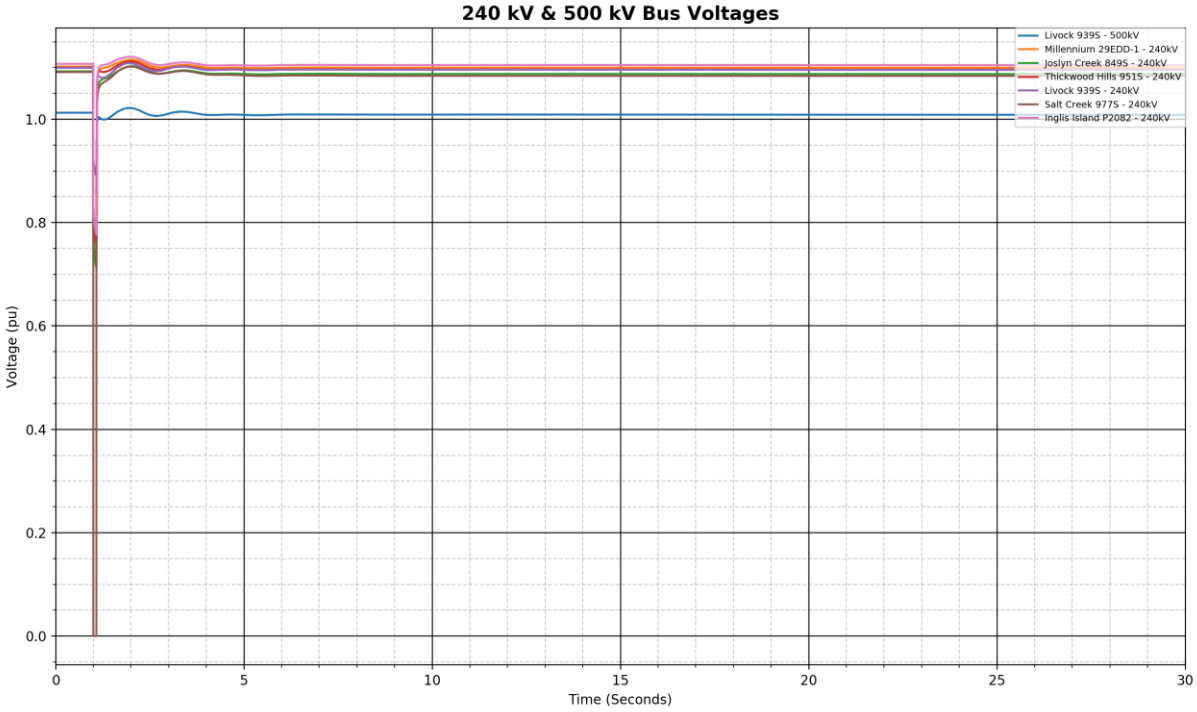
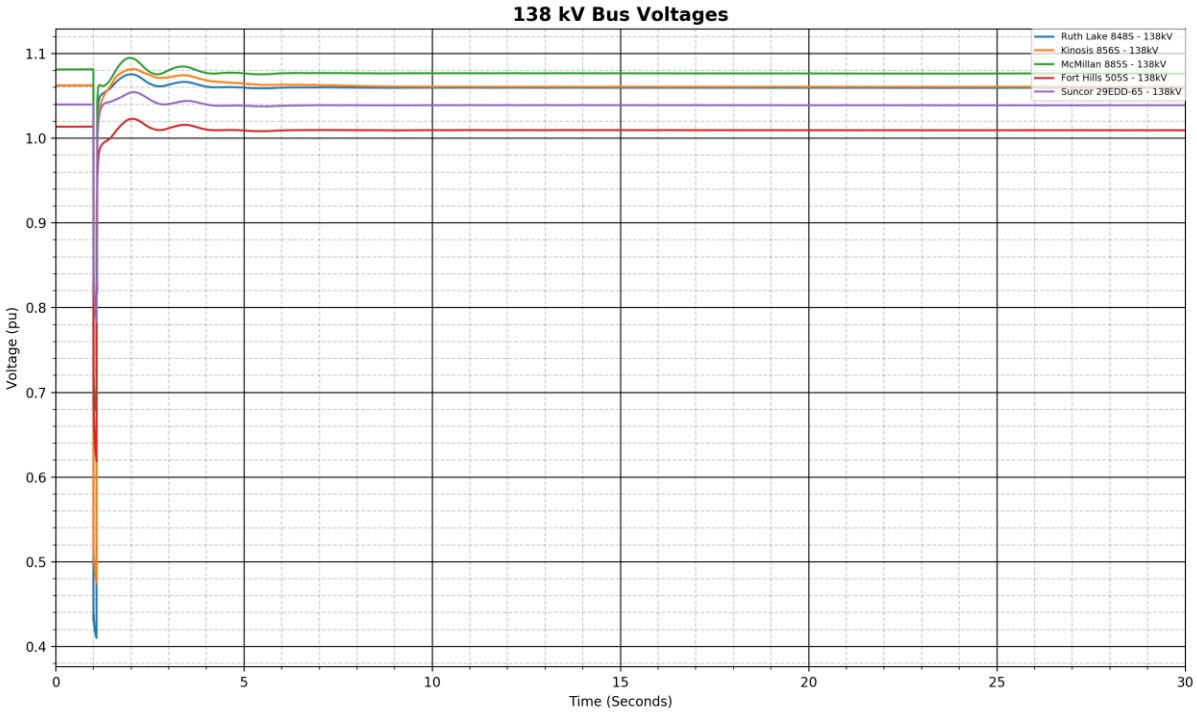
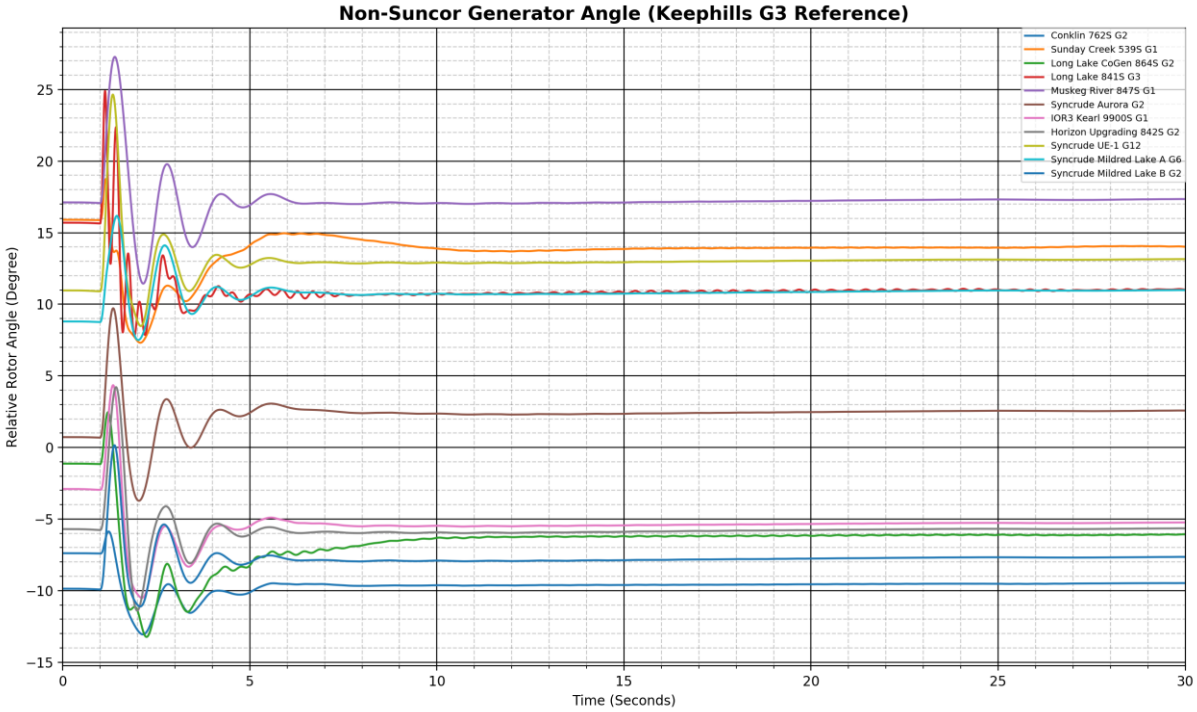
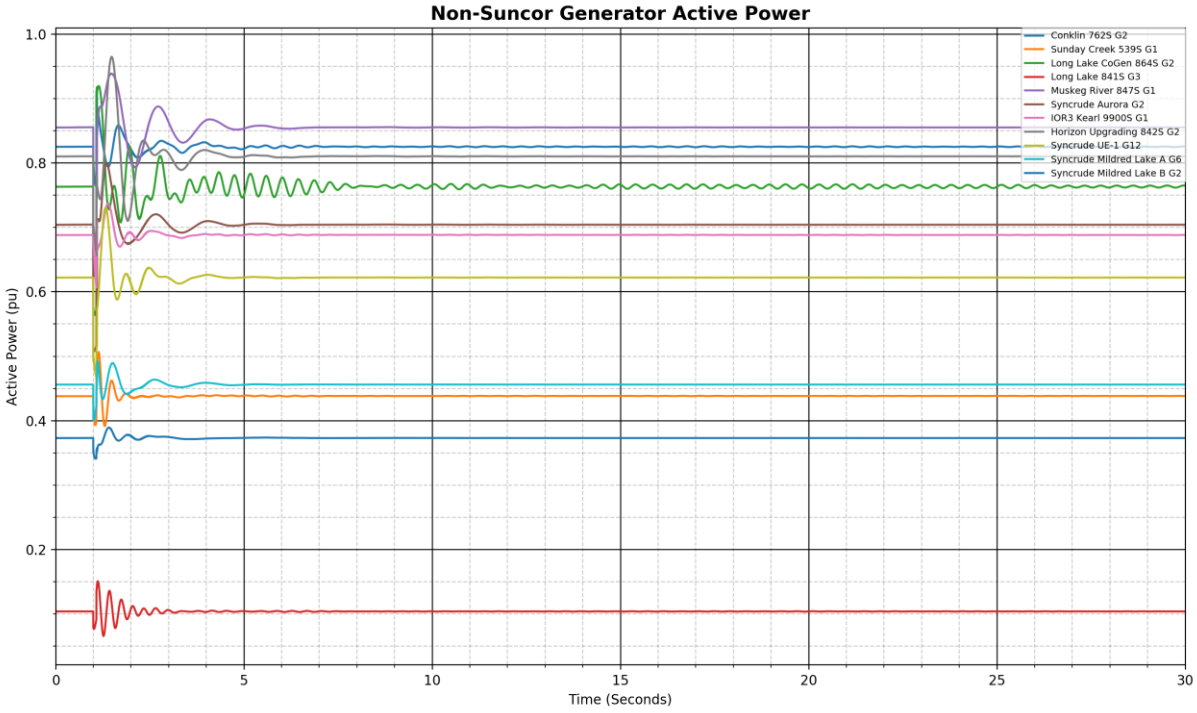

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

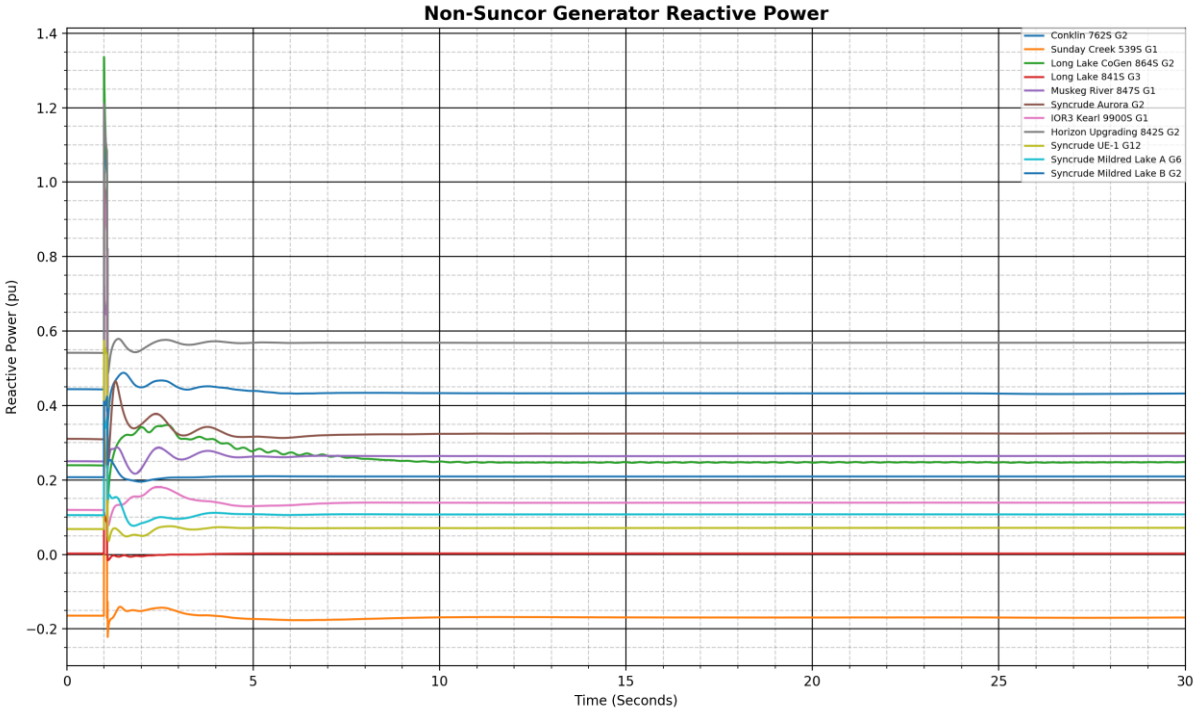
Figure A4-38: 9L23 (Ruth Lake 848S to Salt Creek 977S): Fault at Salt Creek 977S

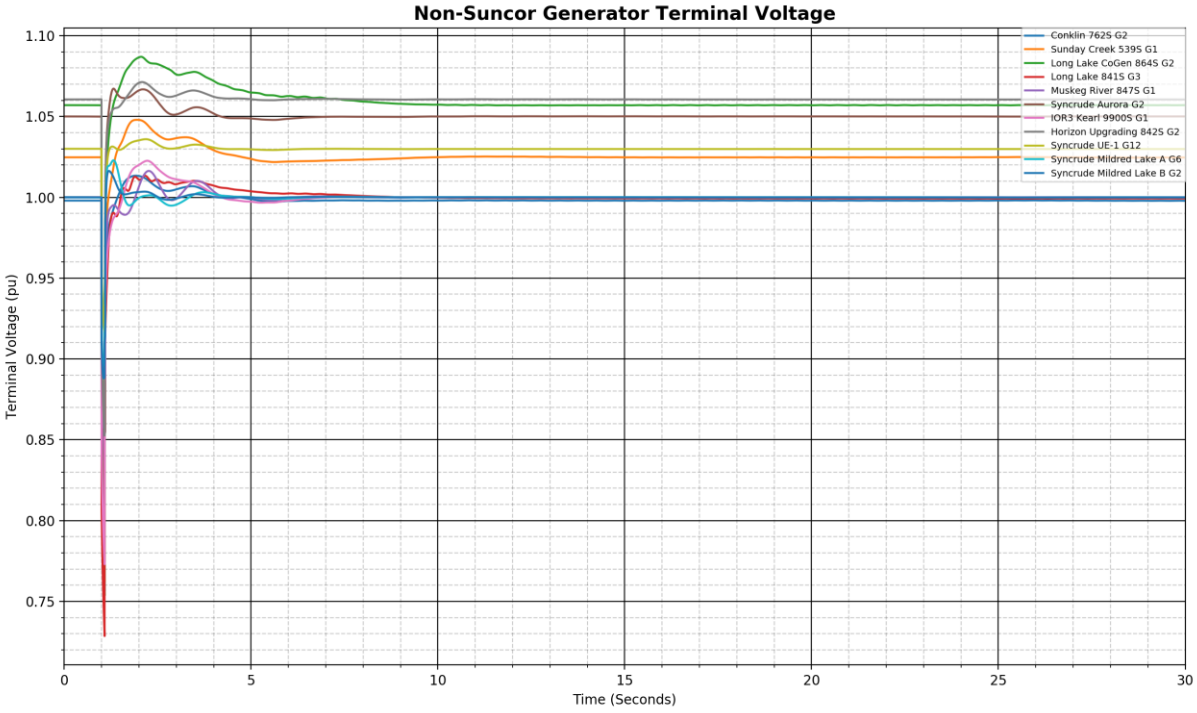


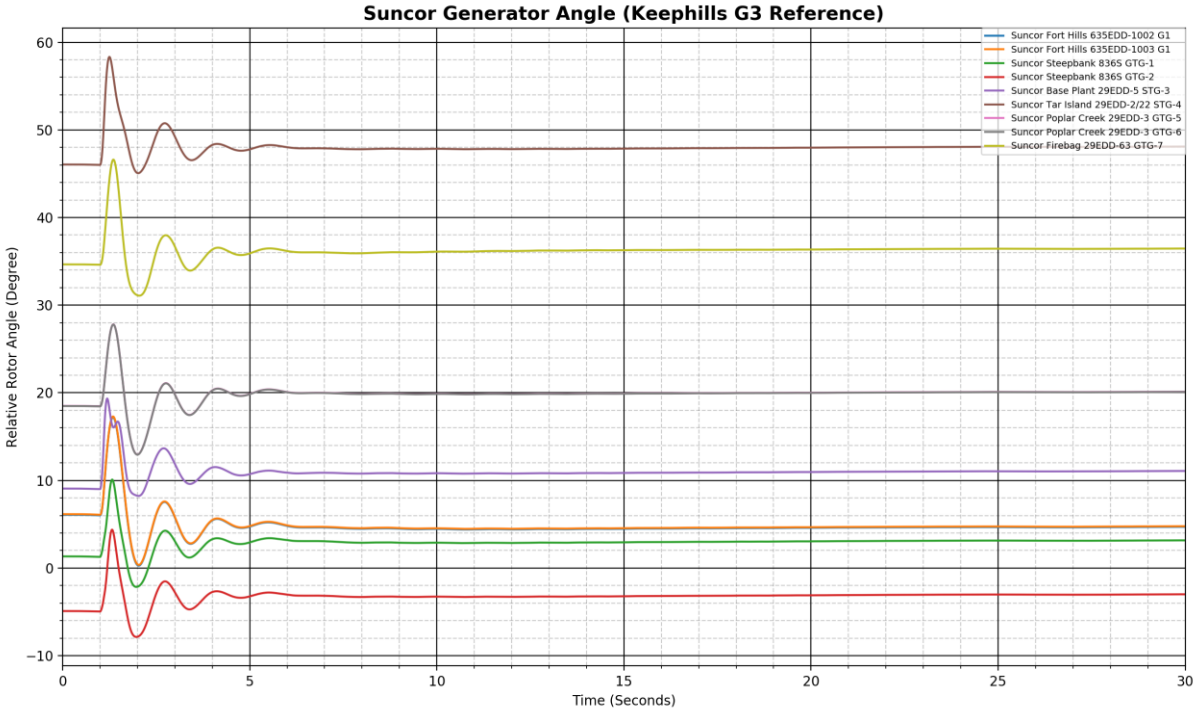


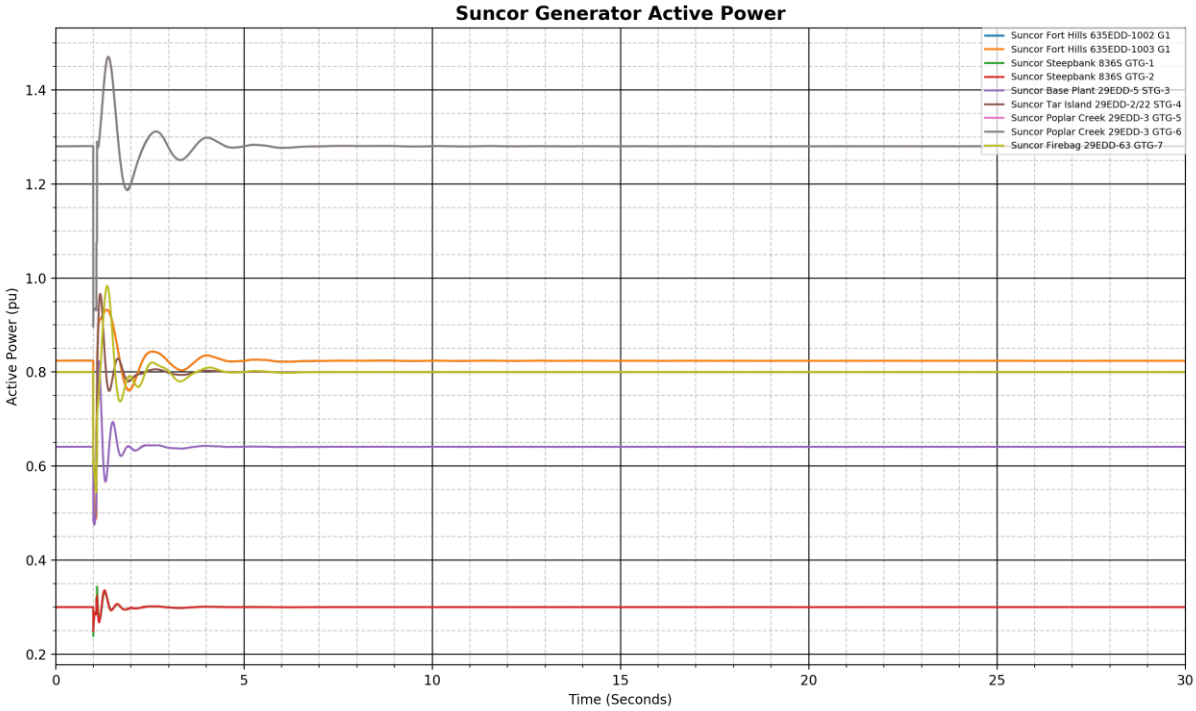

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

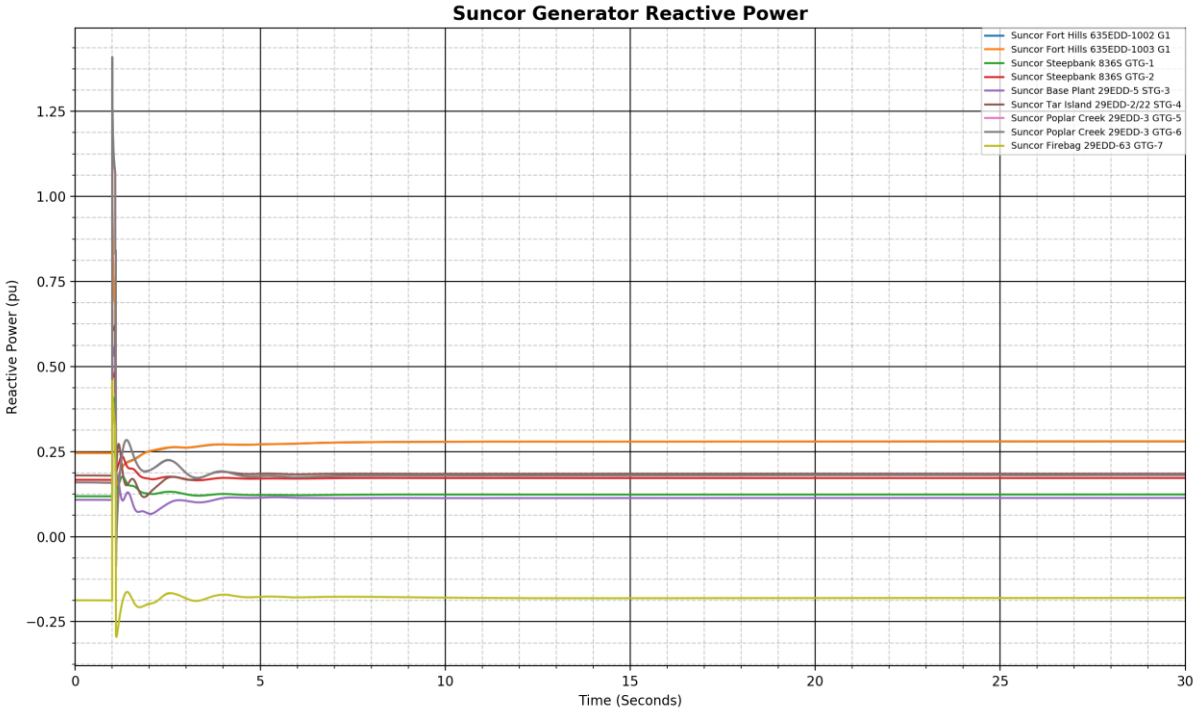

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

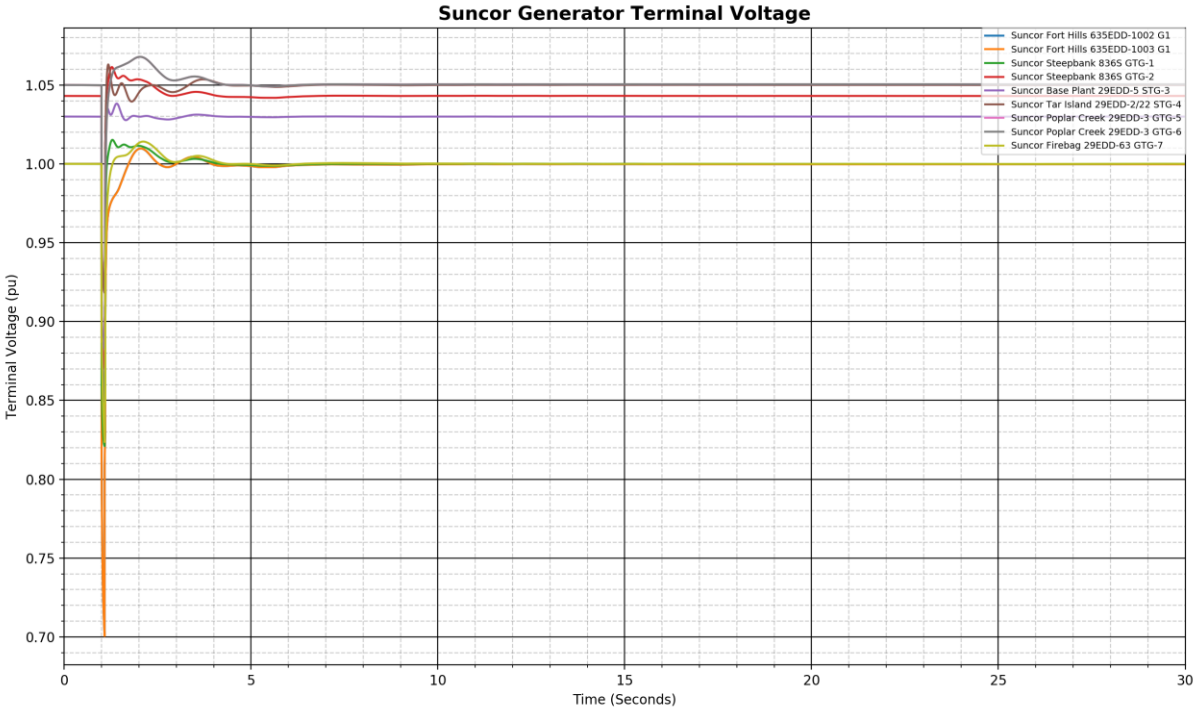

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

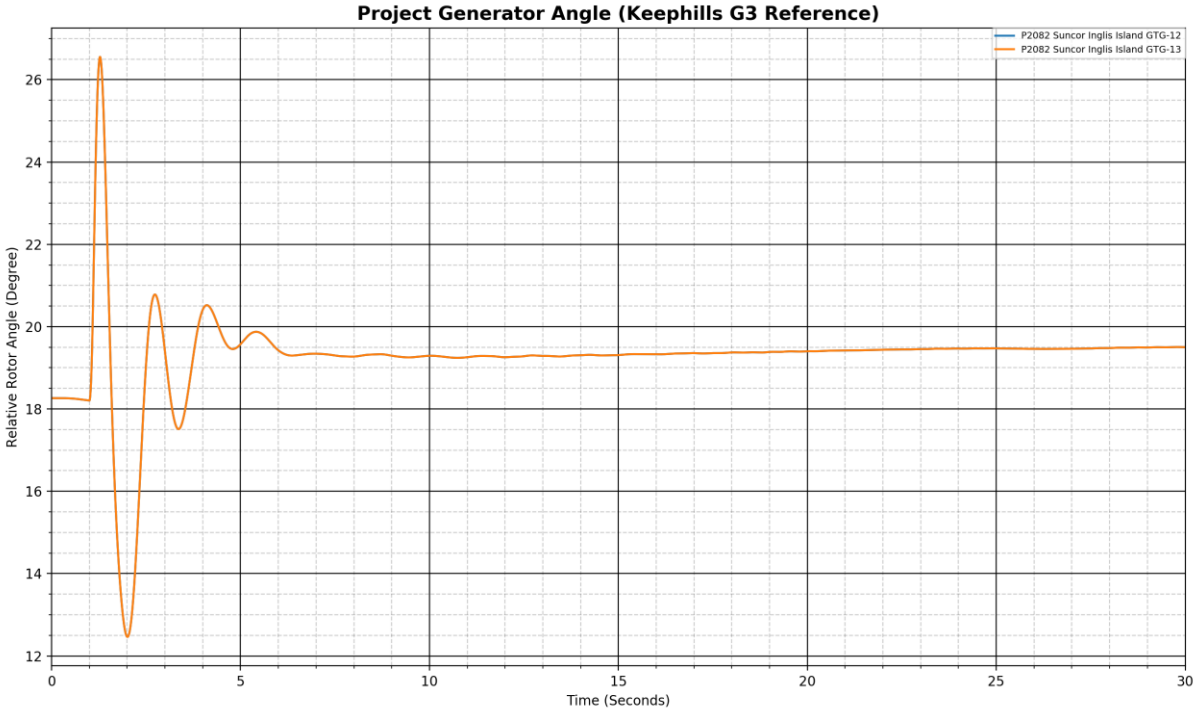

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

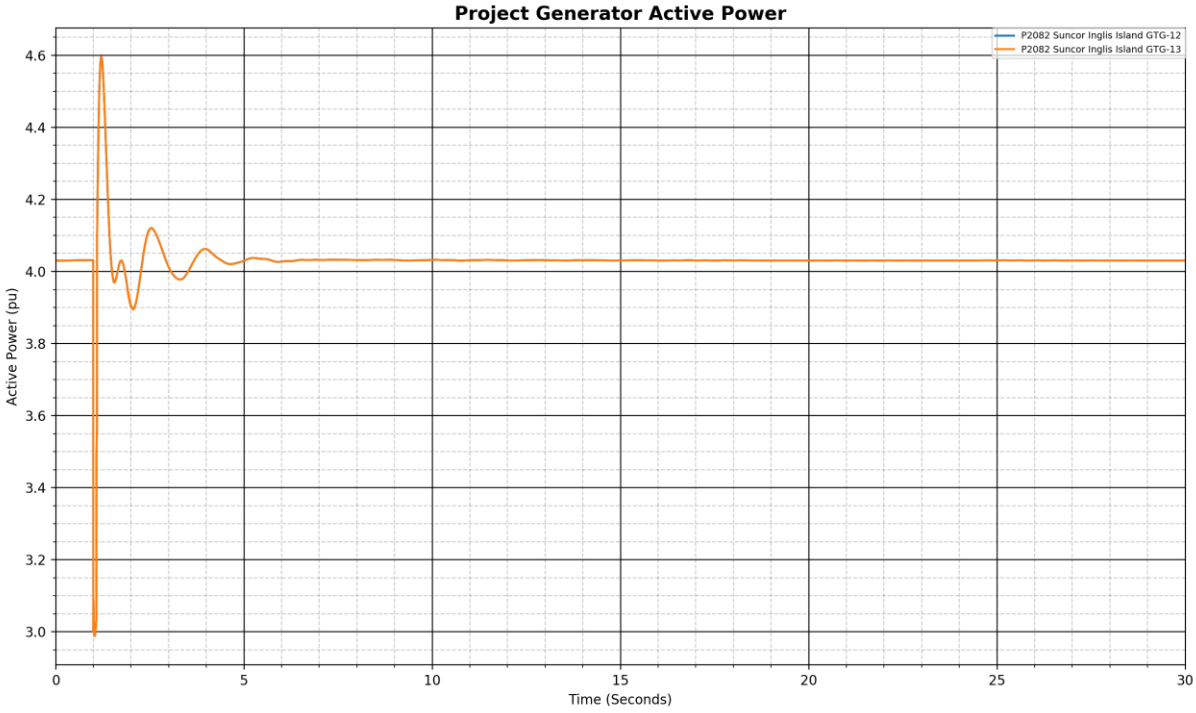

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

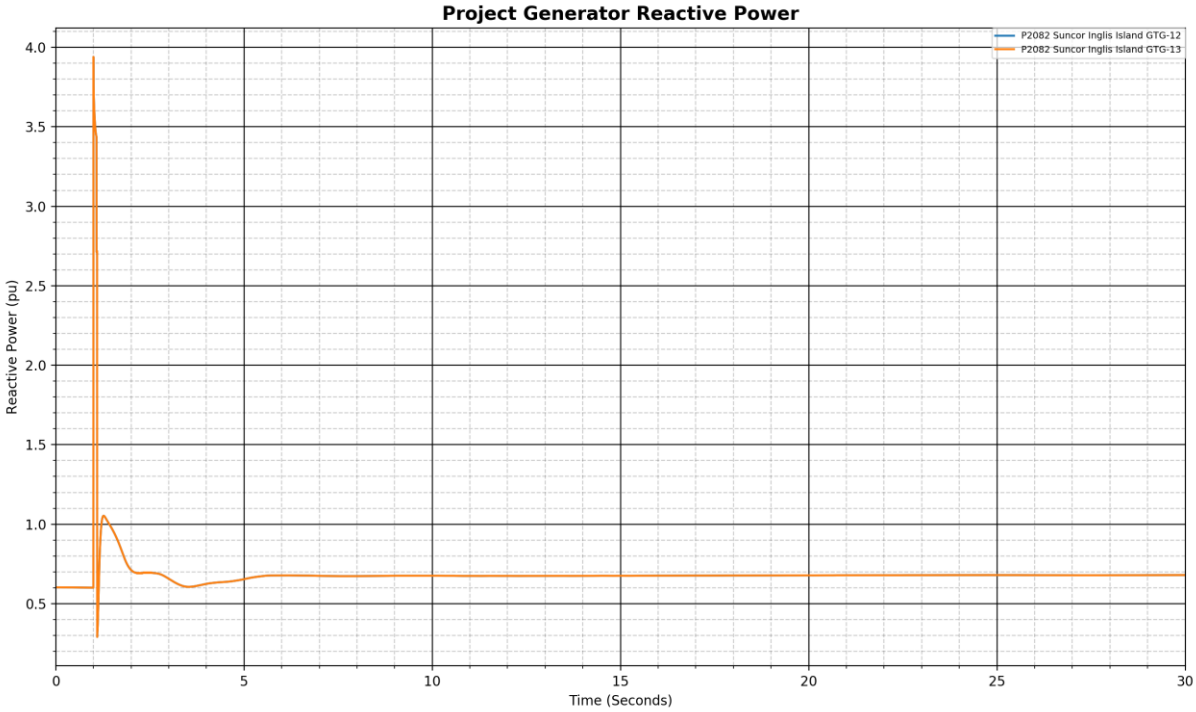

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

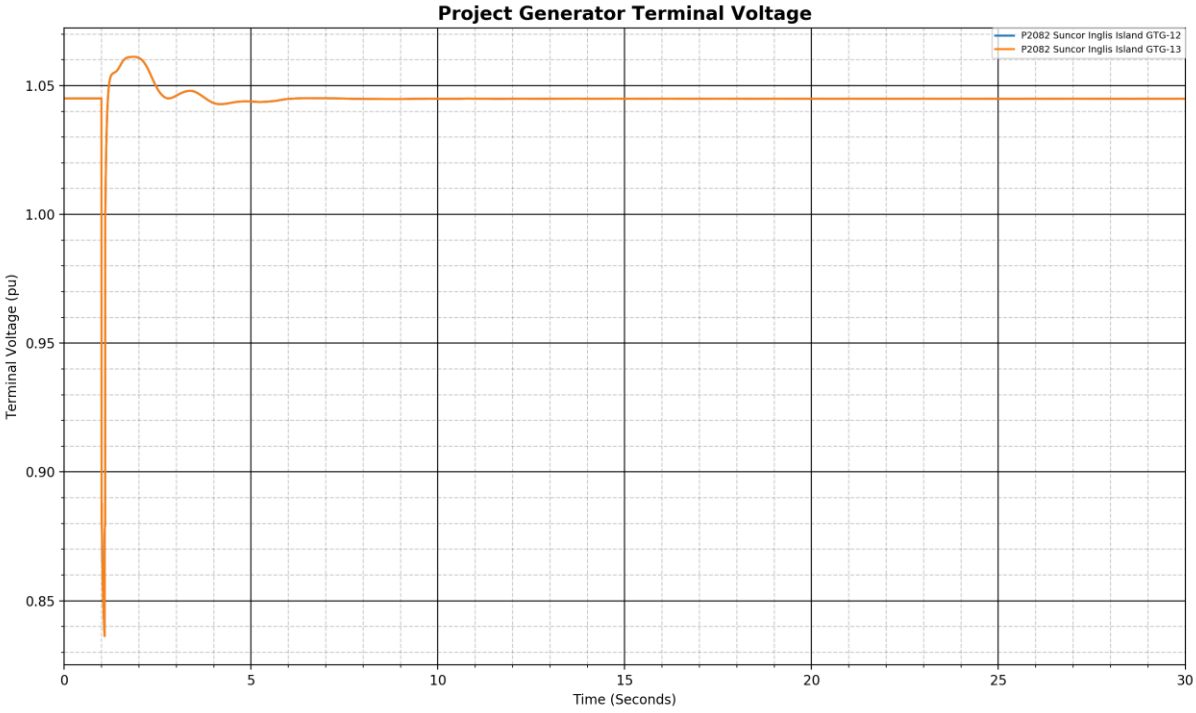

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

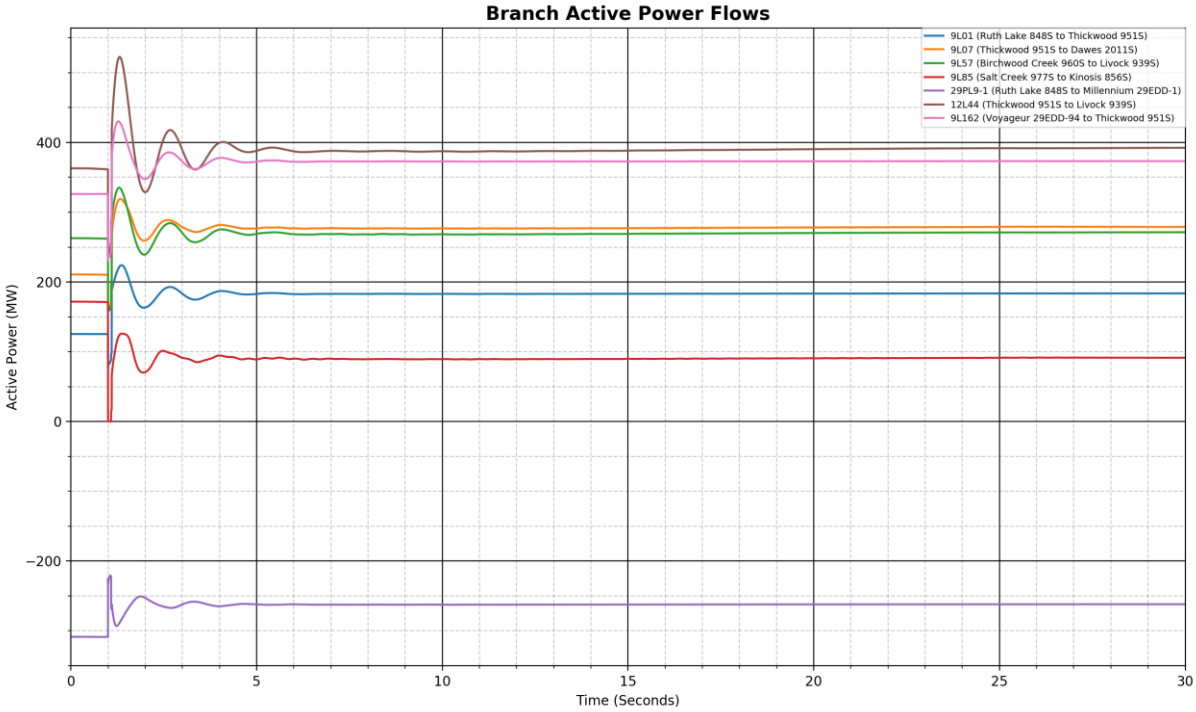

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

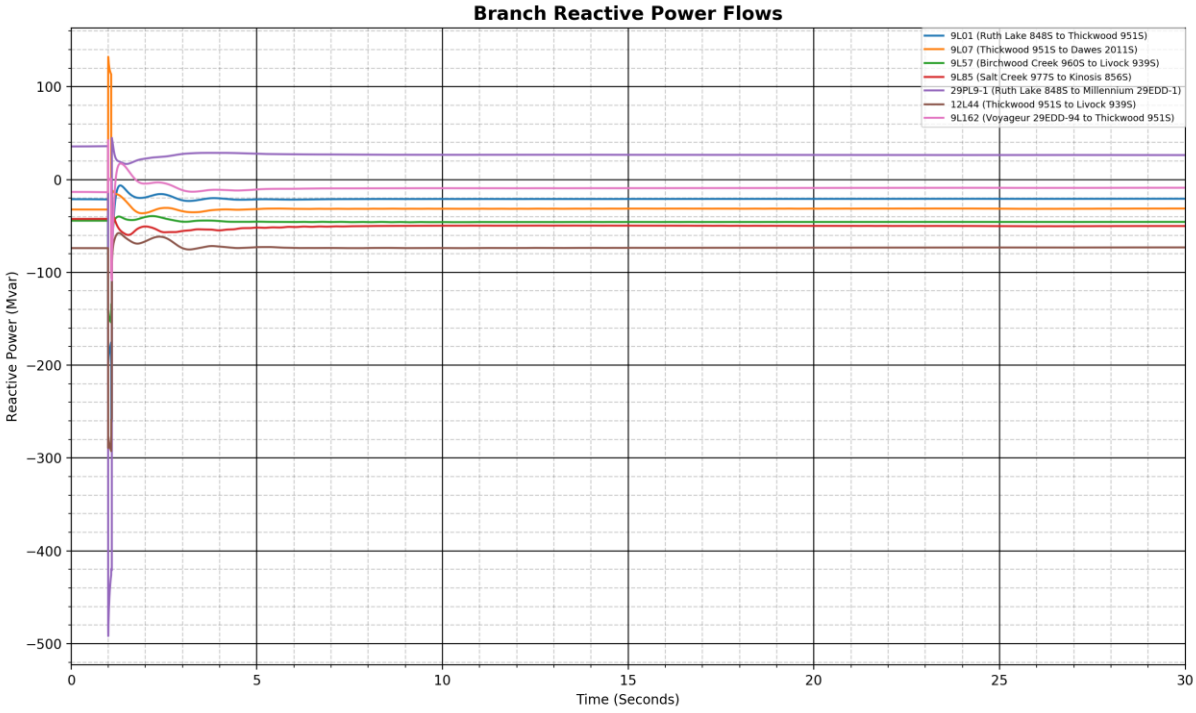
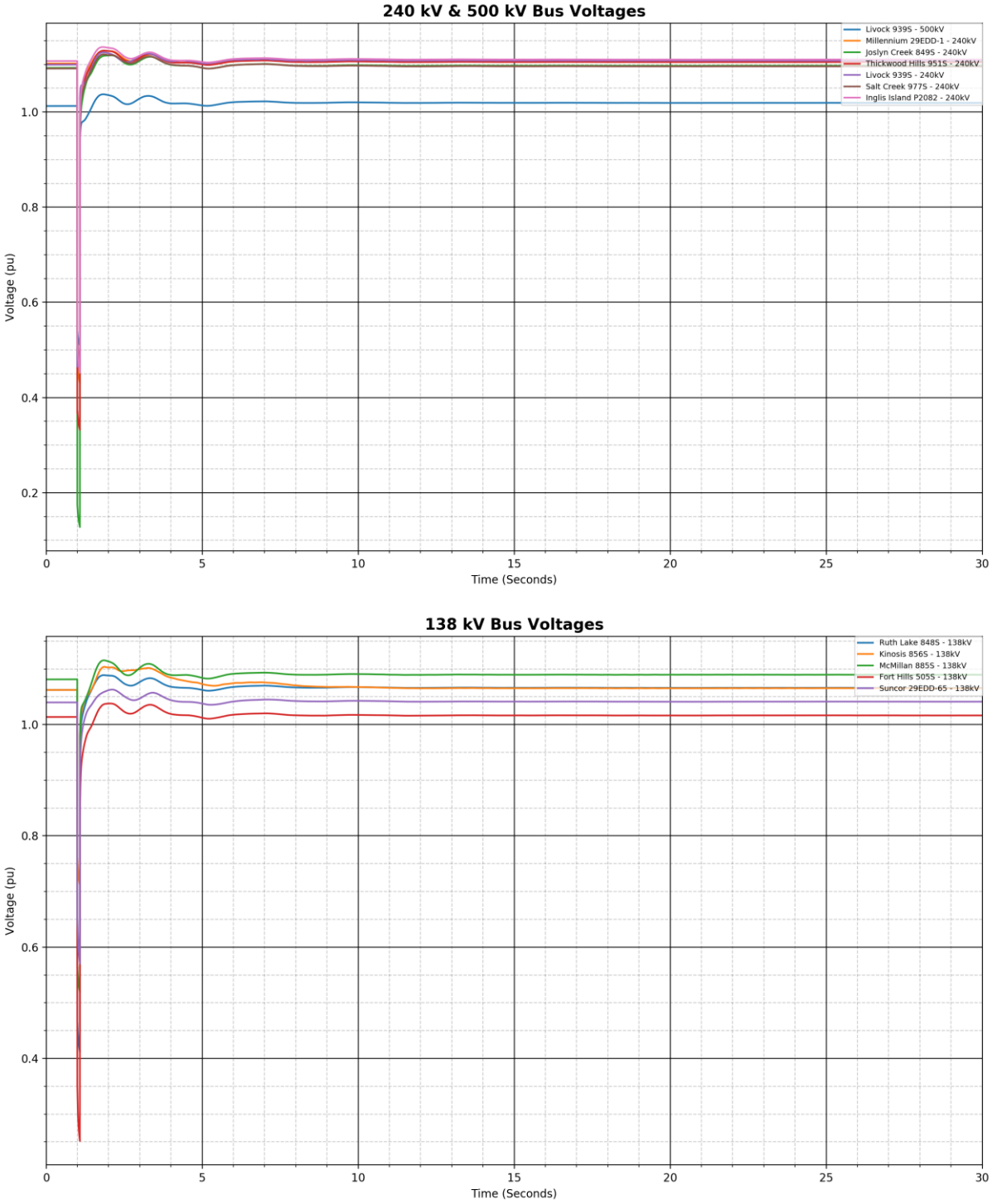
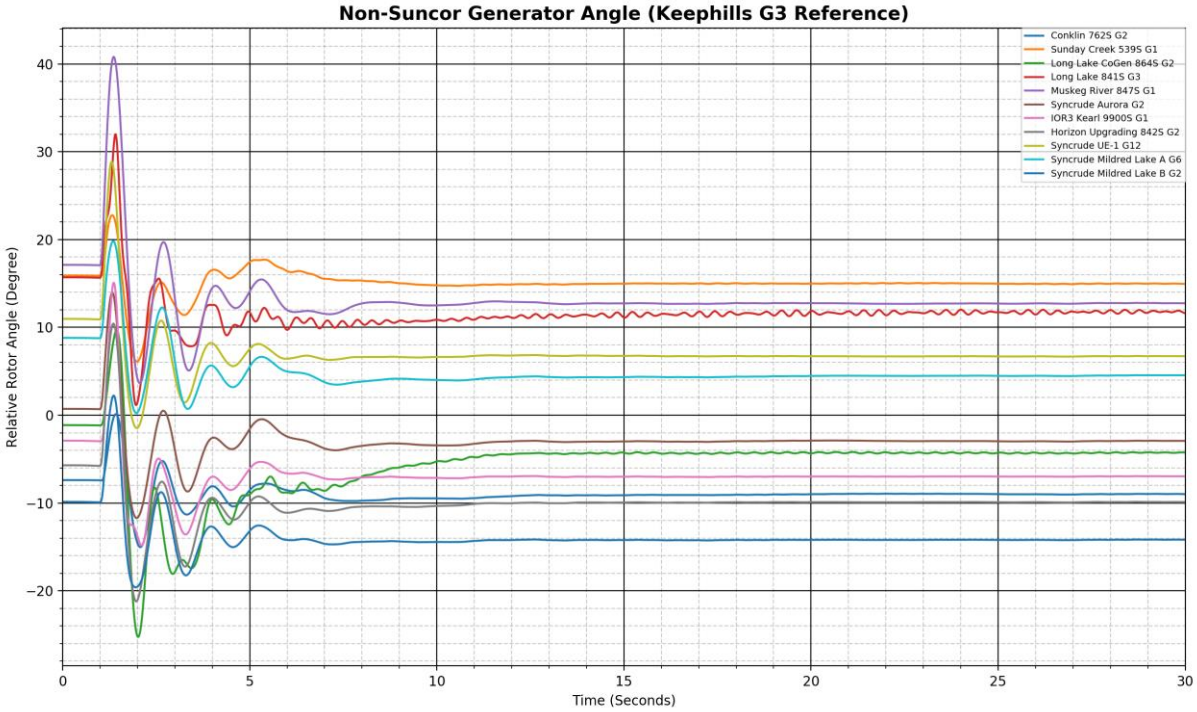
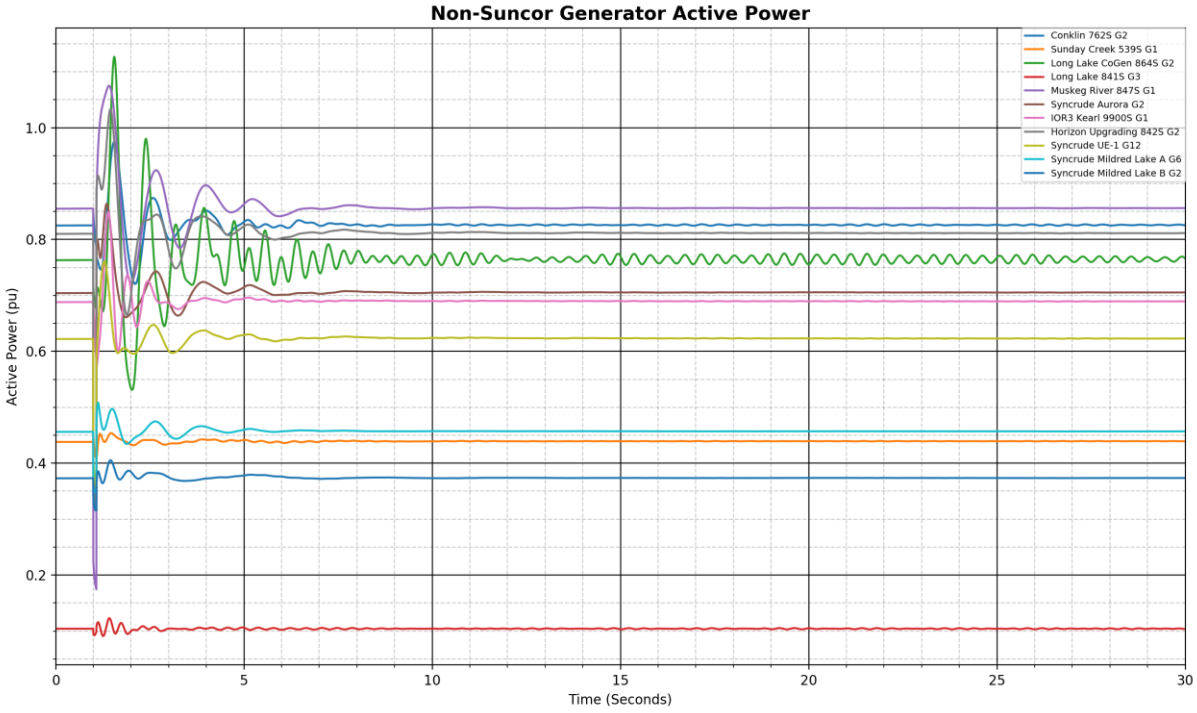
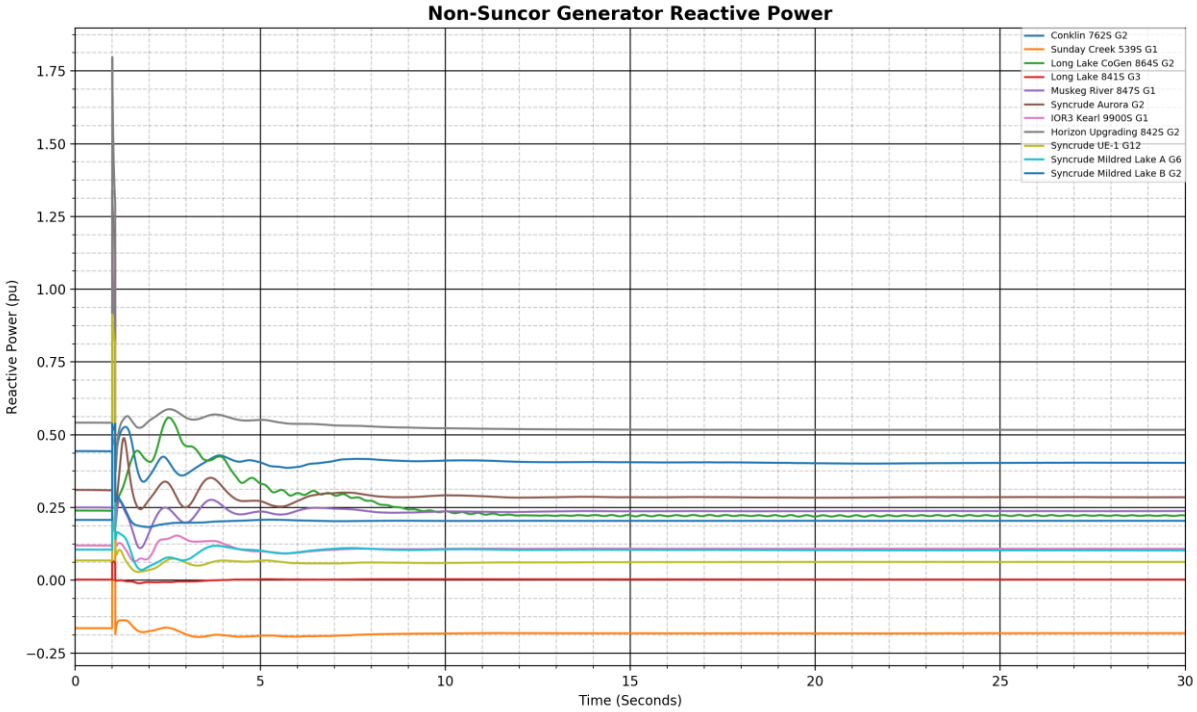

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
100
0
−100
−200
−300
−400
−500
0
5
10
15
20
25
30
Time (Seconds)

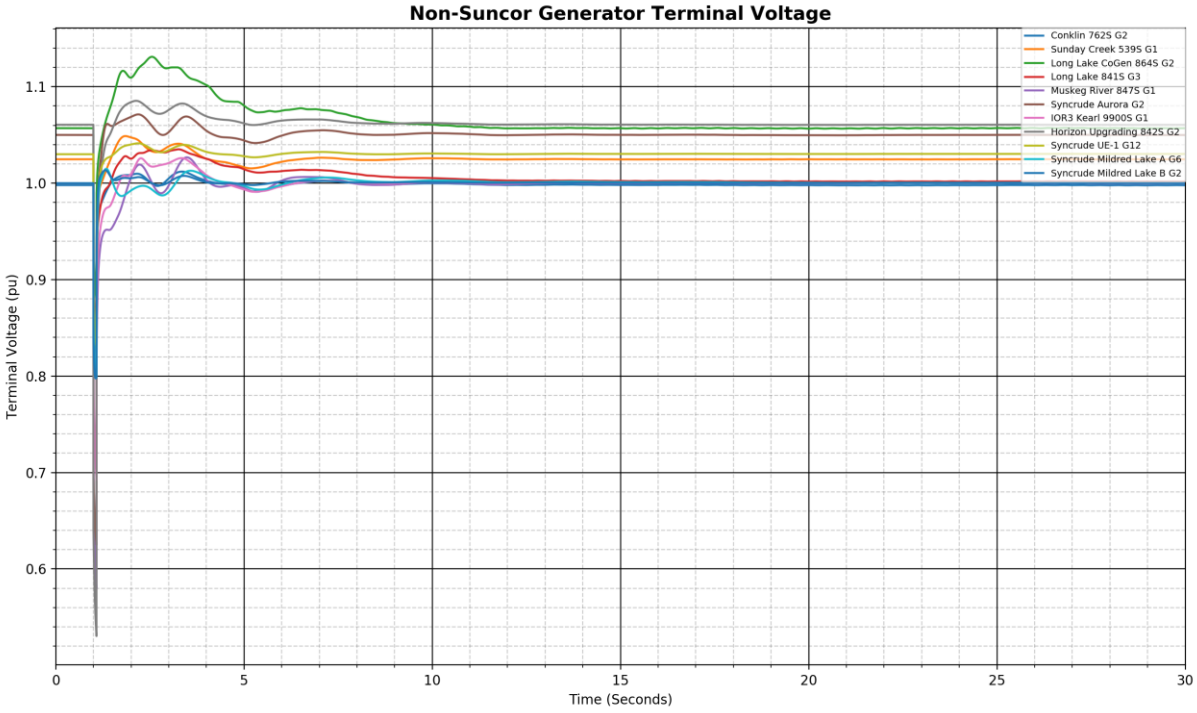
Figure A4-39: 9L43 (Dover 888S to Mackay River 874S): Fault at Dover 888S

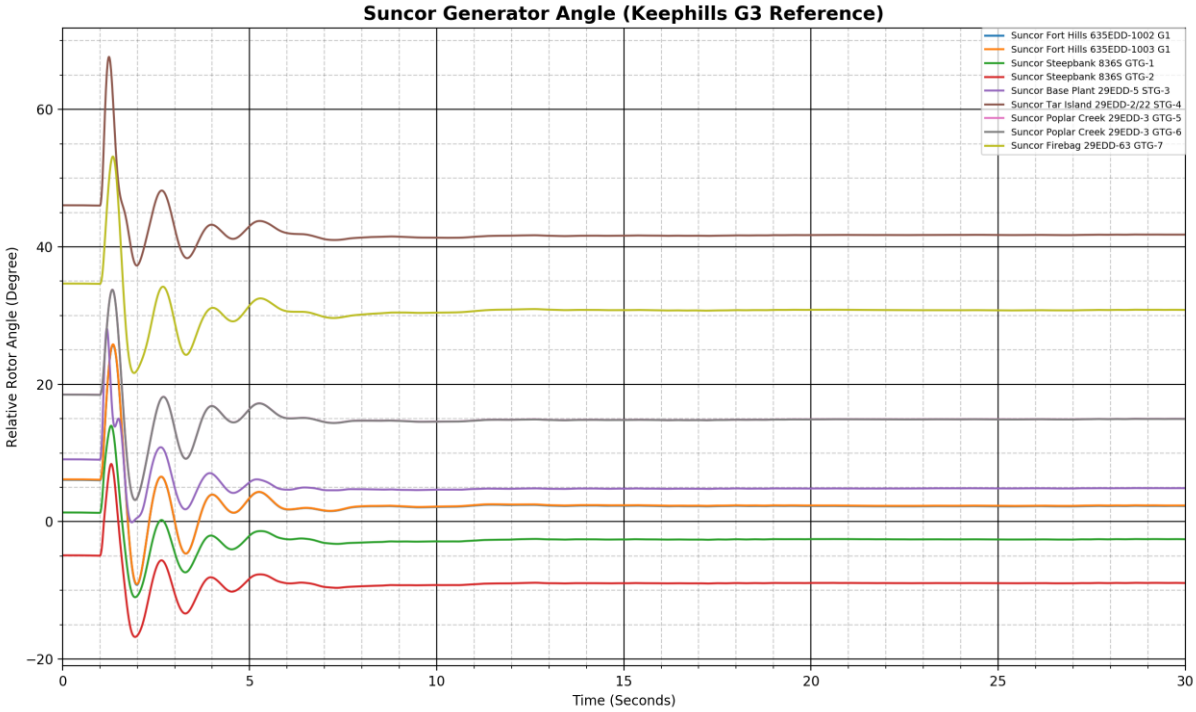


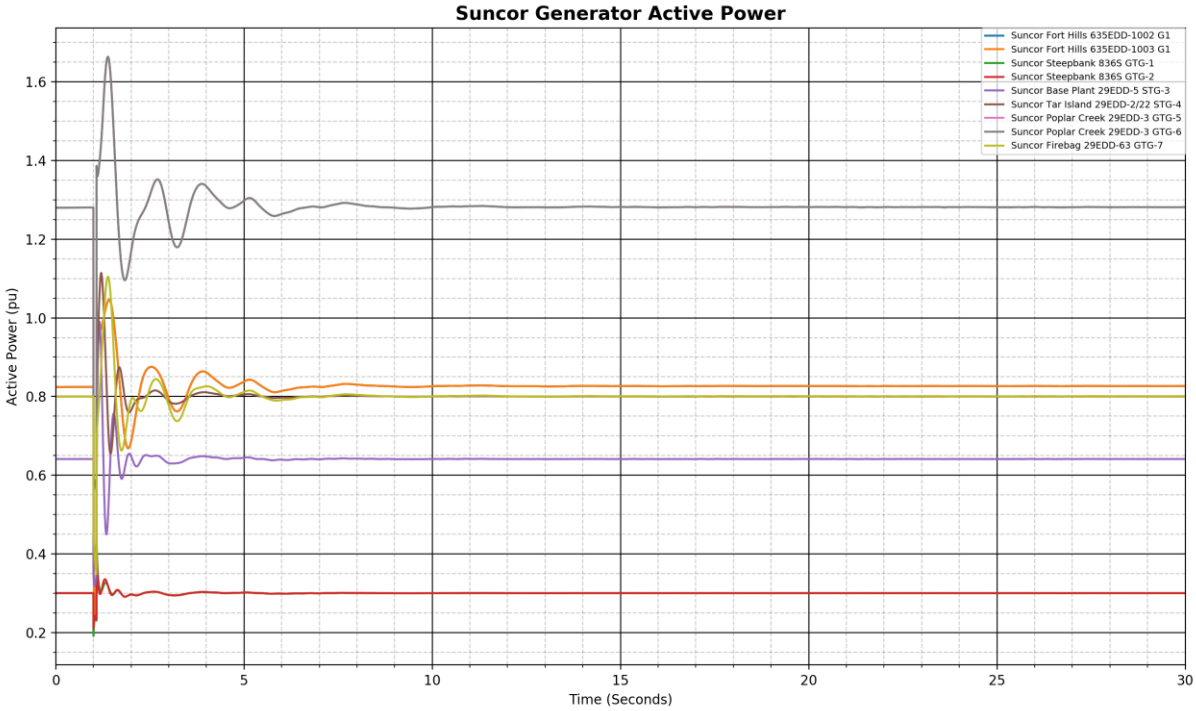

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

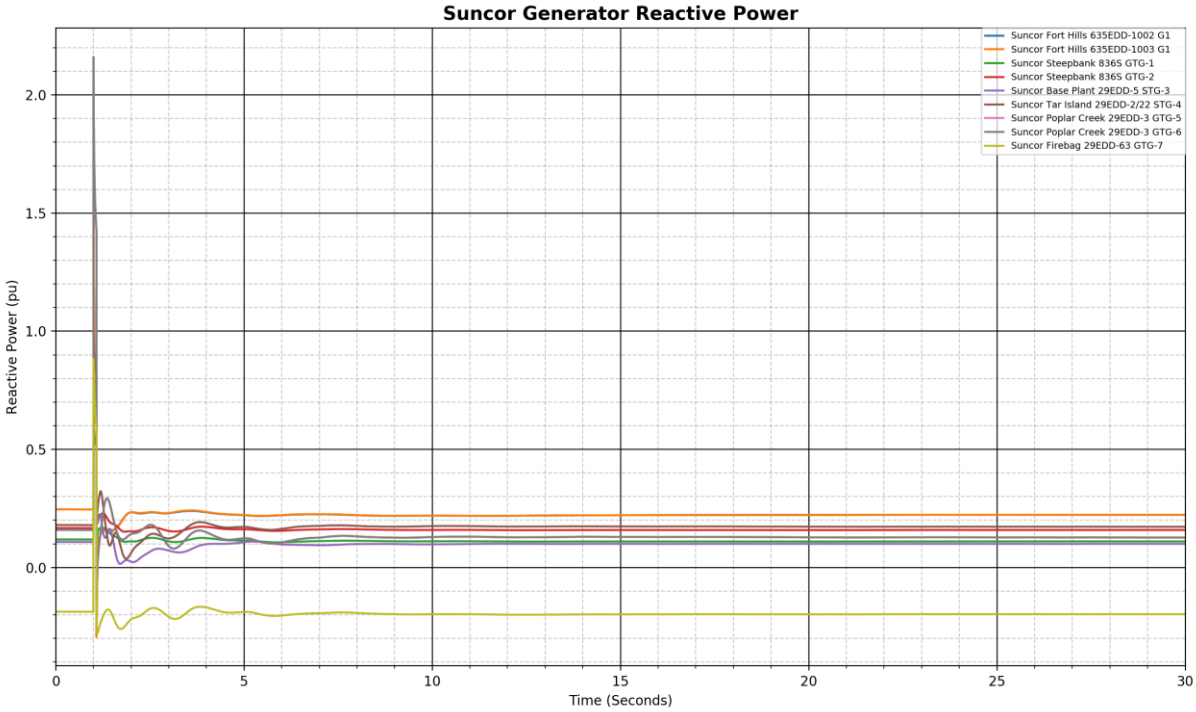

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

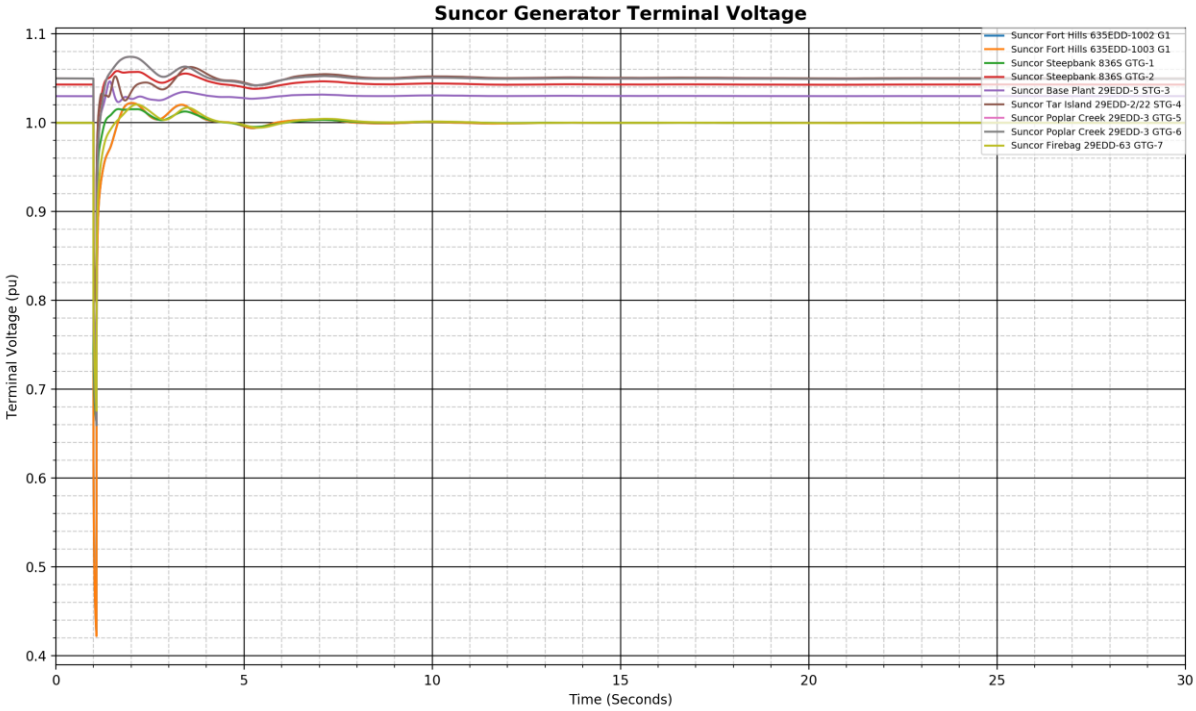

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

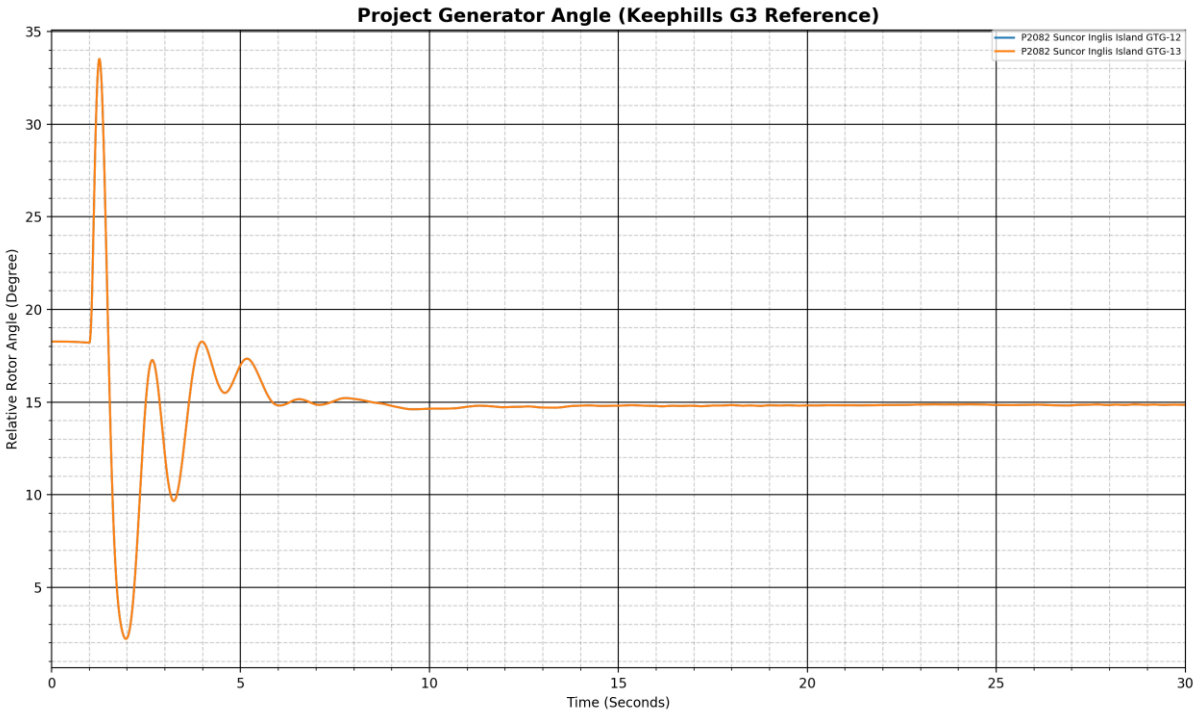

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

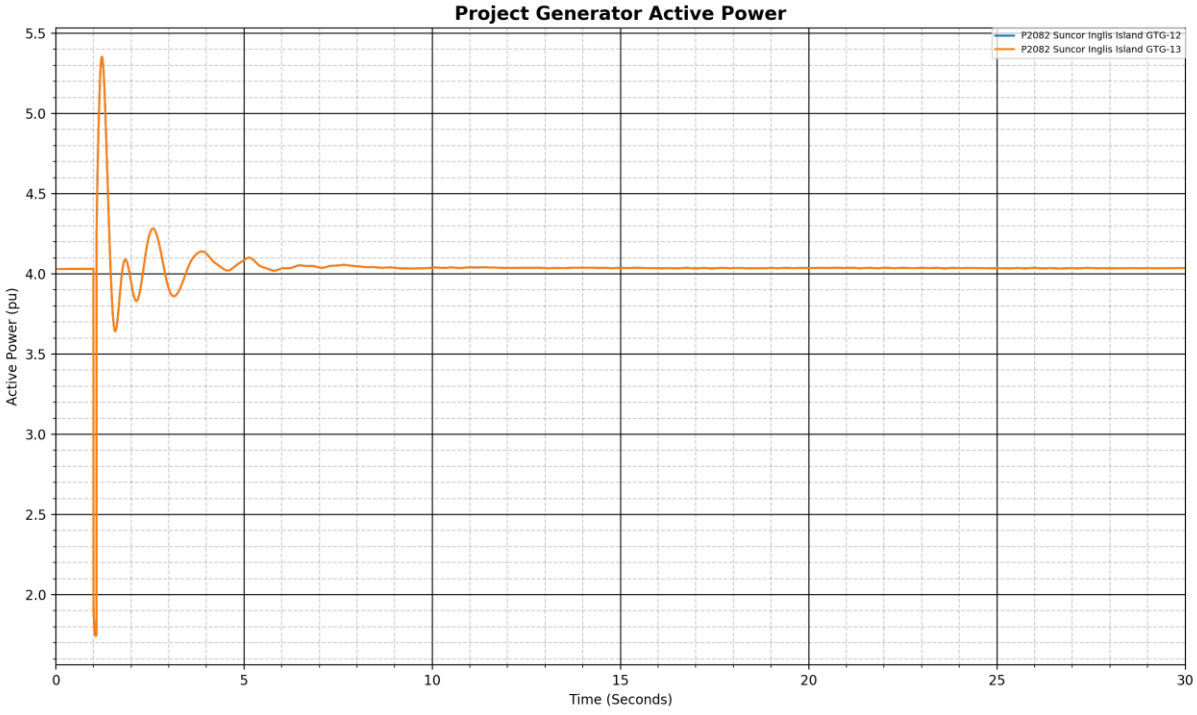

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

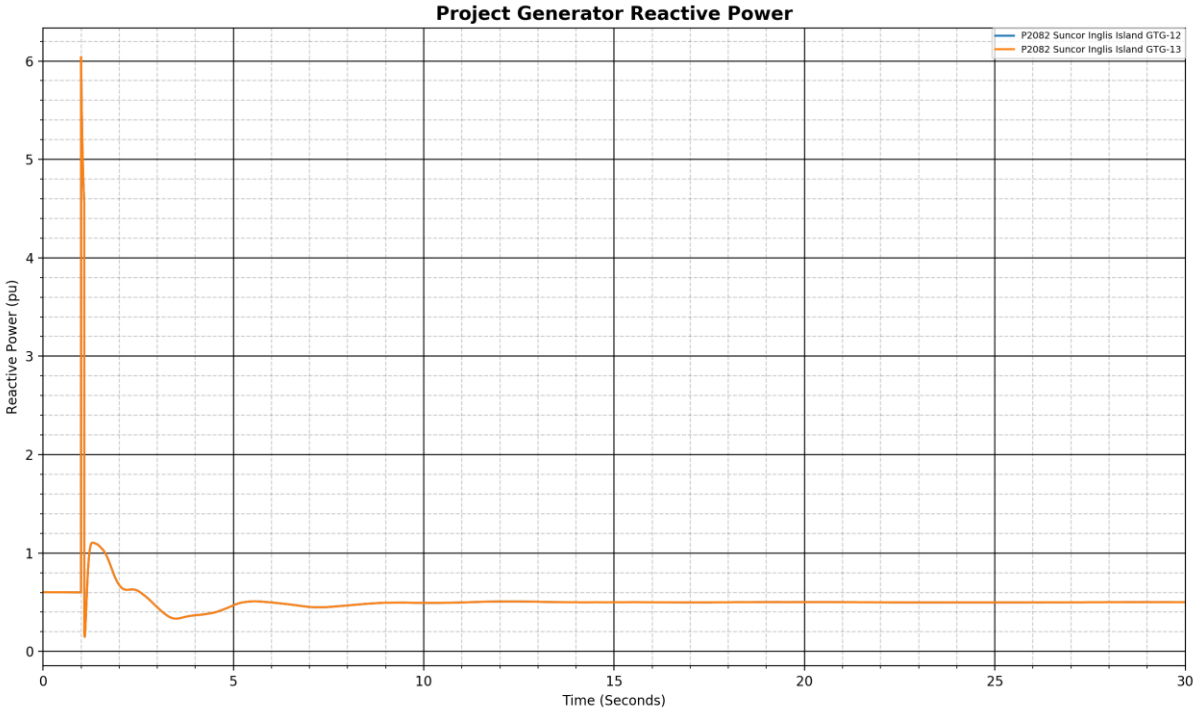

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

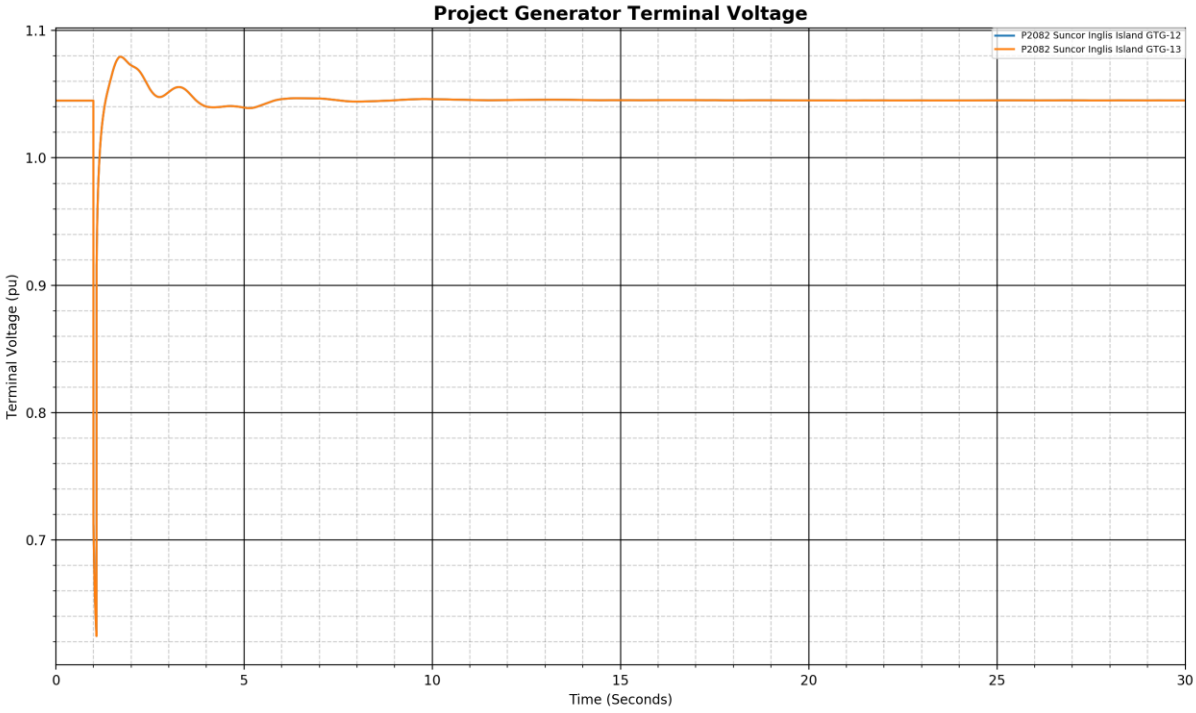

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

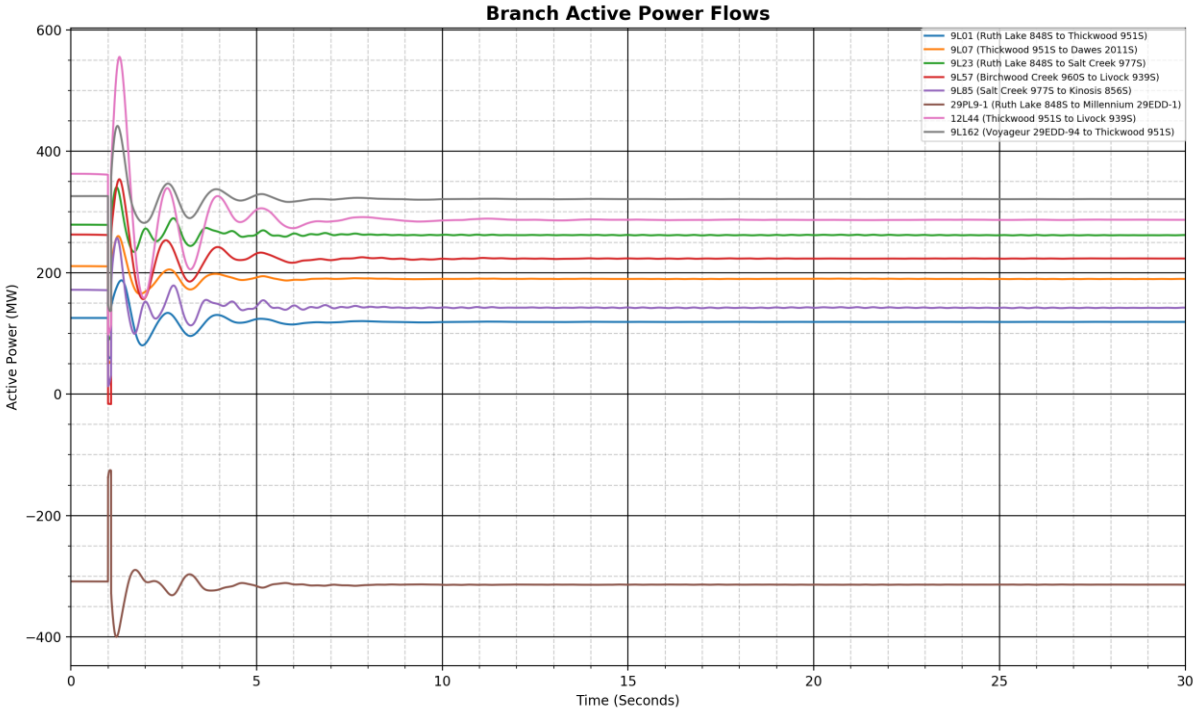

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
35
30
25
20
15
10
5
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

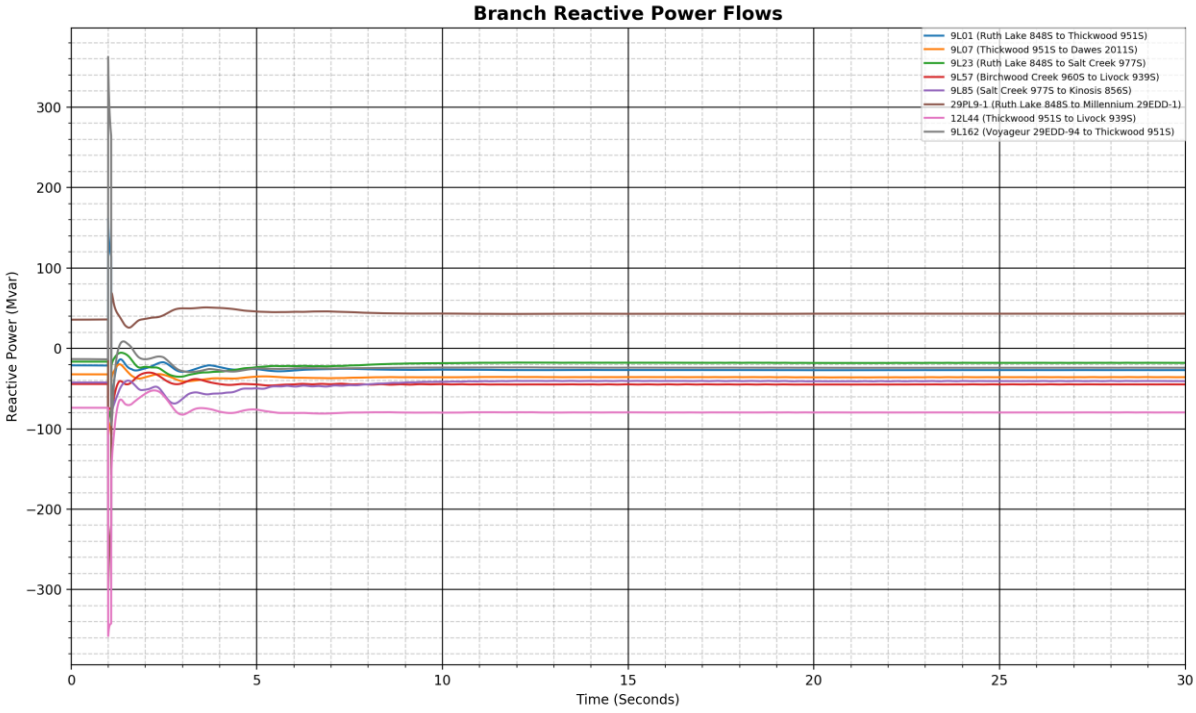
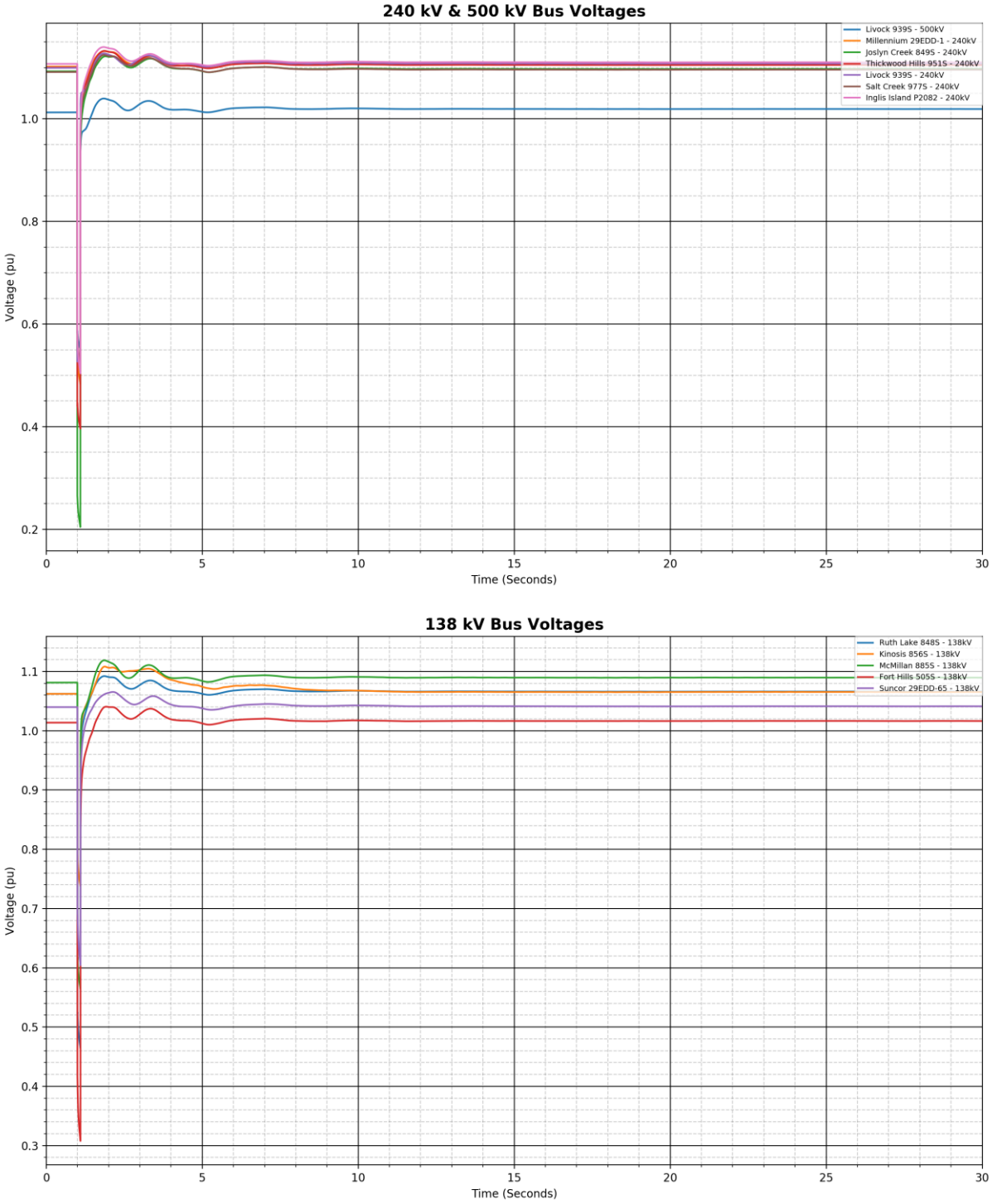
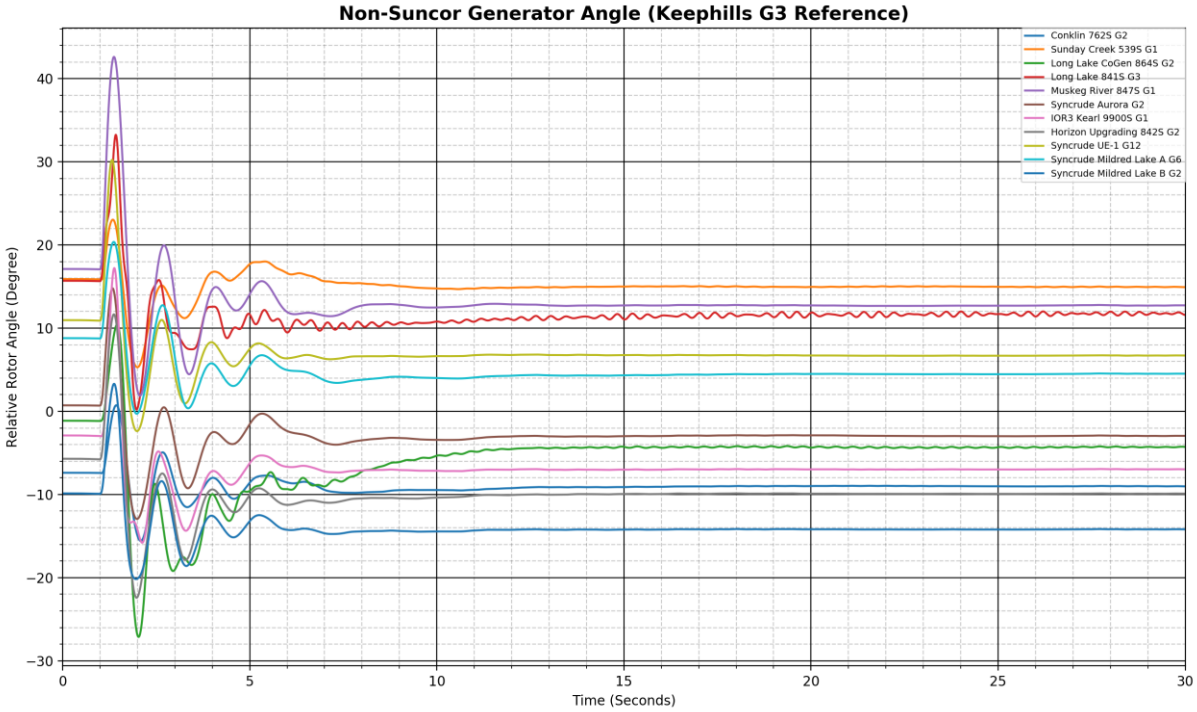
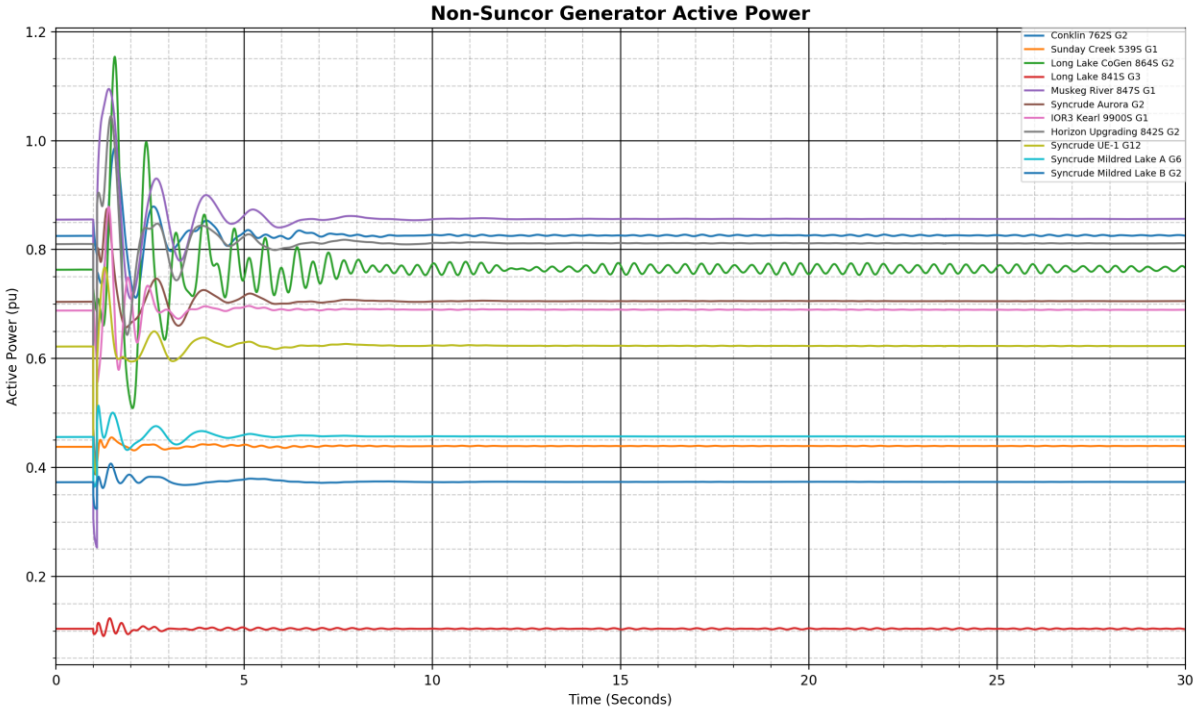
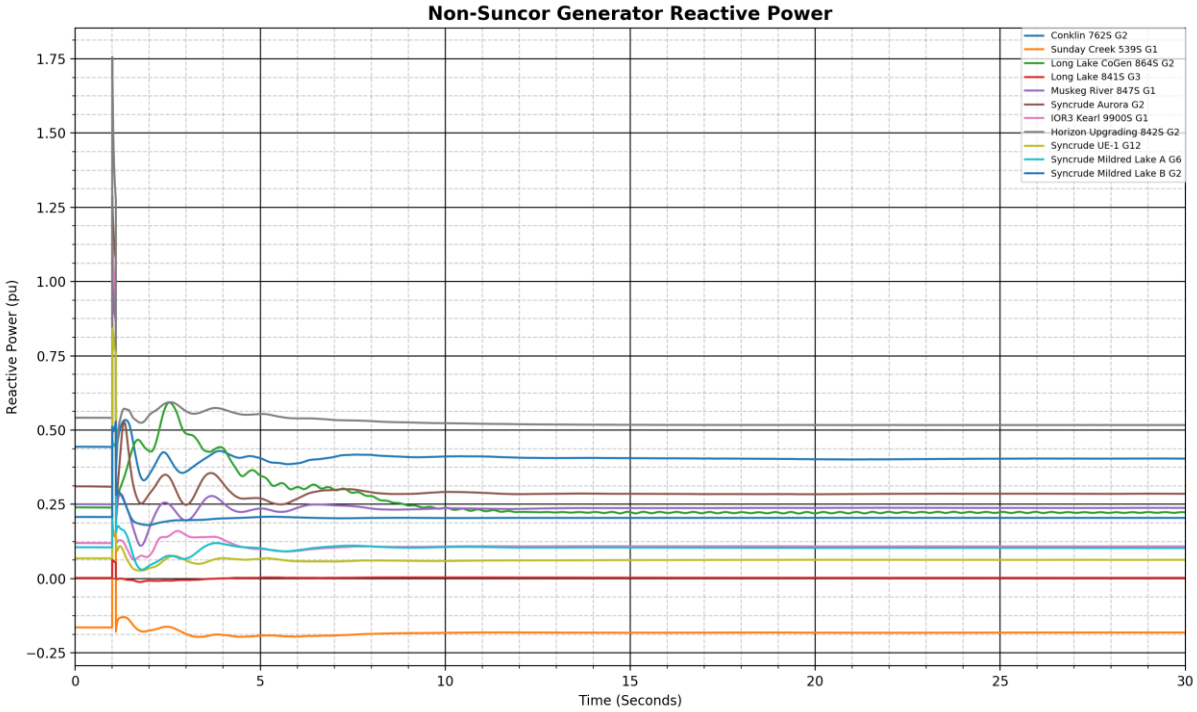

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

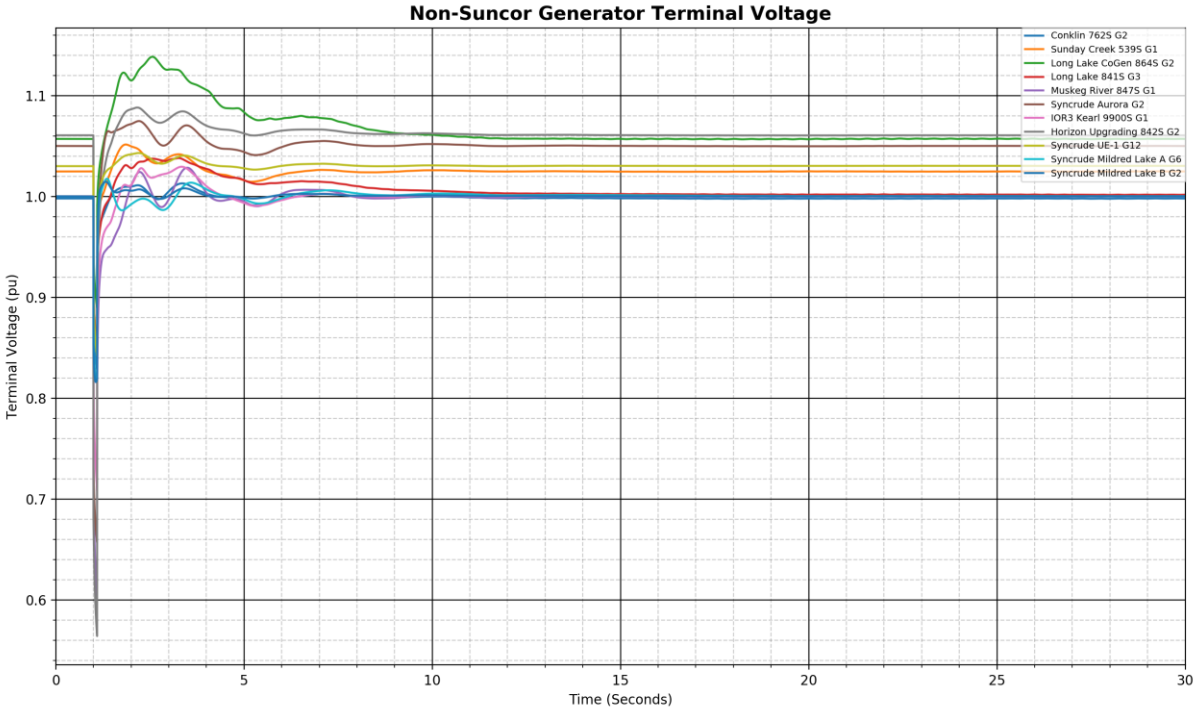
Figure A4-40: 9L43 (Dover 888S to Mackay River 874S): Fault at Mackay River 874S

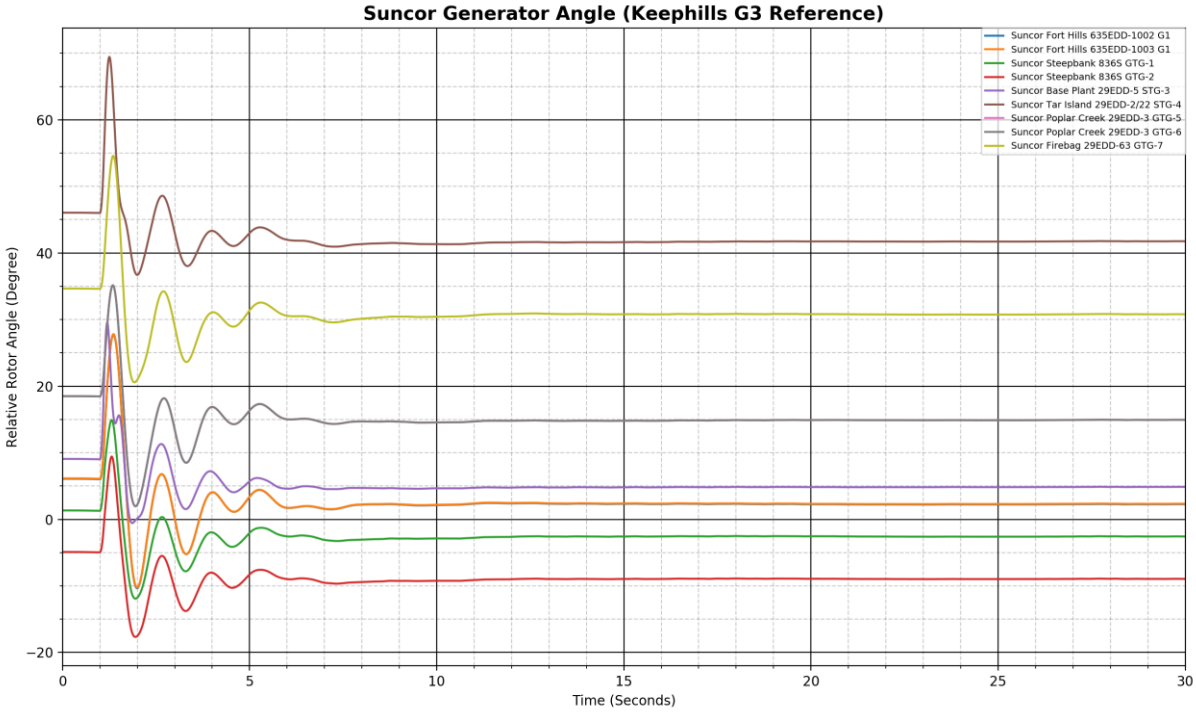


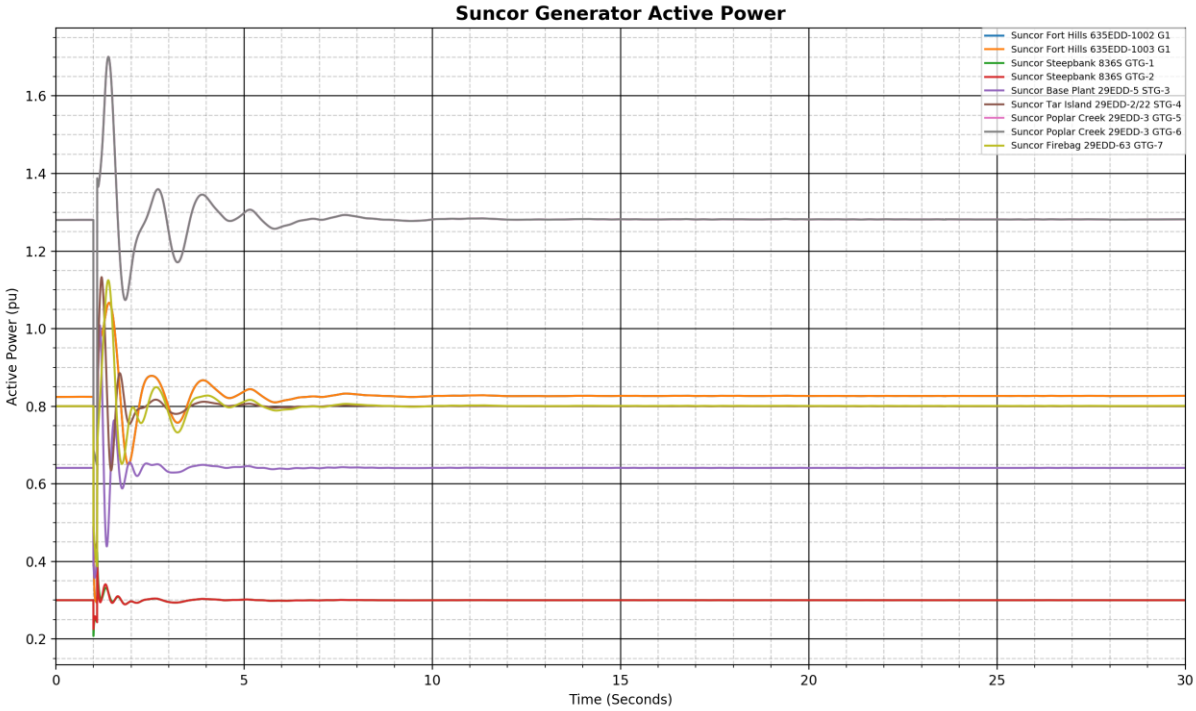

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

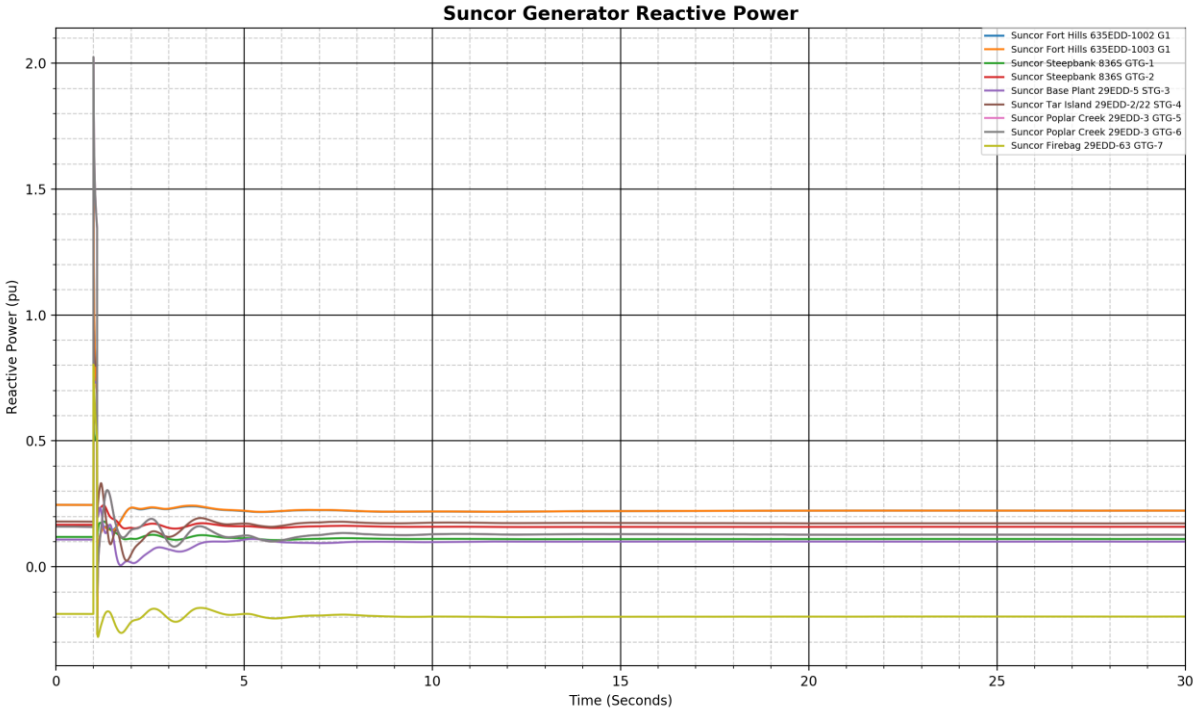

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

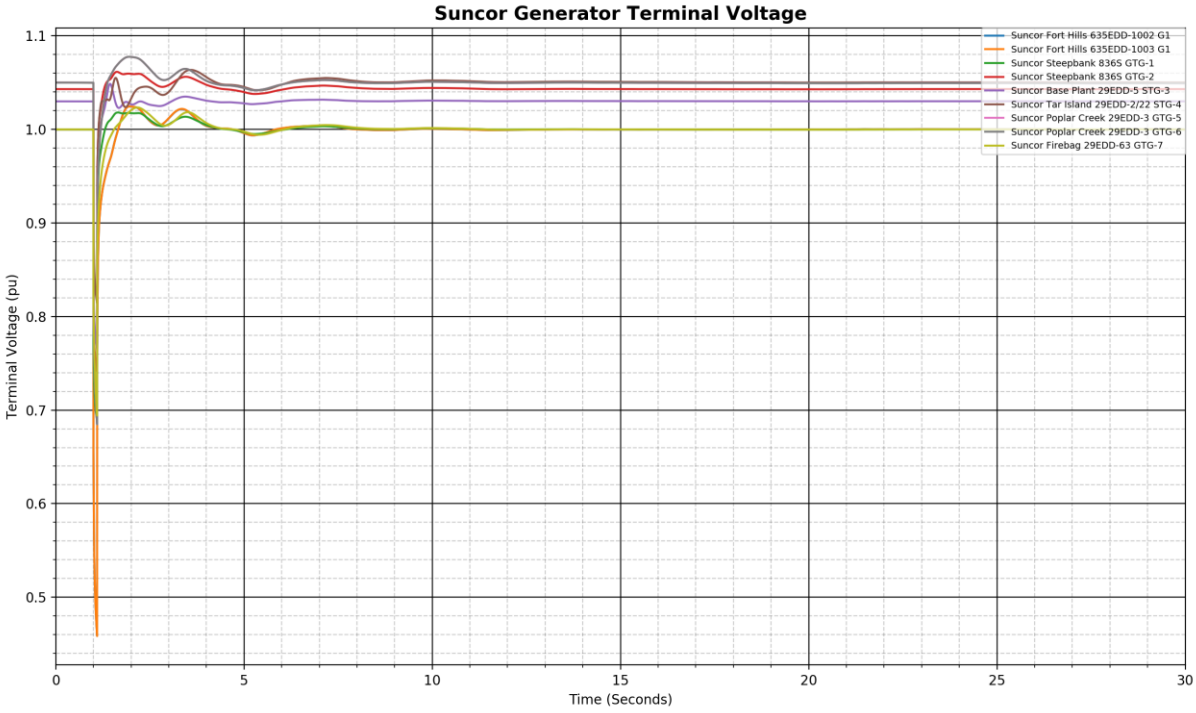

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

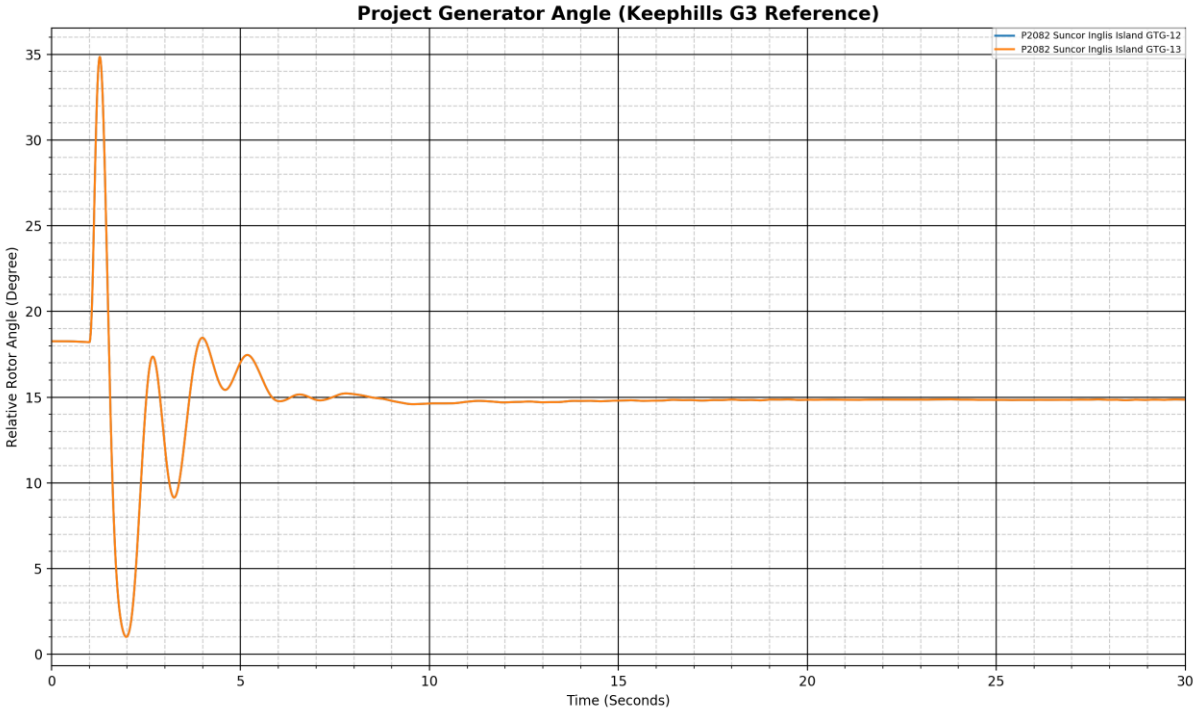

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

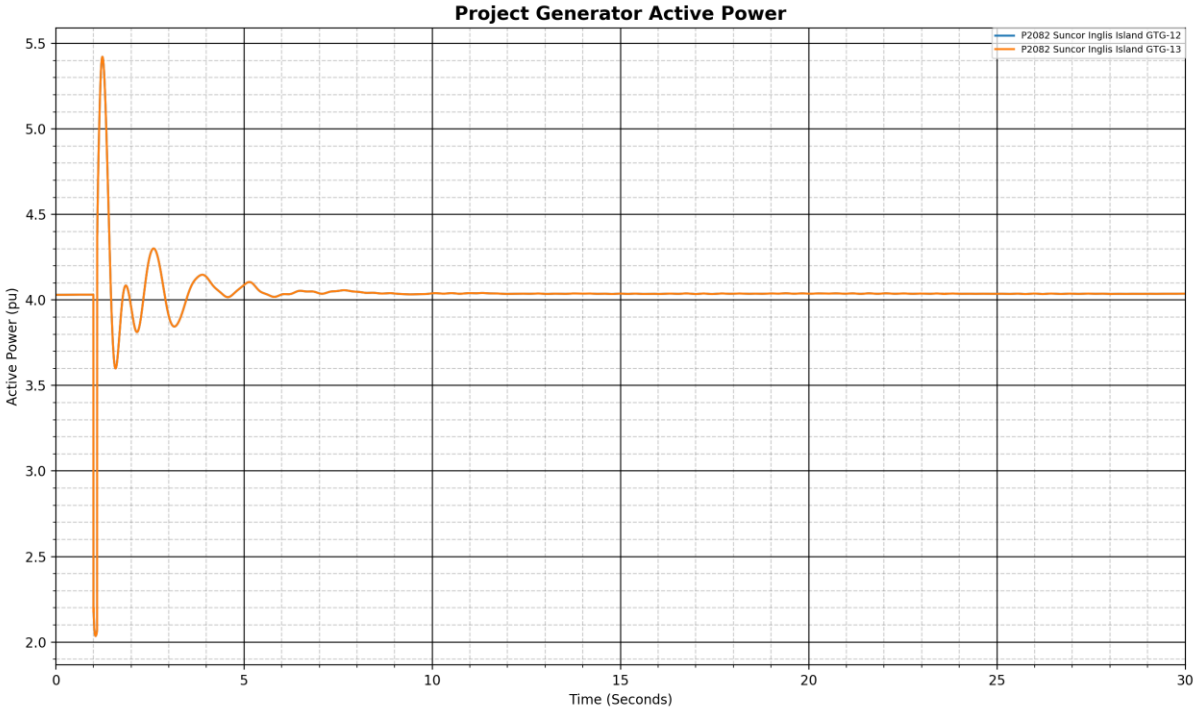

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

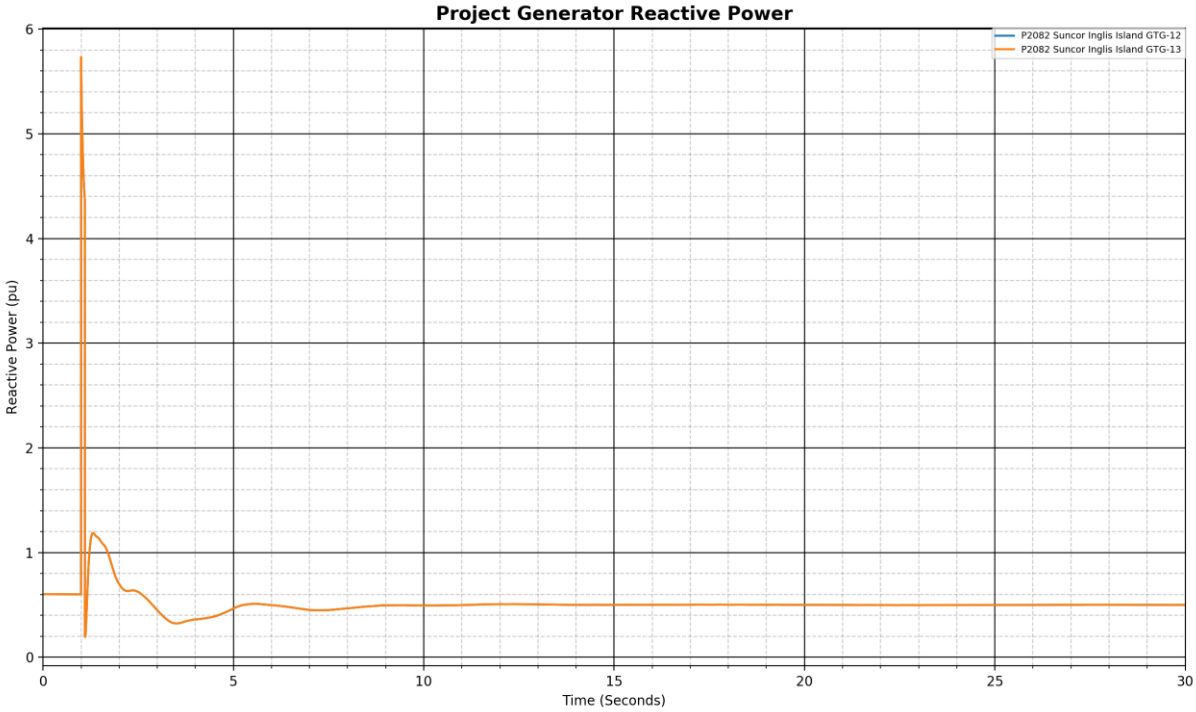

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

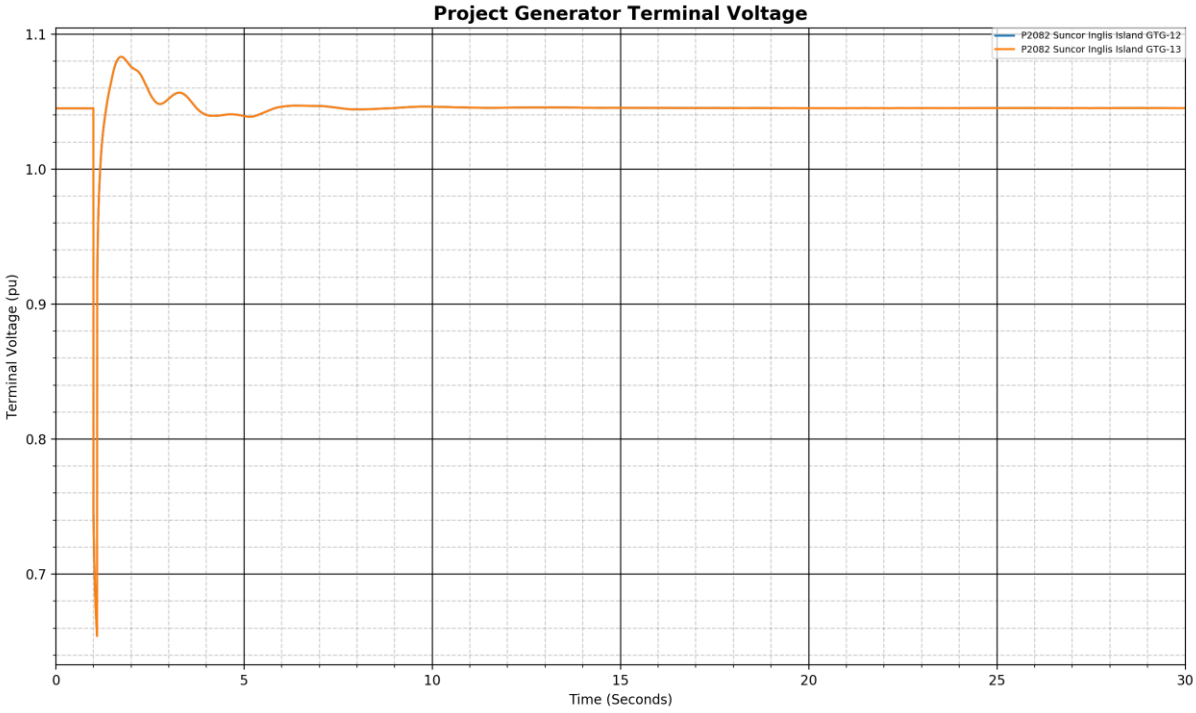

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

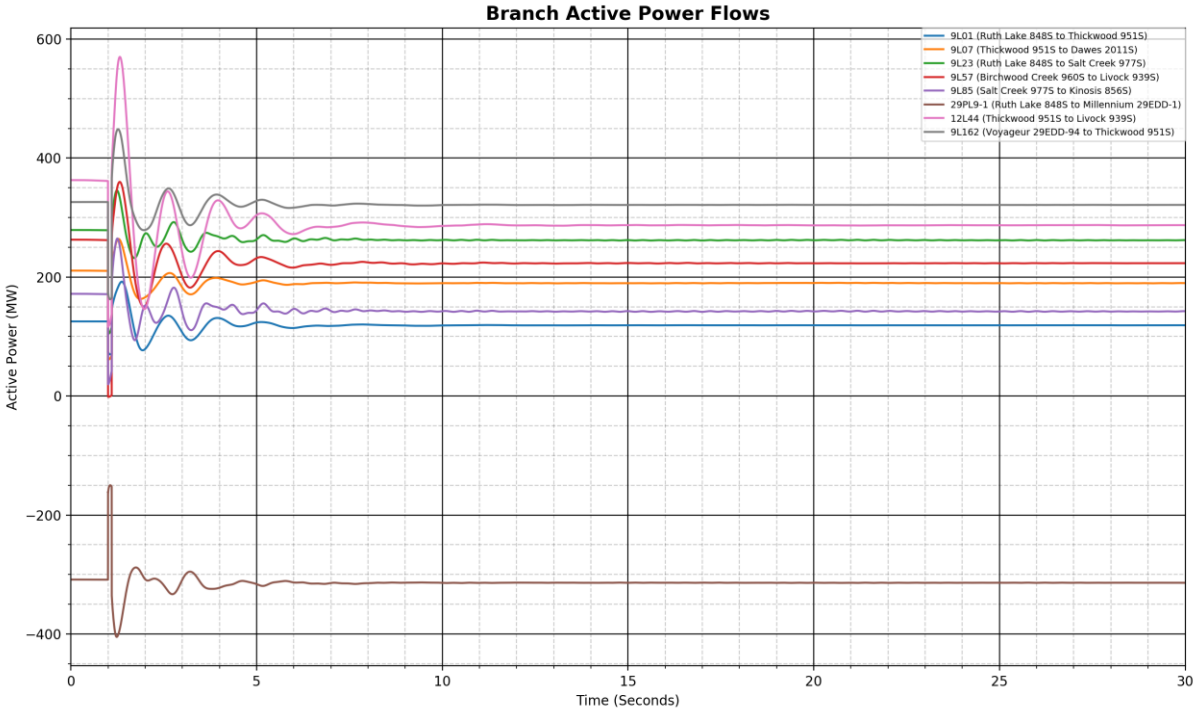

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
0
5
10
15
20
25
30
35


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

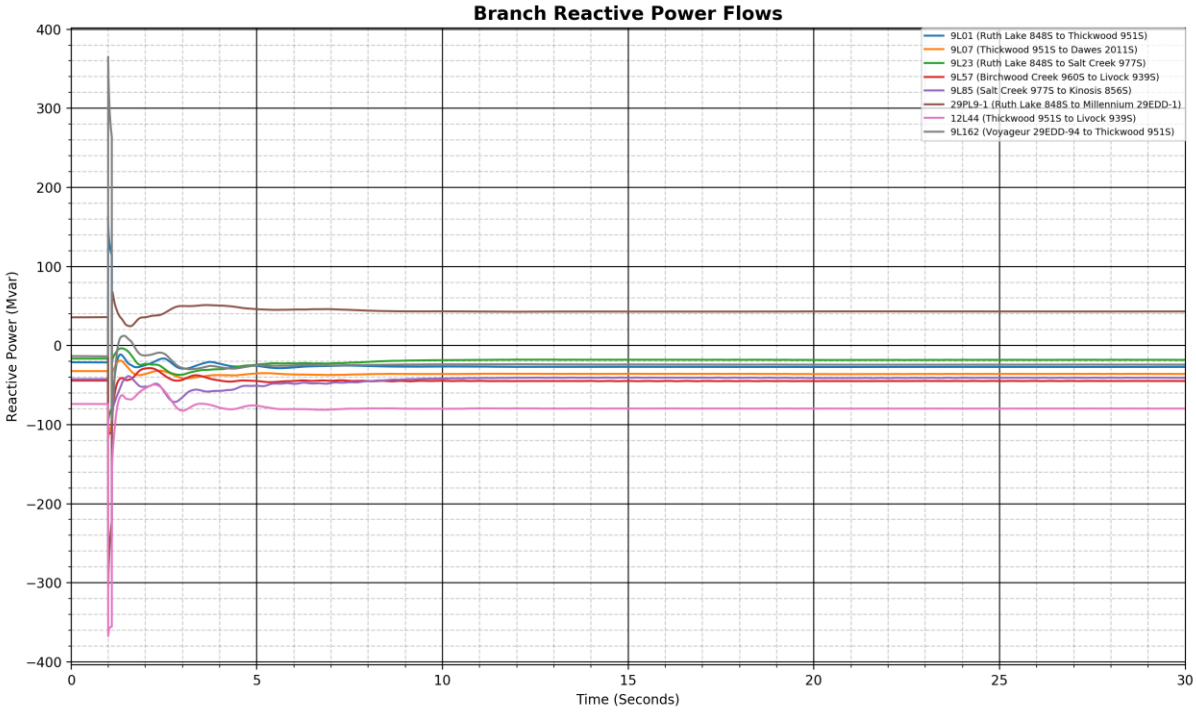
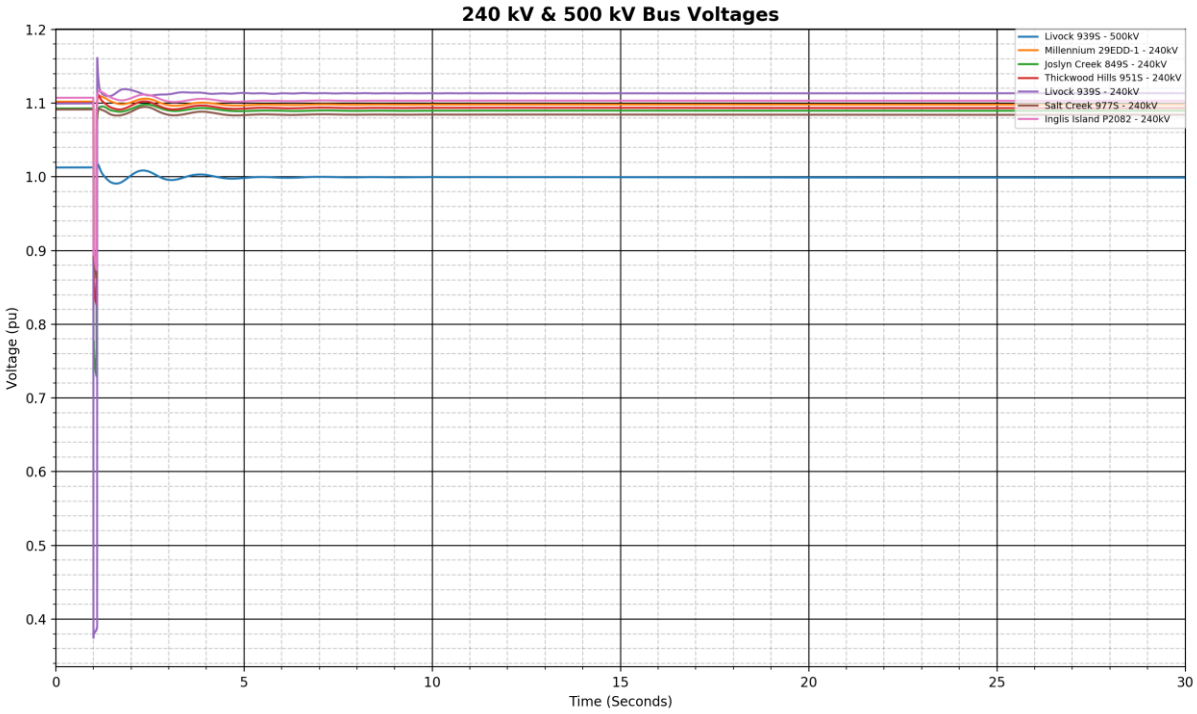
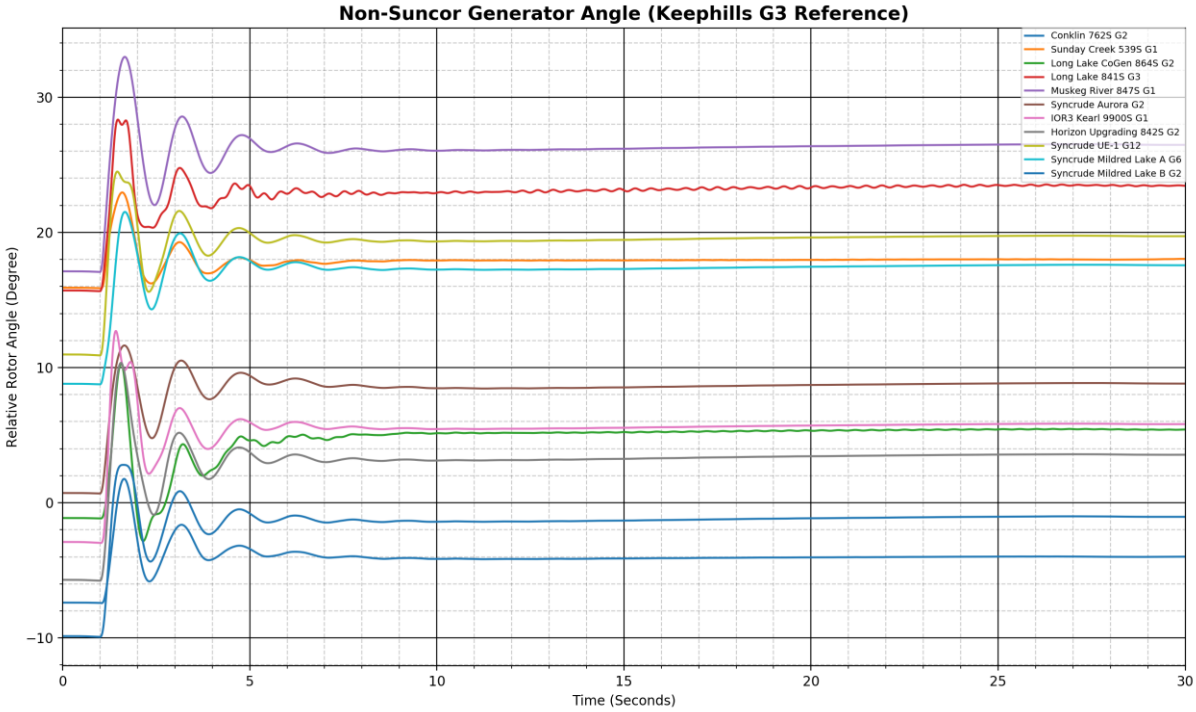
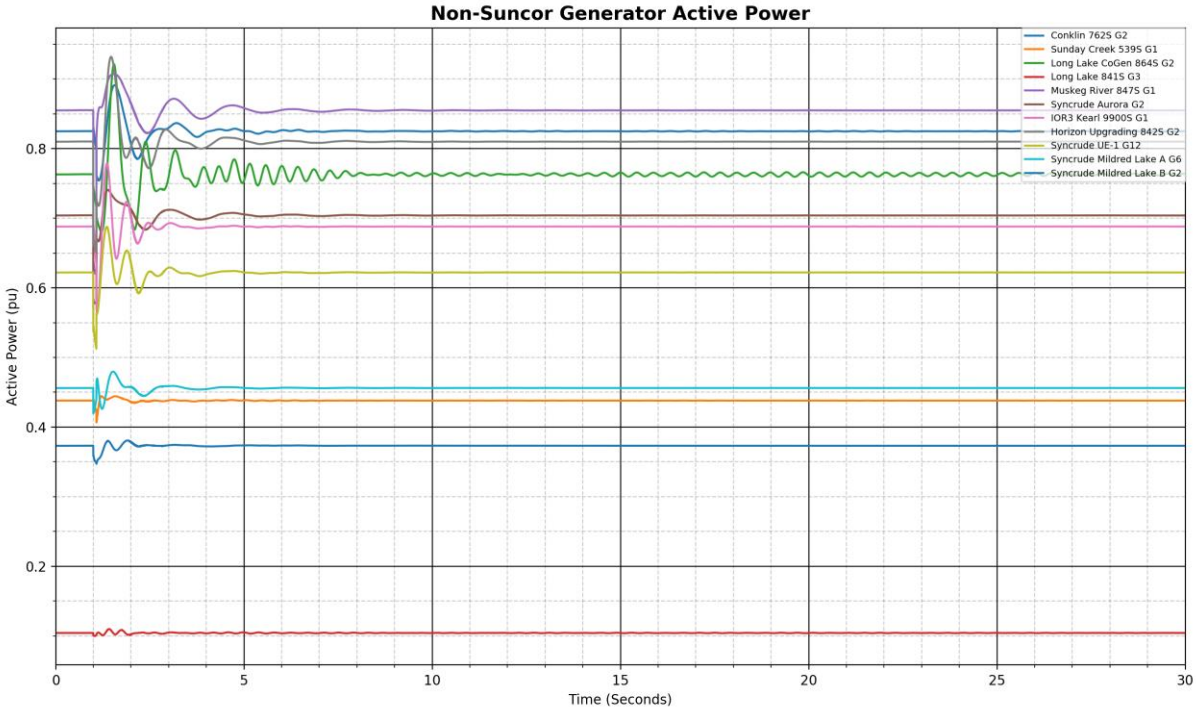
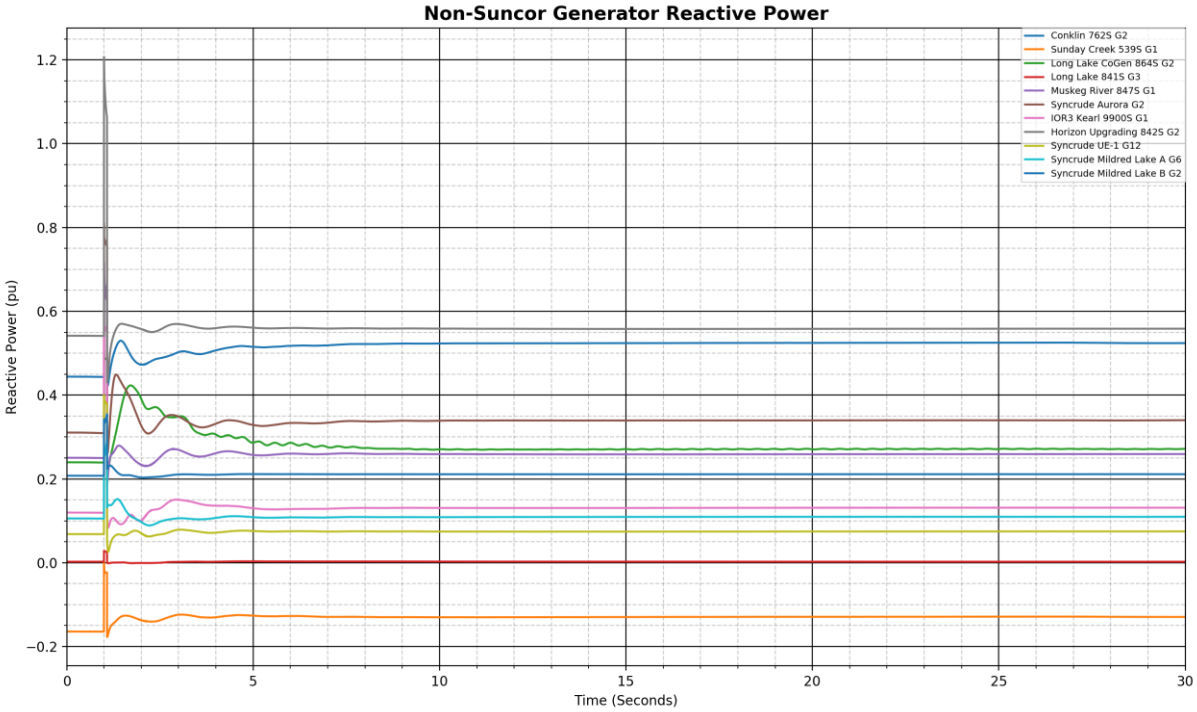

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

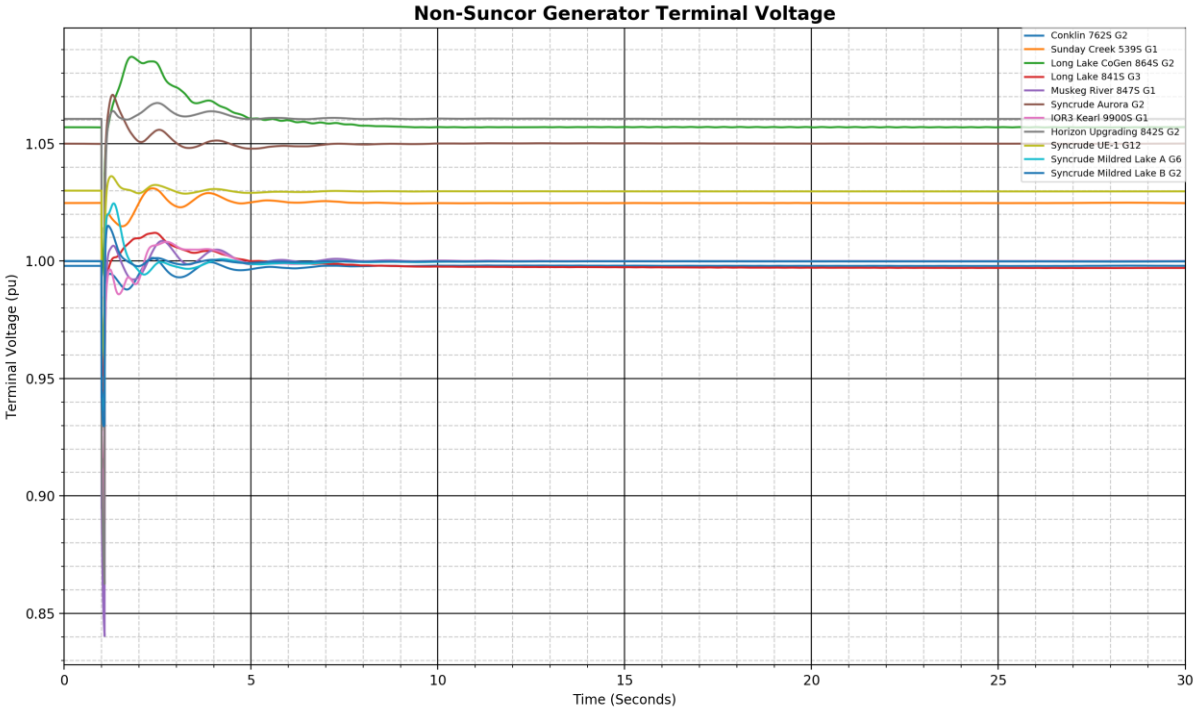
Figure A4-41: 9L57 (9L57 Birchwood Creek 960S to Livock 939S): Fault at Birchwood Creek 960S

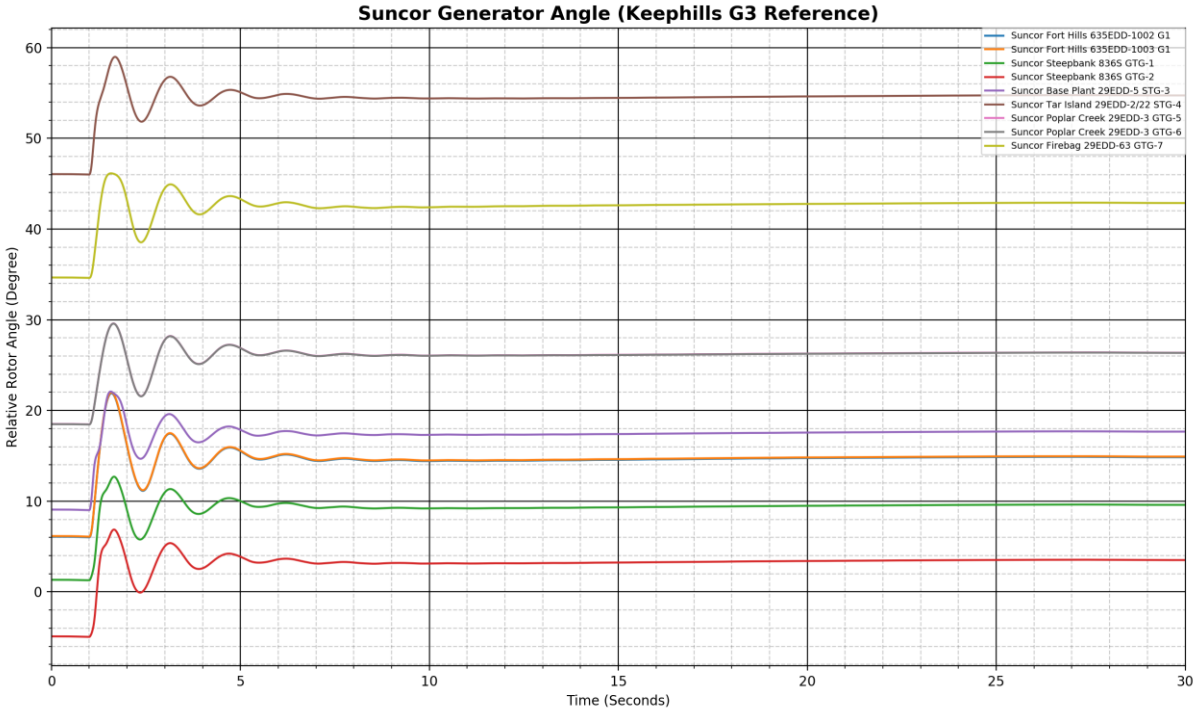


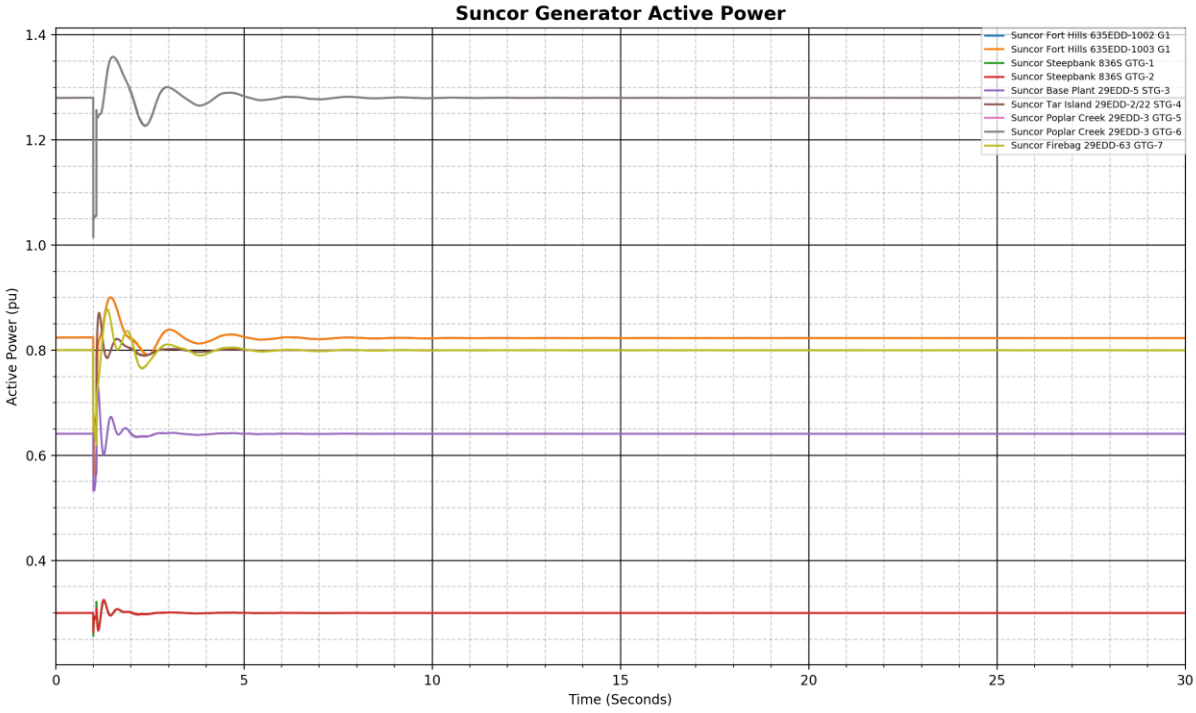

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

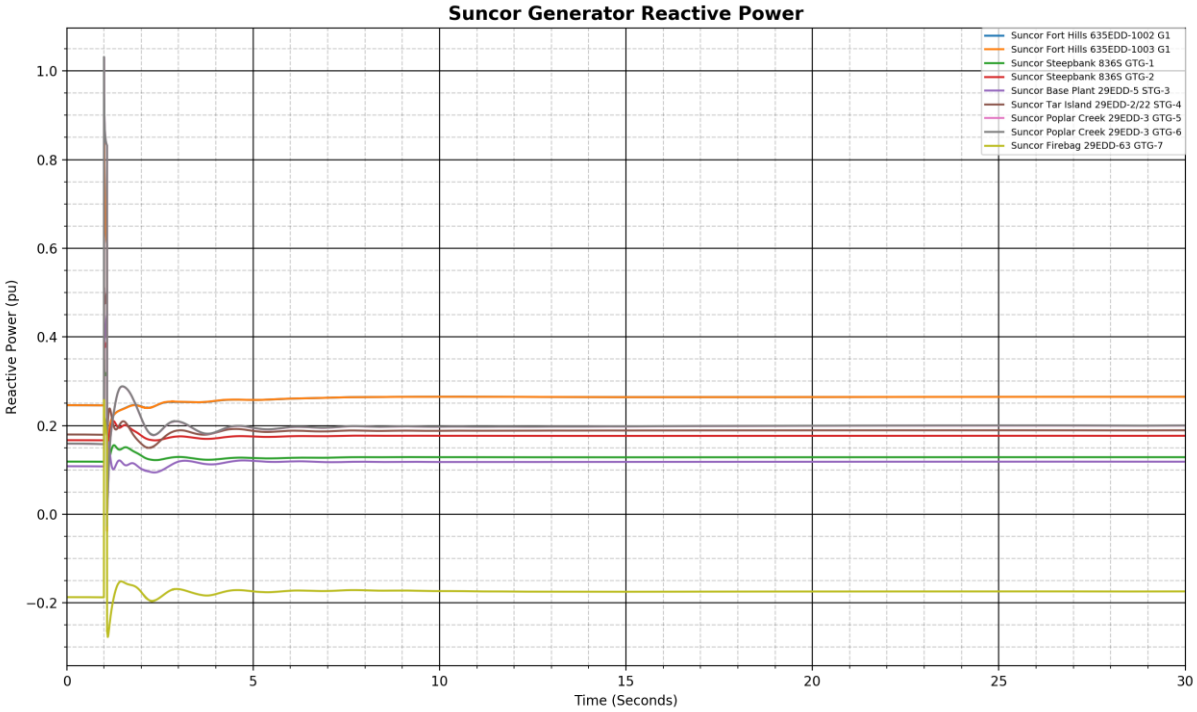

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

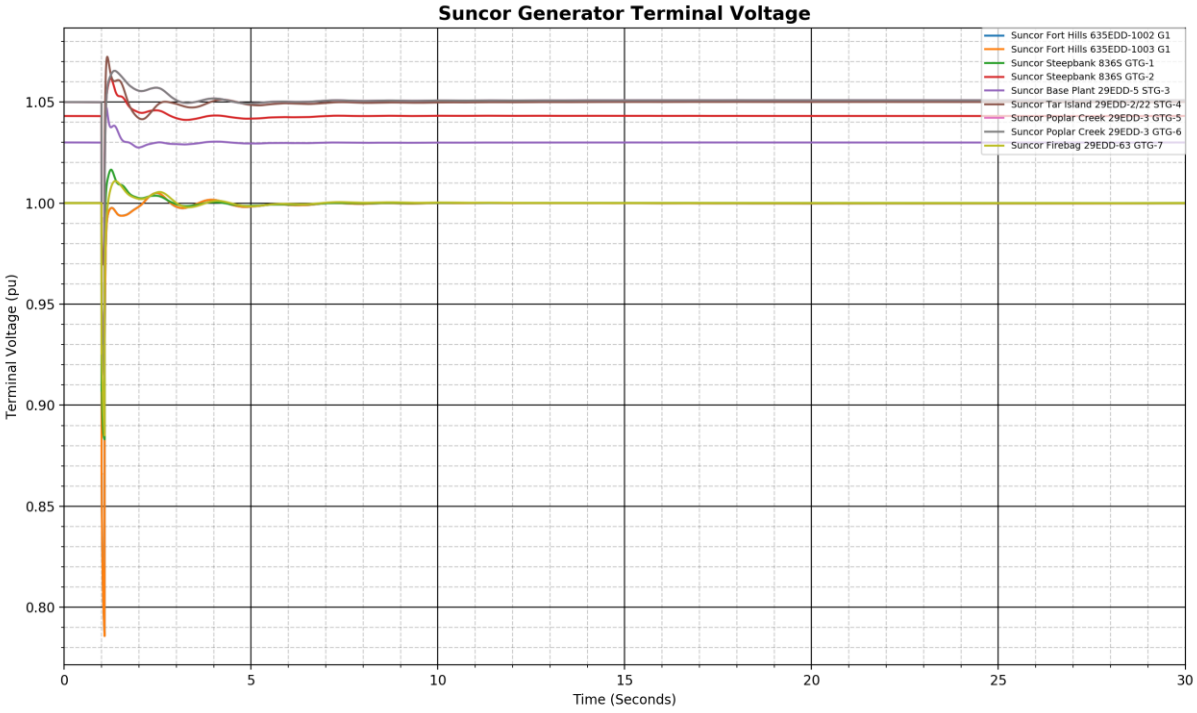

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

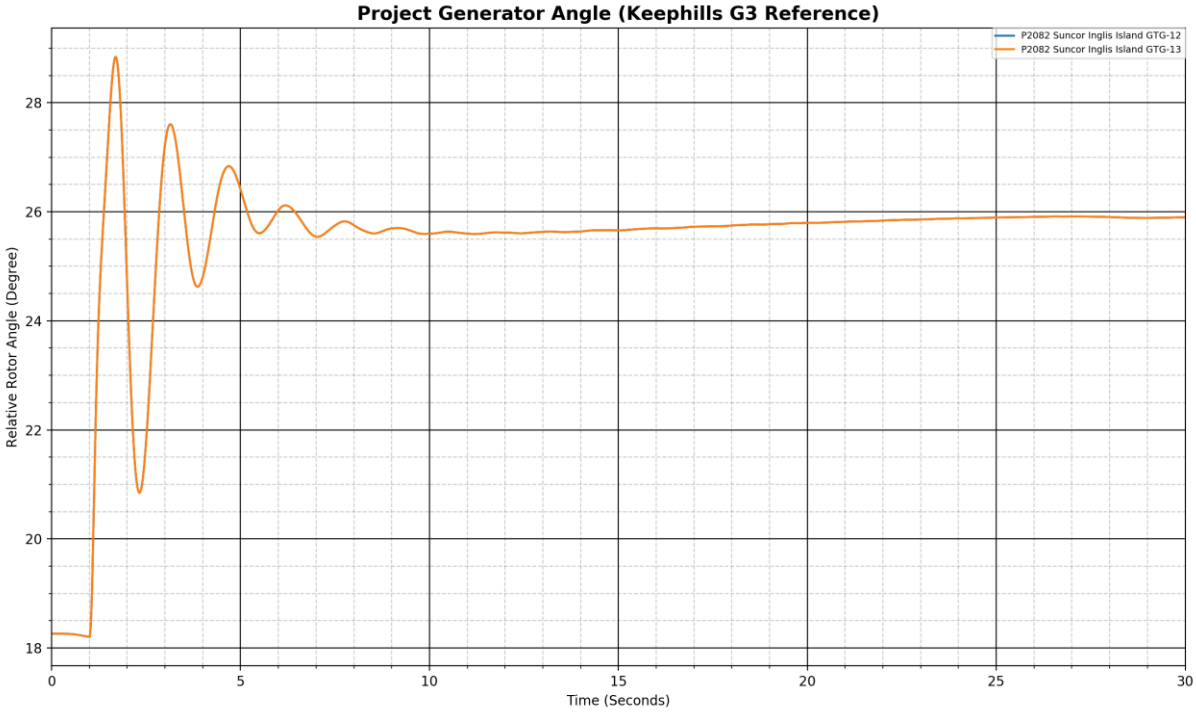

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

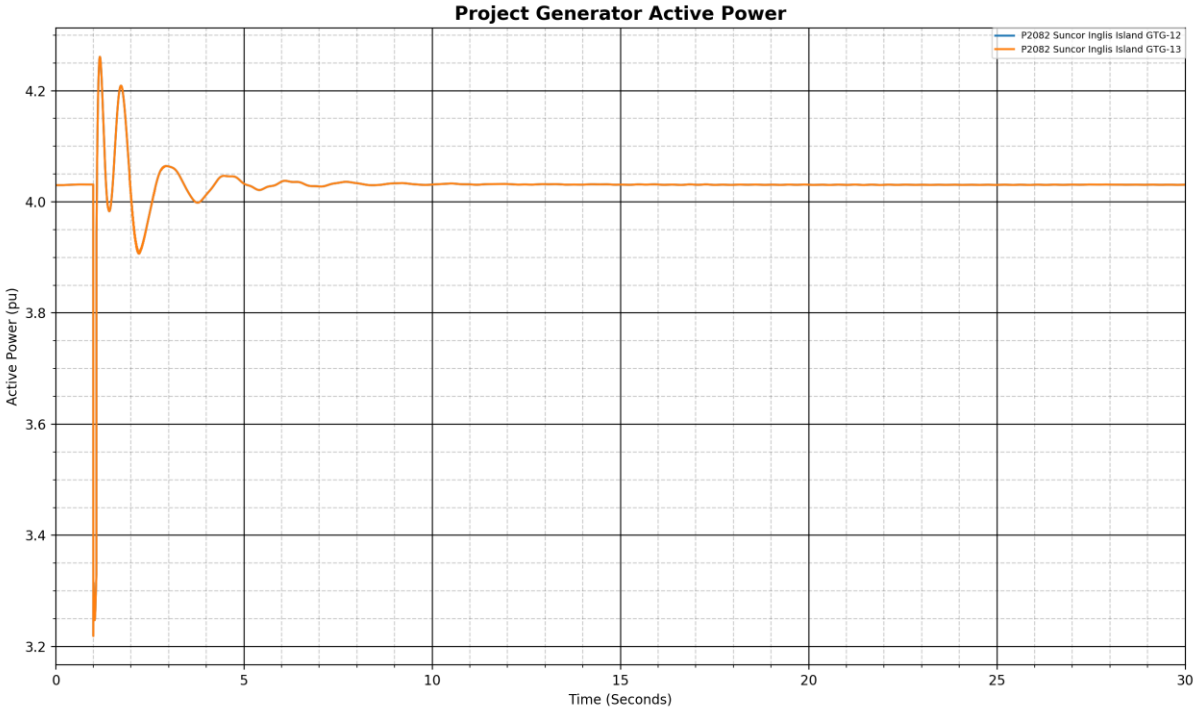

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

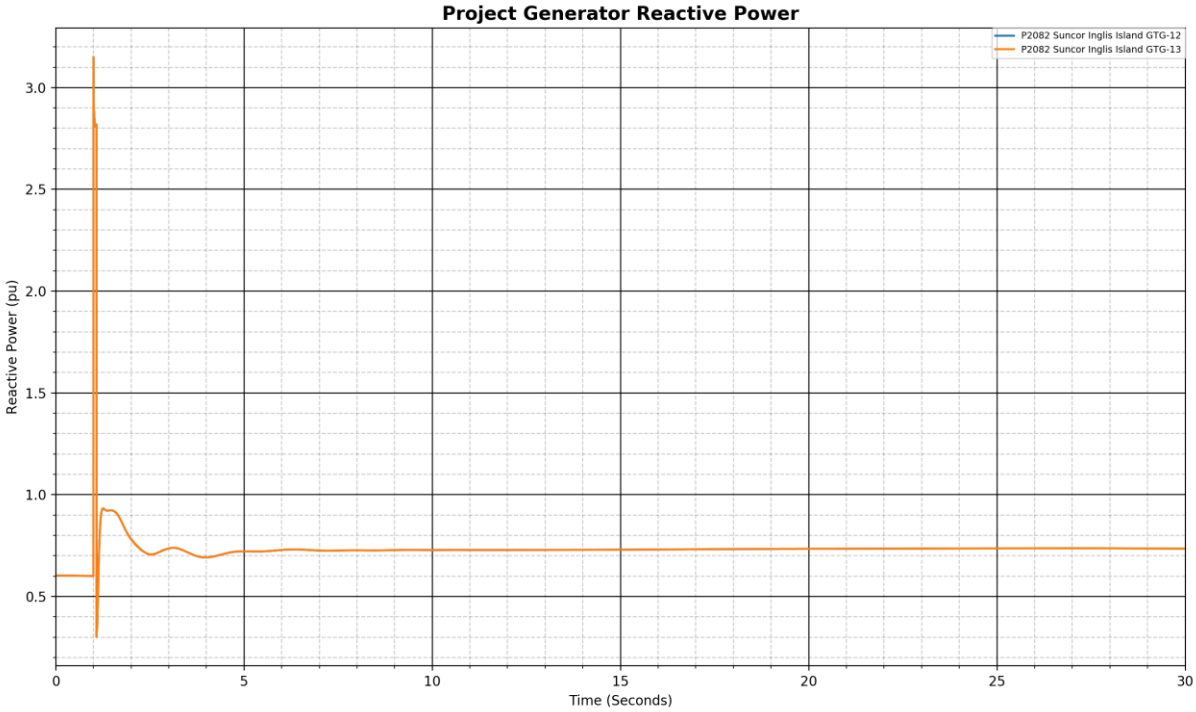

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

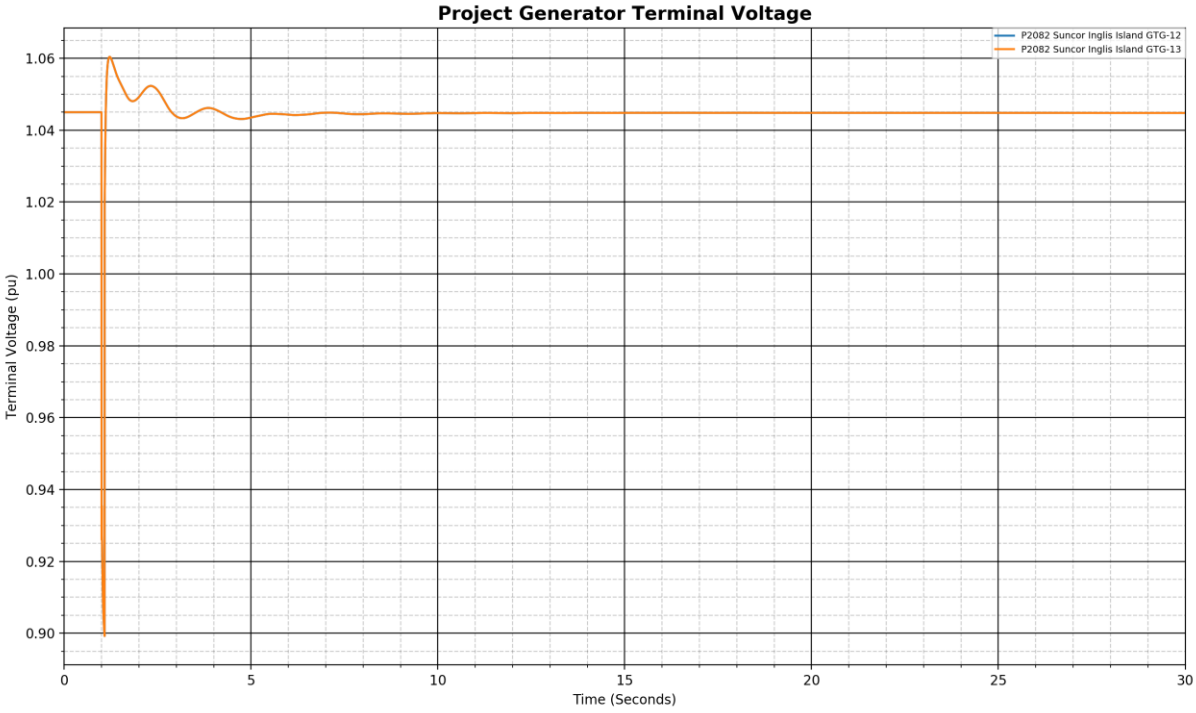

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

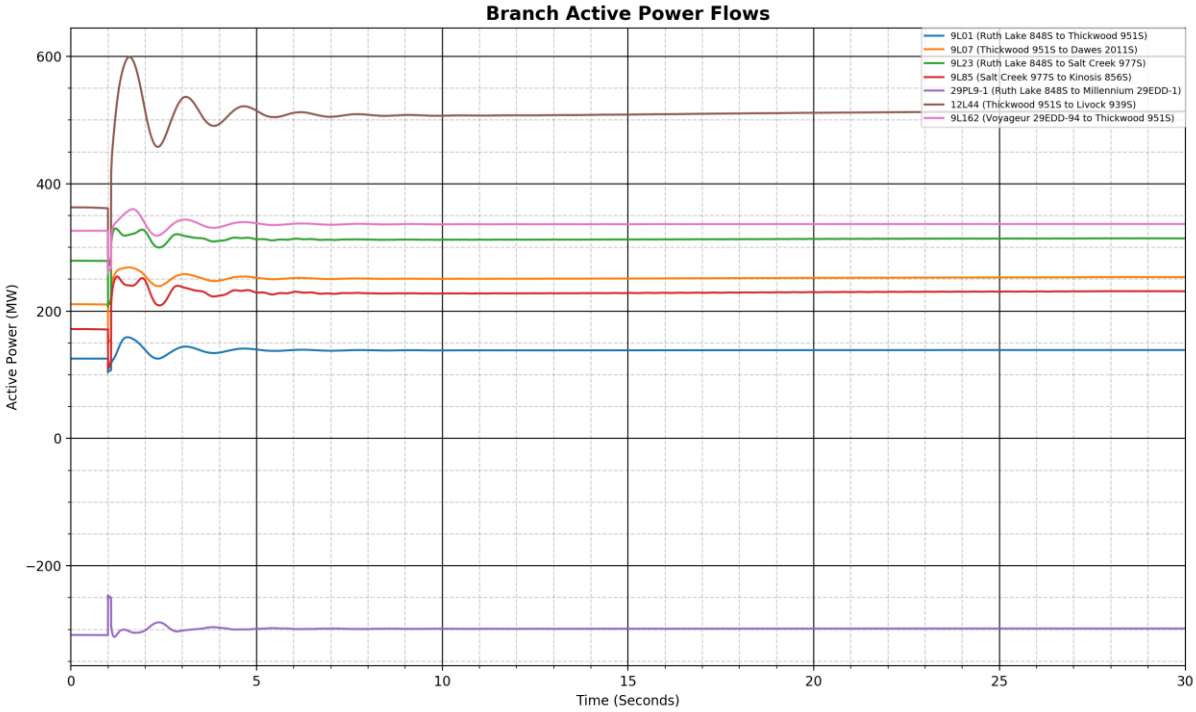

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
18
20
22
24
26
28
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
3.2
3.4
3.6
3.8
4.0
4.2
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

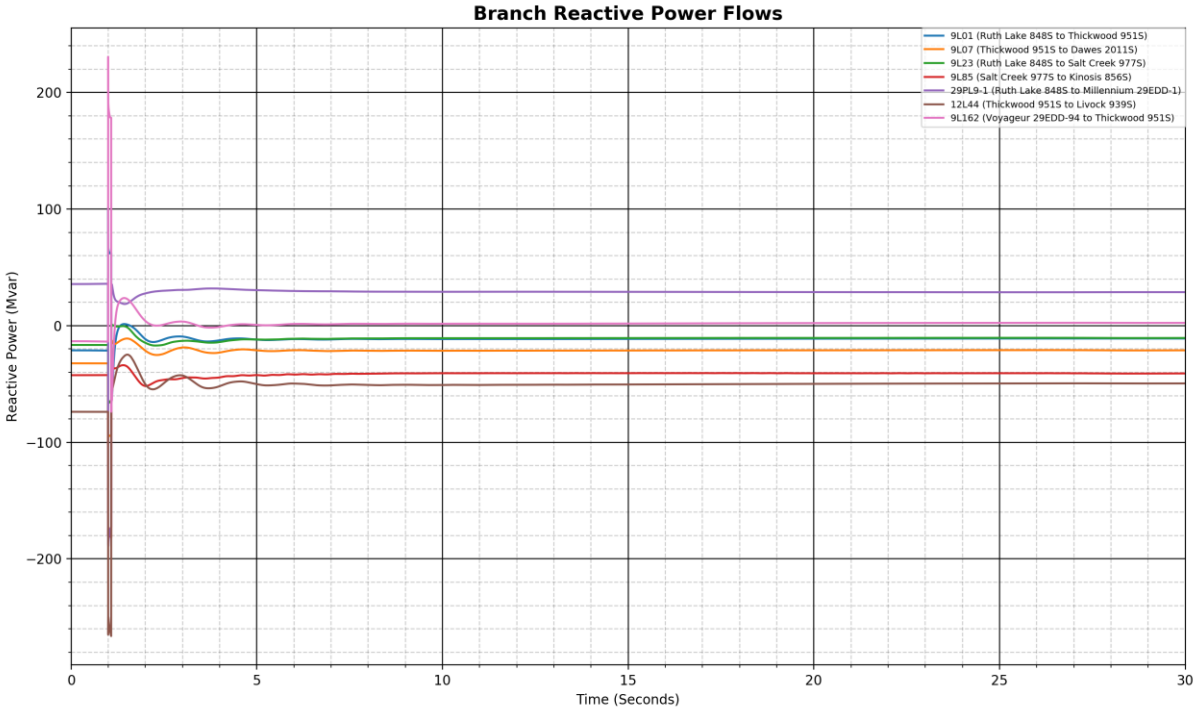
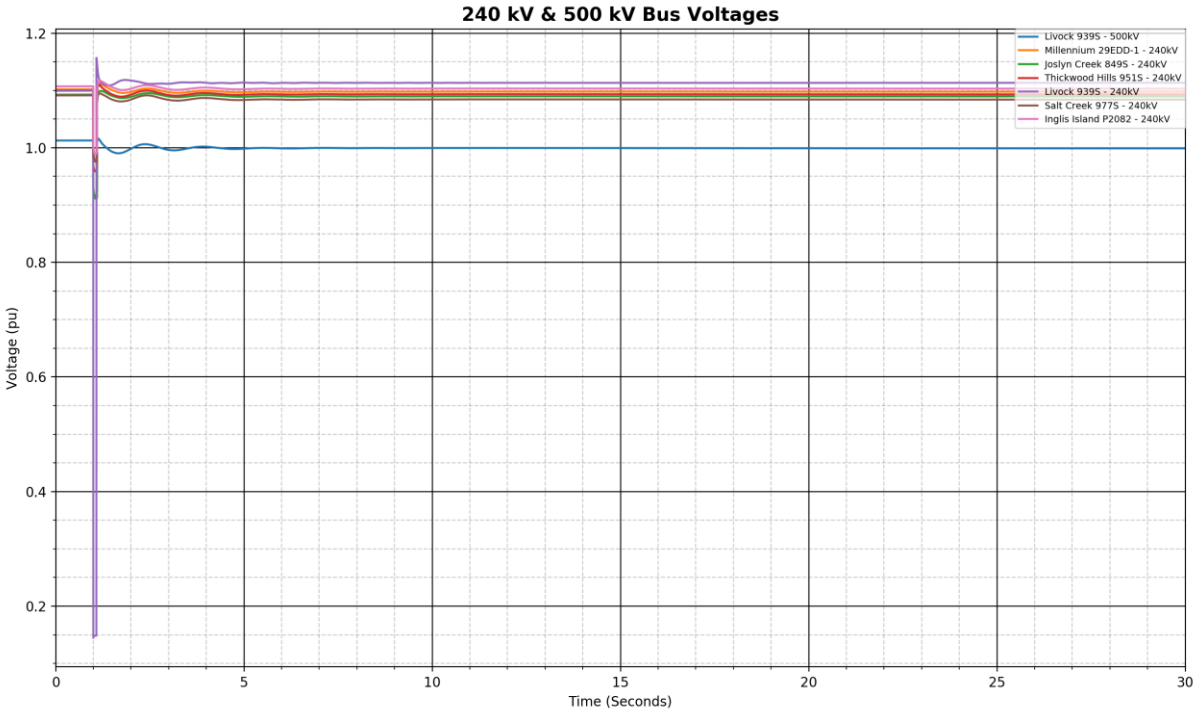
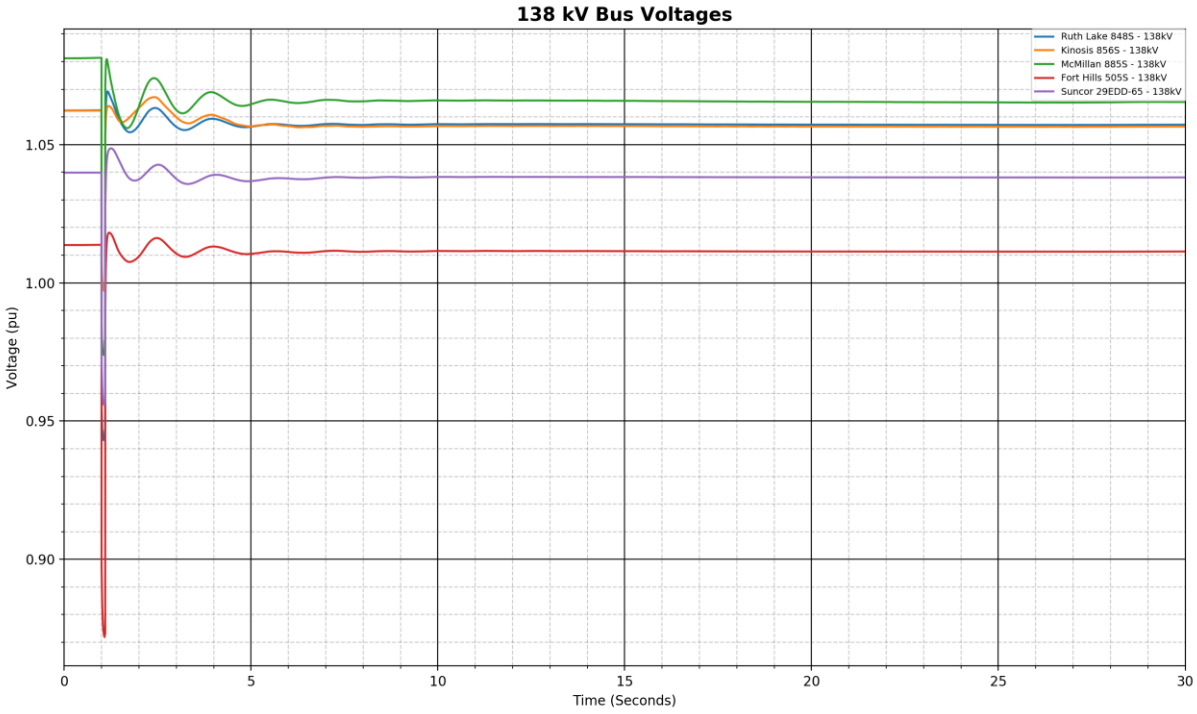
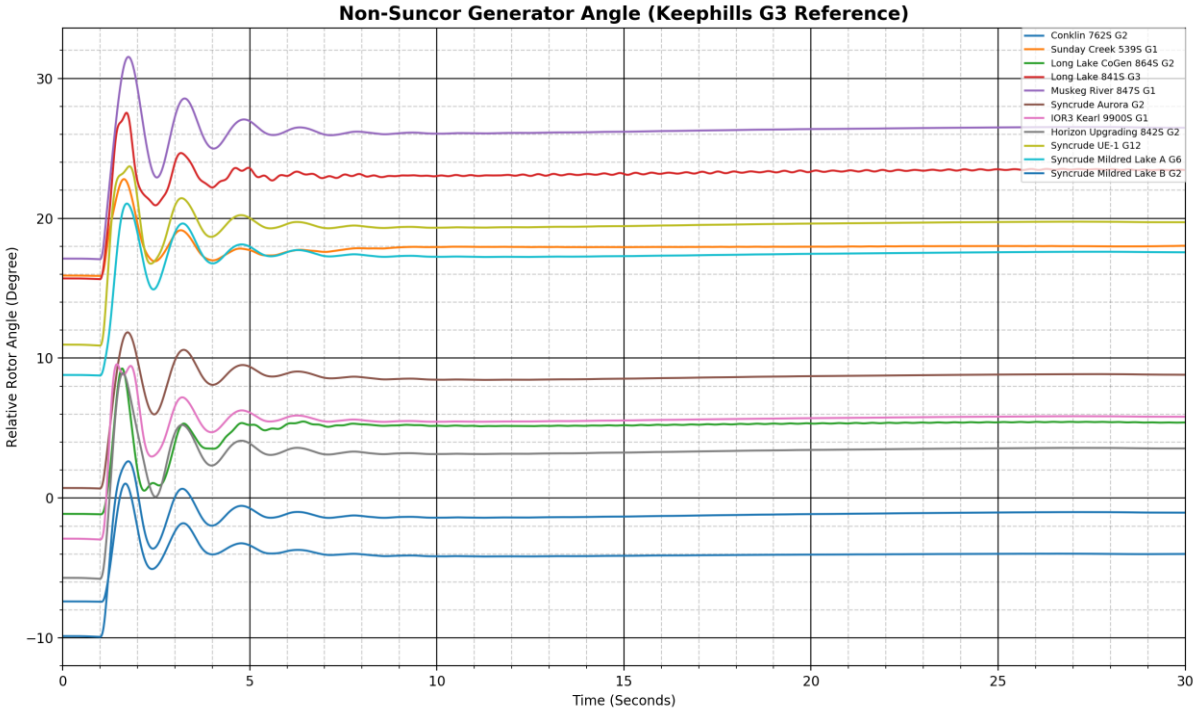
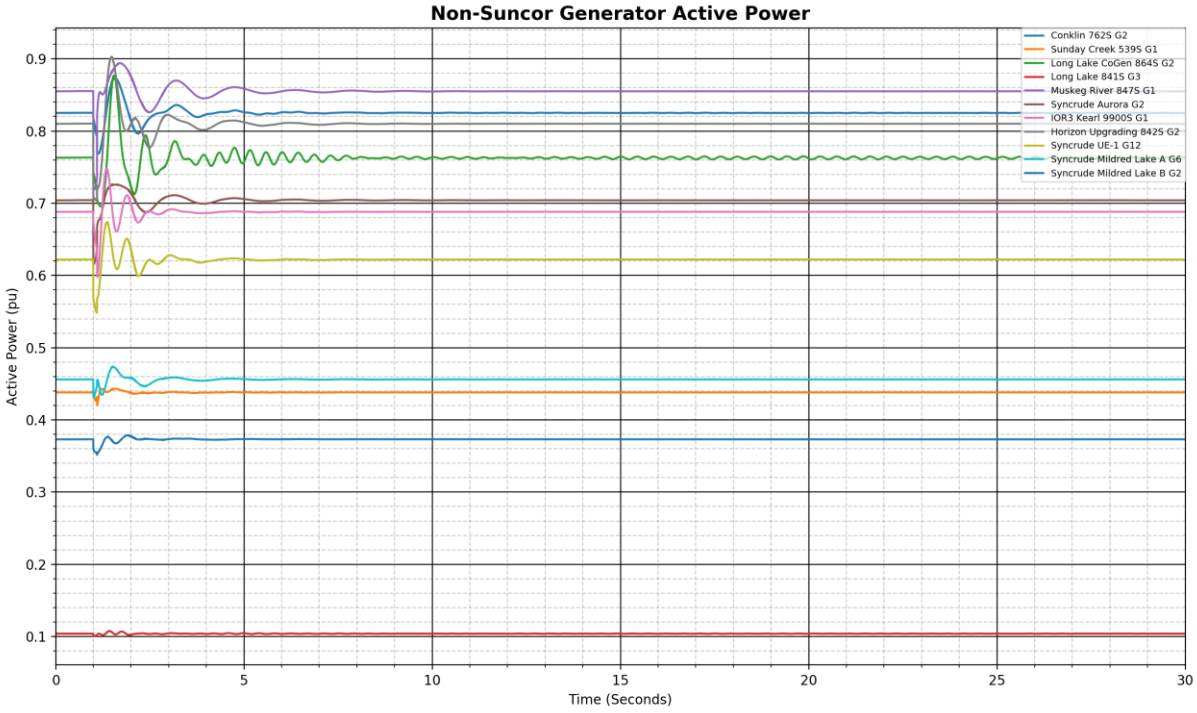

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
200
100
0
−100
−200
0
5
10
15
20
25
30
Time (Seconds)

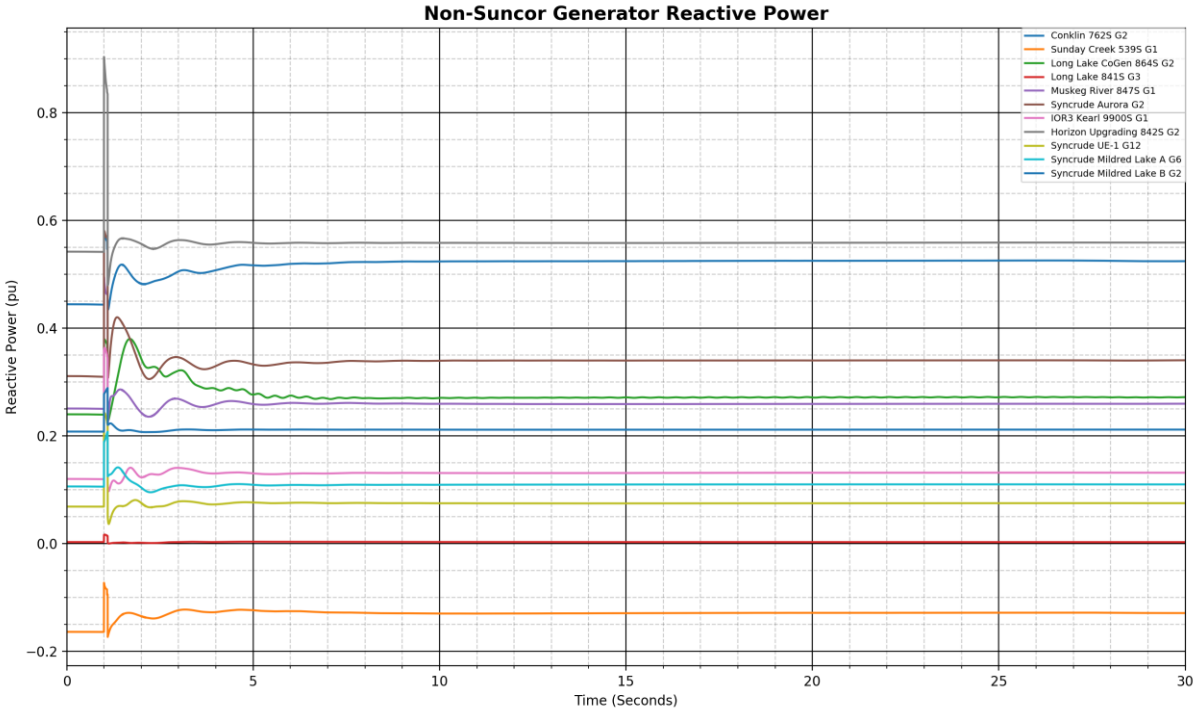
Figure A4-42: 9L57 (9L57 Birchwood Creek 960S to Livock 939S): Fault at Livock 939S

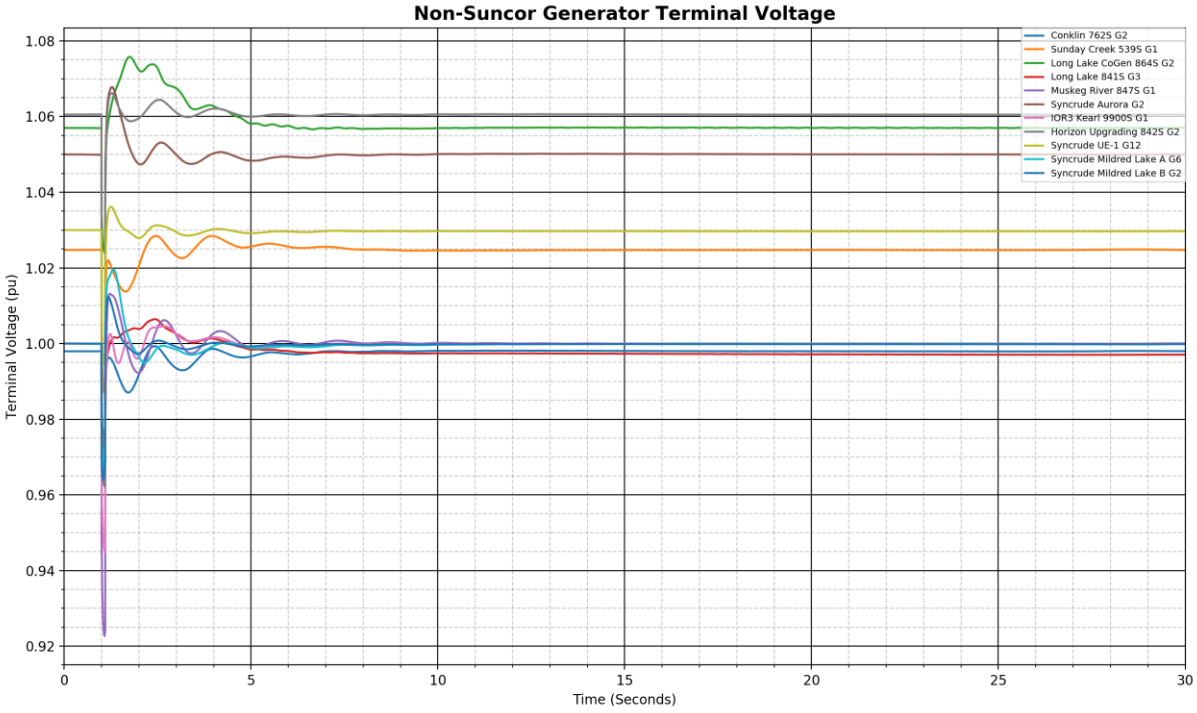


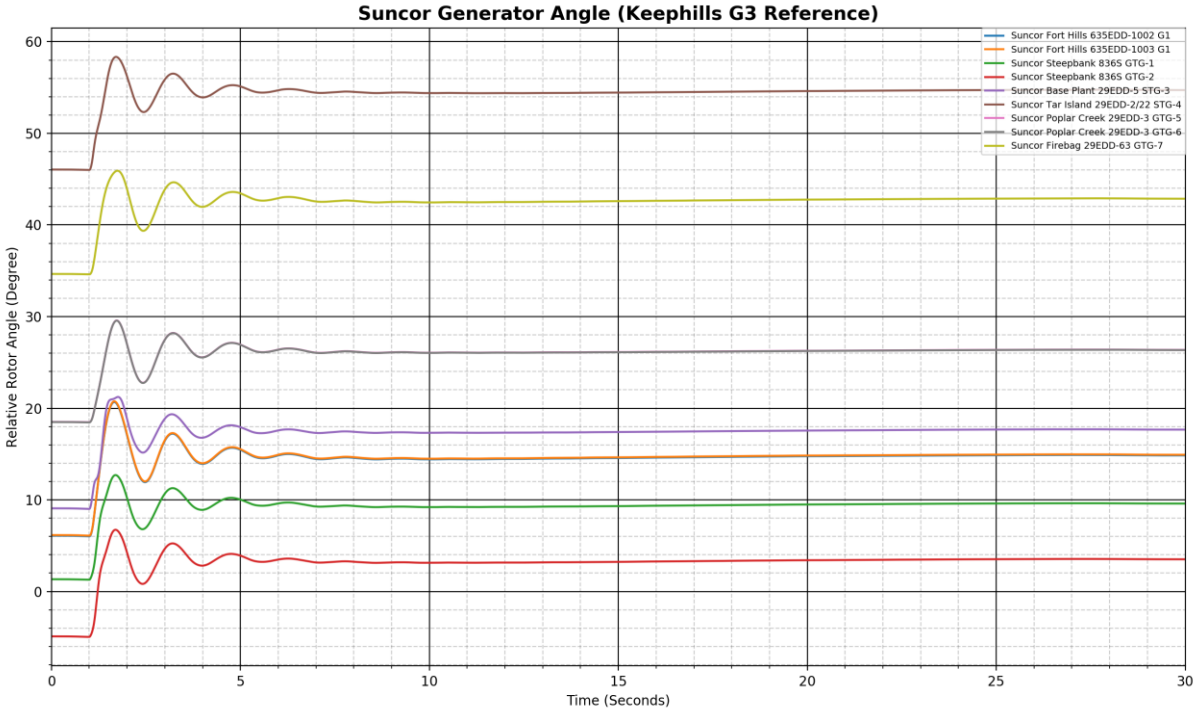


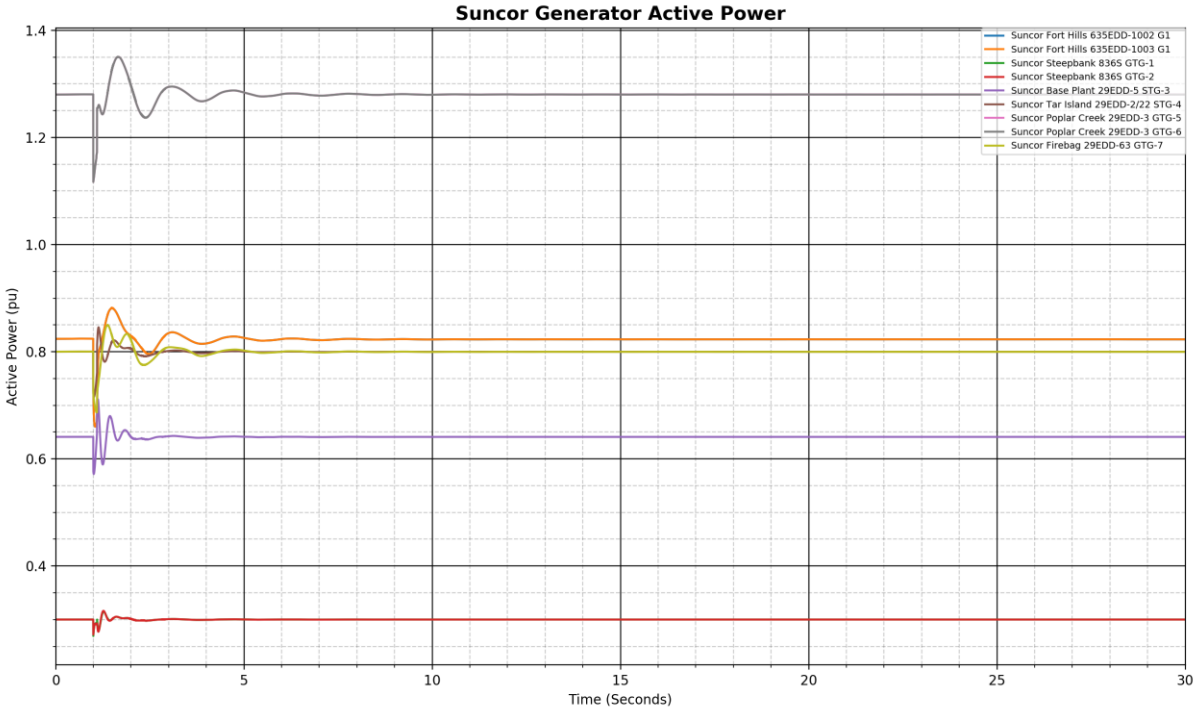

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

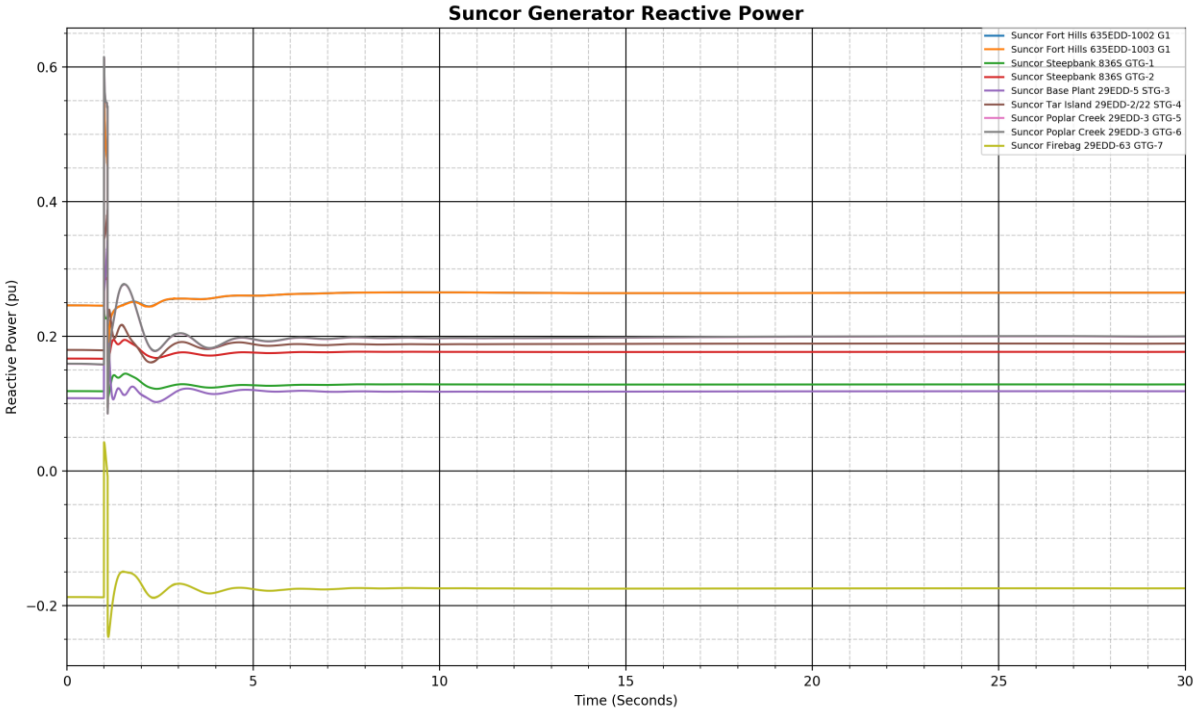

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

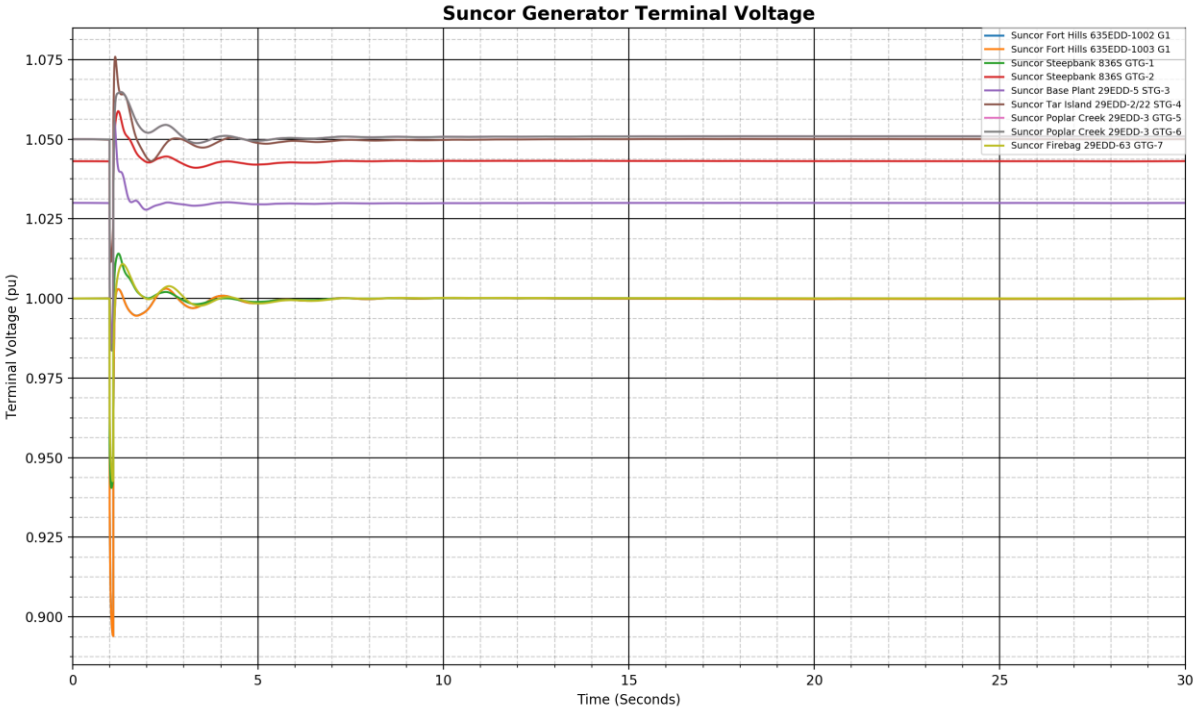

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

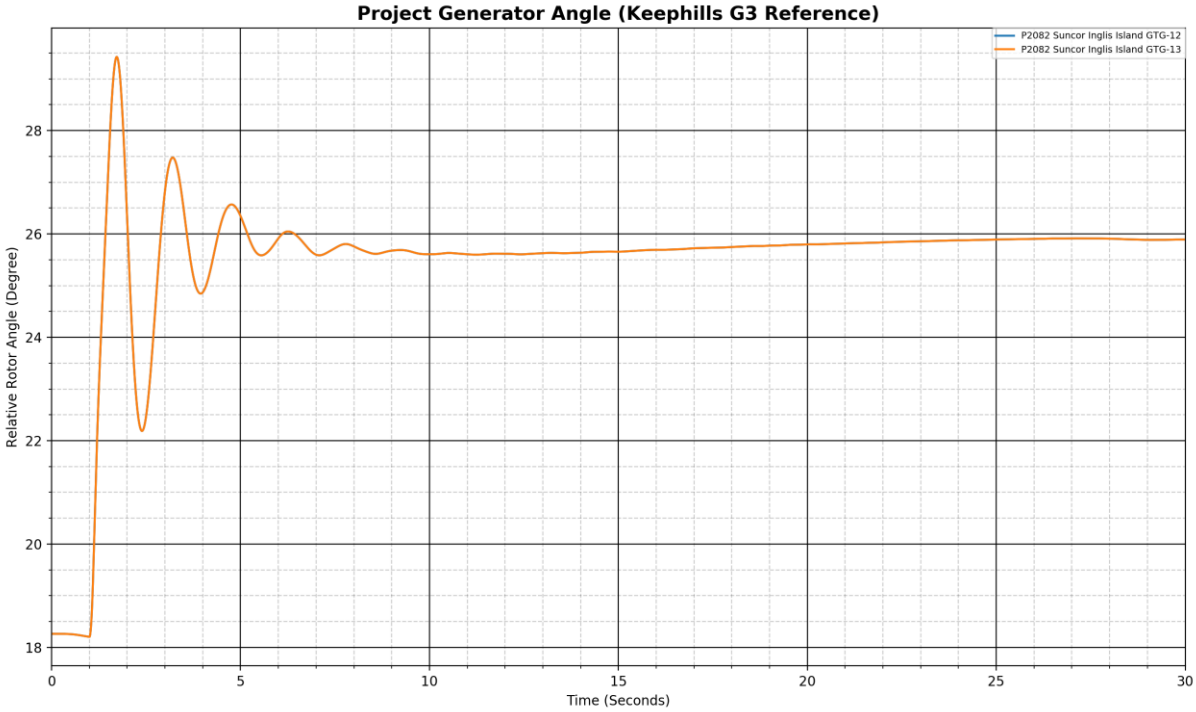

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

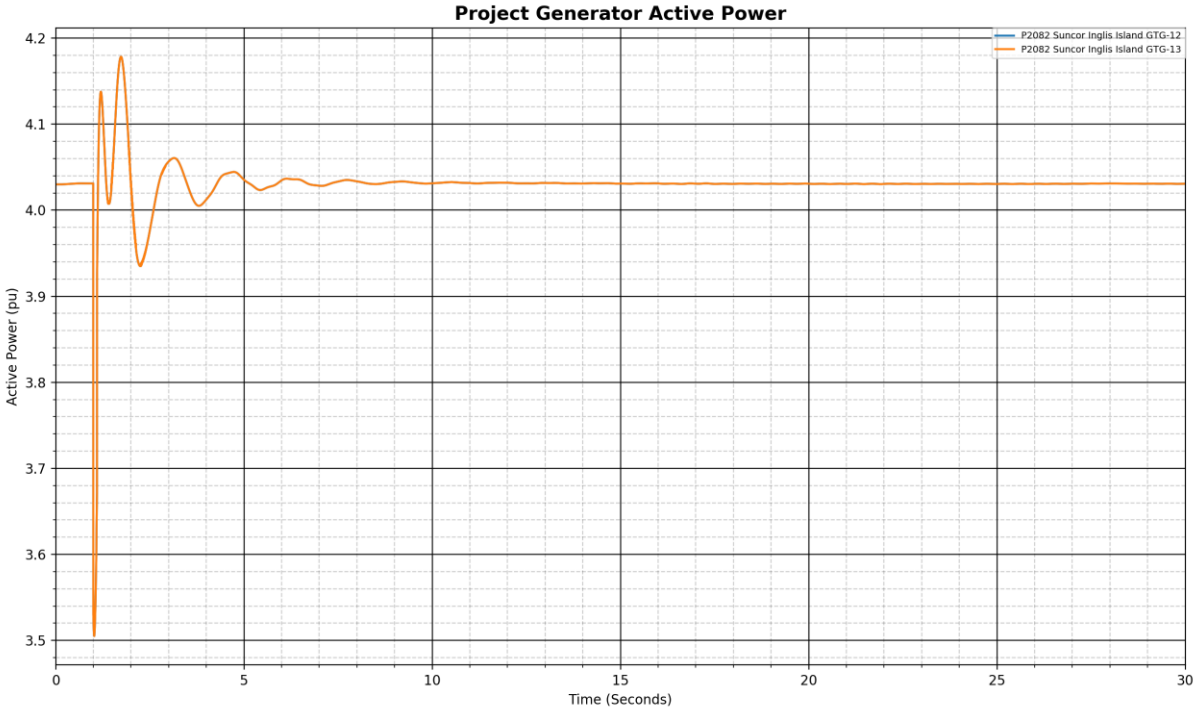

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

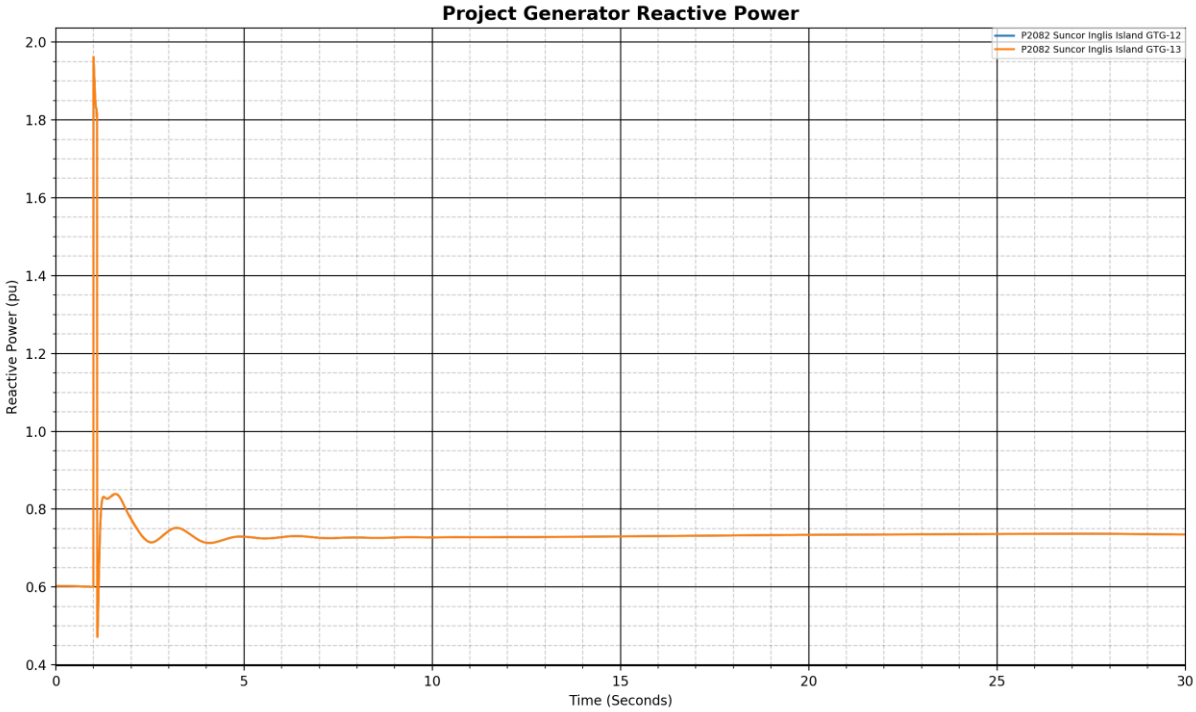

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

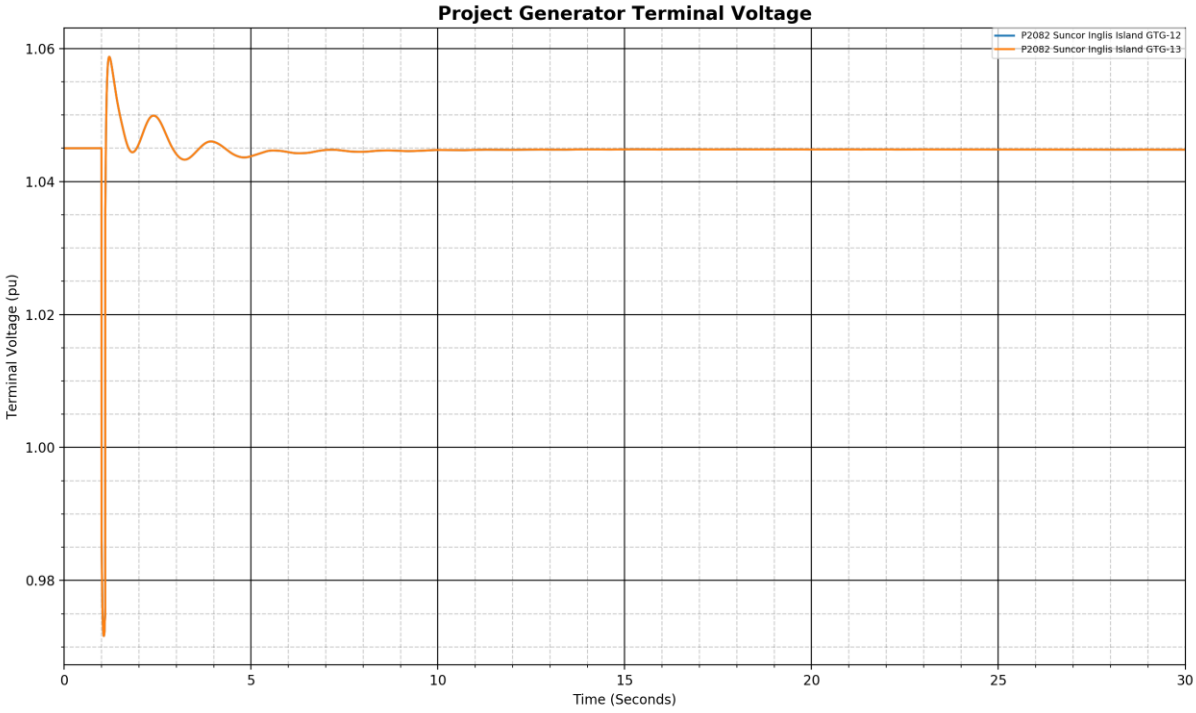

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

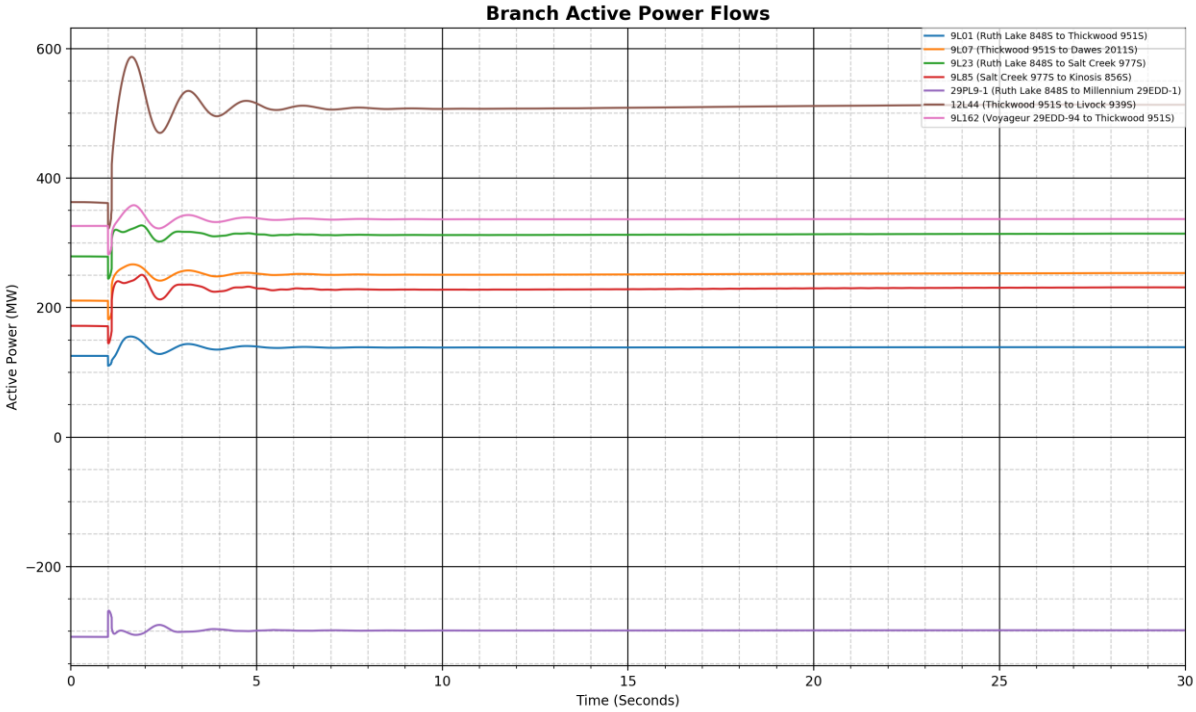

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
28
26
24
22
20
18
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.2
4.1
4.0
3.9
3.8
3.7
3.6
3.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

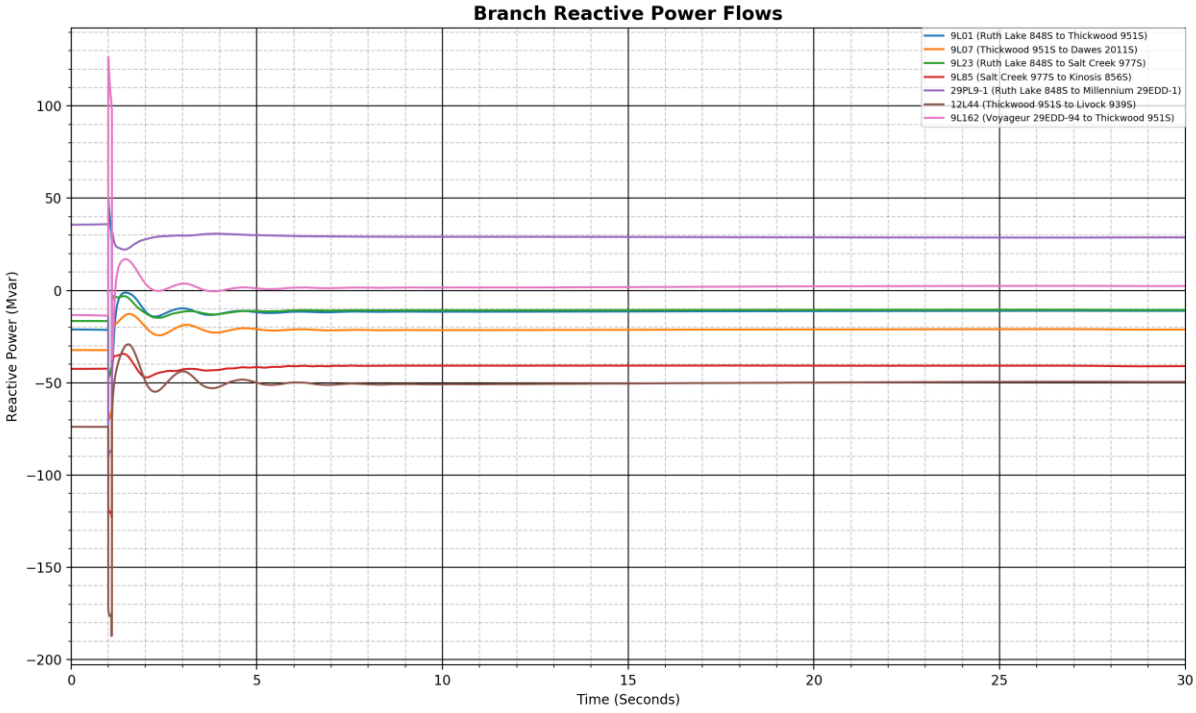
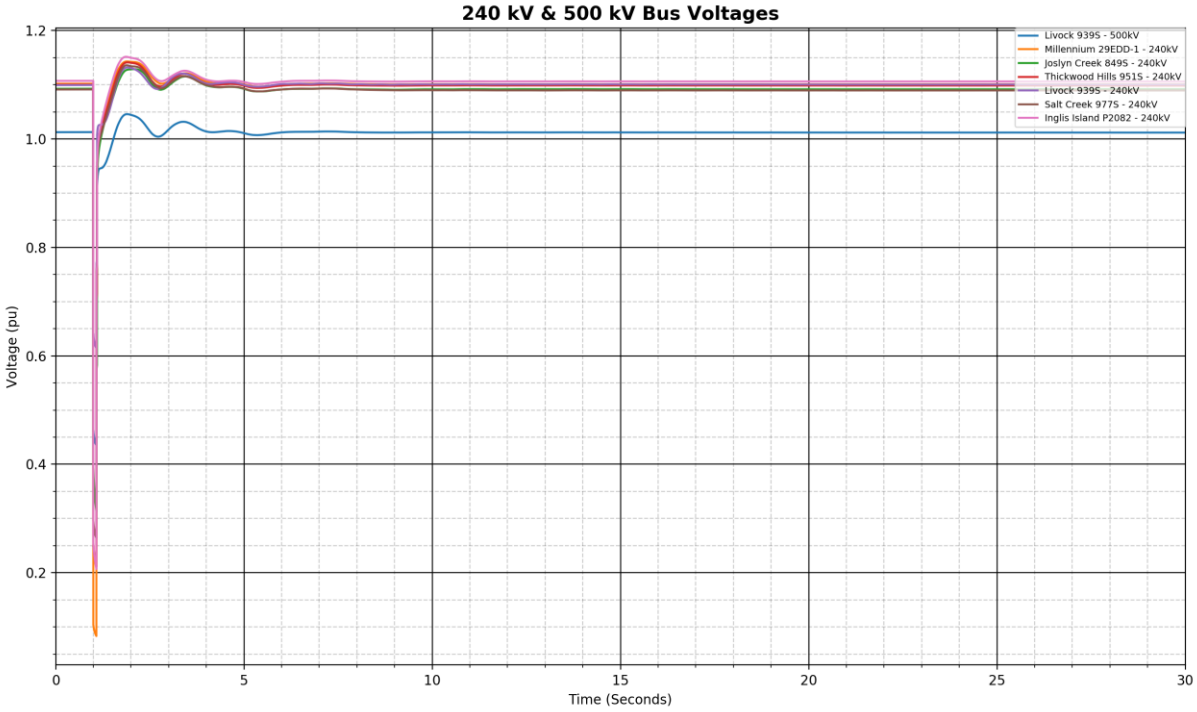
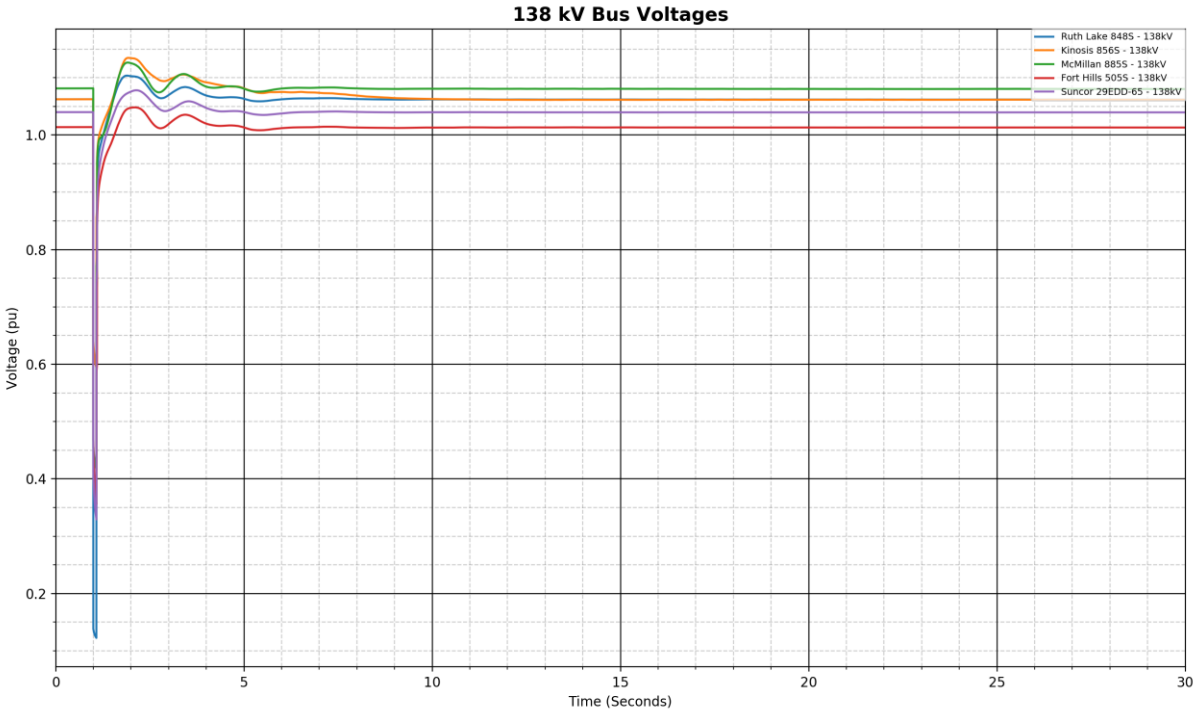
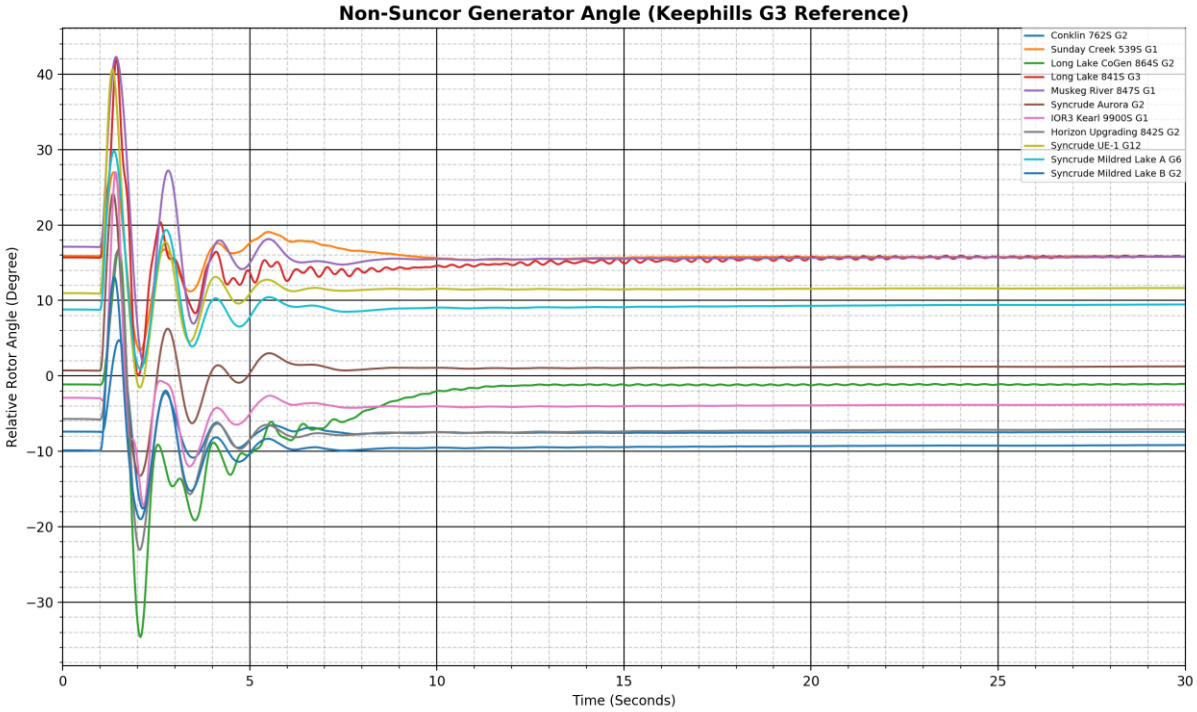
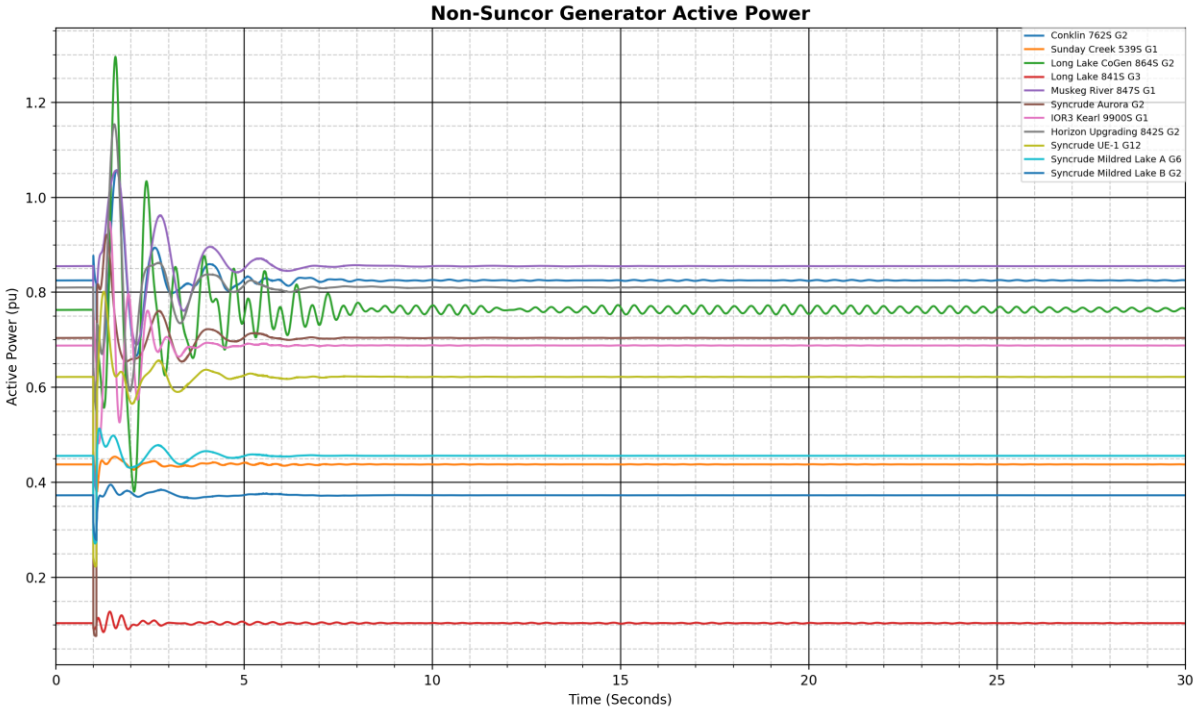

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
100
50
0
−50
−100
−150
−200
0
5
10
15
20
25
30
Time (Seconds)

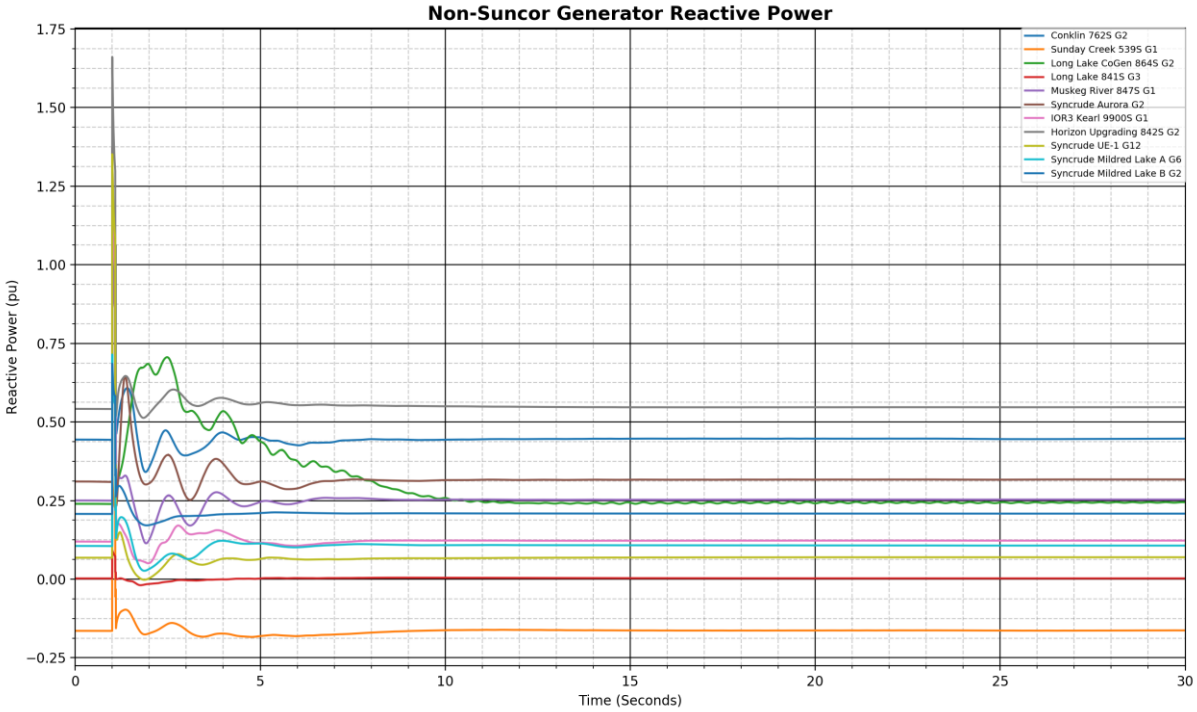
Figure A4-43: 9L58 (Ruth Lake 848S to Dover 888S): Fault at Ruth Lake 848S

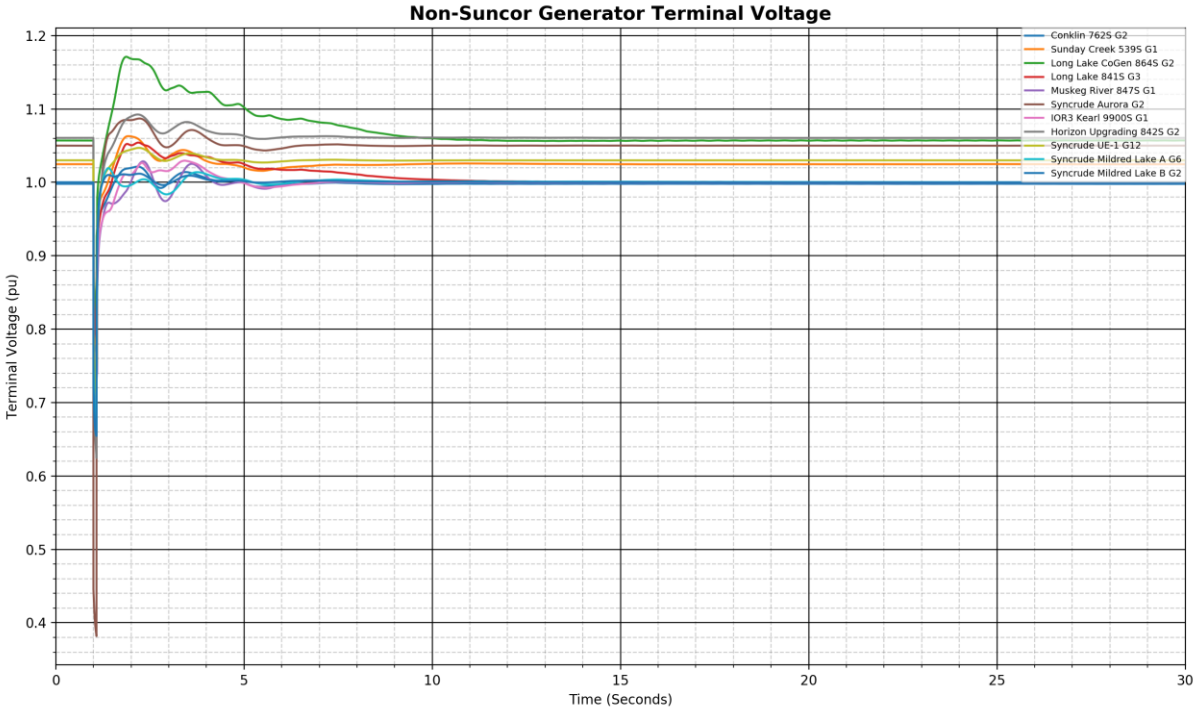


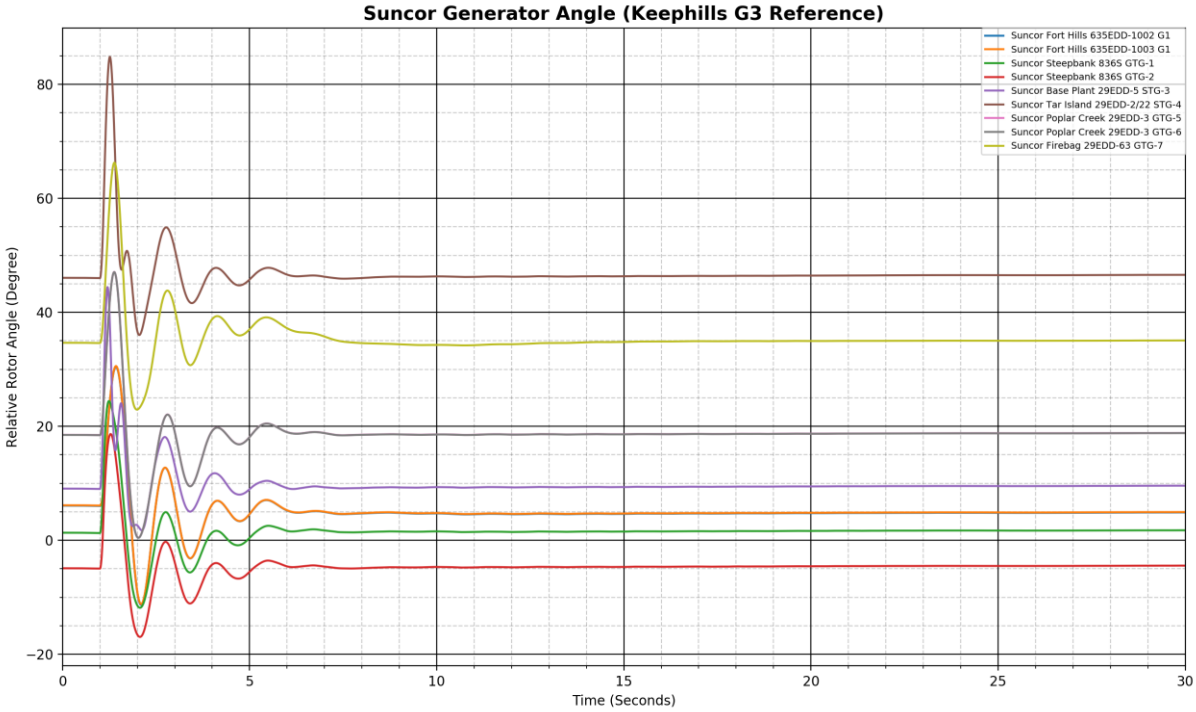


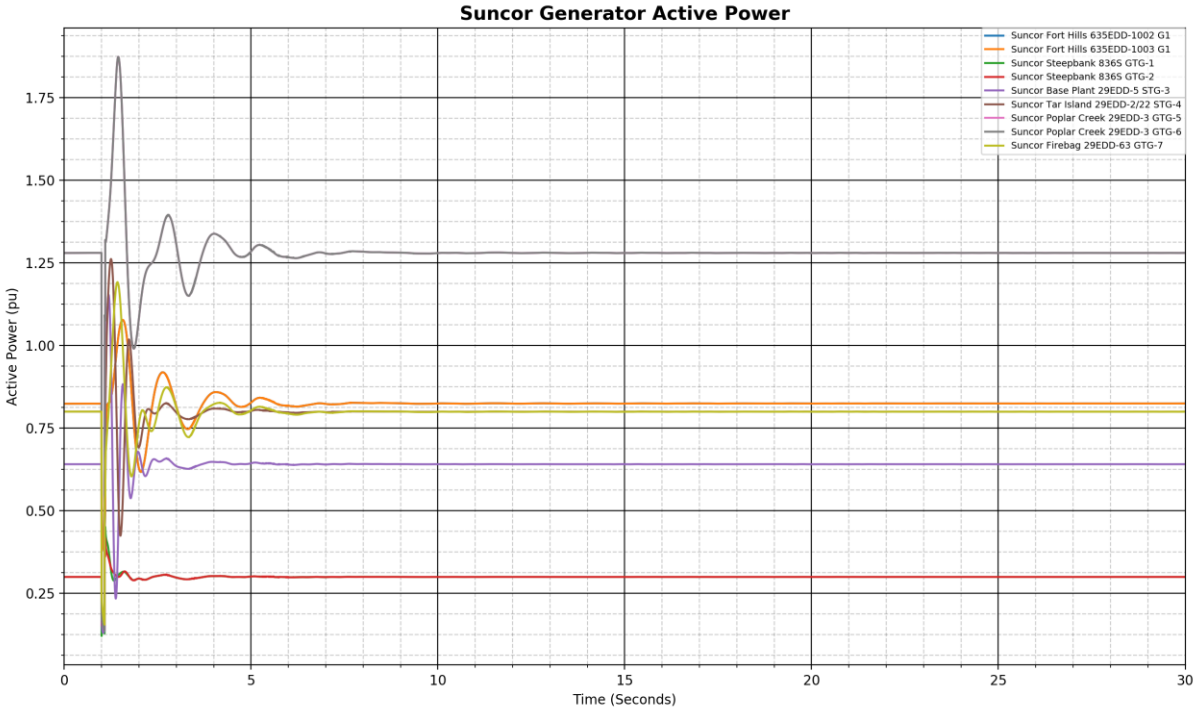

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

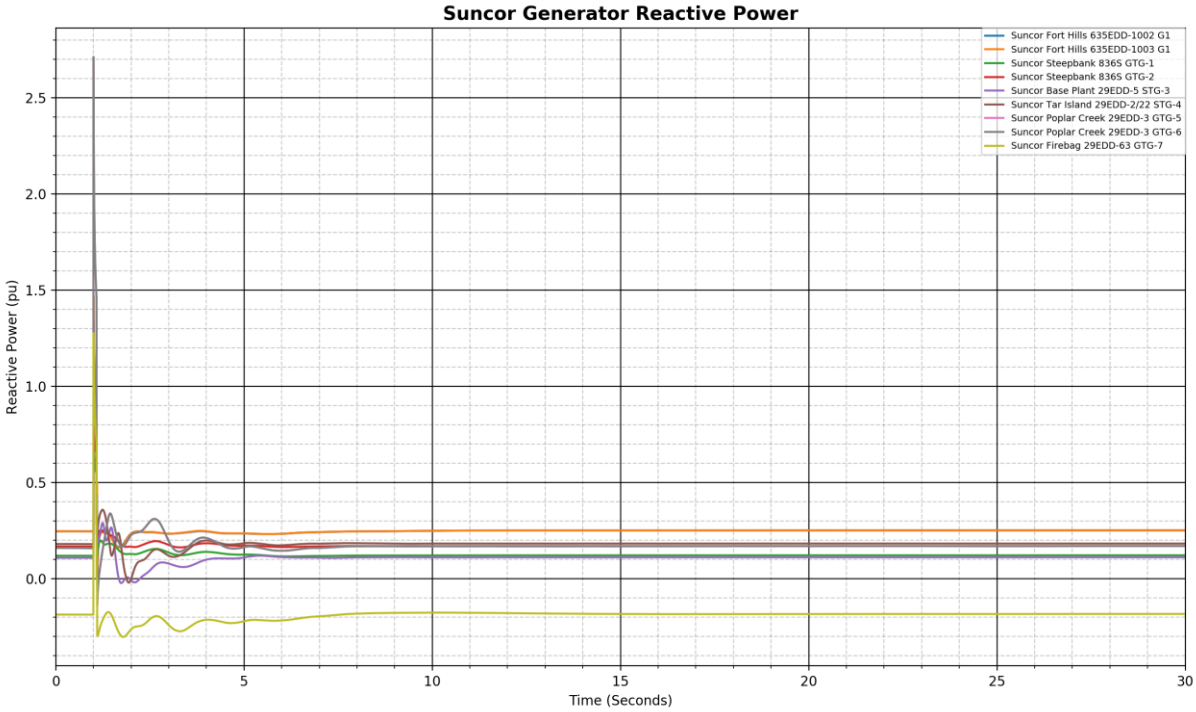

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

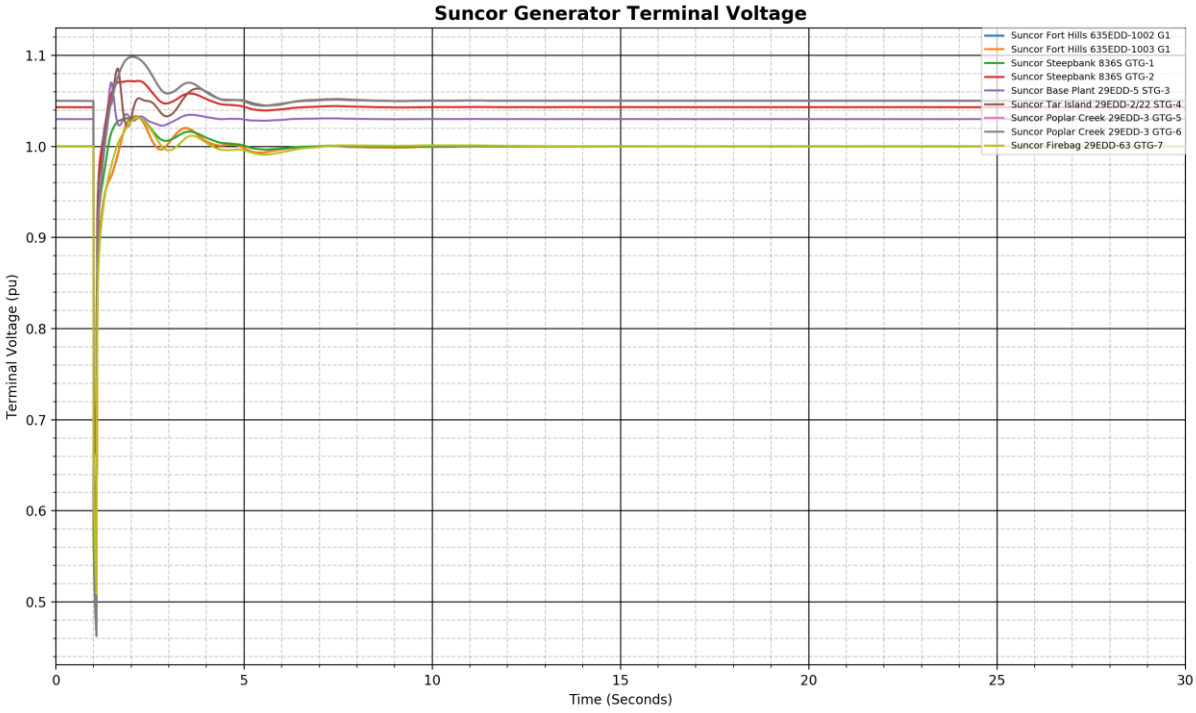

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

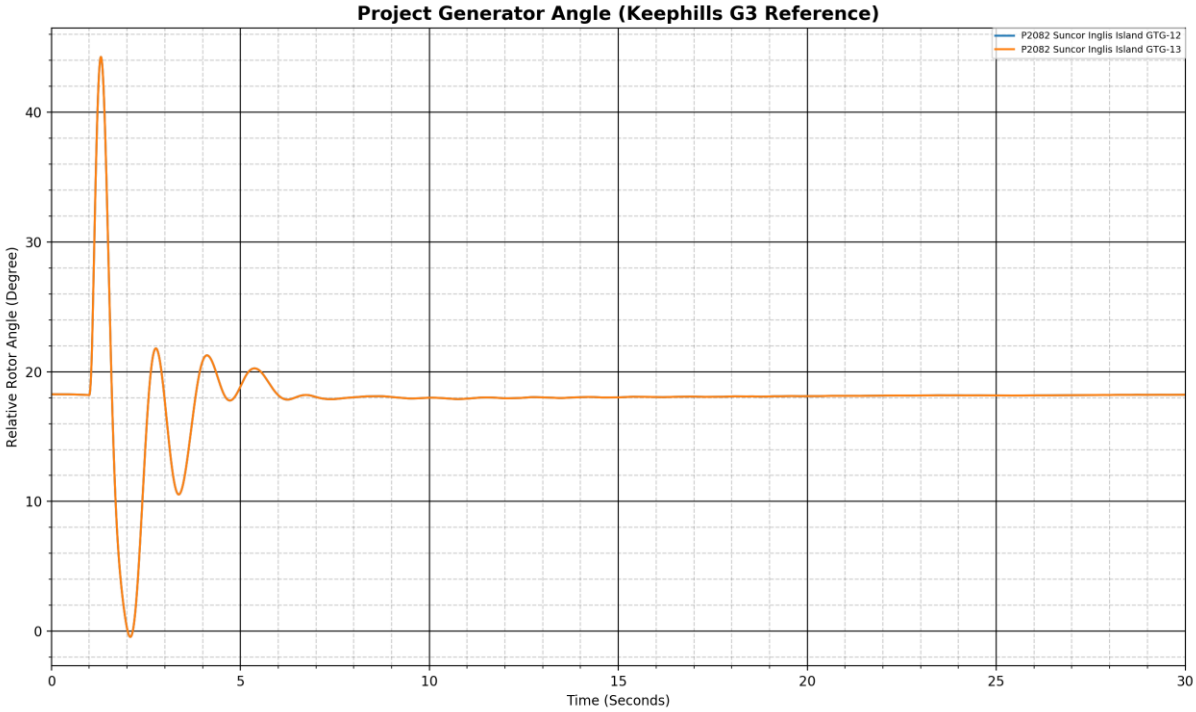

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

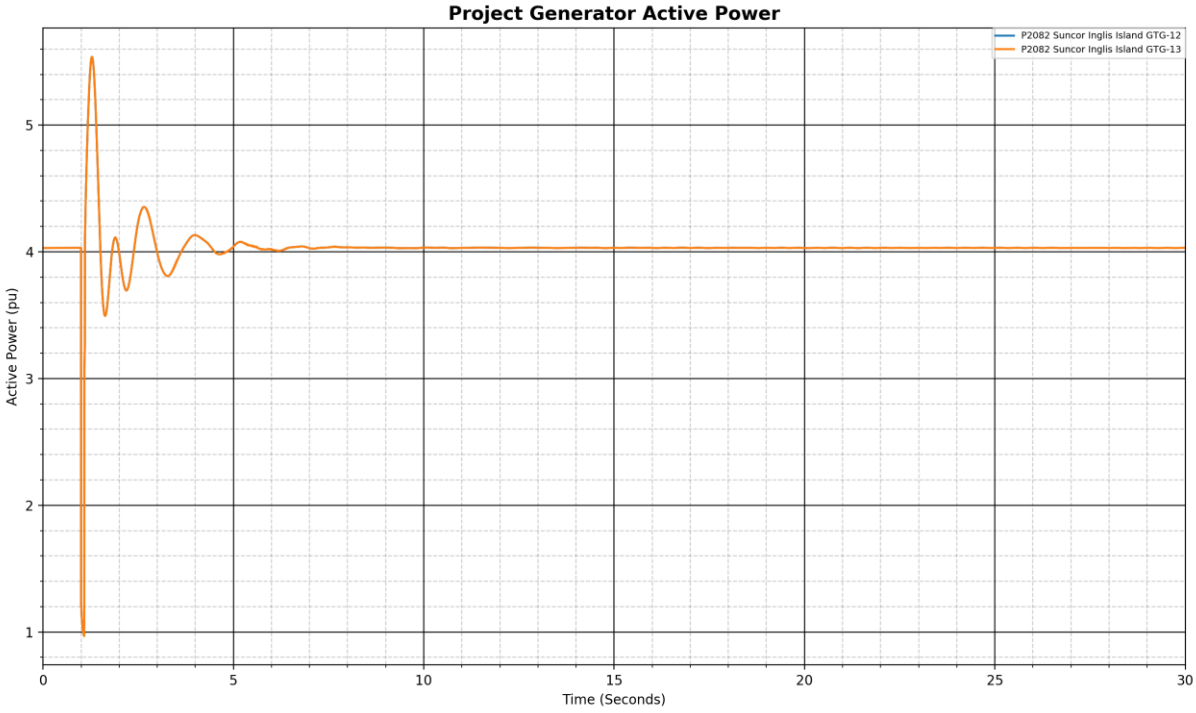

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

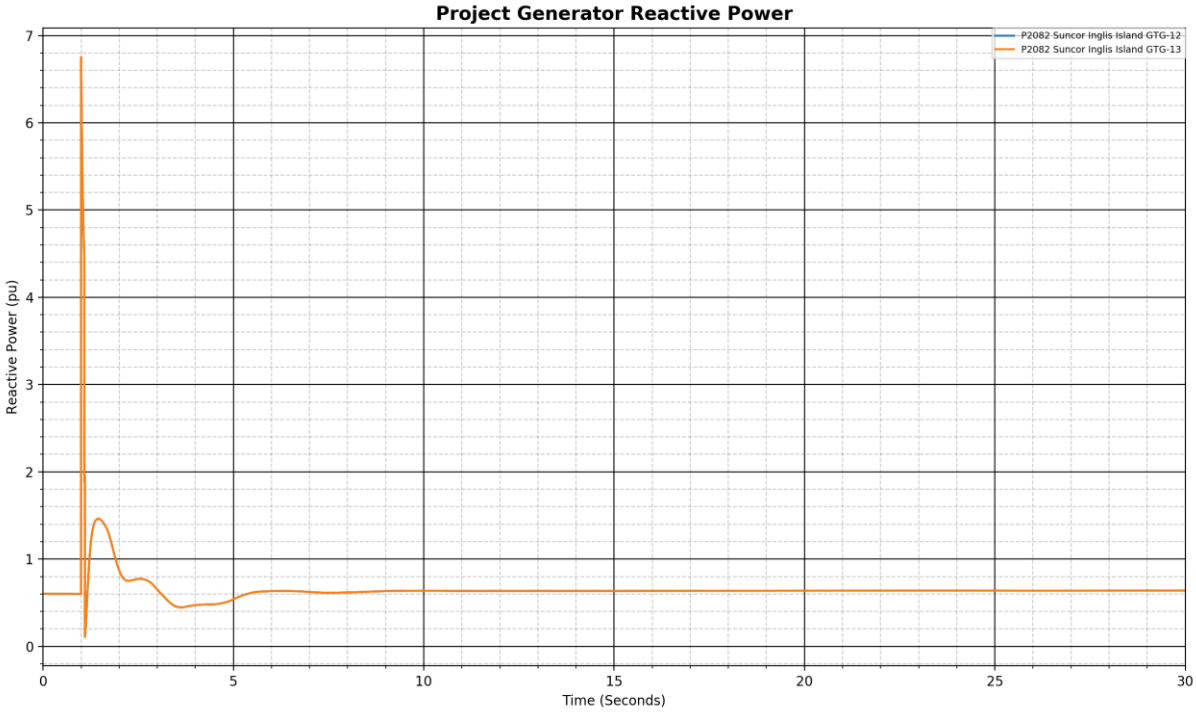

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

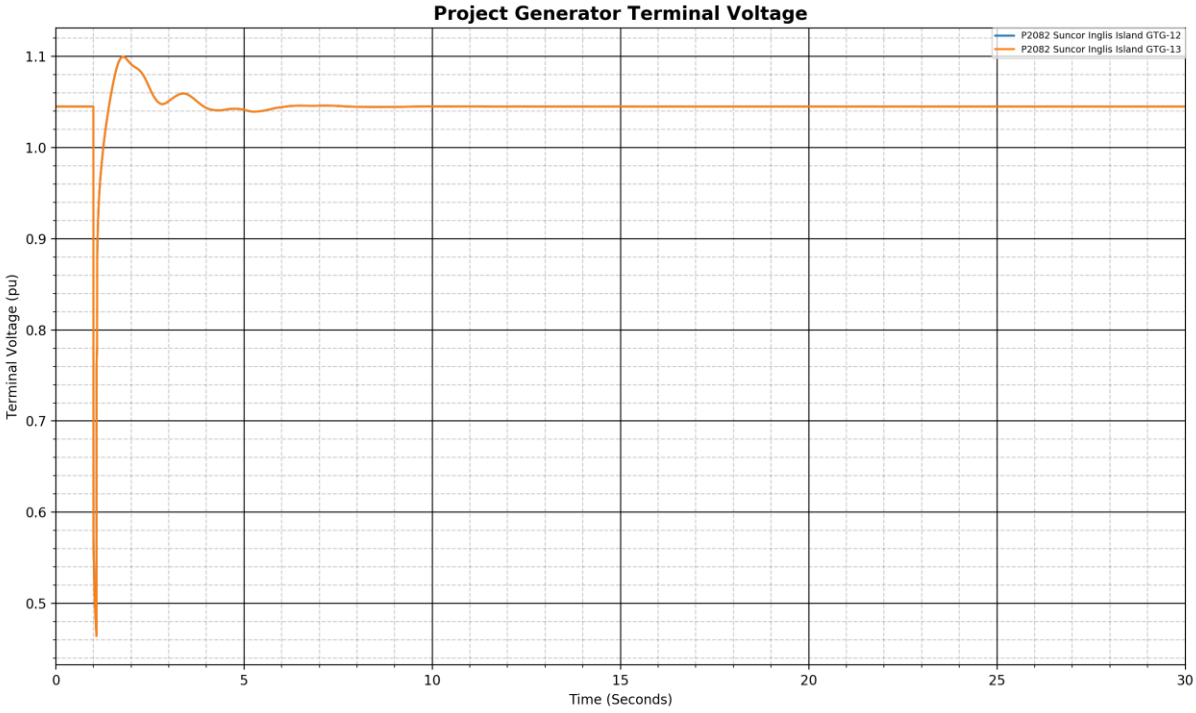

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

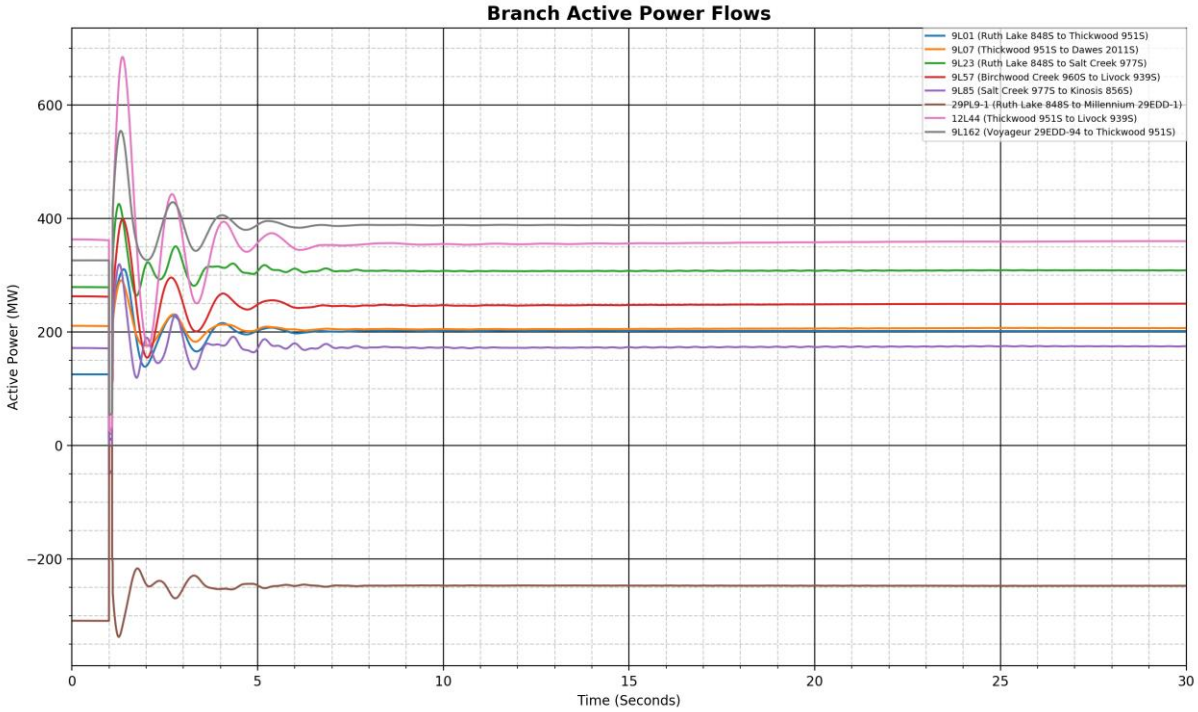

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
0
10
20
30
40
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
1
2
3
4
5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

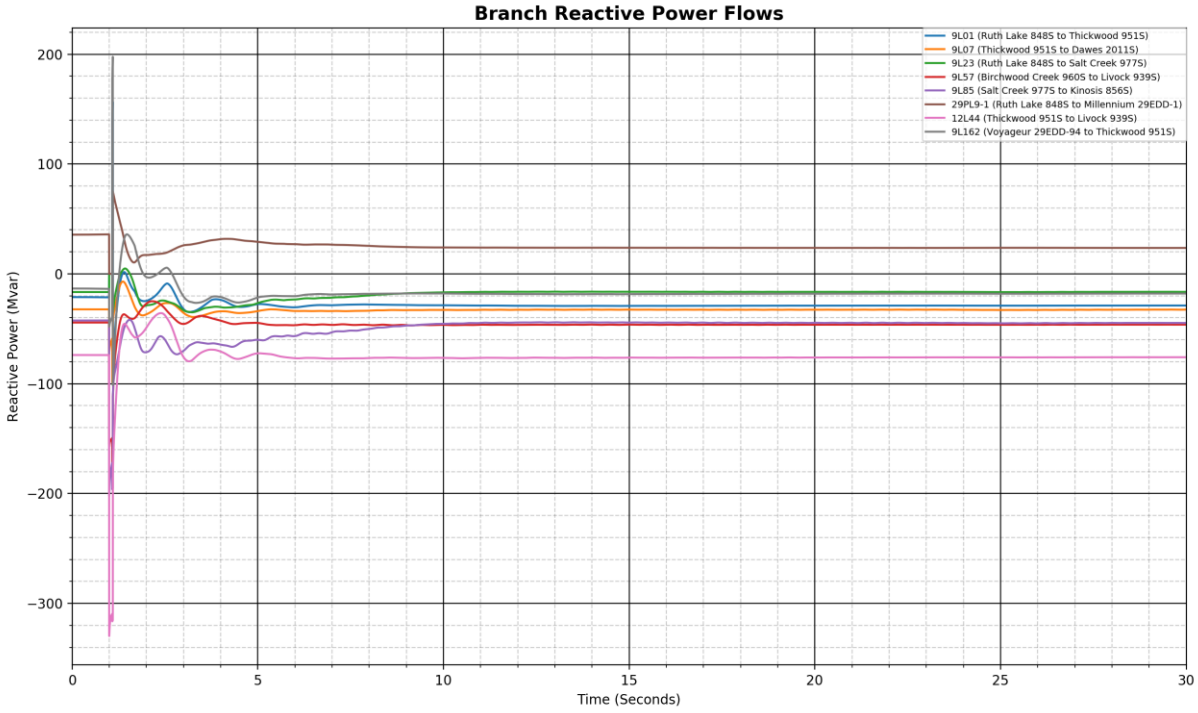
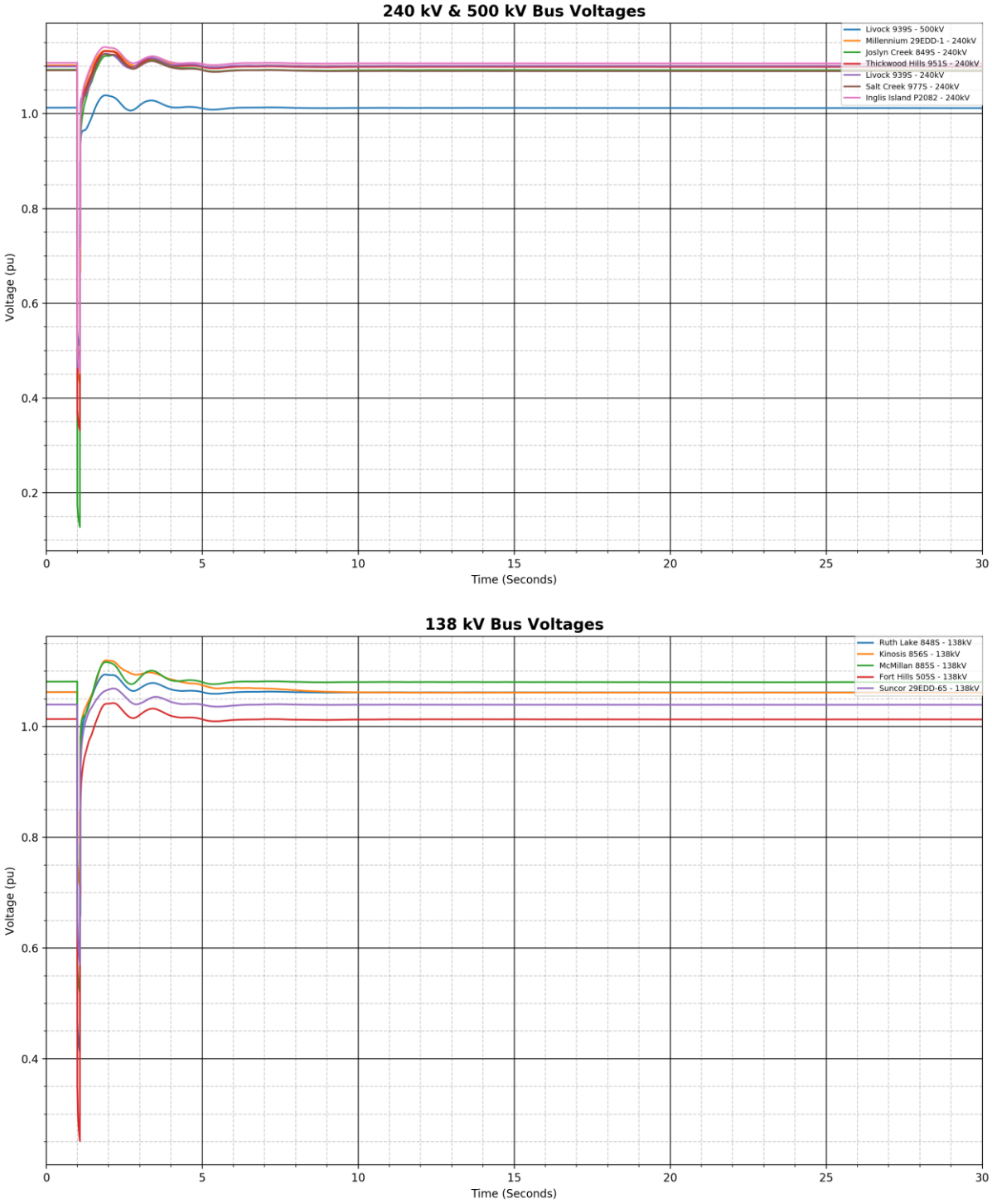
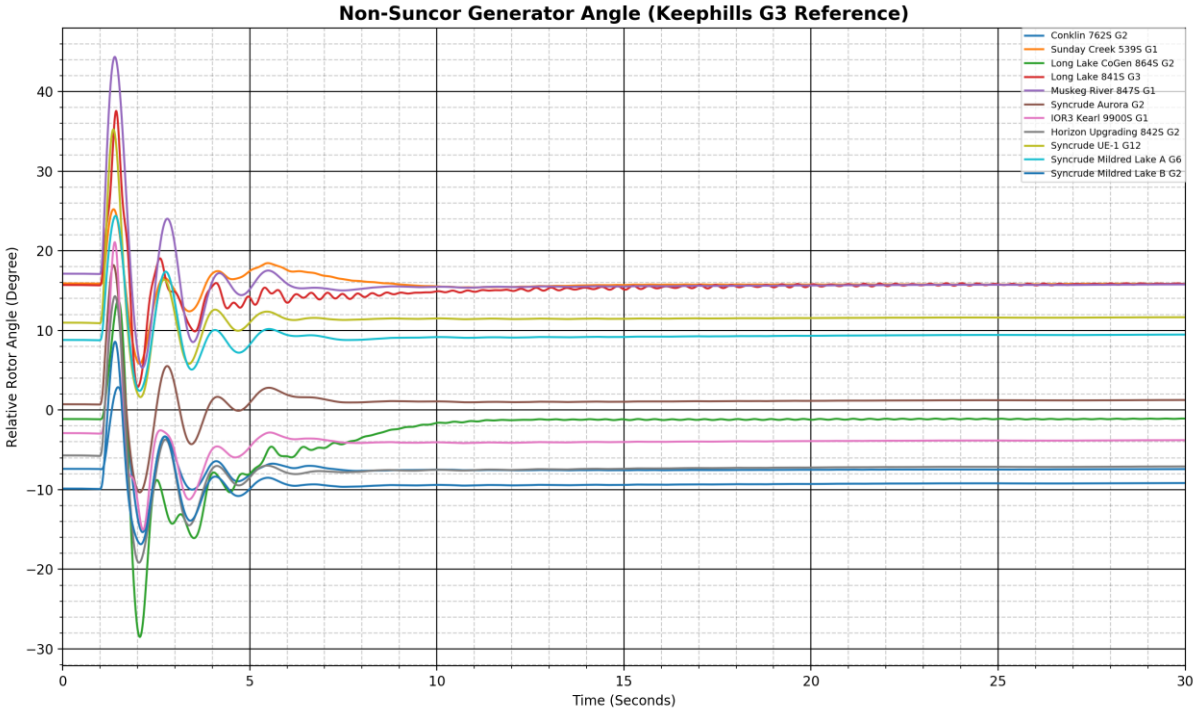
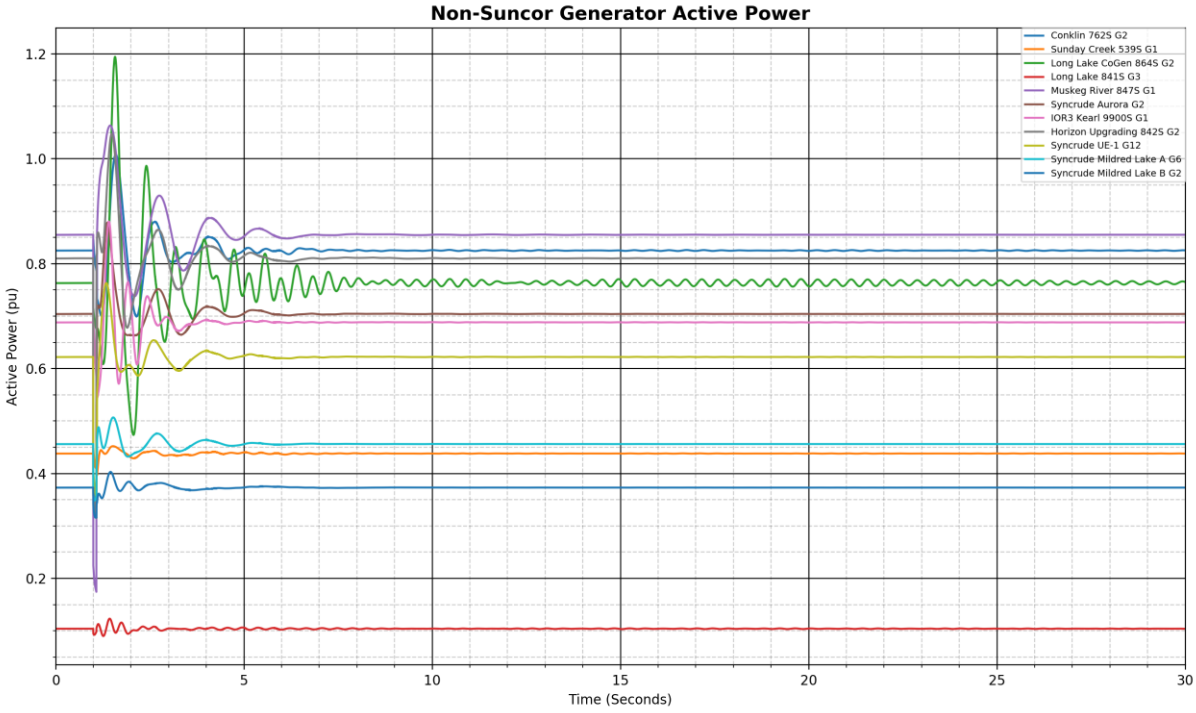
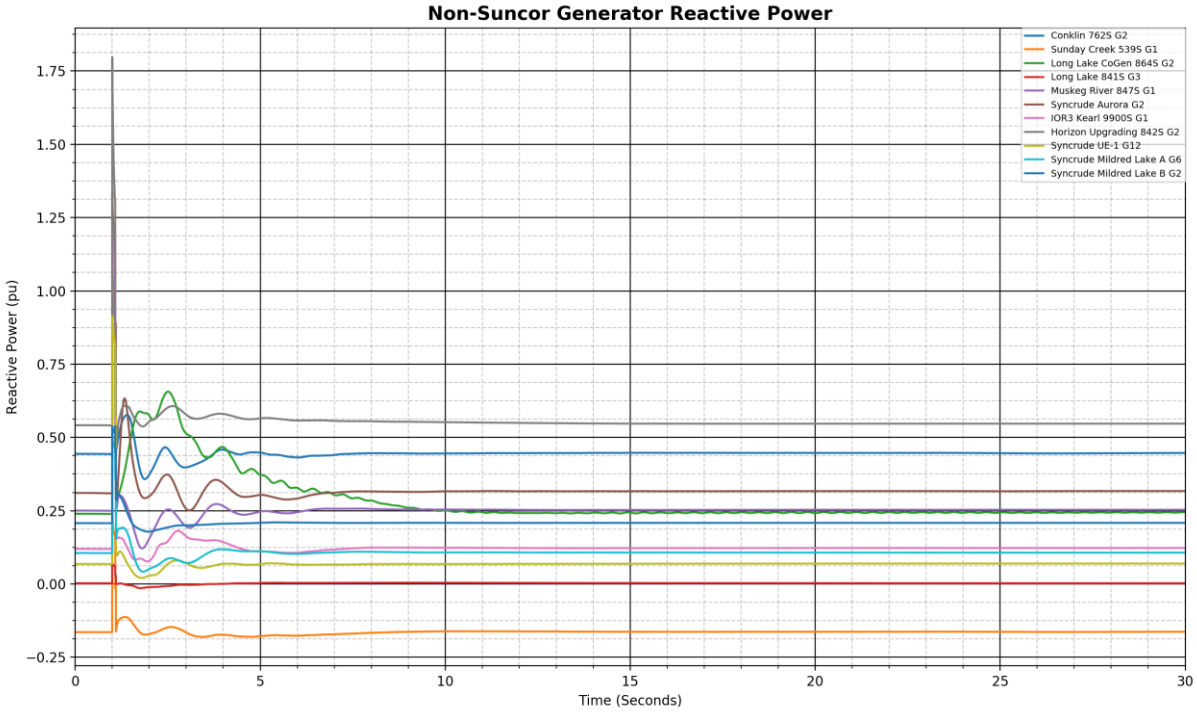

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

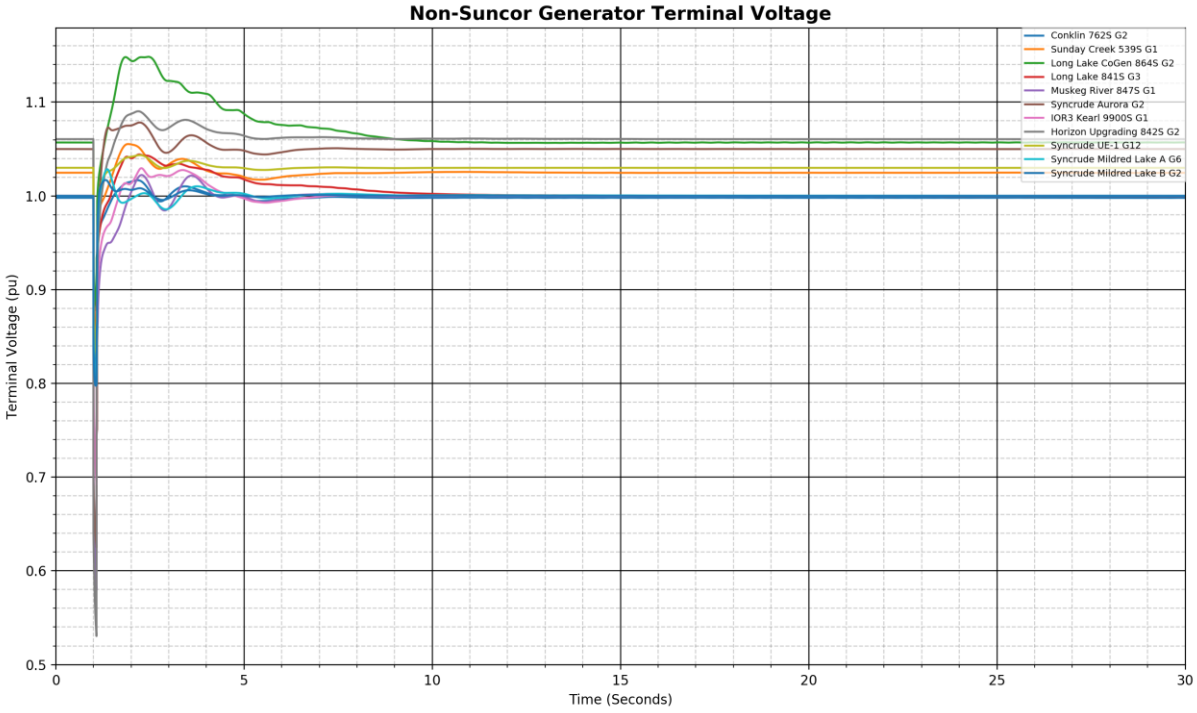
Figure A4-44: 9L58 (Ruth Lake 848S to Dover 888S): Fault at Dover 888S

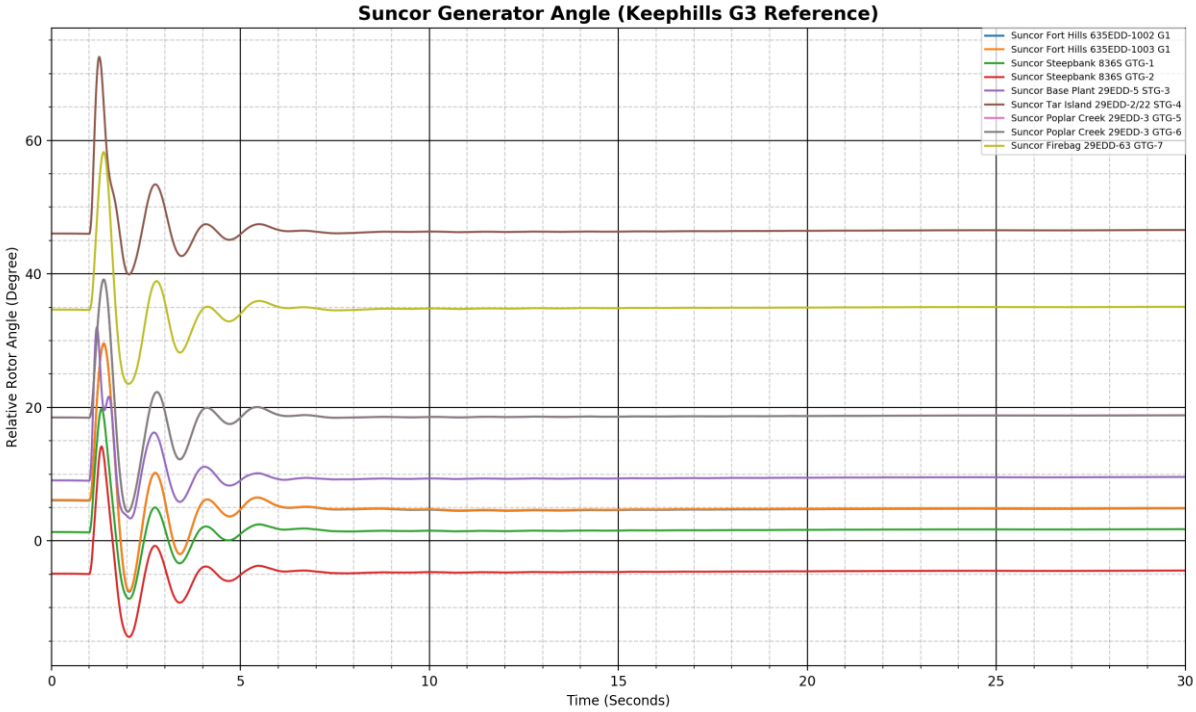


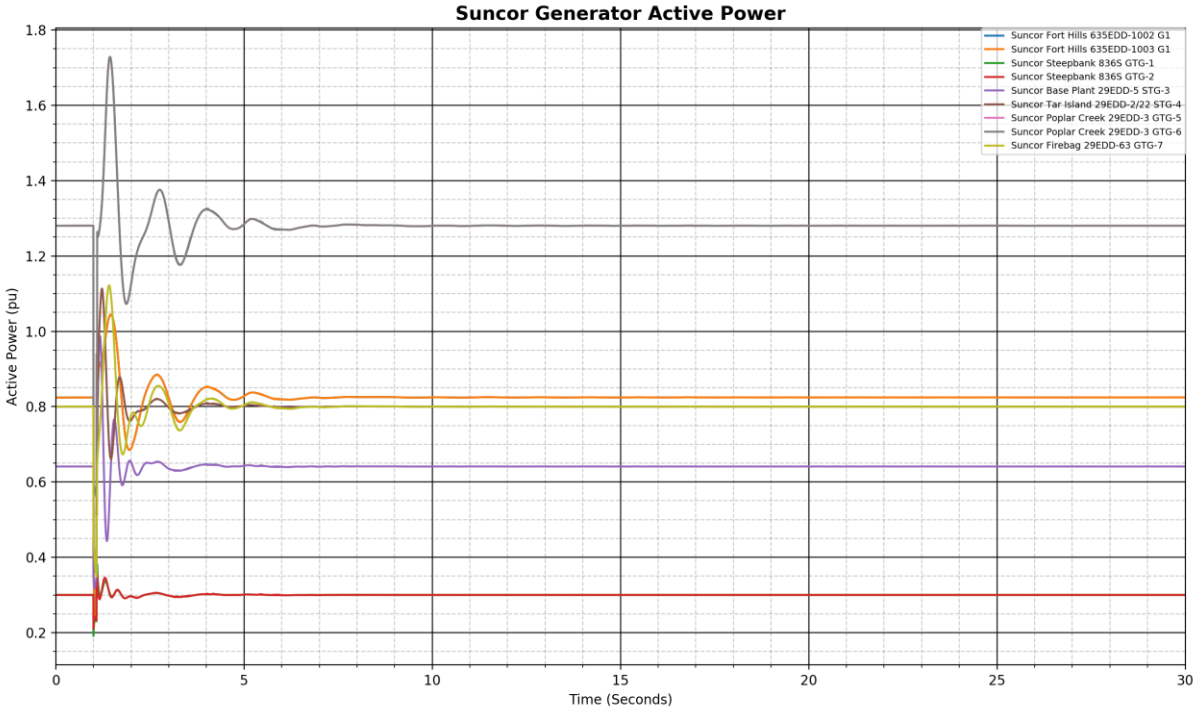

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

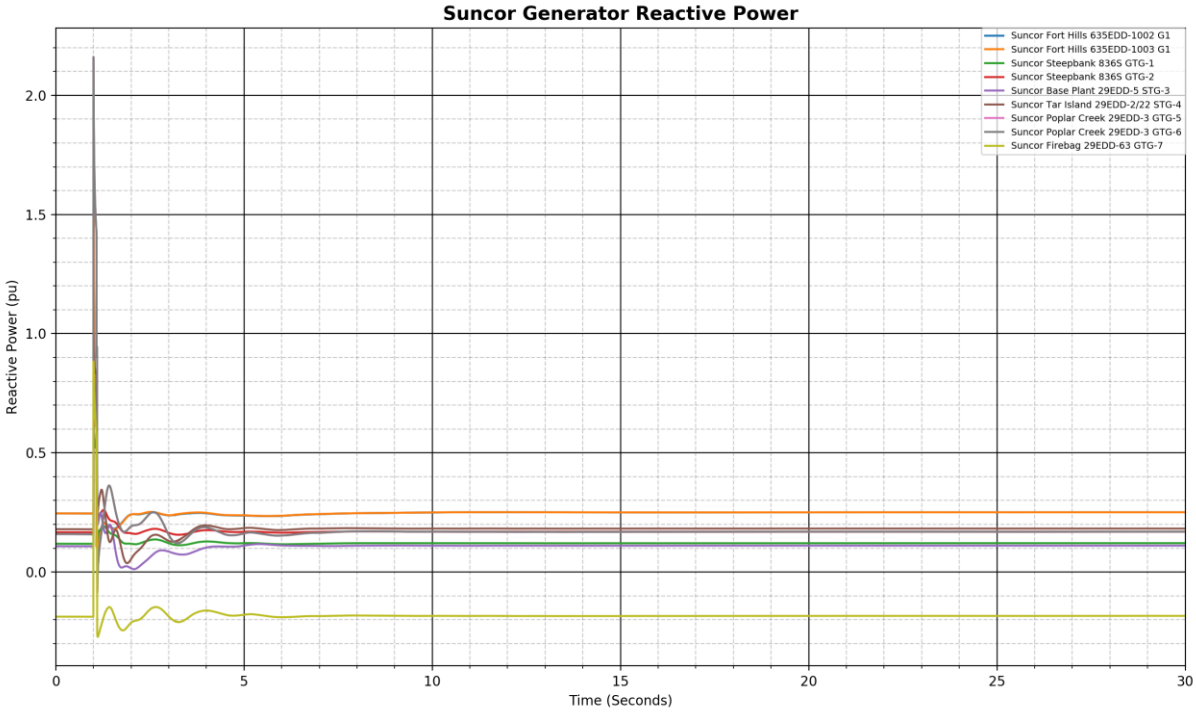

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

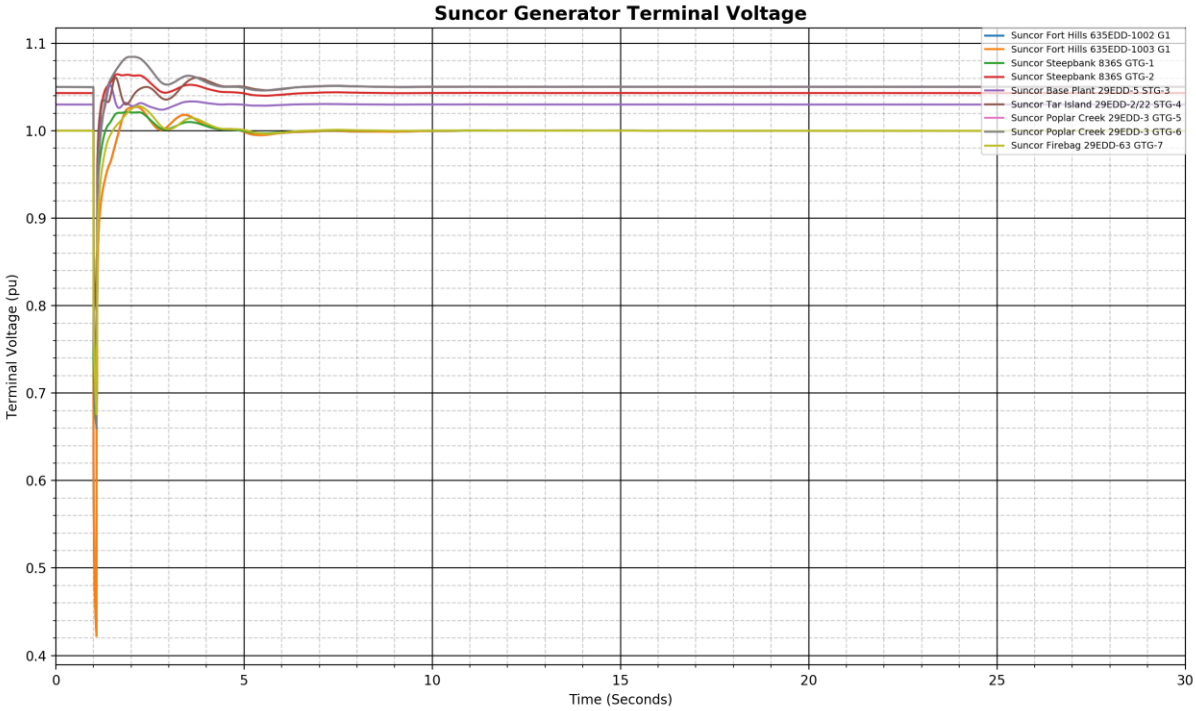

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

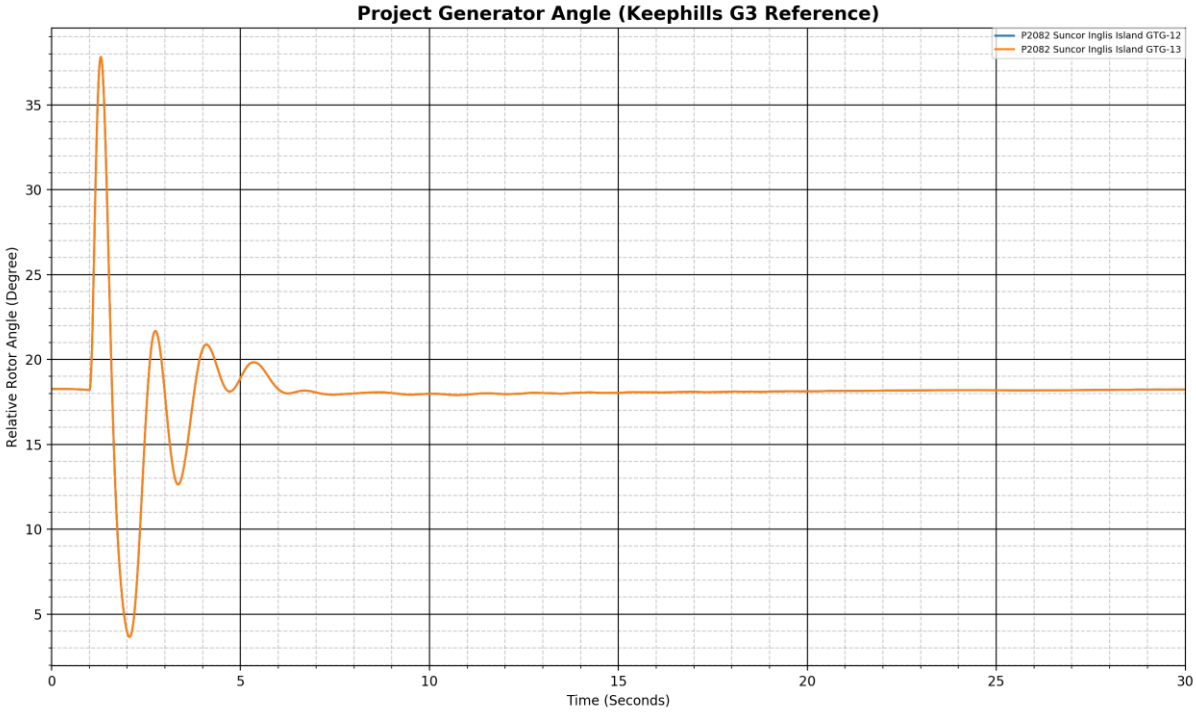

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

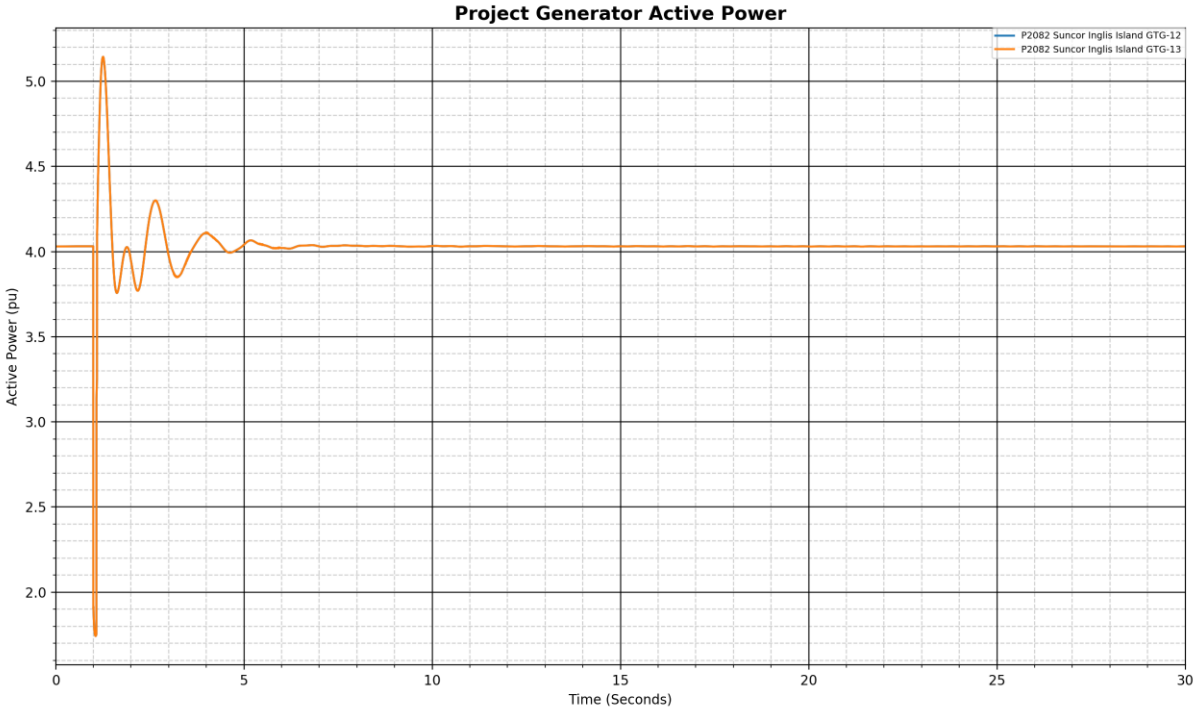

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

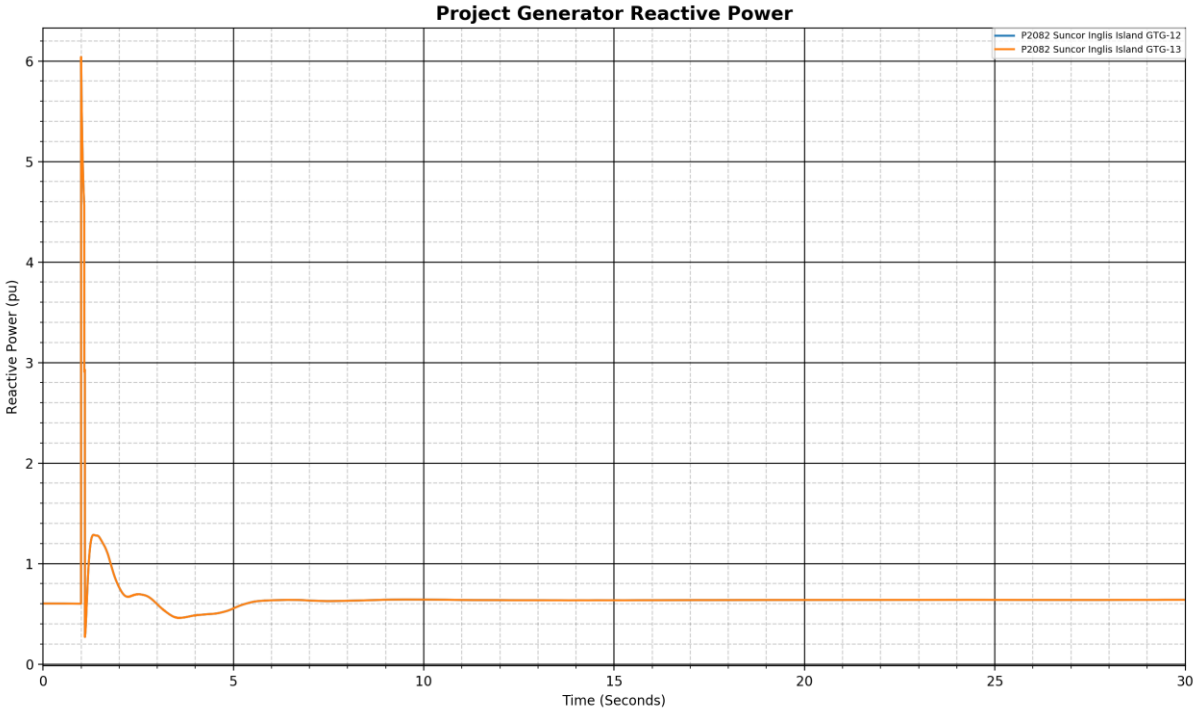

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

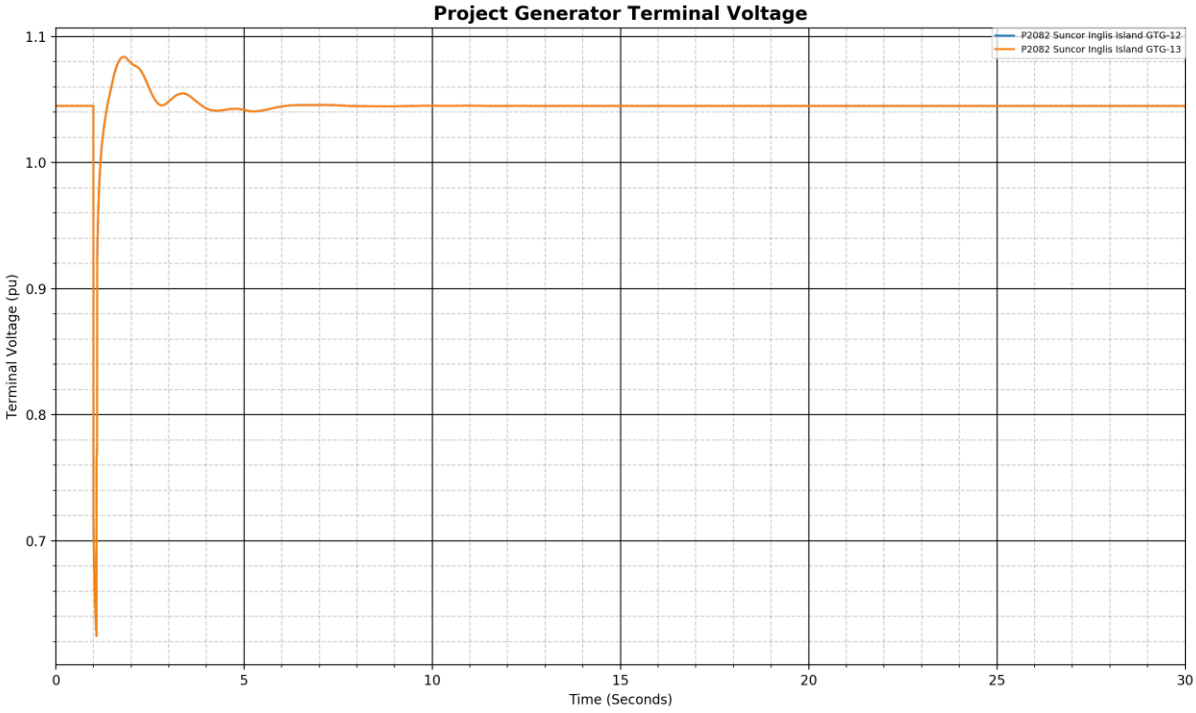

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

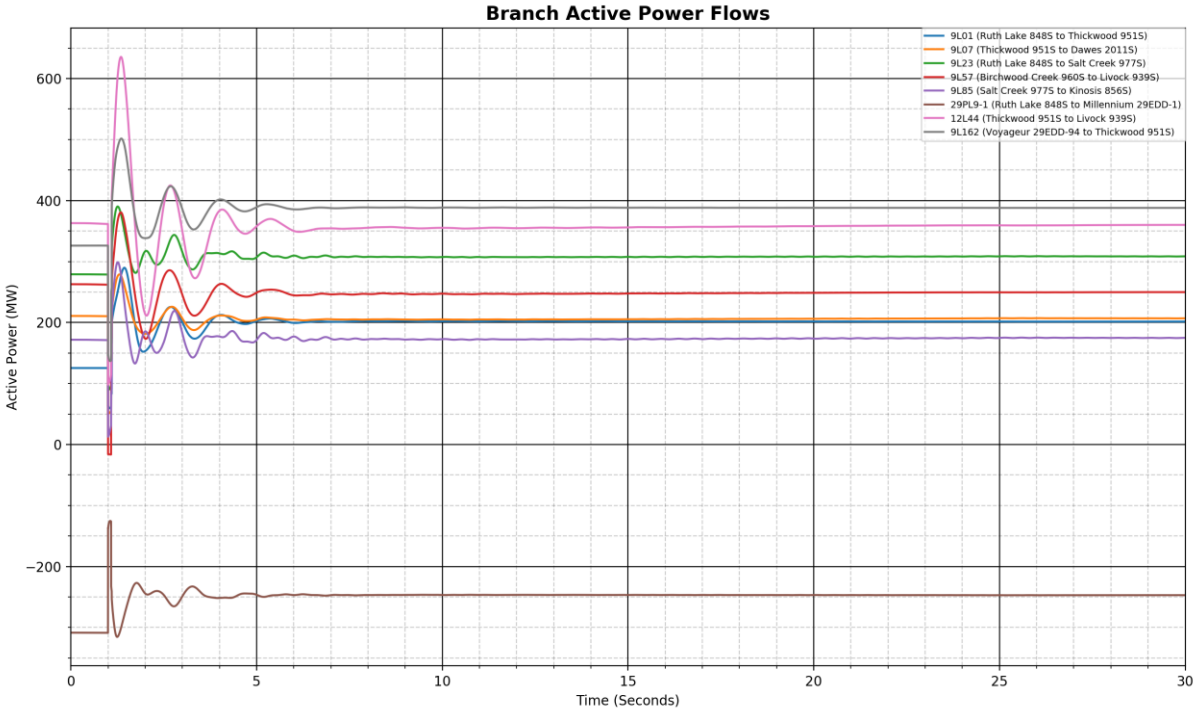

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
0
5
10
15
20
25
30
35


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

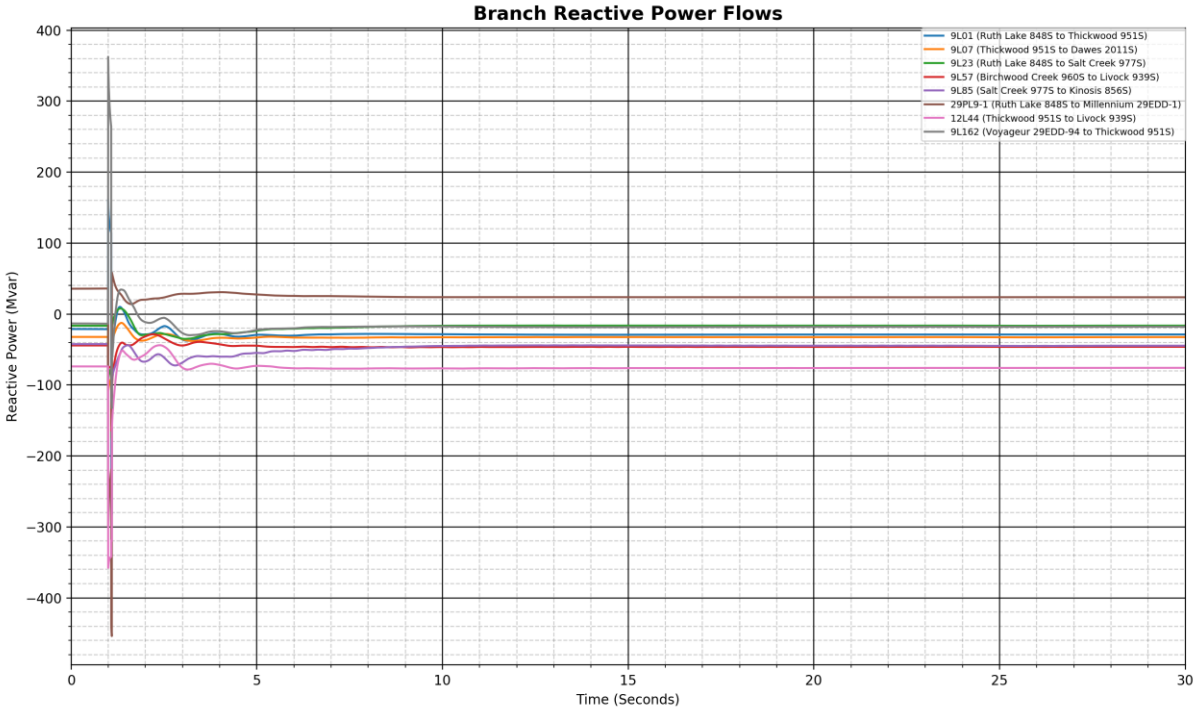
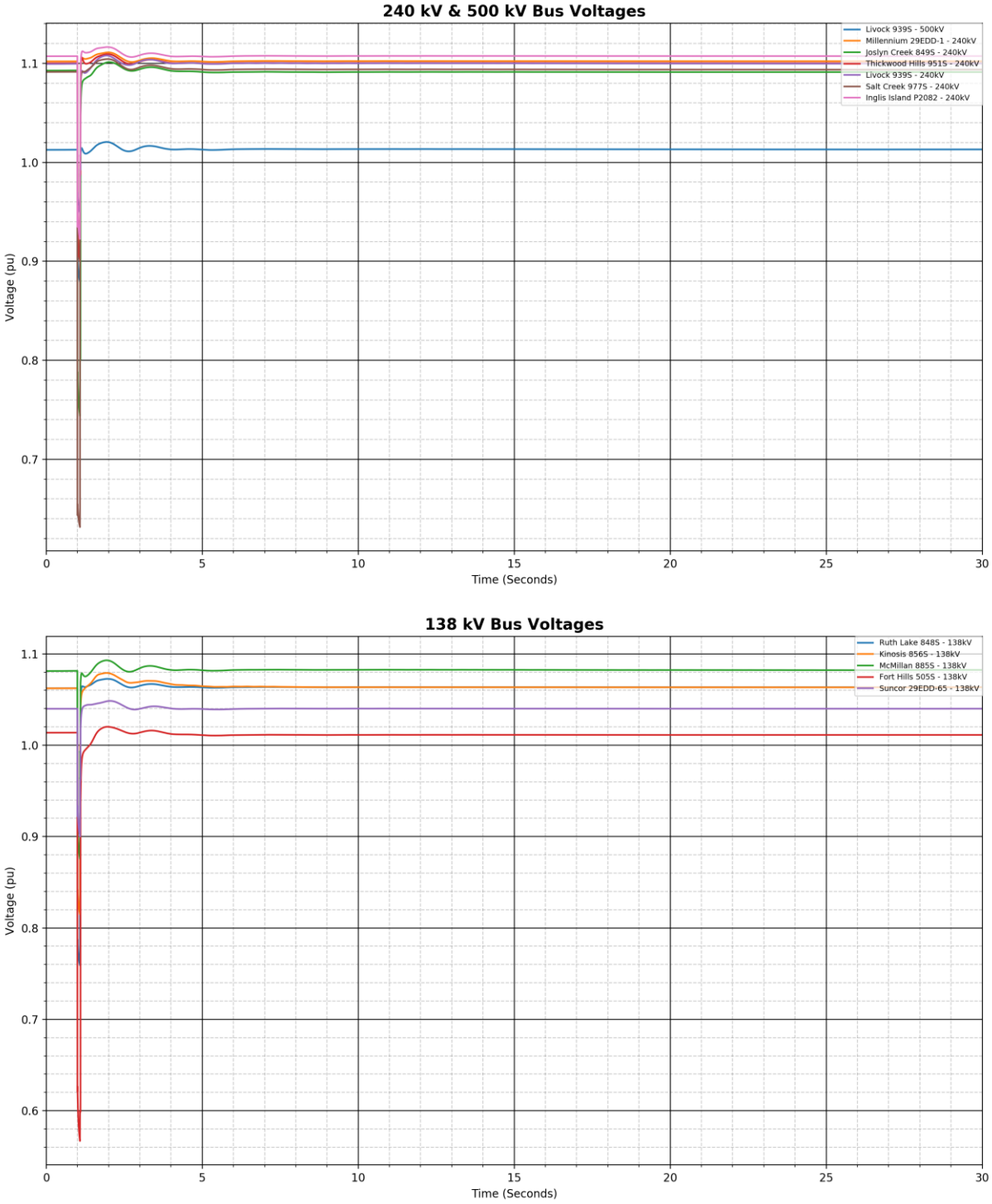
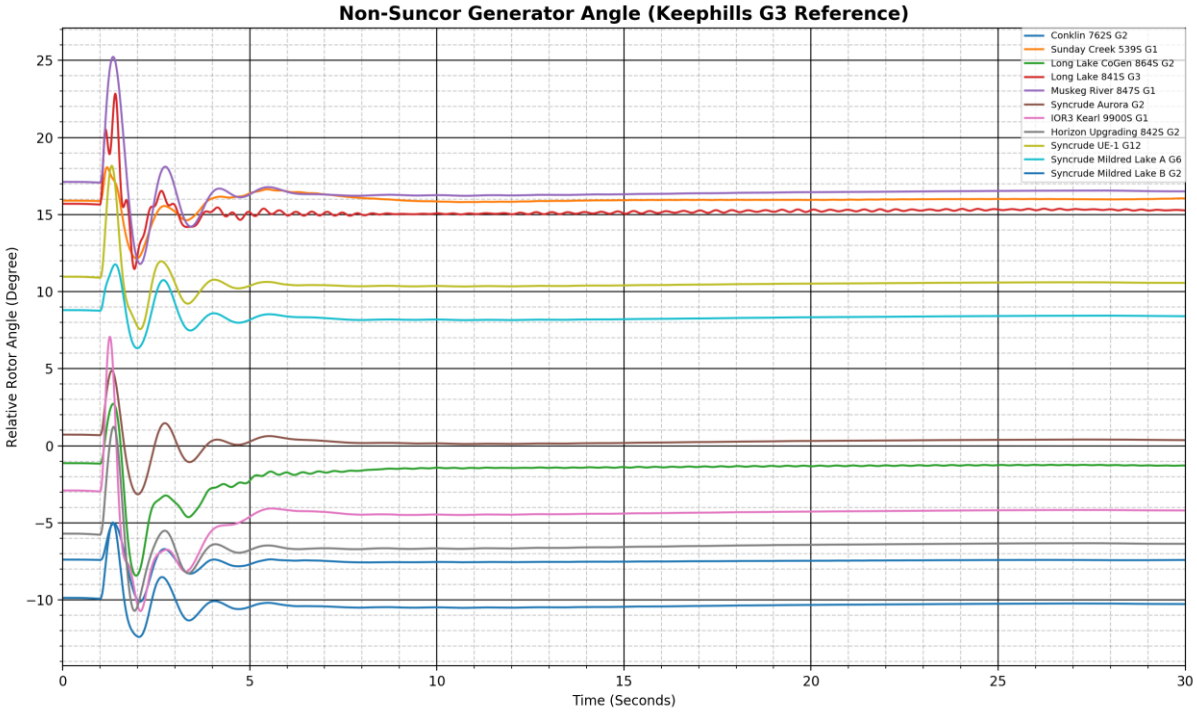
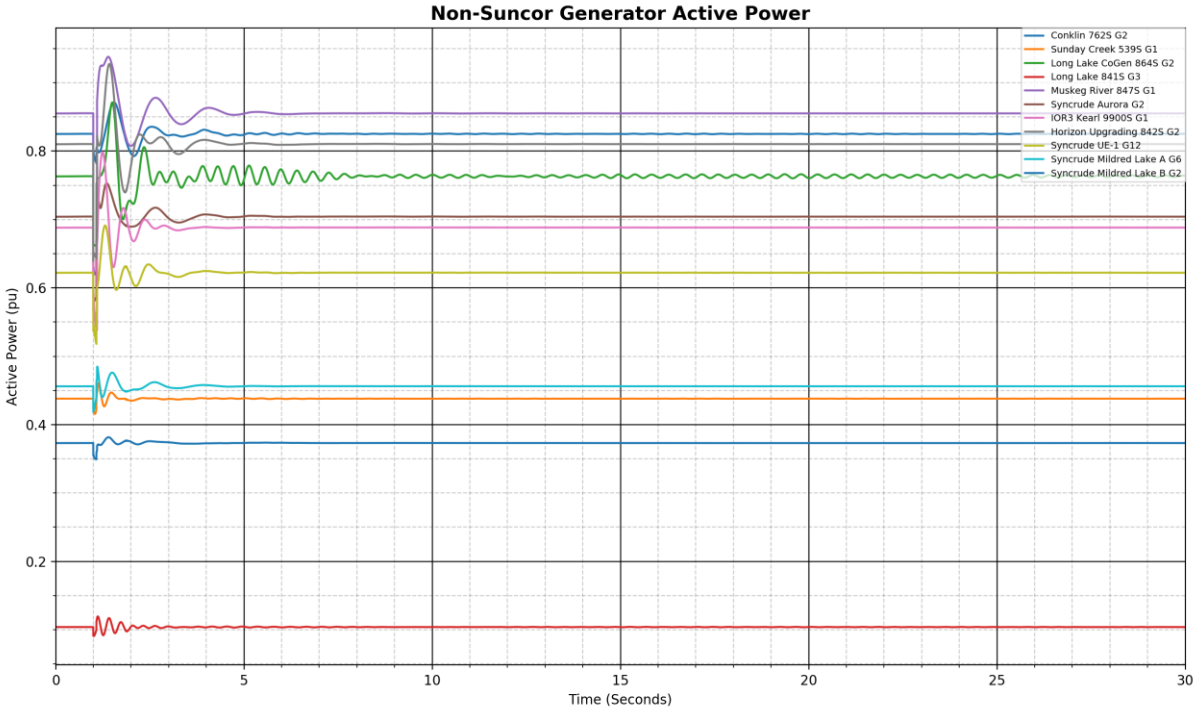
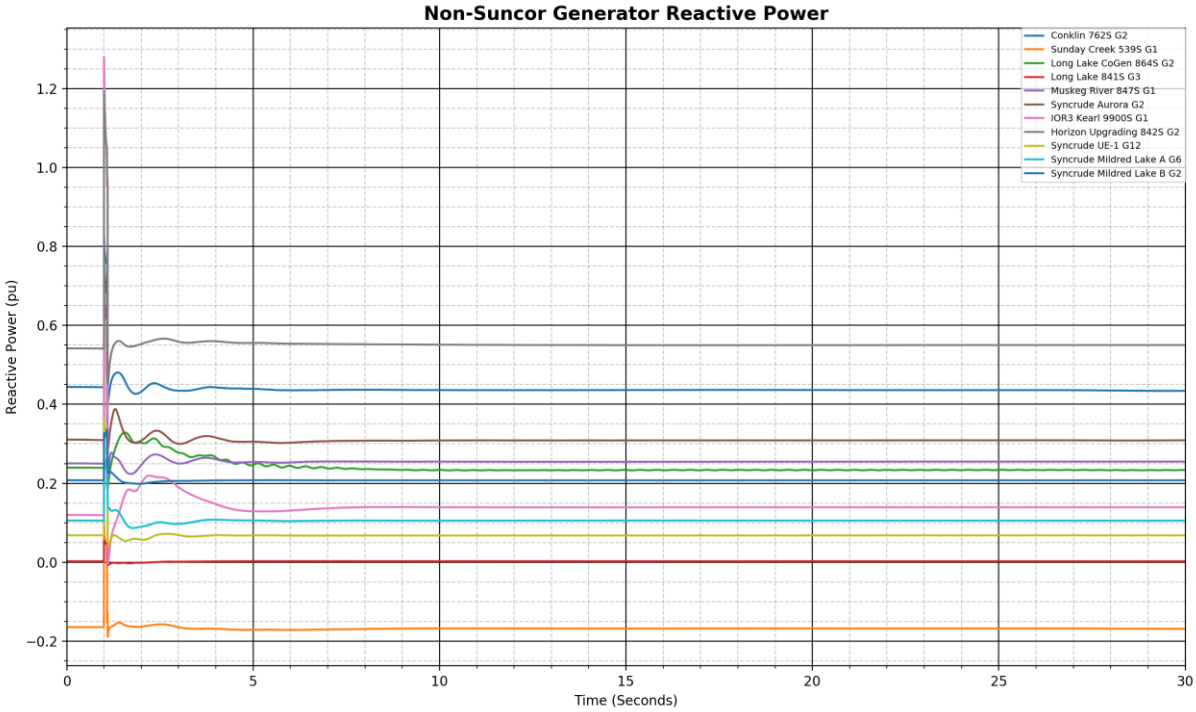

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

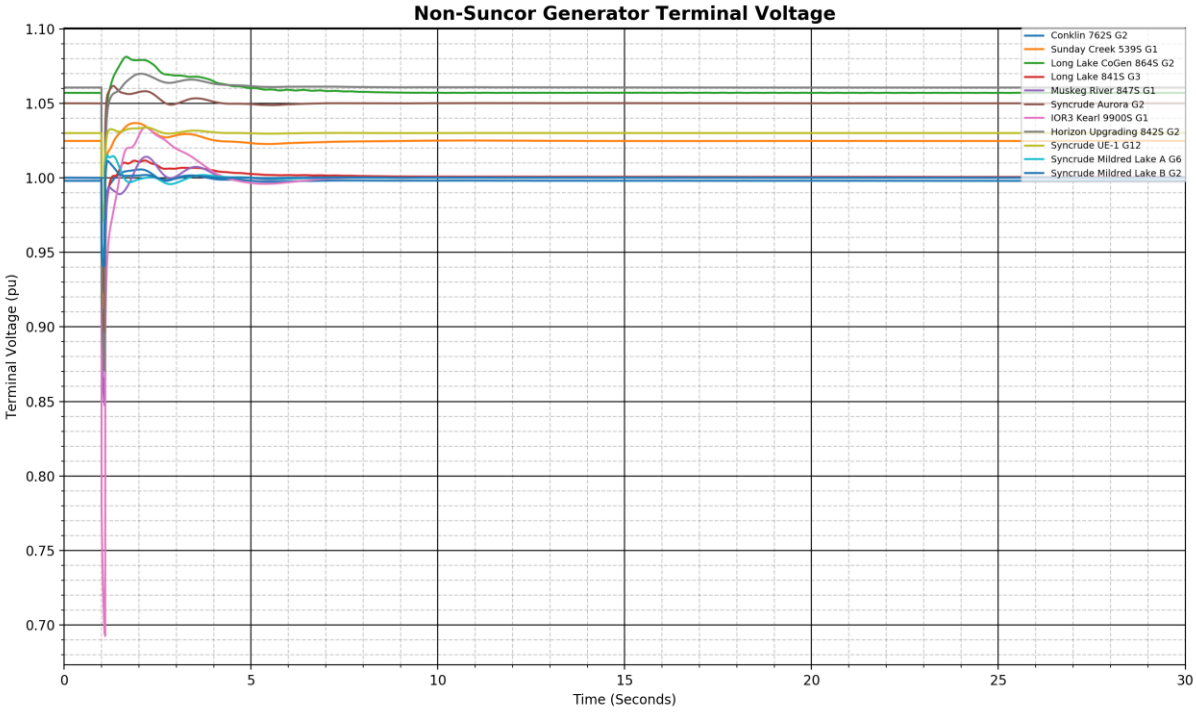
Figure A4-45: 9L69 (Black Fly 934S to McClelland 957S): Fault at Black Fly 934S

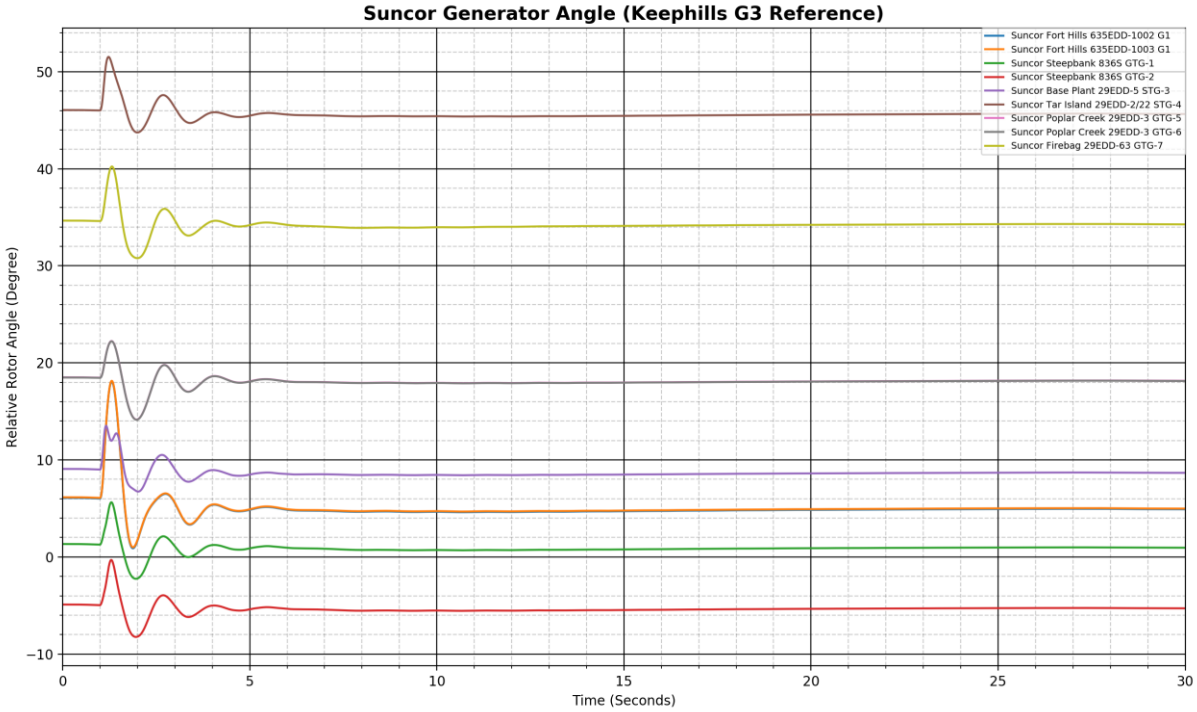


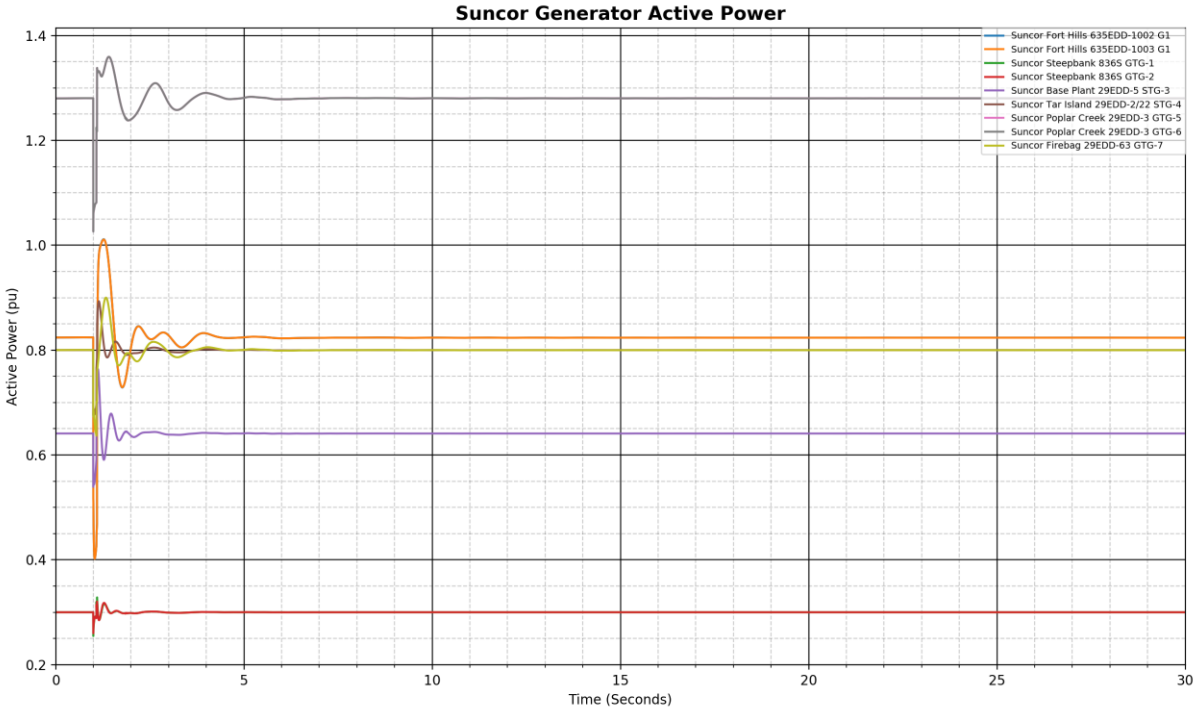

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

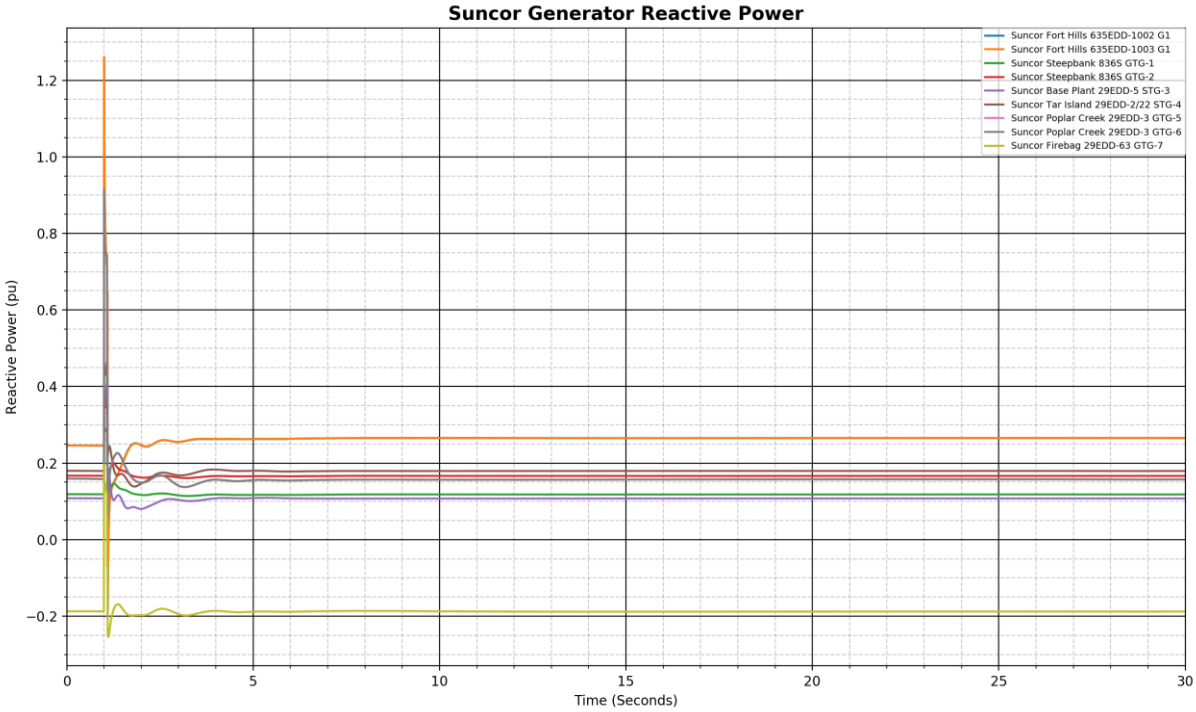

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

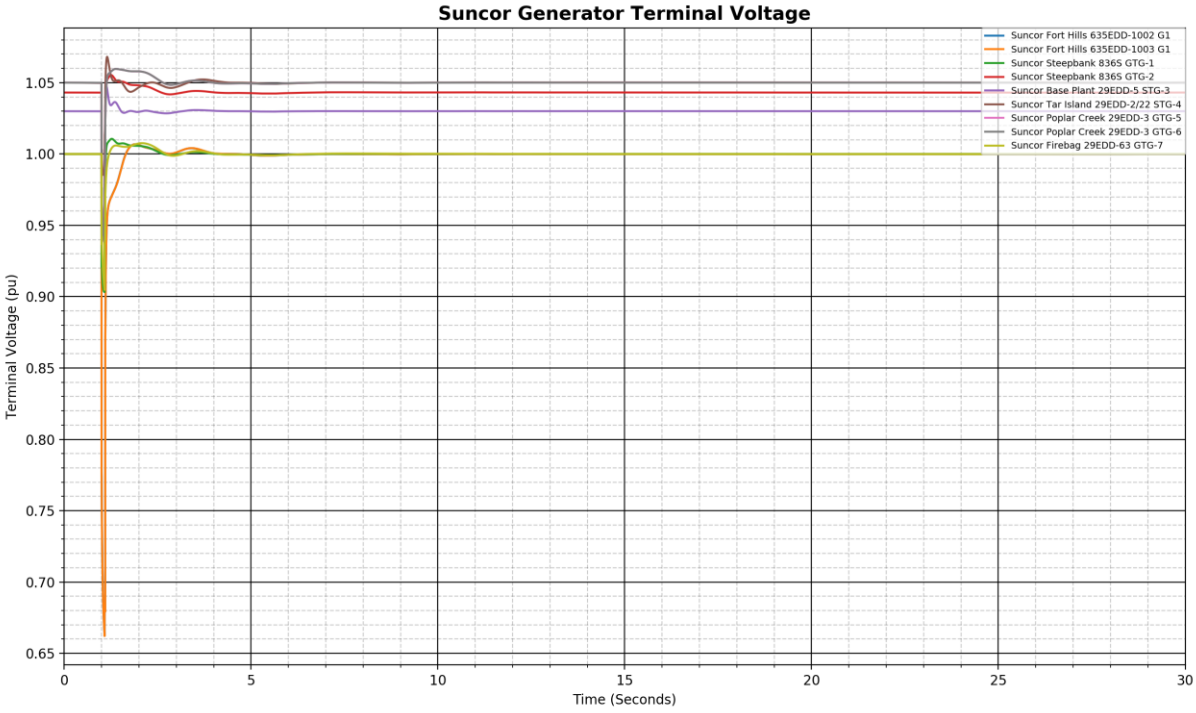

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

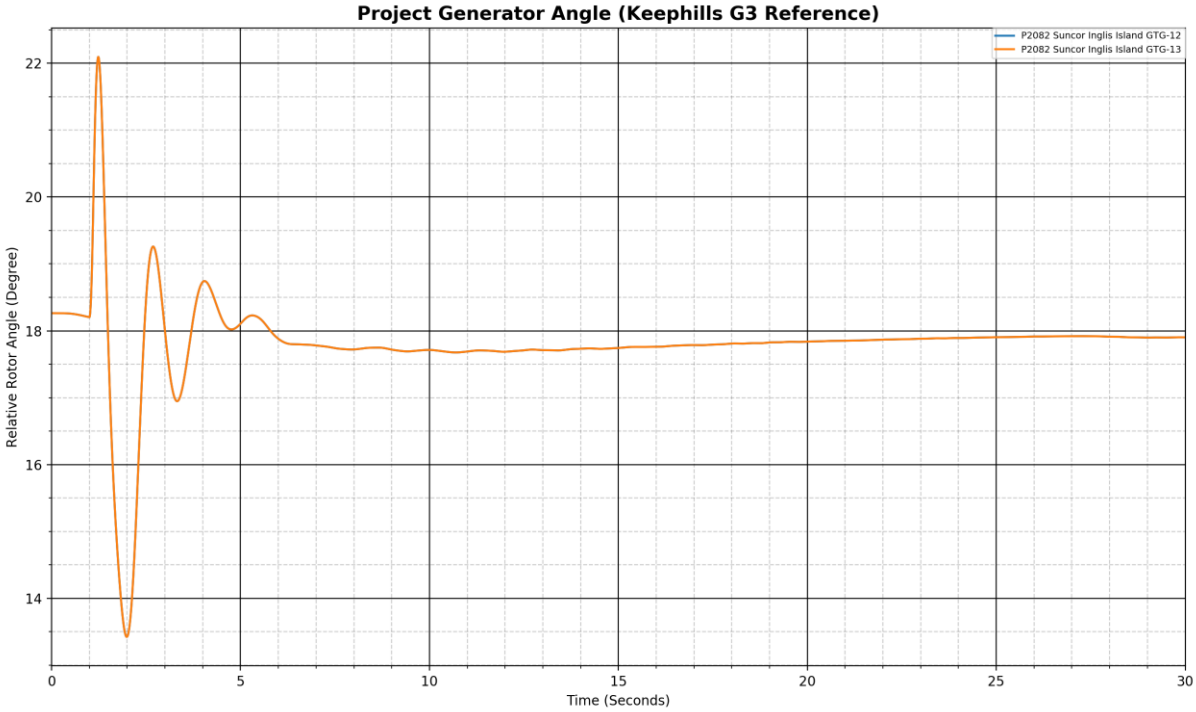

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

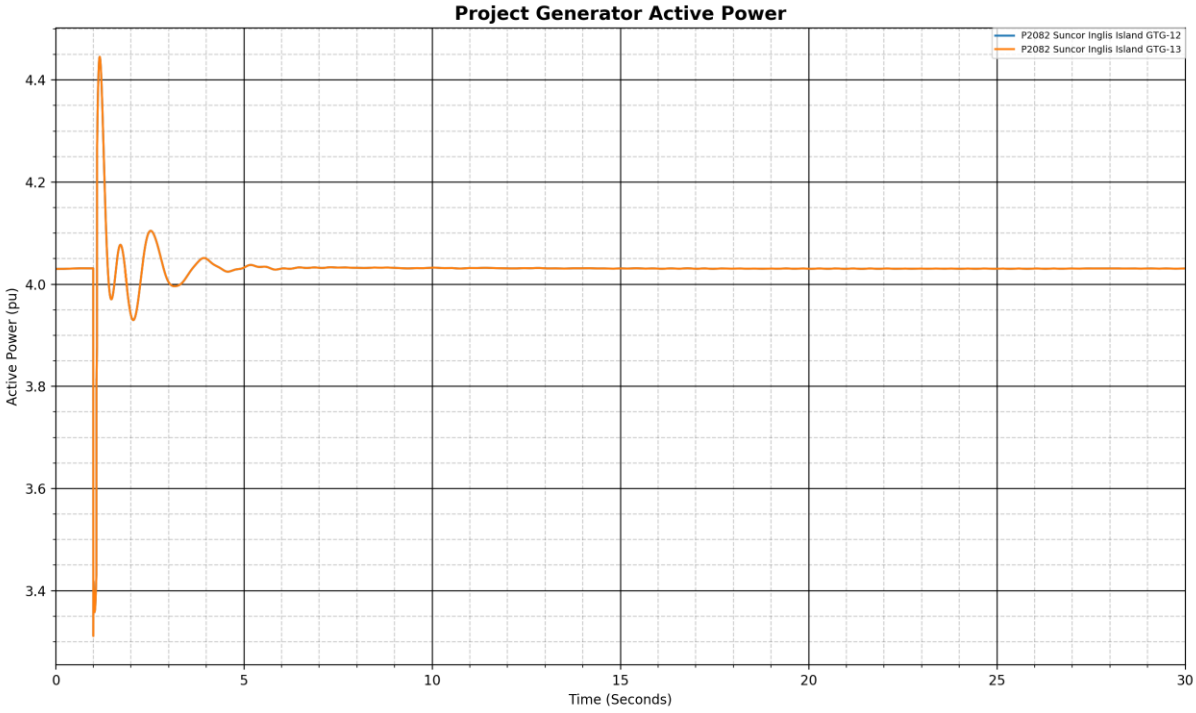

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

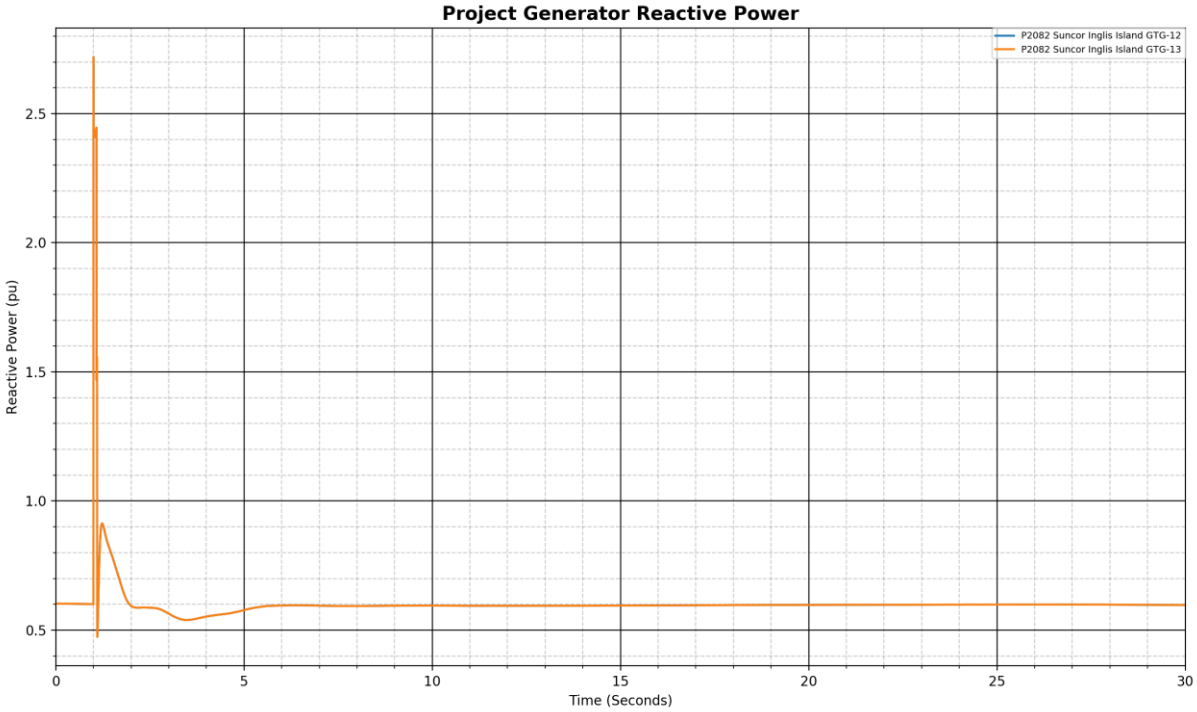

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

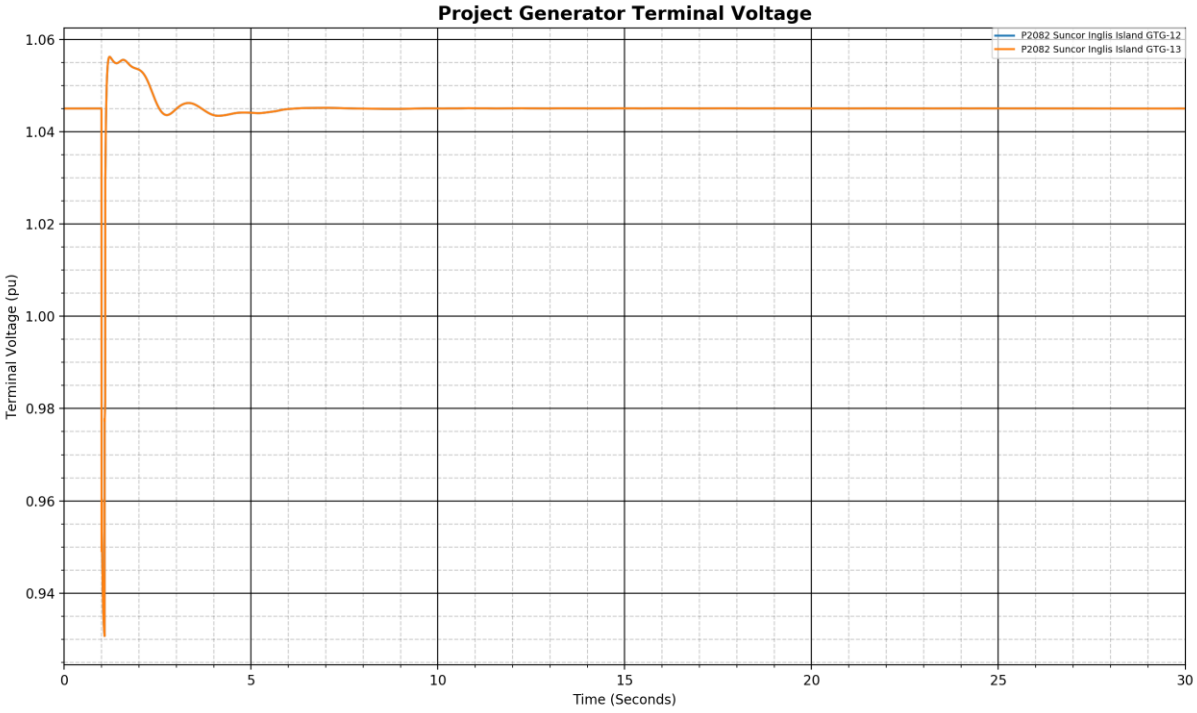

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

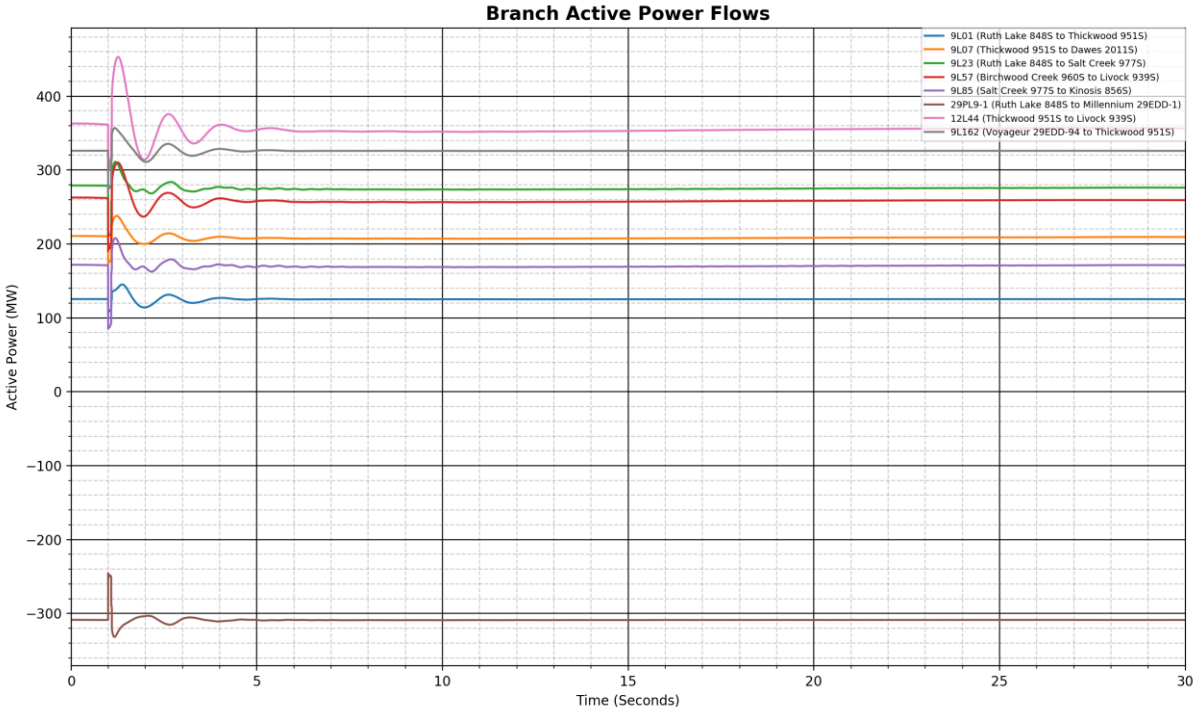

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
22
20
18
16
14
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.4
4.2
4.0
3.8
3.6
3.4
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

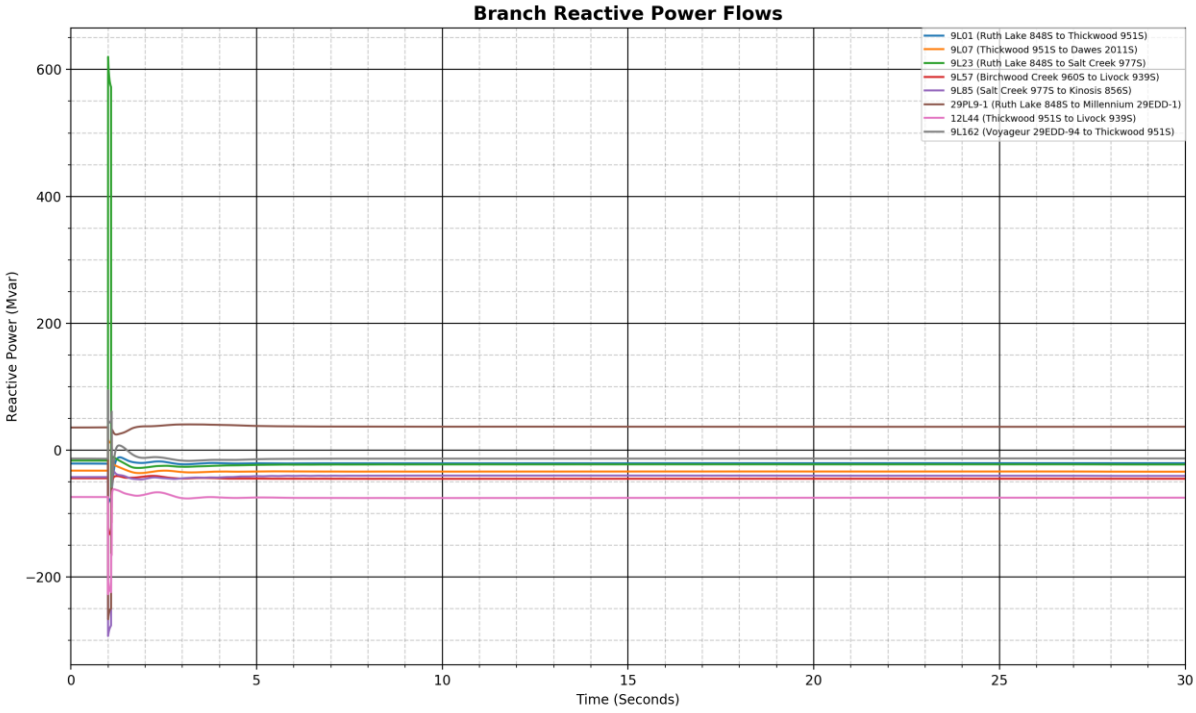
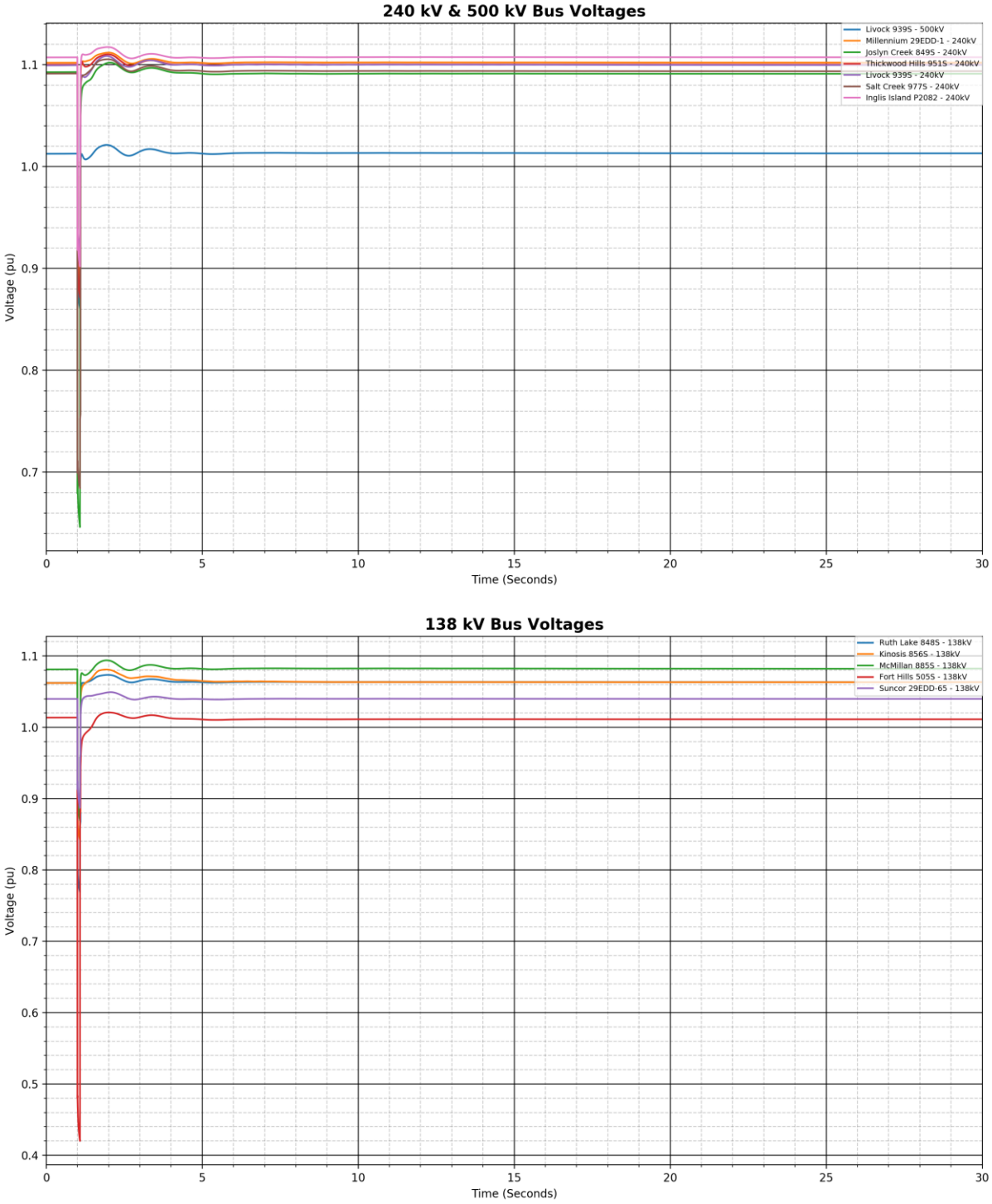
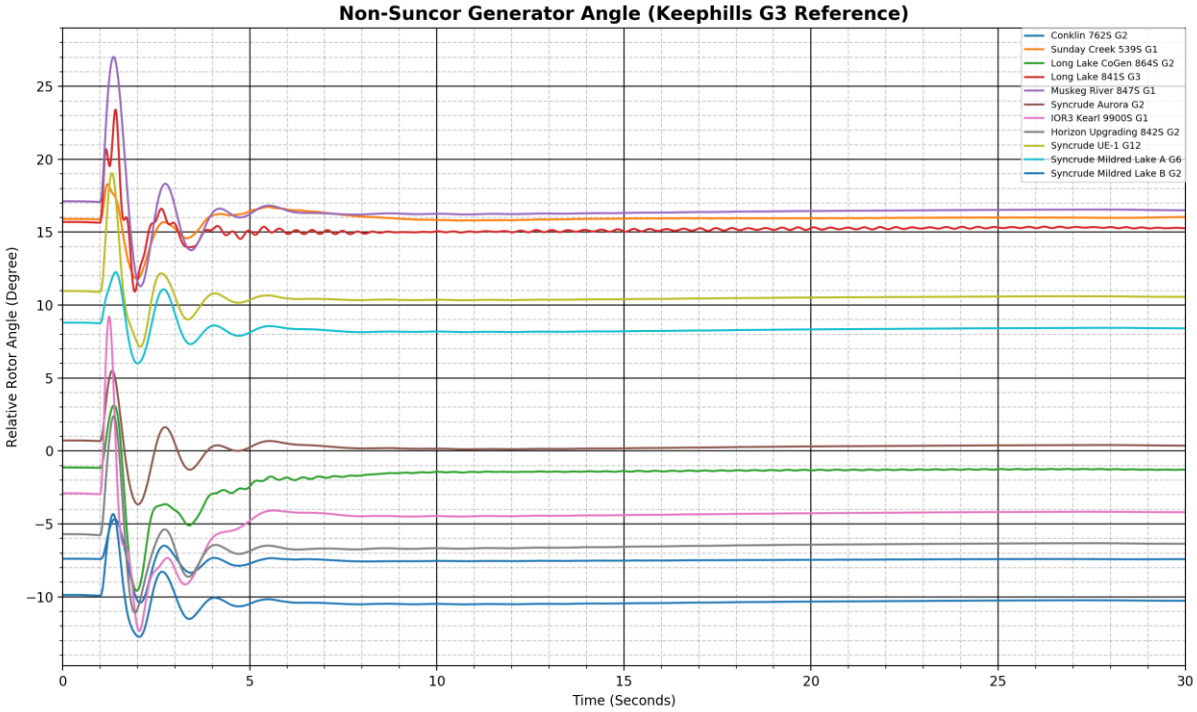
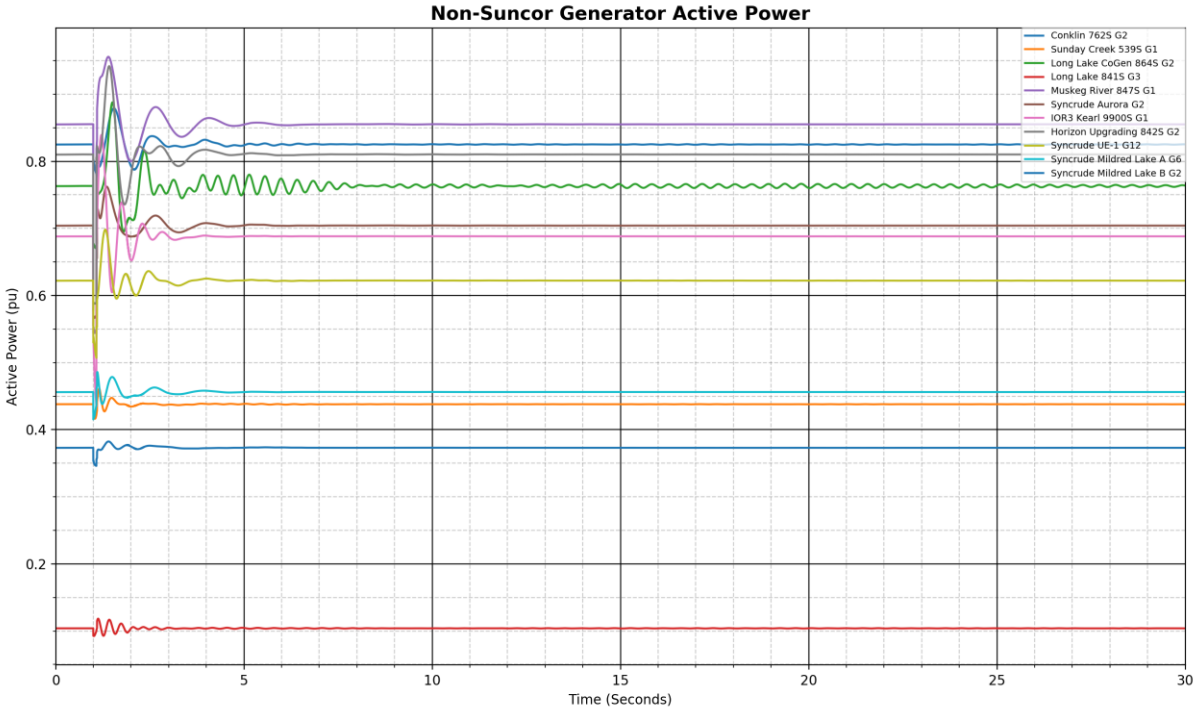
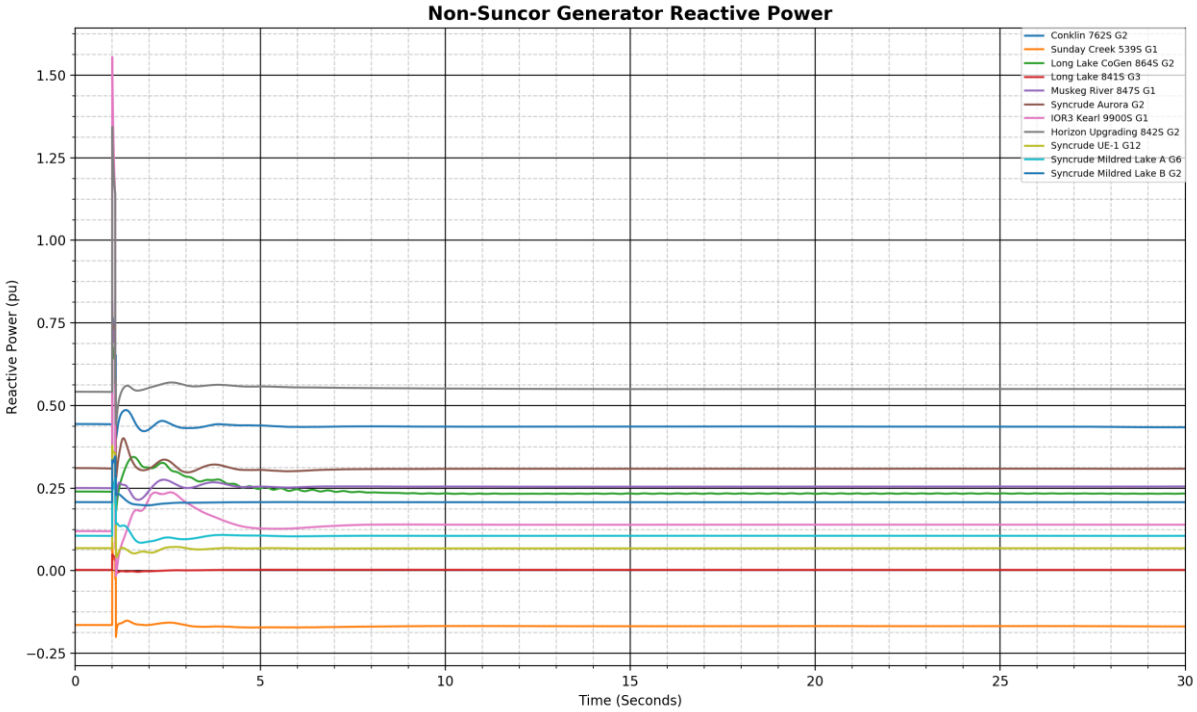

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

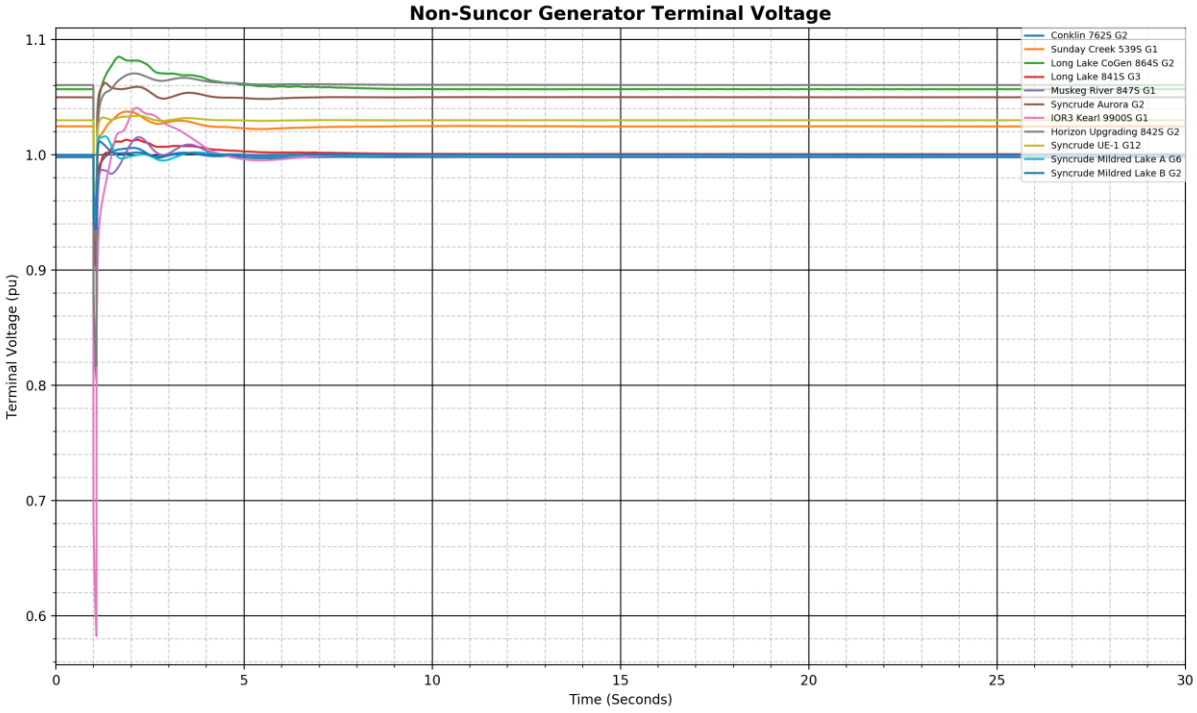
Figure A4-46: 9L69 (Black Fly 934S to McClelland 957S): Fault at McClelland 957S

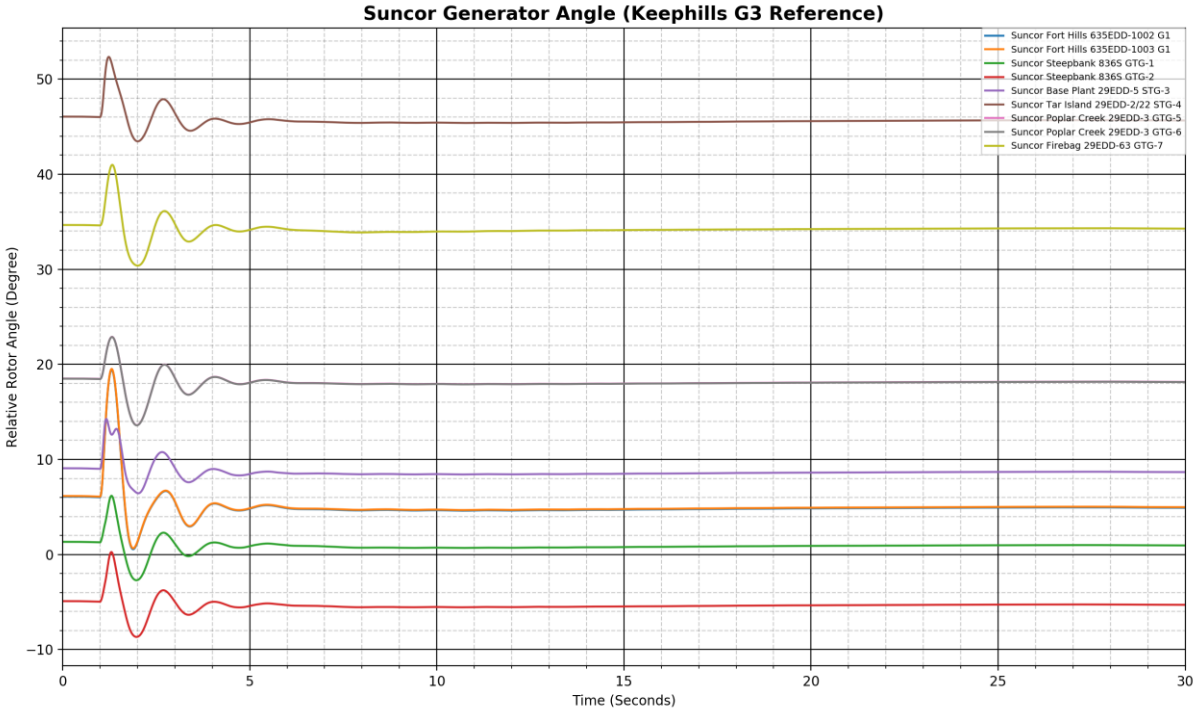


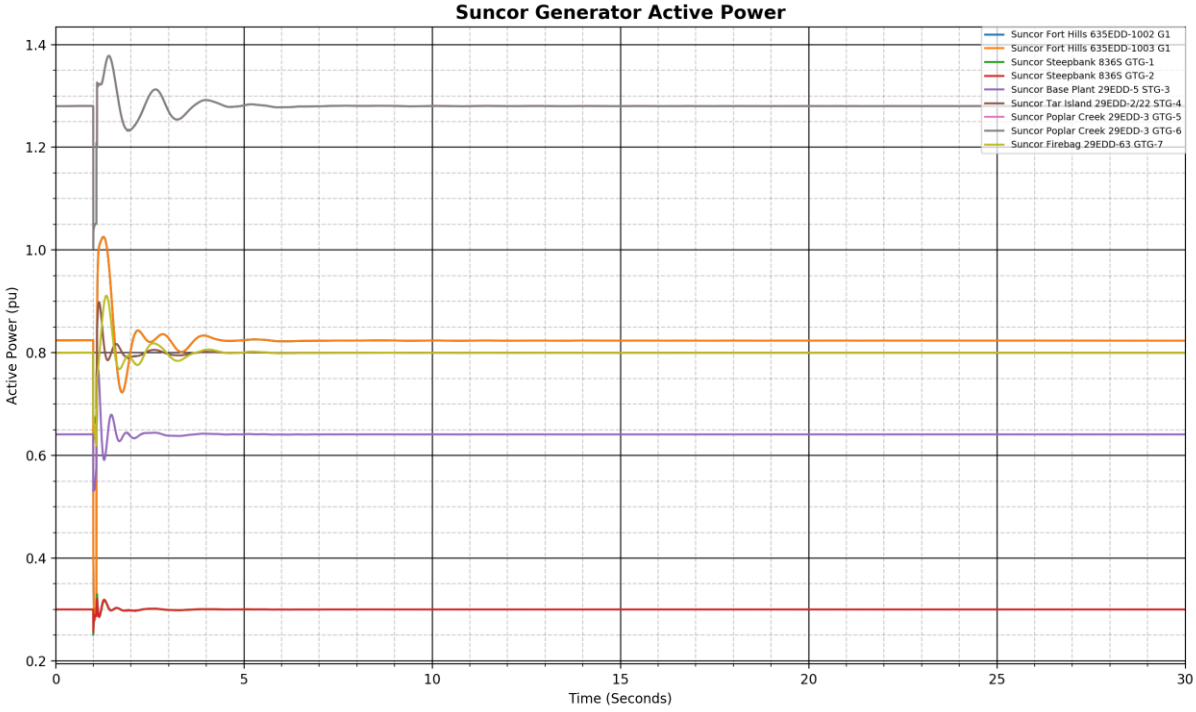

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

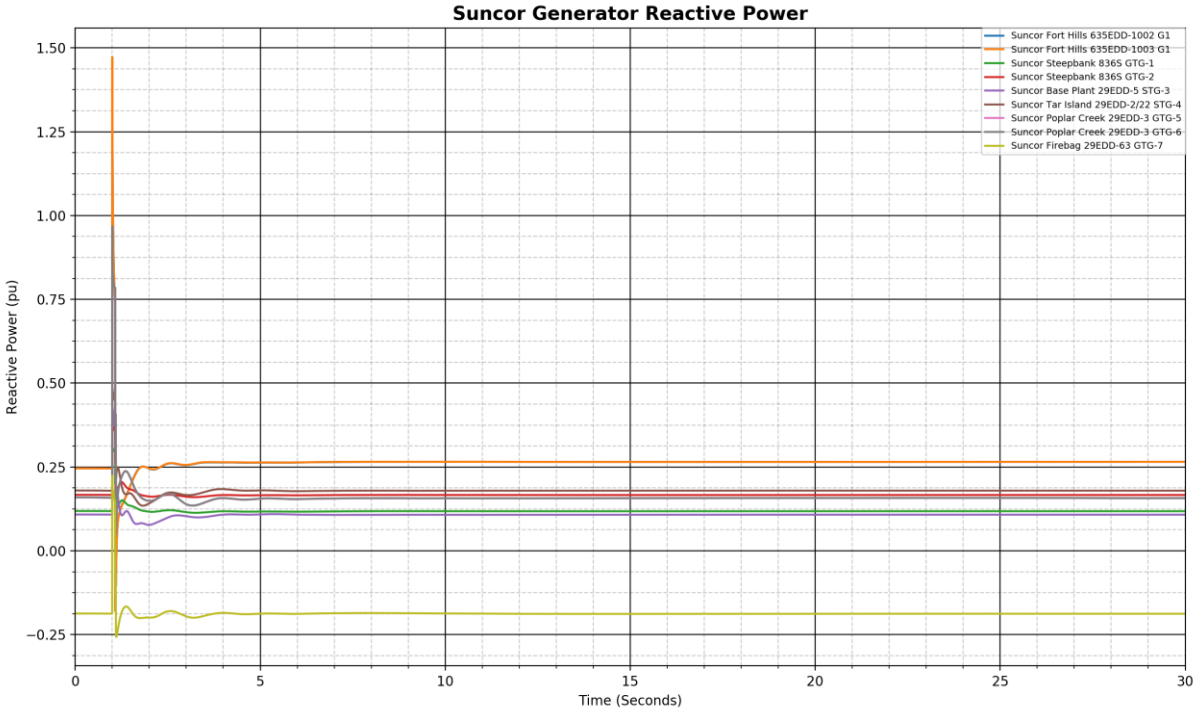

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

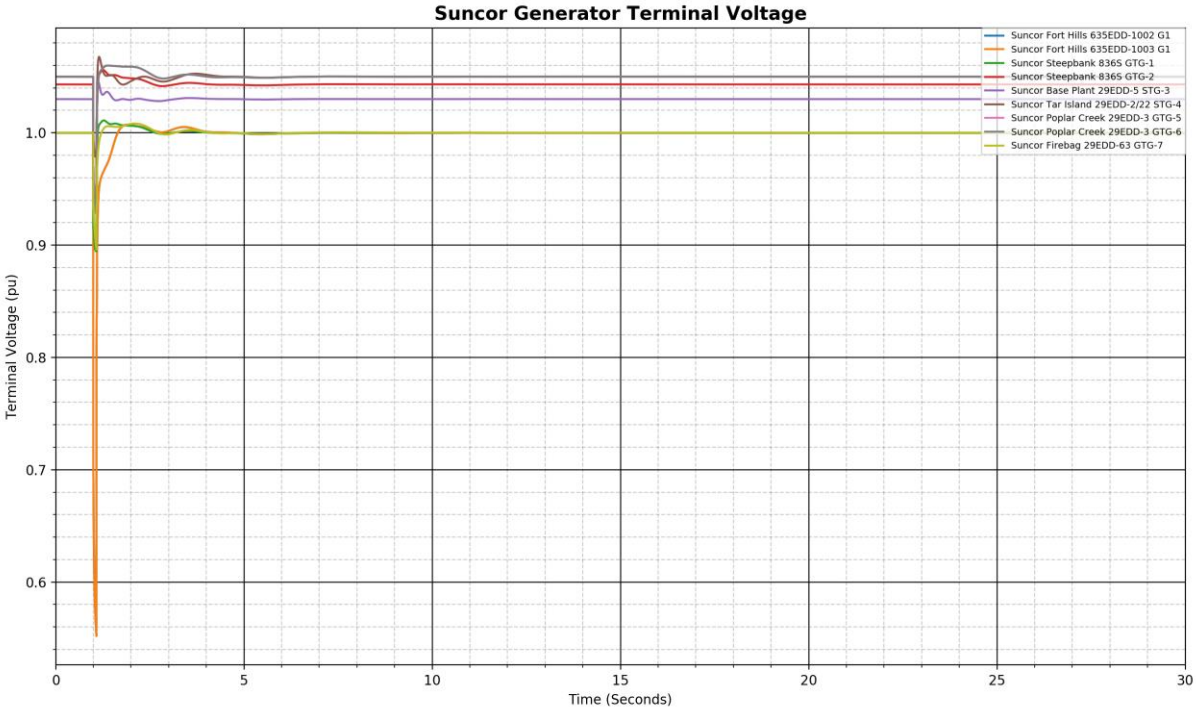

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

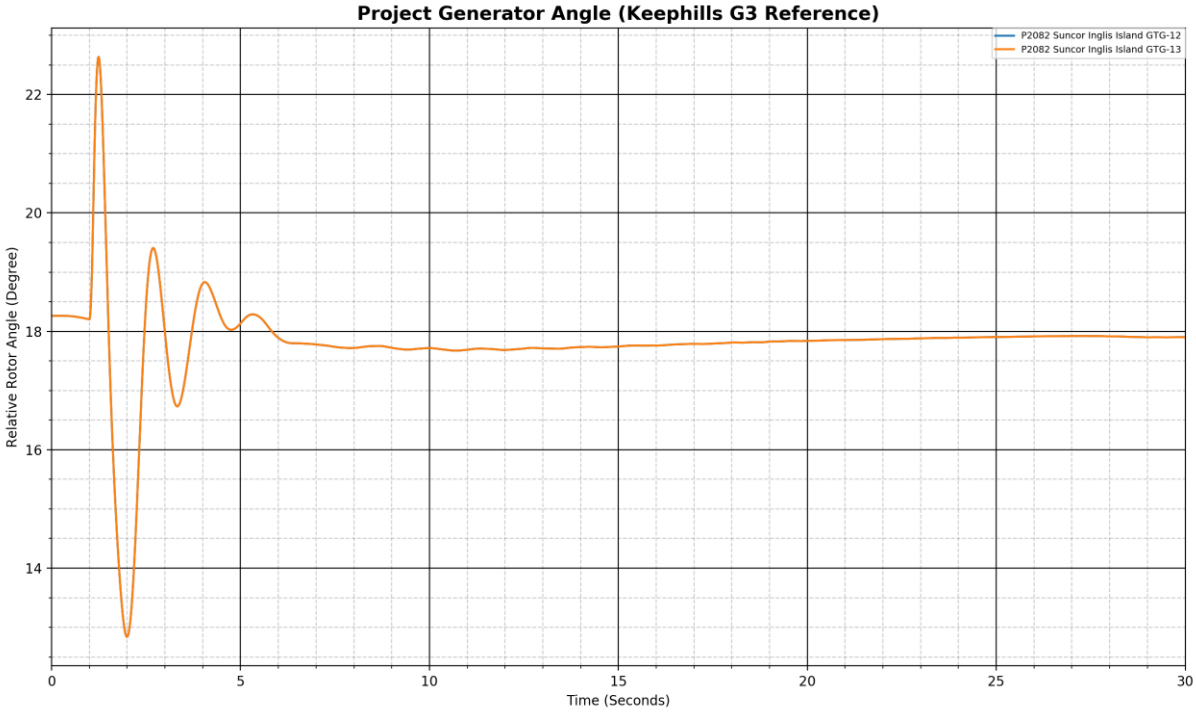

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

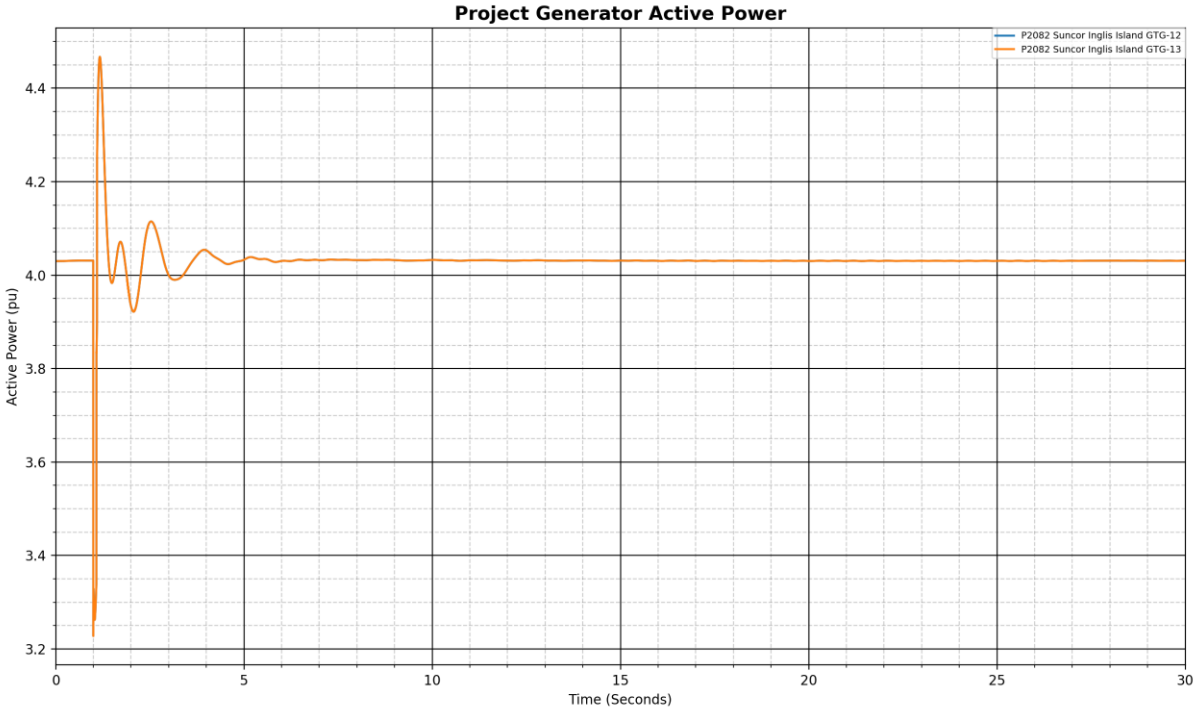

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

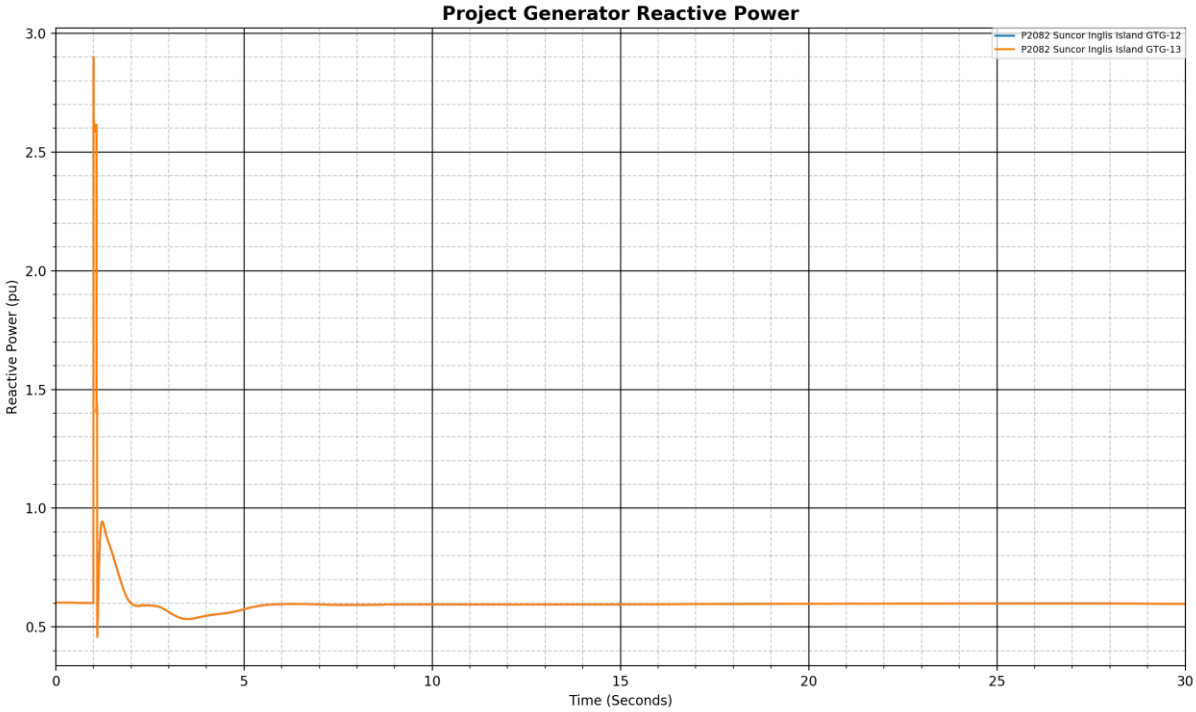

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

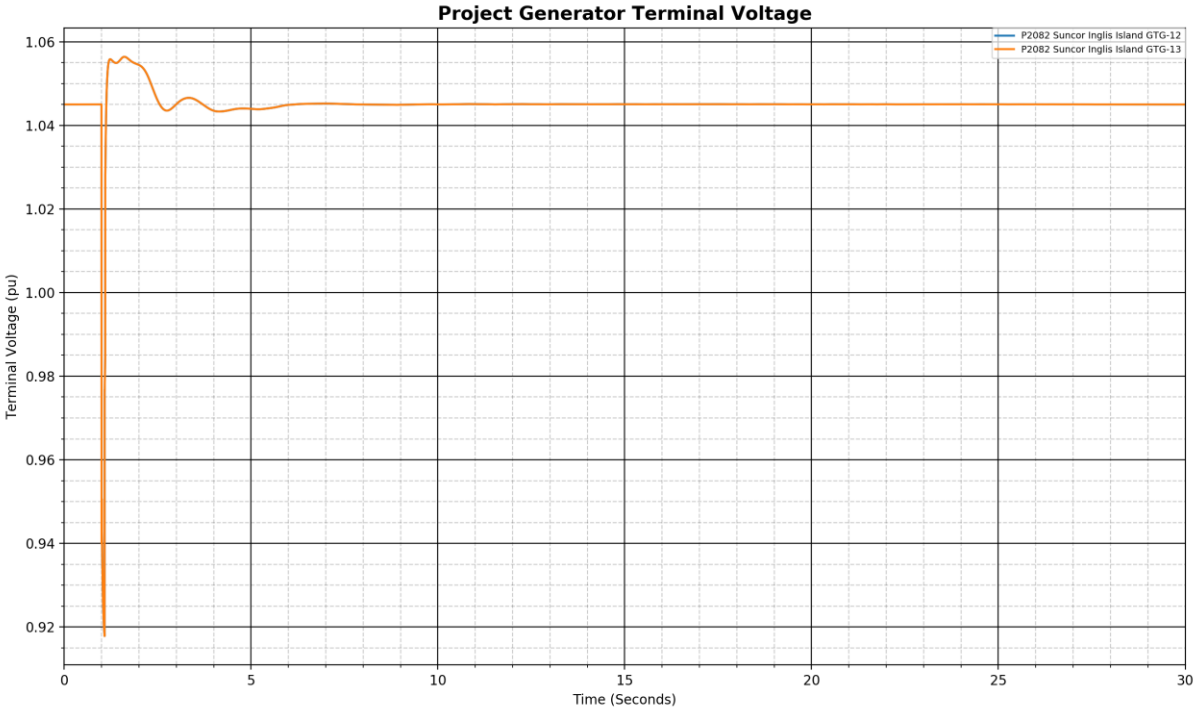

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

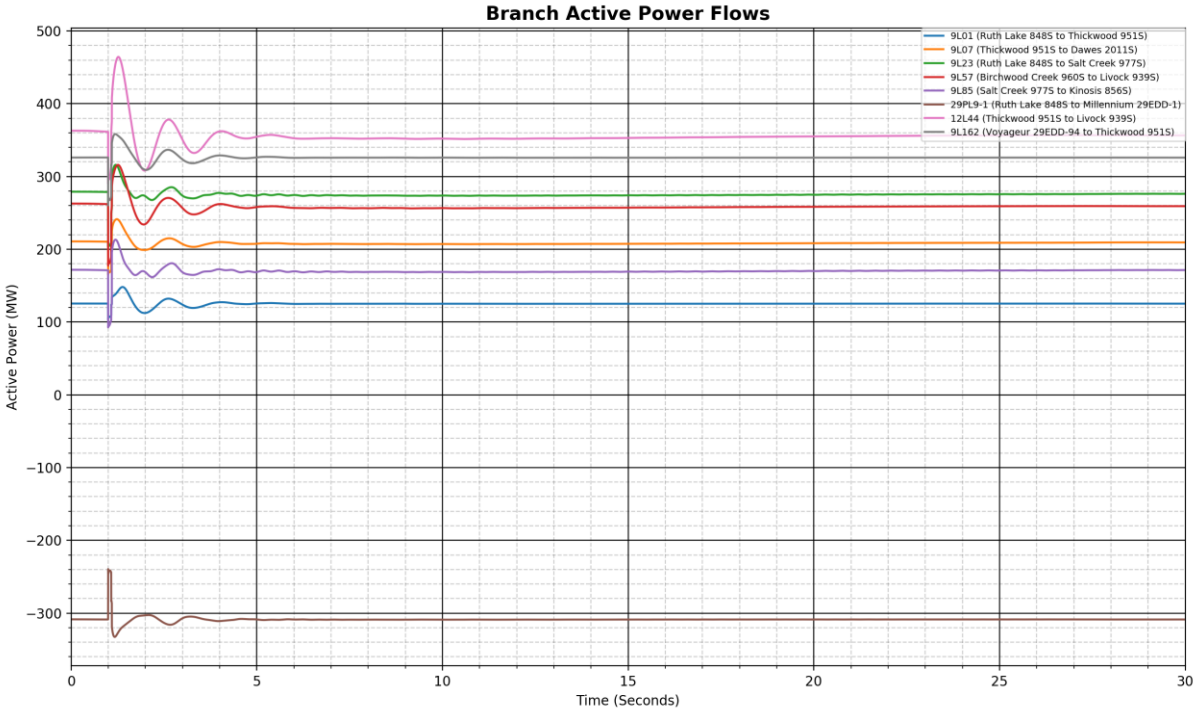

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
22
20
18
16
14
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.4
4.2
4.0
3.8
3.6
3.4
3.2
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

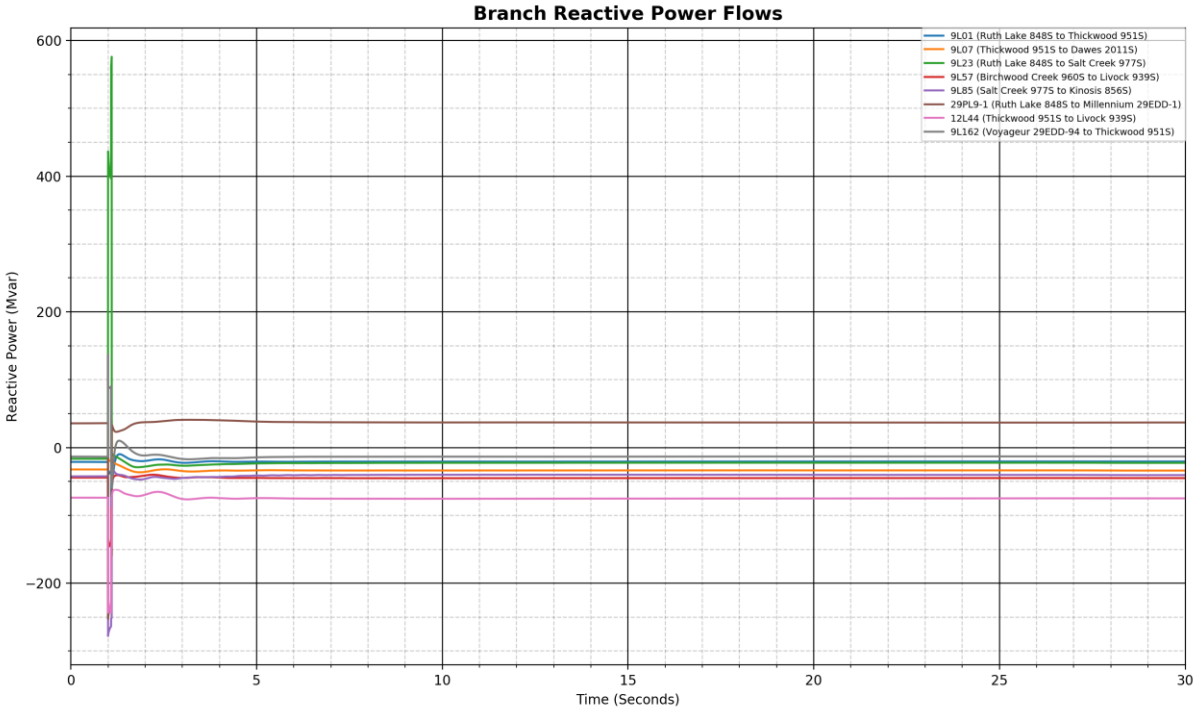
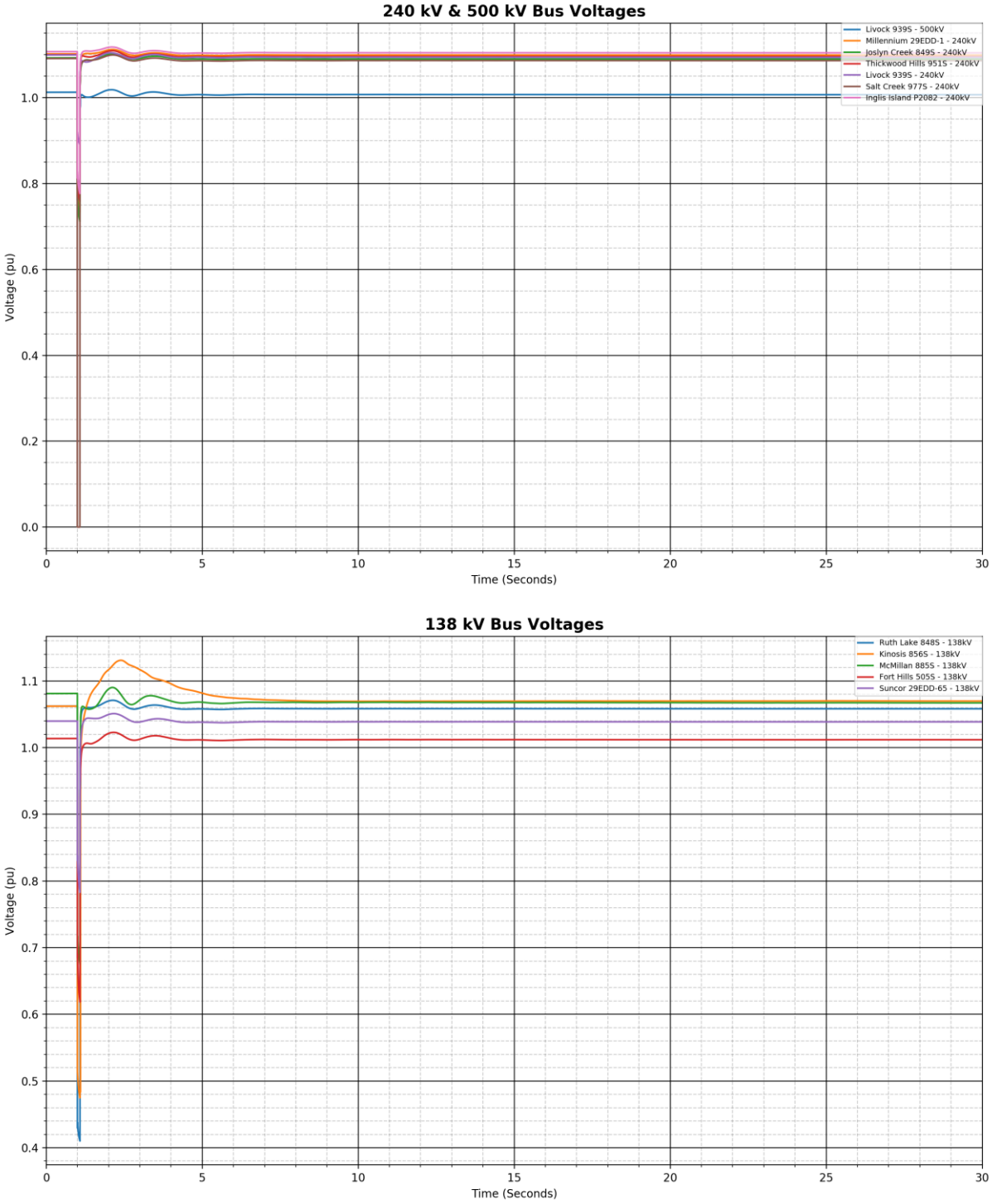
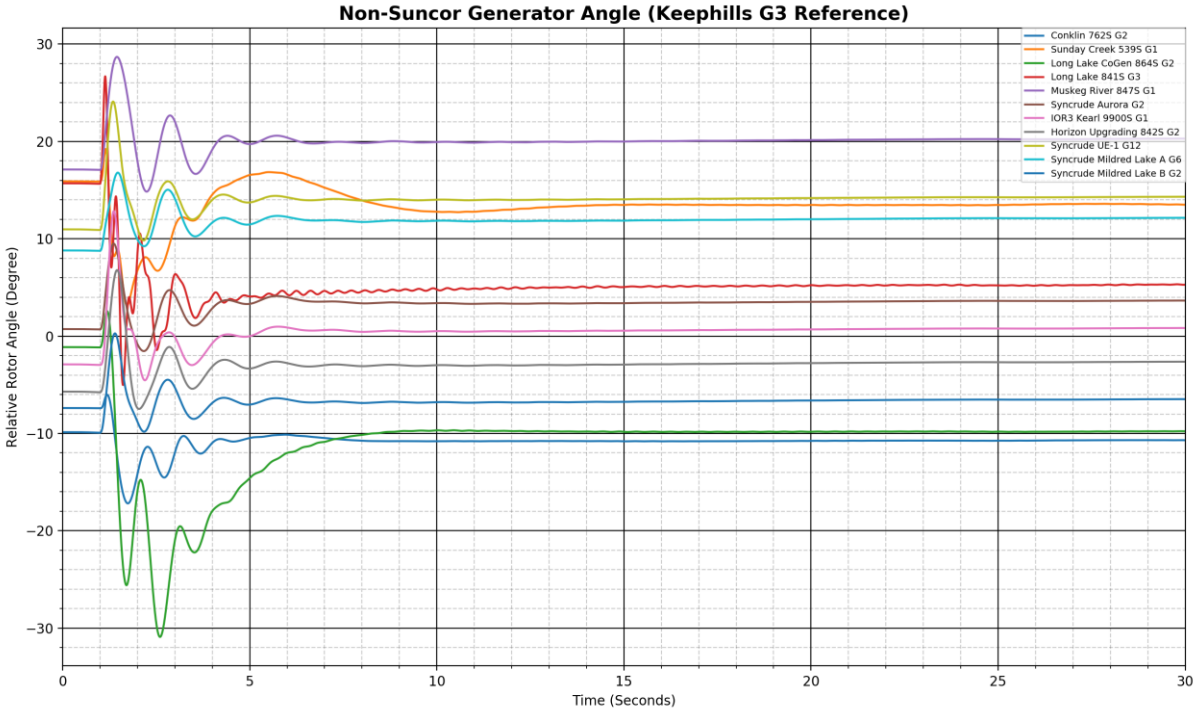
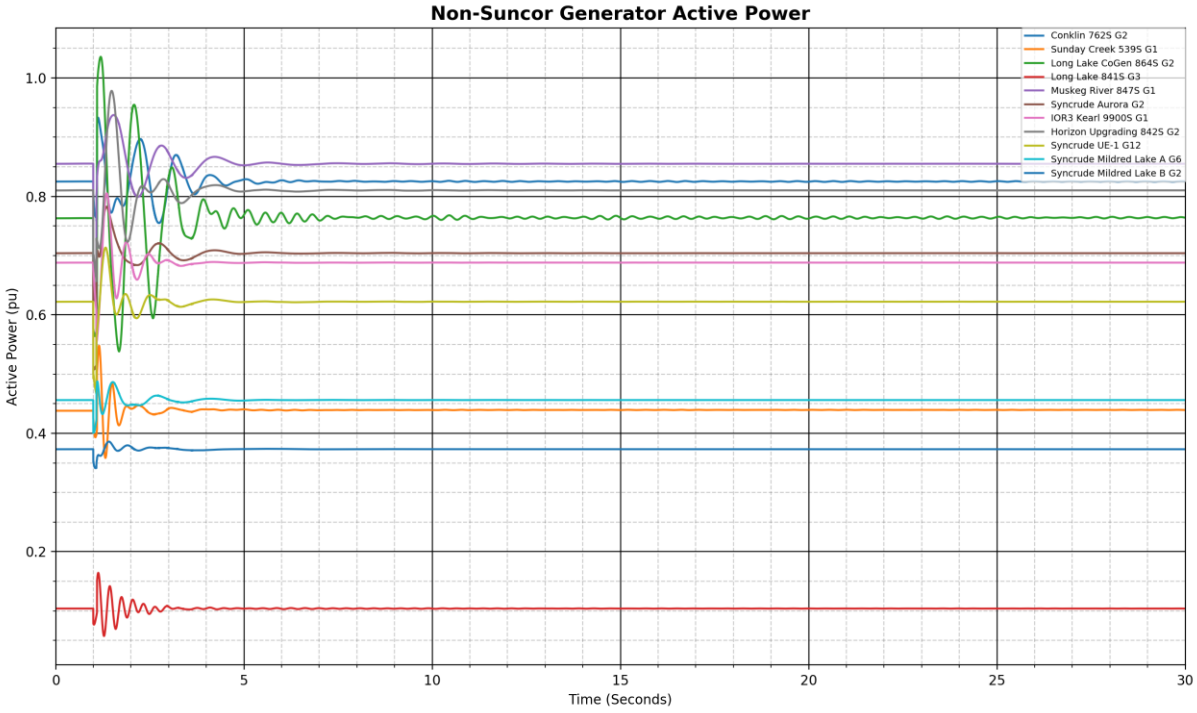
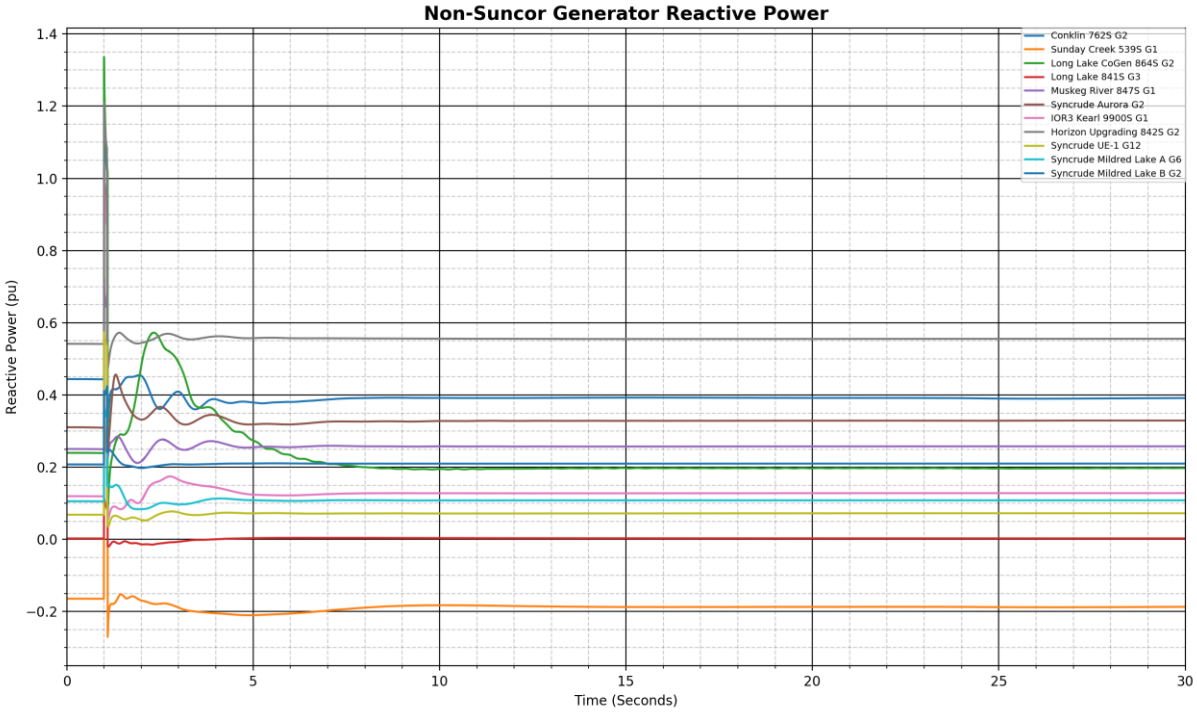

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

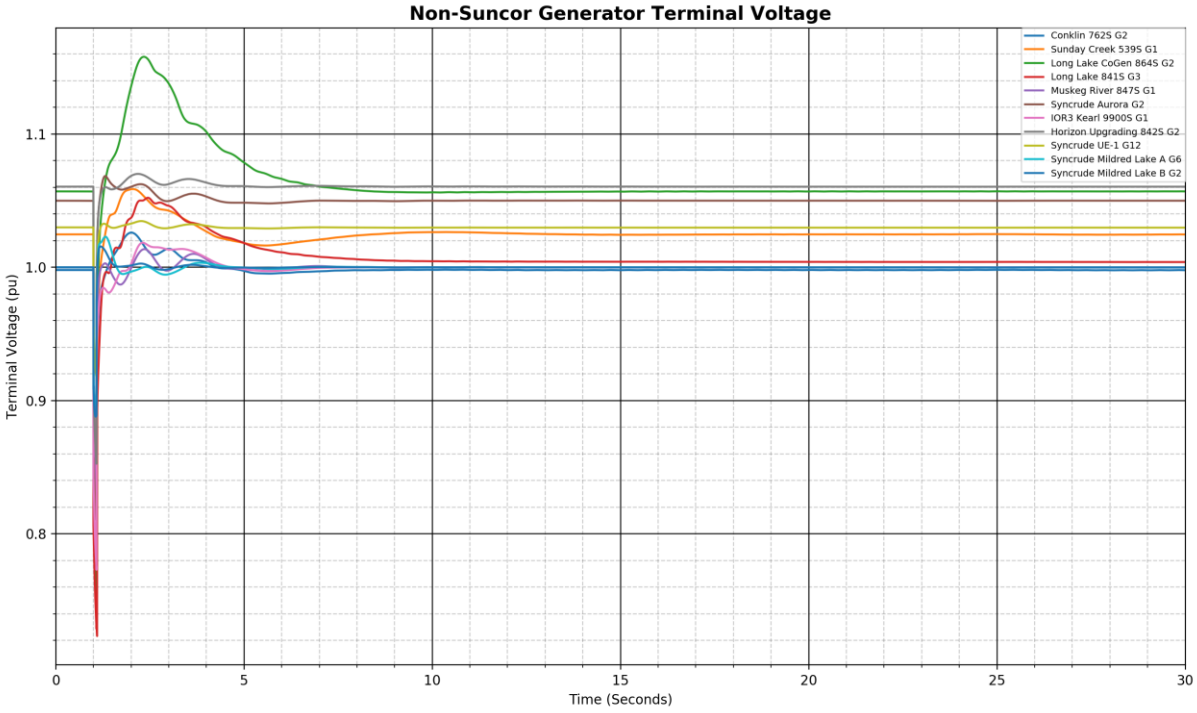
Figure A4-47: 9L85 (Salt Creek 977S to Kinosis 856S): Fault at Salt Creek 977S

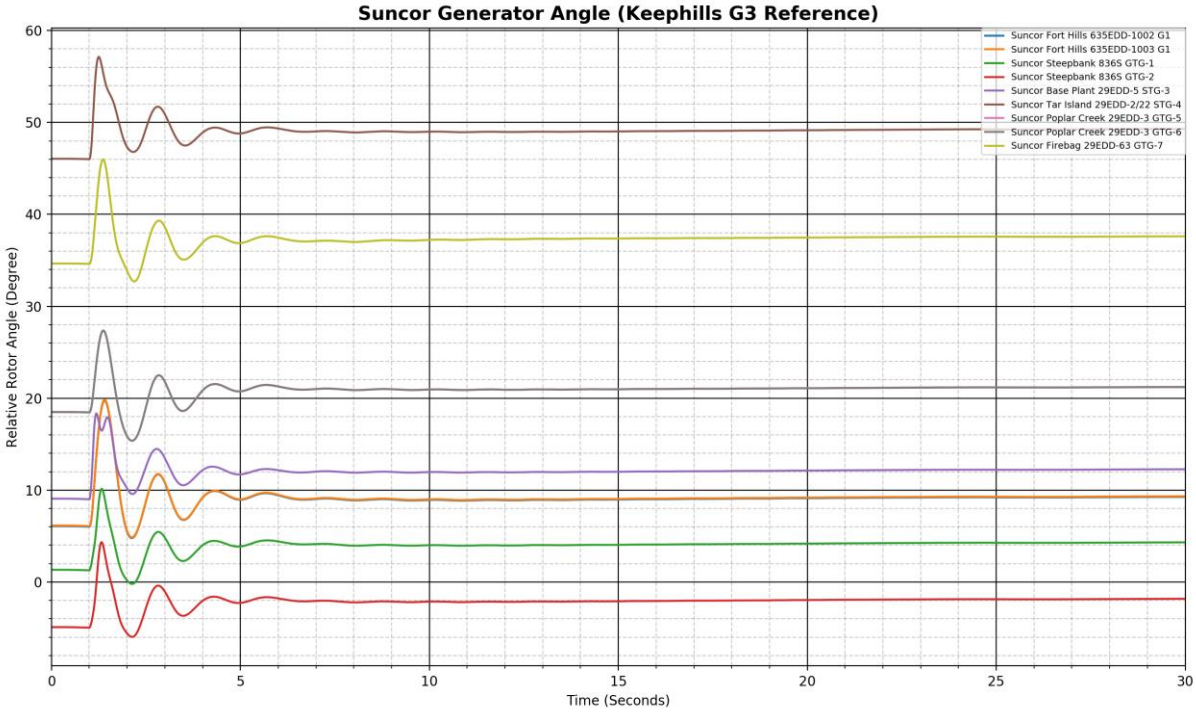


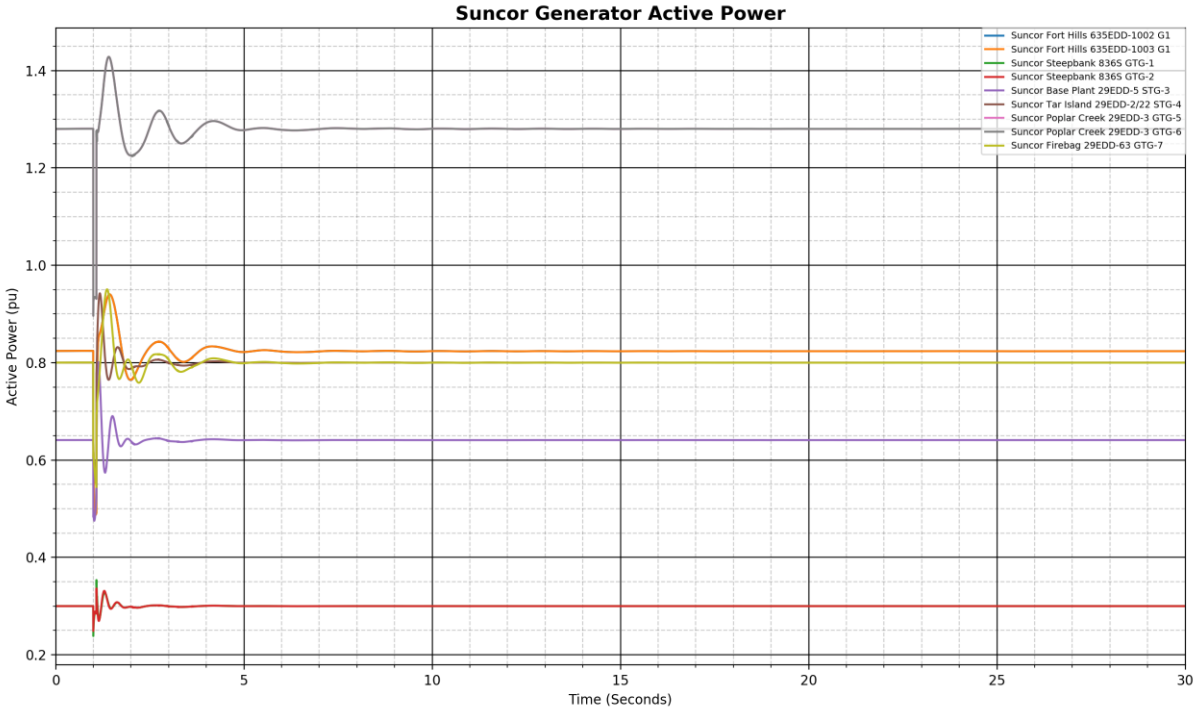

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

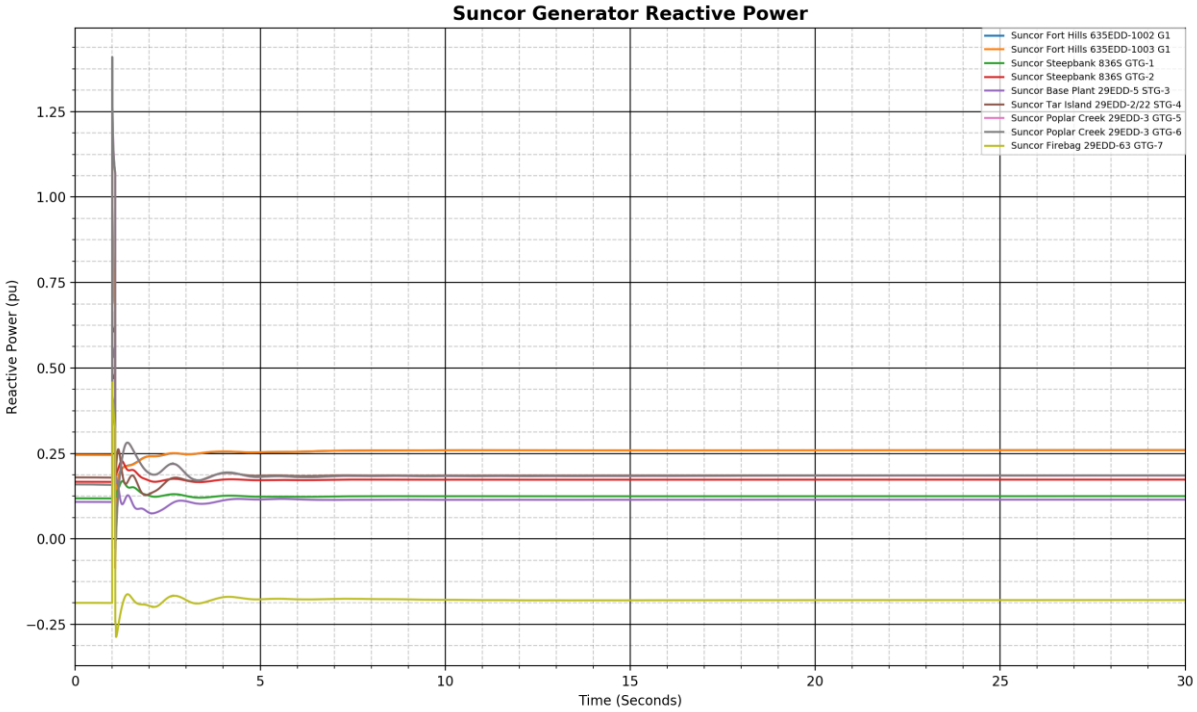

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

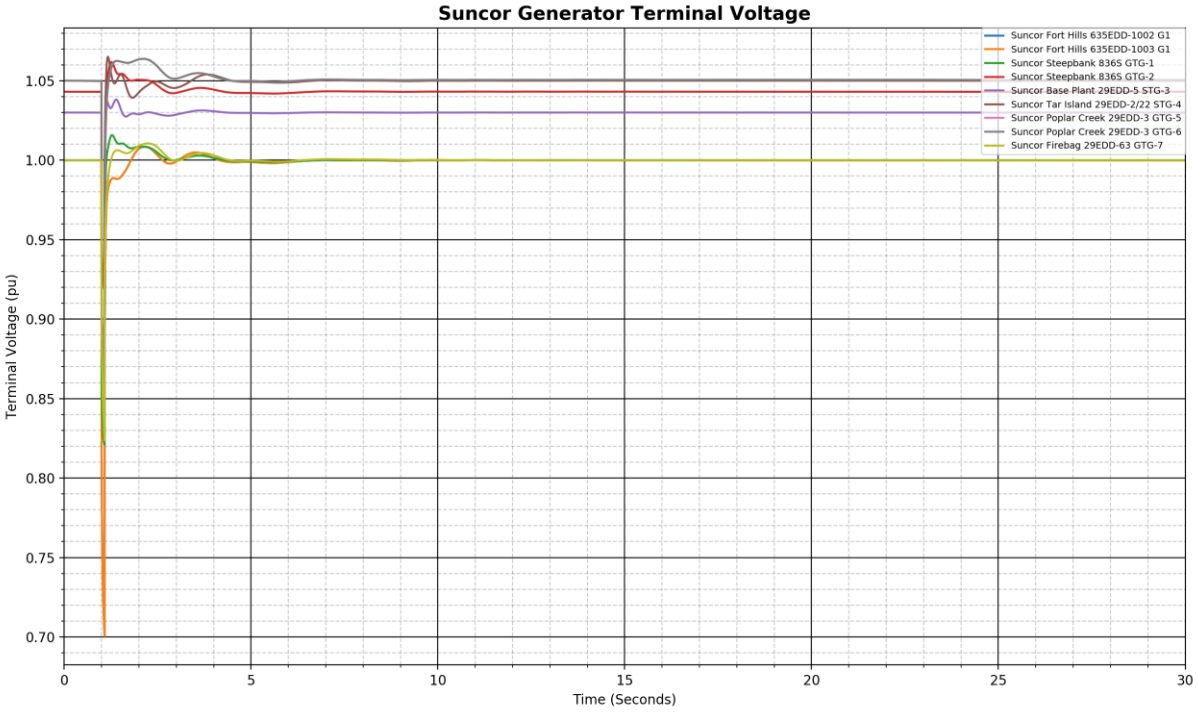

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

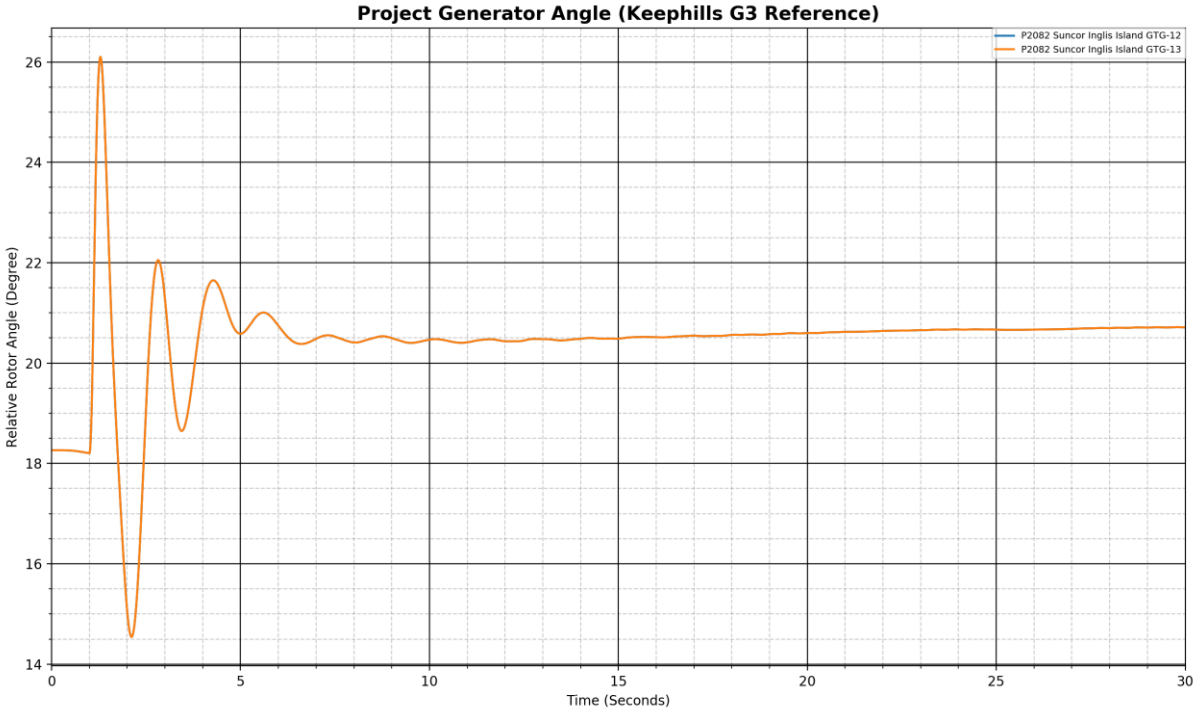

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

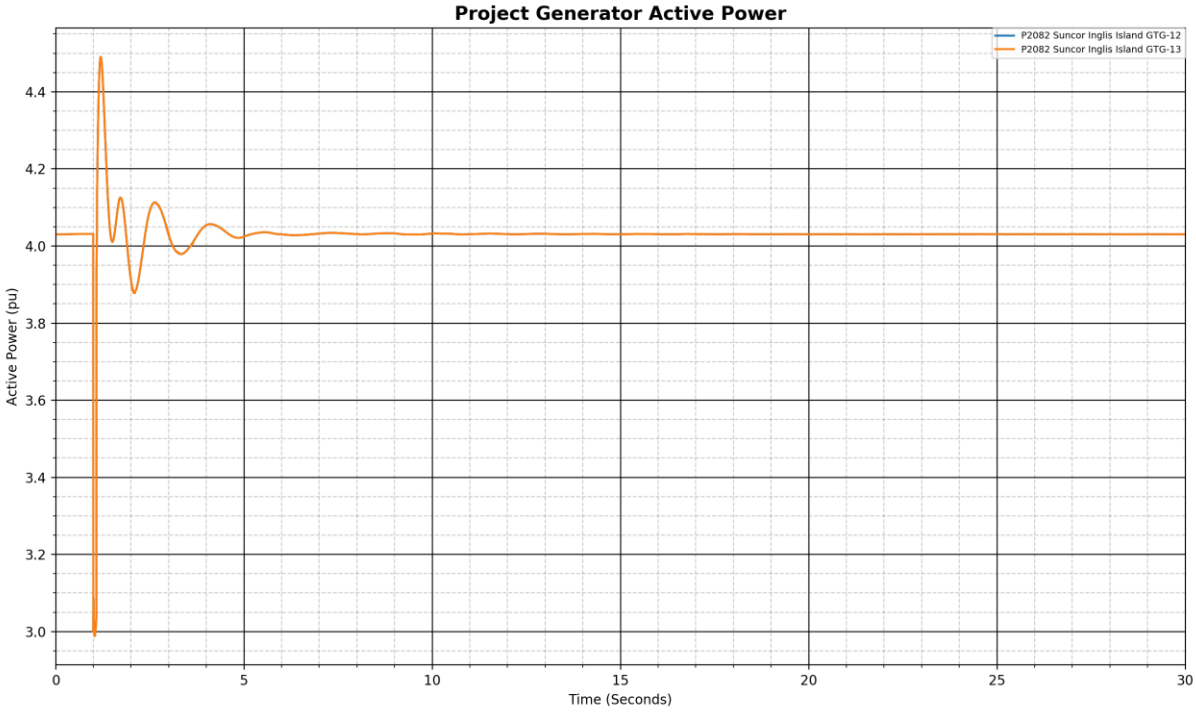

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

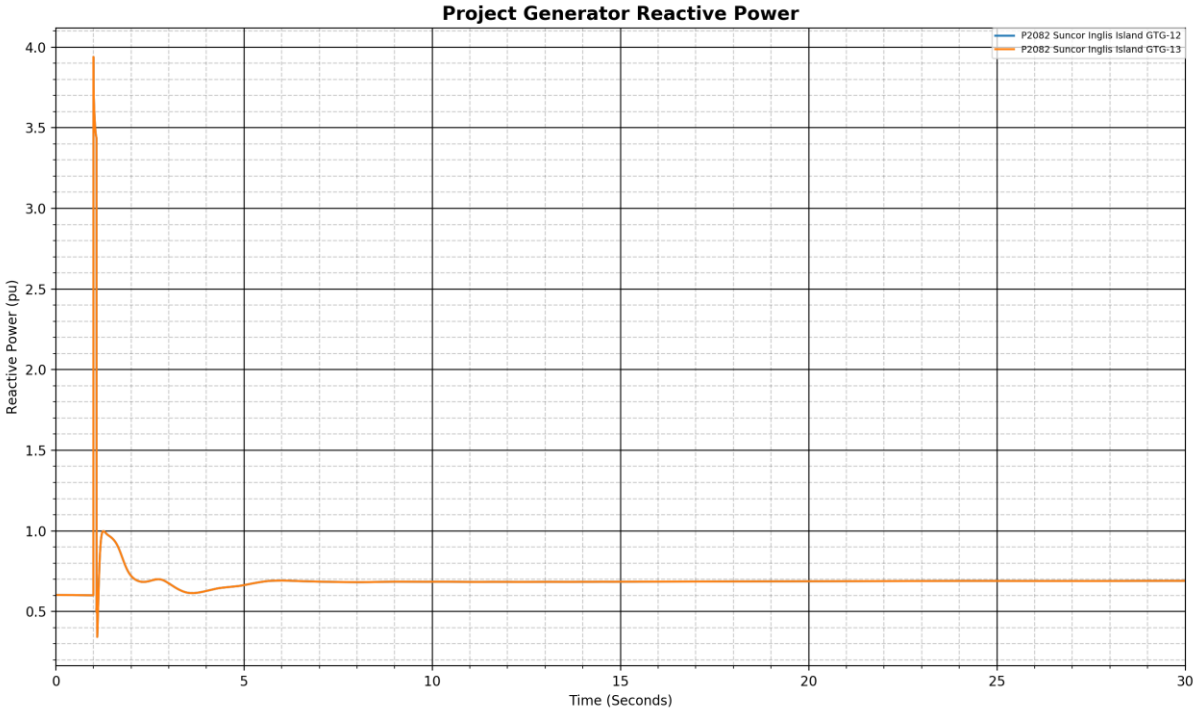

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

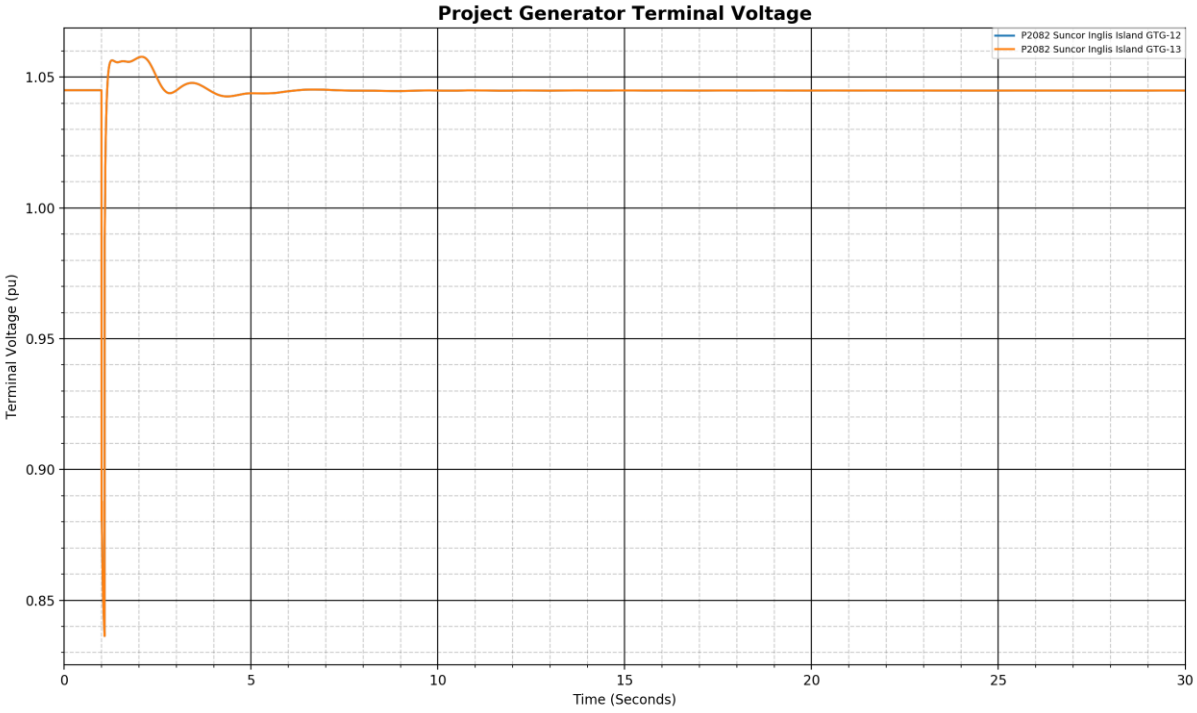

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

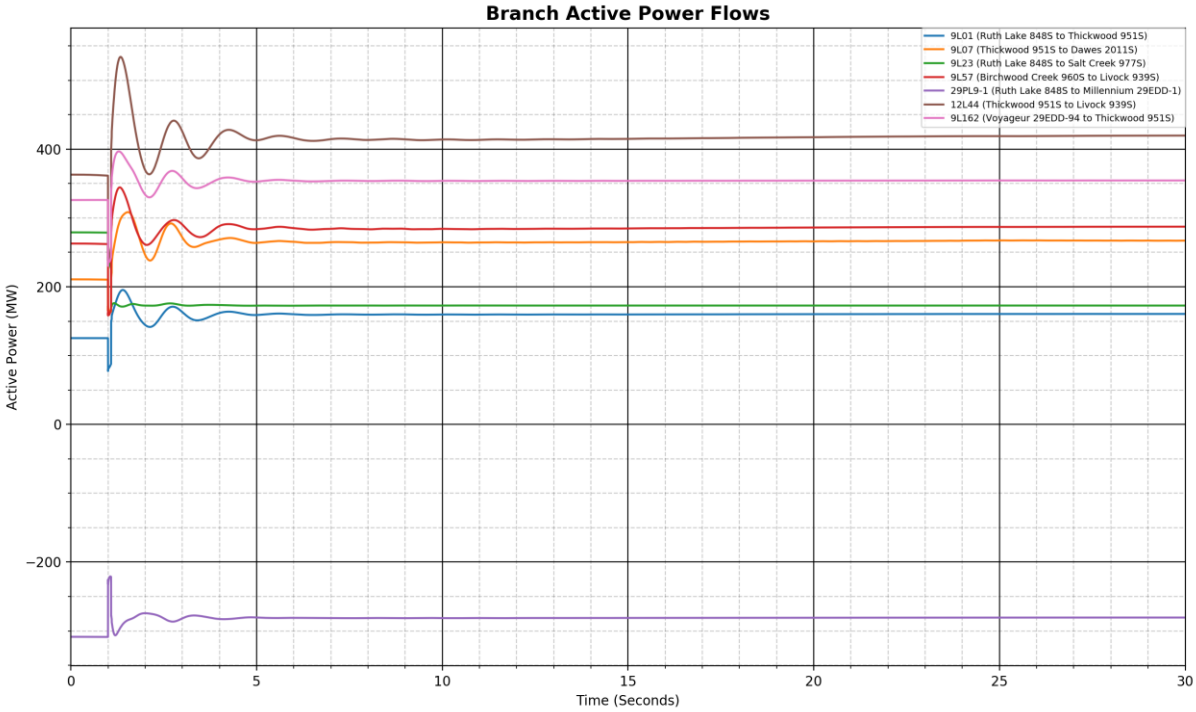

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
26
24
22
20
18
16
14
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

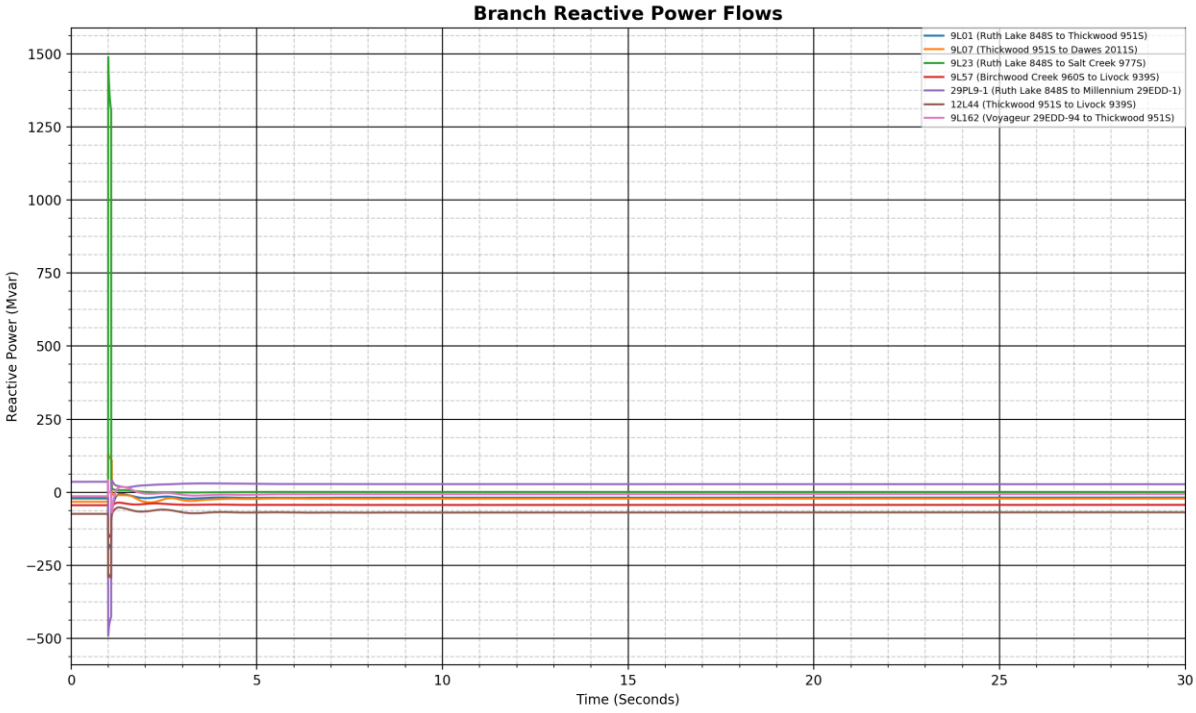
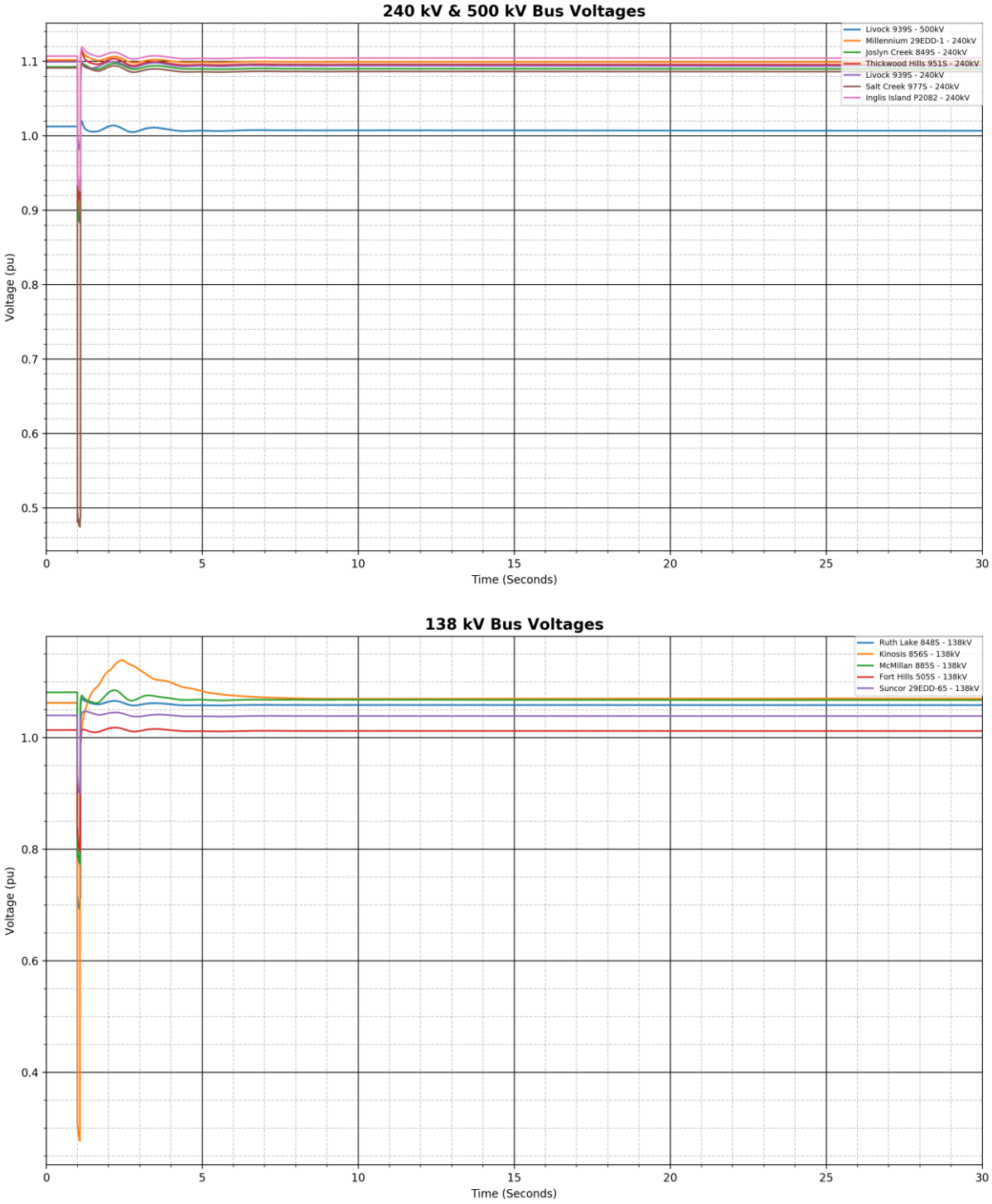
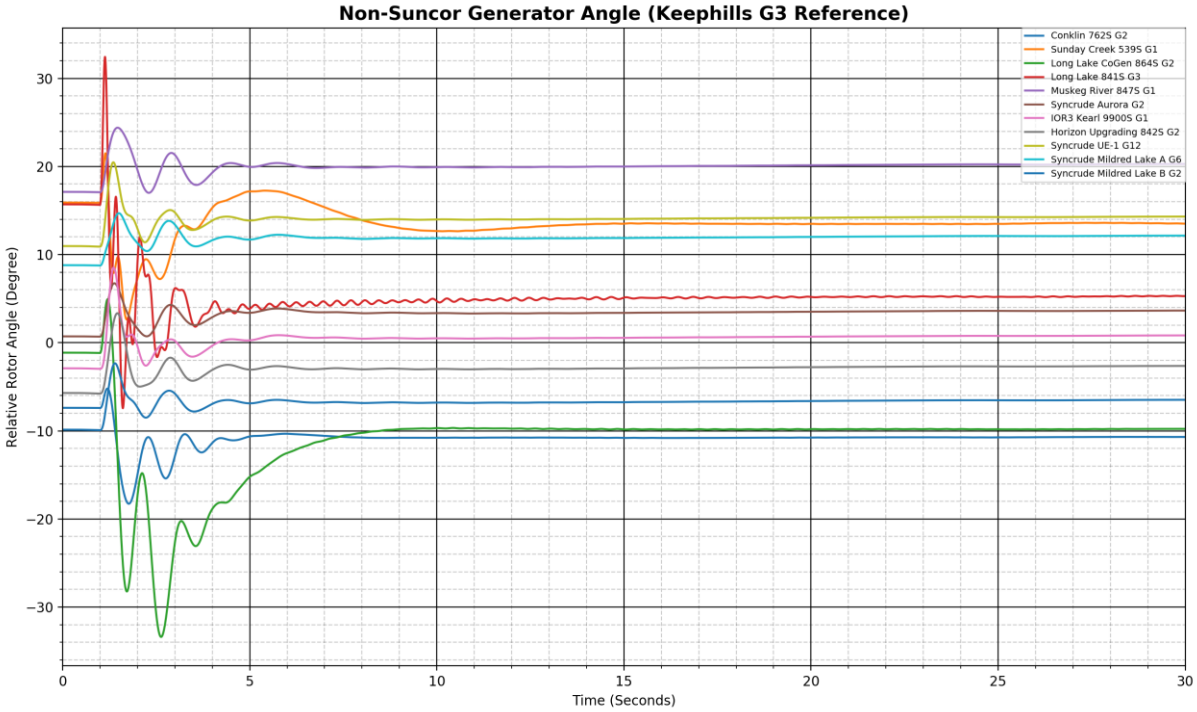
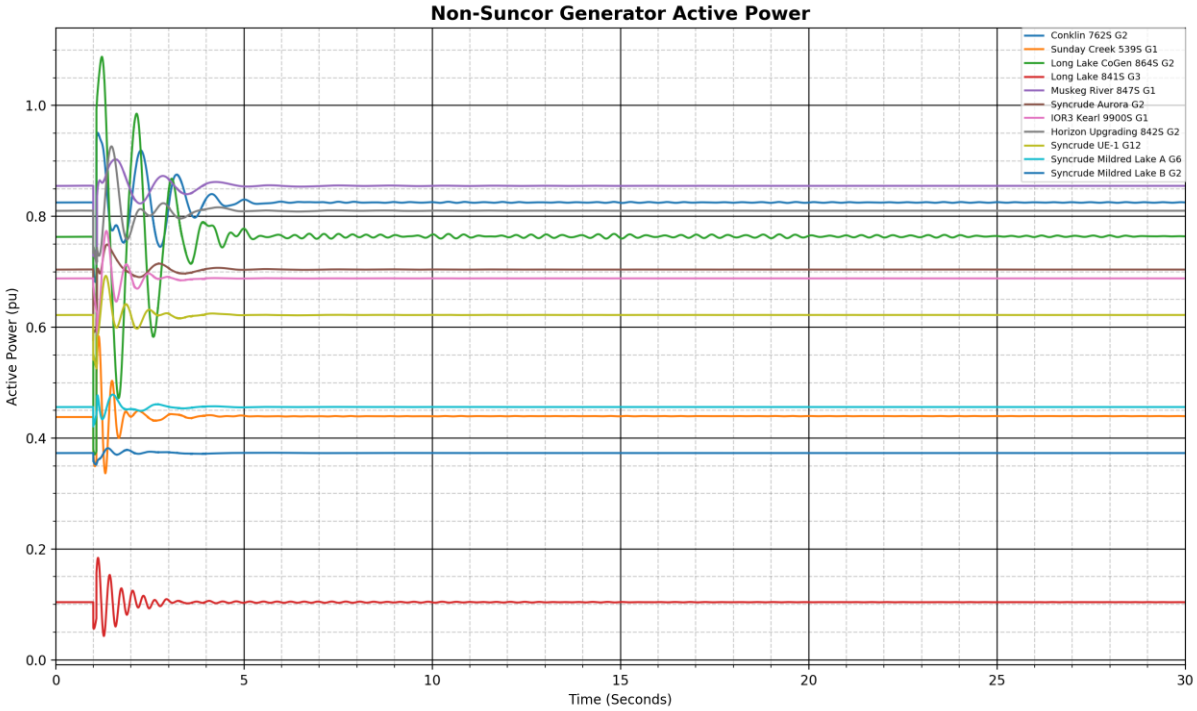
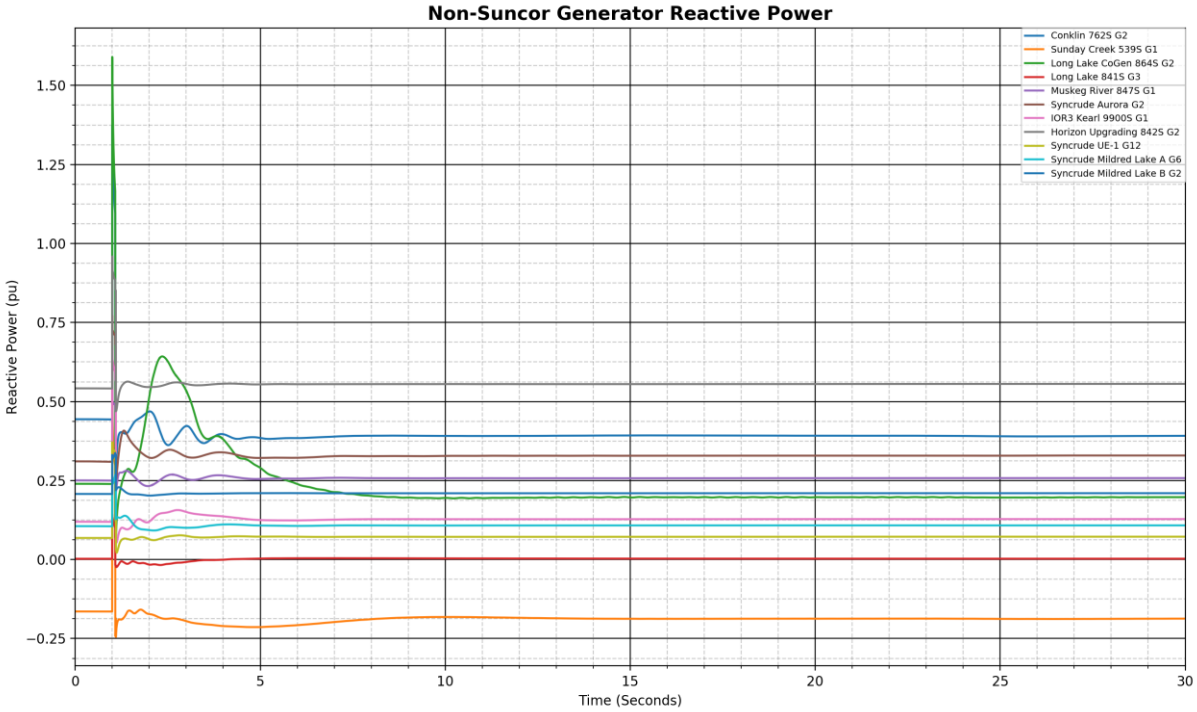

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
1500
1250
1000
750
500
250
0
−250
−500
0
5
10
15
20
25
30
Time (Seconds)

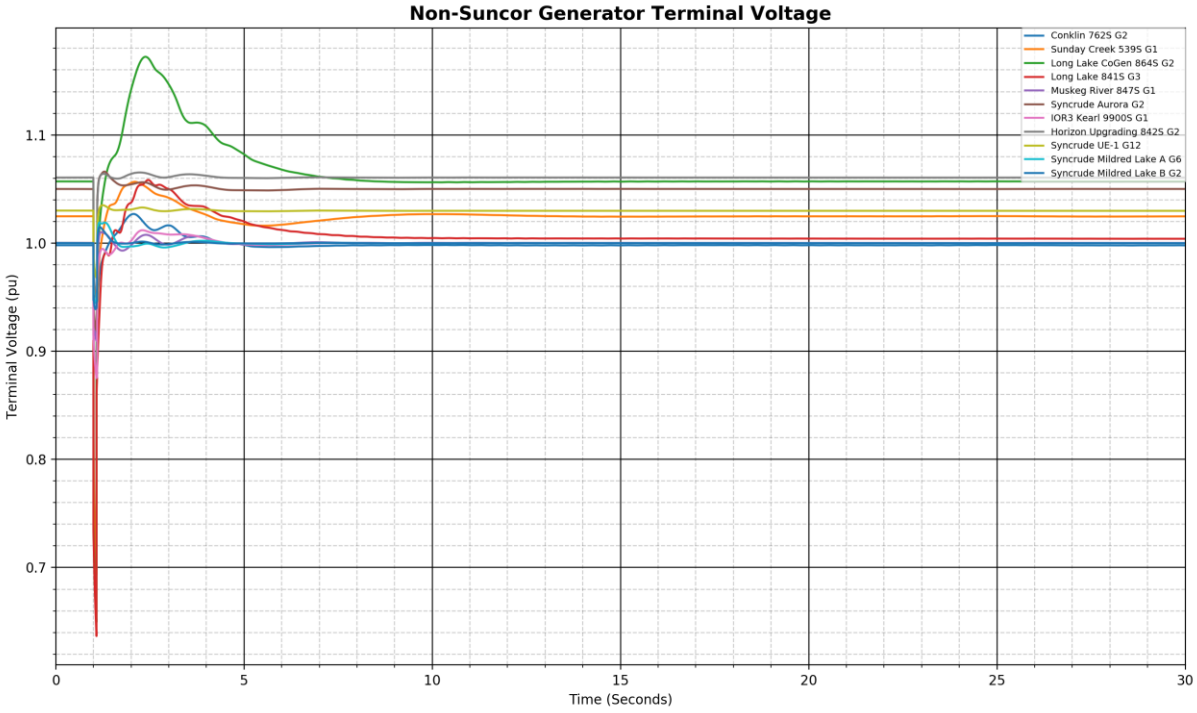
Figure A4-48: 9L85 (Salt Creek 977S to Kinosis 856S): Fault at Kinosis 856S

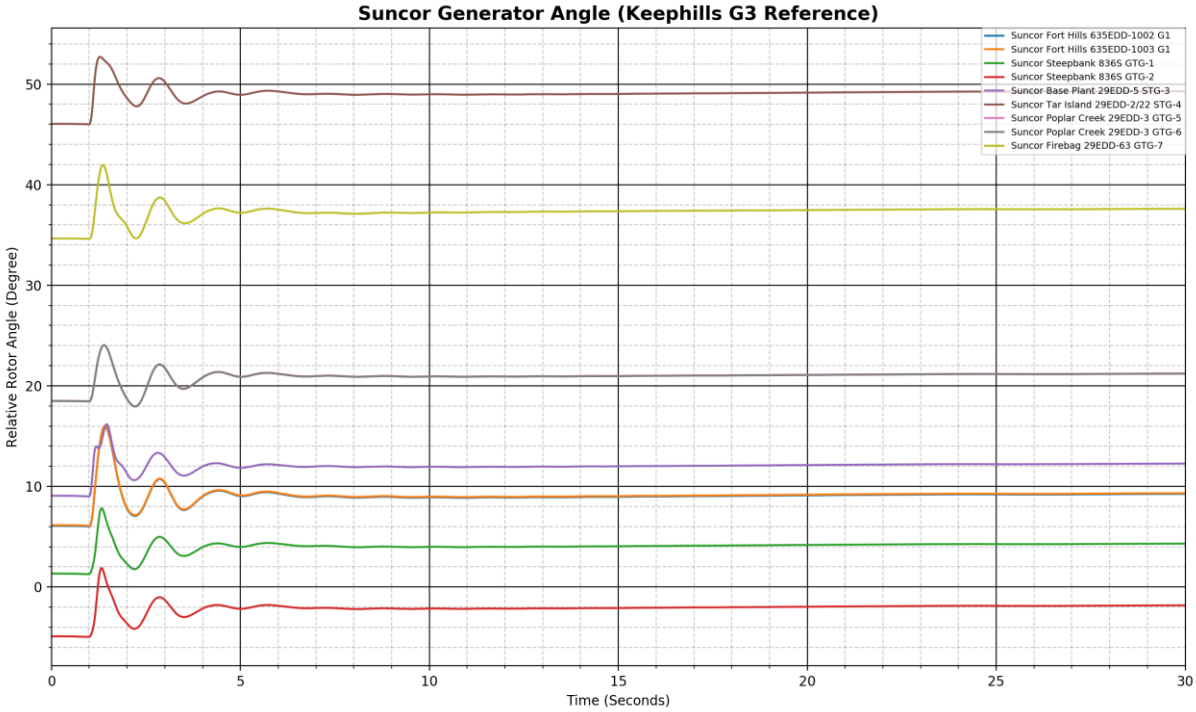


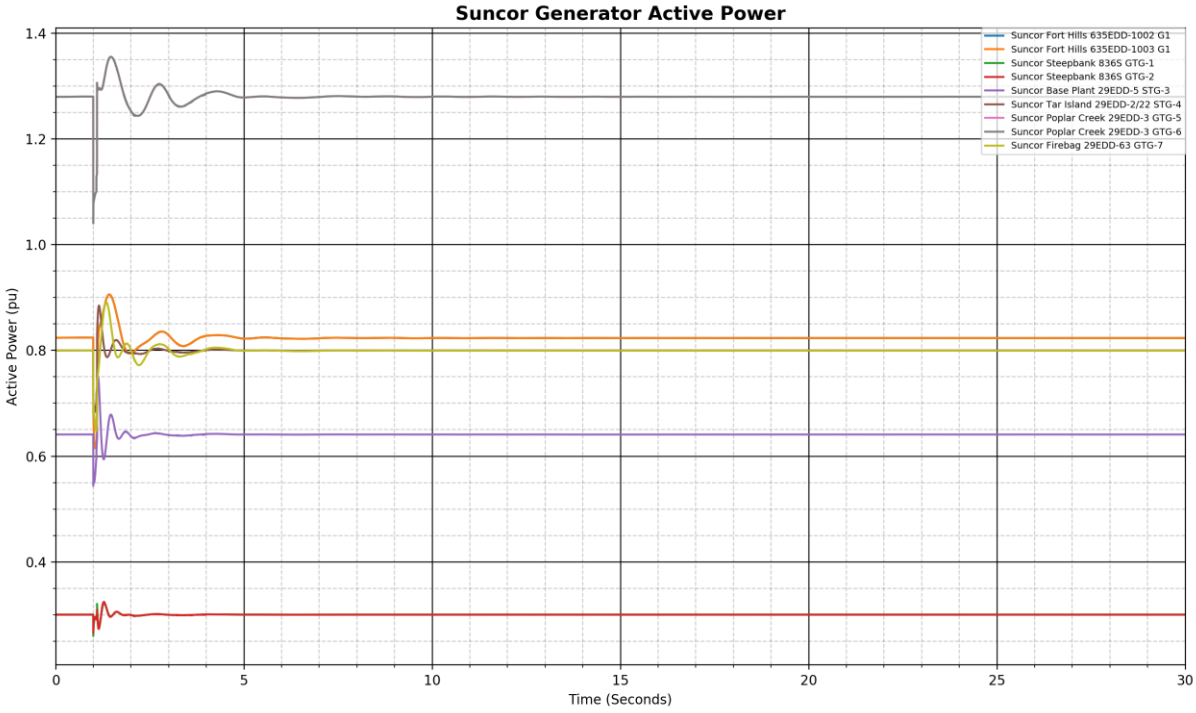

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

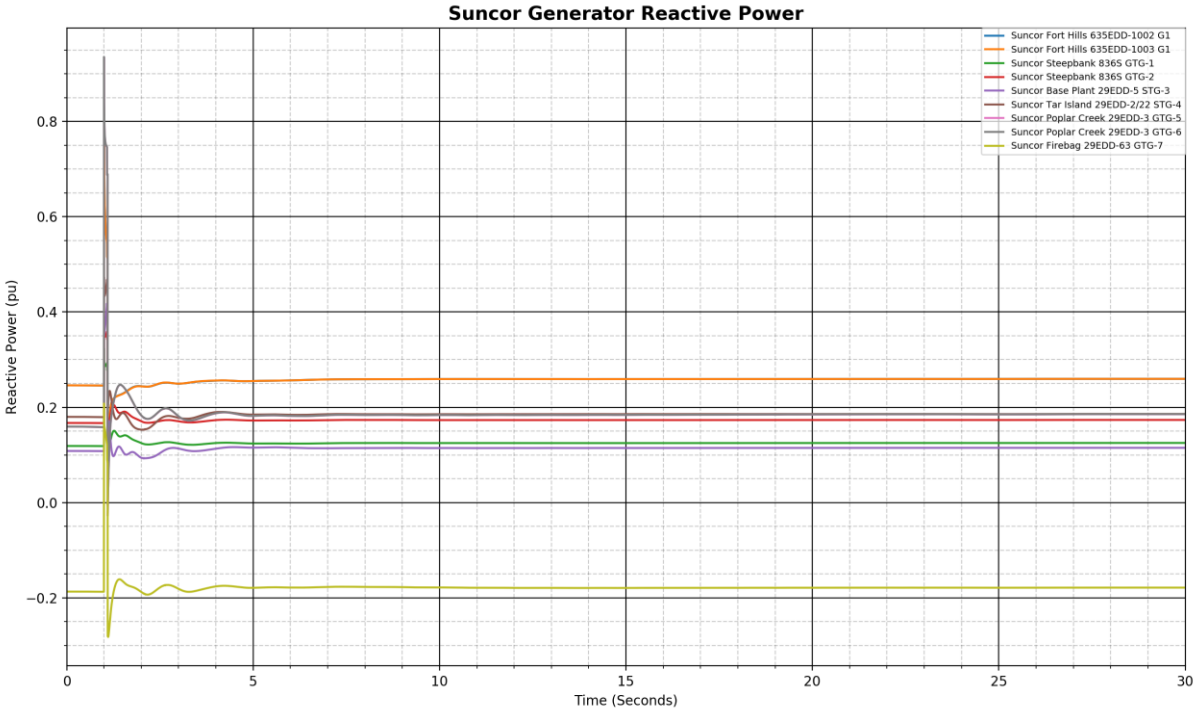

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

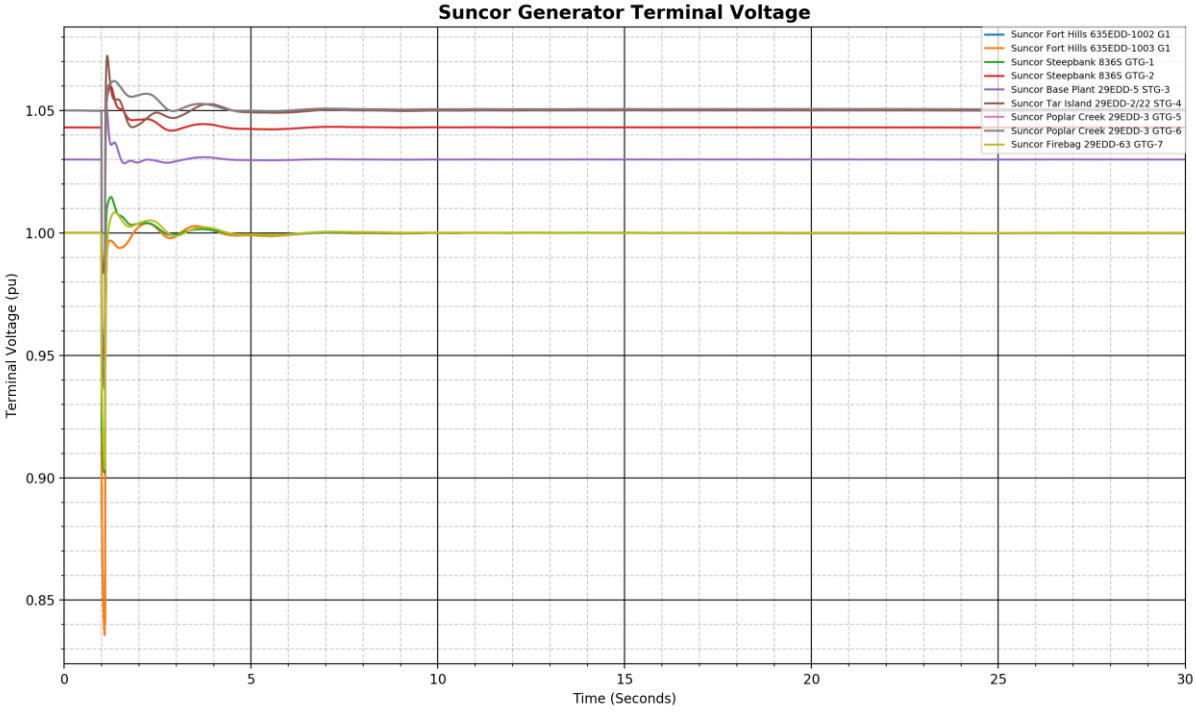

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

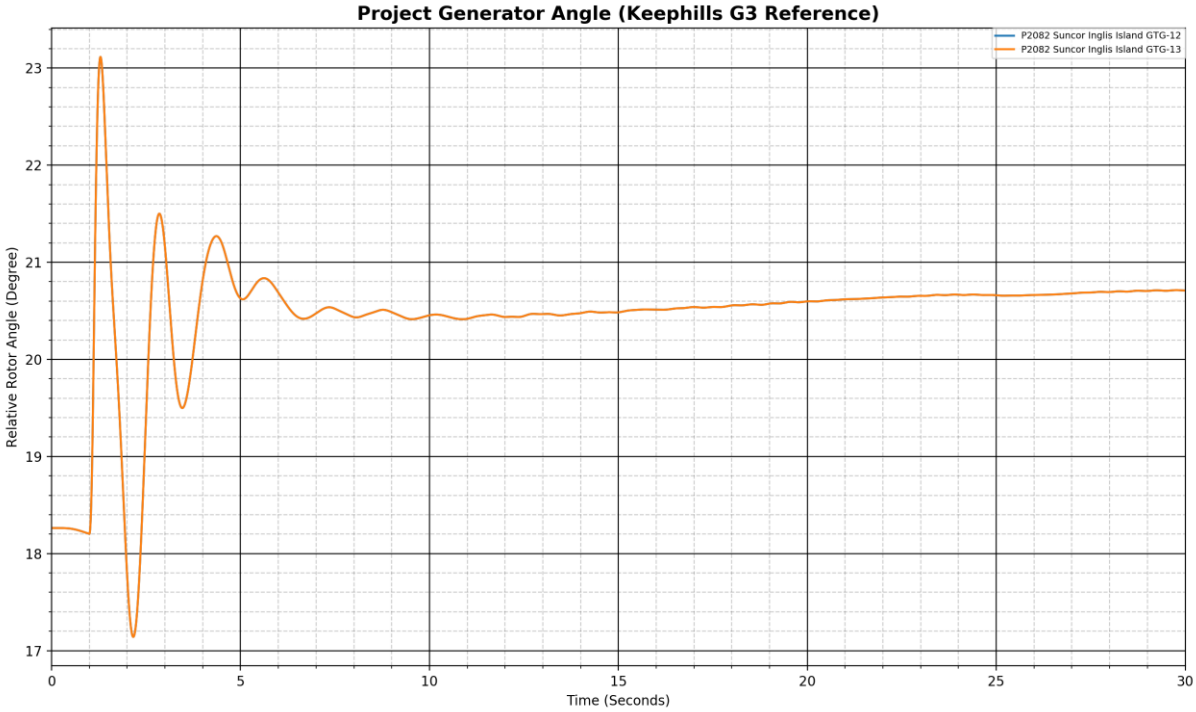

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

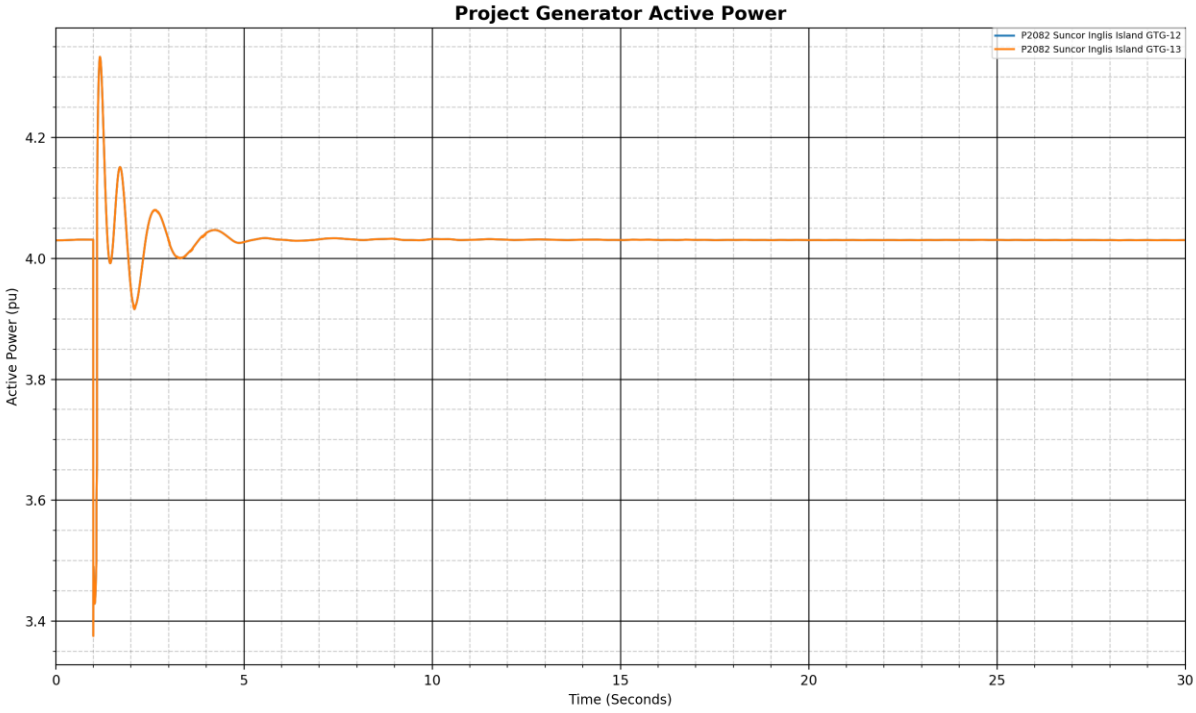

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

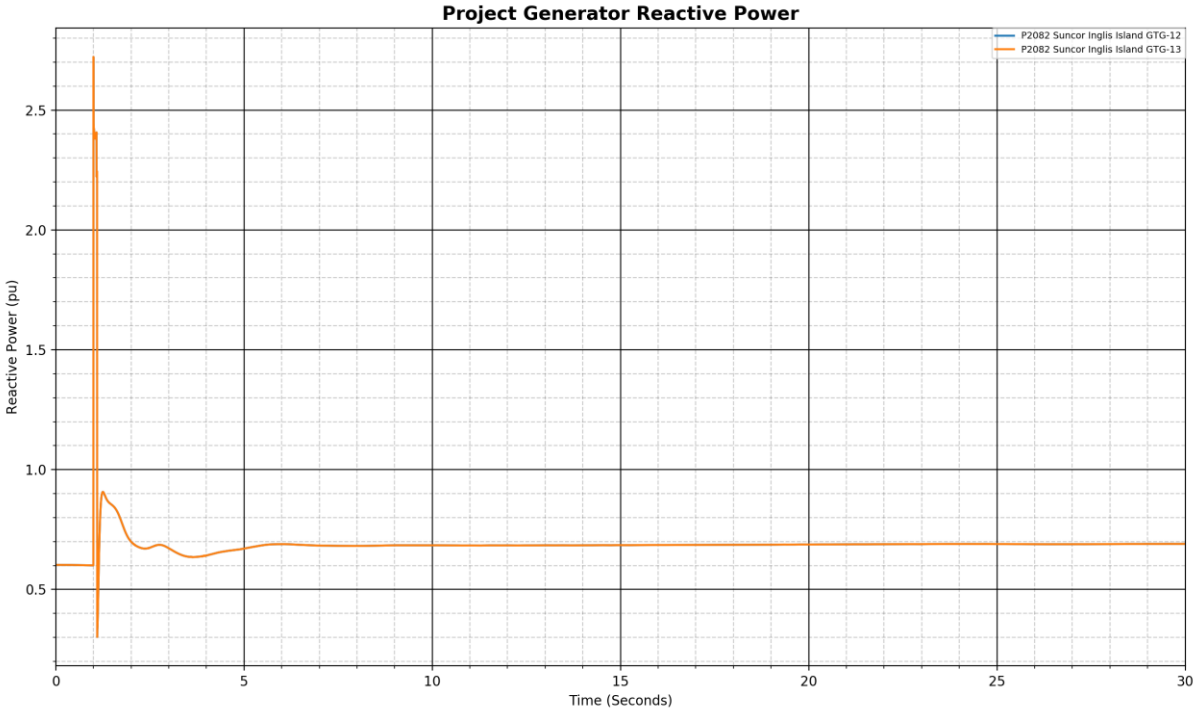

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

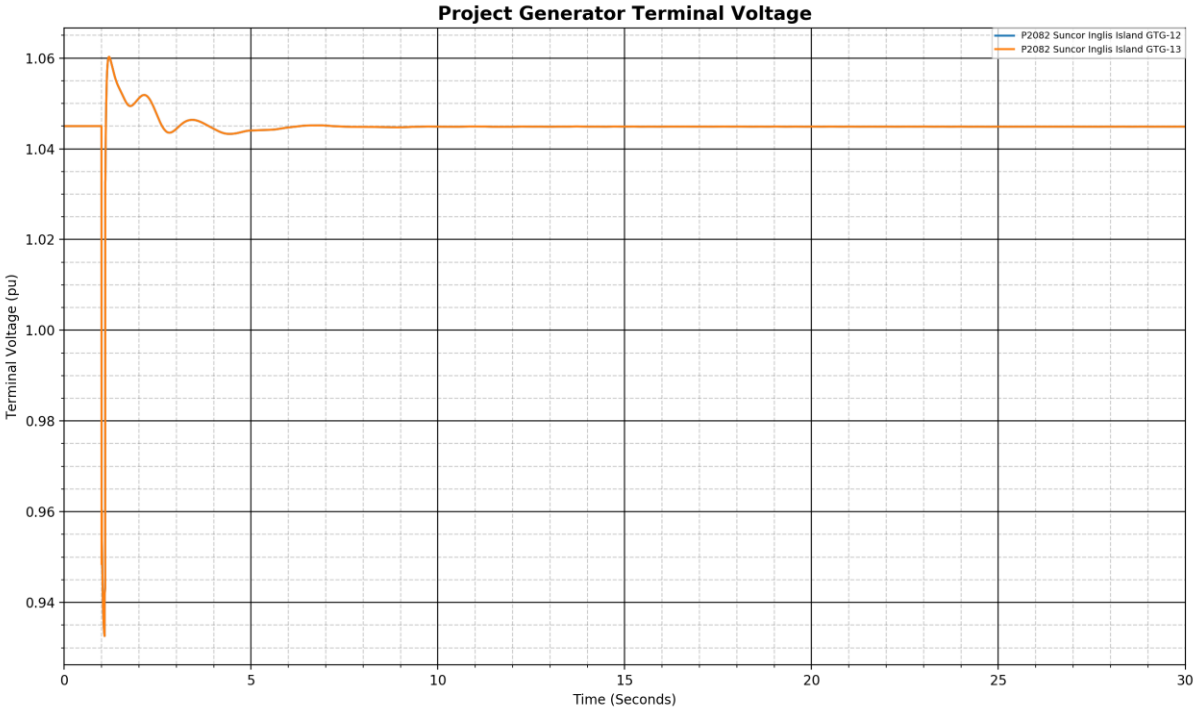

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

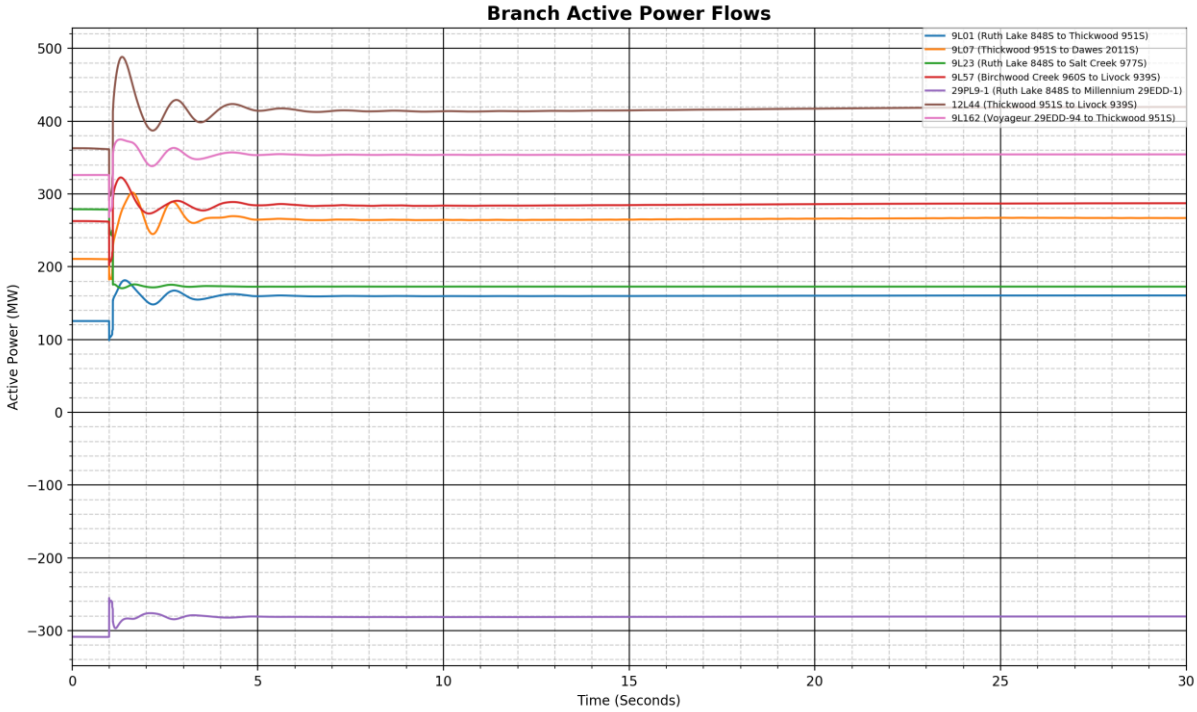

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
23
22
21
20
19
18
17
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.2
4.0
3.8
3.6
3.4
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

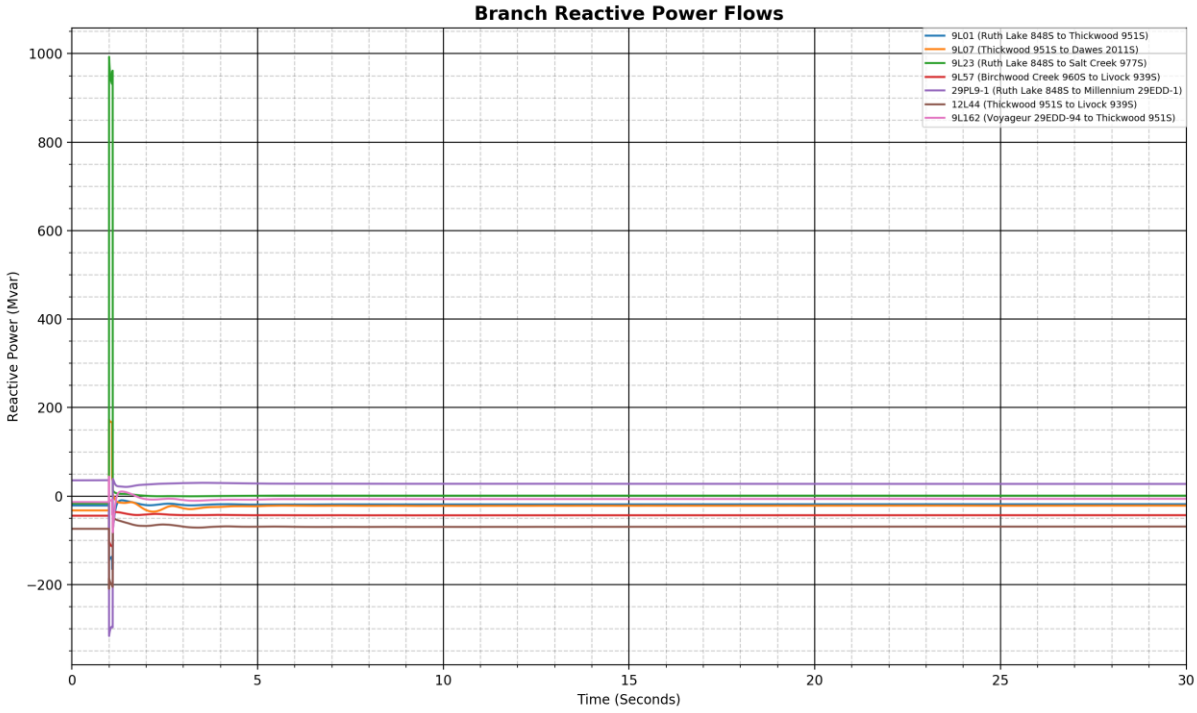
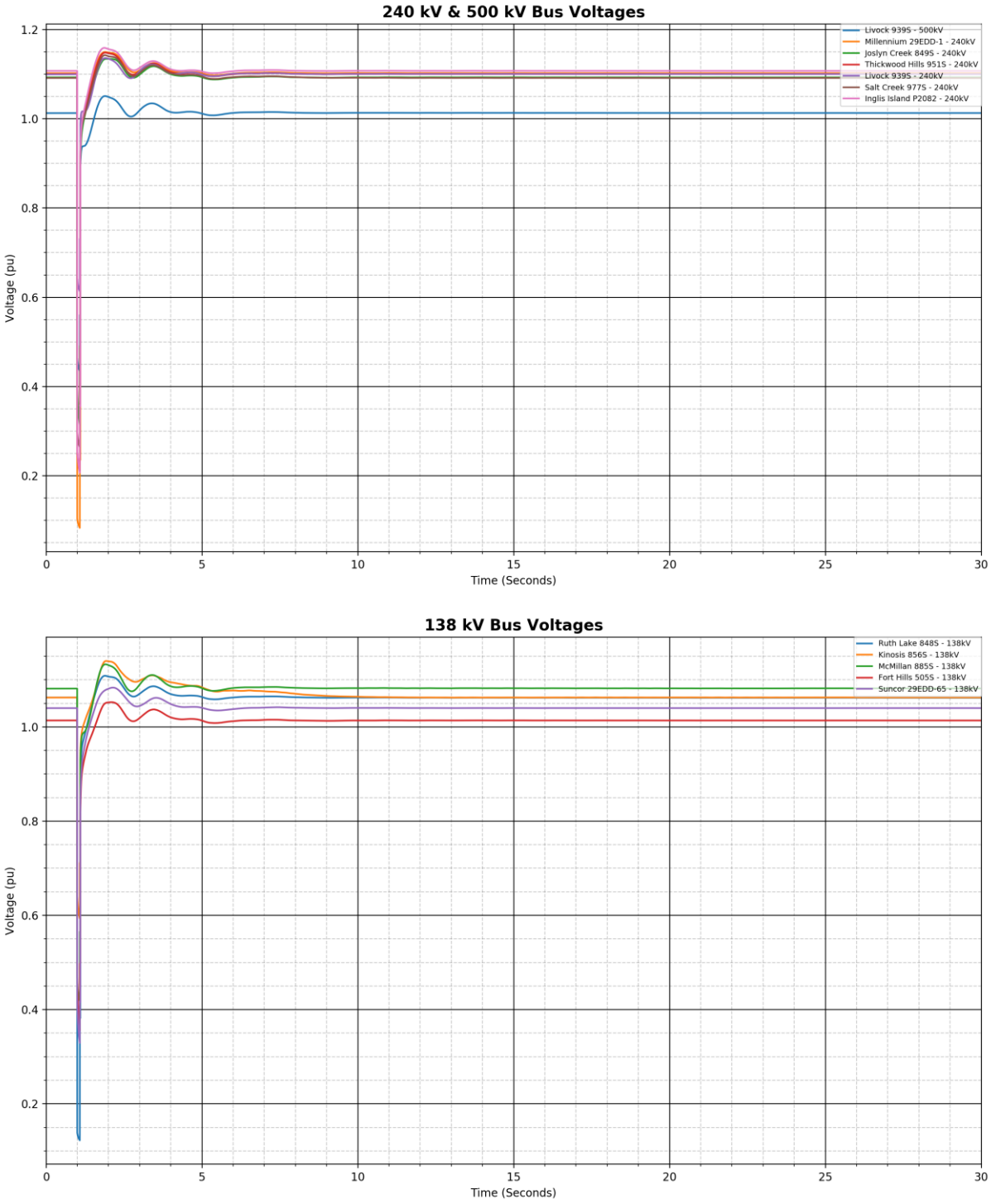
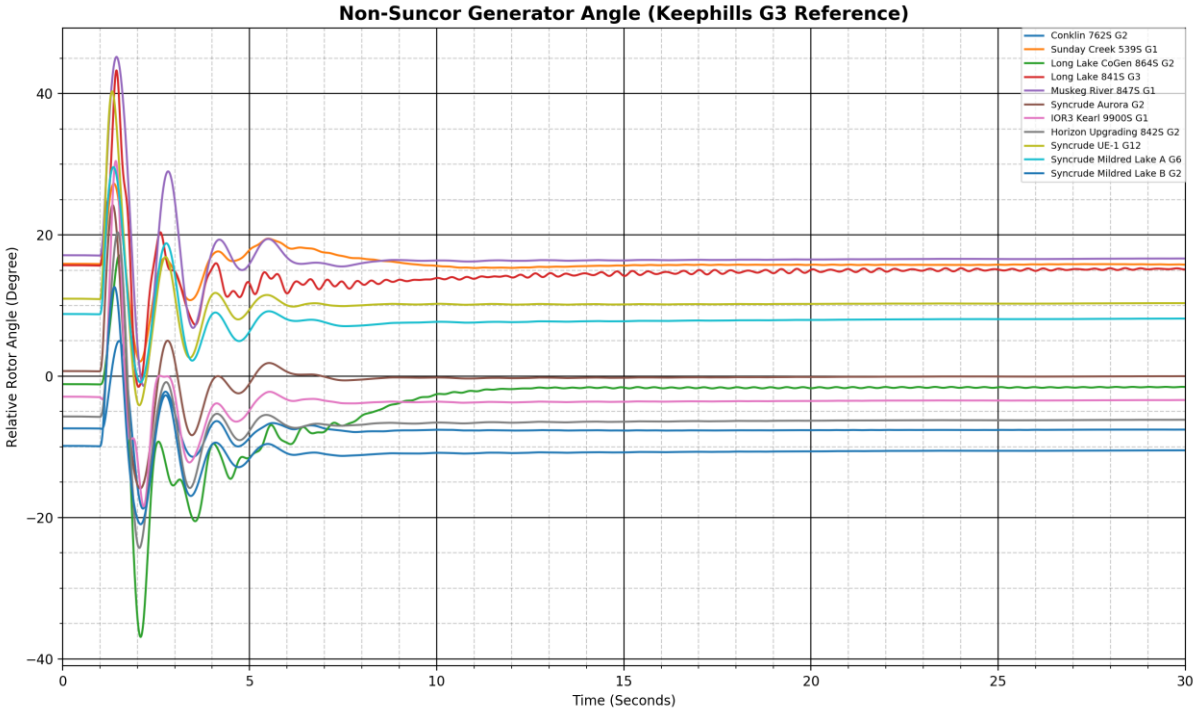
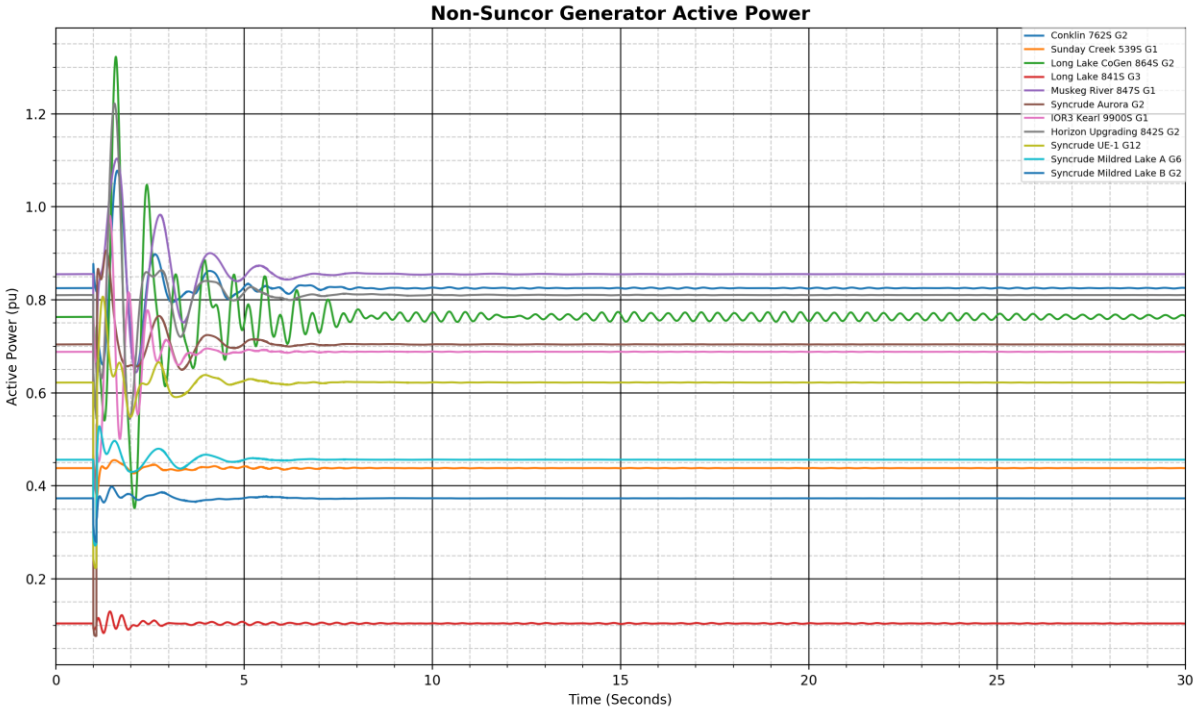
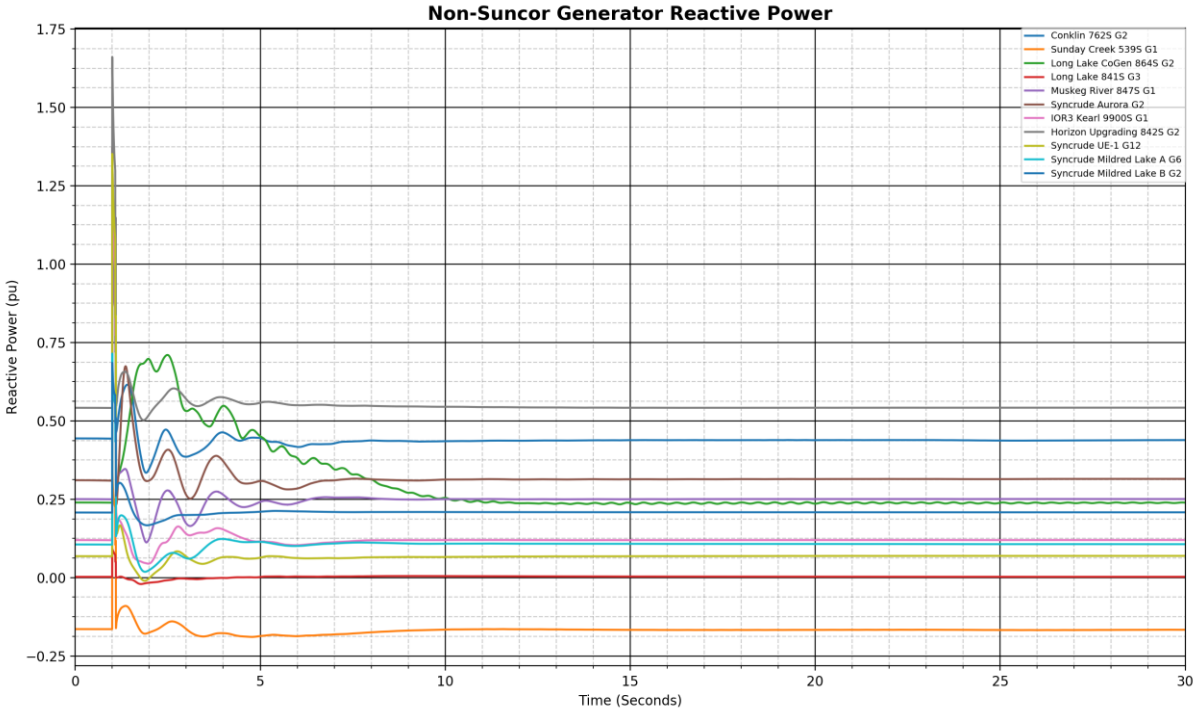

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

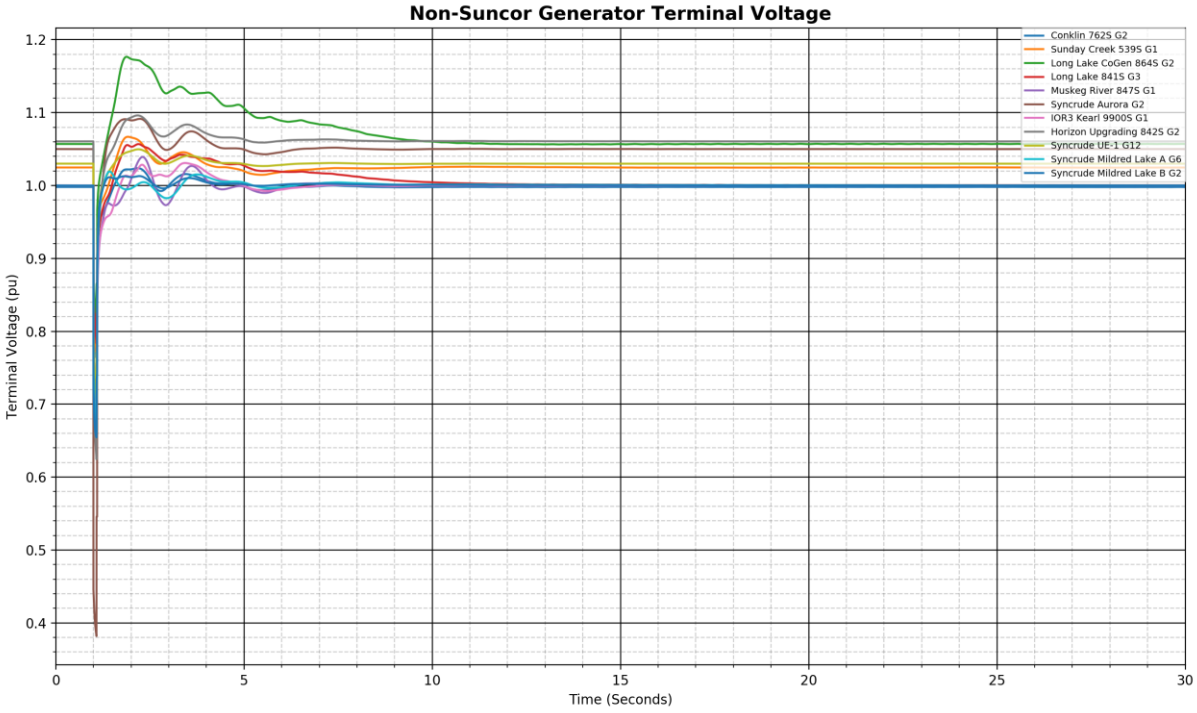
Figure A4-49: 29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1): Fault at Ruth Lake 848S

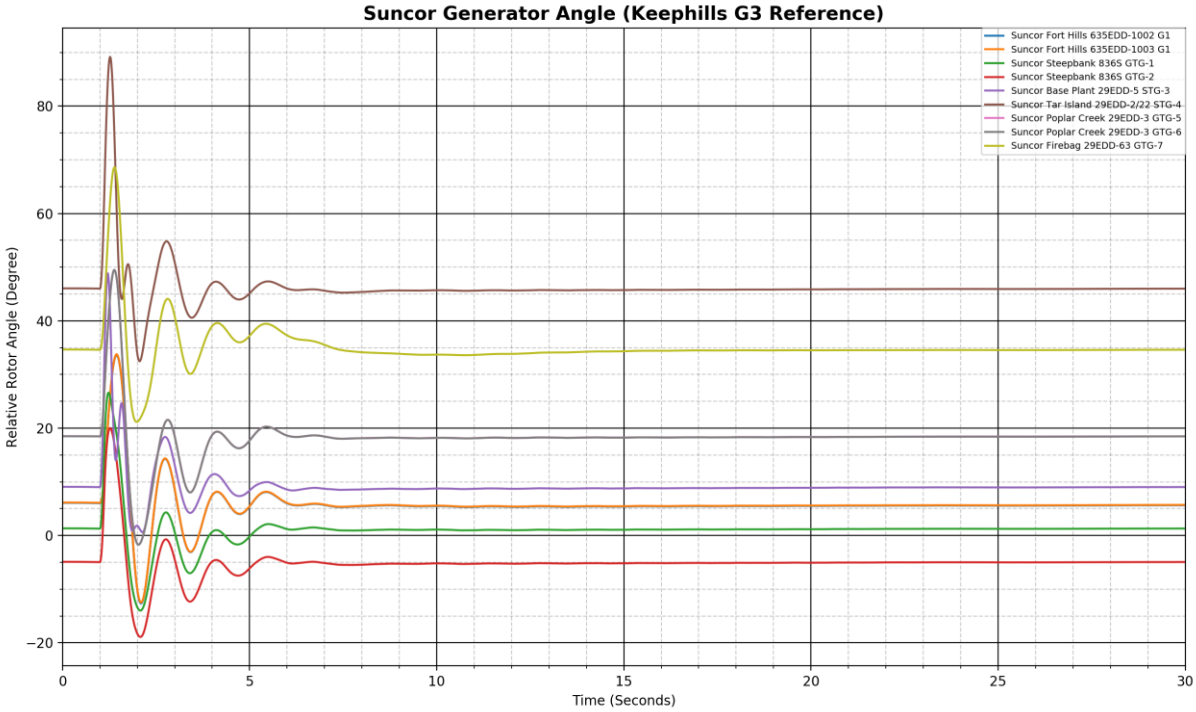


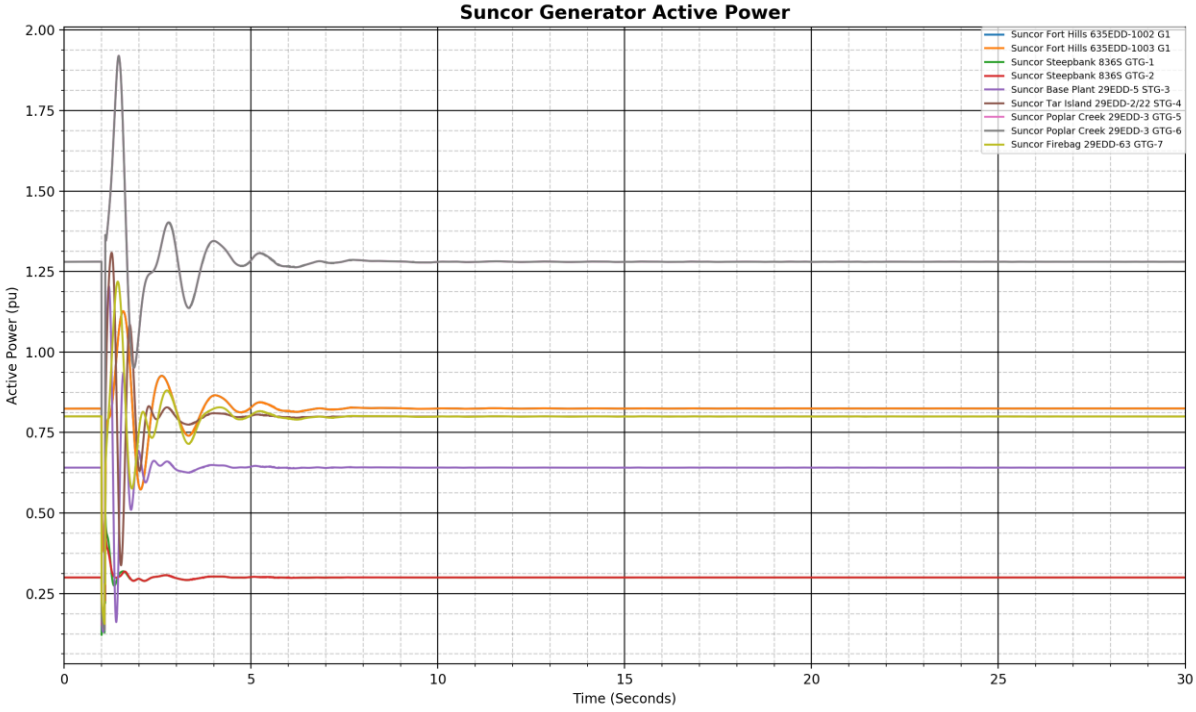

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

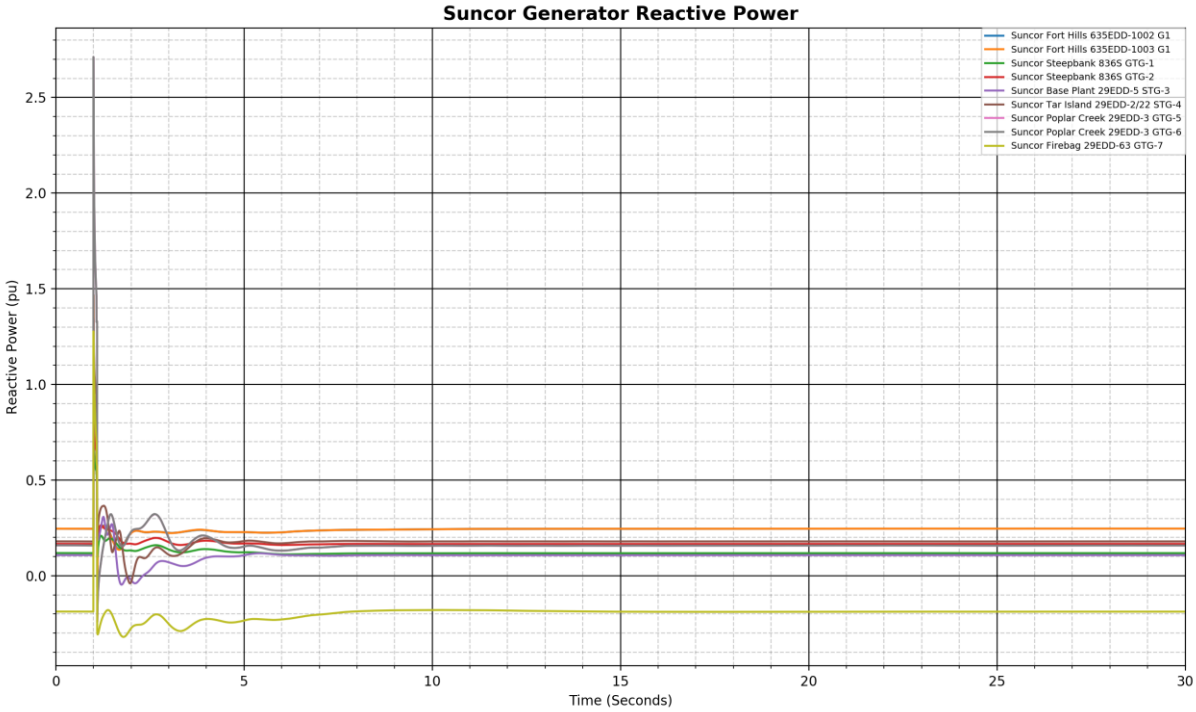

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

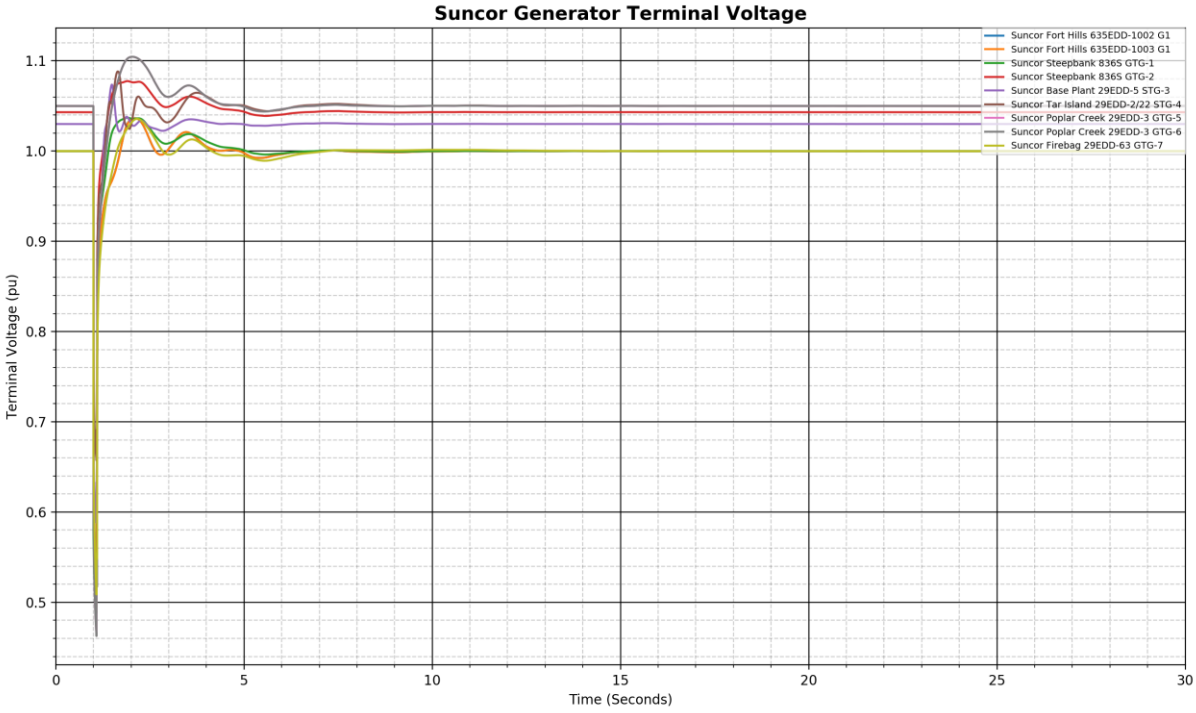

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

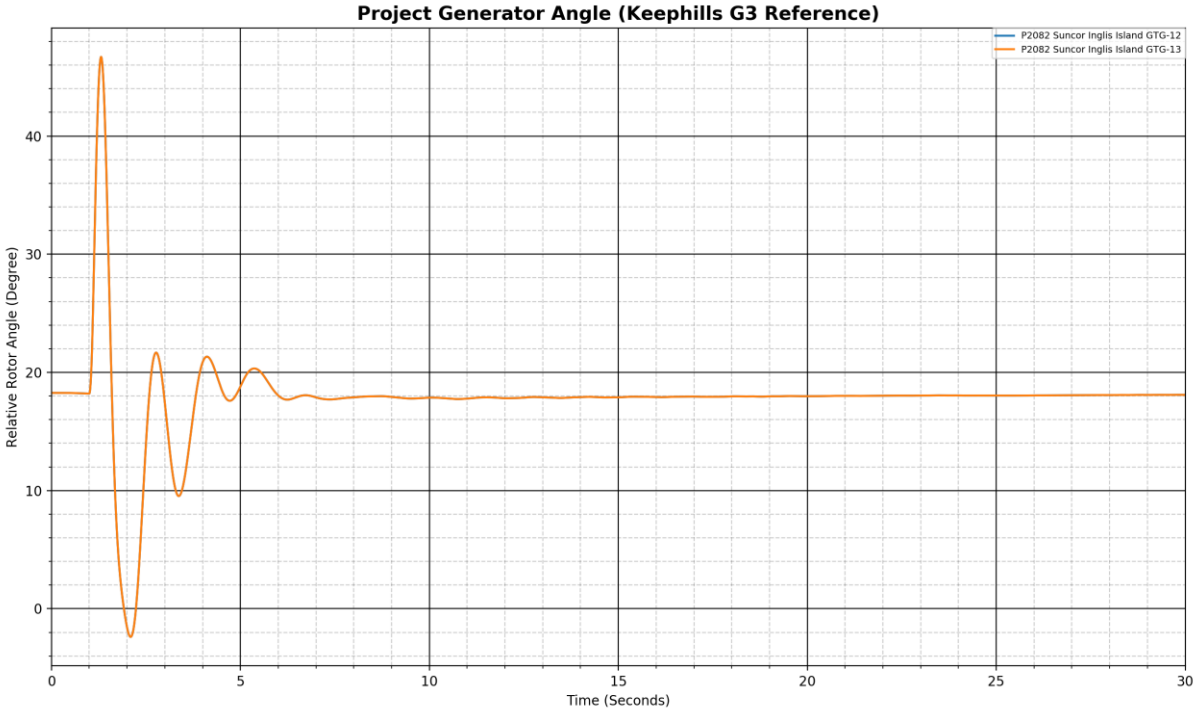

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

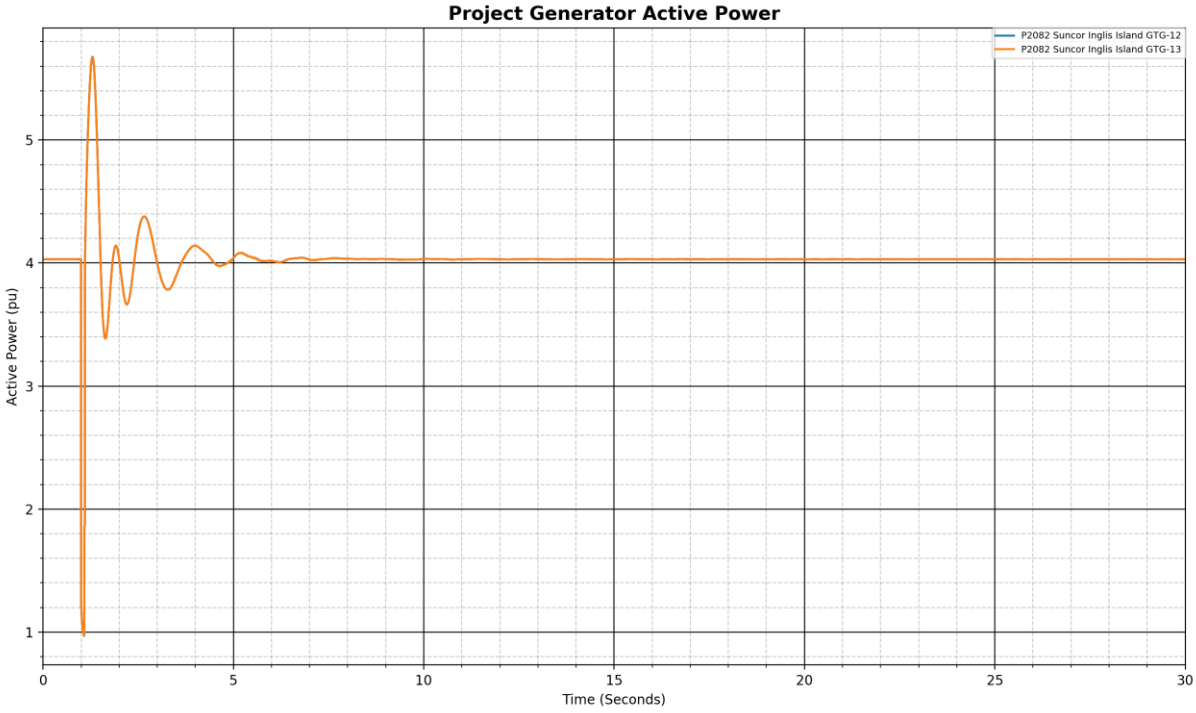

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

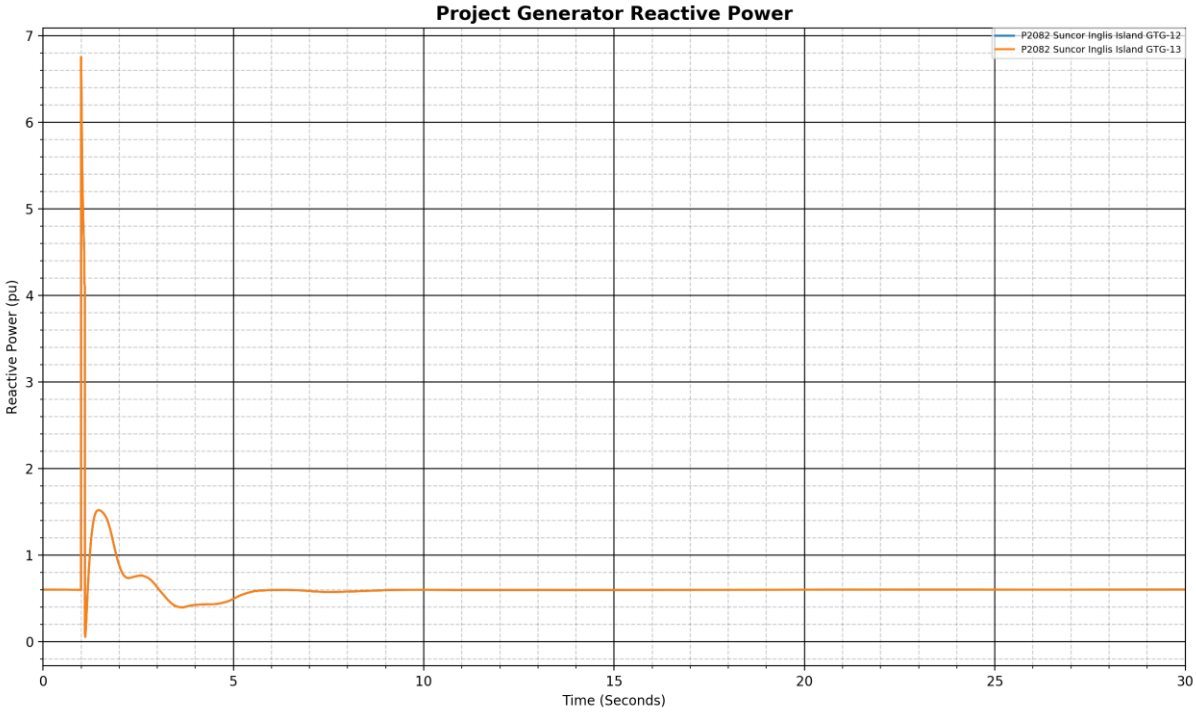

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

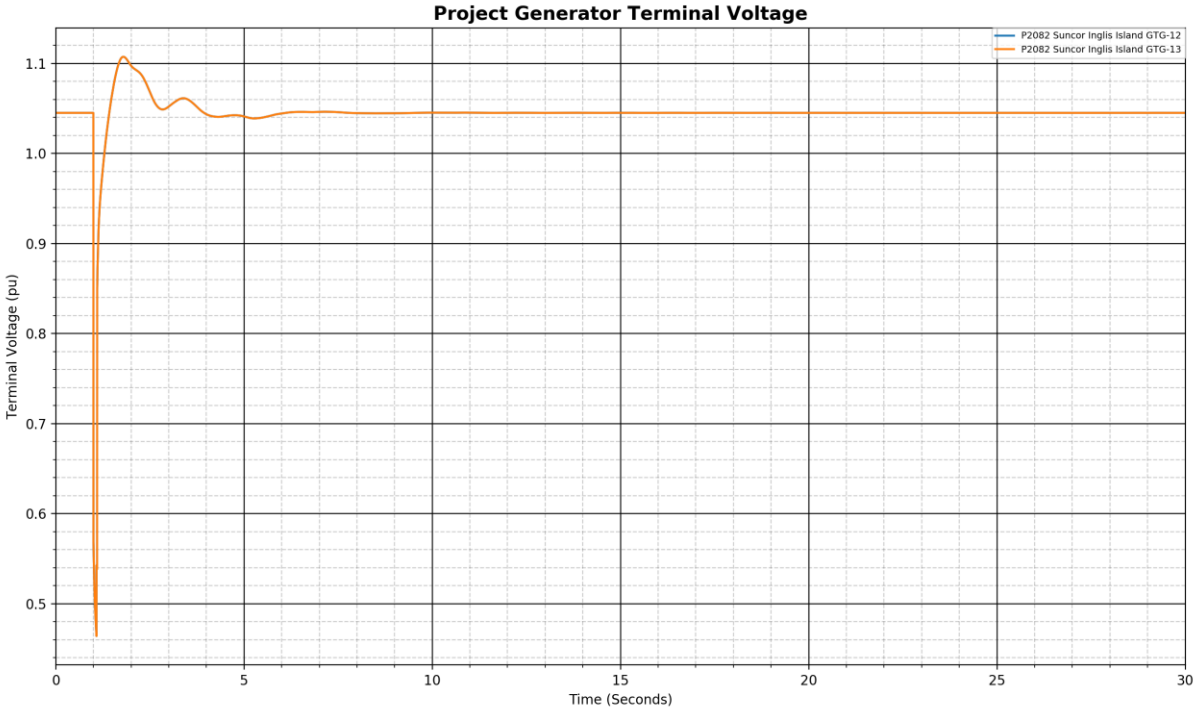

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

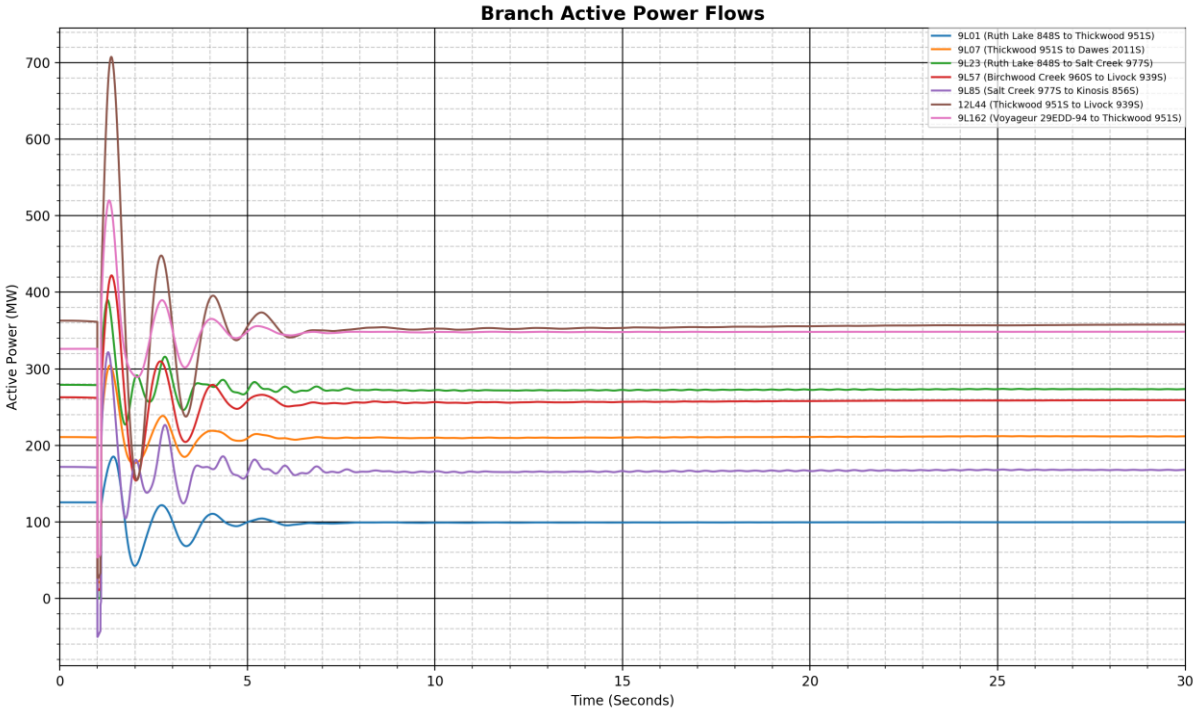

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
0
10
20
30
40
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
1
2
3
4
5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

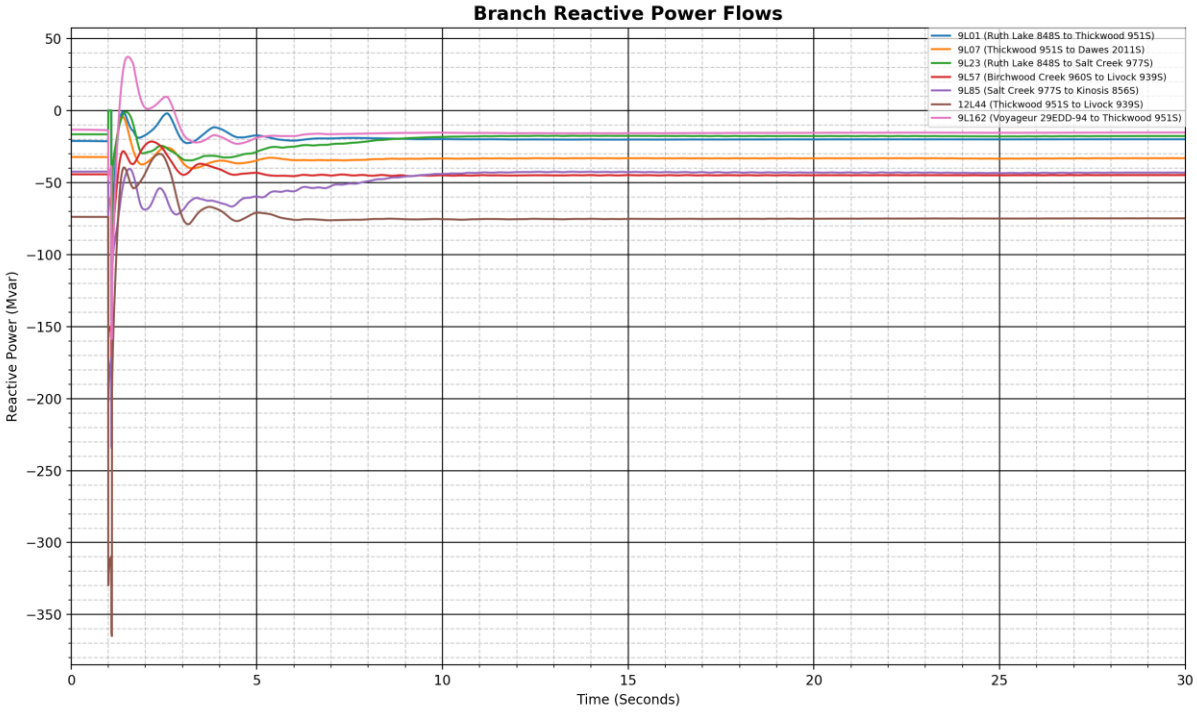
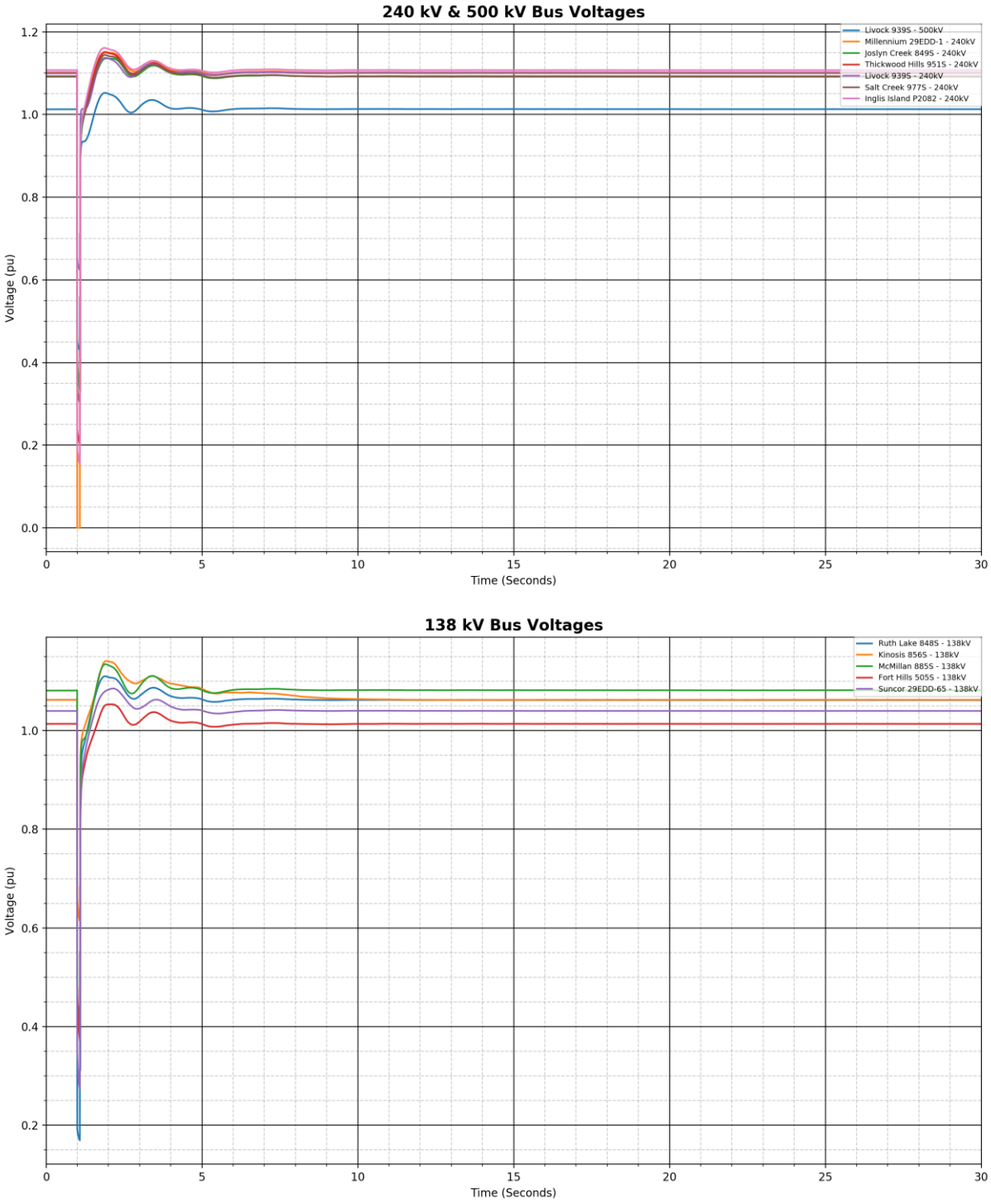
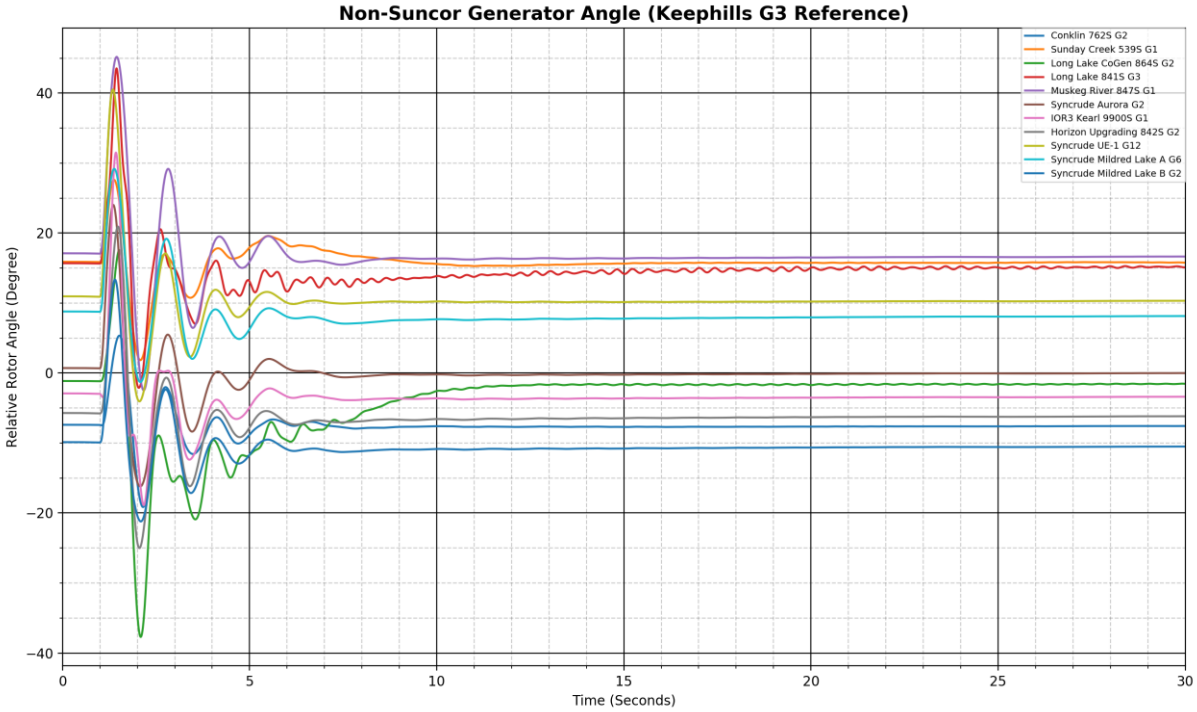
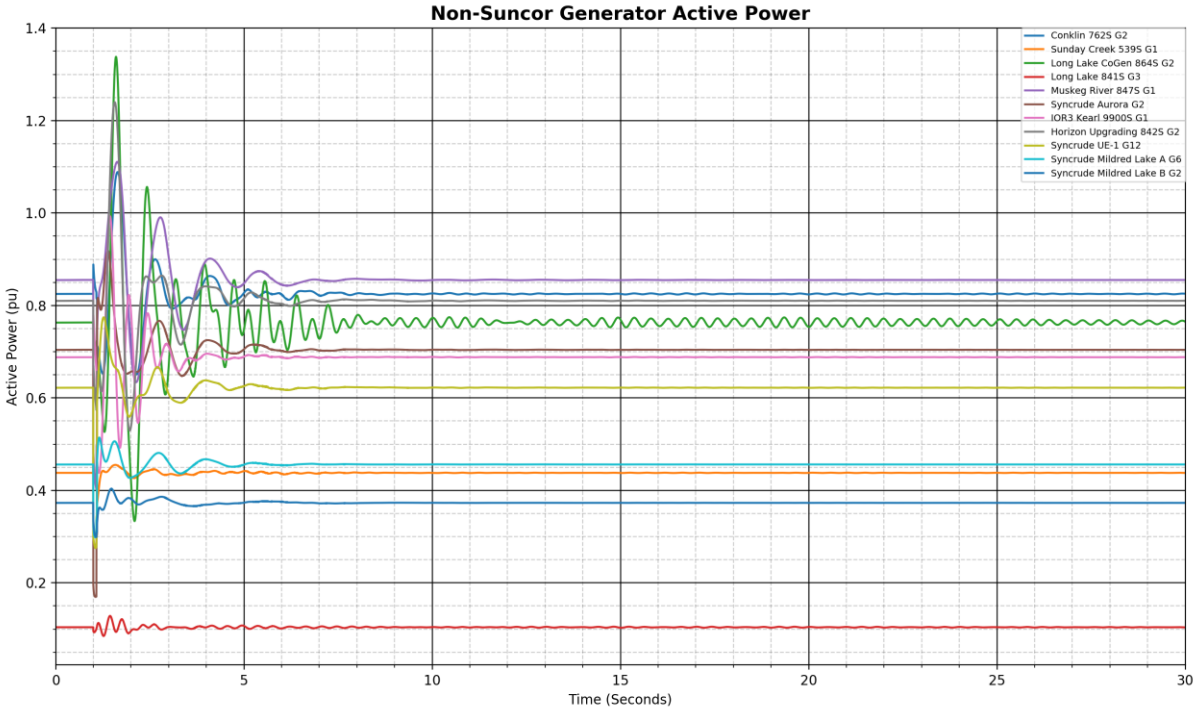
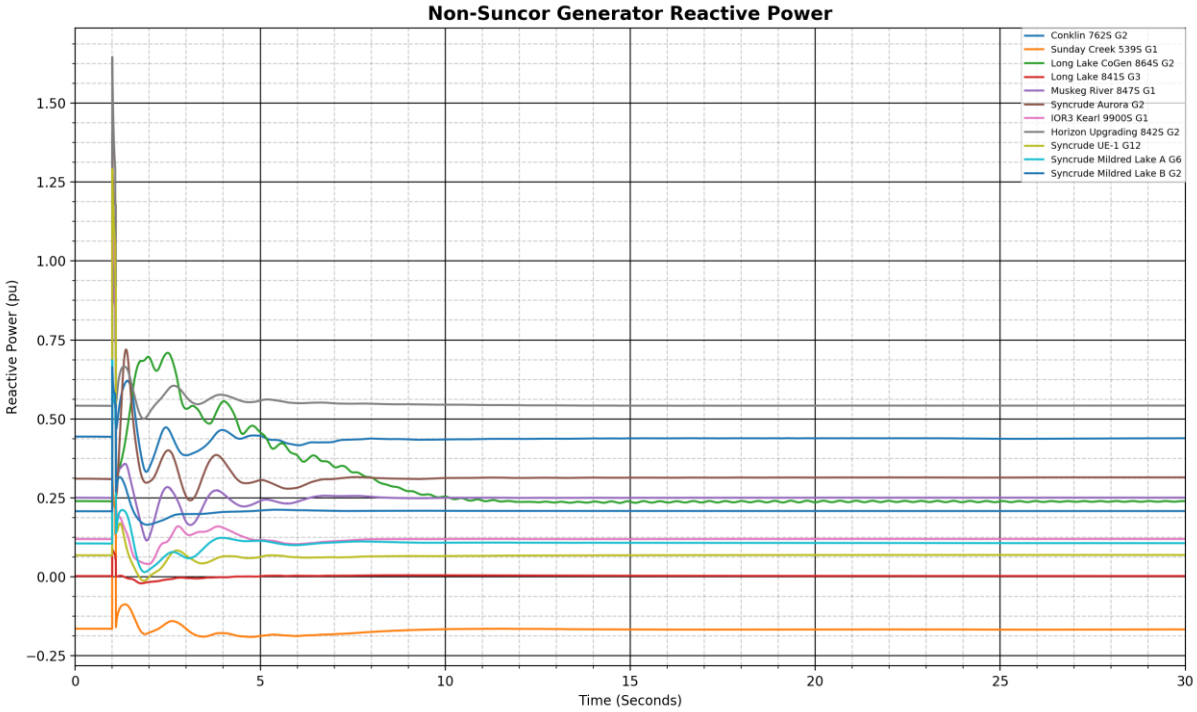

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

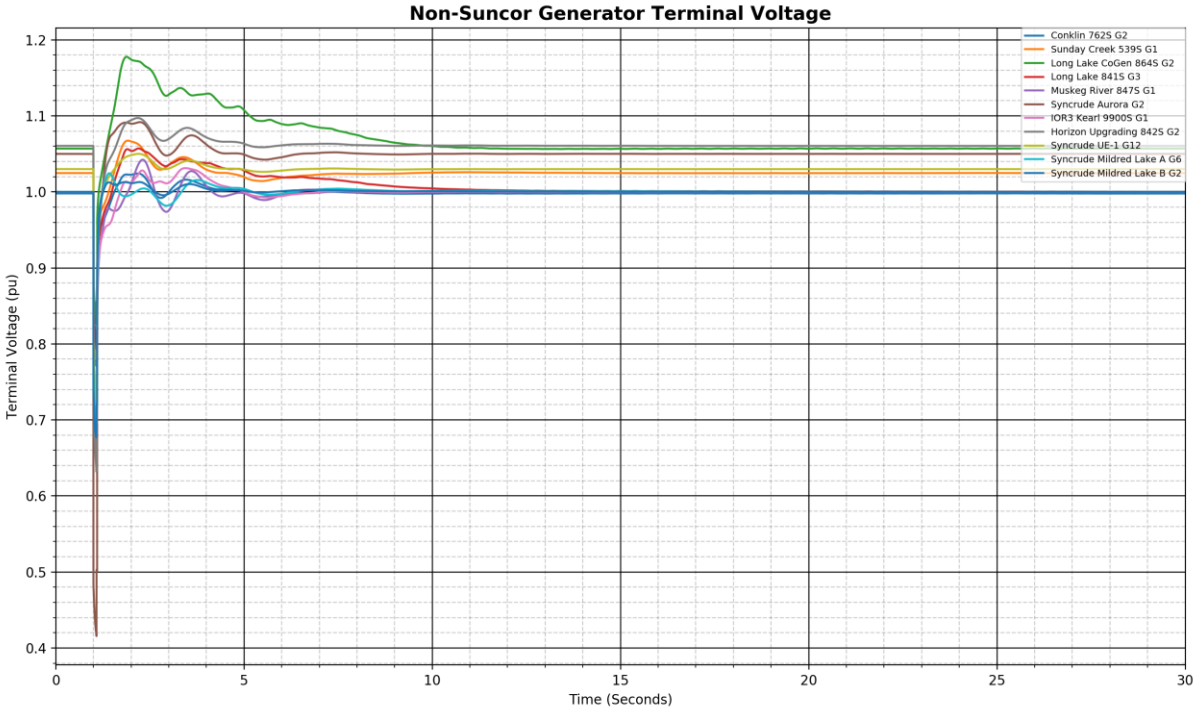
Figure A4-50: 29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1): Fault at Millennium 29EDD-1

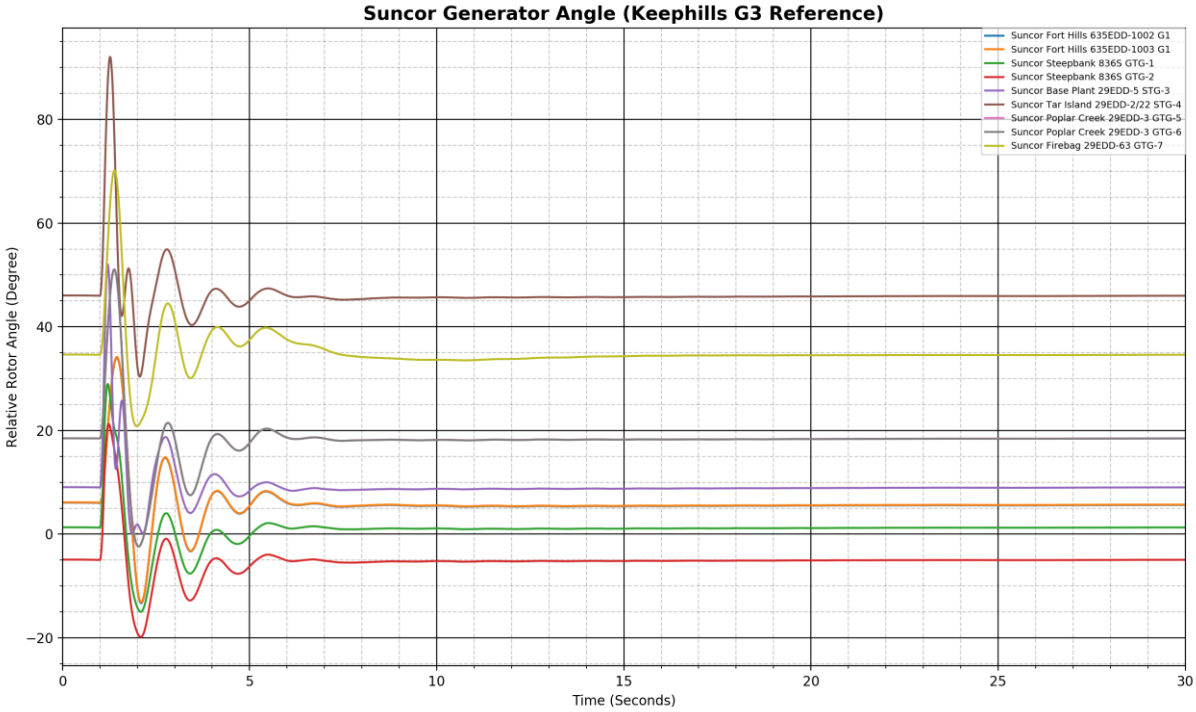


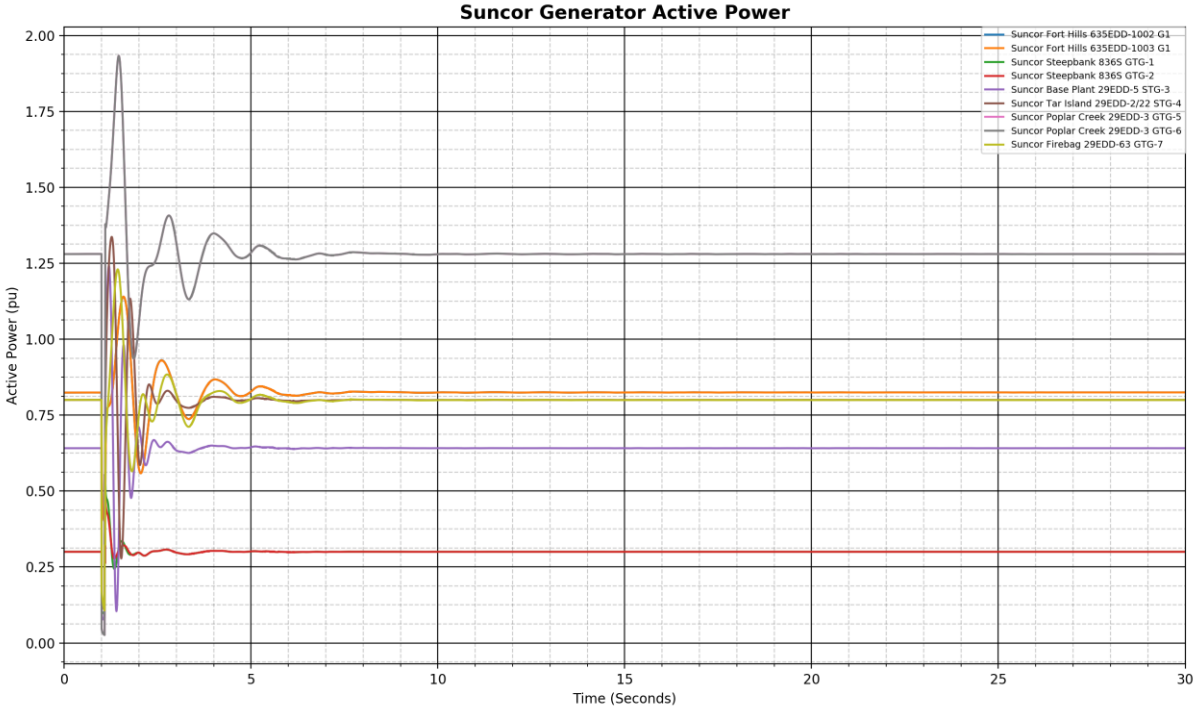

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

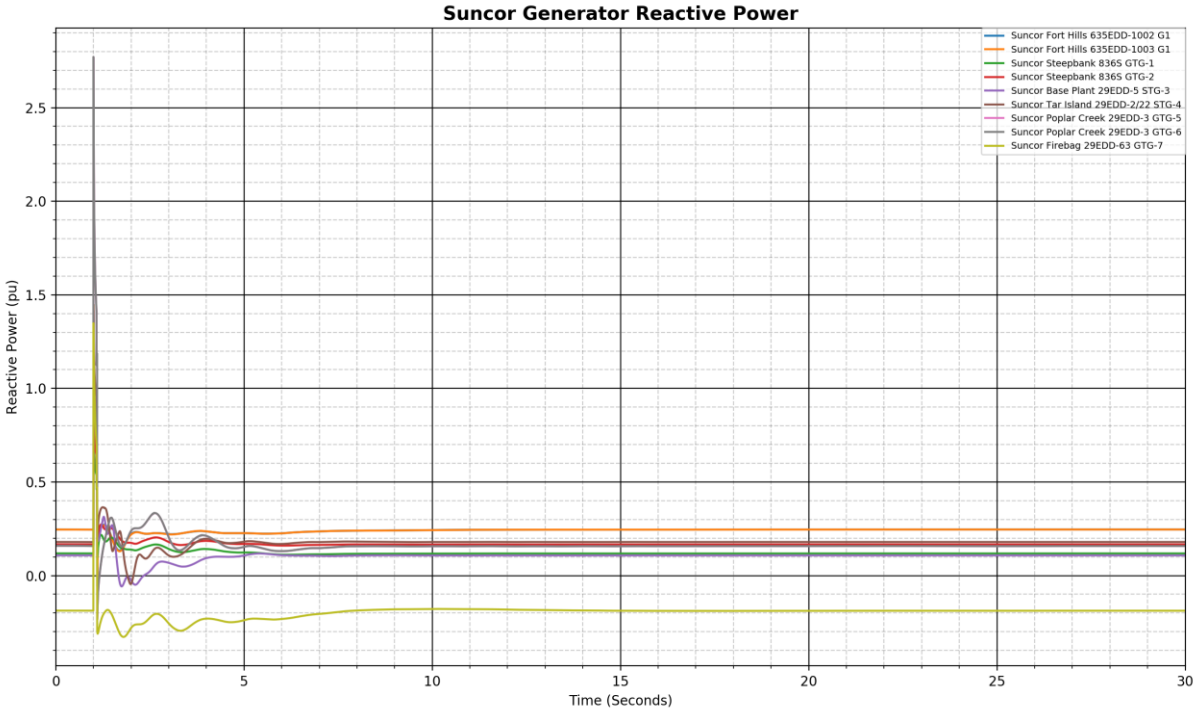

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

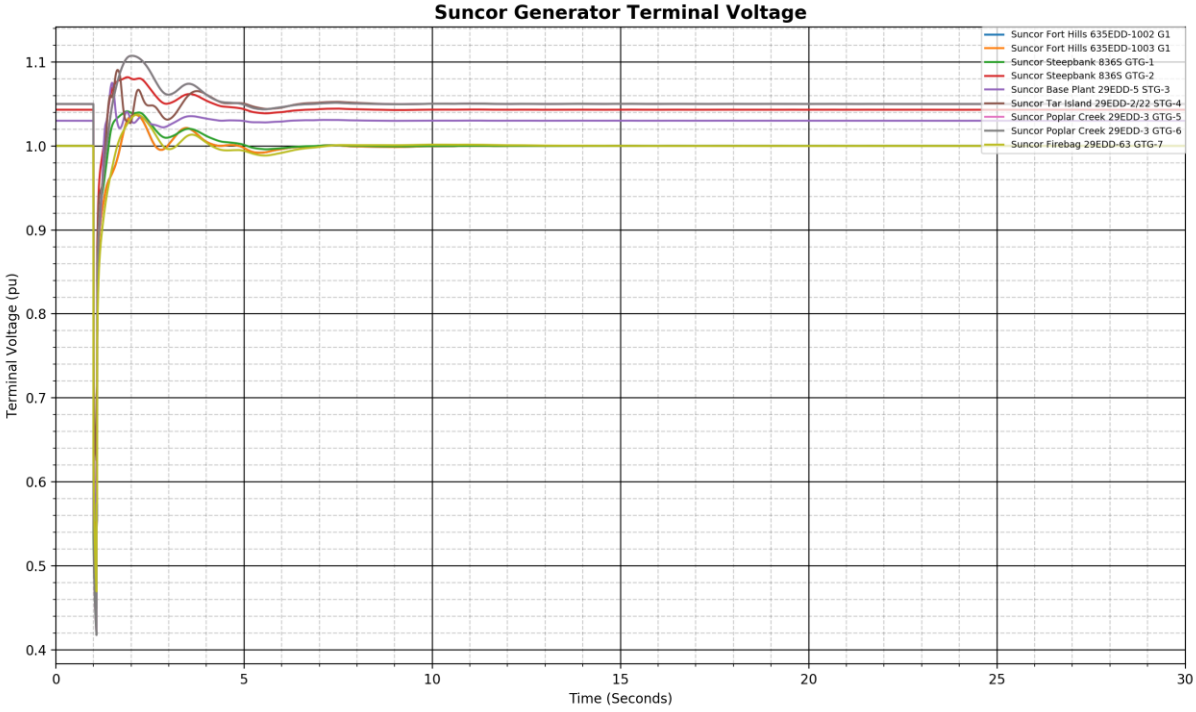

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

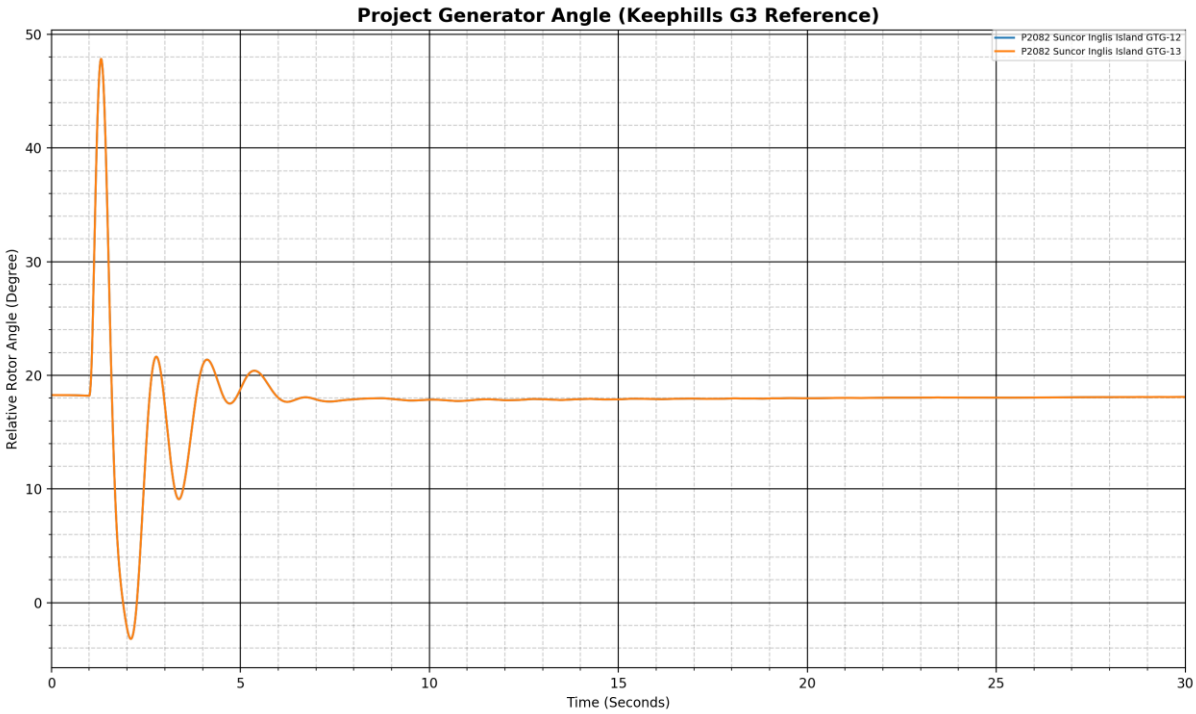

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

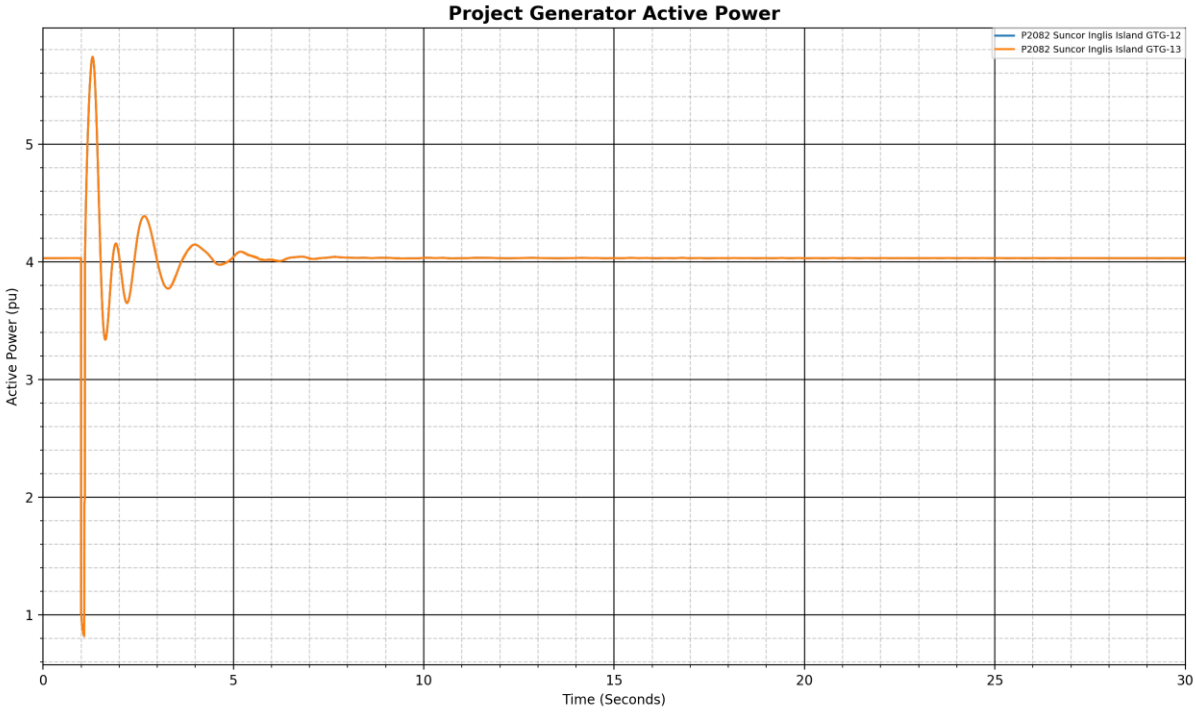

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

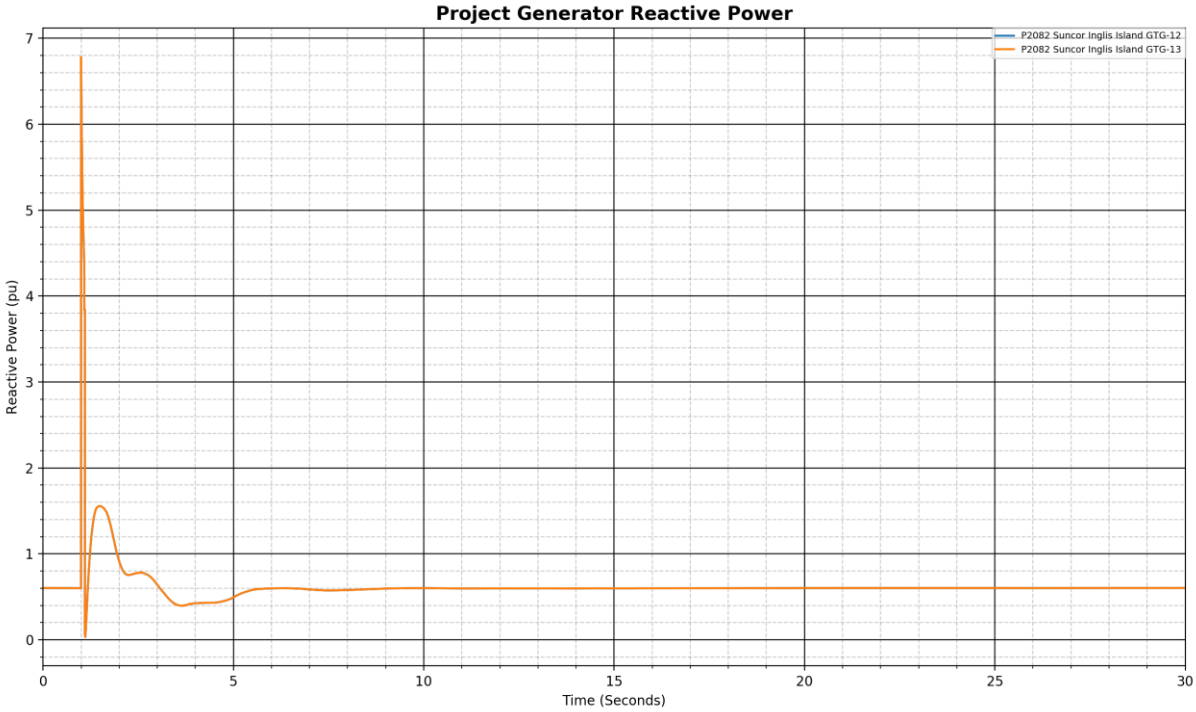

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

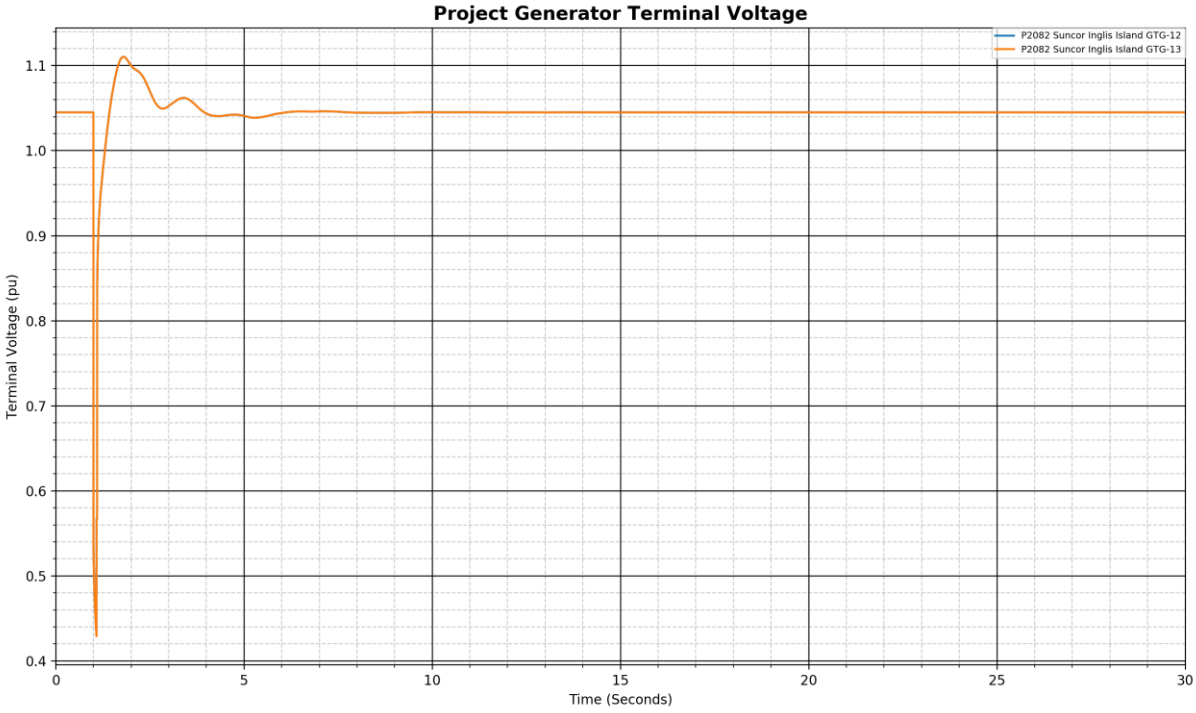

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

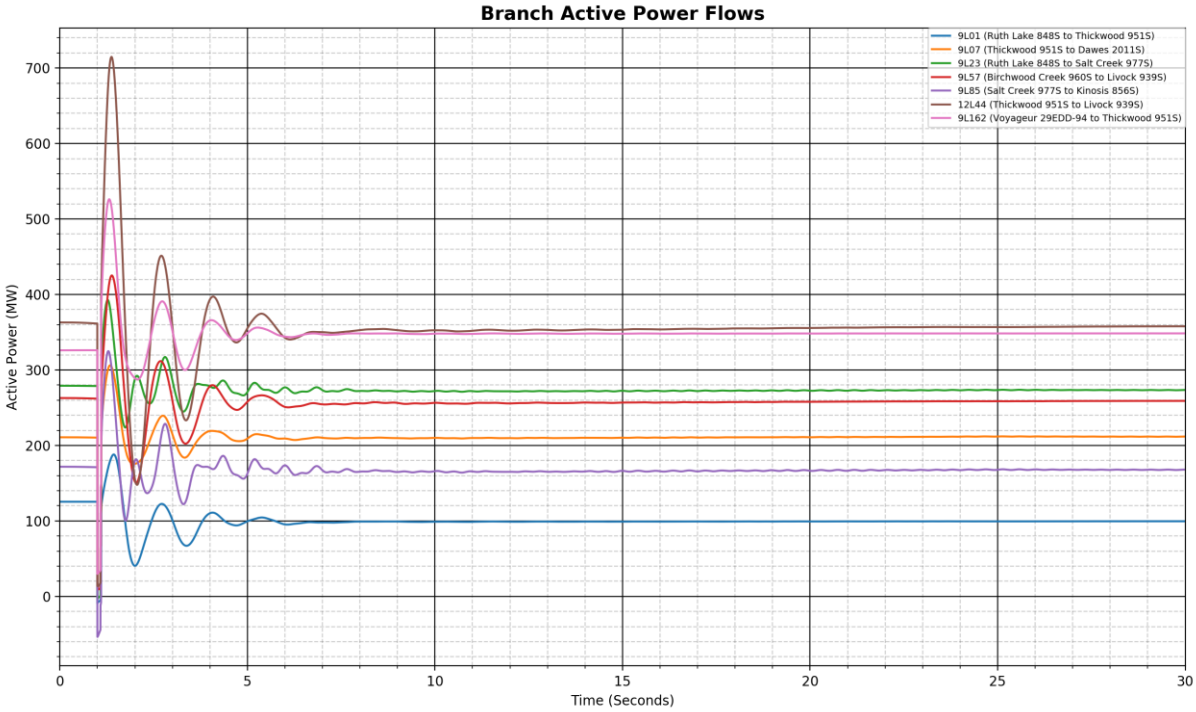

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
0
10
20
30
40
50
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

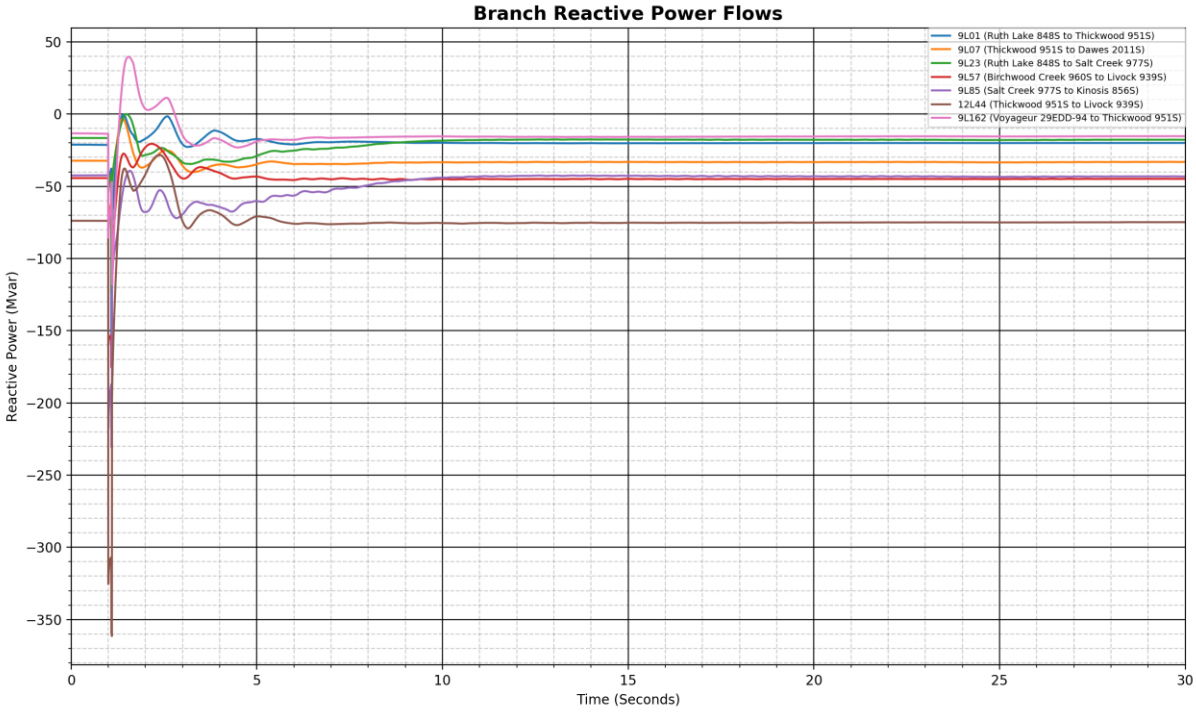
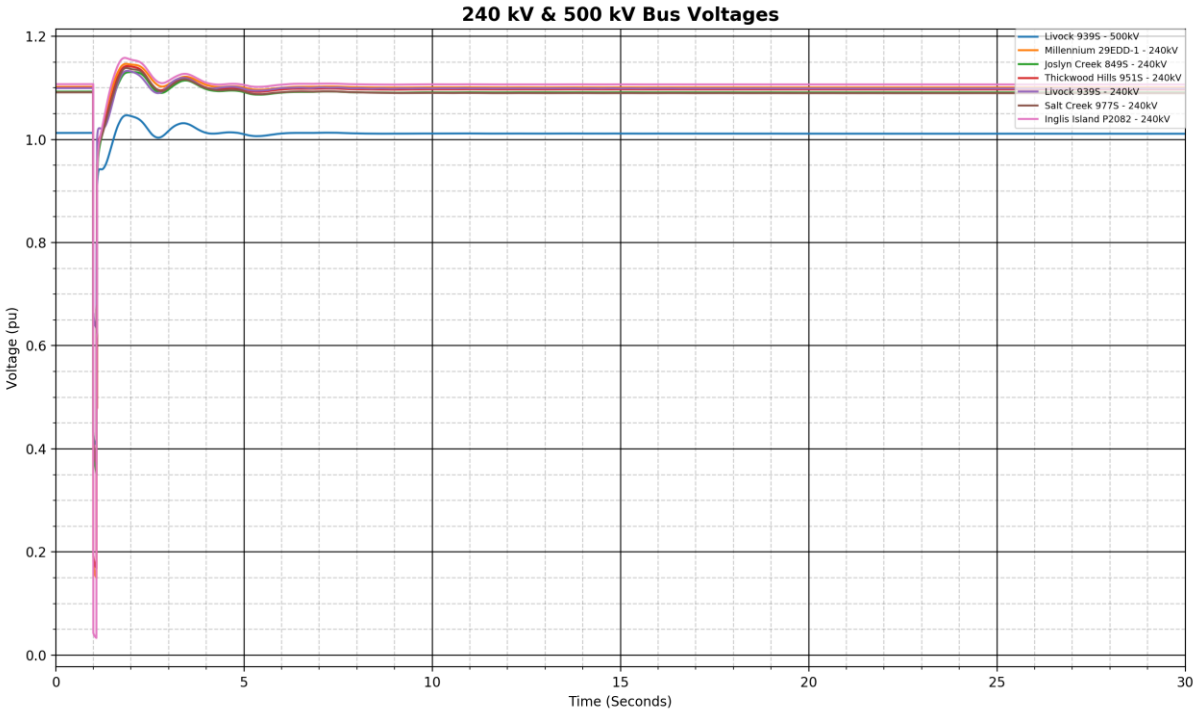
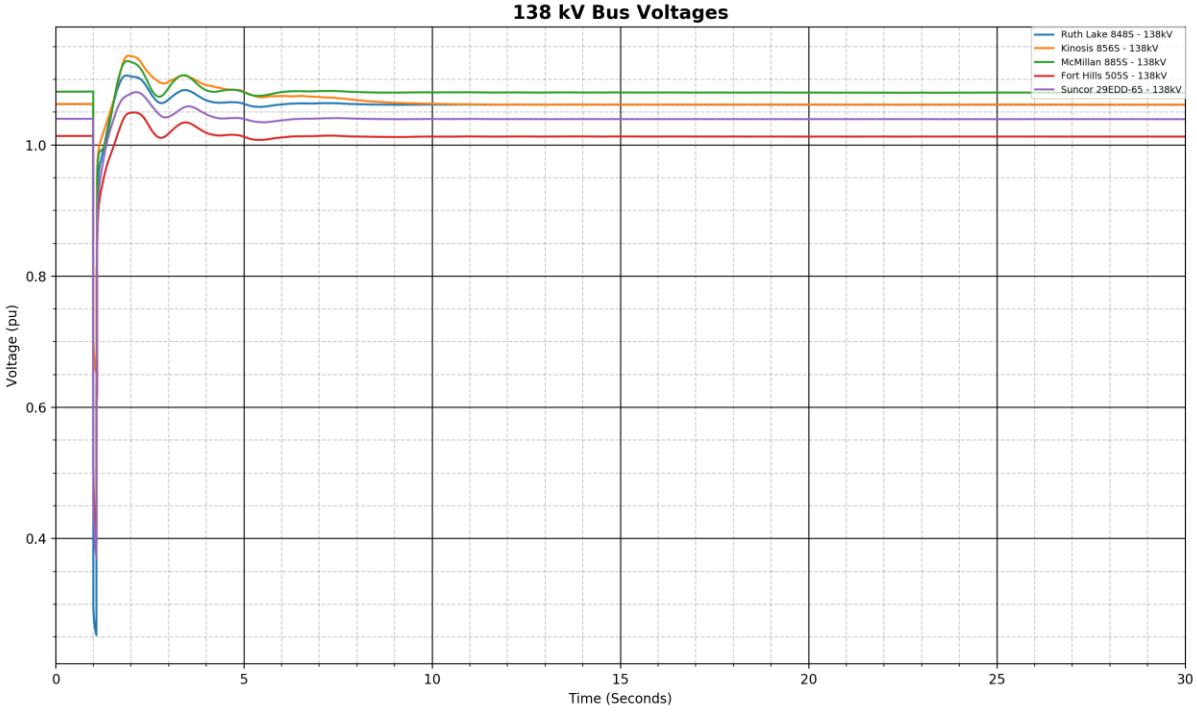
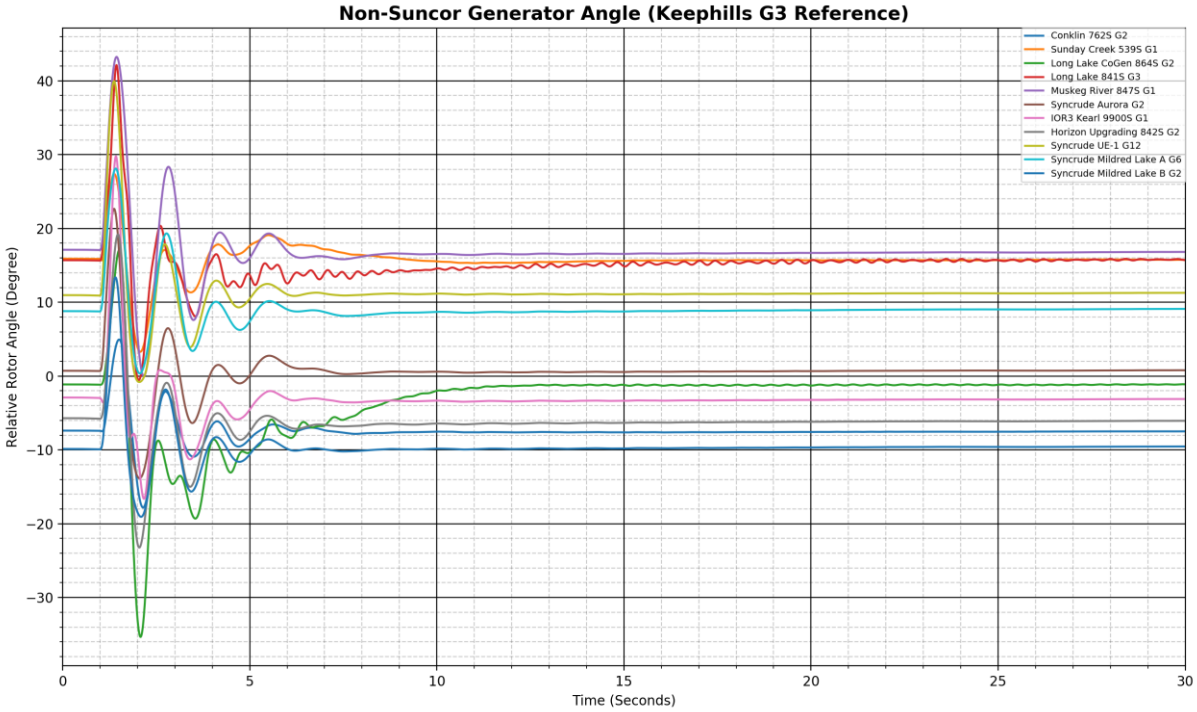
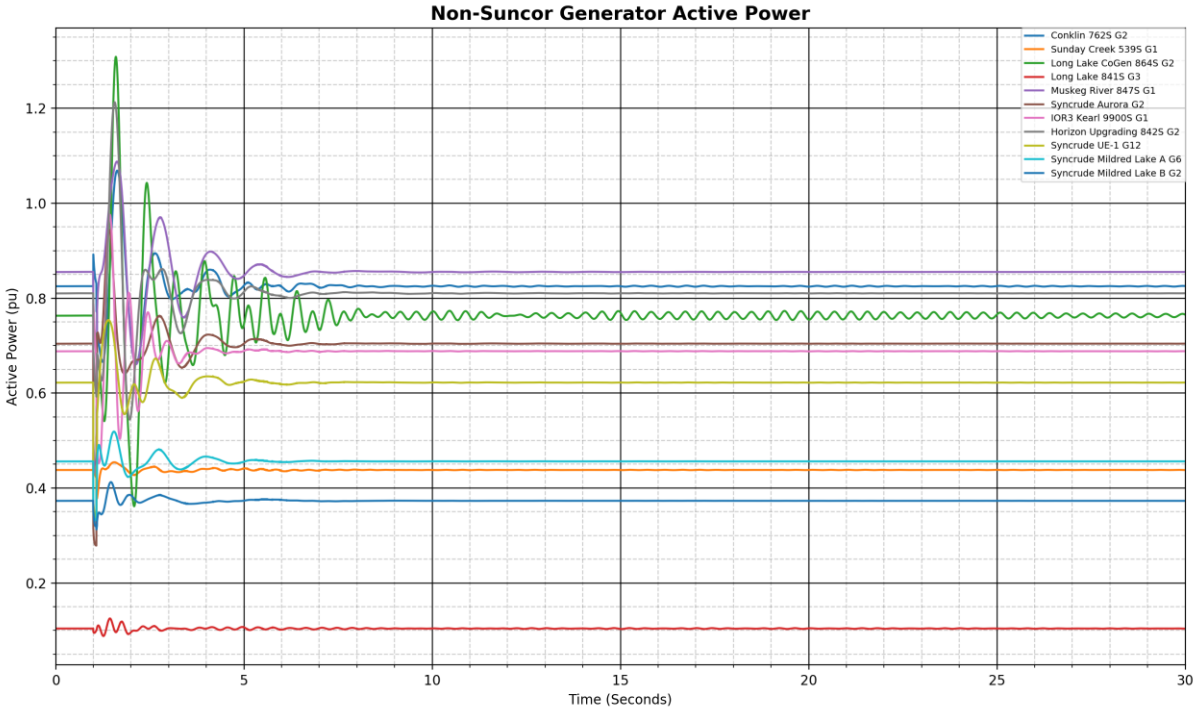

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

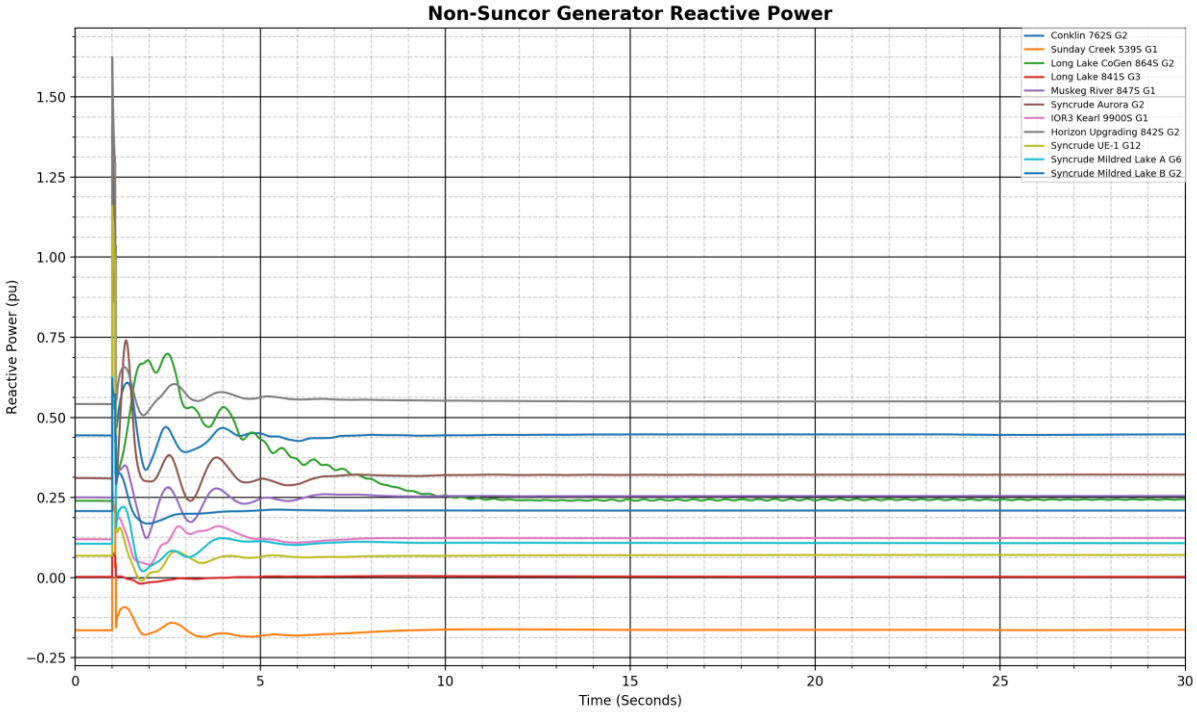
Figure A4-51: 9L162 (Voyageur 29EDD-94 to Thickwood Hills 951S): Fault at Voyageur 29EDD-94

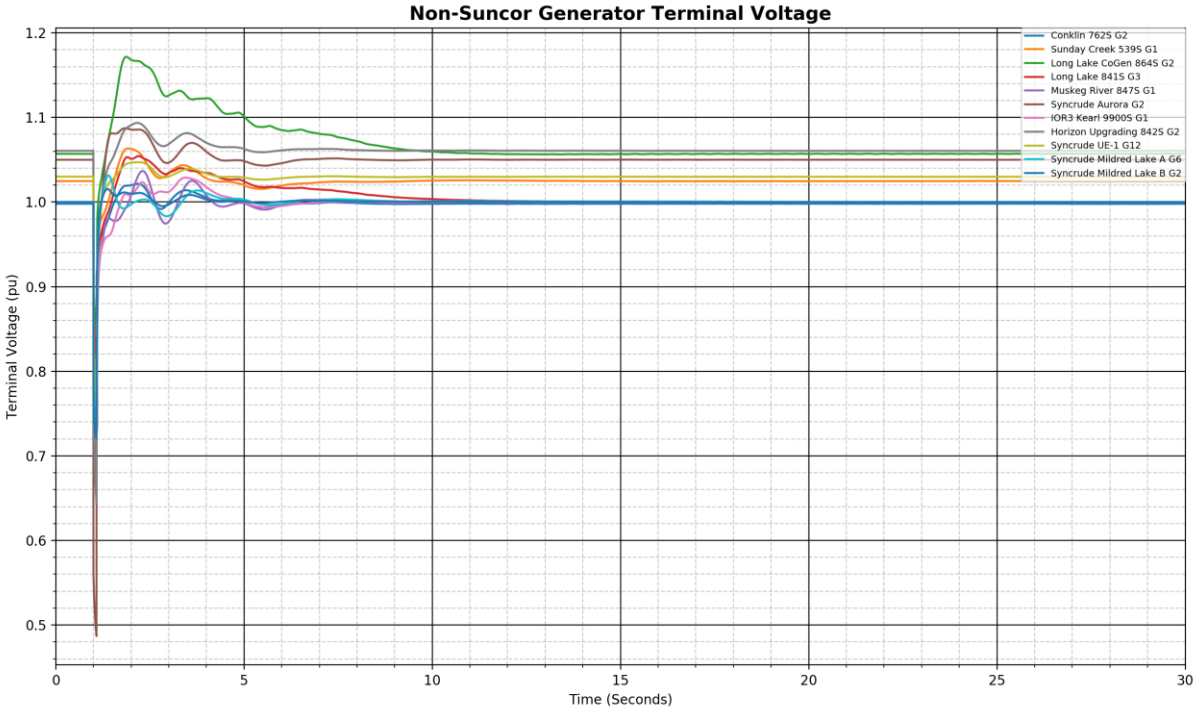


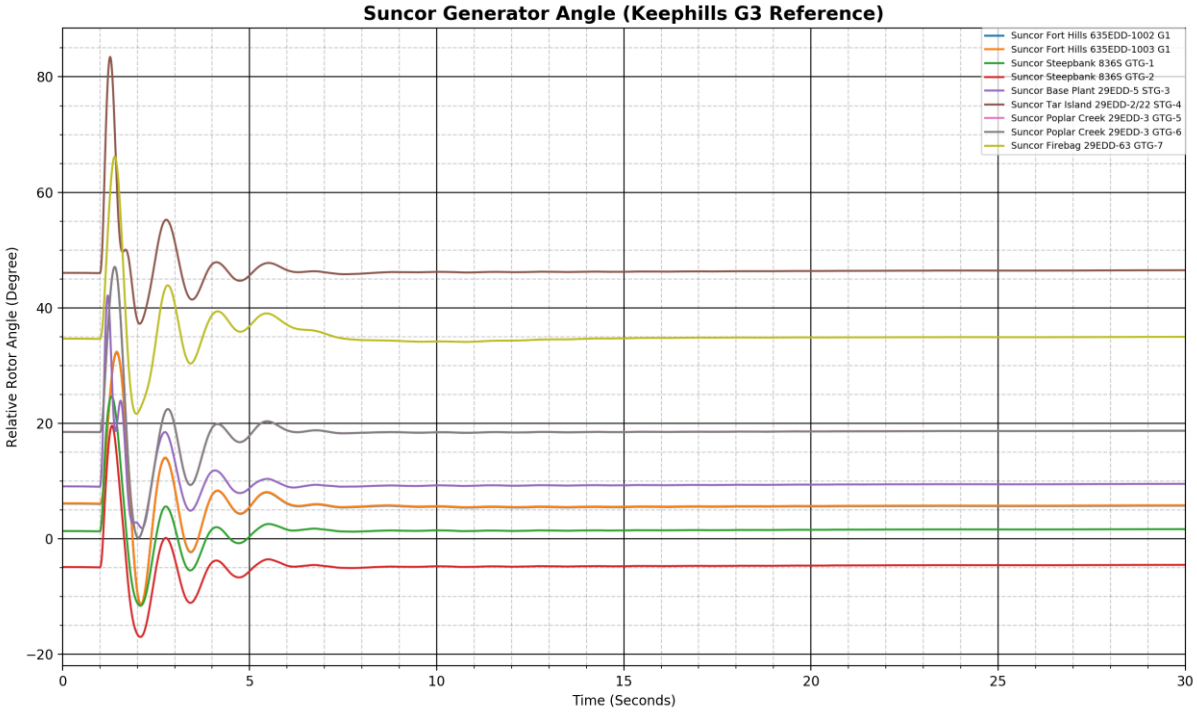


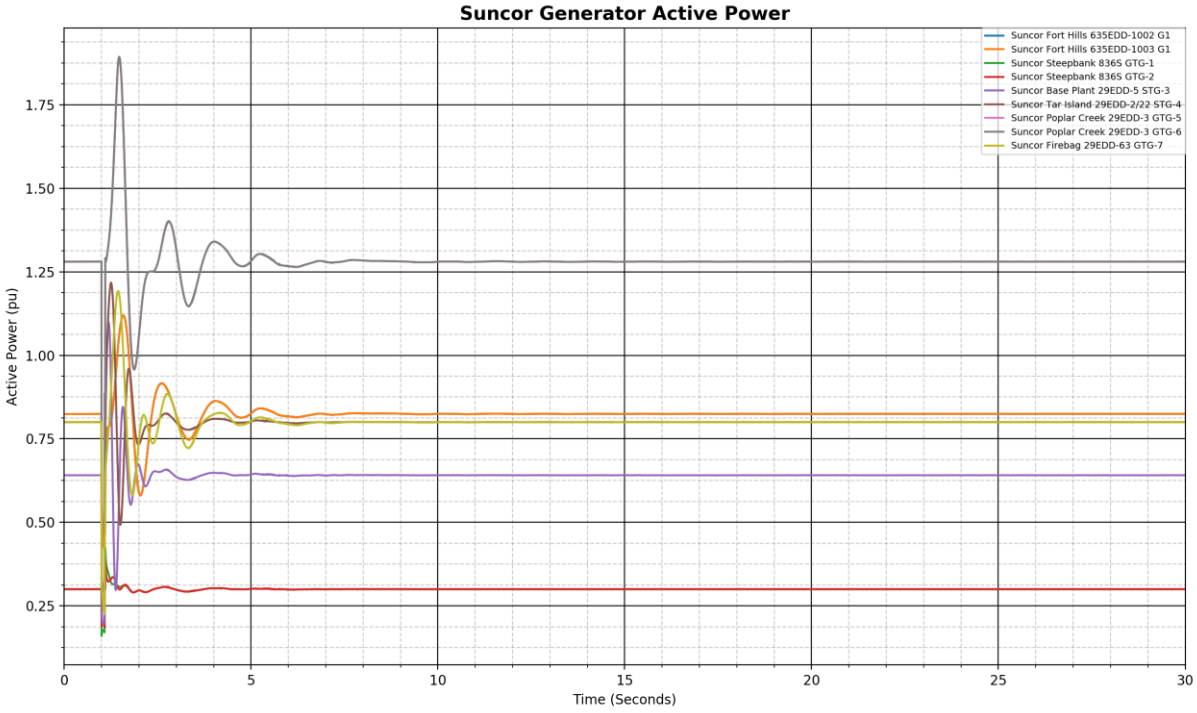

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

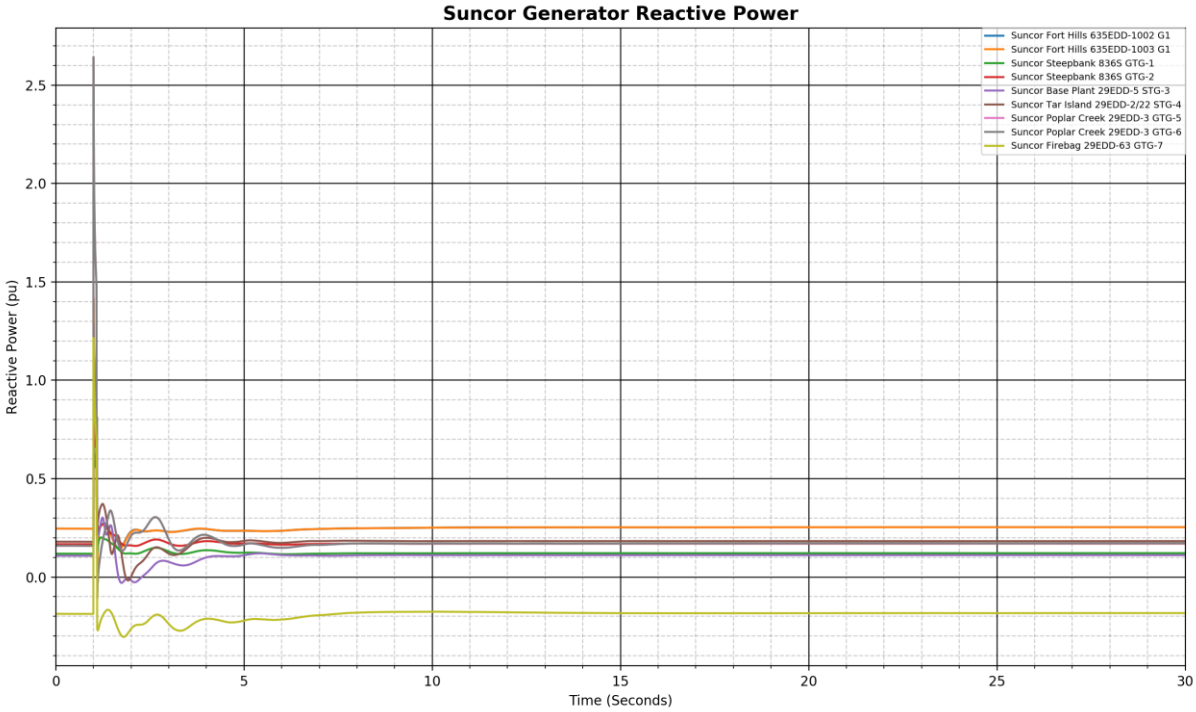

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

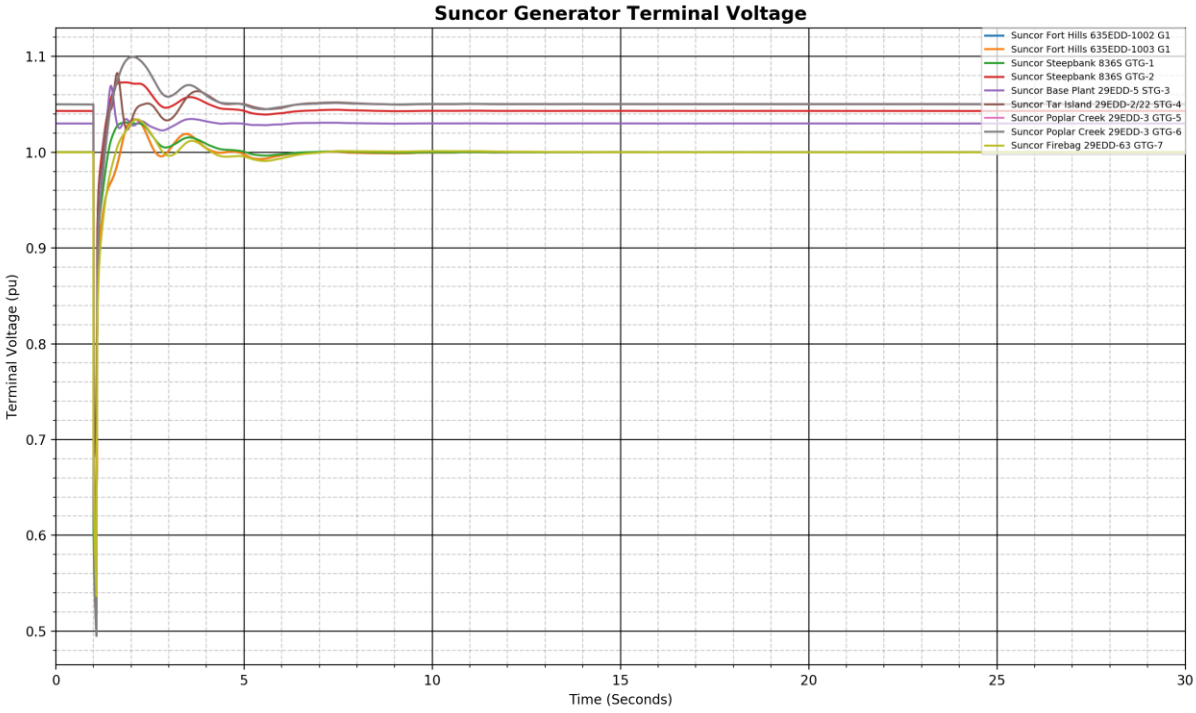

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

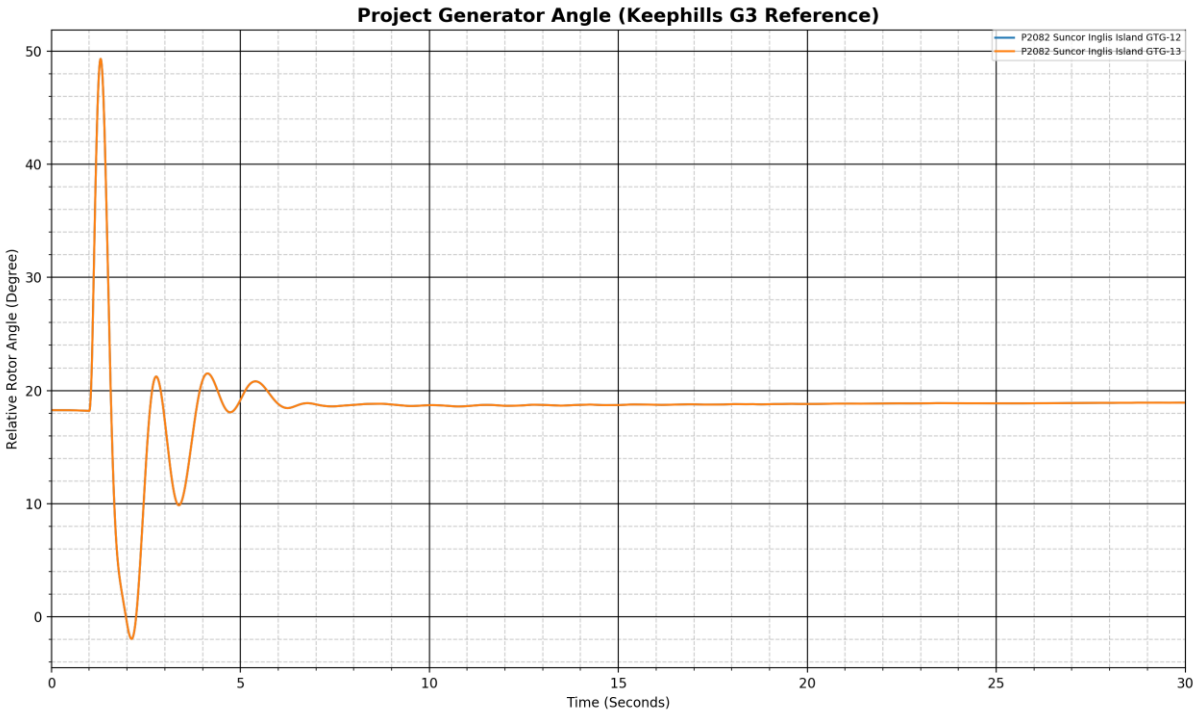

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

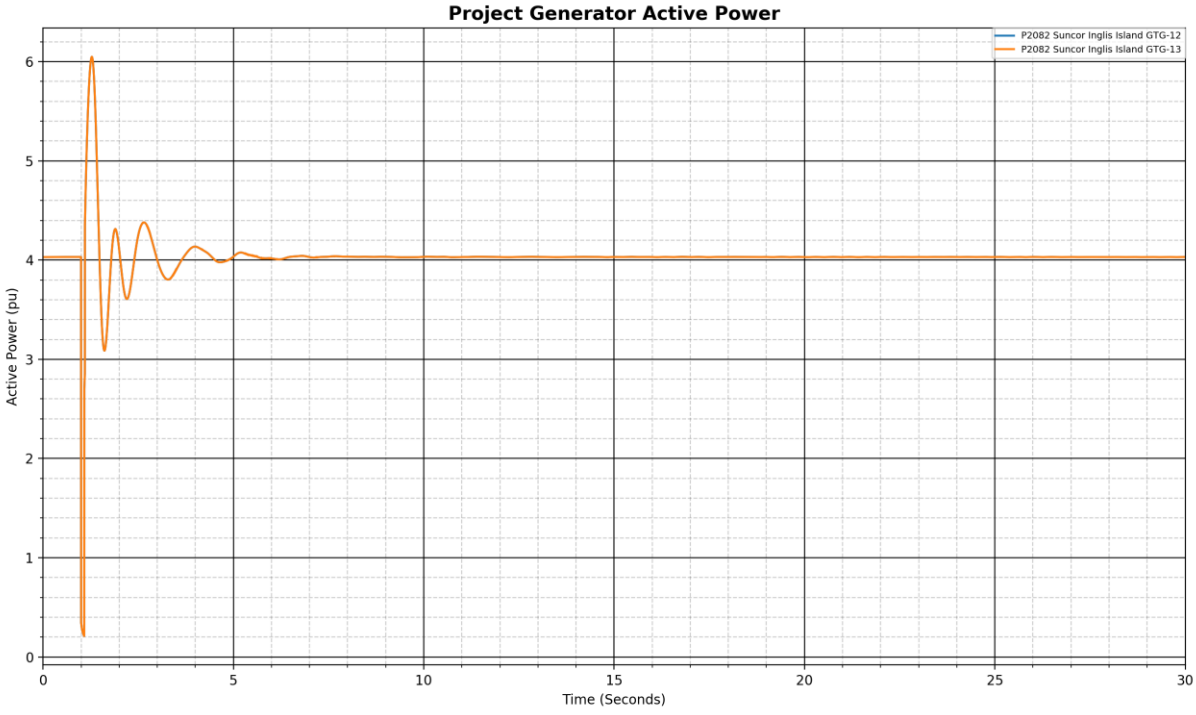

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

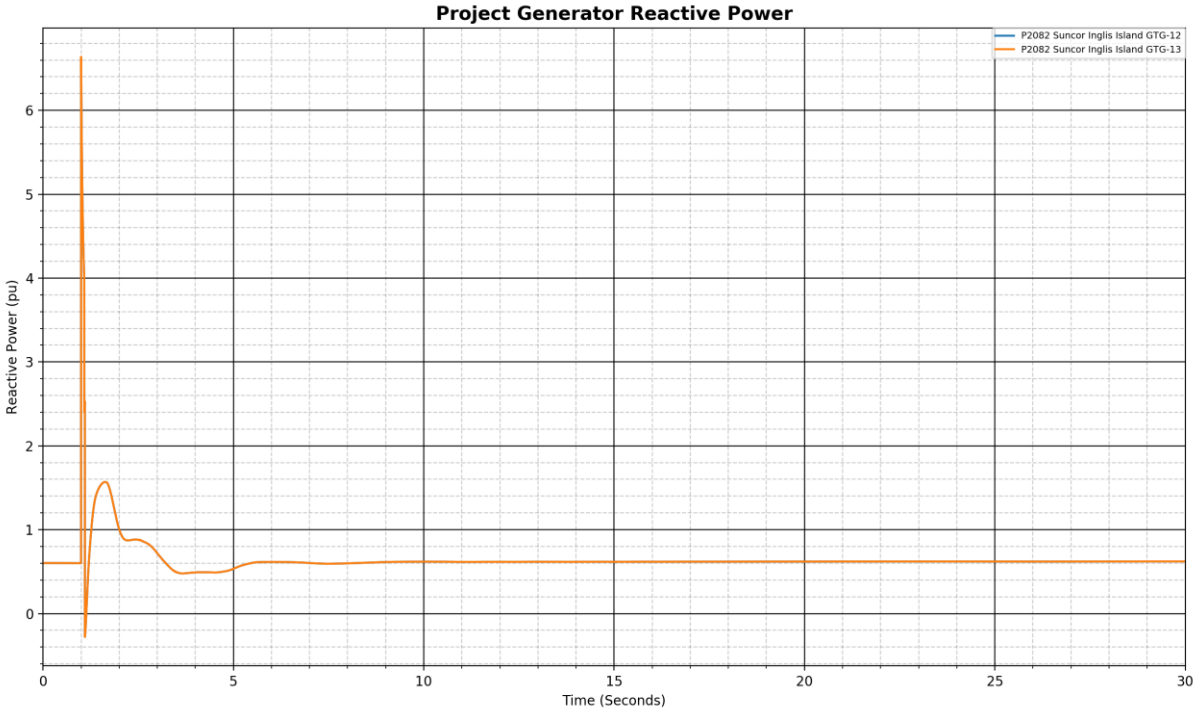

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

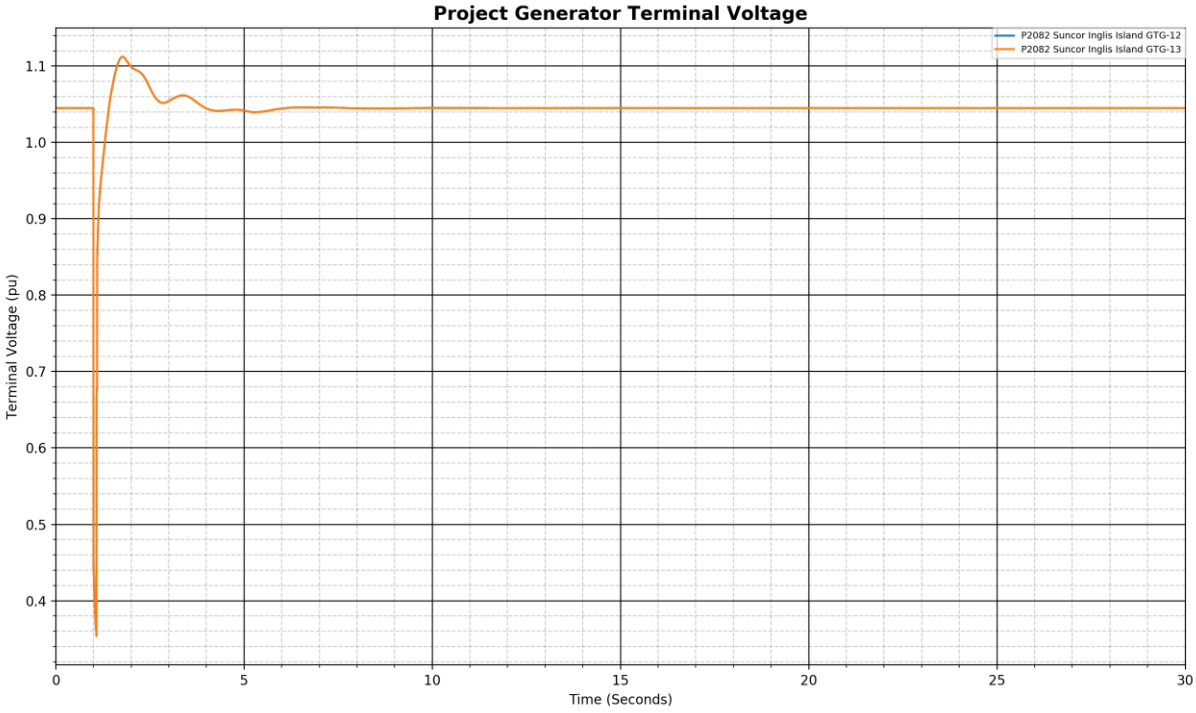

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

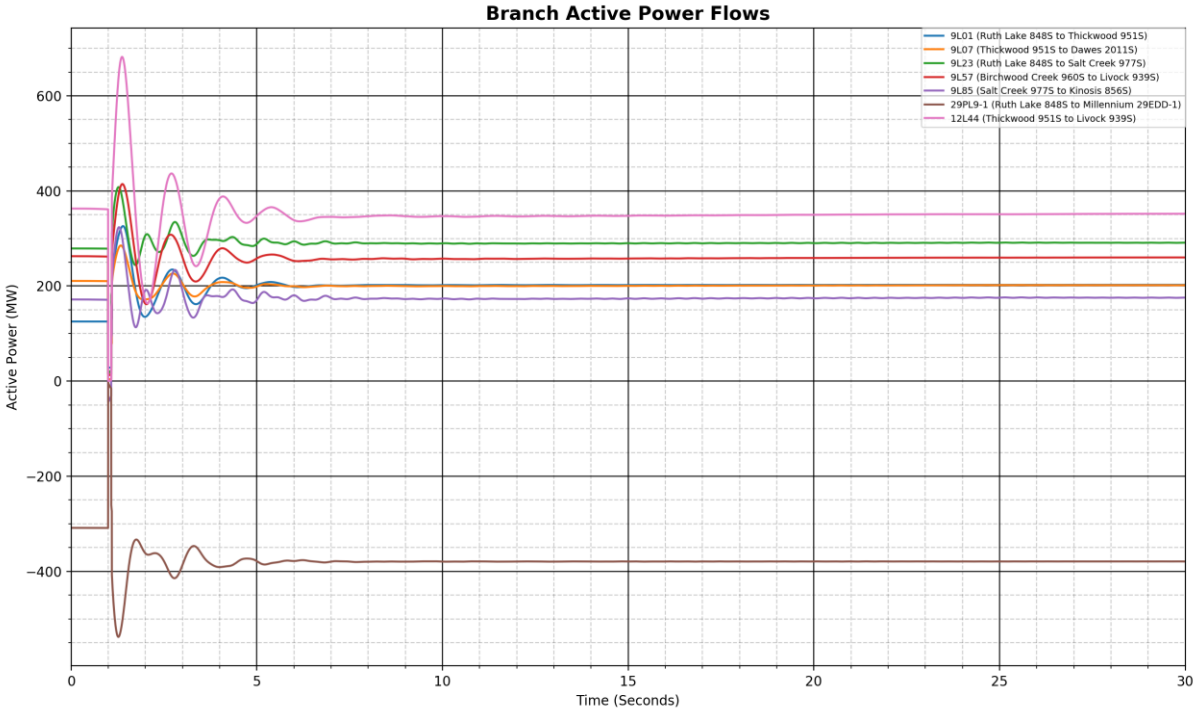

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
0
10
20
30
40
50
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

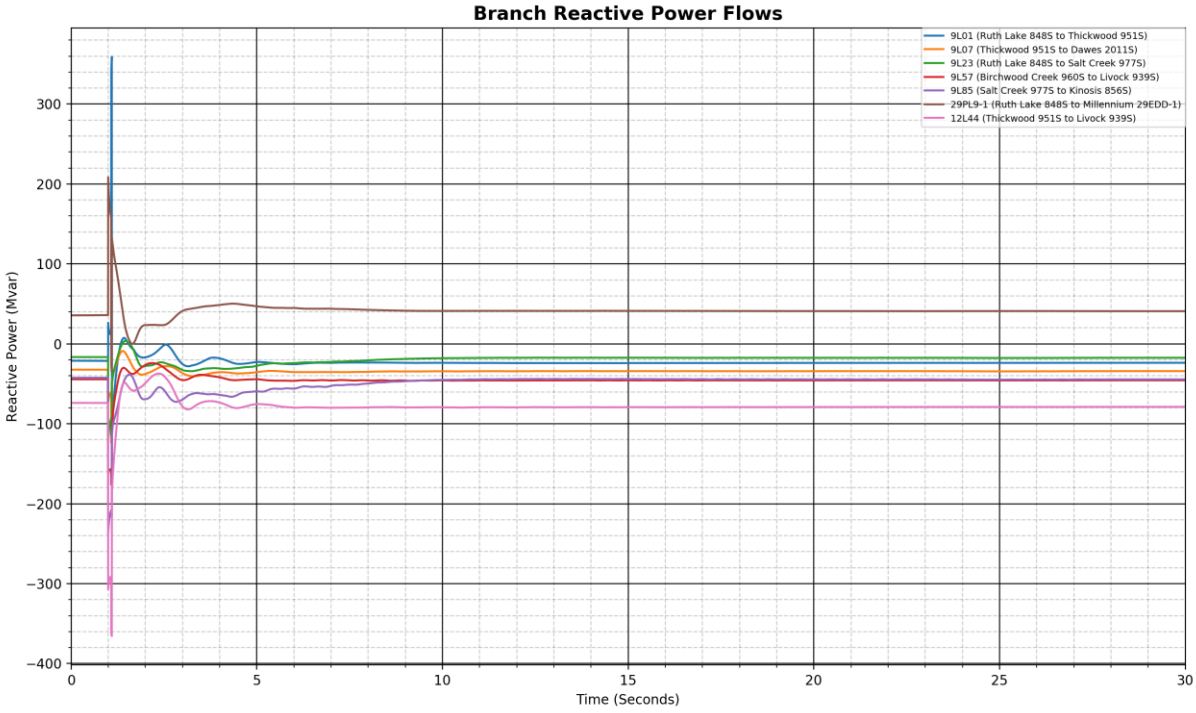
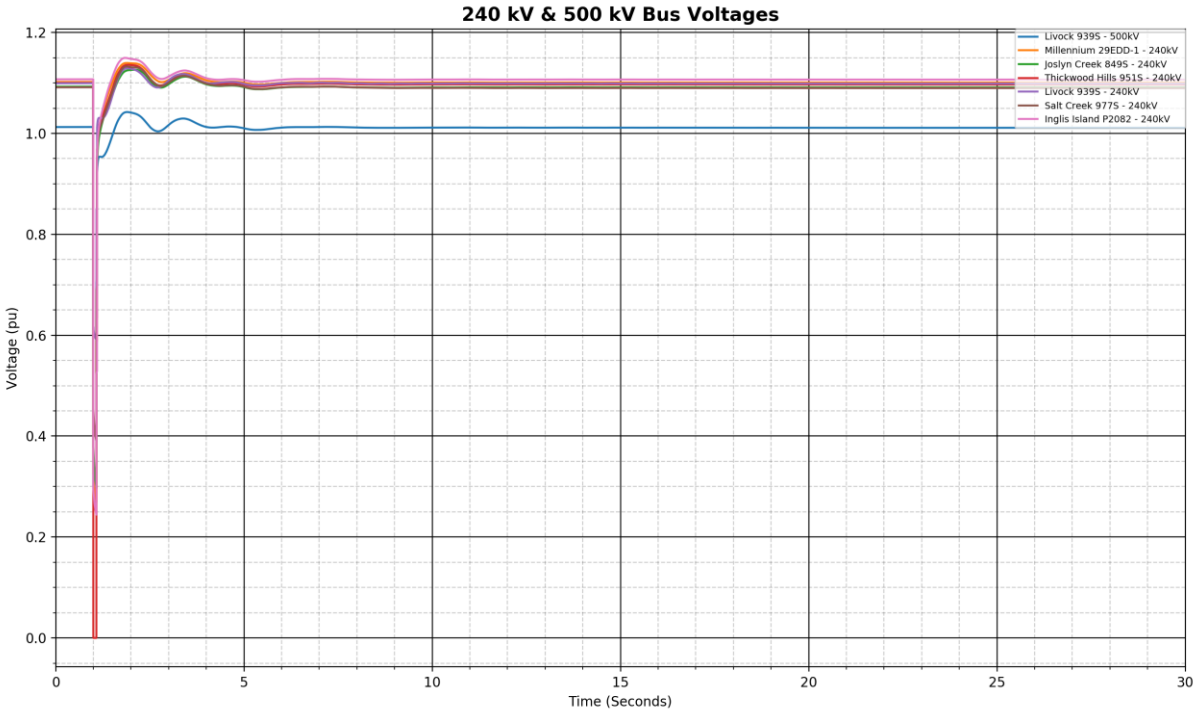
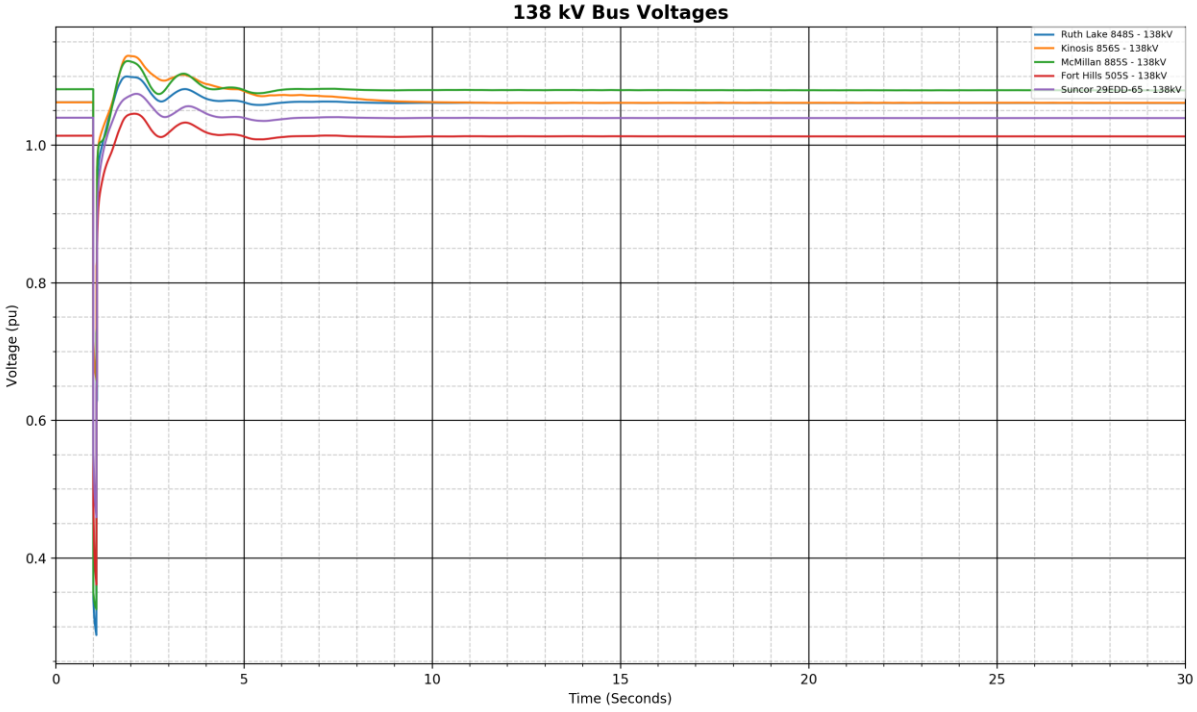
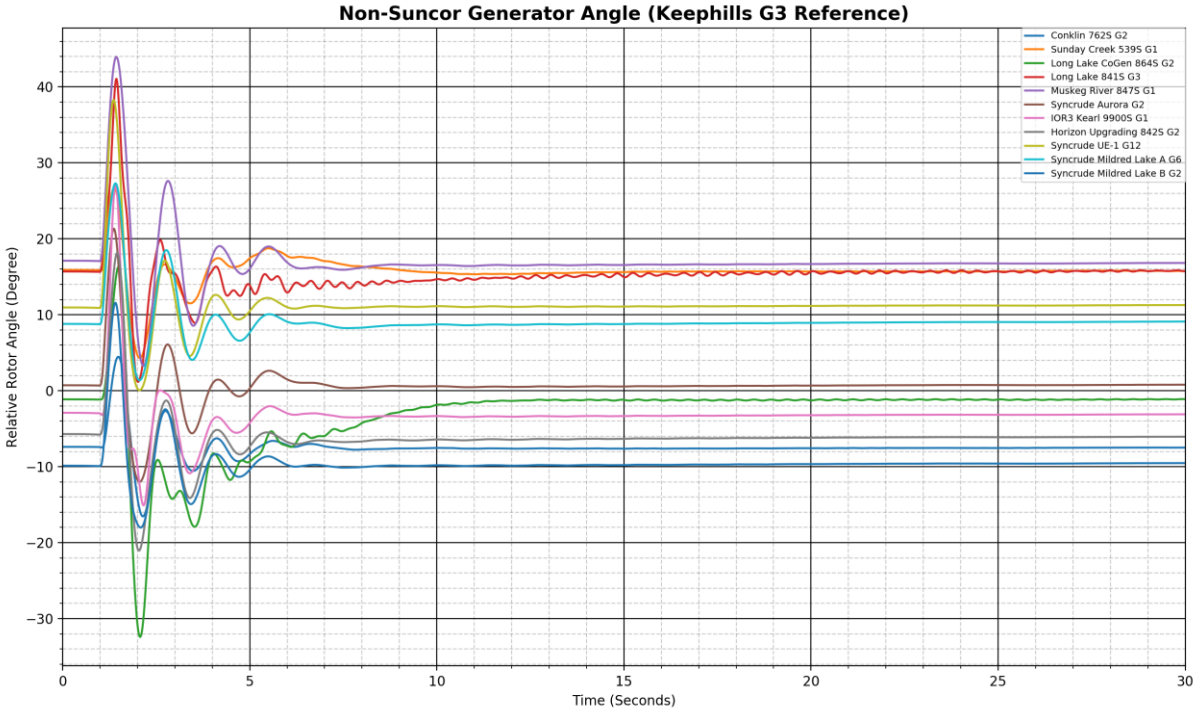
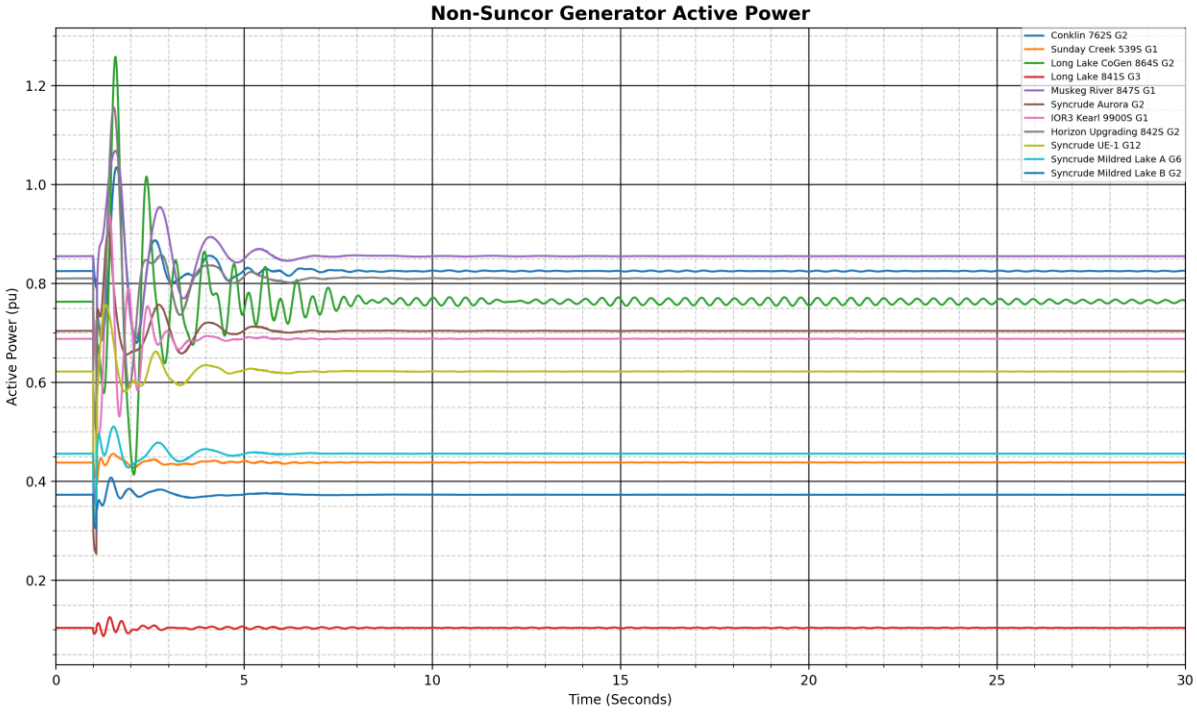

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

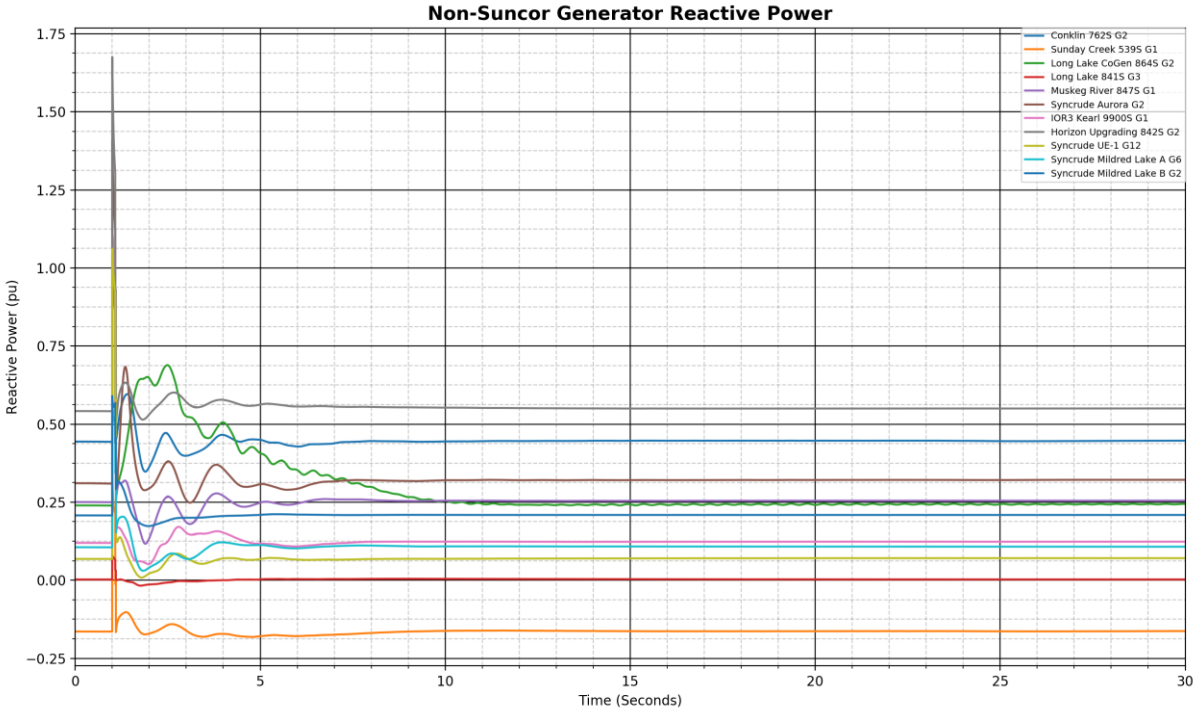
Figure A4-52: 9L162 (Voyageur 29EDD-94 to Thickwood Hills 951S): Fault at Thickwood Hills 951S

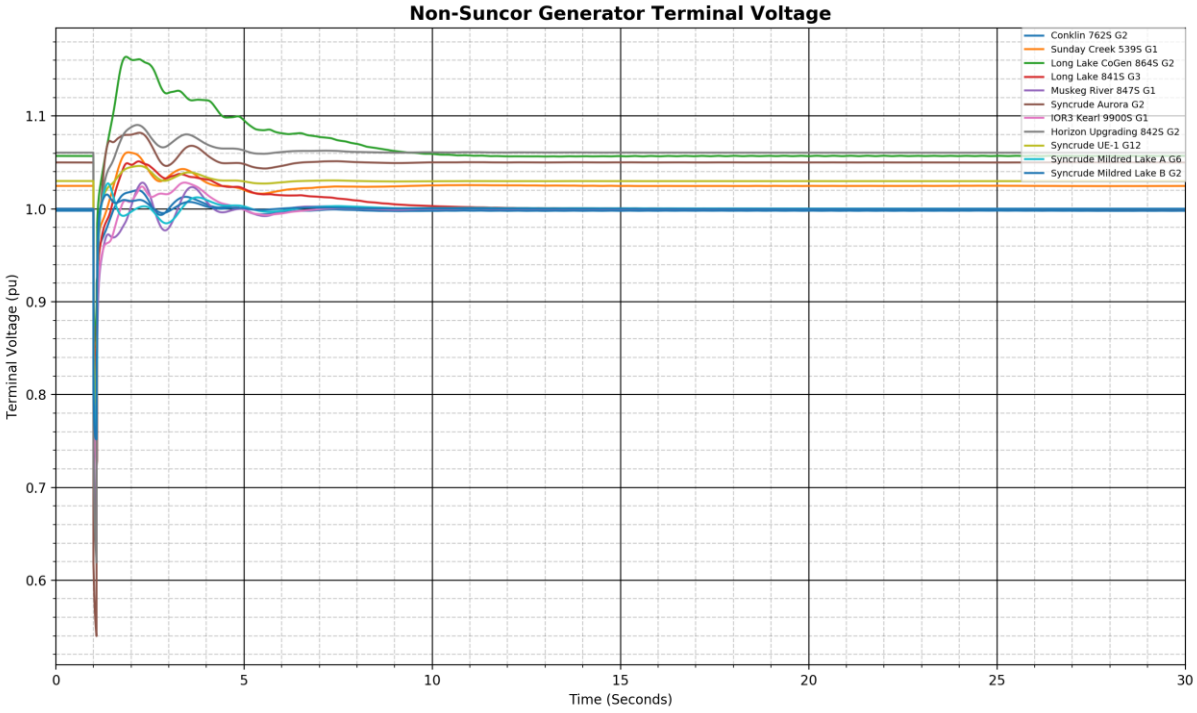


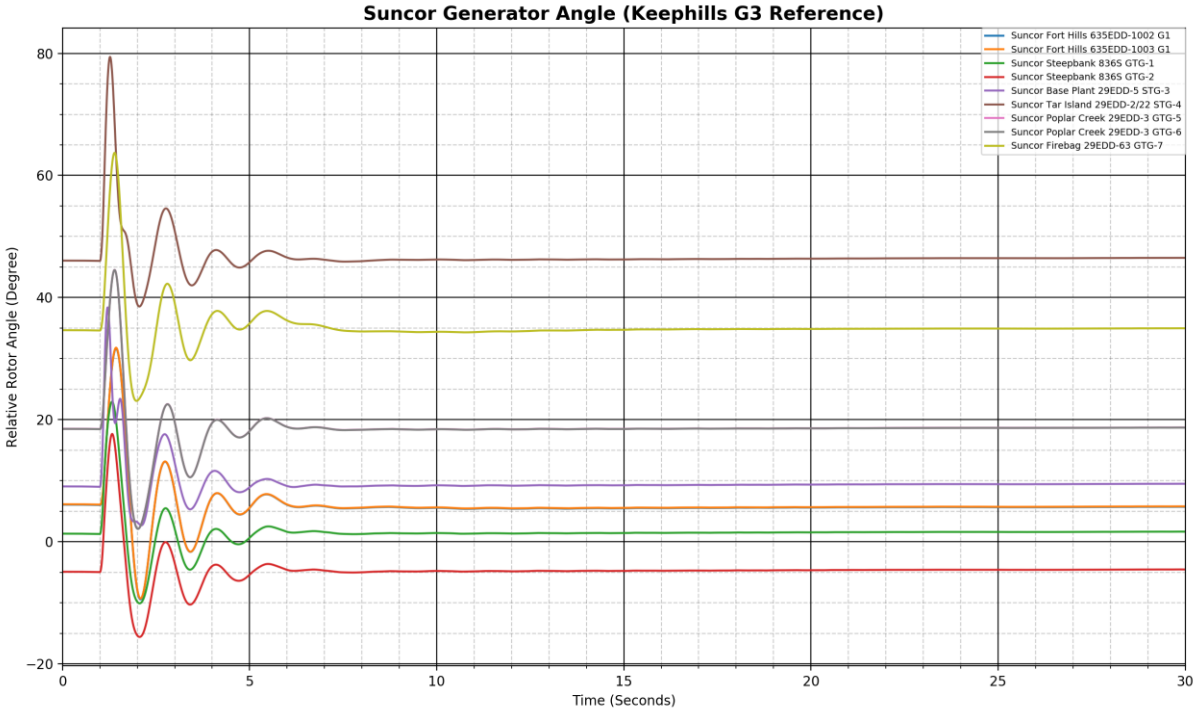


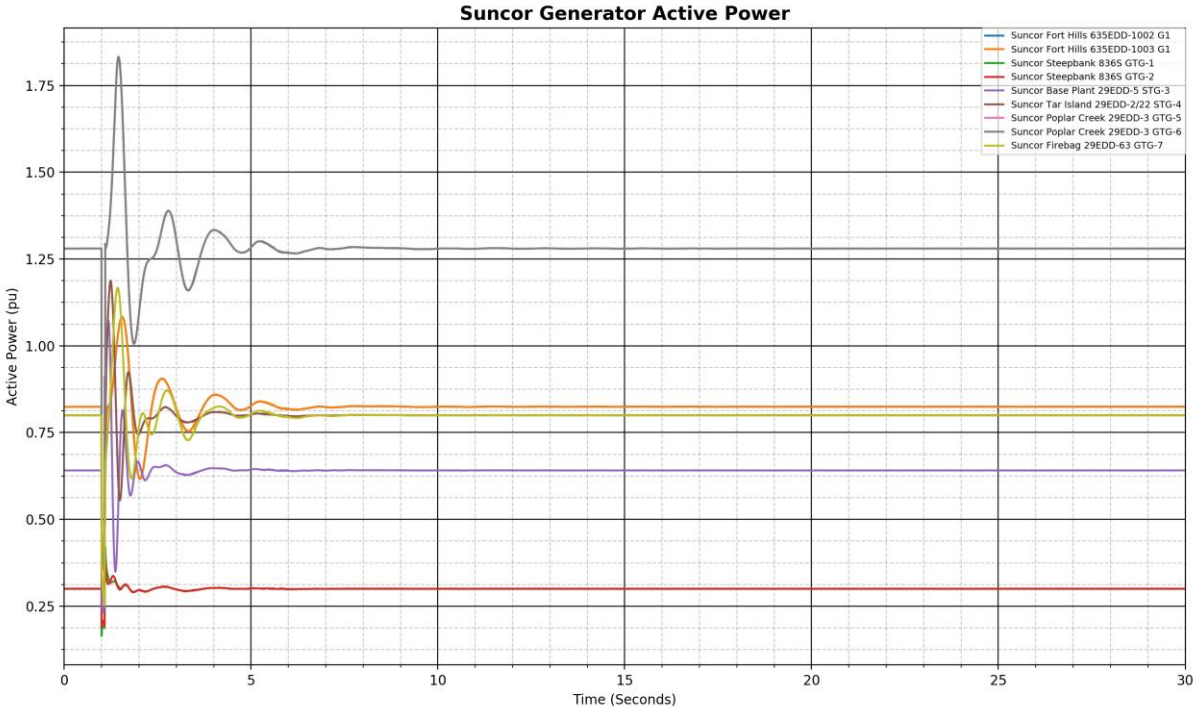

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

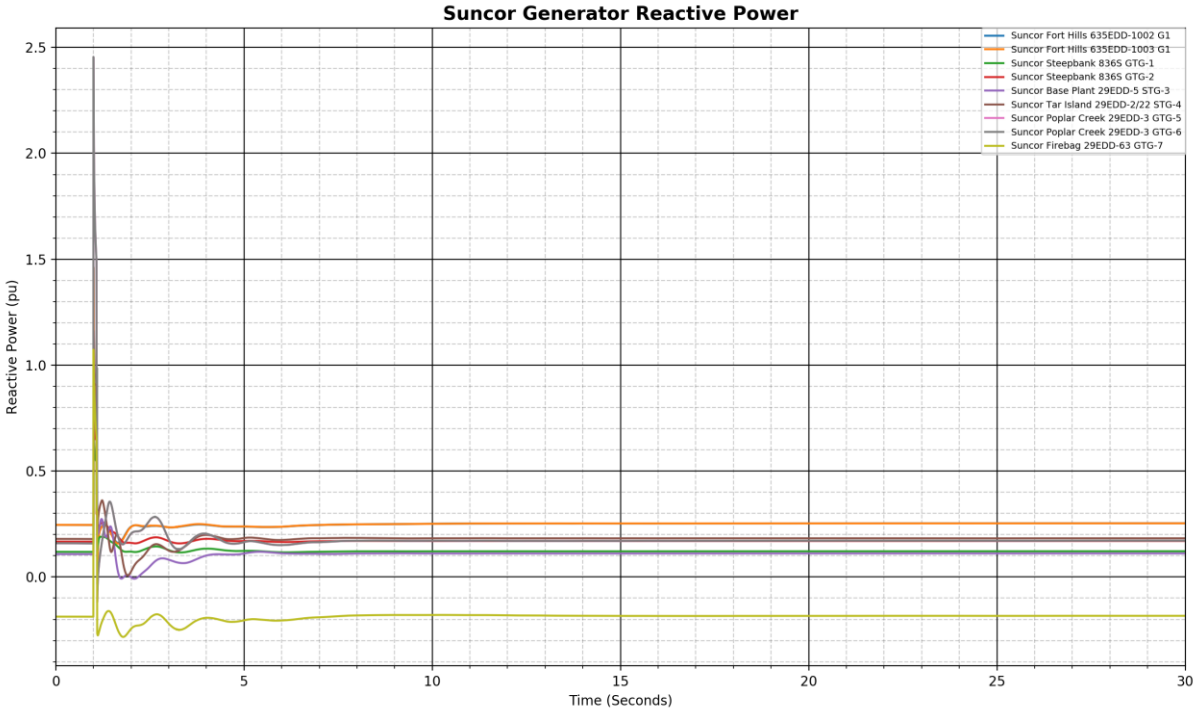

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

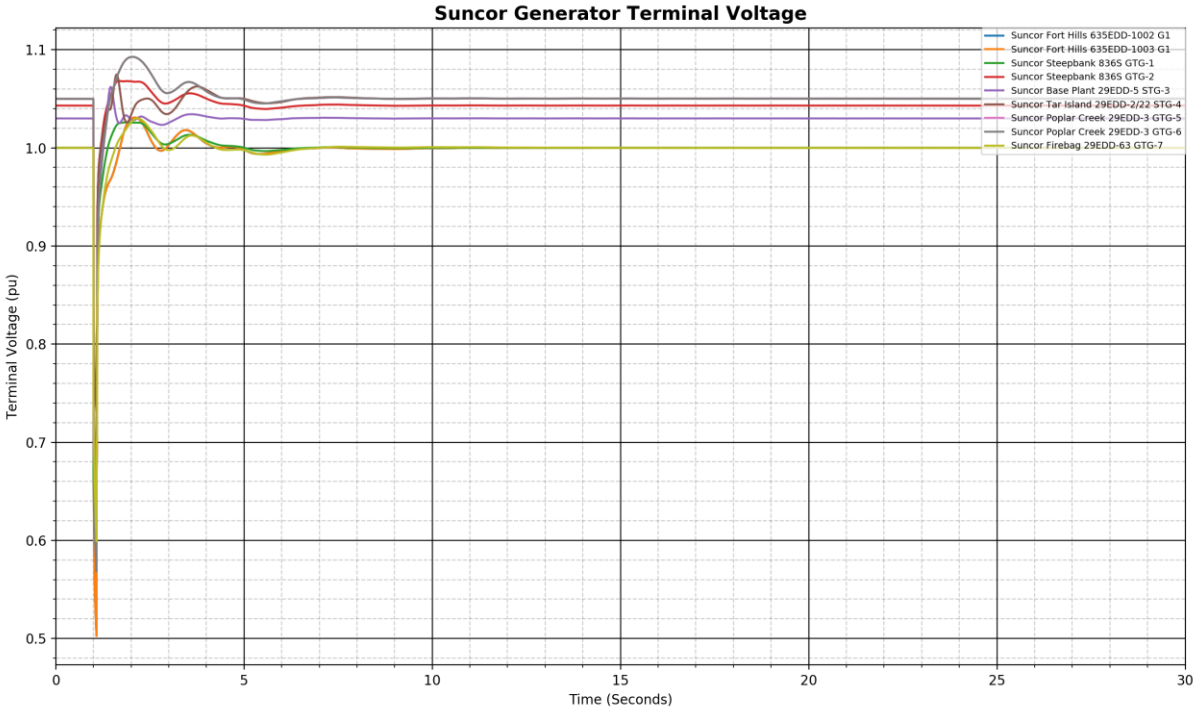

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

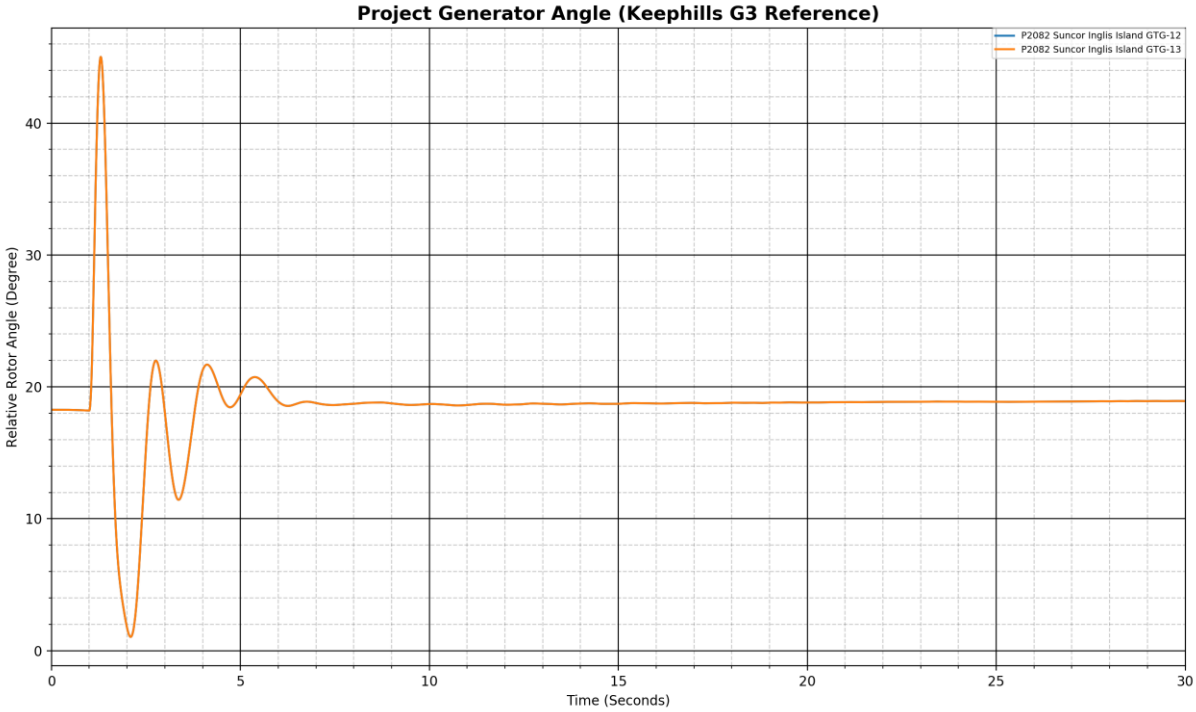

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

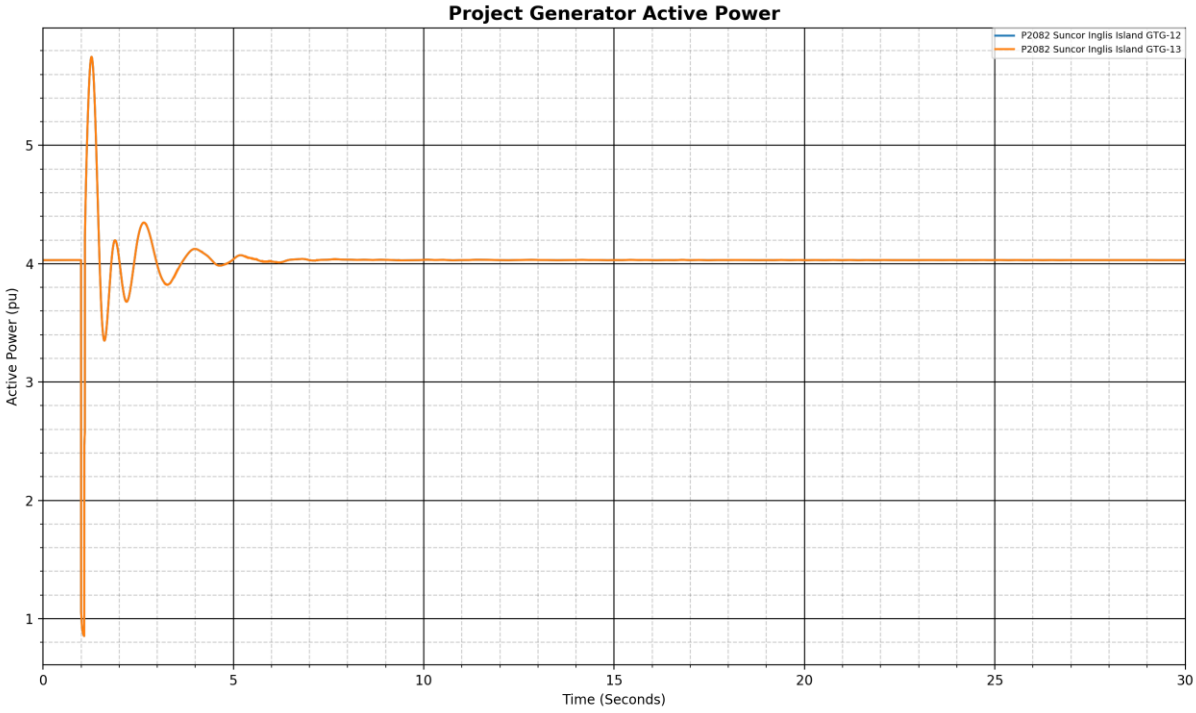

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

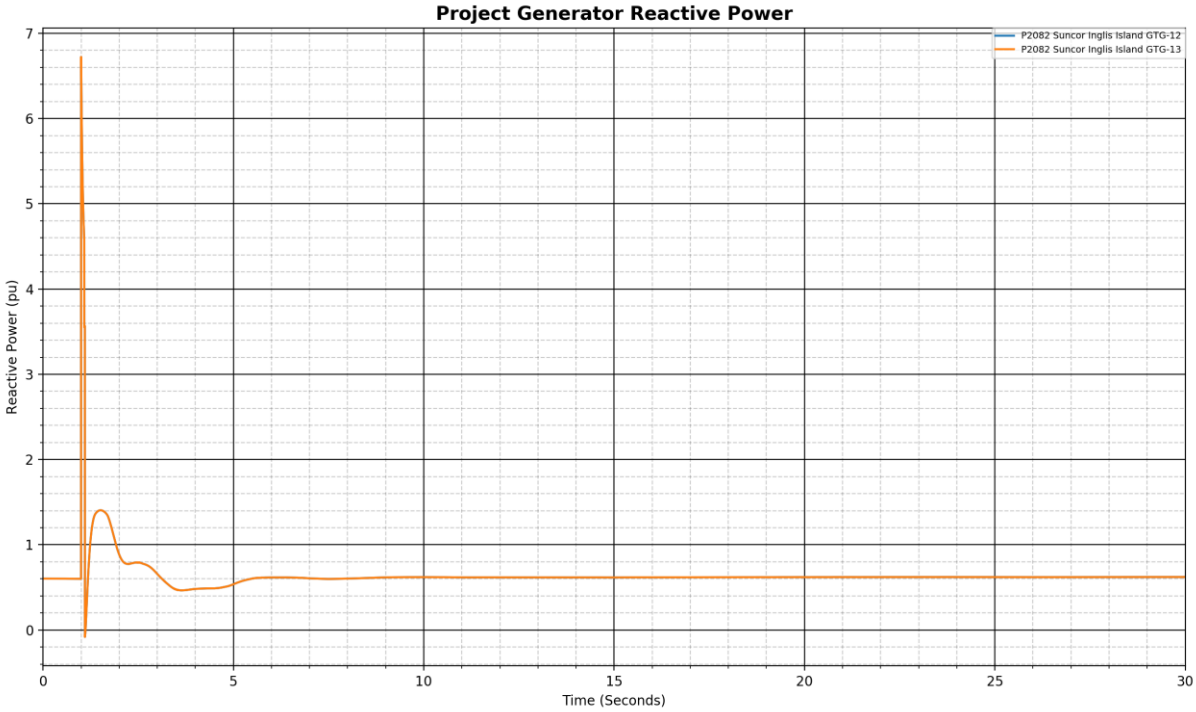

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

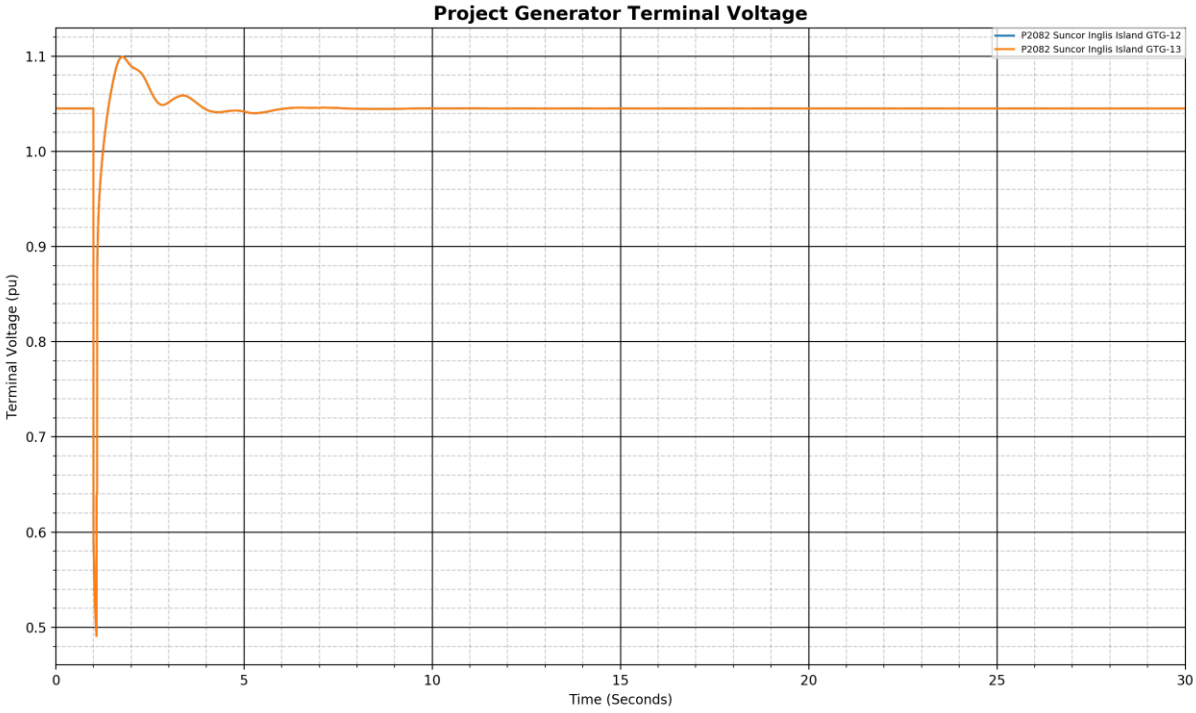

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

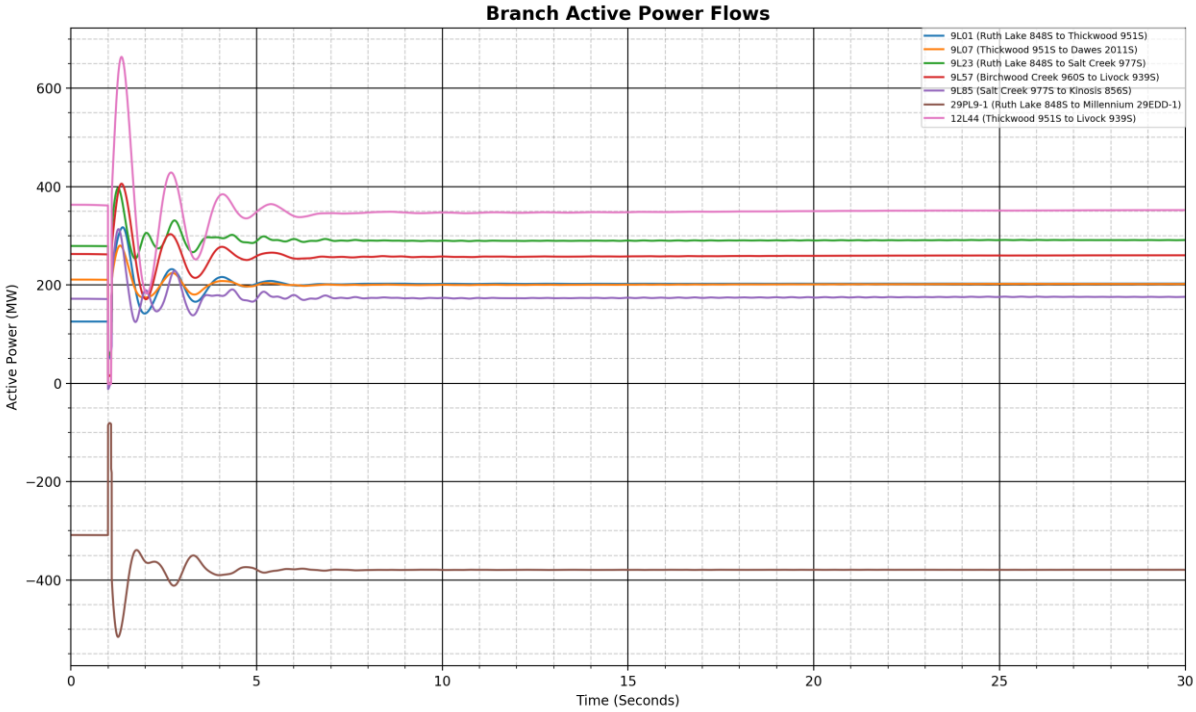

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

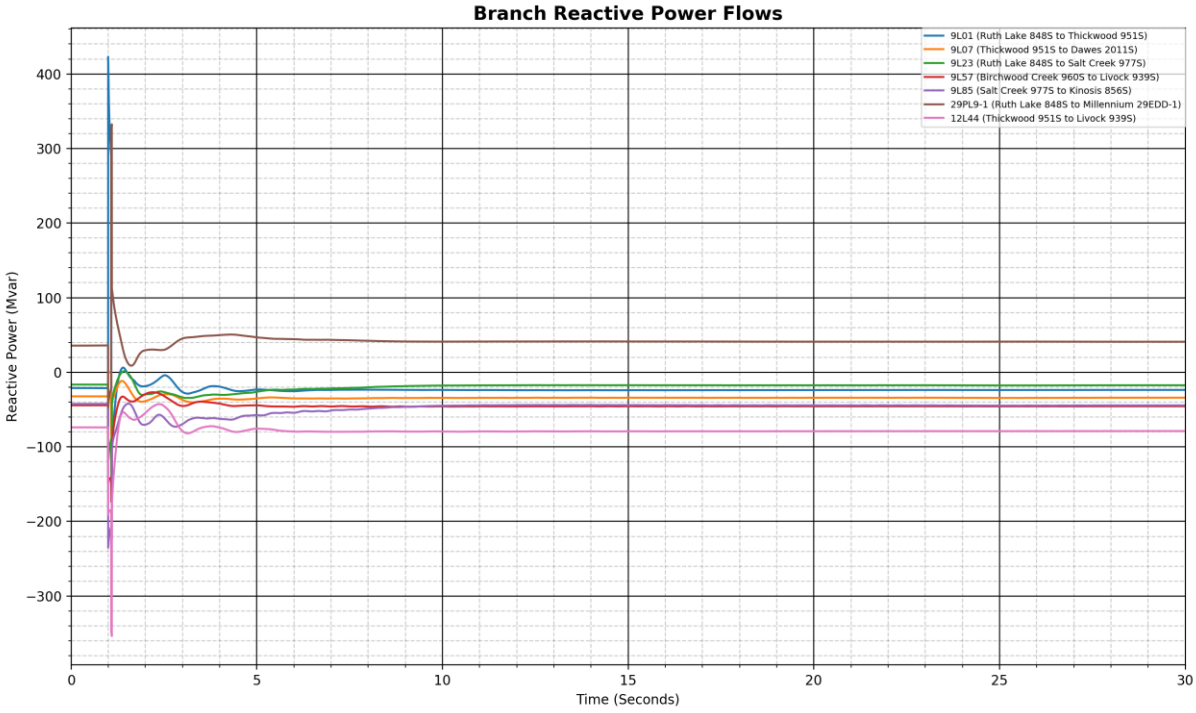

Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
0
10
20
30
40
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
1
2
3
4
5
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30

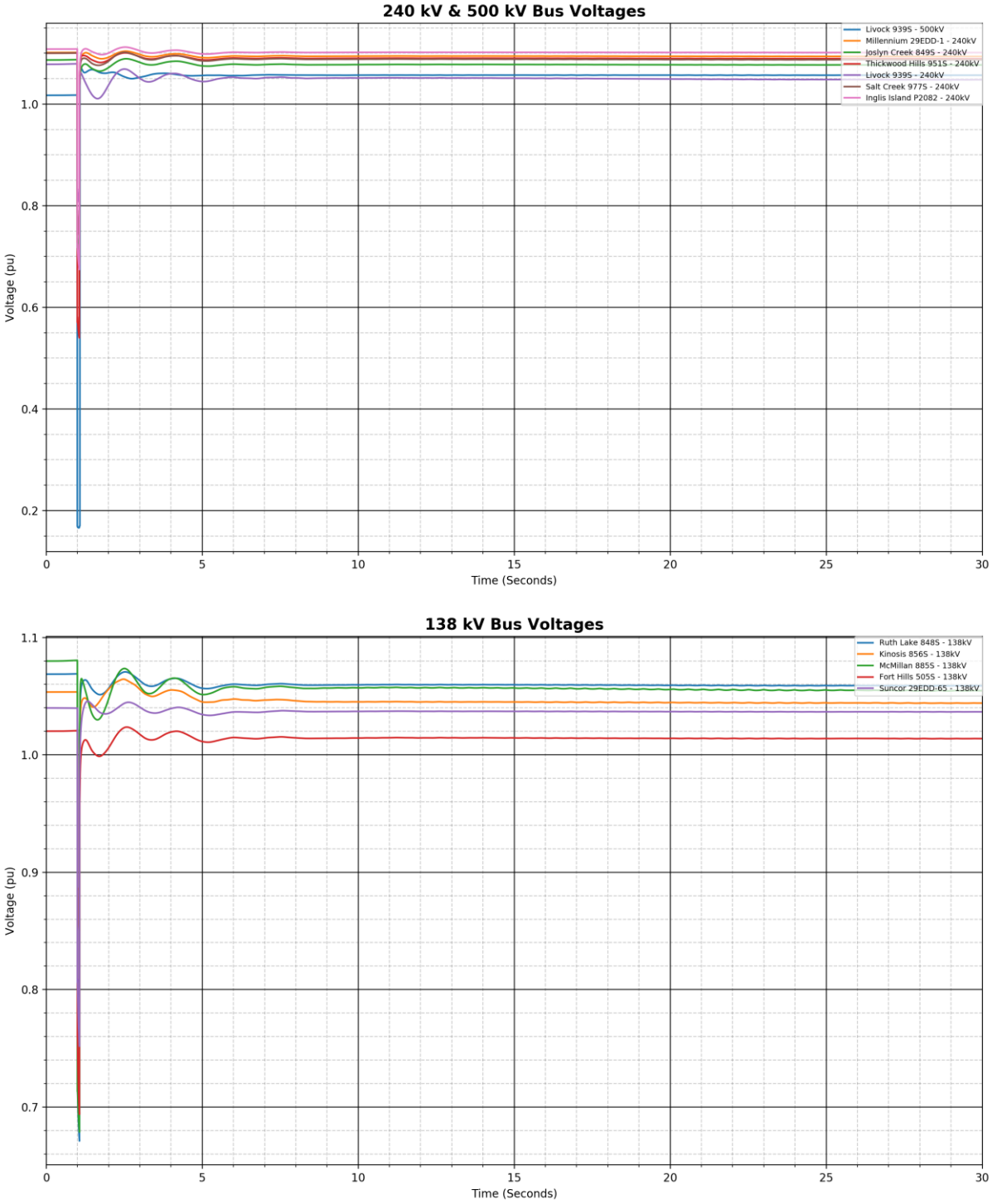

Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30

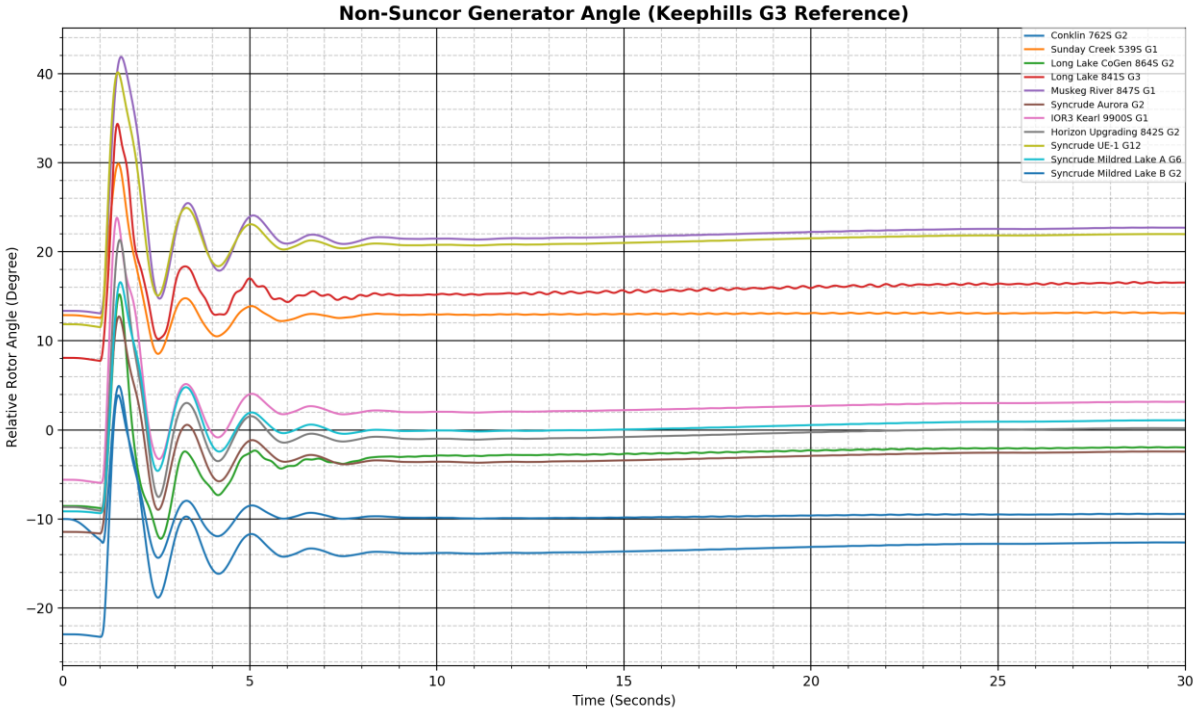

Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

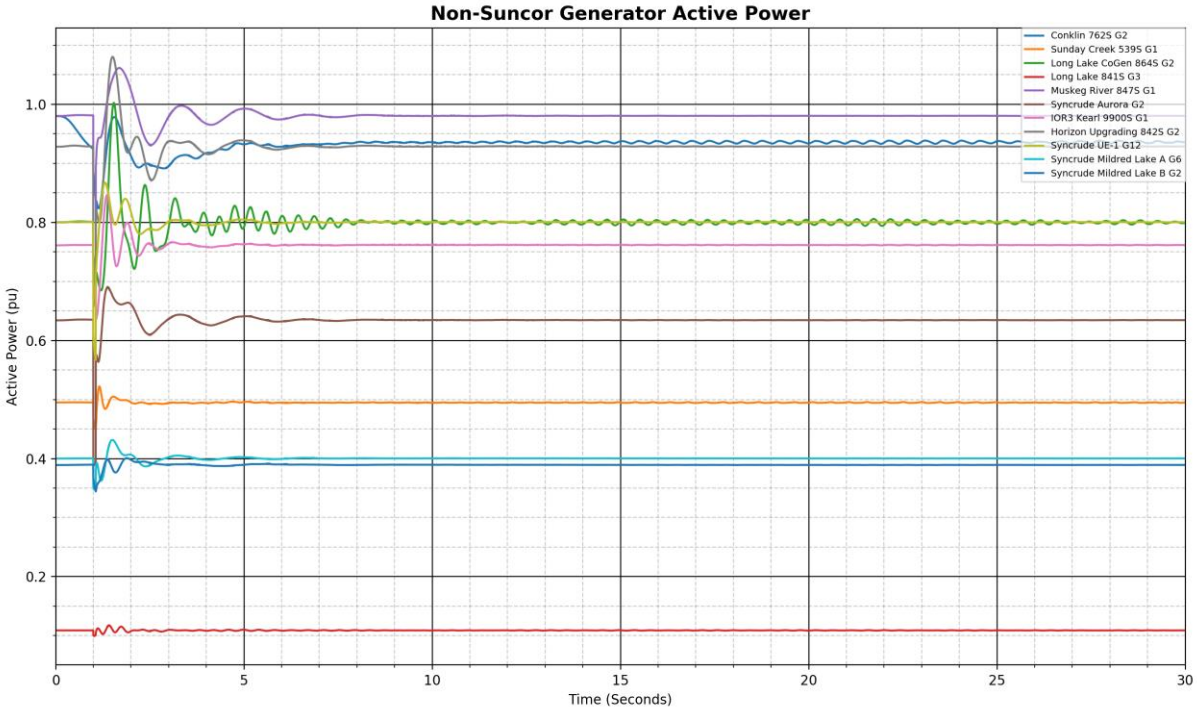

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

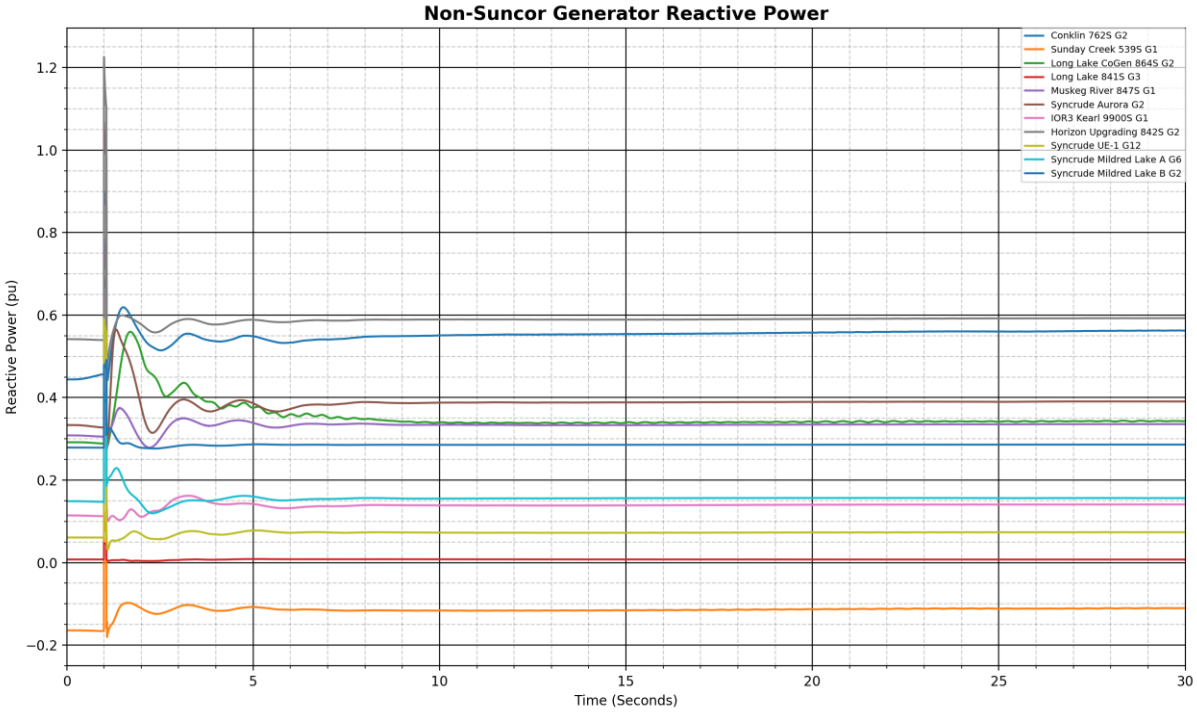
3. Stability Results 2023 Winter Peak

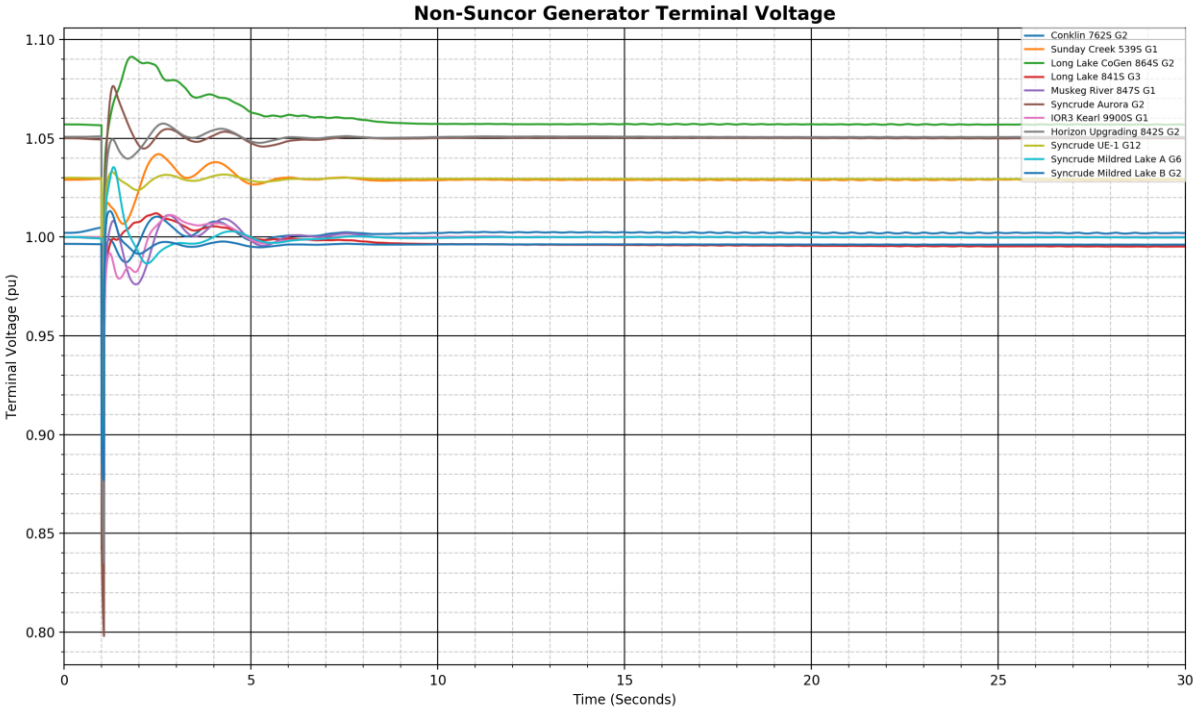
Figure A4-53: 12L44 (Thickwood Hills 951S to Livock 939S): Fault at Thickwood Hills 951S

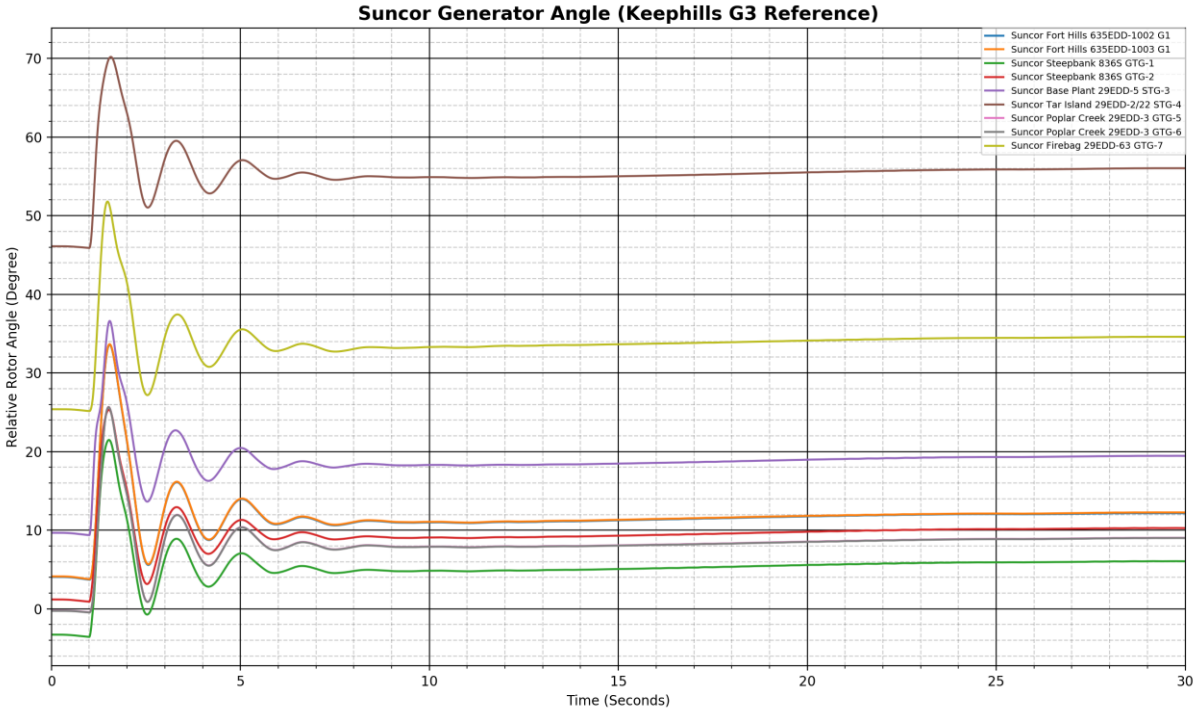


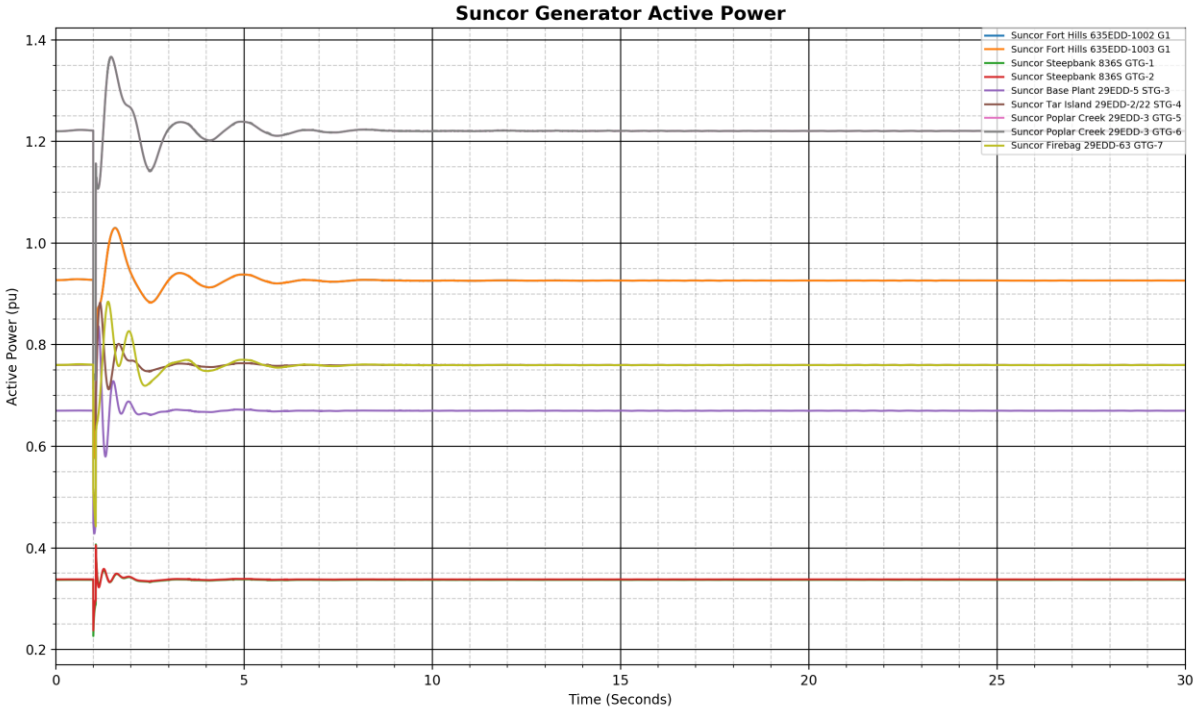

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

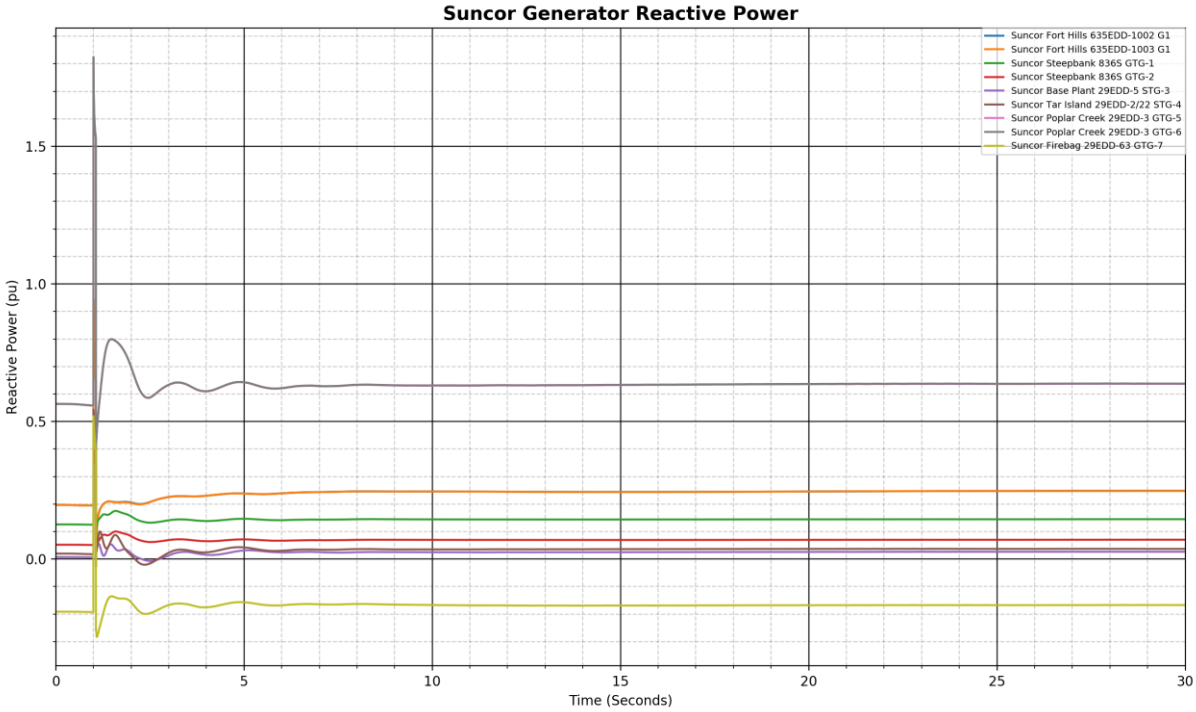

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

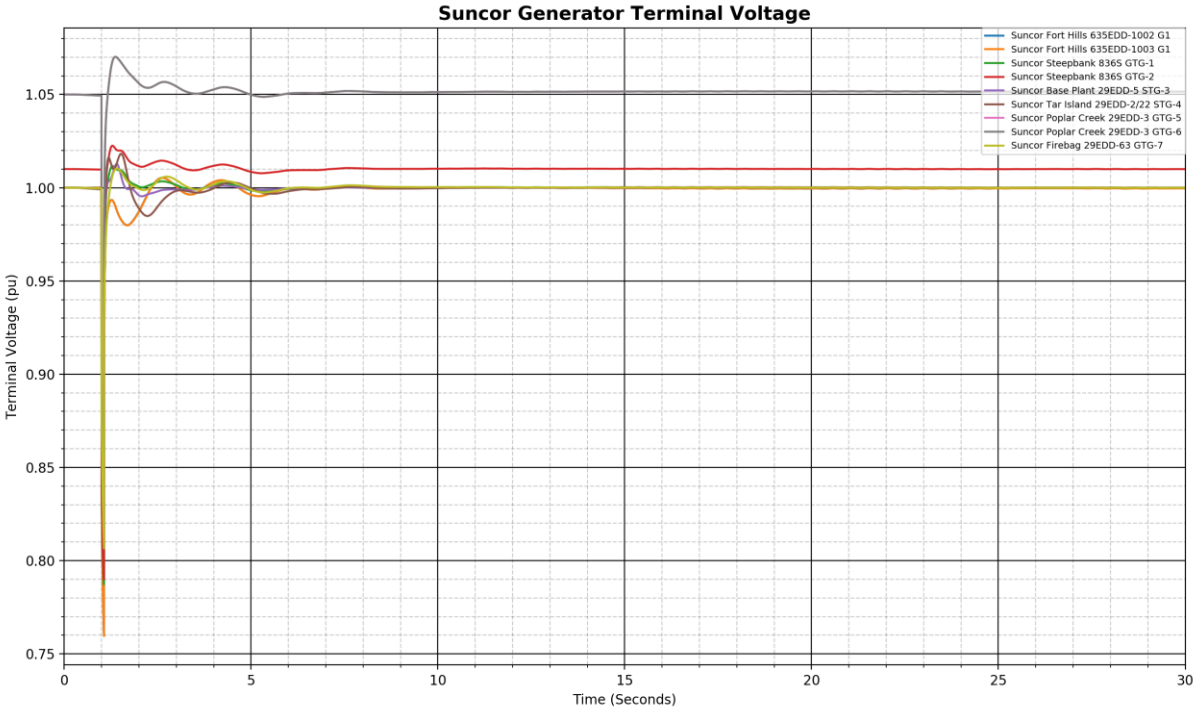

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

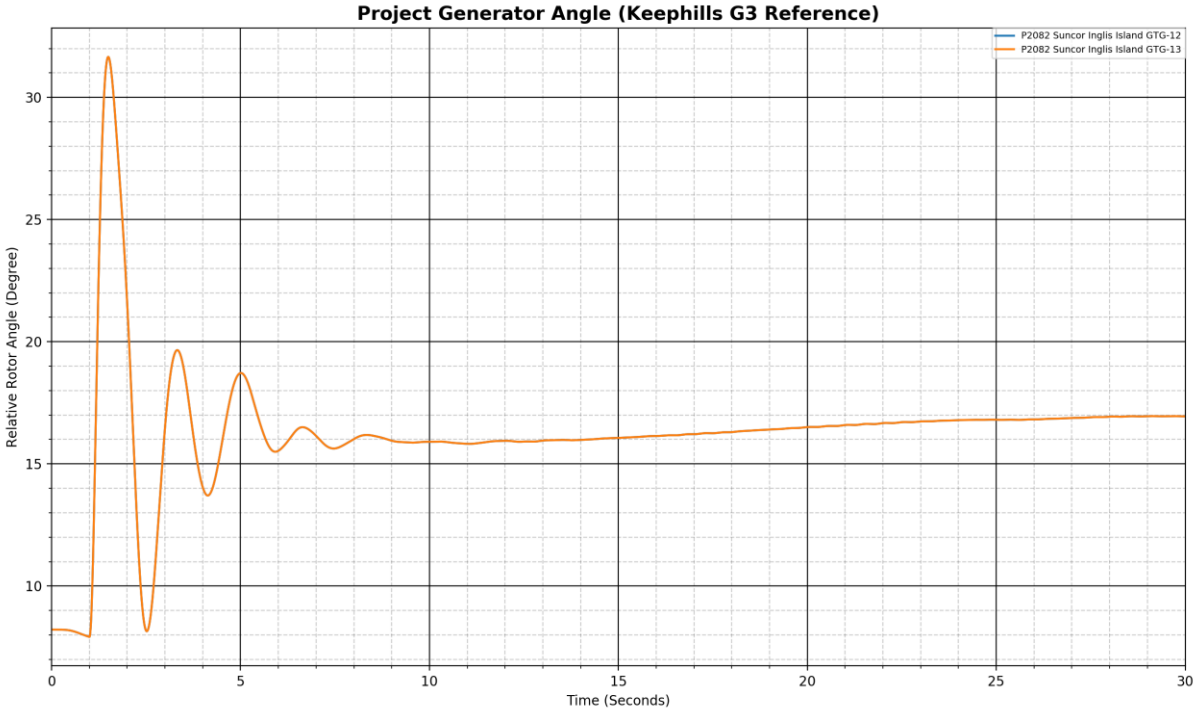

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

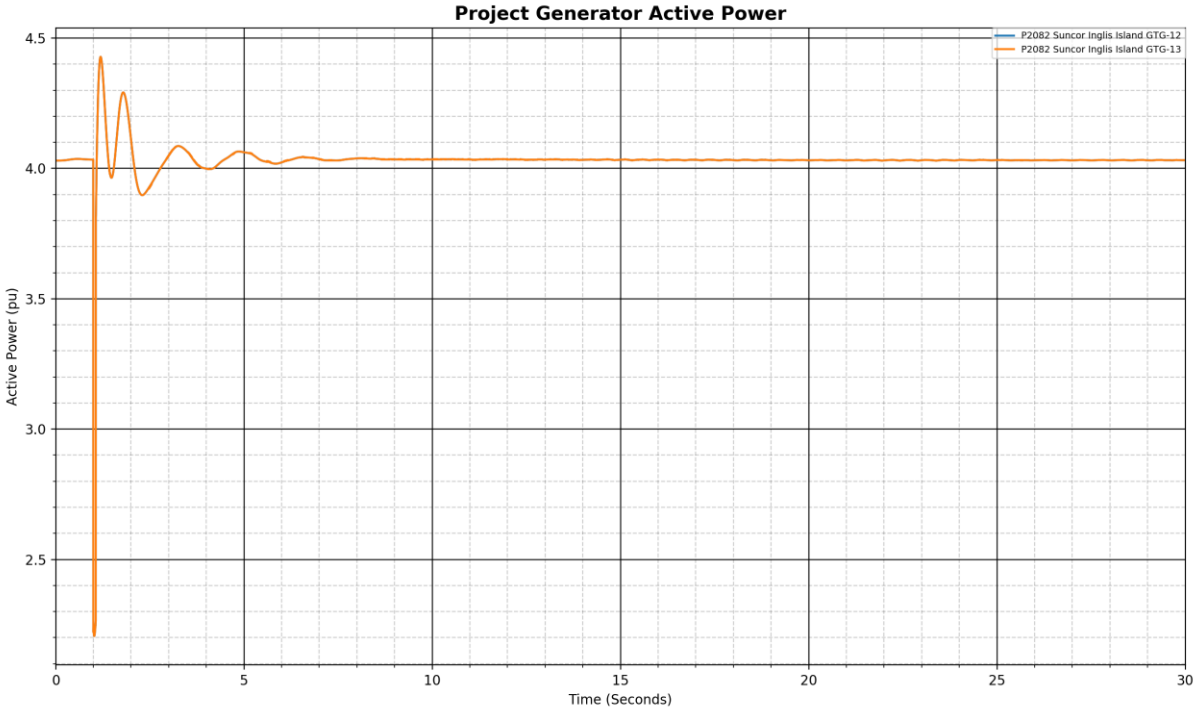

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

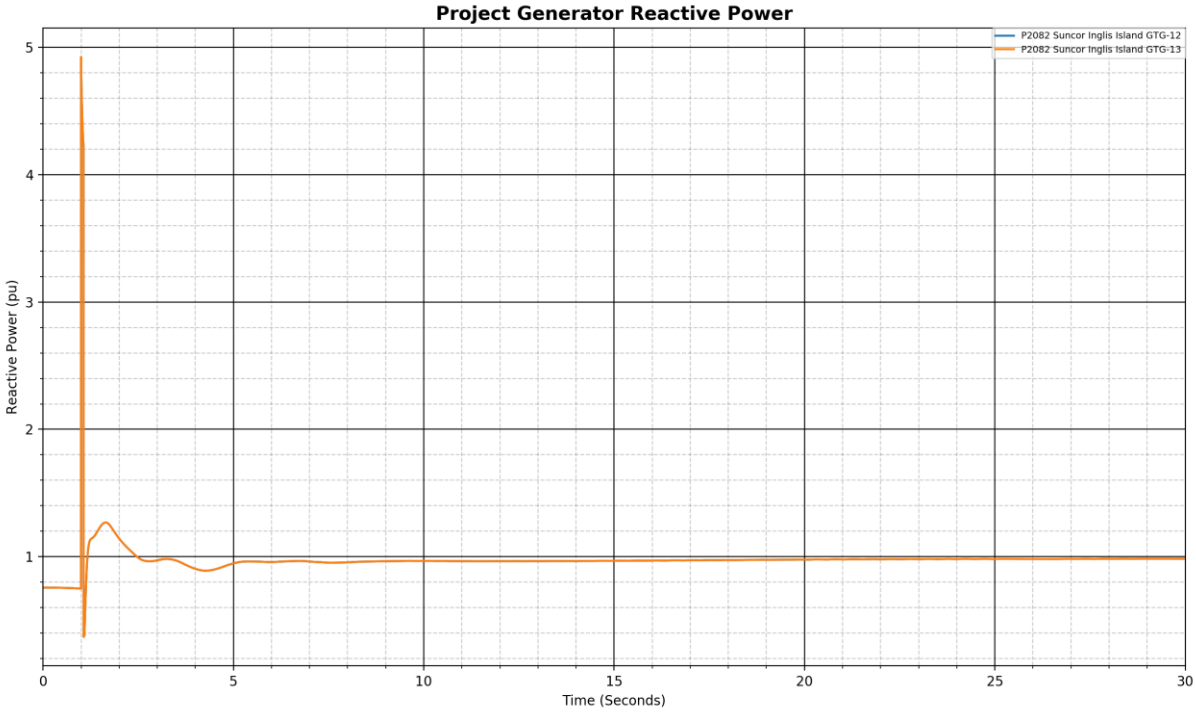

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

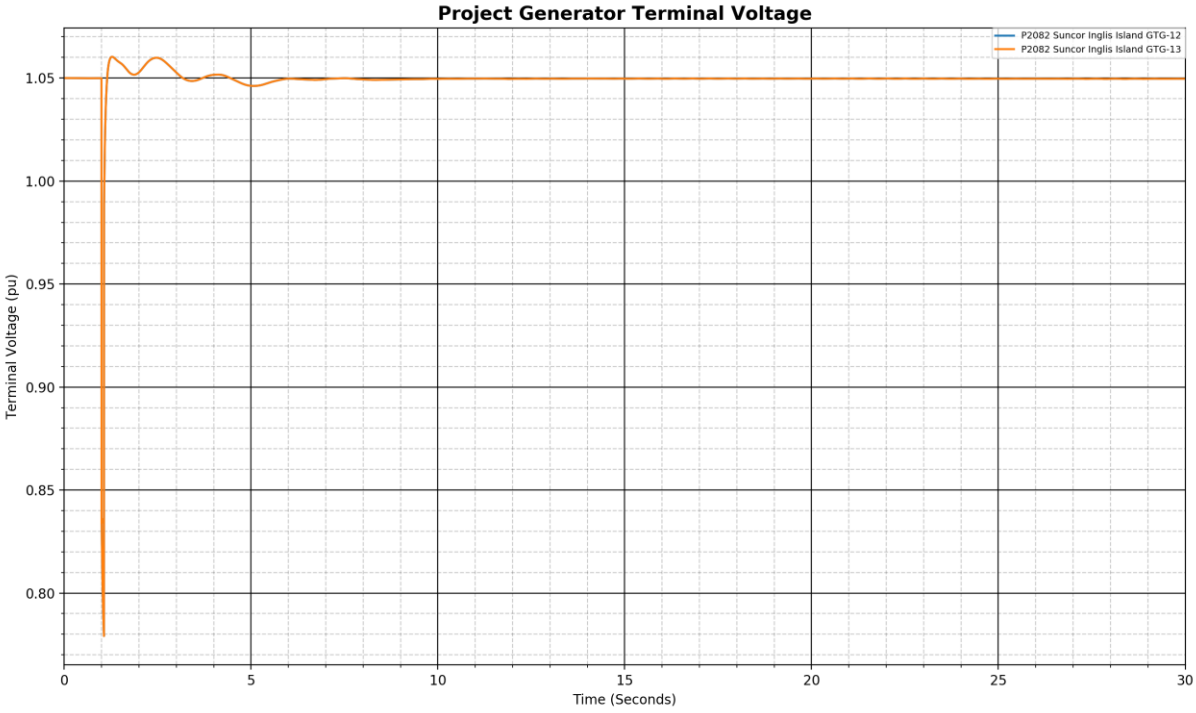

Suncor Generator Reactive Power
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7
Reactive Power (pu)
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
Time (Seconds)

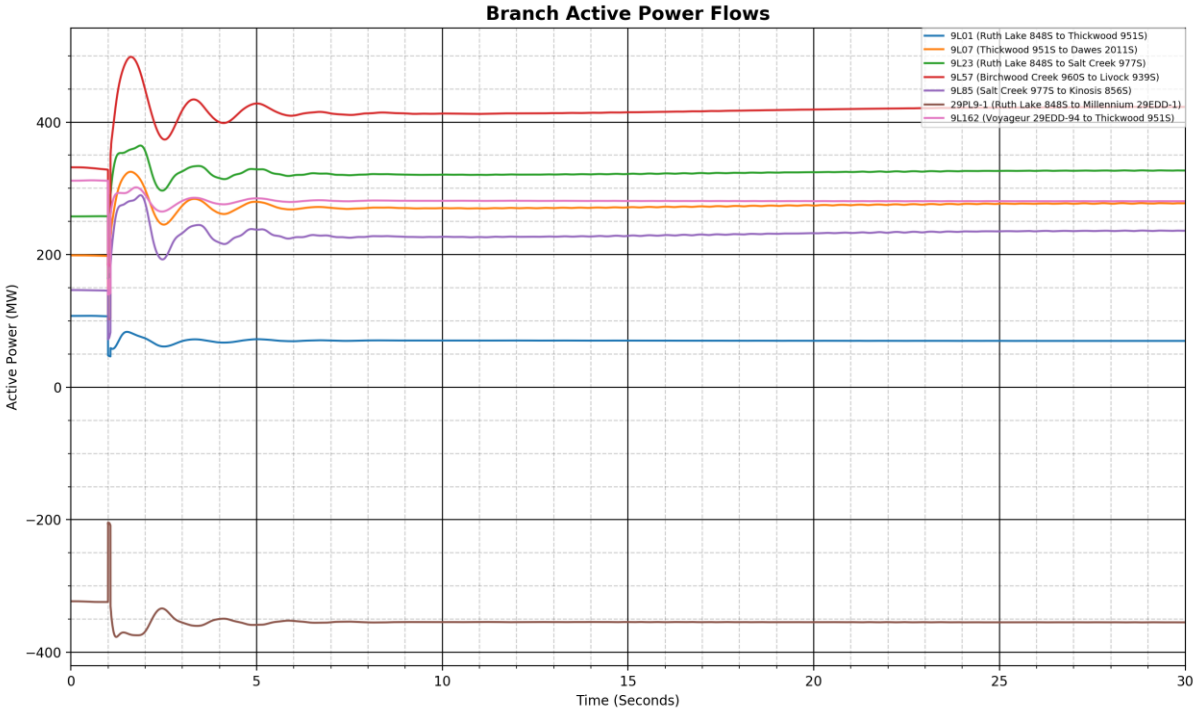

Suncor Generator Terminal Voltage
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
10
15
20
25
30
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
2.5
3.0
3.5
4.0
4.5
0
5
10
15
20
25
30

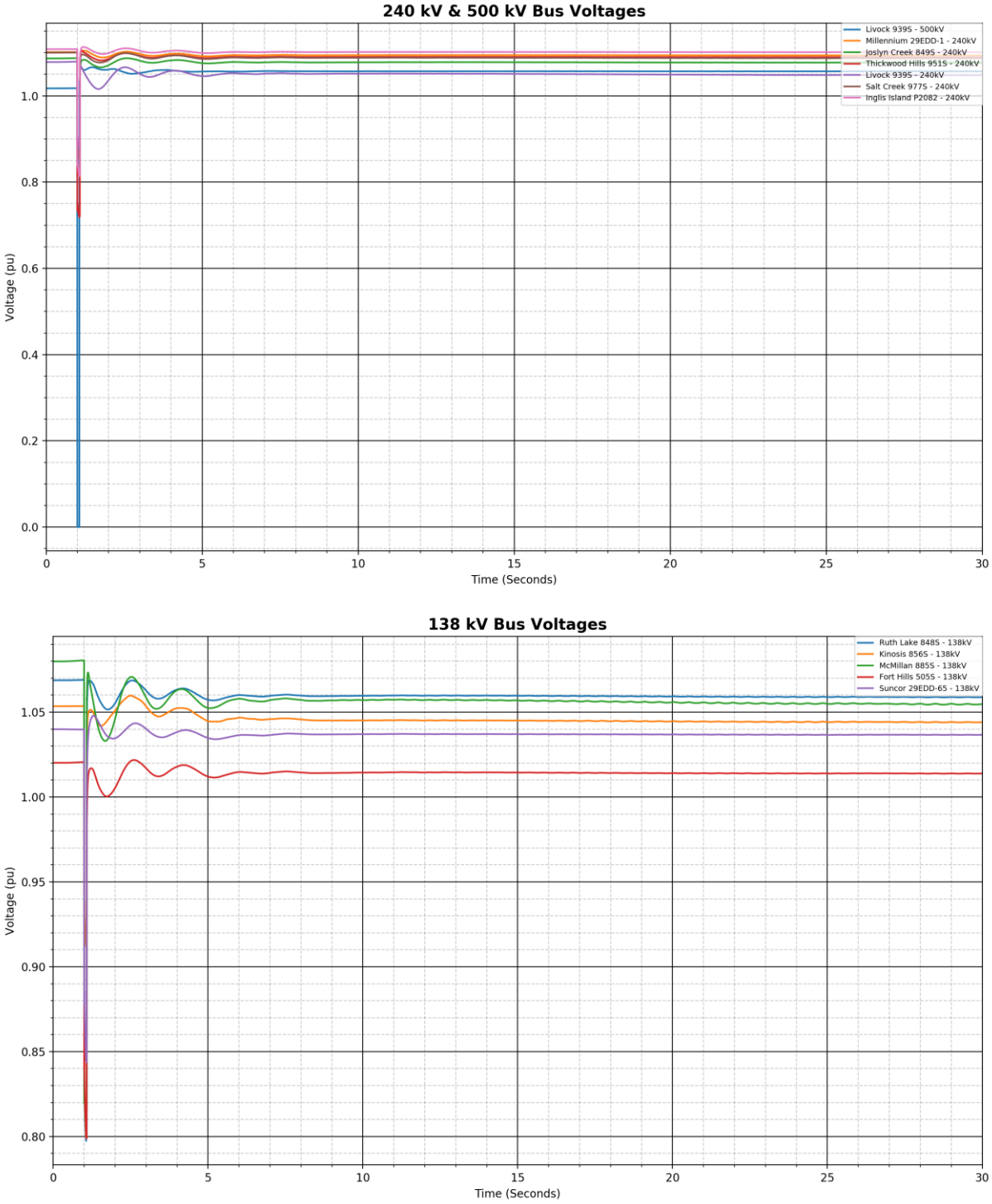

Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
5
10
15
20
25
30
1
2
3
4
5

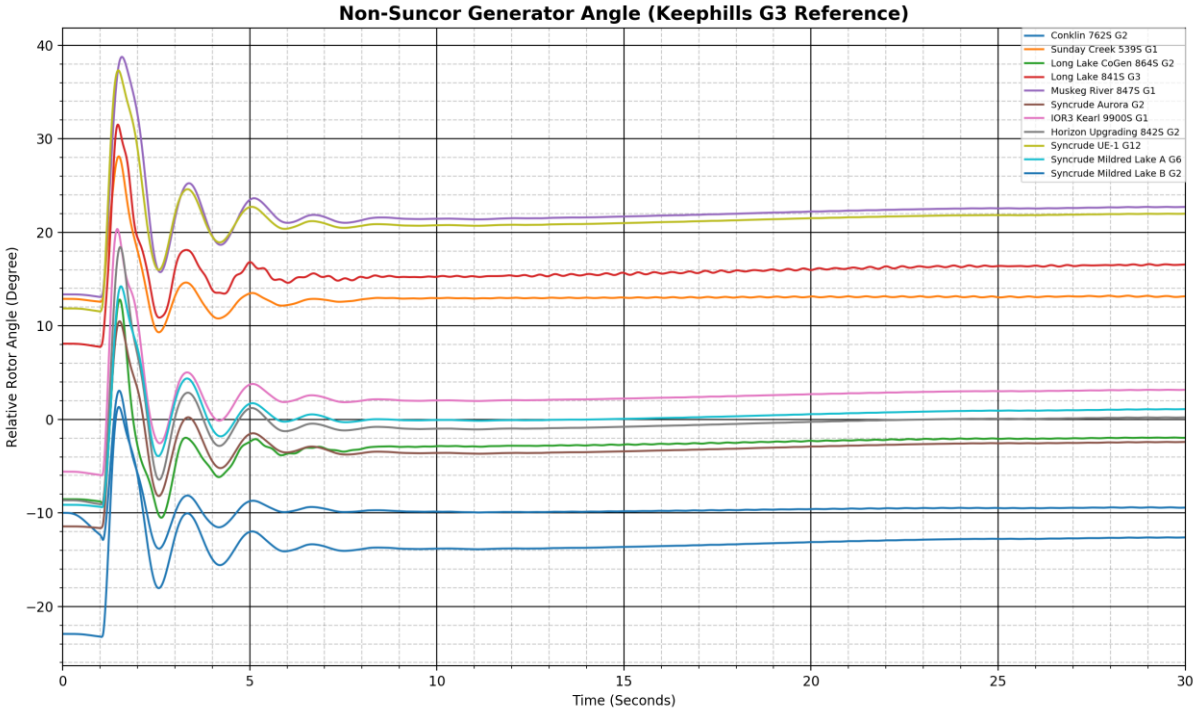

Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0
5
10
15
20
25
30
0.80
0.85
0.90
0.95
1.00
1.05

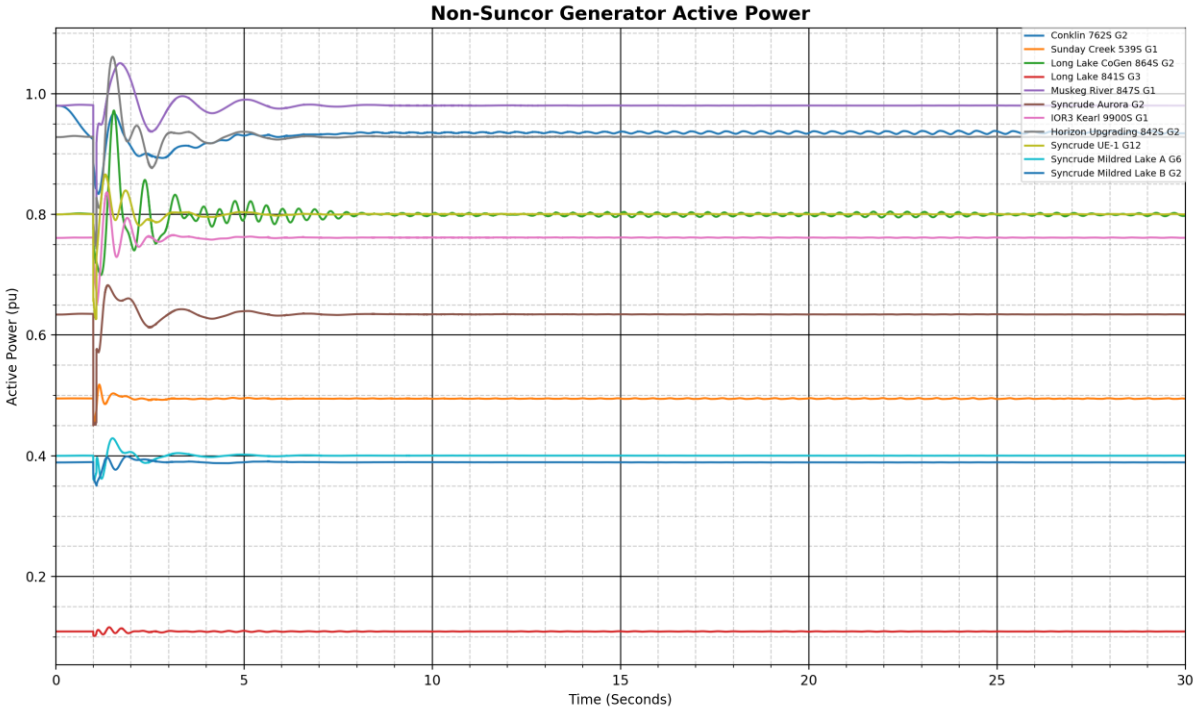

Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

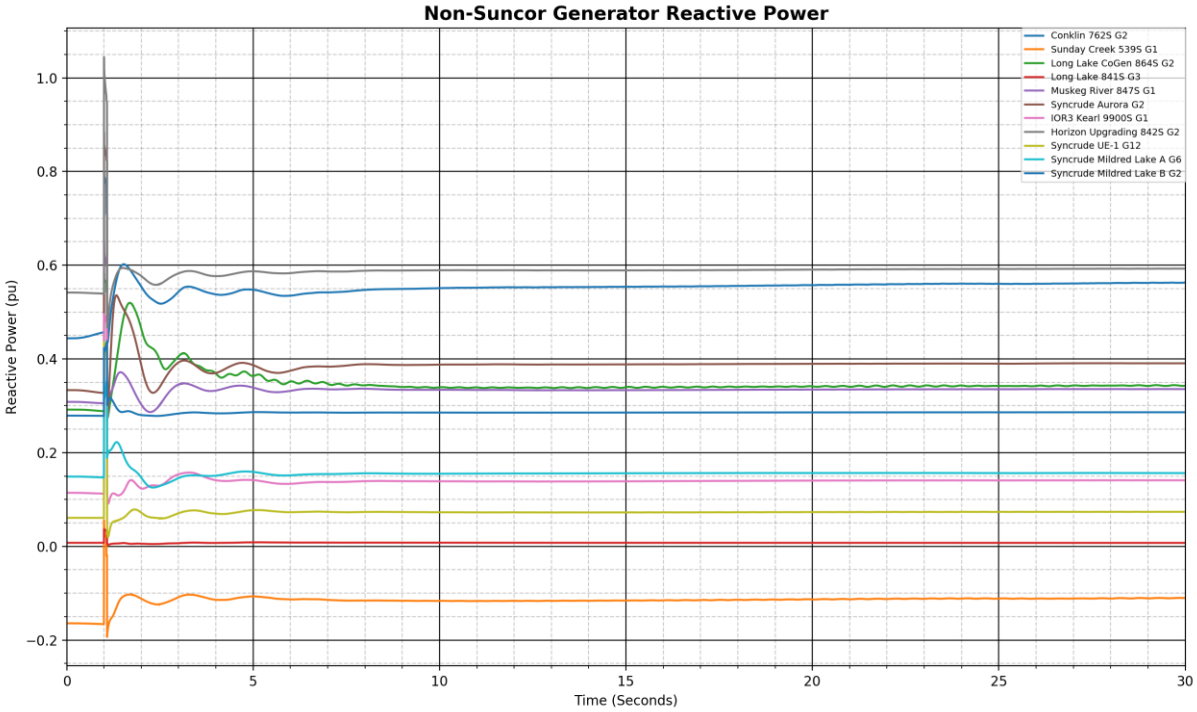
Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

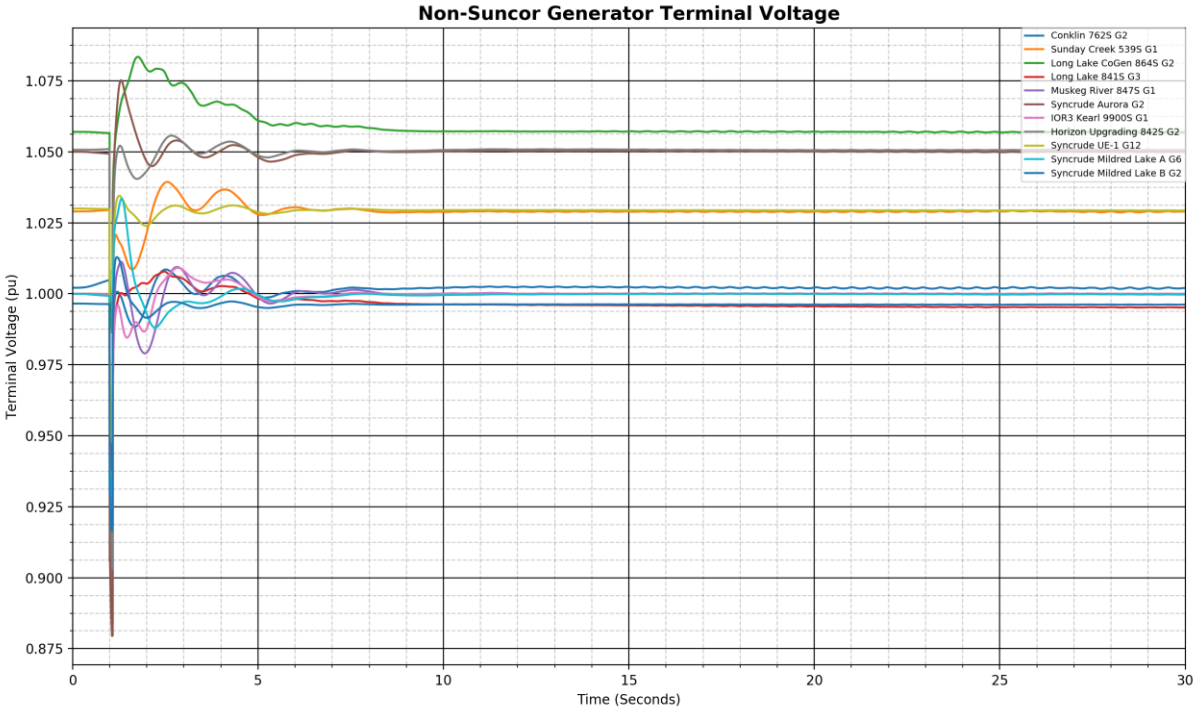
Figure A4-54: 12L44 (Thickwood Hills 951S to Livock 939S): Fault at Livock 939S

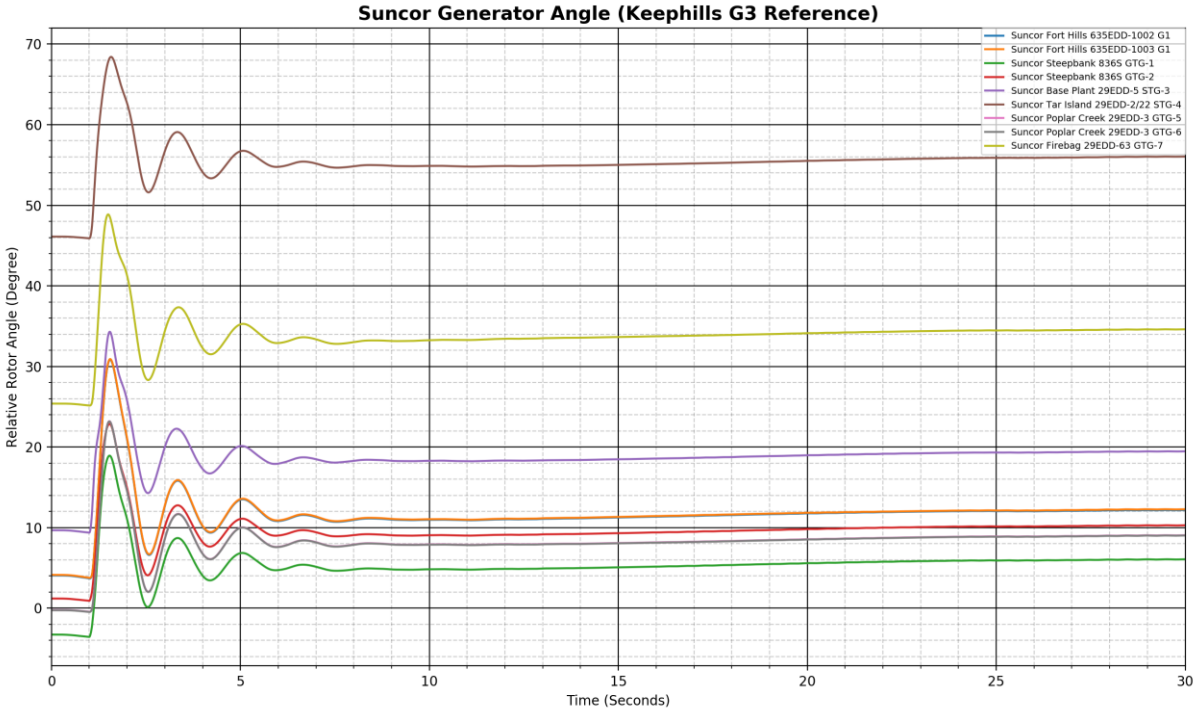


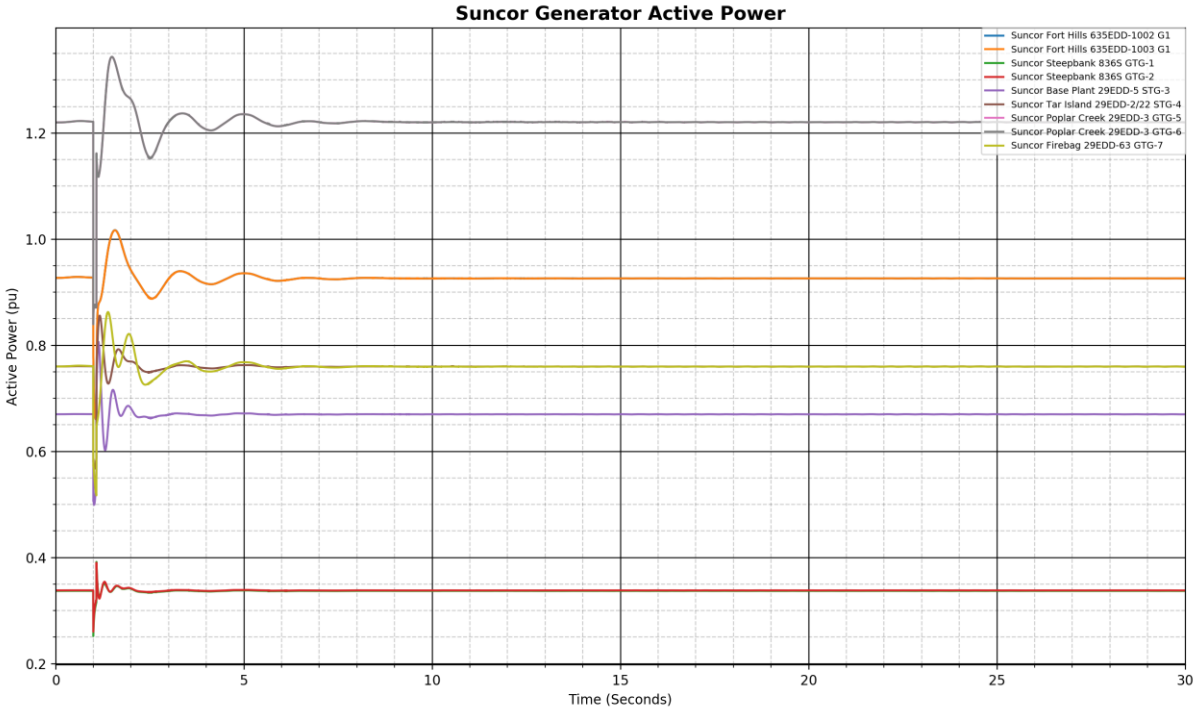

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

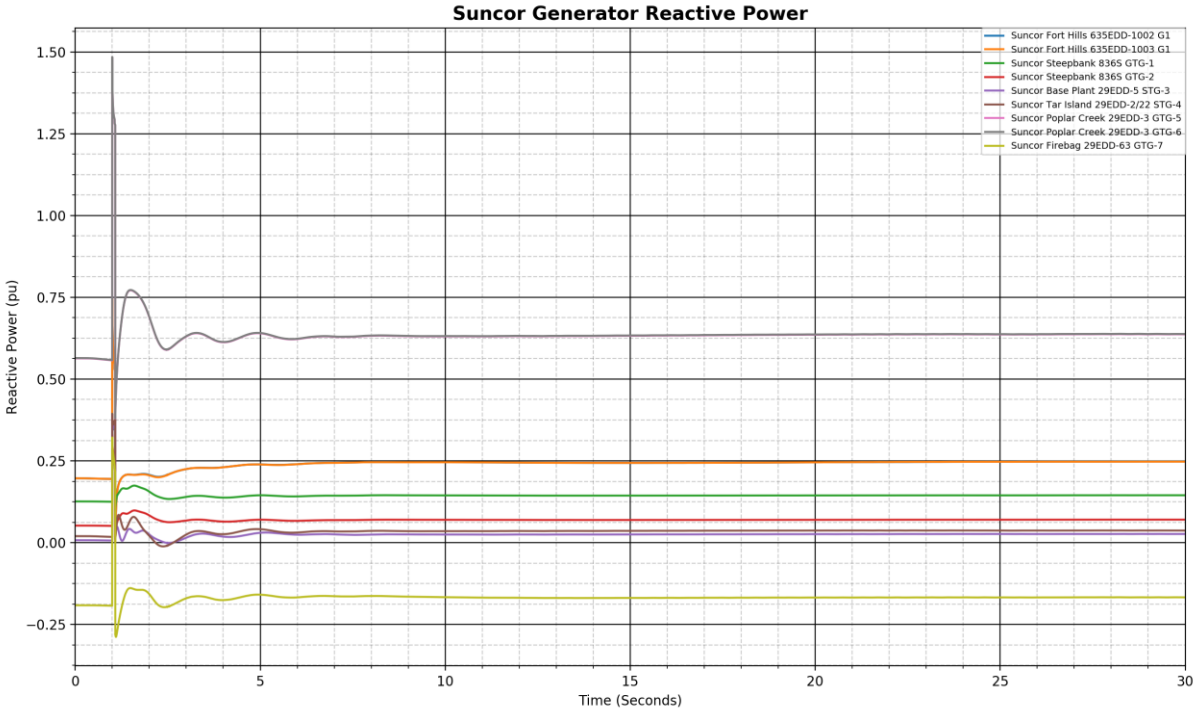

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

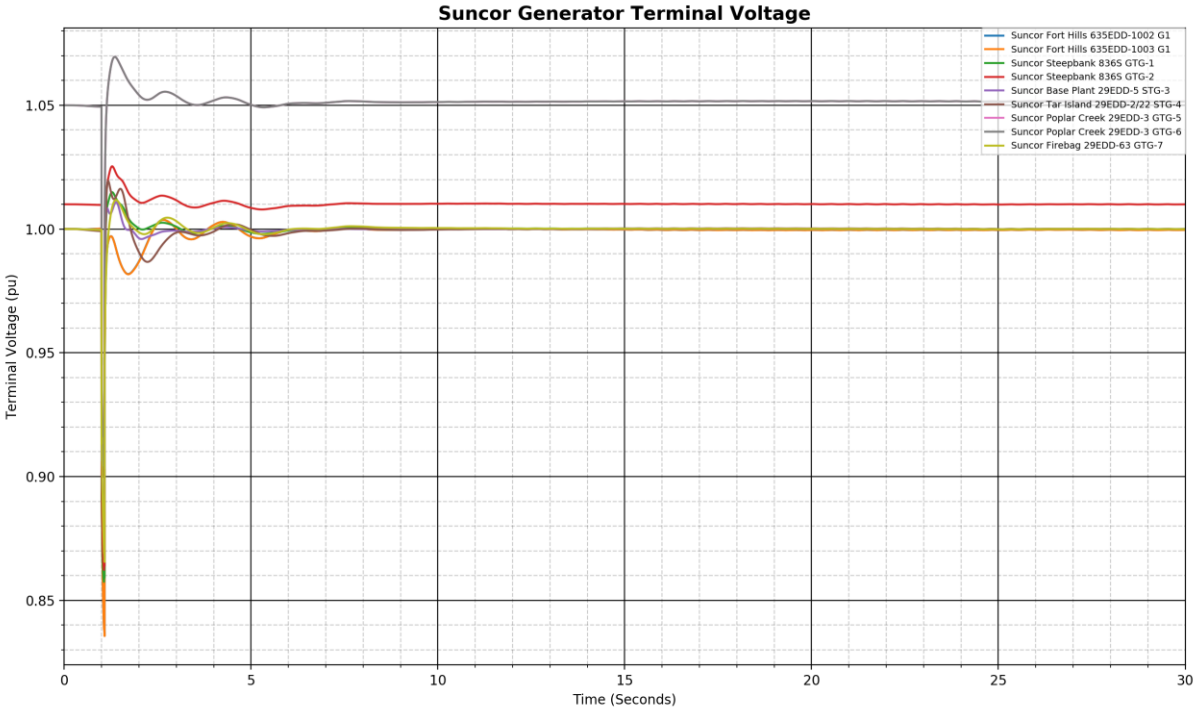

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

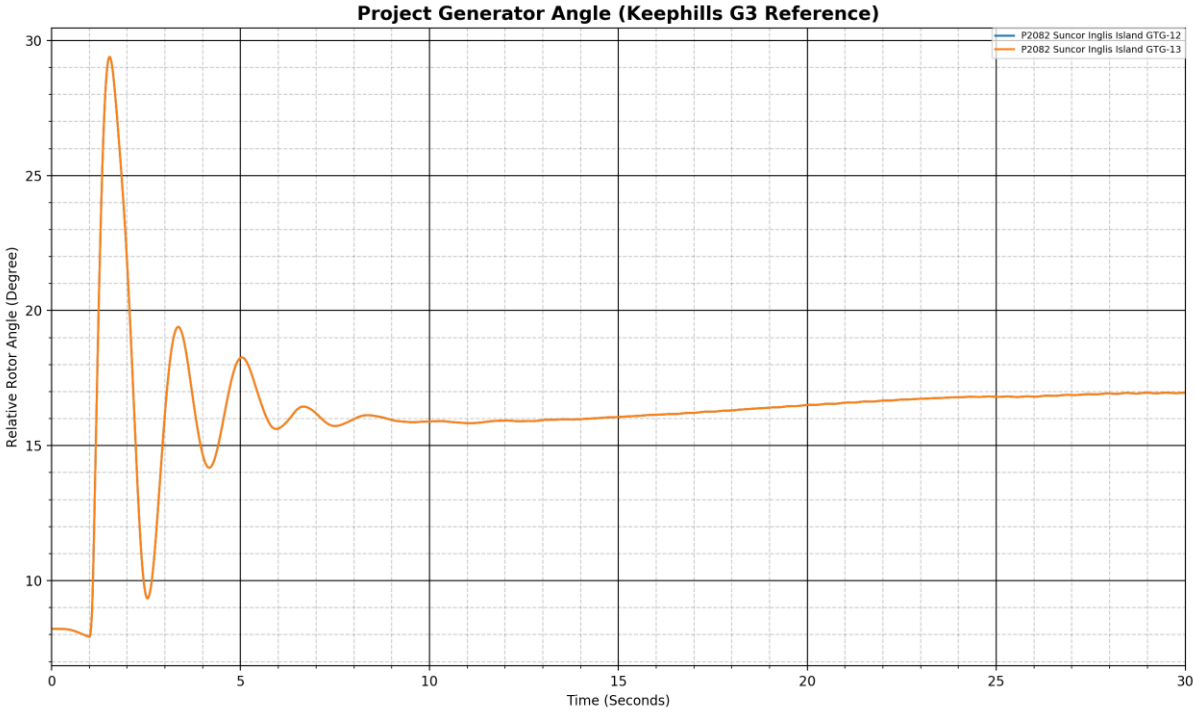

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

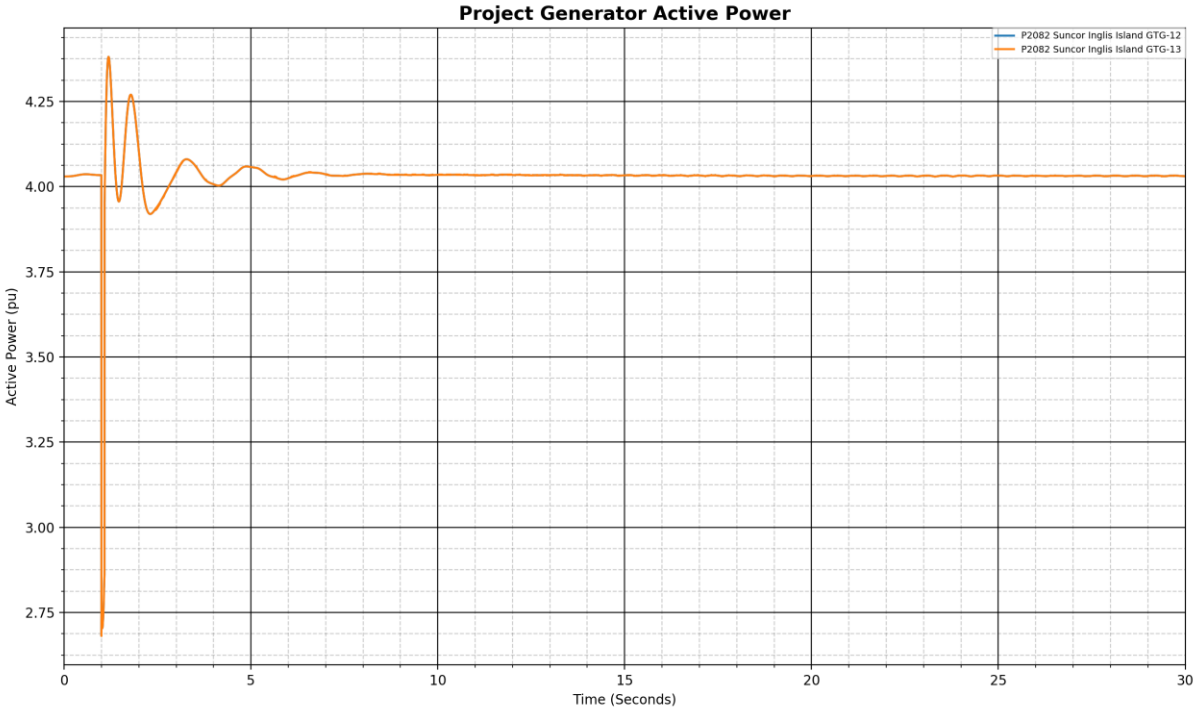

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

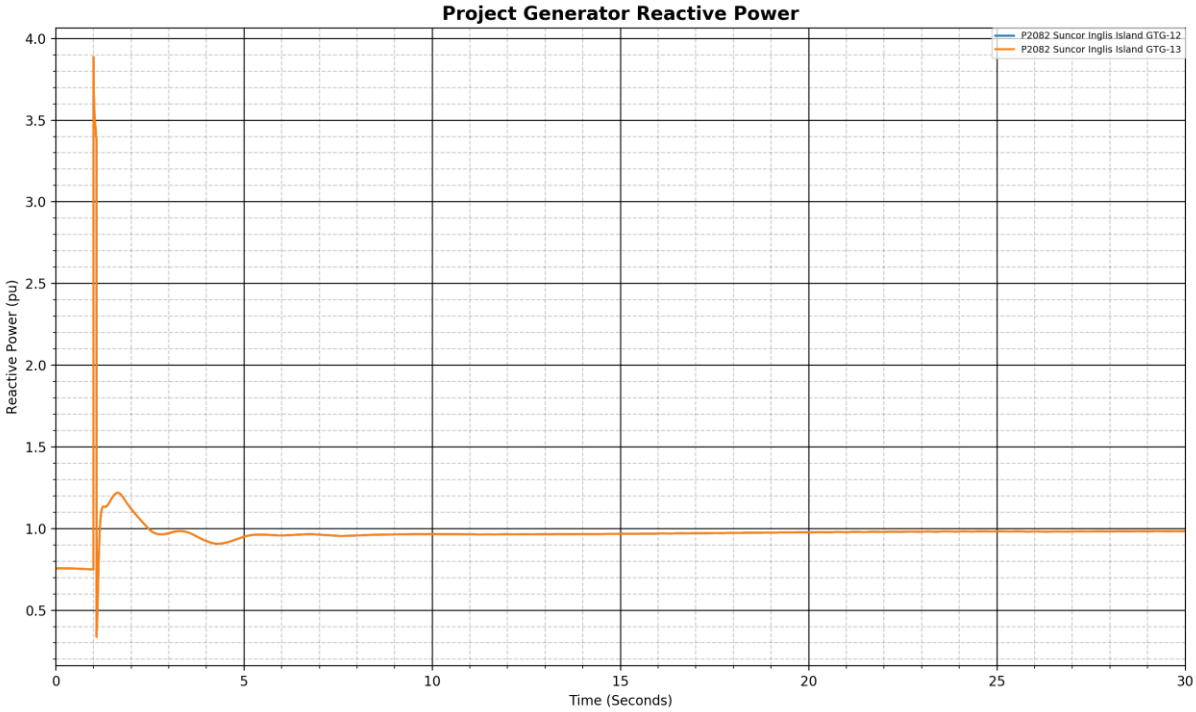

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

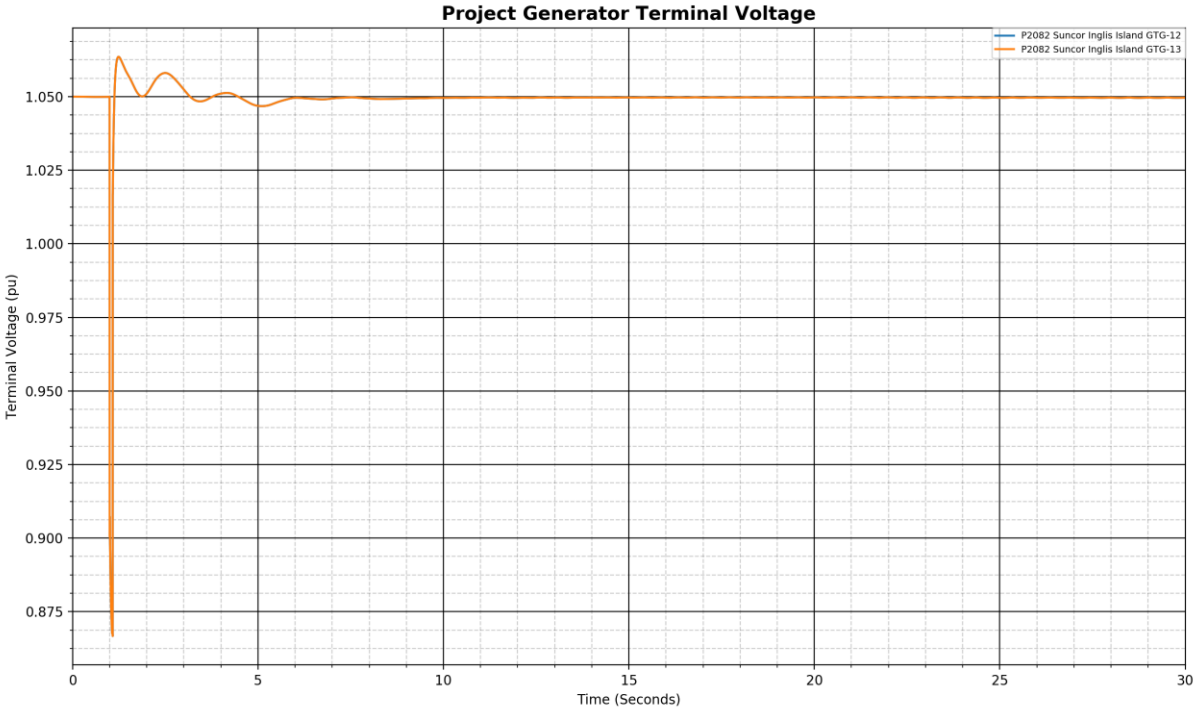

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

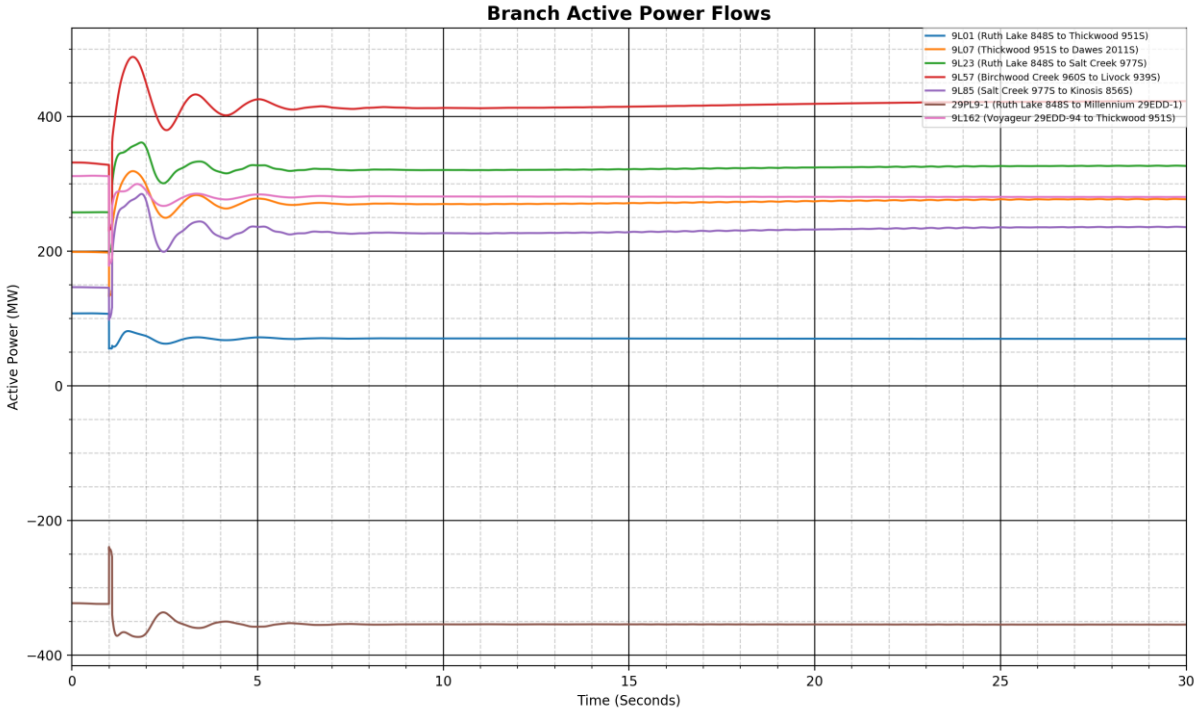

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
25
20
15
10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.25
4.00
3.75
3.50
3.25
3.00
2.75
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.050
1.025
1.000
0.975
0.950
0.925
0.900
0.875
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

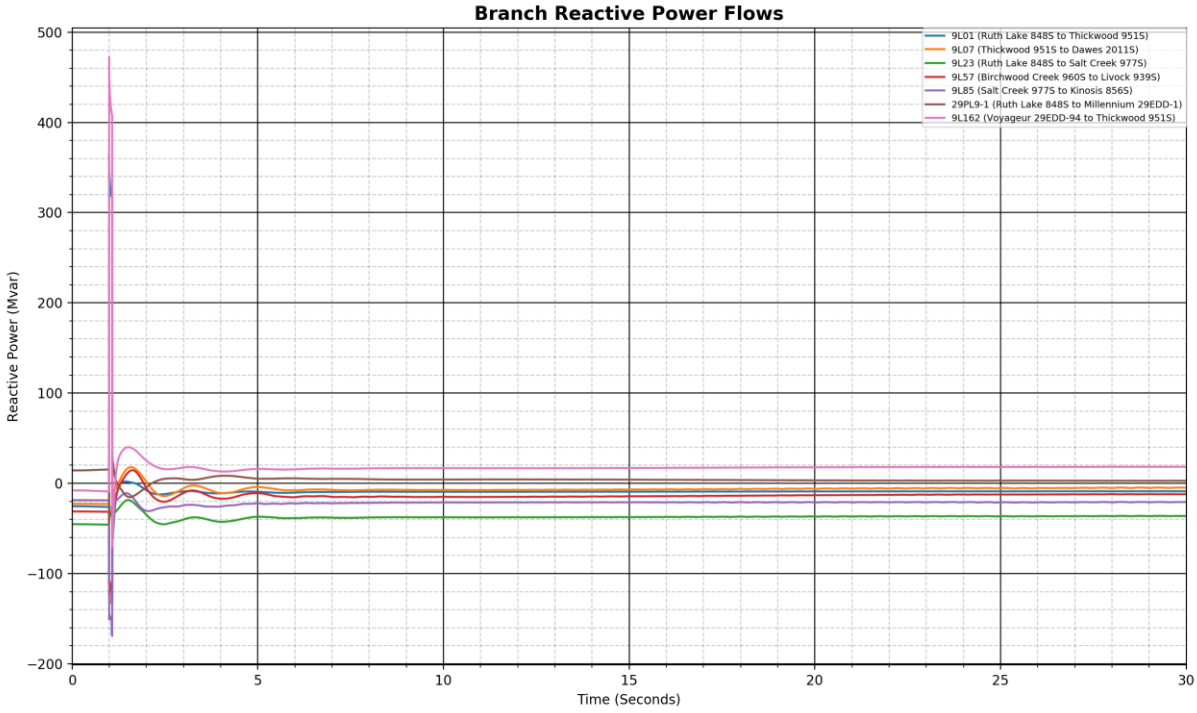
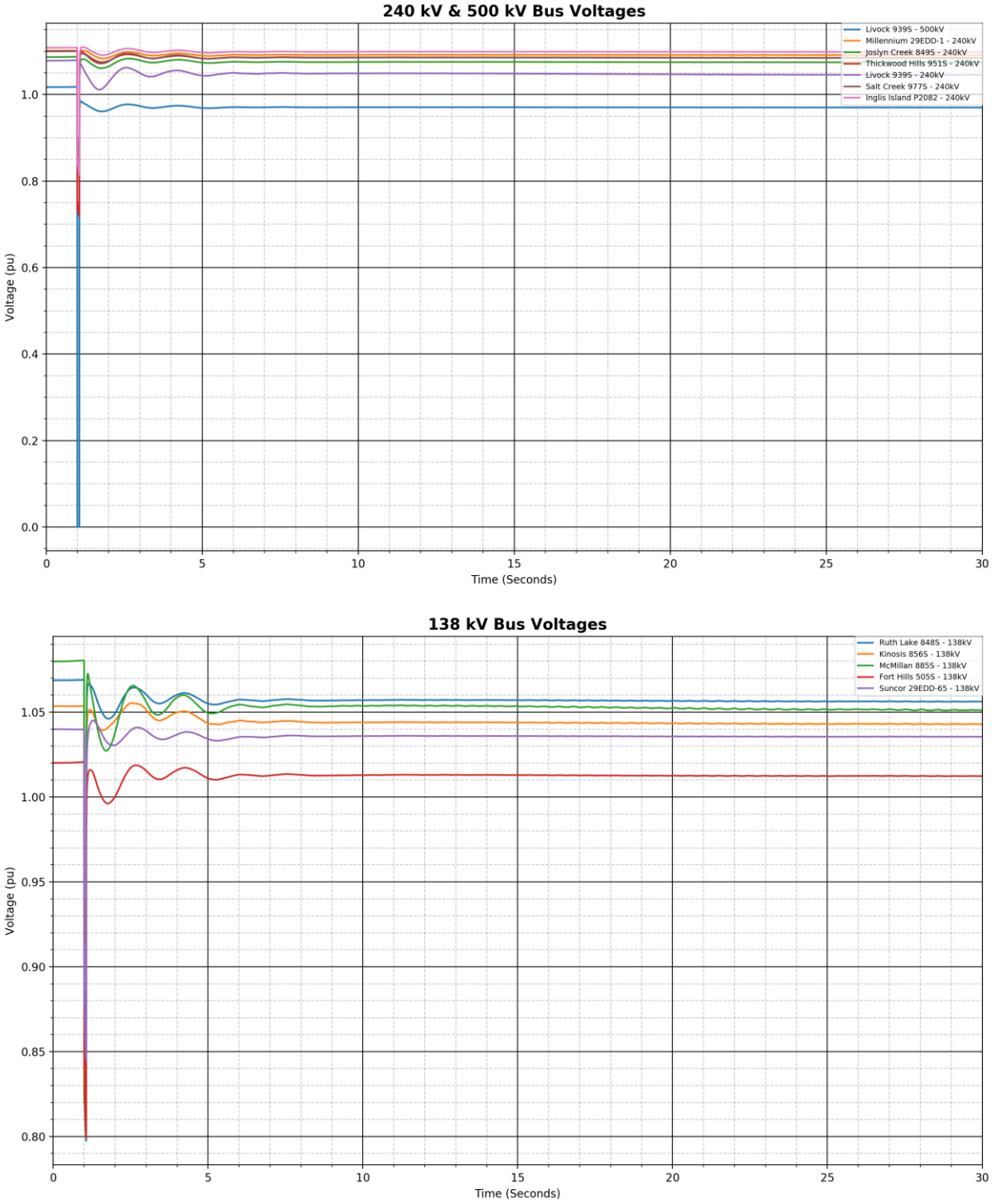
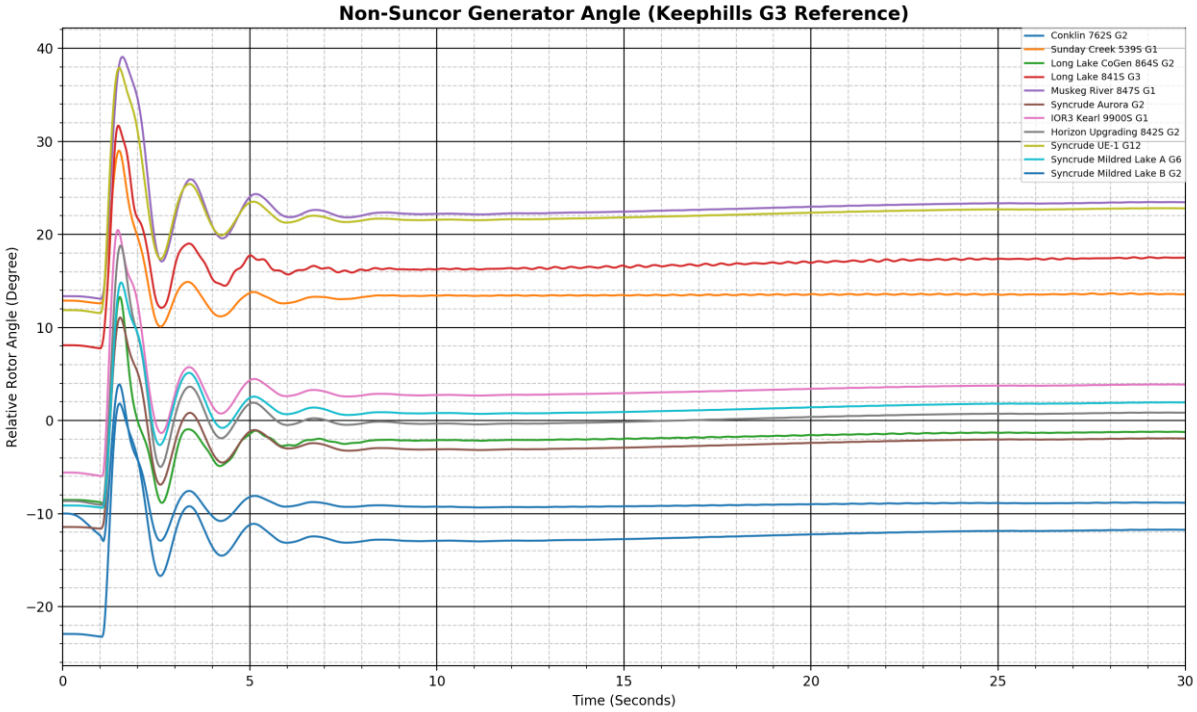
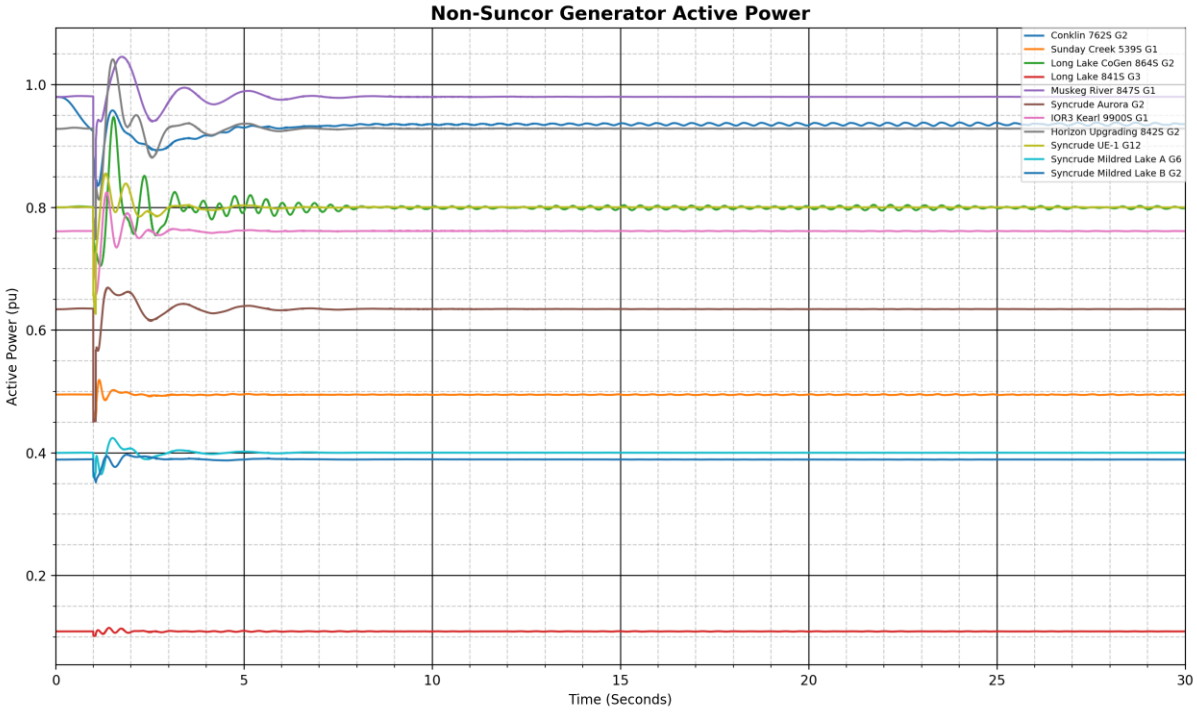
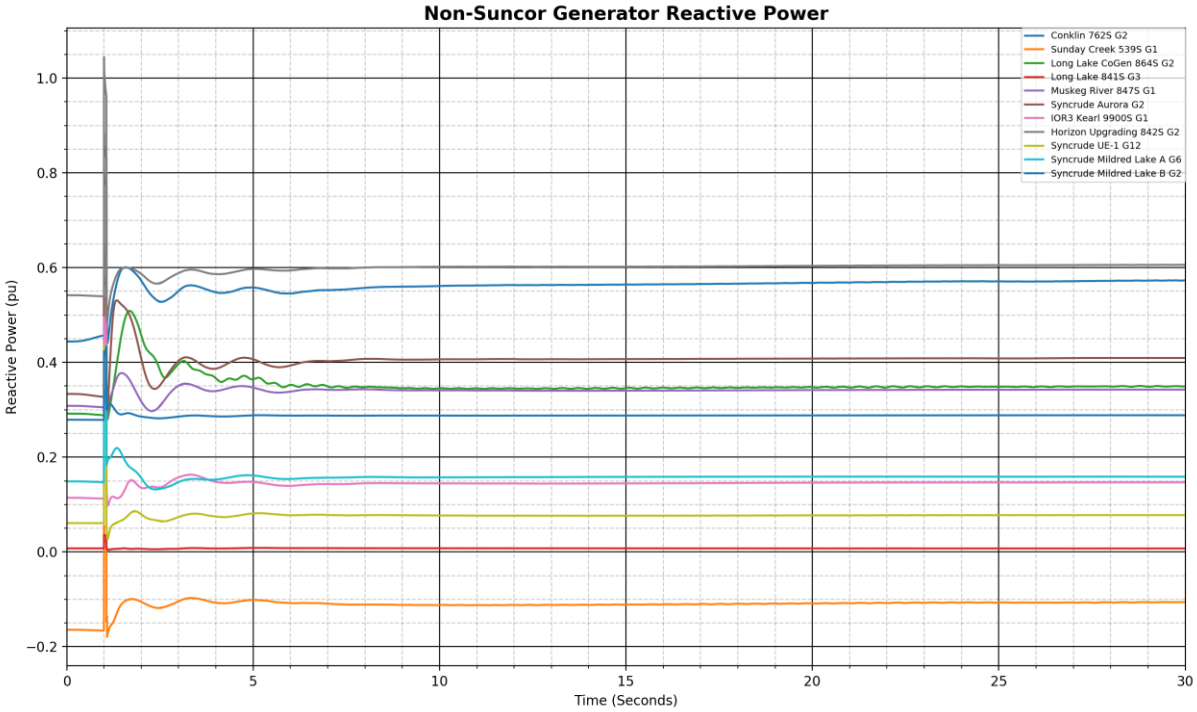

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

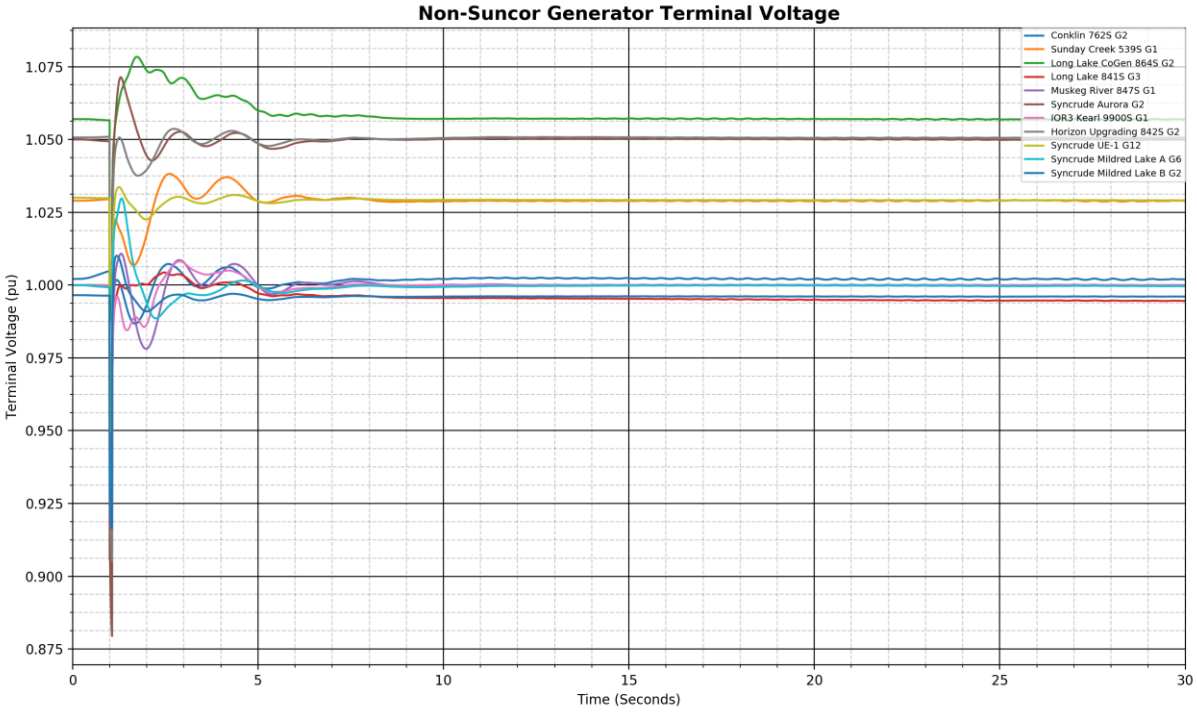
Figure A4-55: 12L41 (Livock 939S to Sunnybrook 510S): Fault at Livock 939S

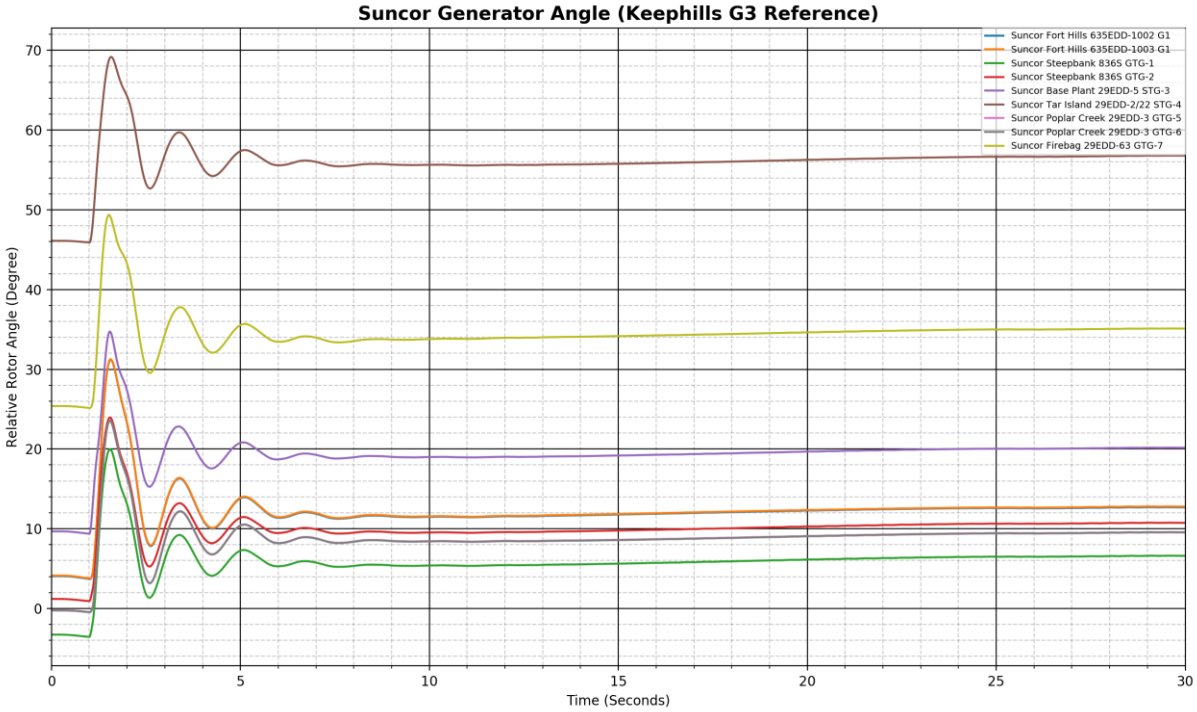


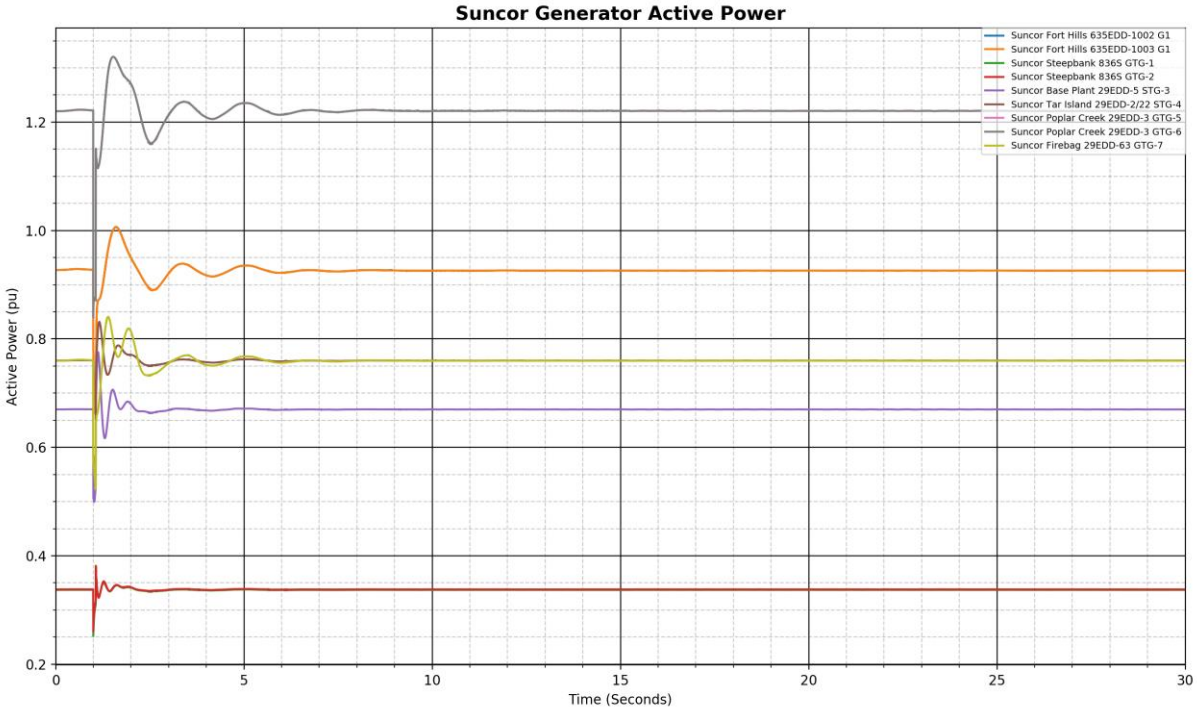

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

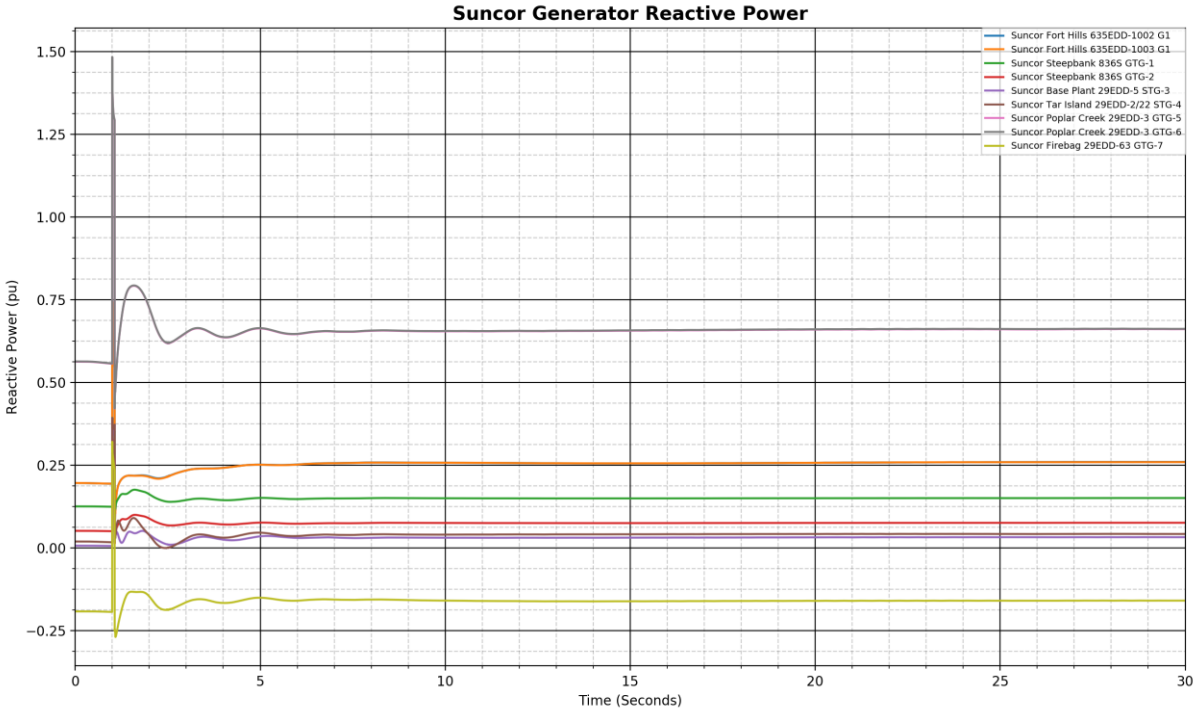

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

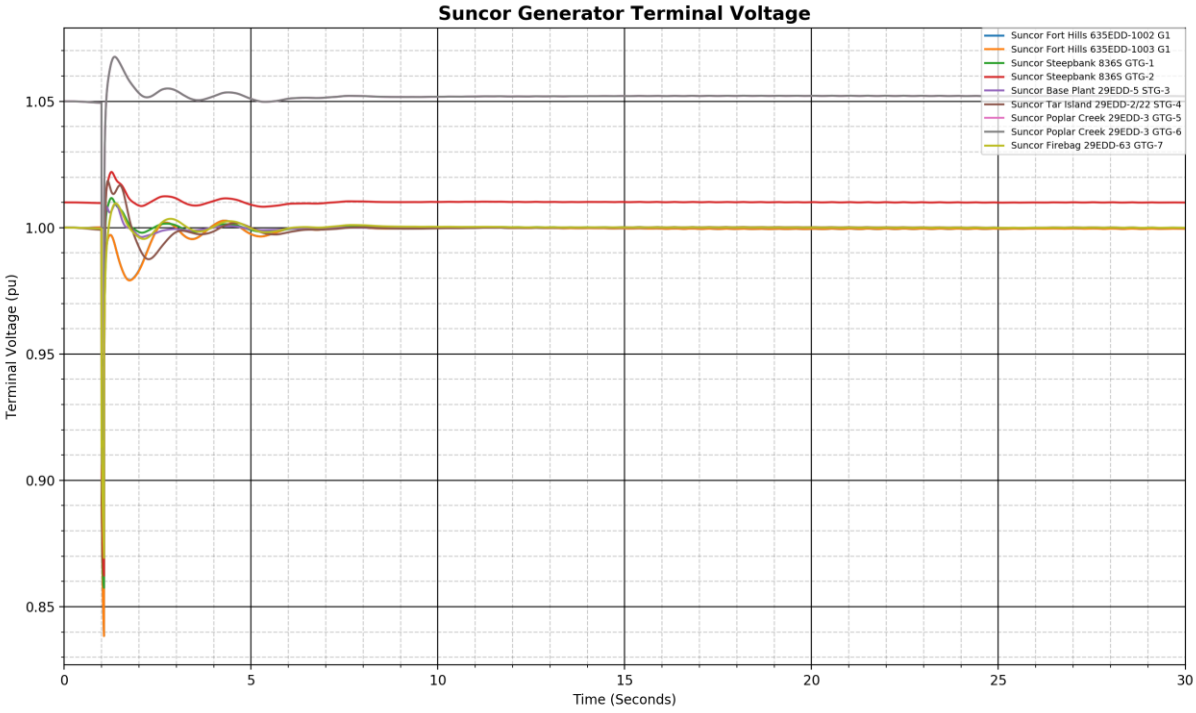

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

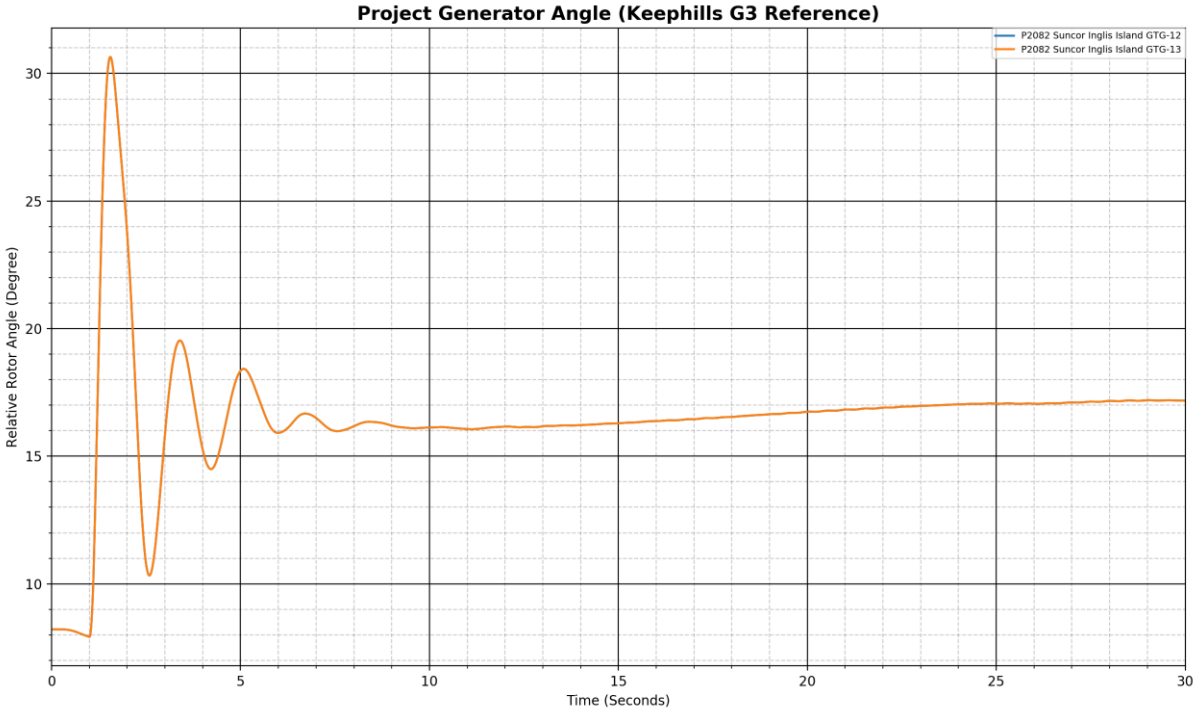

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

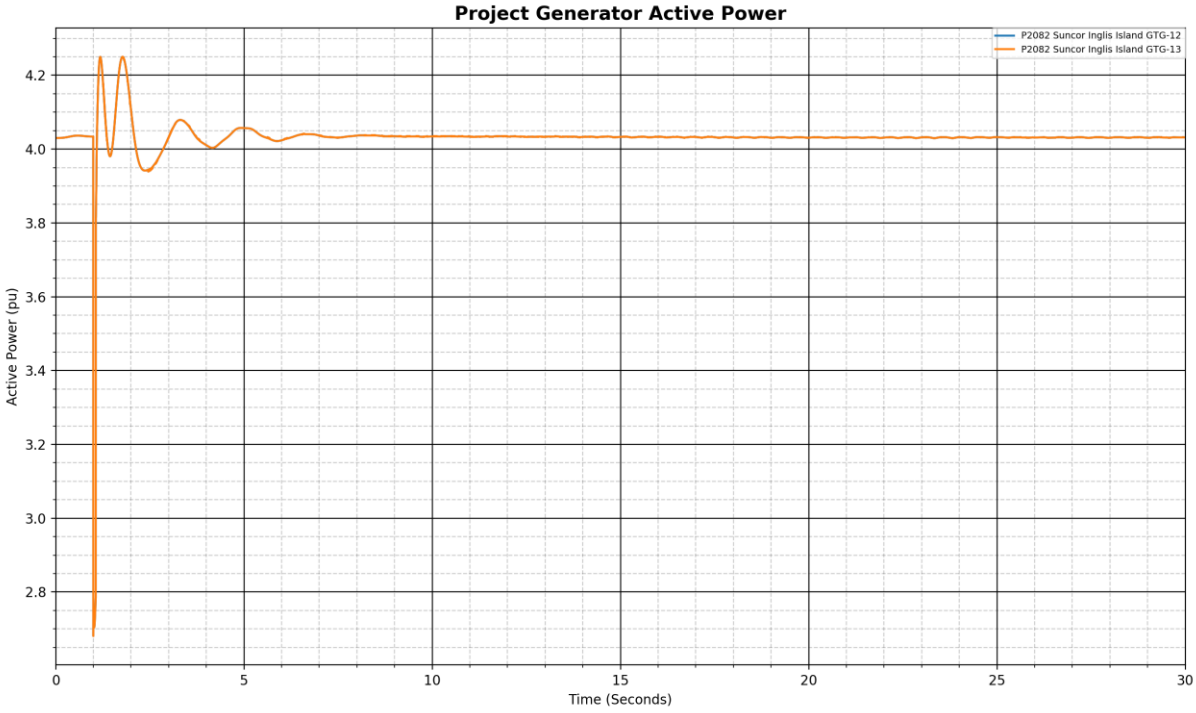

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

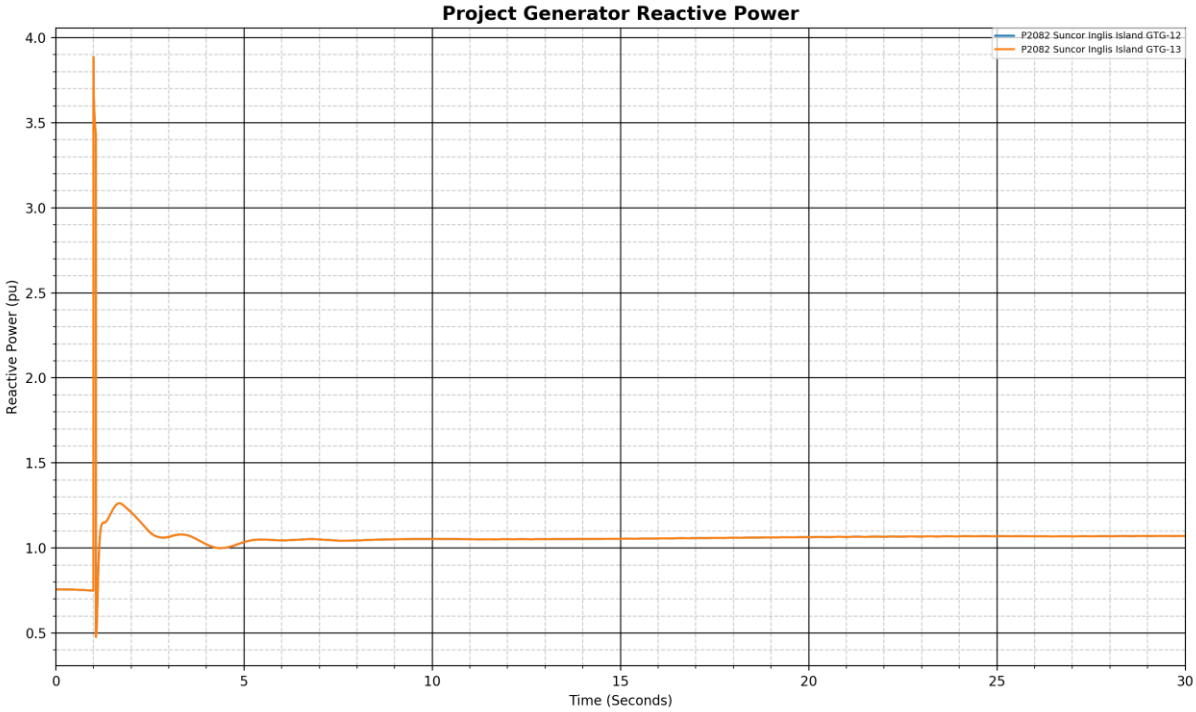

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

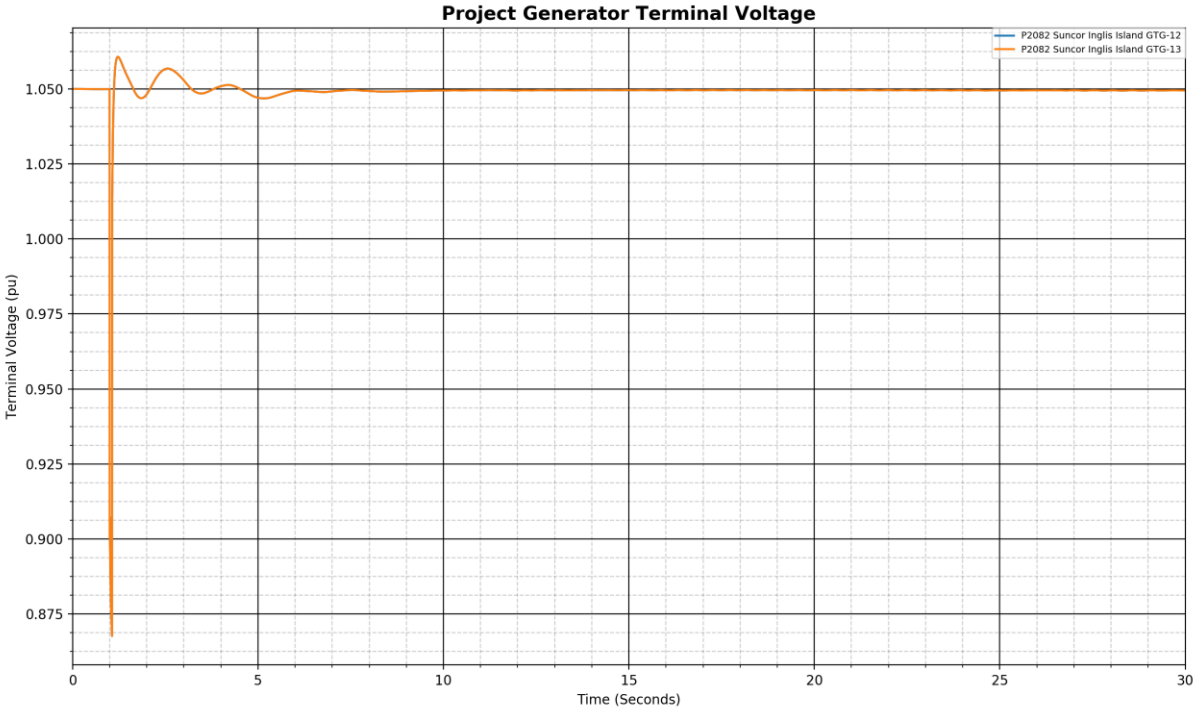

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

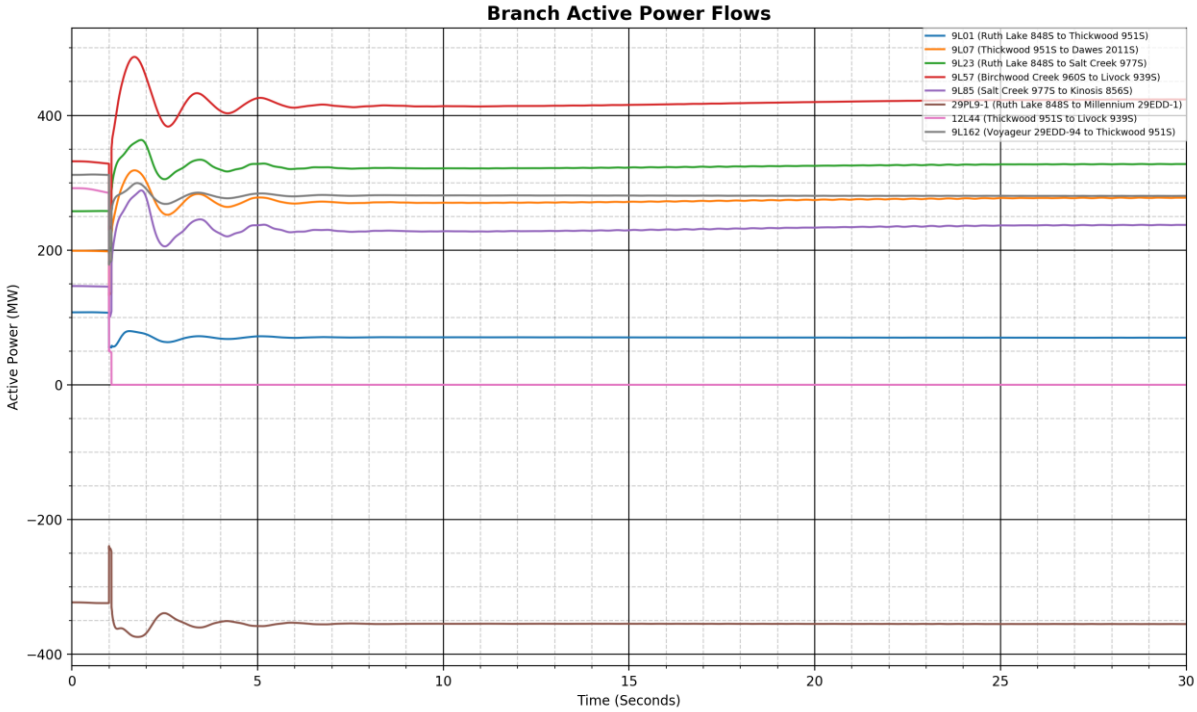

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
25
20
15
10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.050
1.025
1.000
0.975
0.950
0.925
0.900
0.875
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

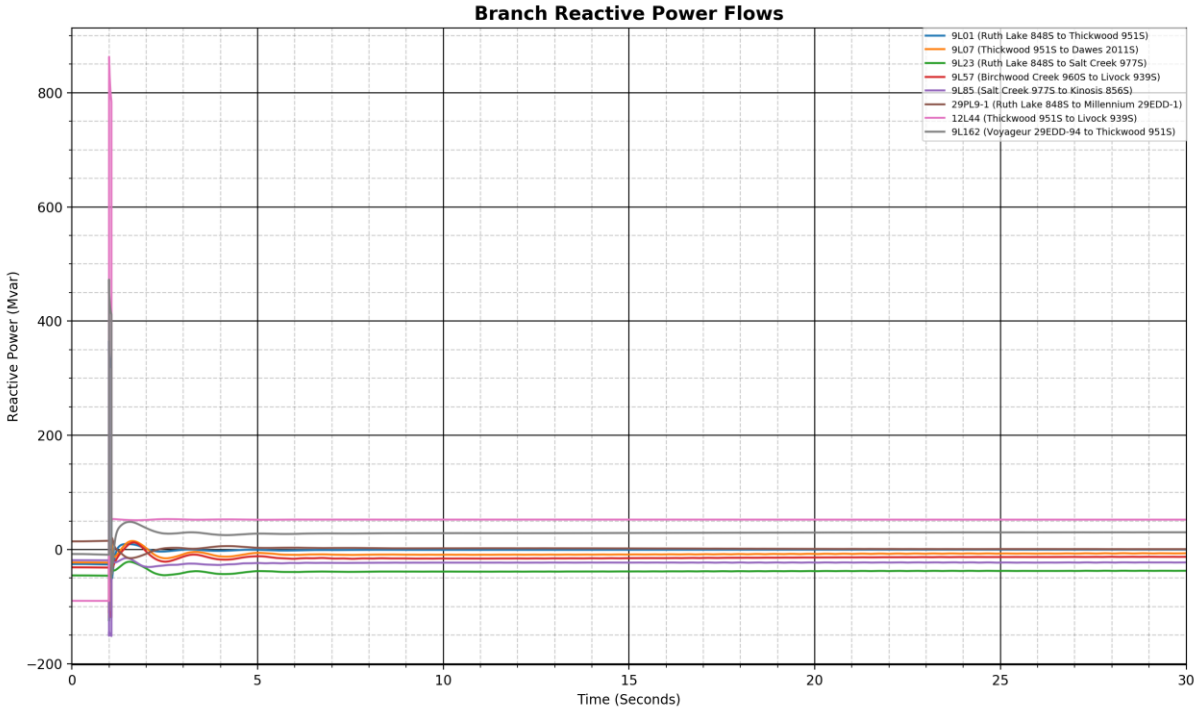
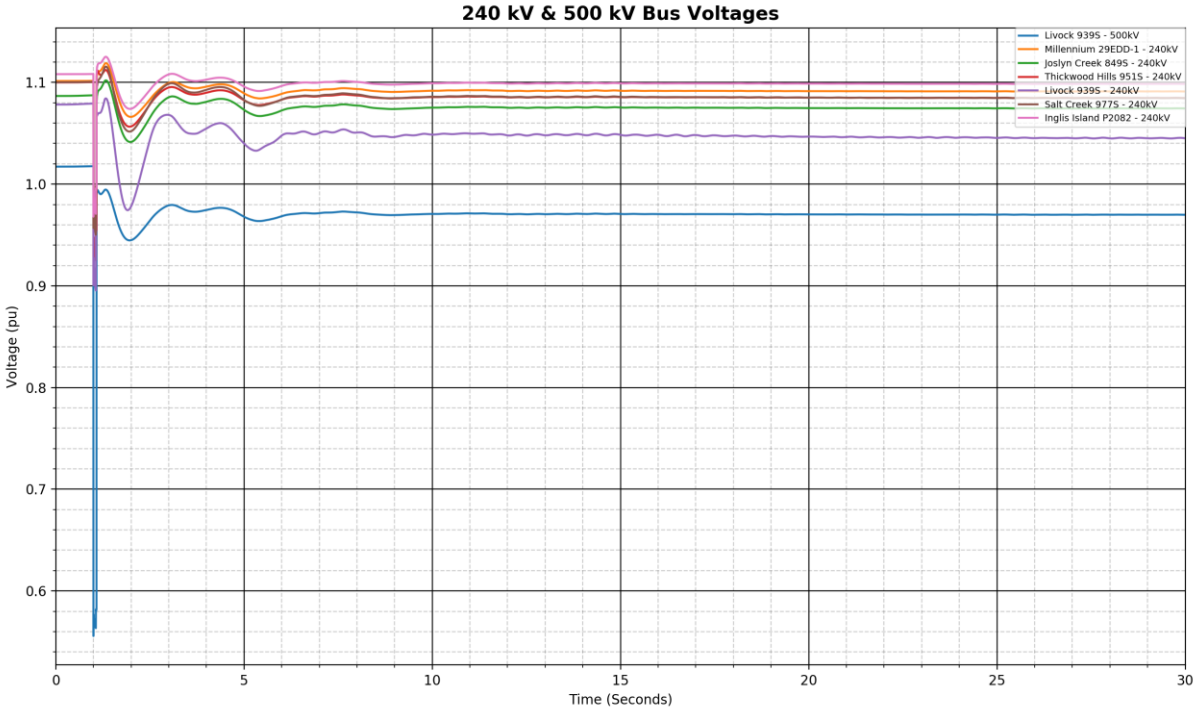
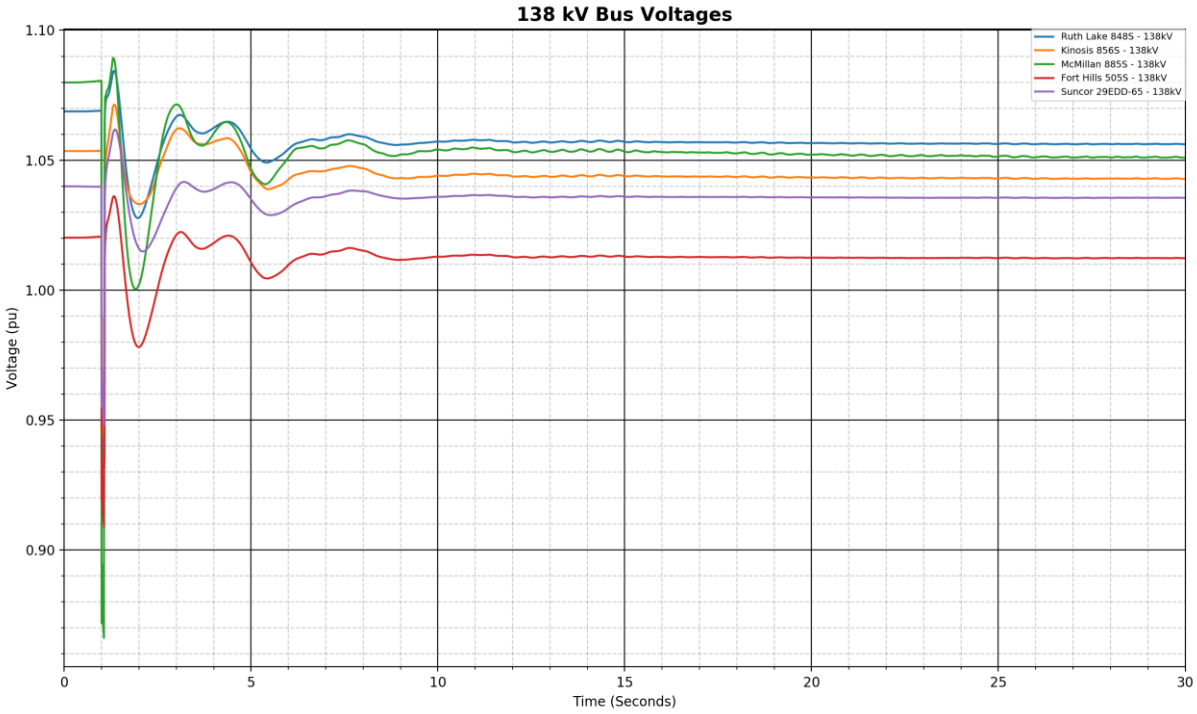
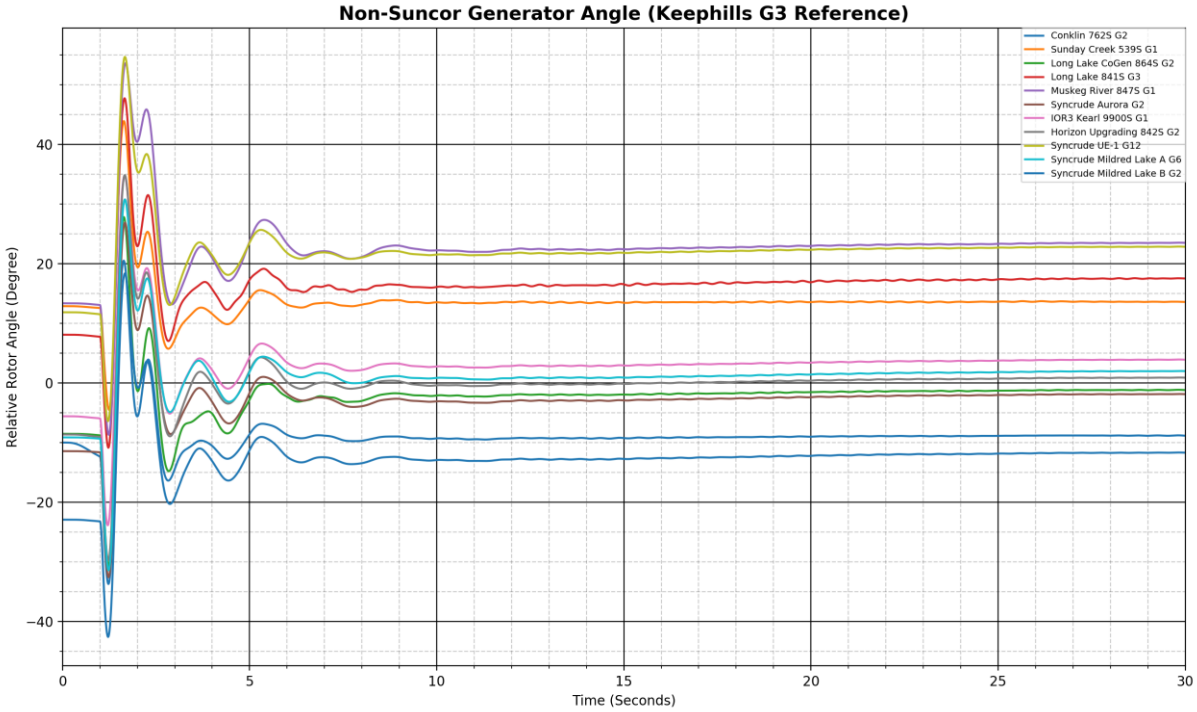
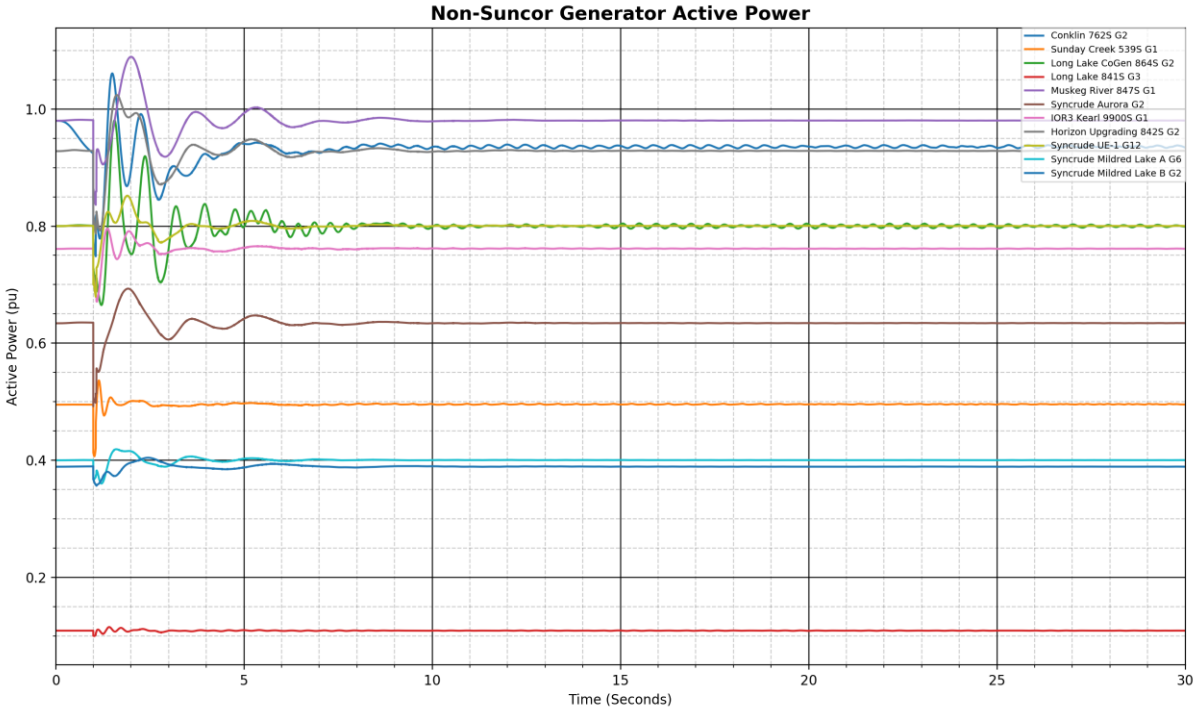

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
800
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

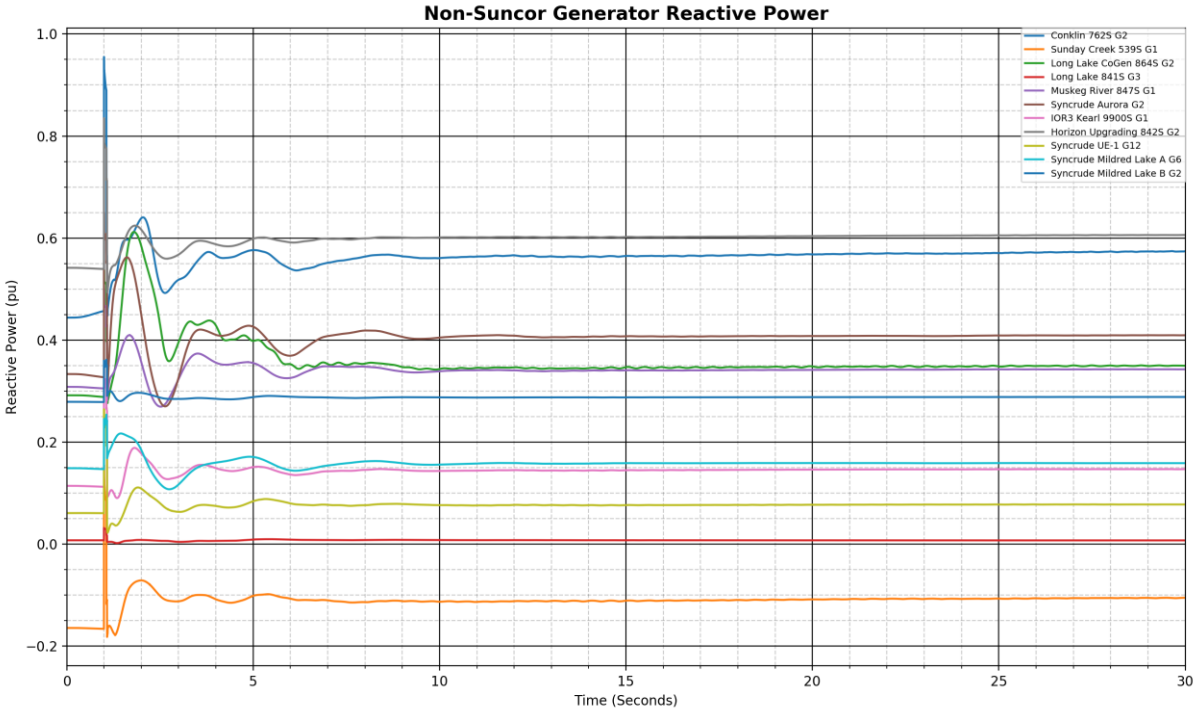
Figure A4-56: 12L41 (Livock 939S to Sunnybrook 510S): Fault at Sunnybrook 510S

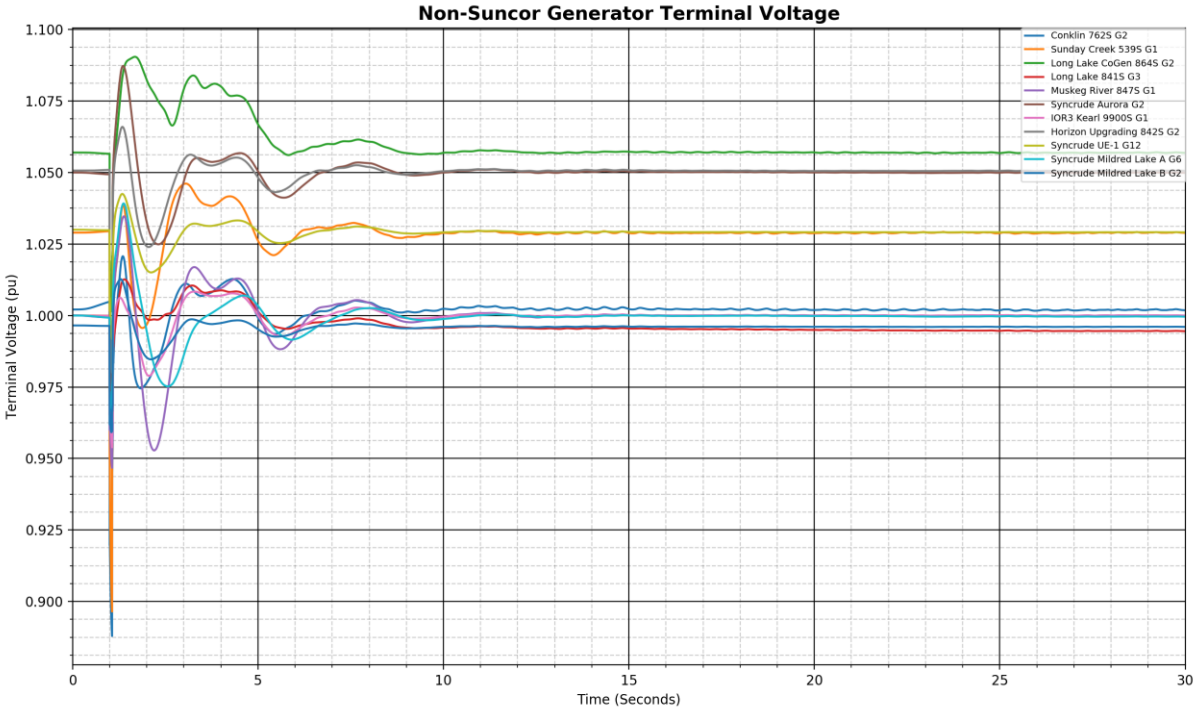


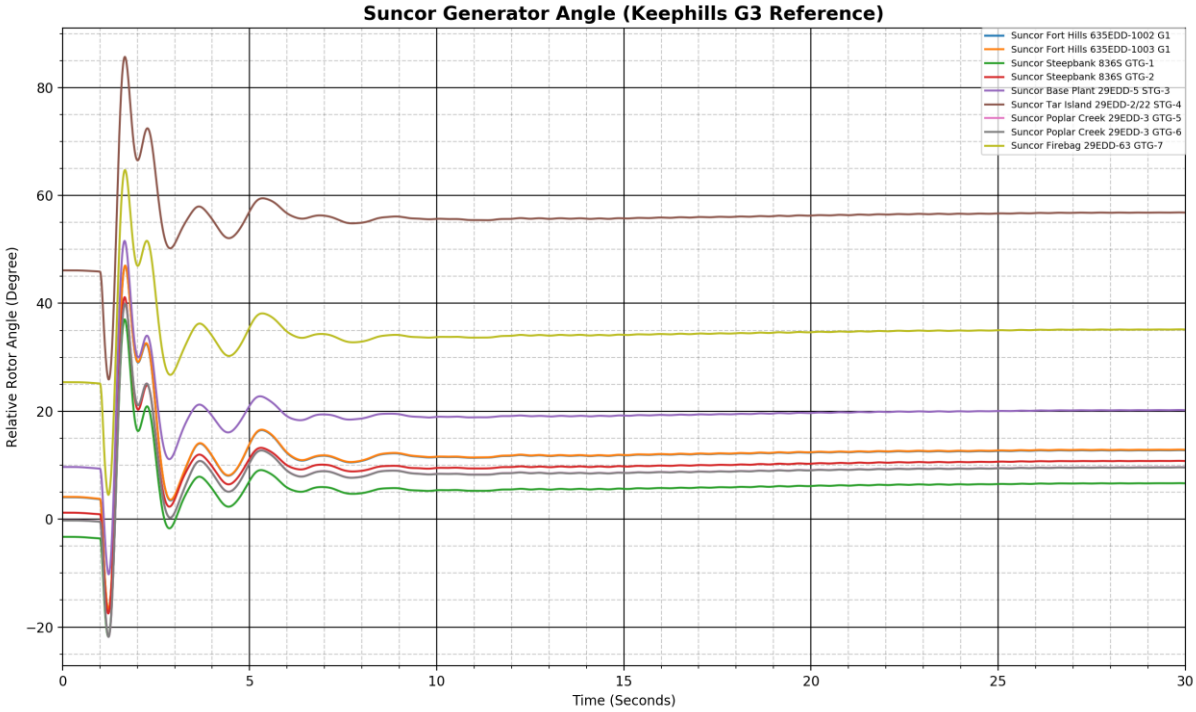


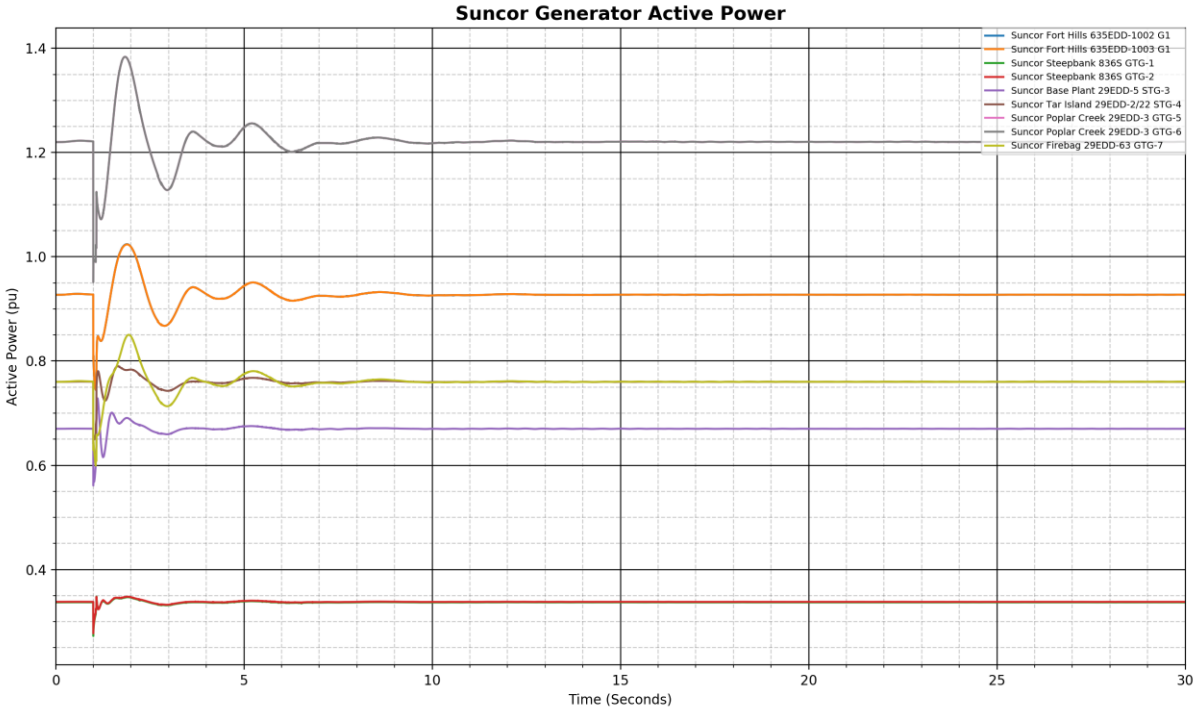

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

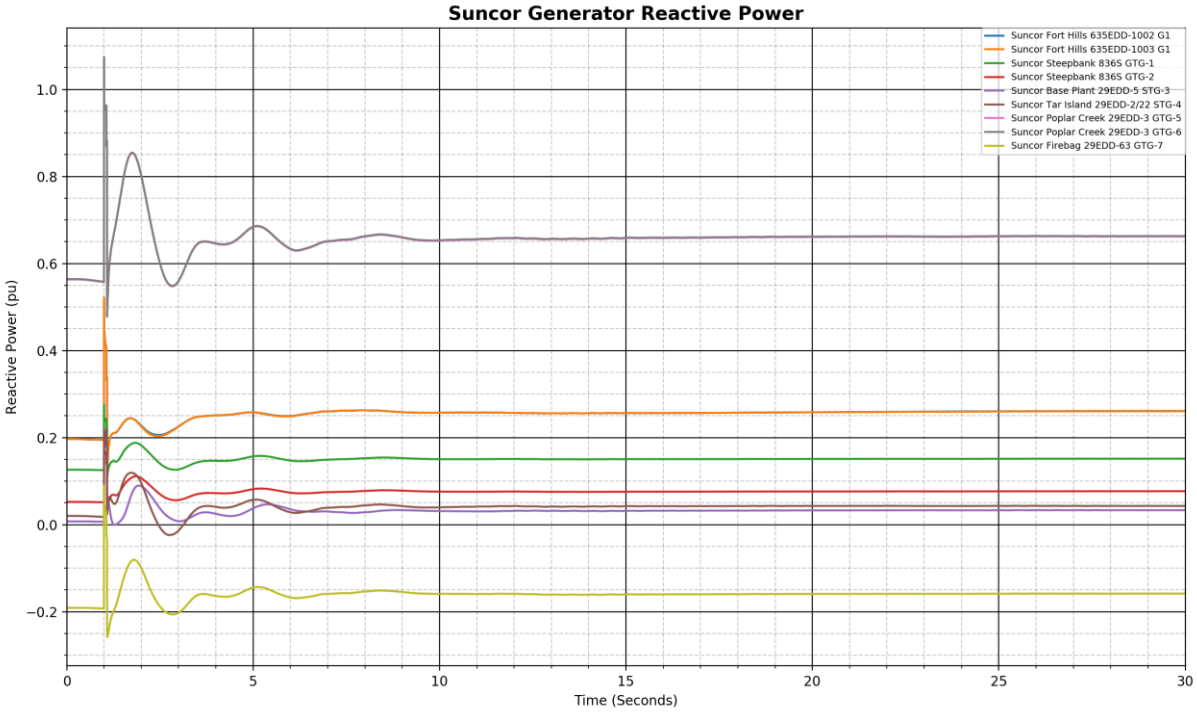

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

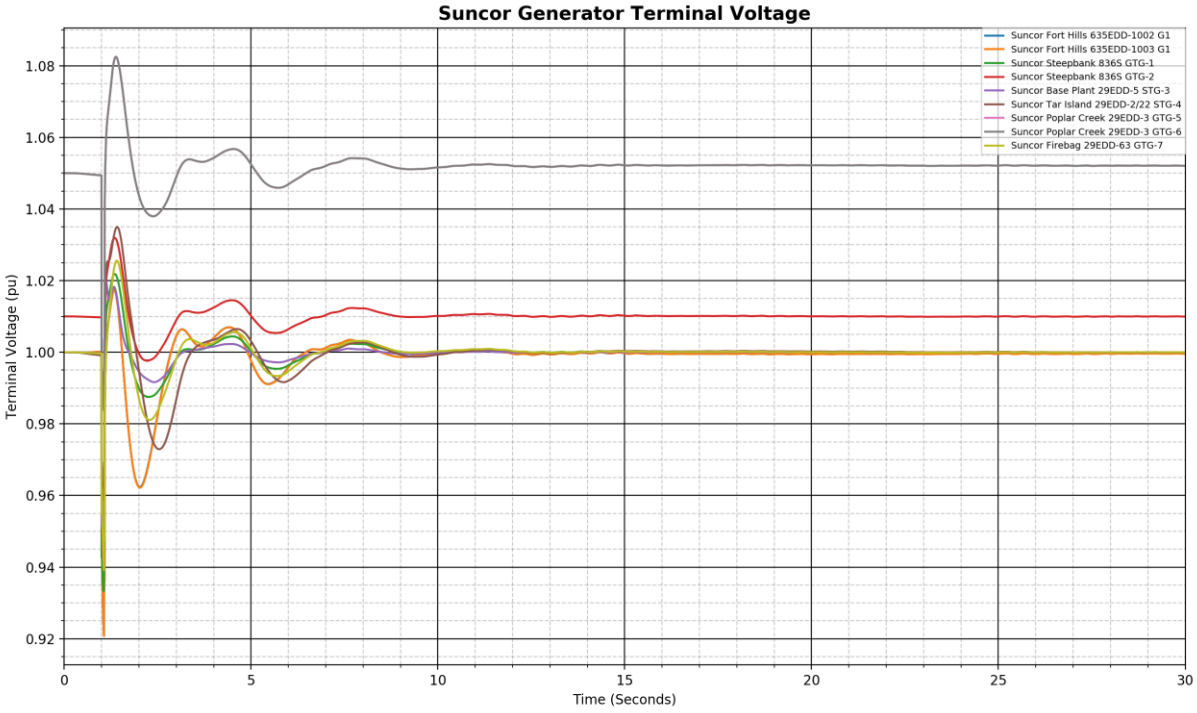

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

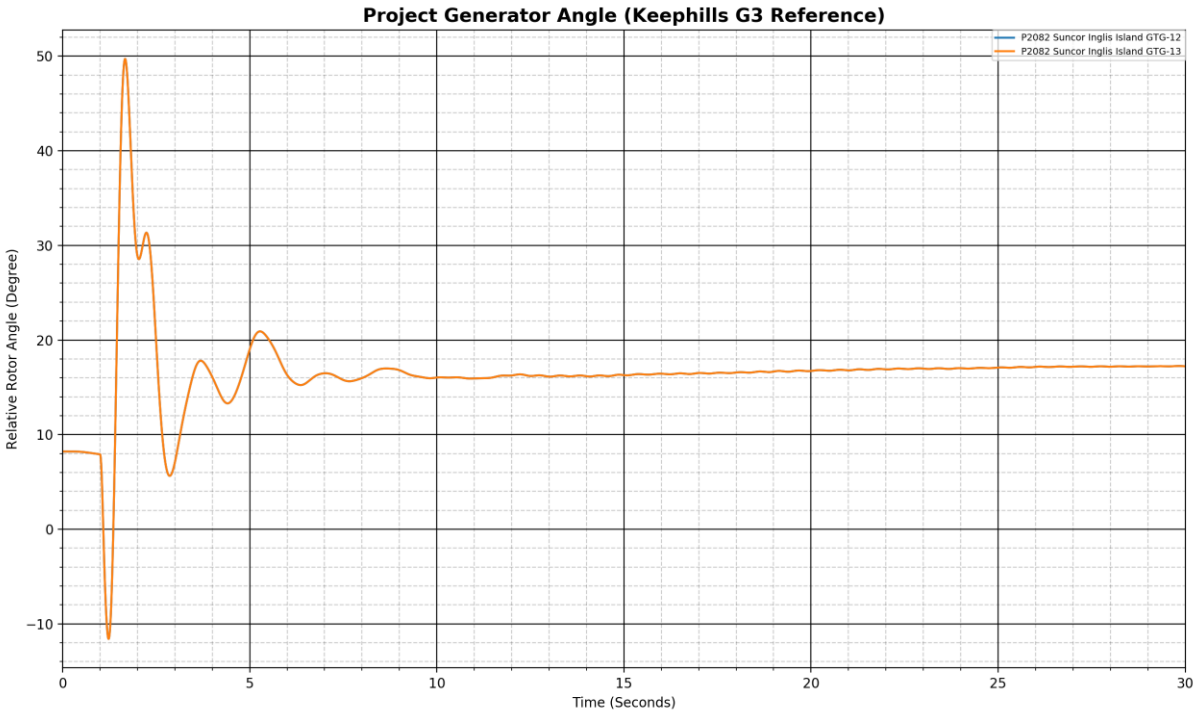

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

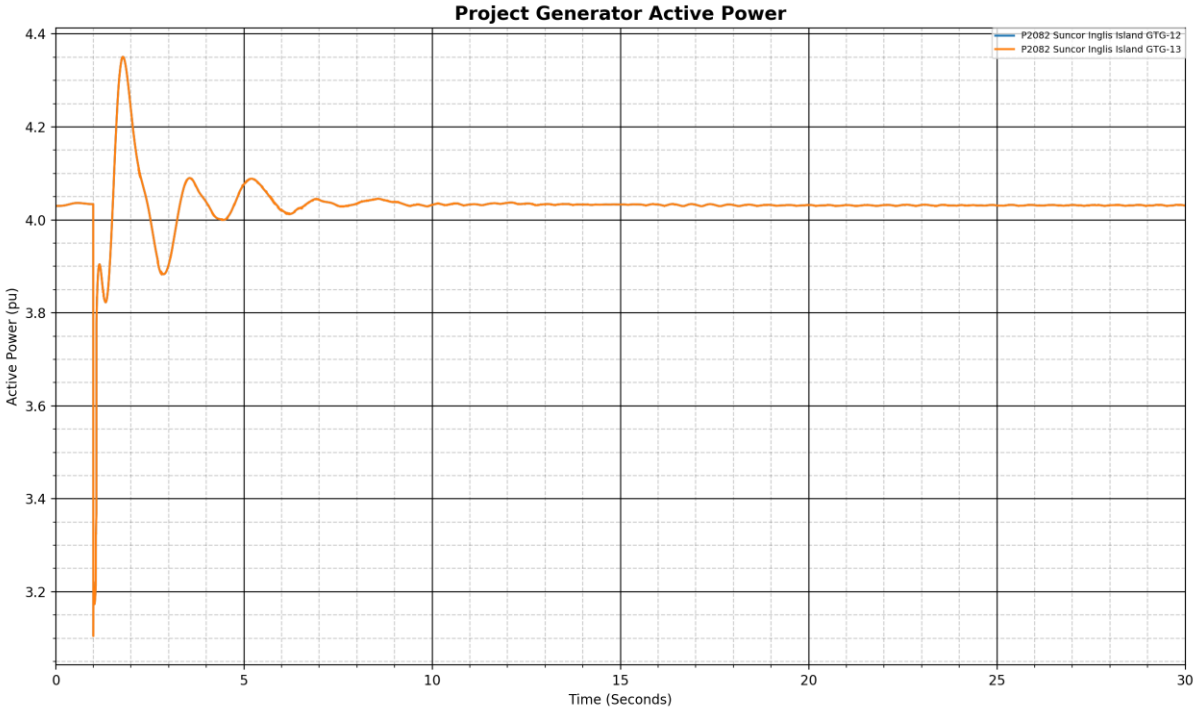

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

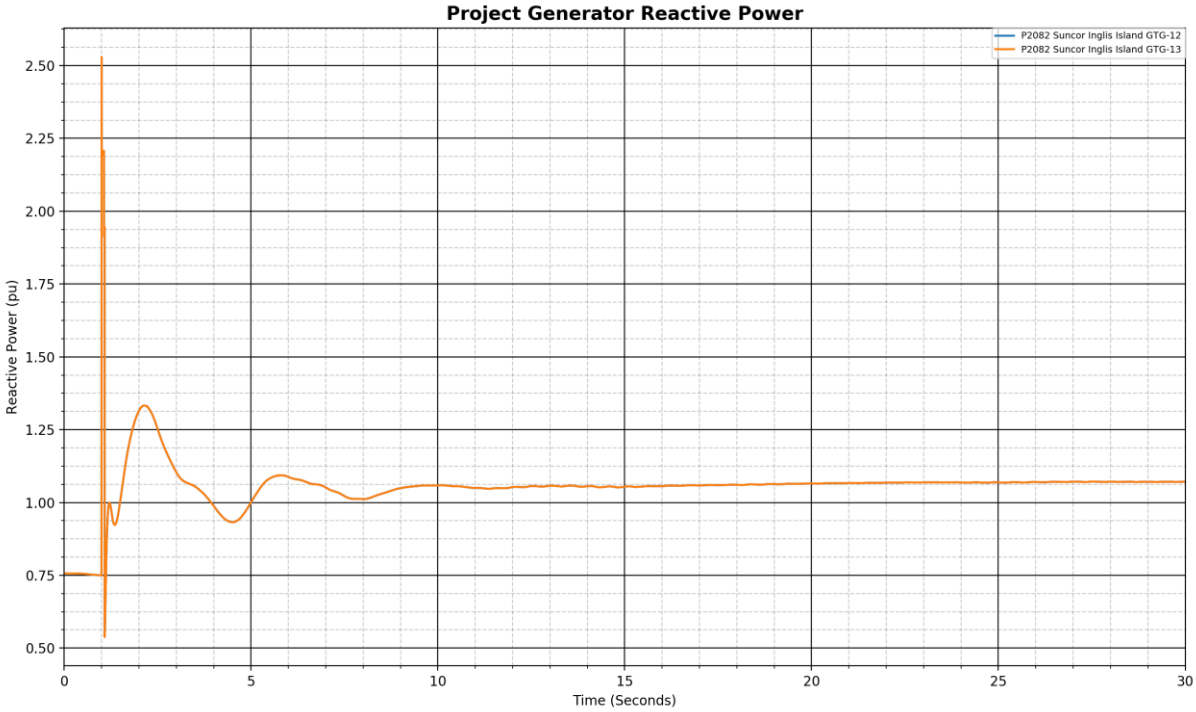

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

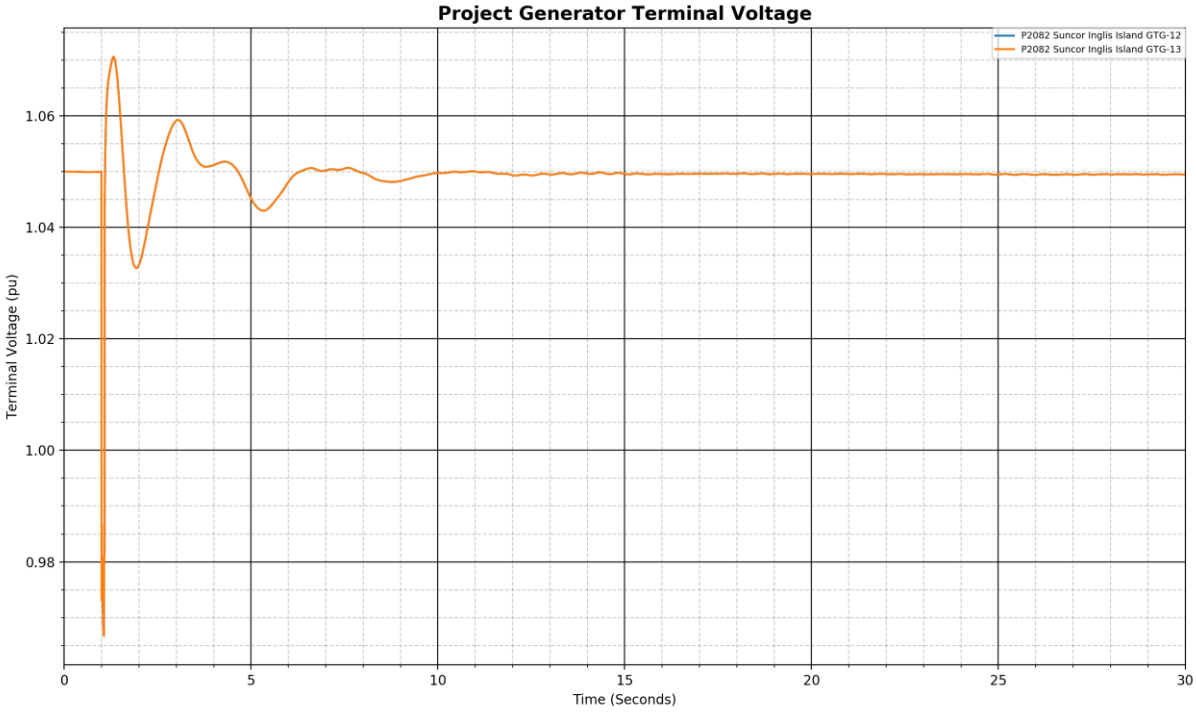

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

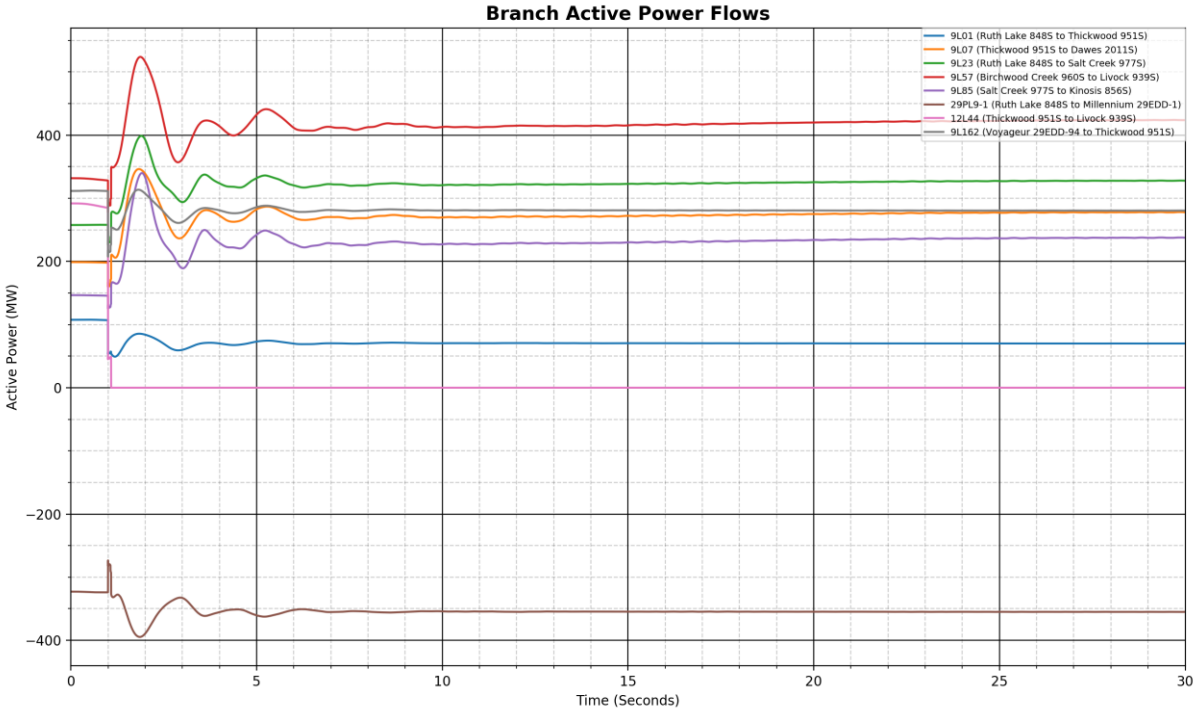

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
50
40
30
20
10
0
−10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.4
4.2
4.0
3.8
3.6
3.4
3.2
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

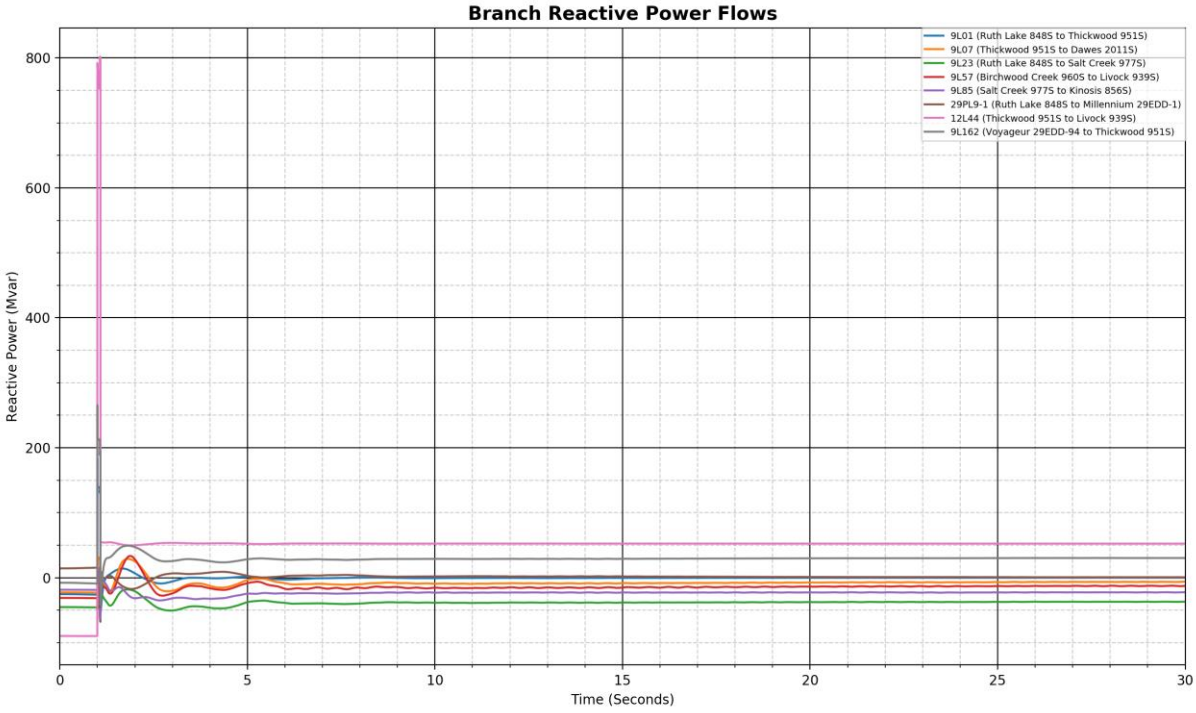
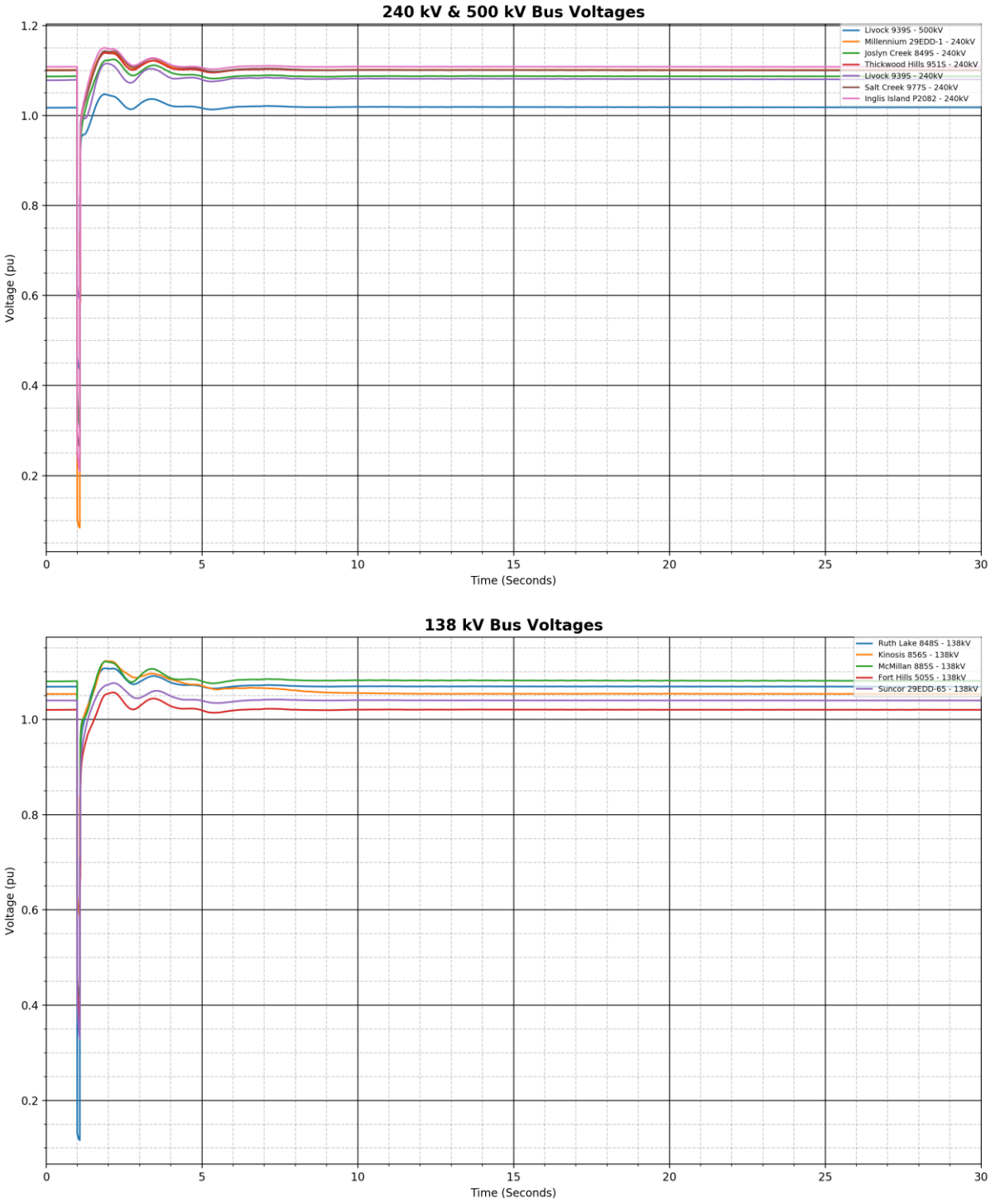
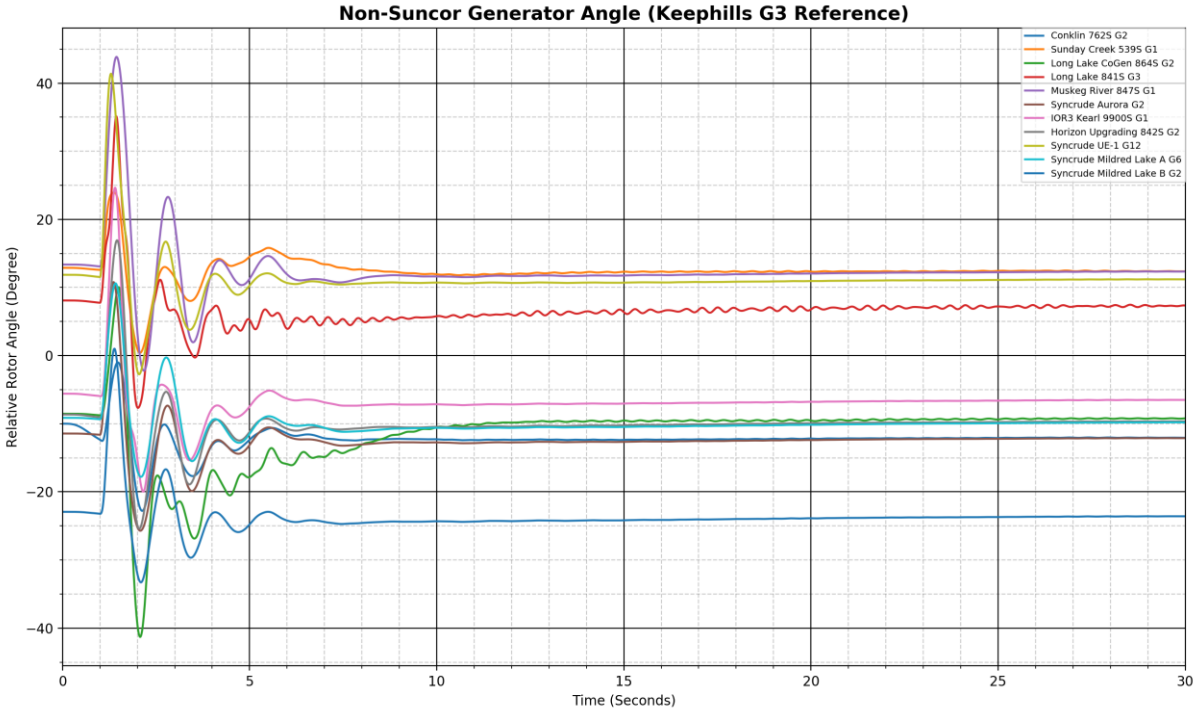
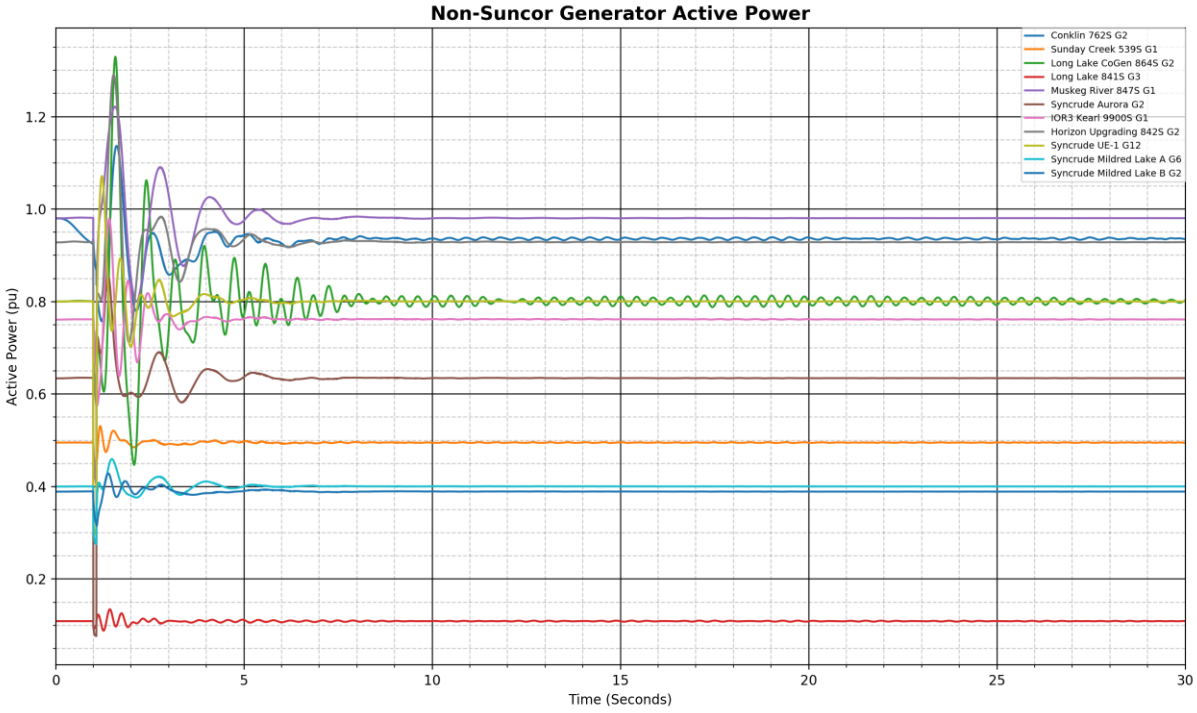
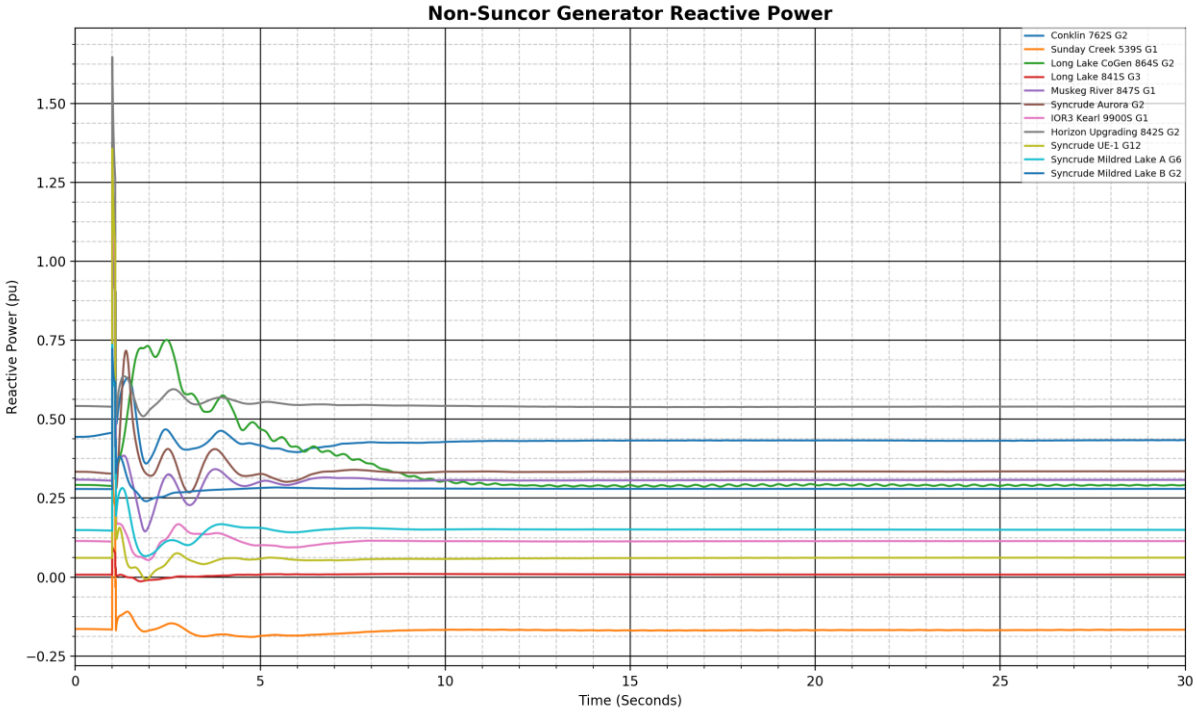

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
800
600
400
200
0
0
5
10
15
20
25
30
Time (Seconds)

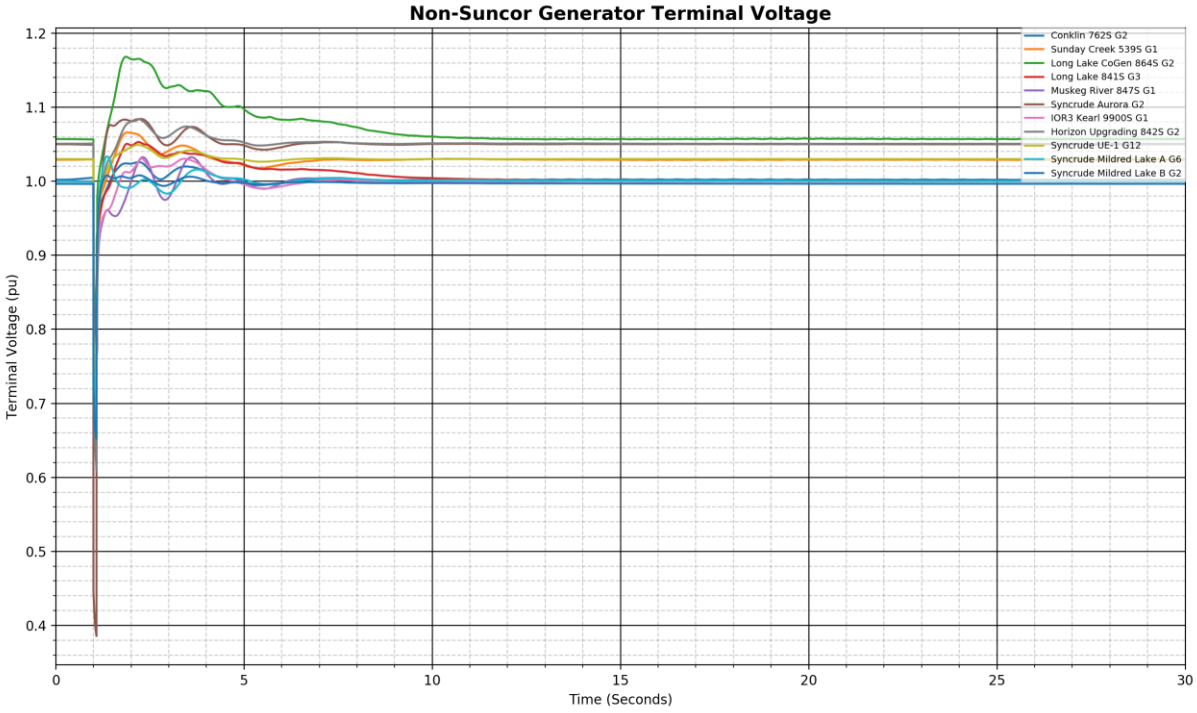
Figure A4-57: 9L01 (Ruth Lake 848S to Thickwood Hills 951S): Fault at Ruth Lake 848S

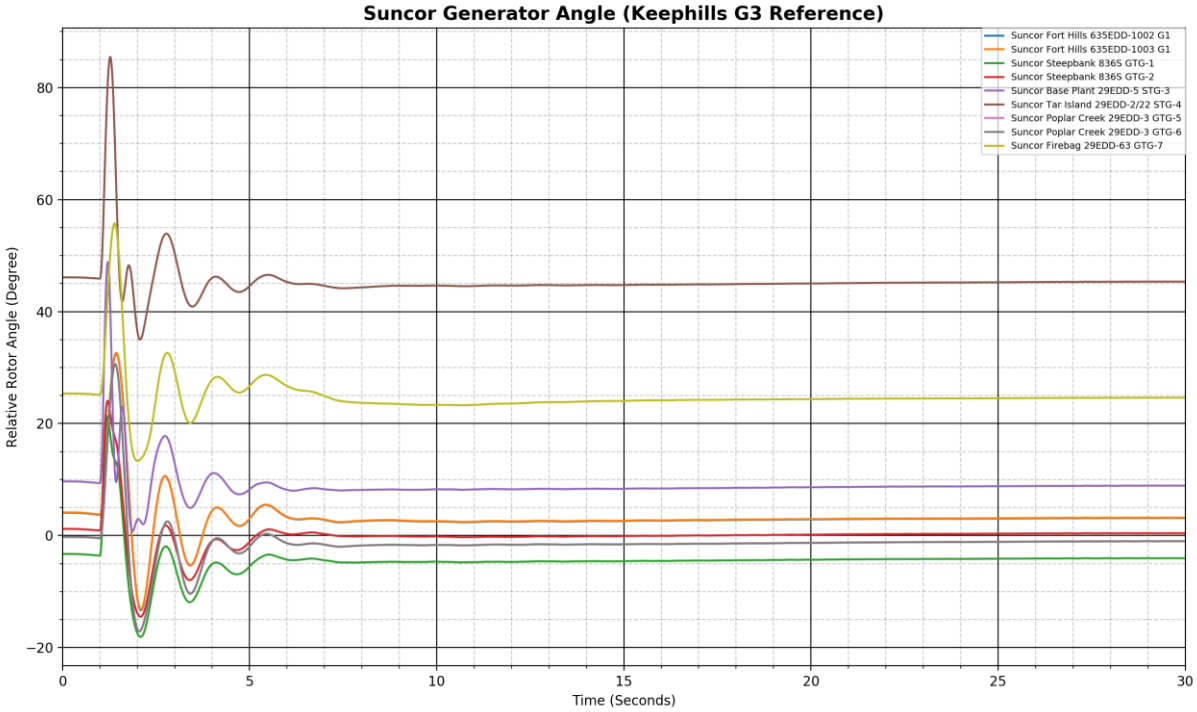


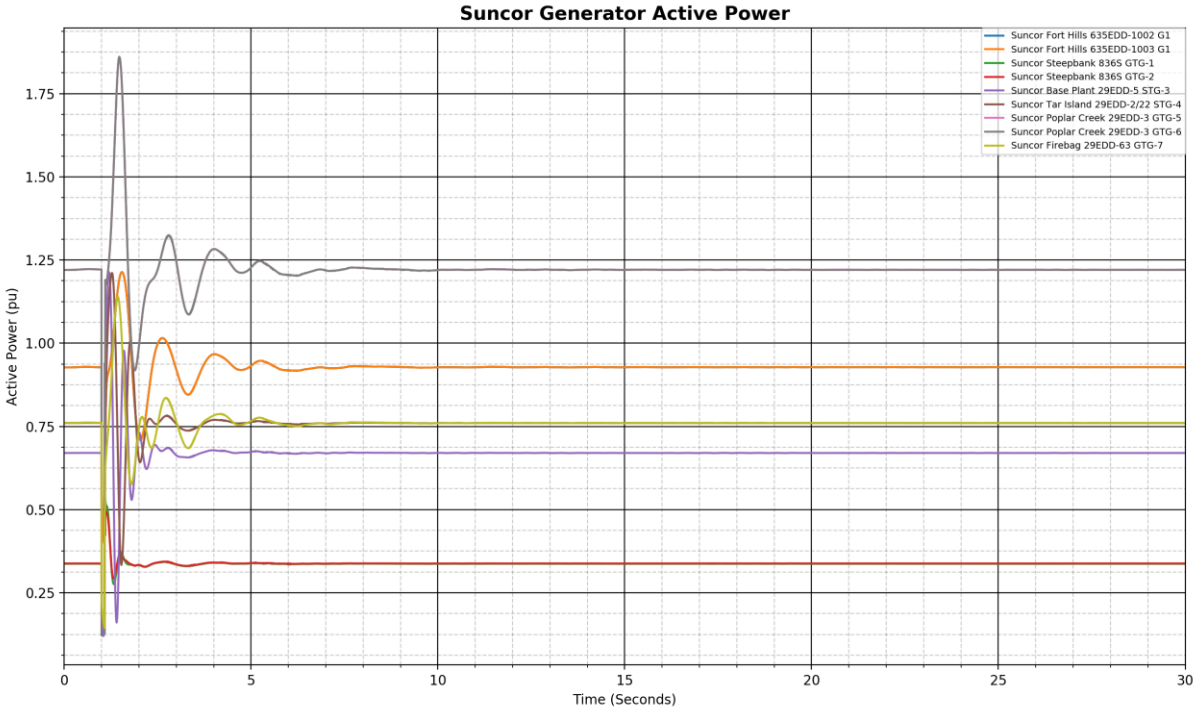

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

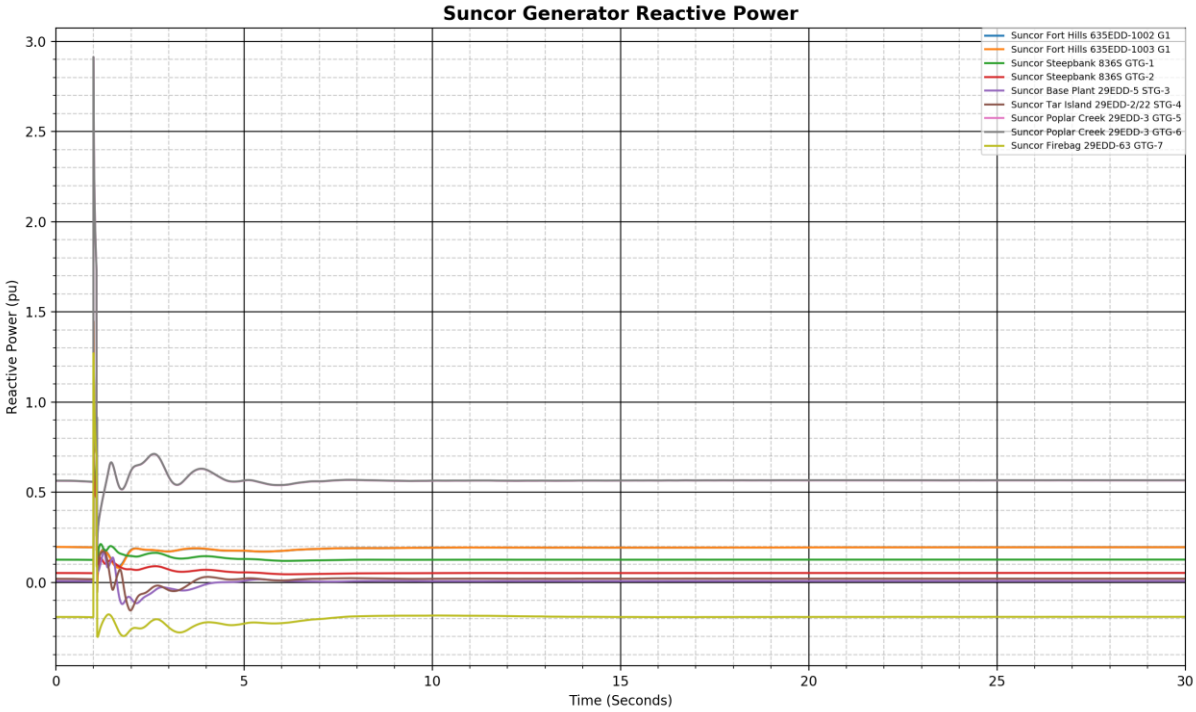

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

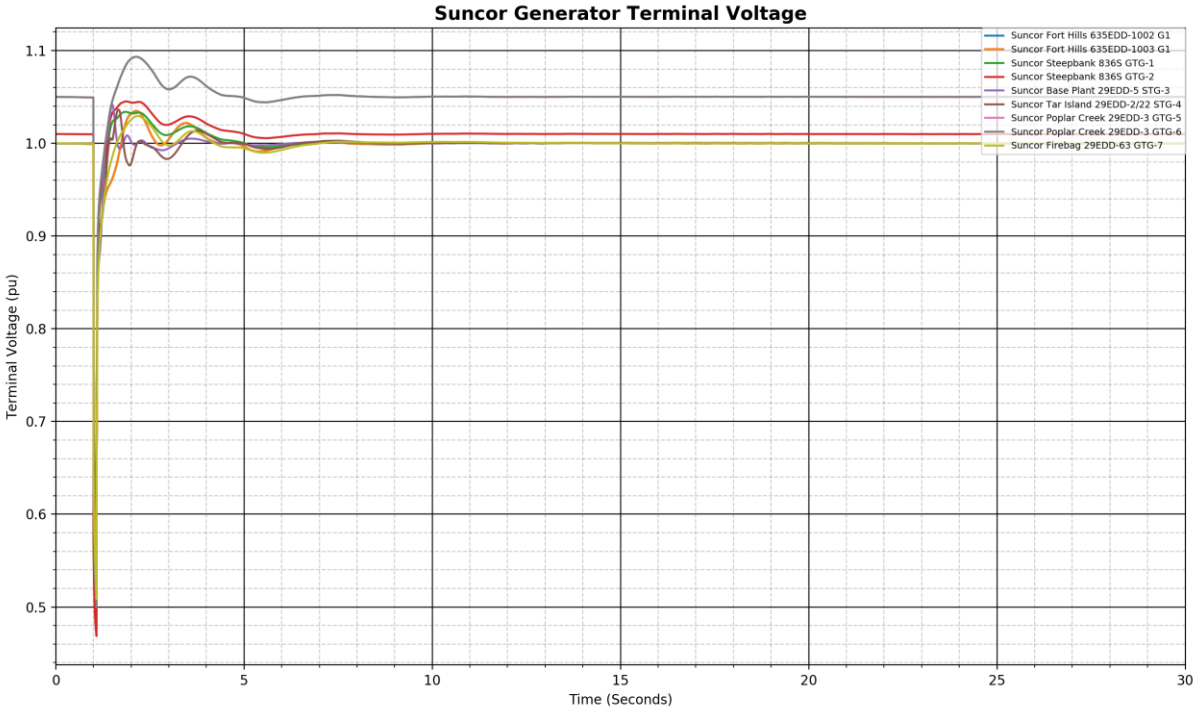

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

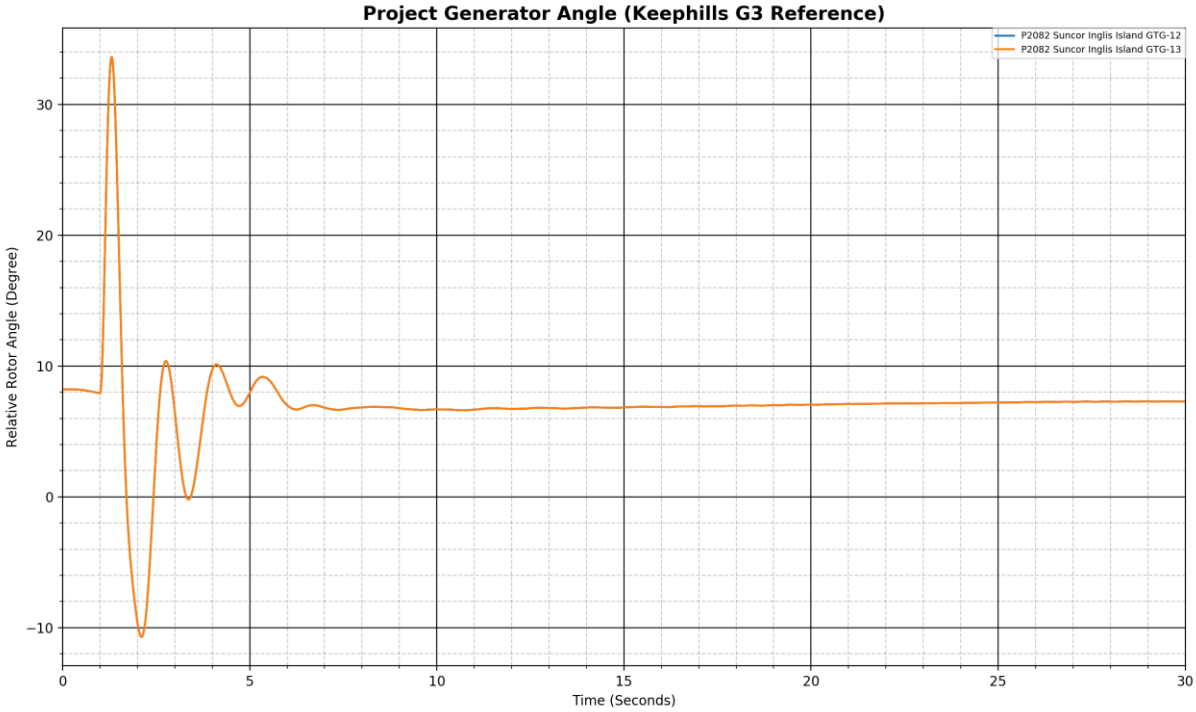

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

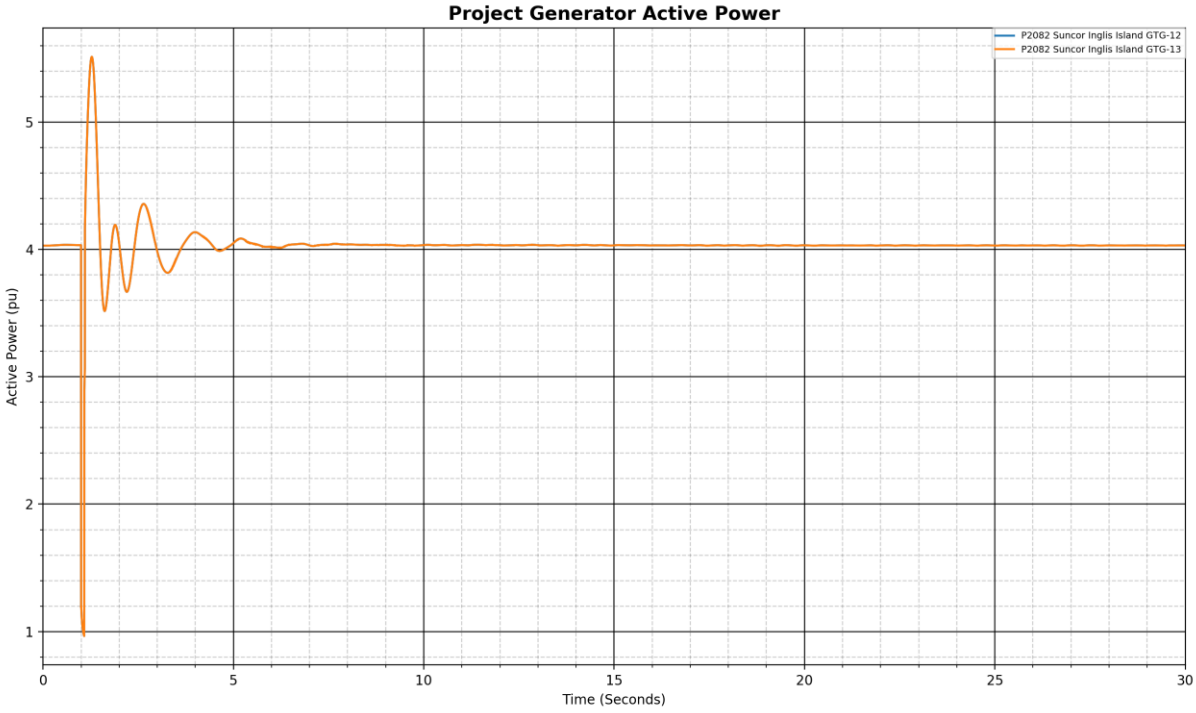

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

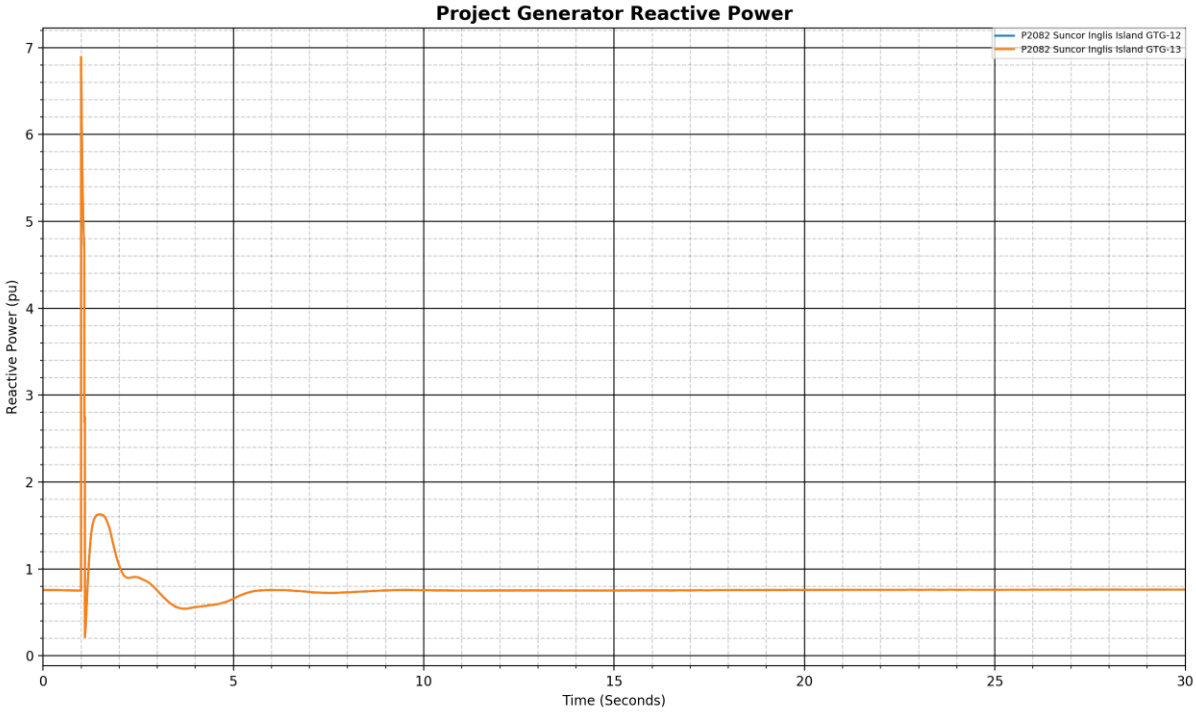

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

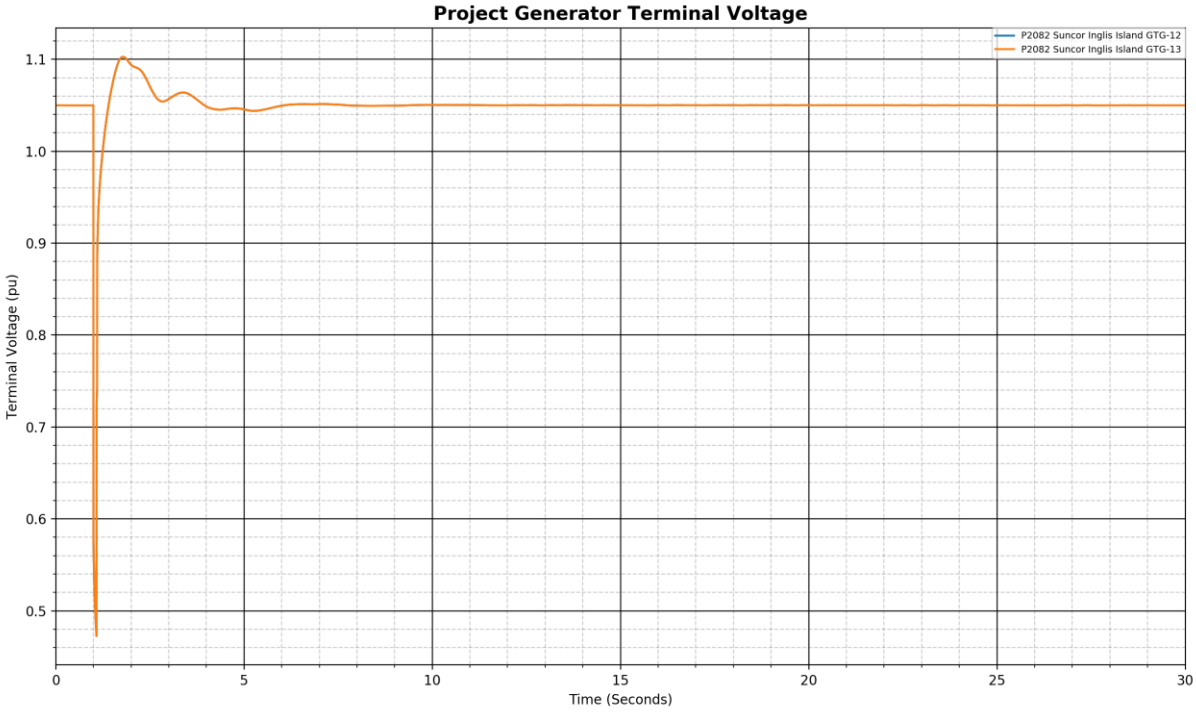

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

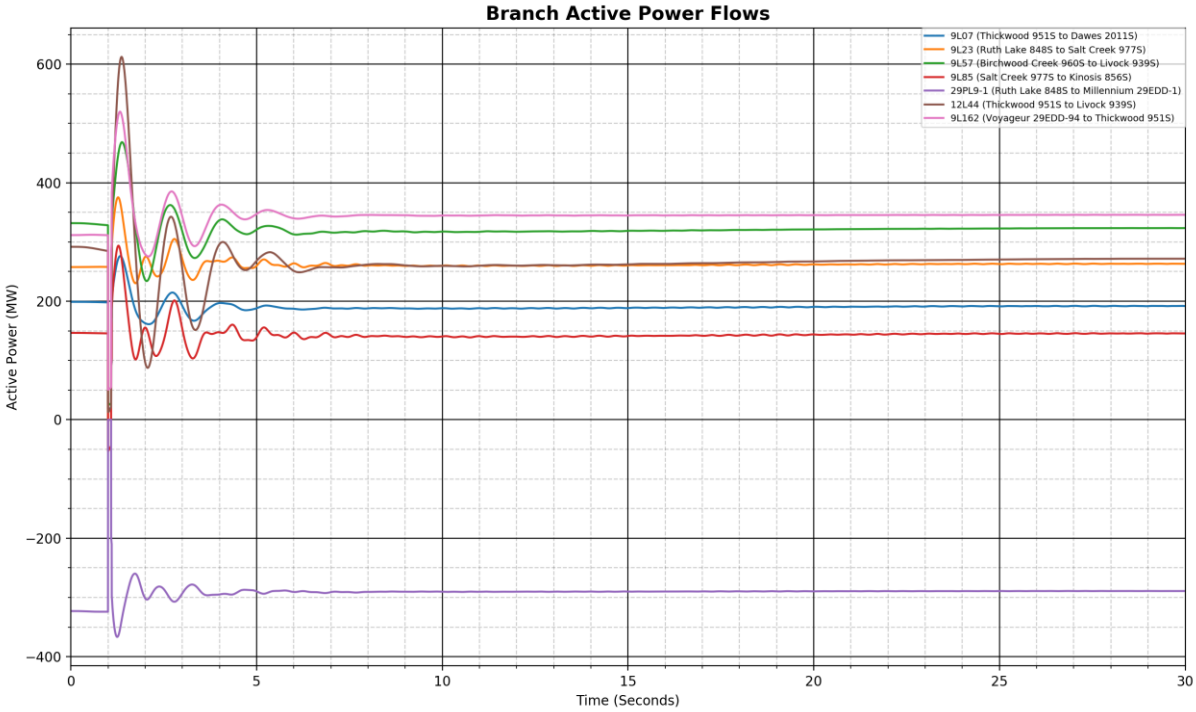

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
20
10
0
−10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5
4
3
2
1
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

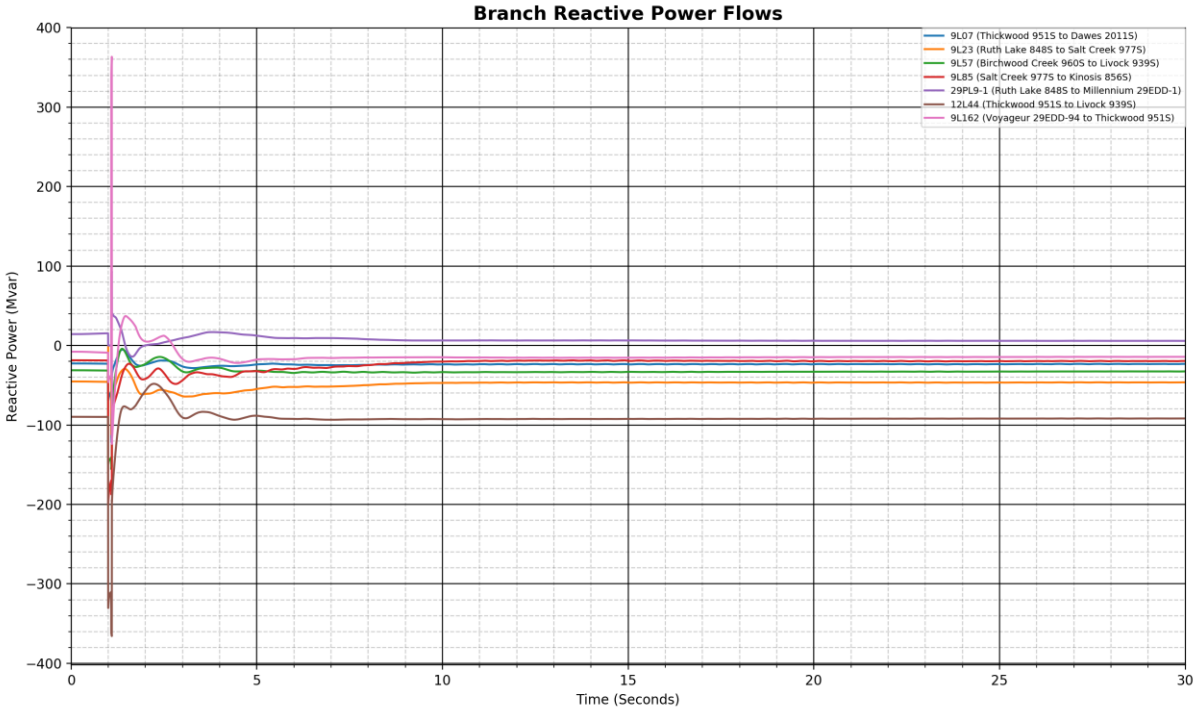
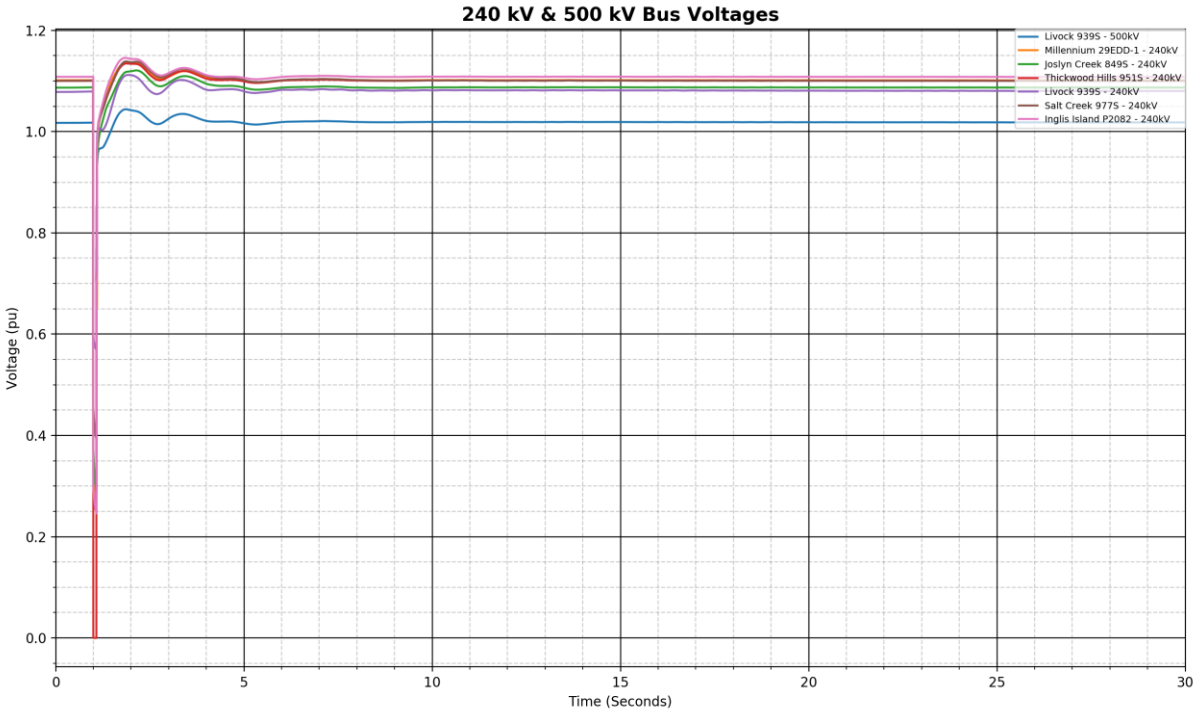
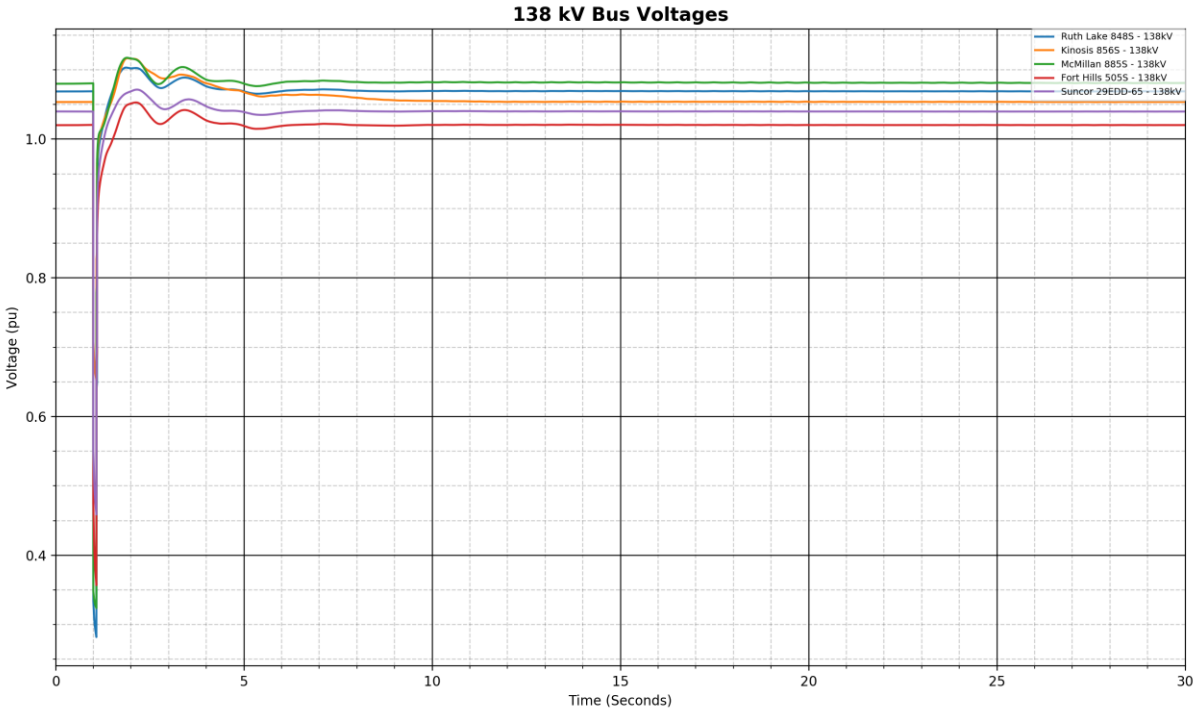
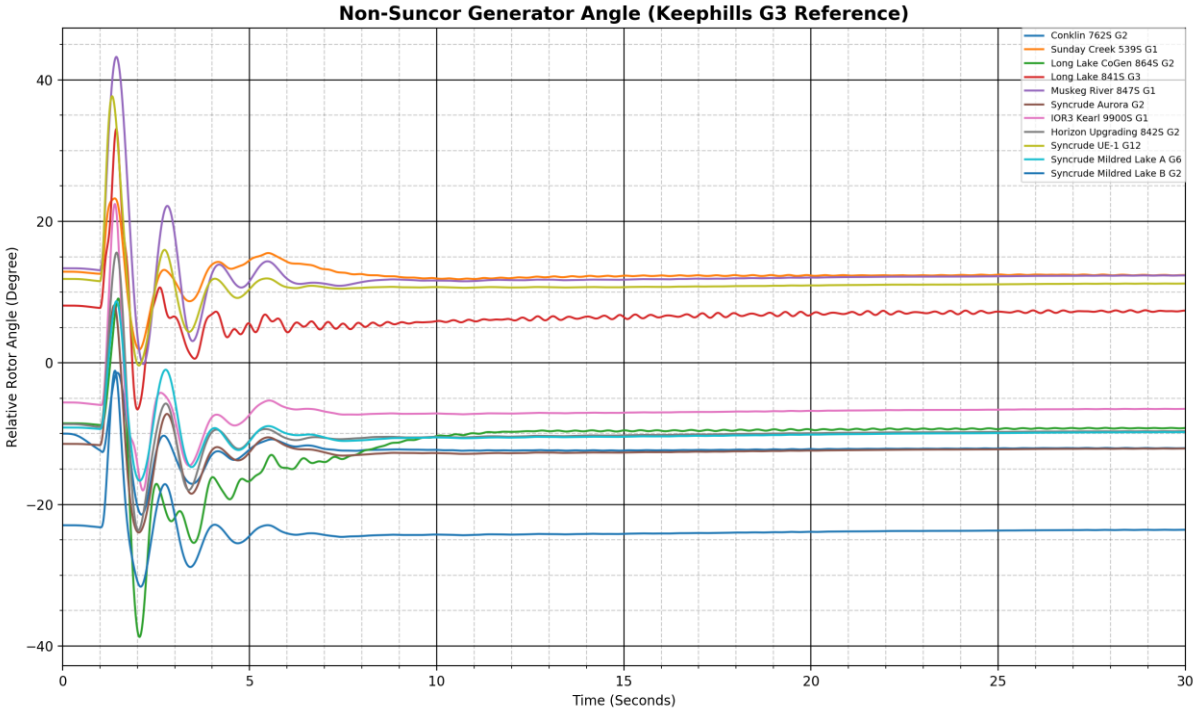
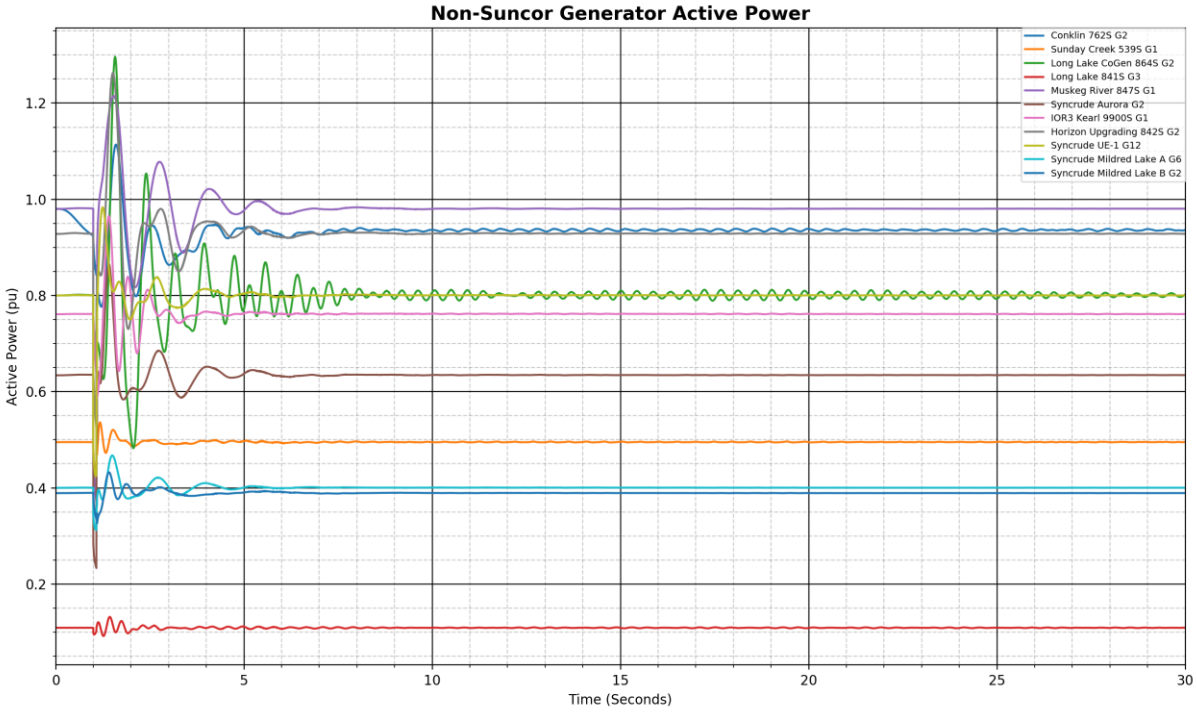

Branch Reactive Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

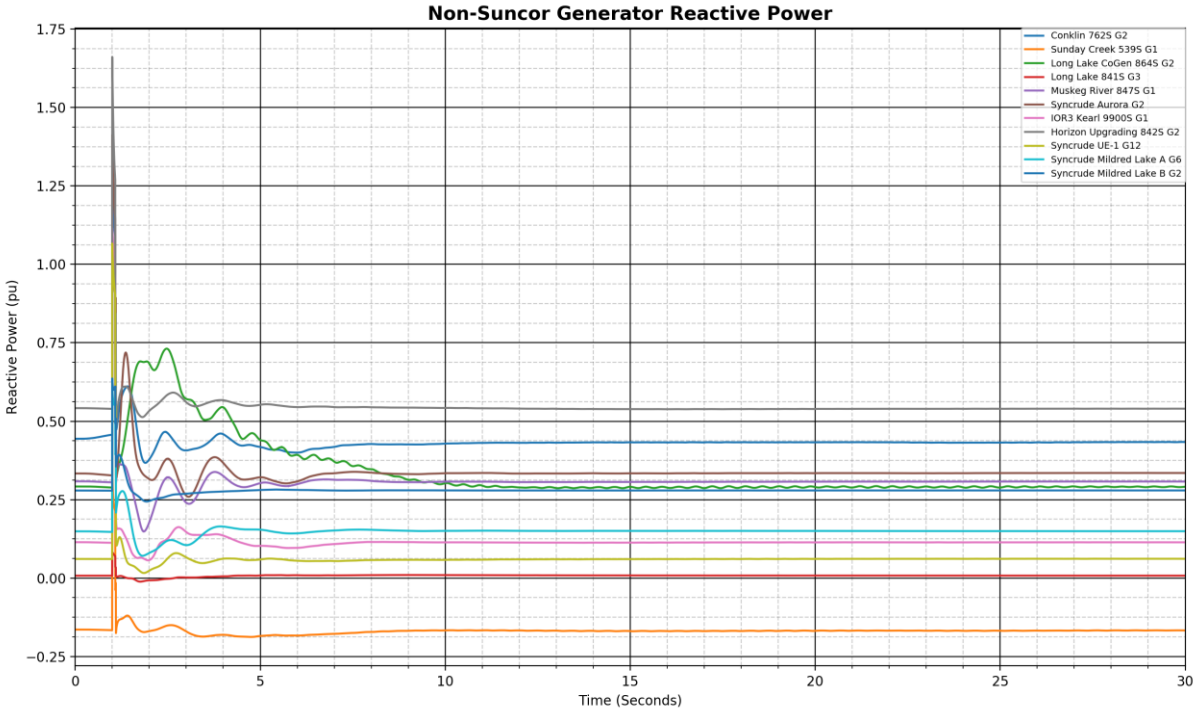
Figure A4-58: 9L01 (Ruth Lake 848S to Thickwood Hills 951S): Fault at Thickwood Hills 951S

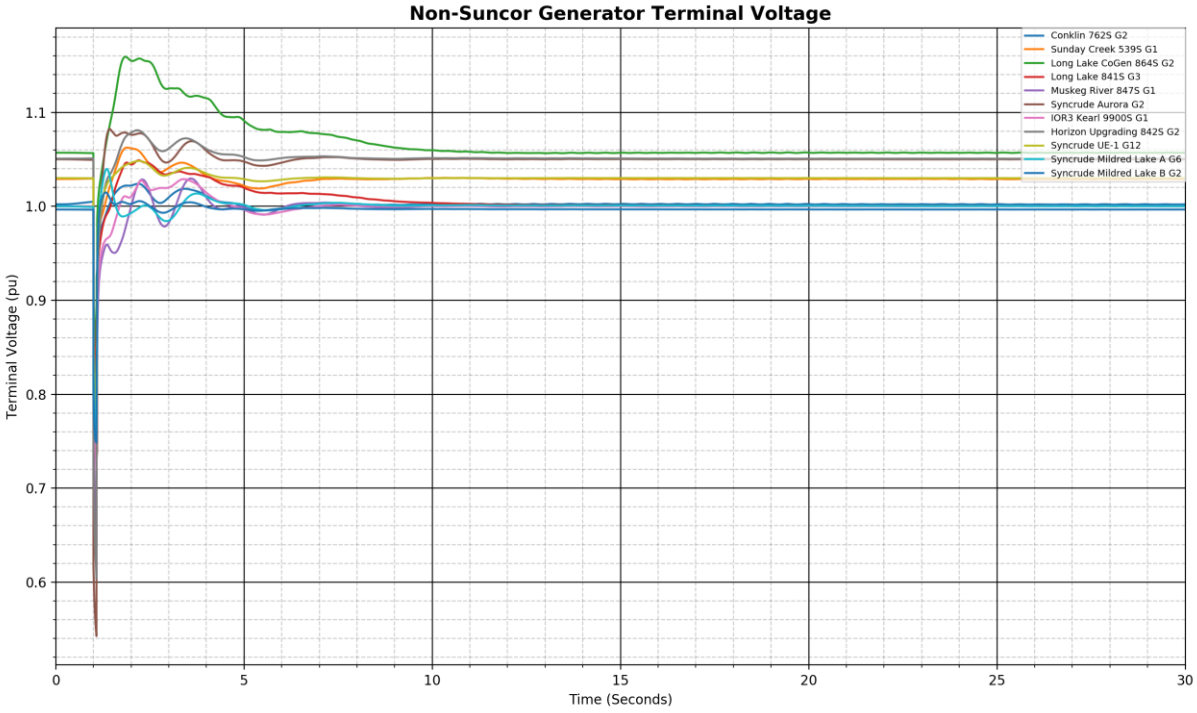


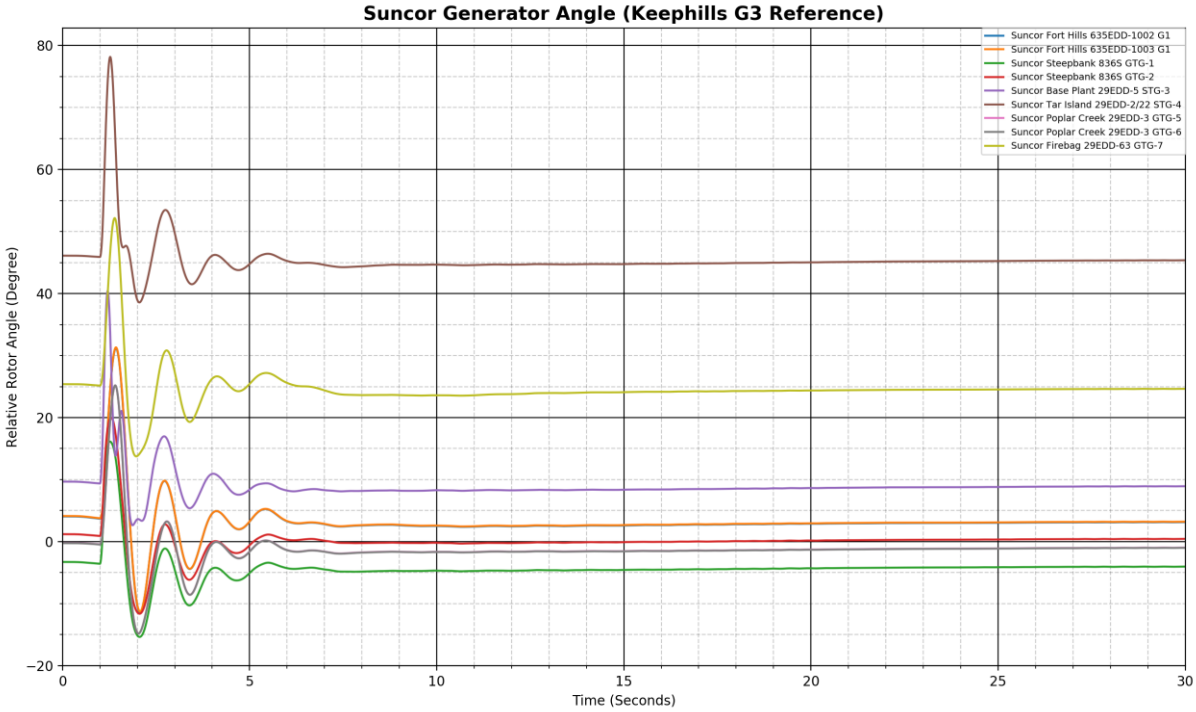


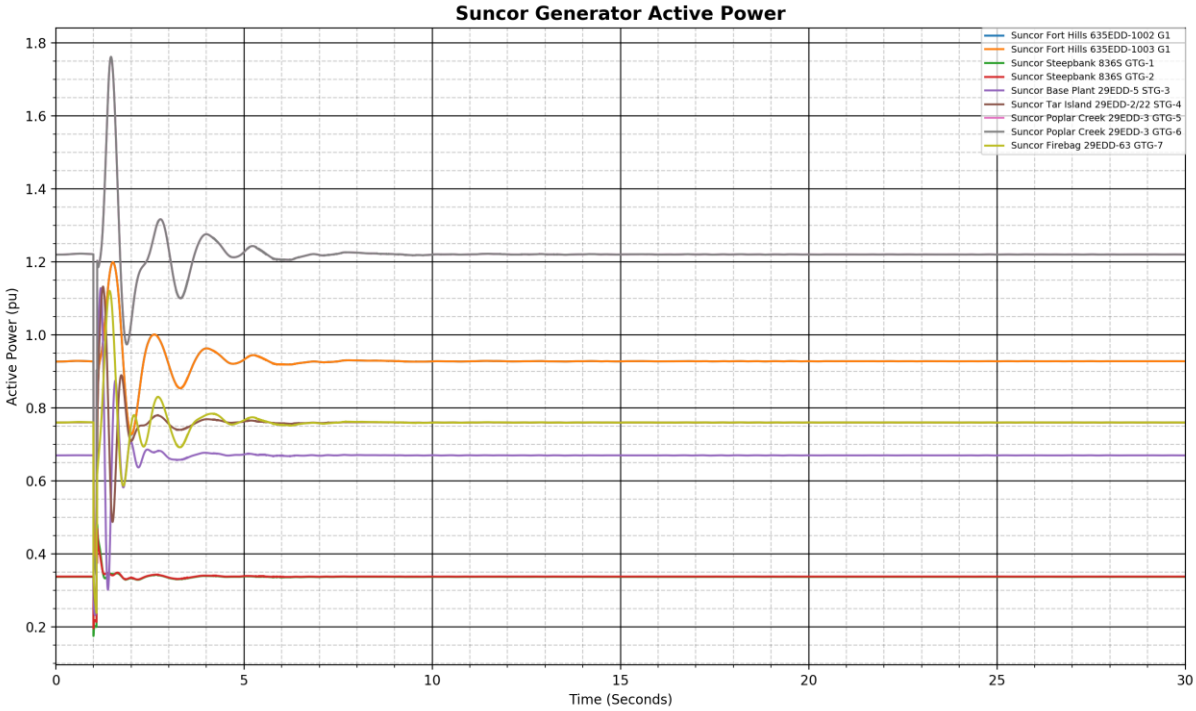

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

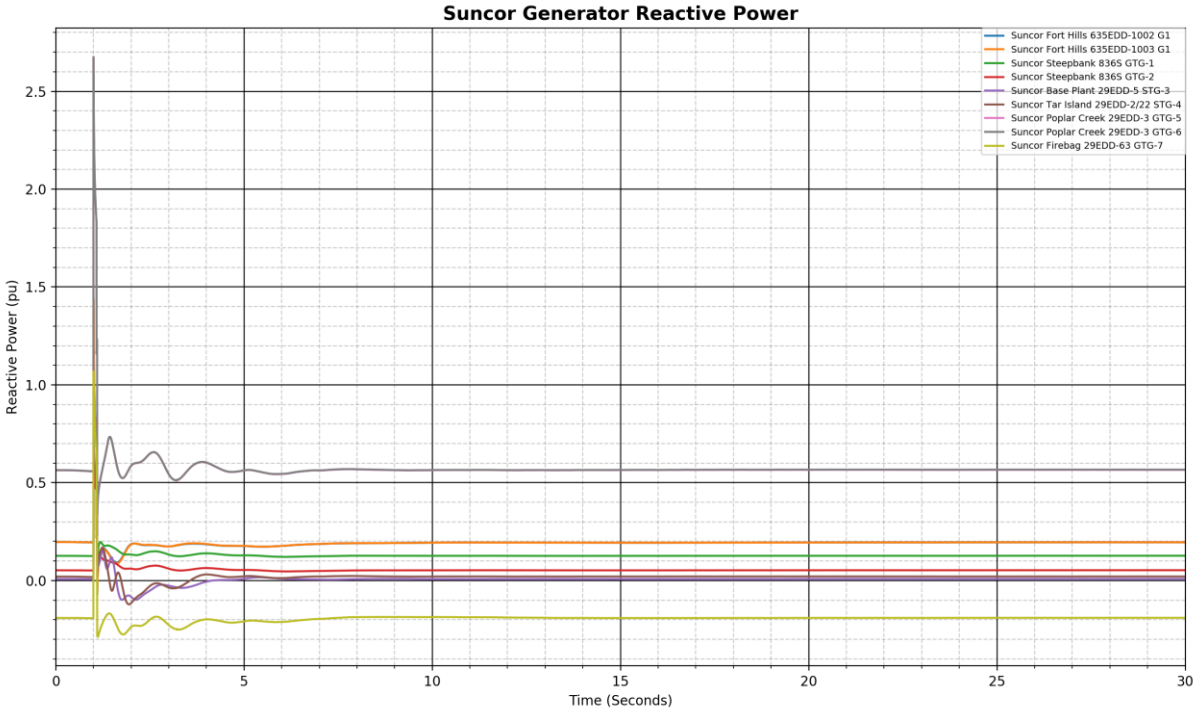

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

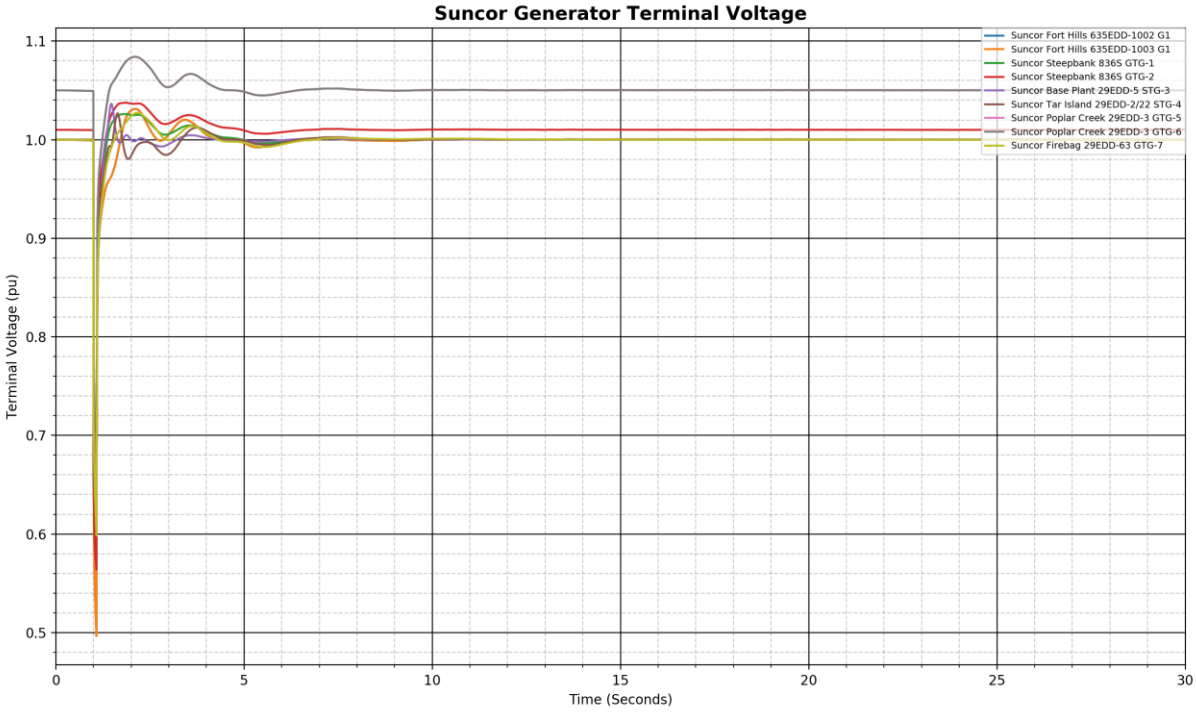

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

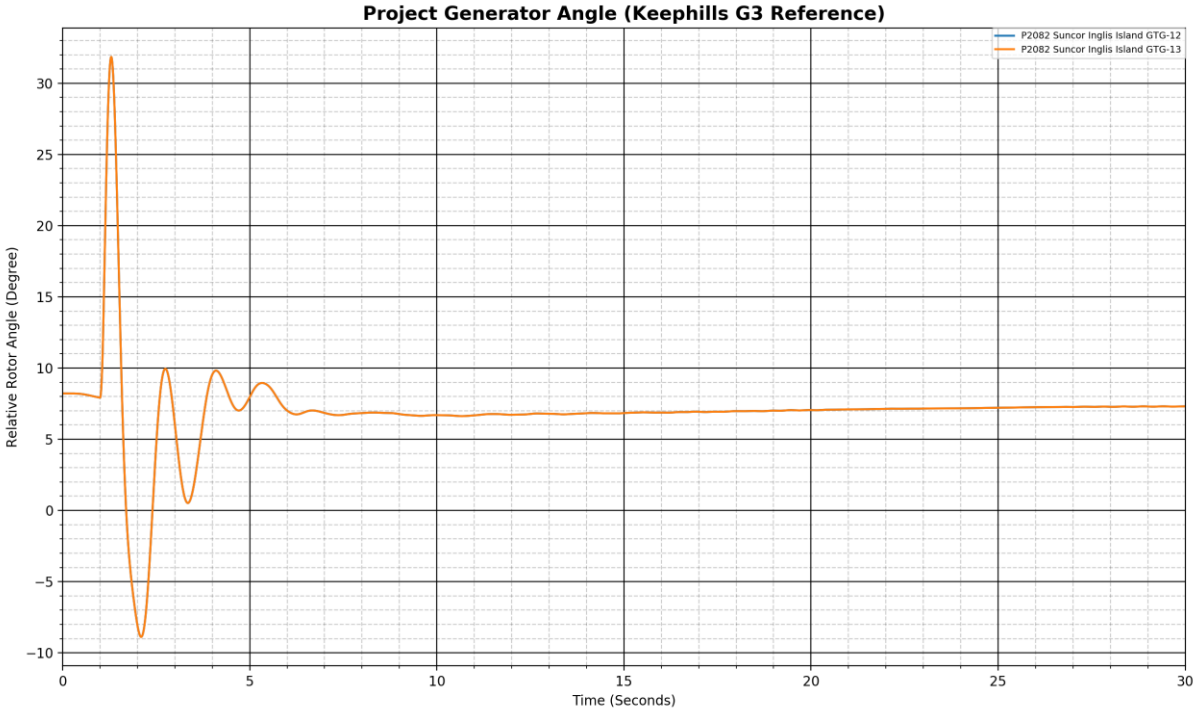

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

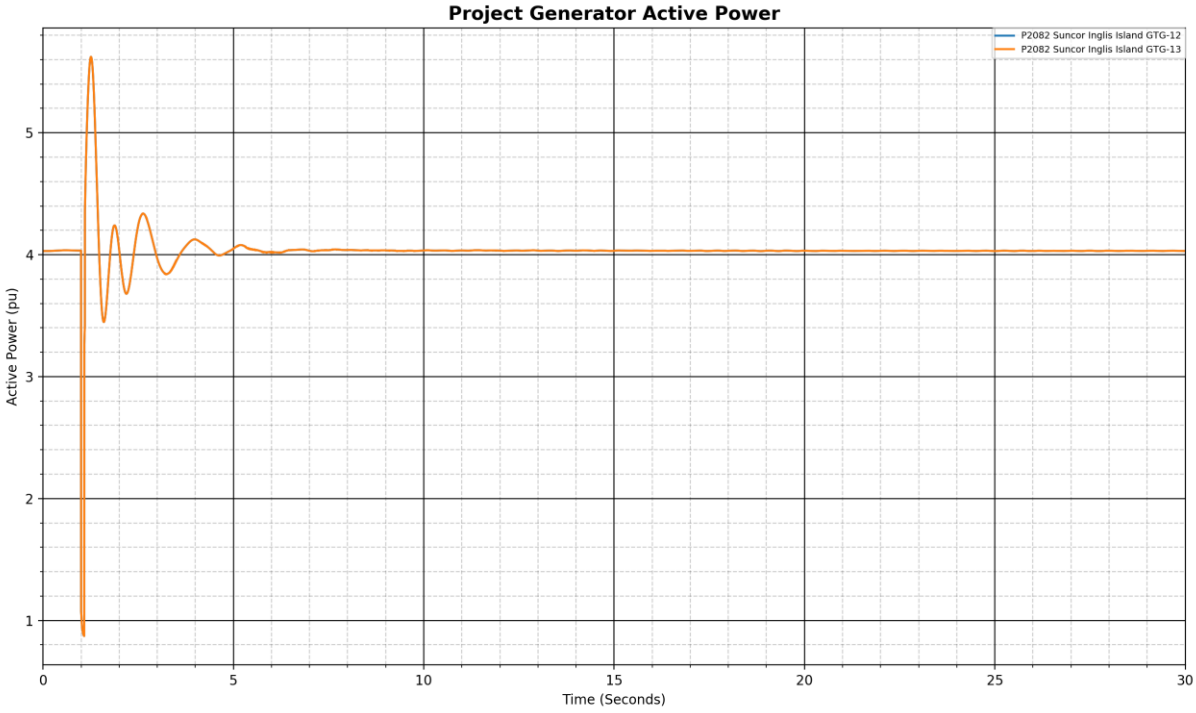

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

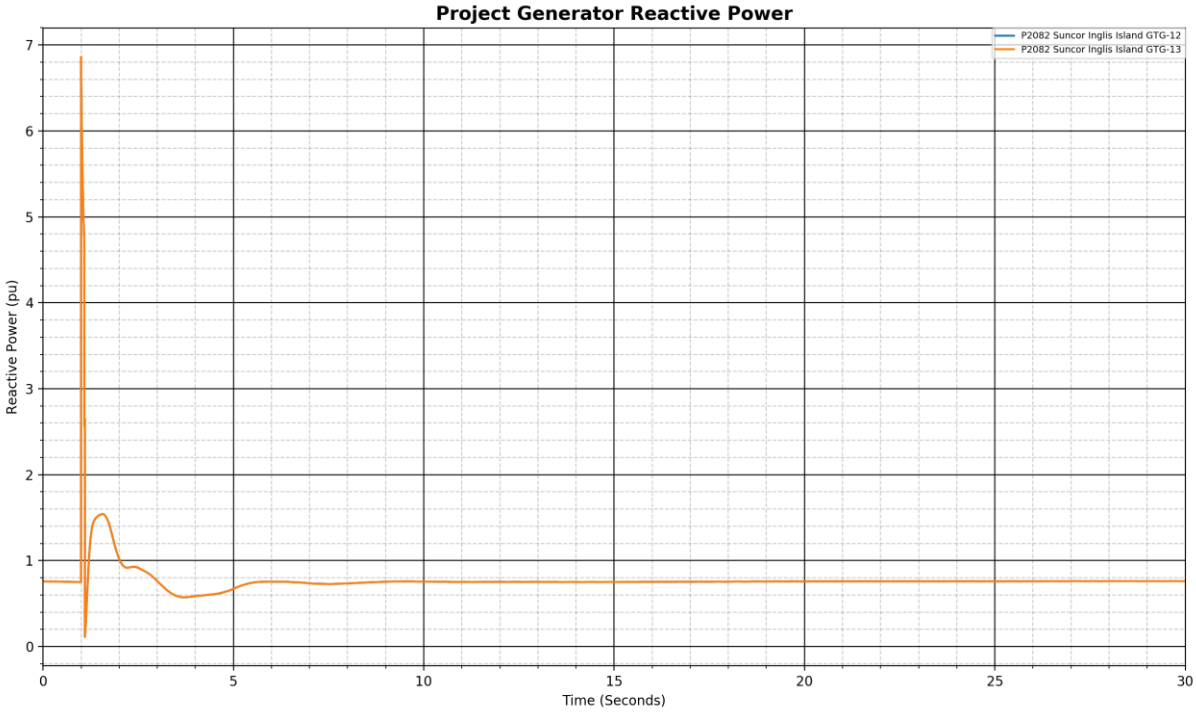

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

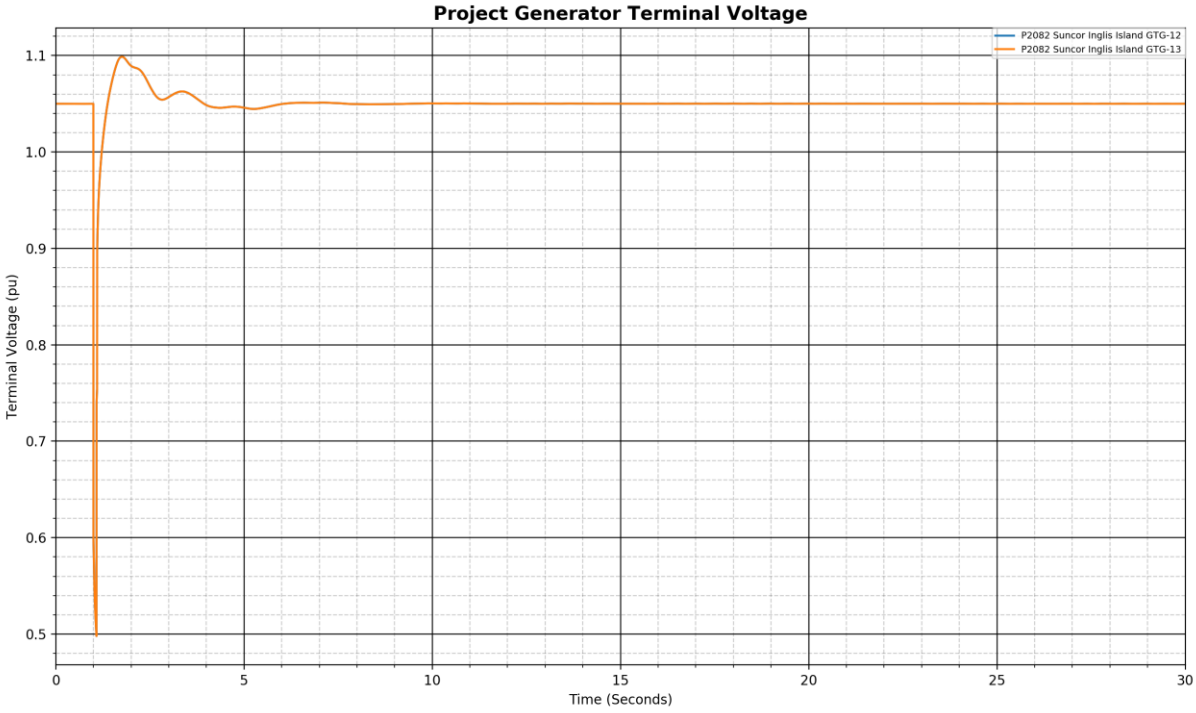

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

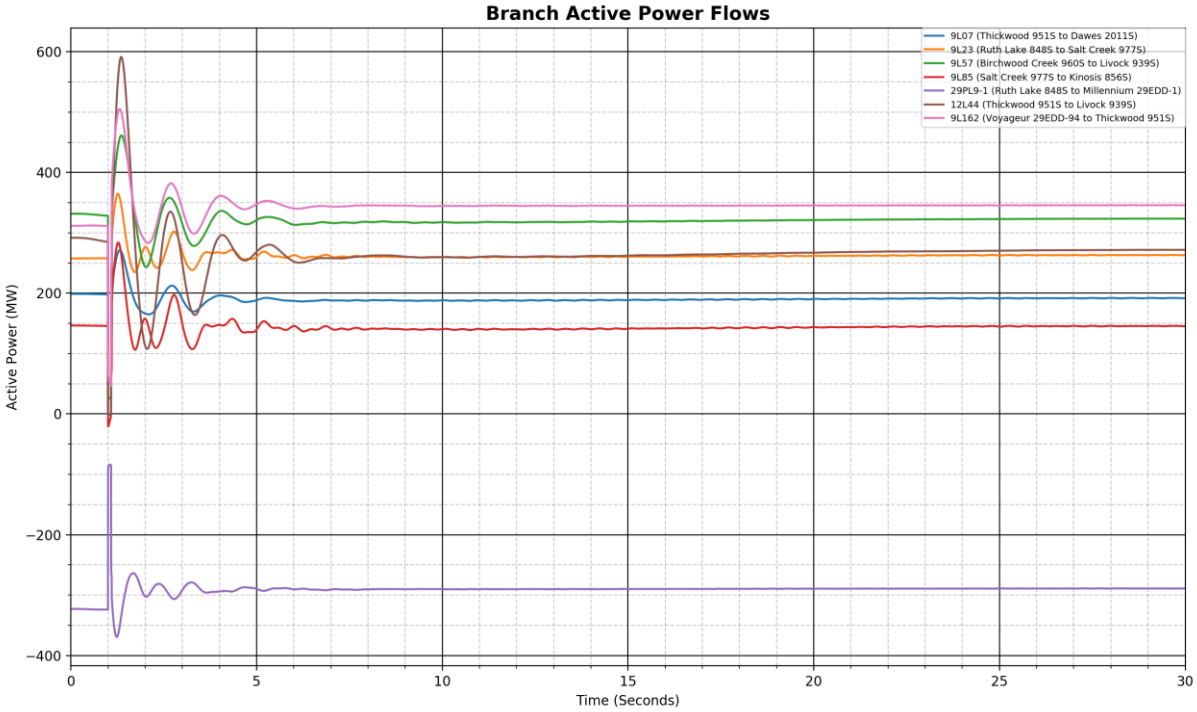

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

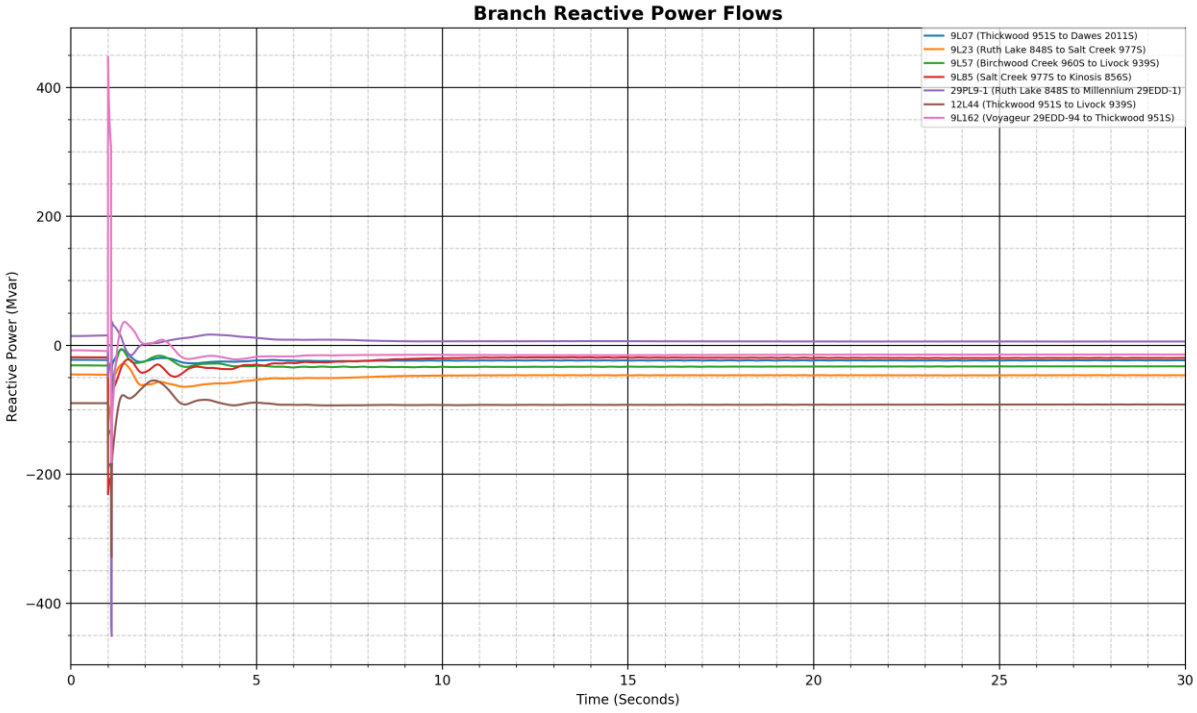
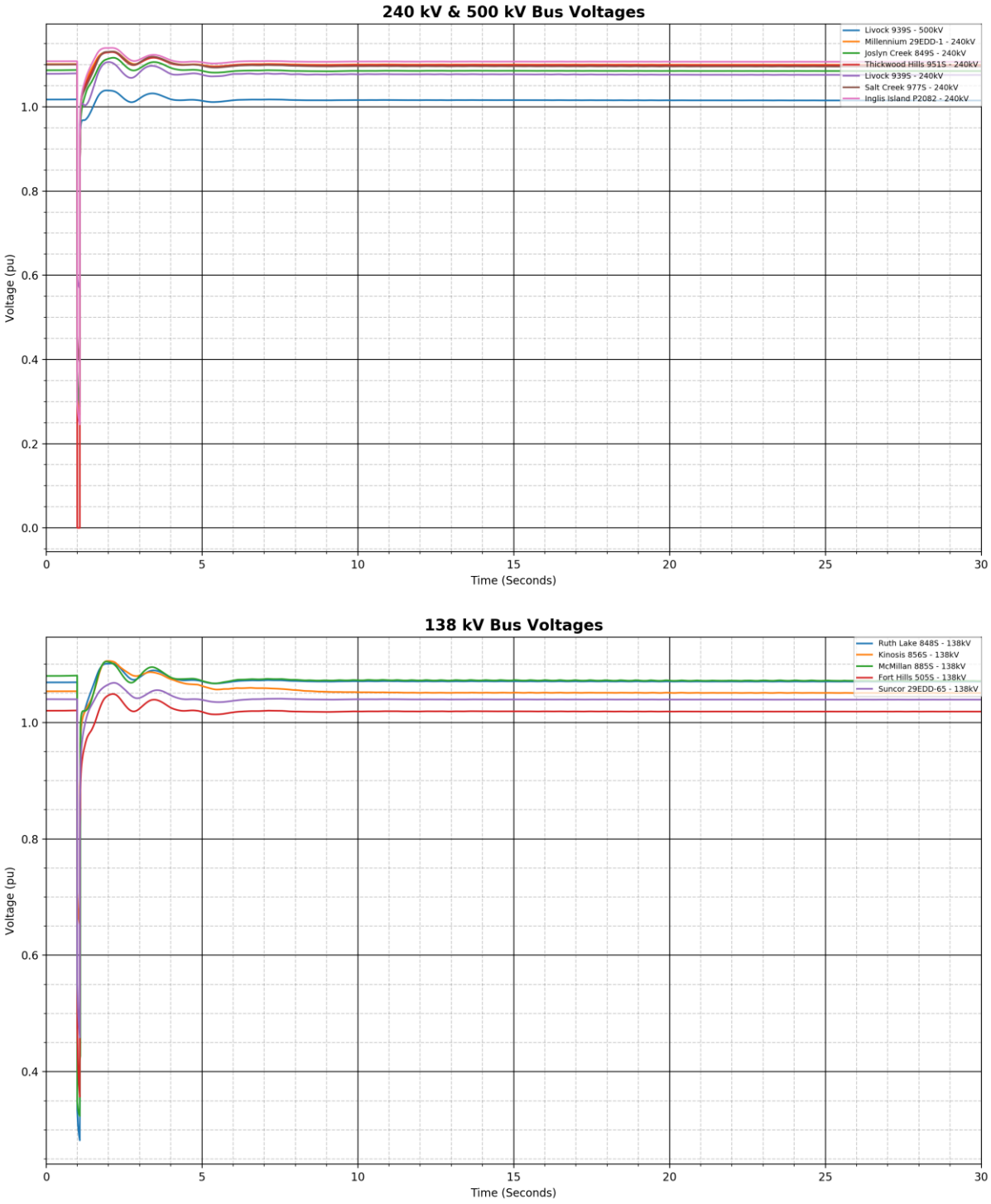
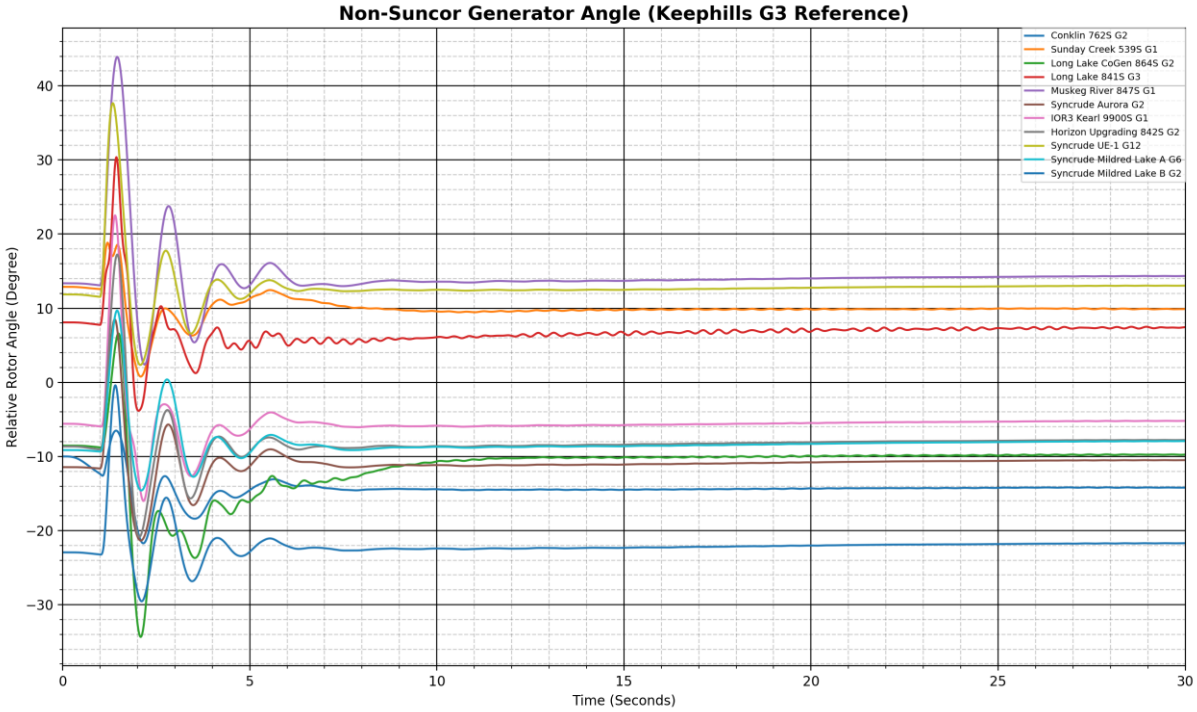
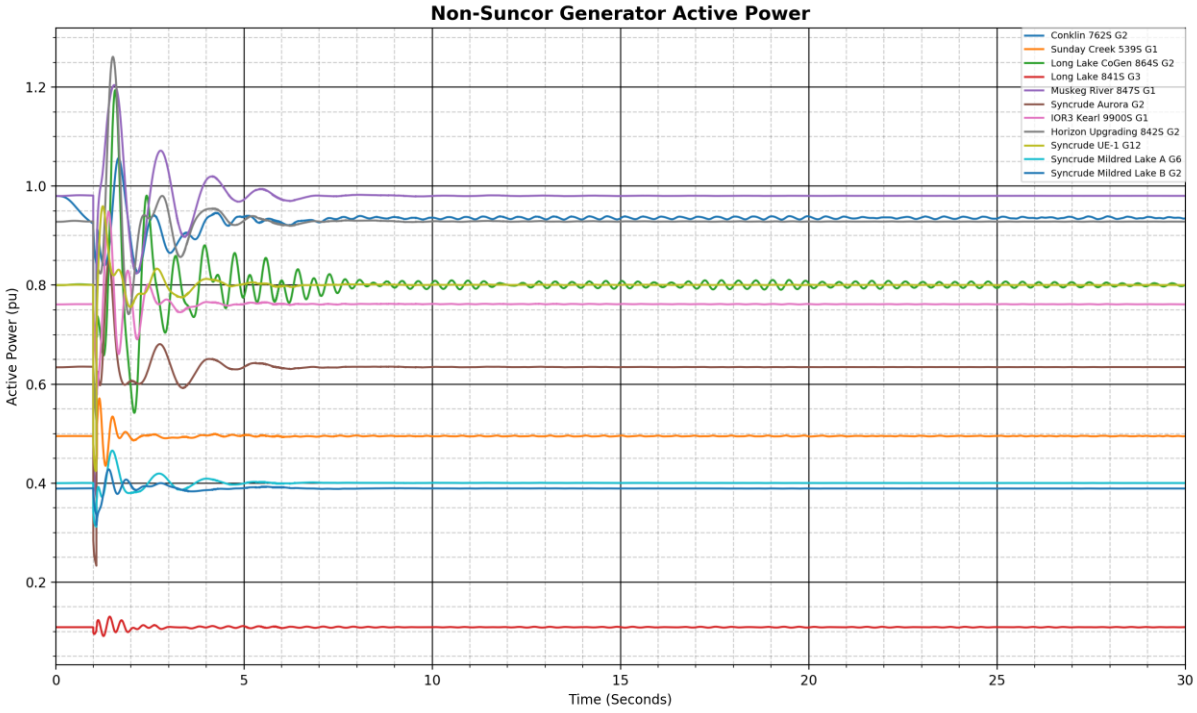
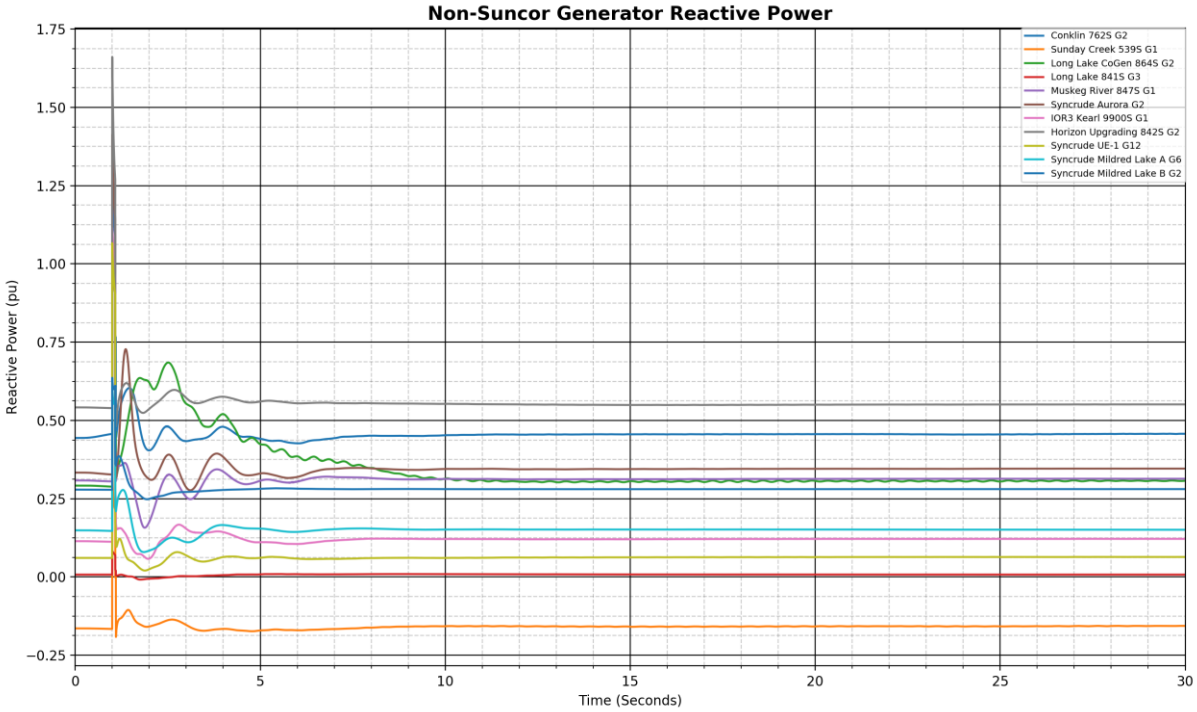

Branch Reactive Power Flows
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

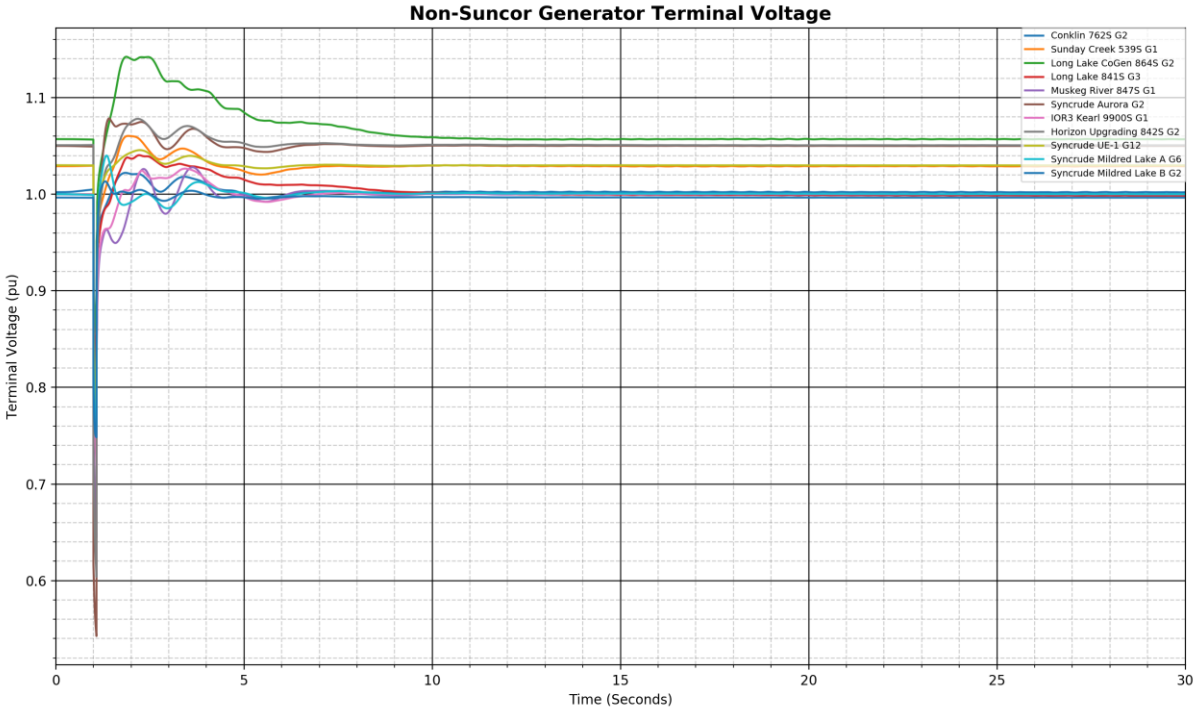
Figure A4-59: 9L07 (Thickwood Hills 951S to Dawes 2011S): Fault at Thickwood Hills 951S

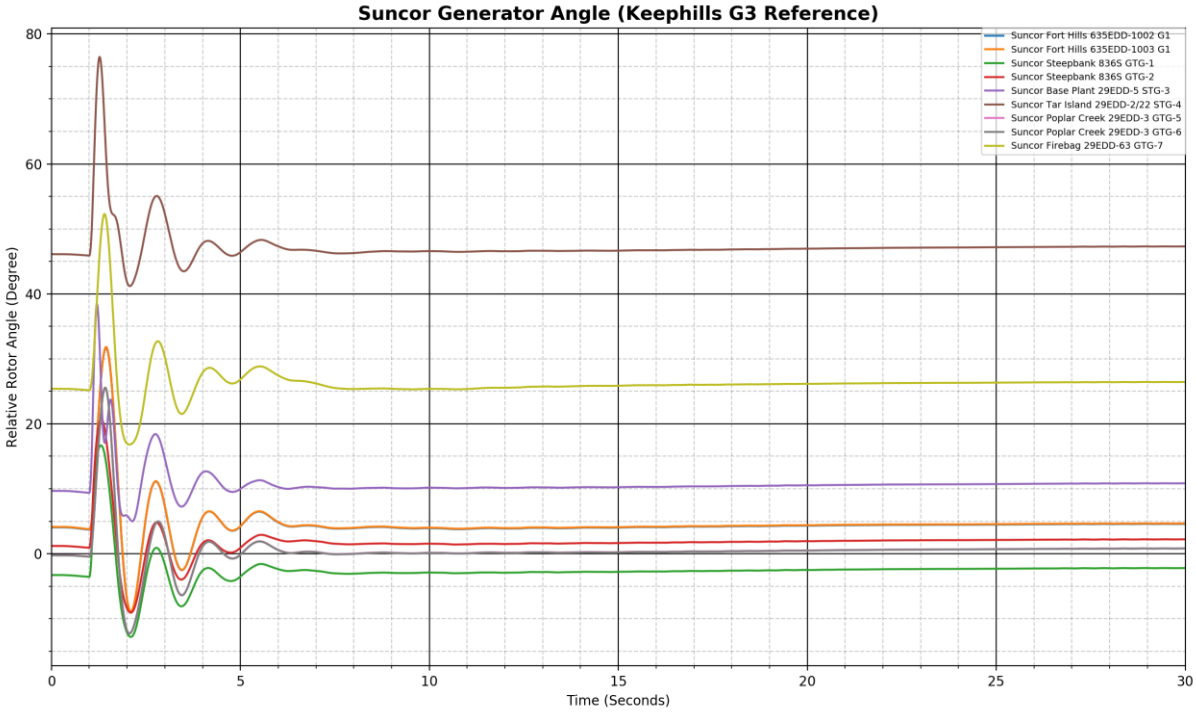


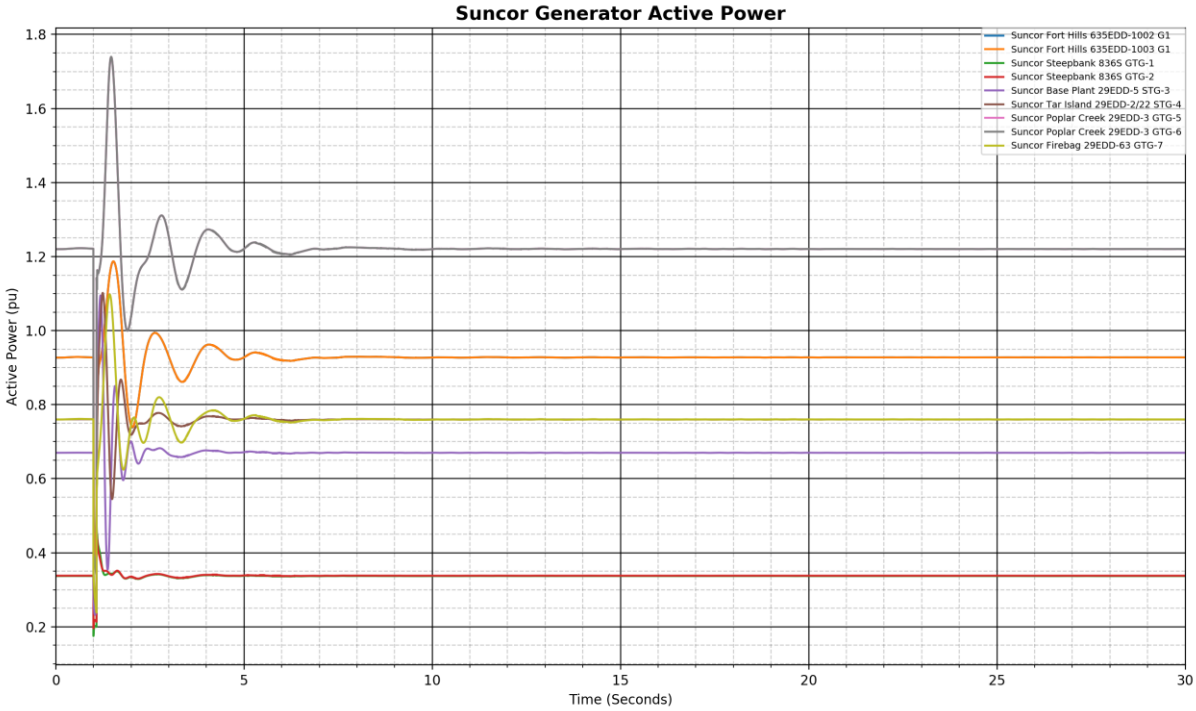

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

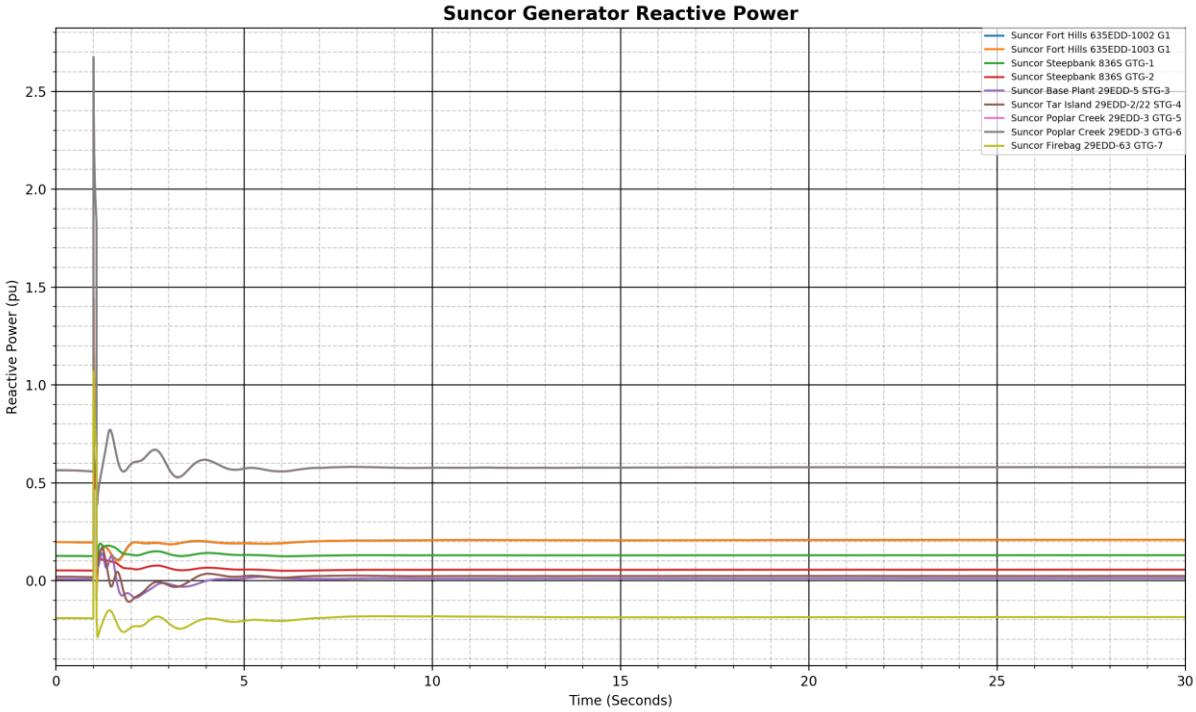

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

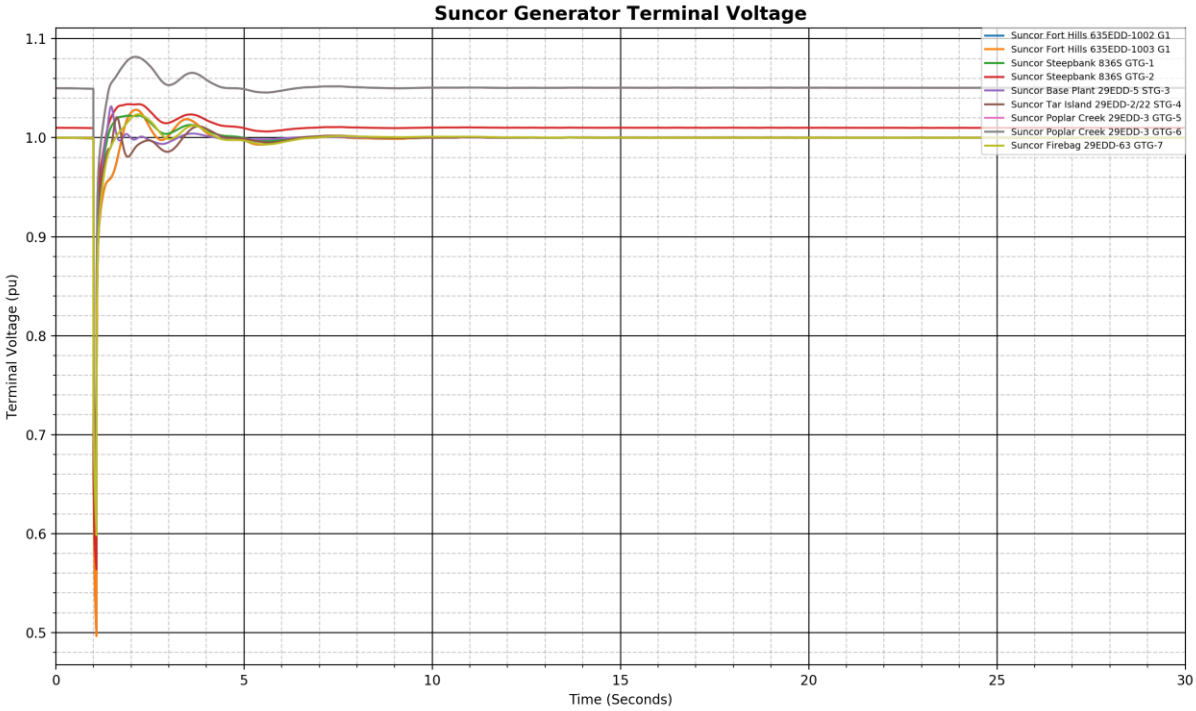

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

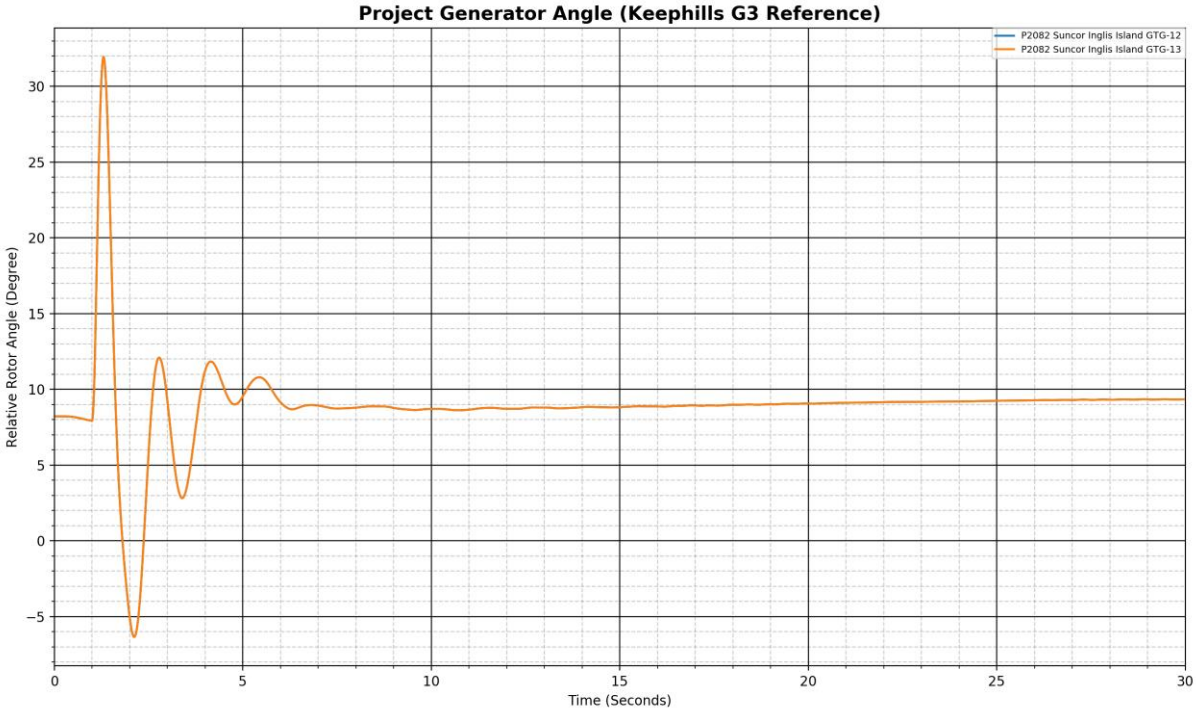

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

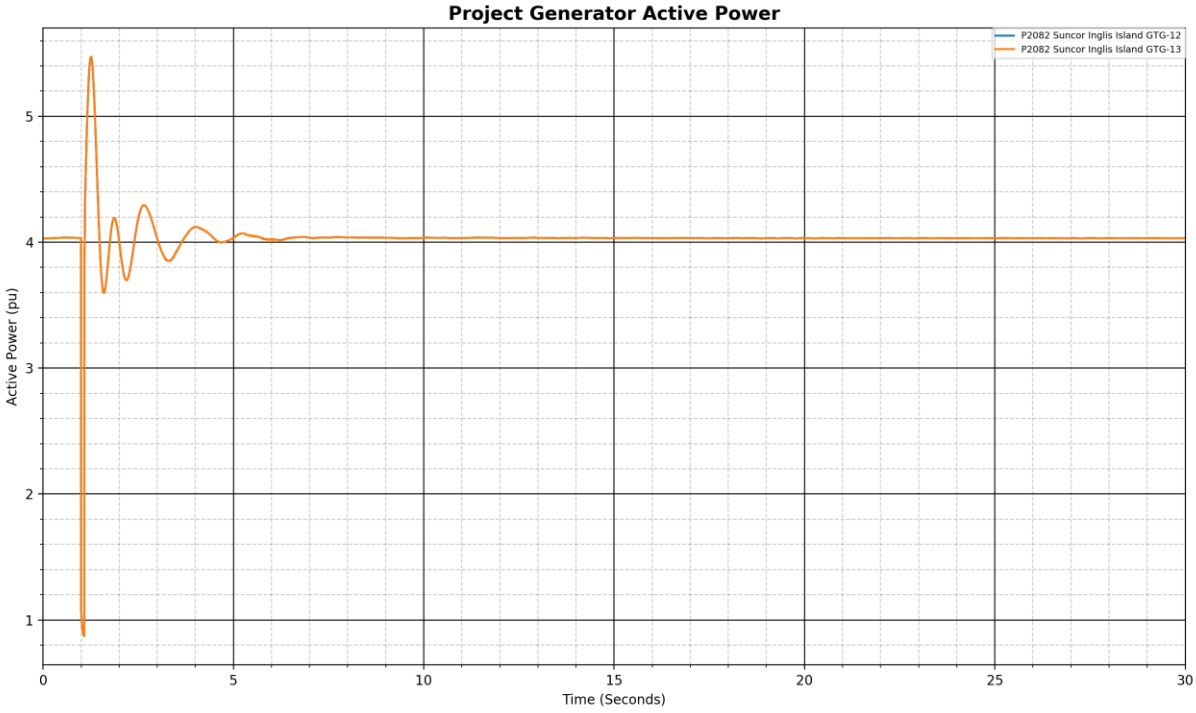

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

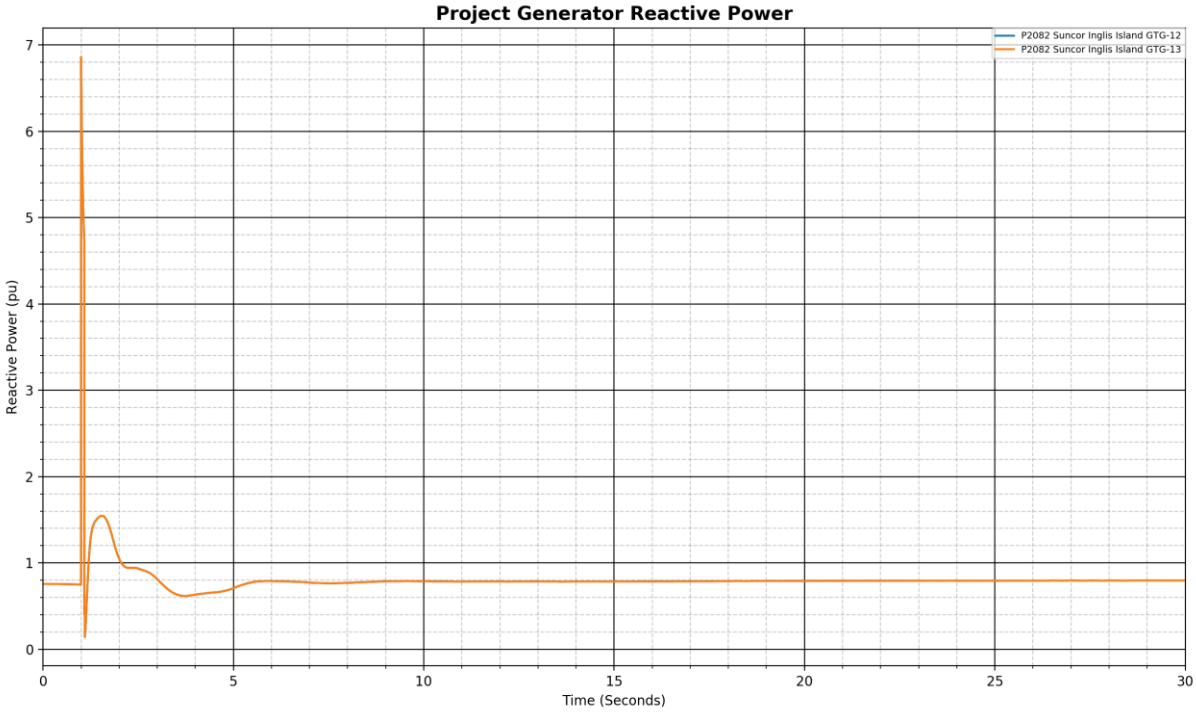

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

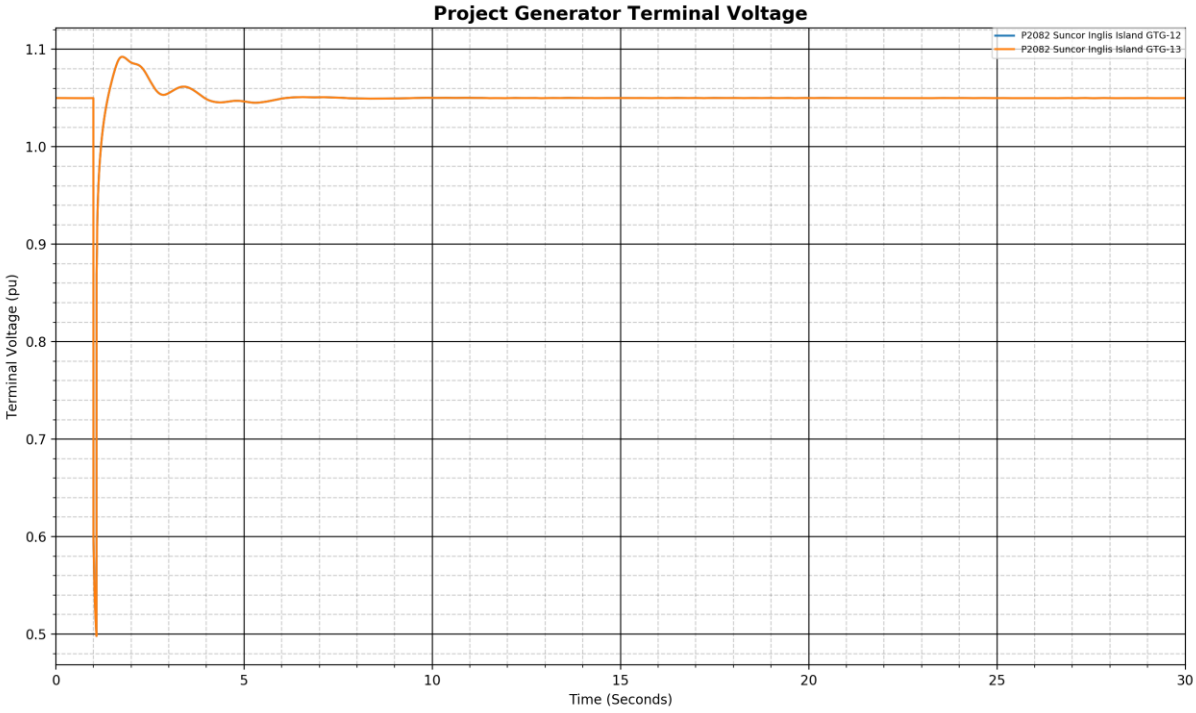

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

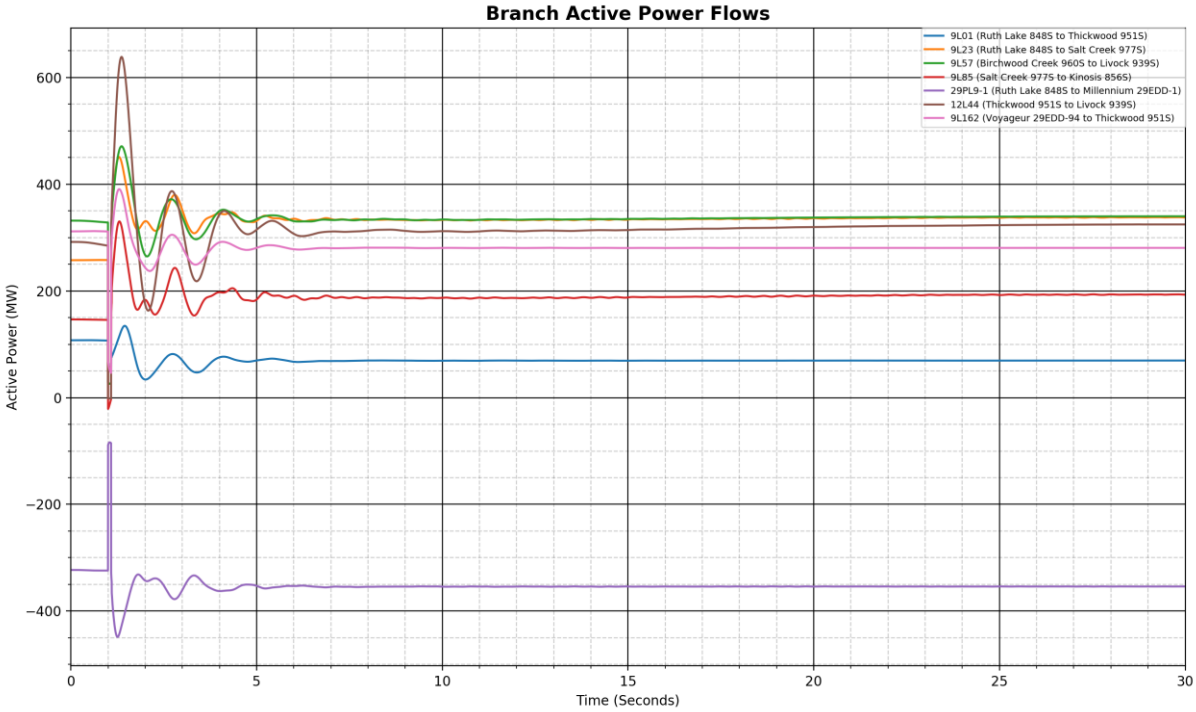

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

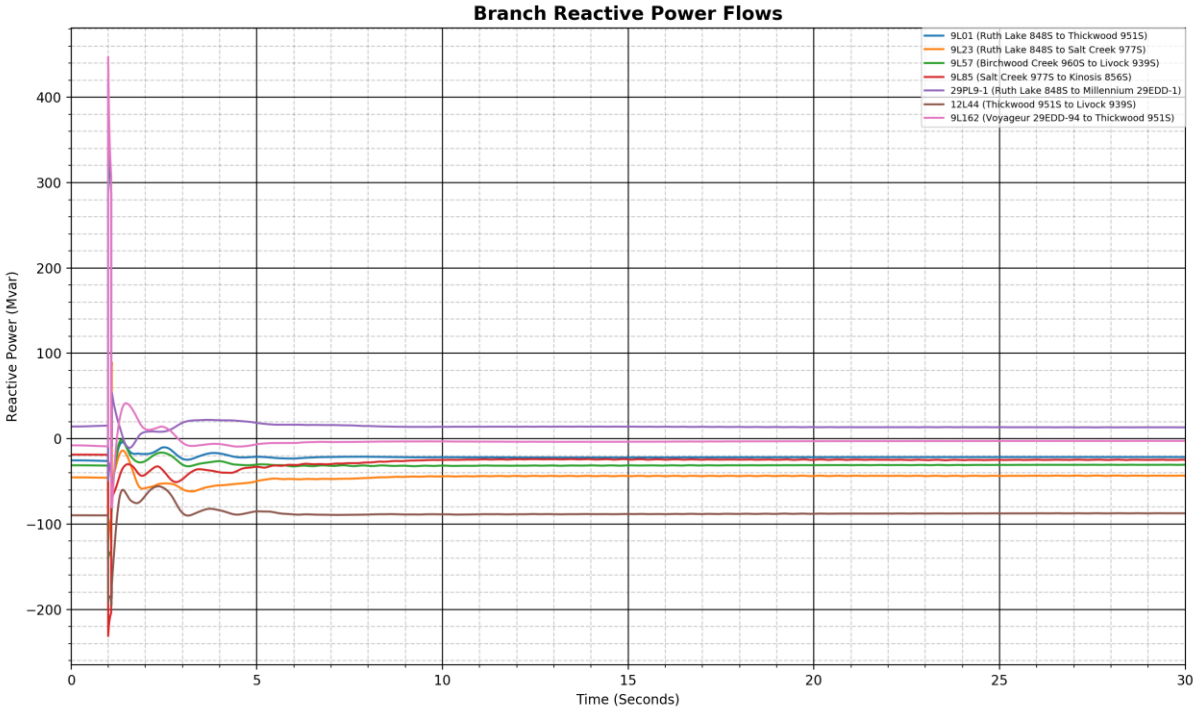
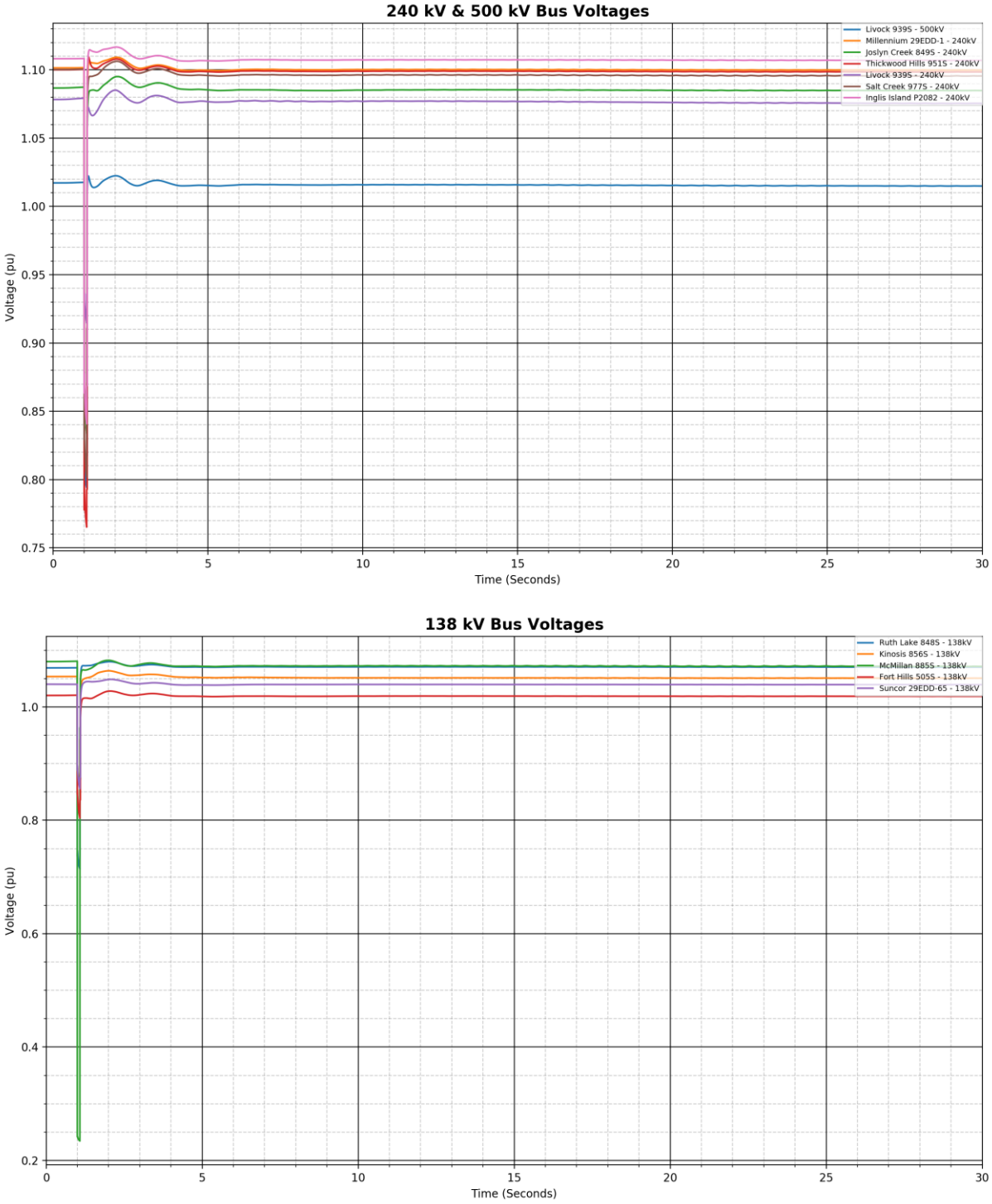
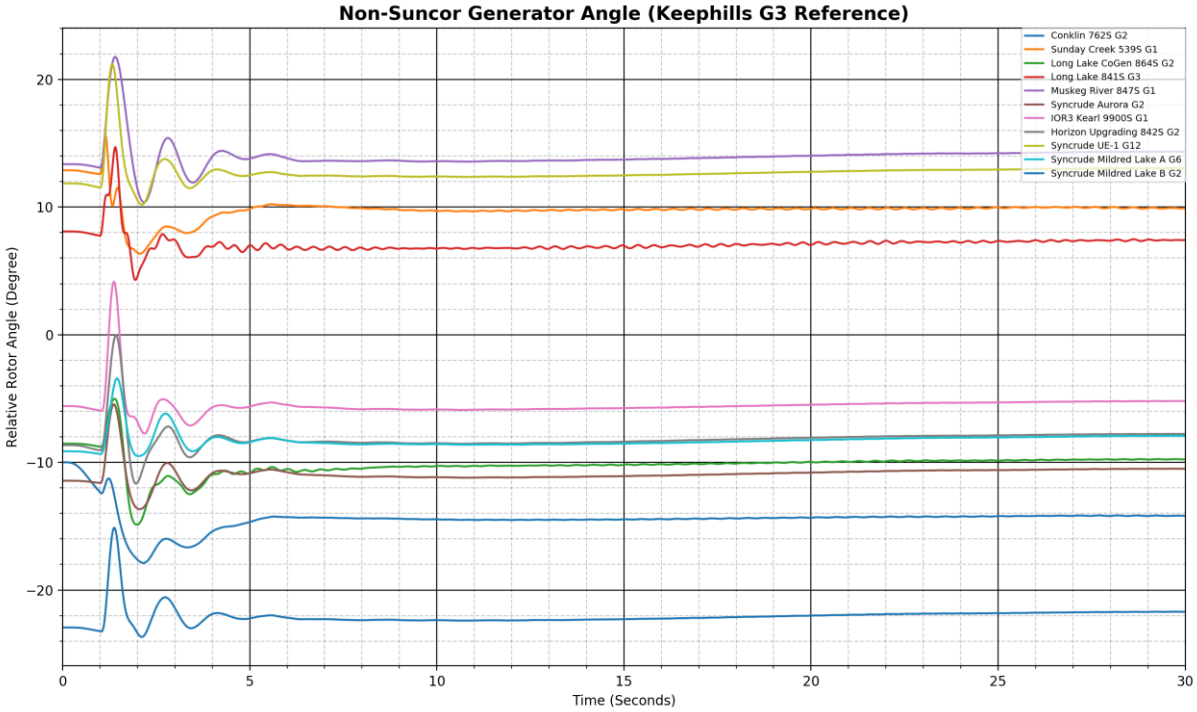
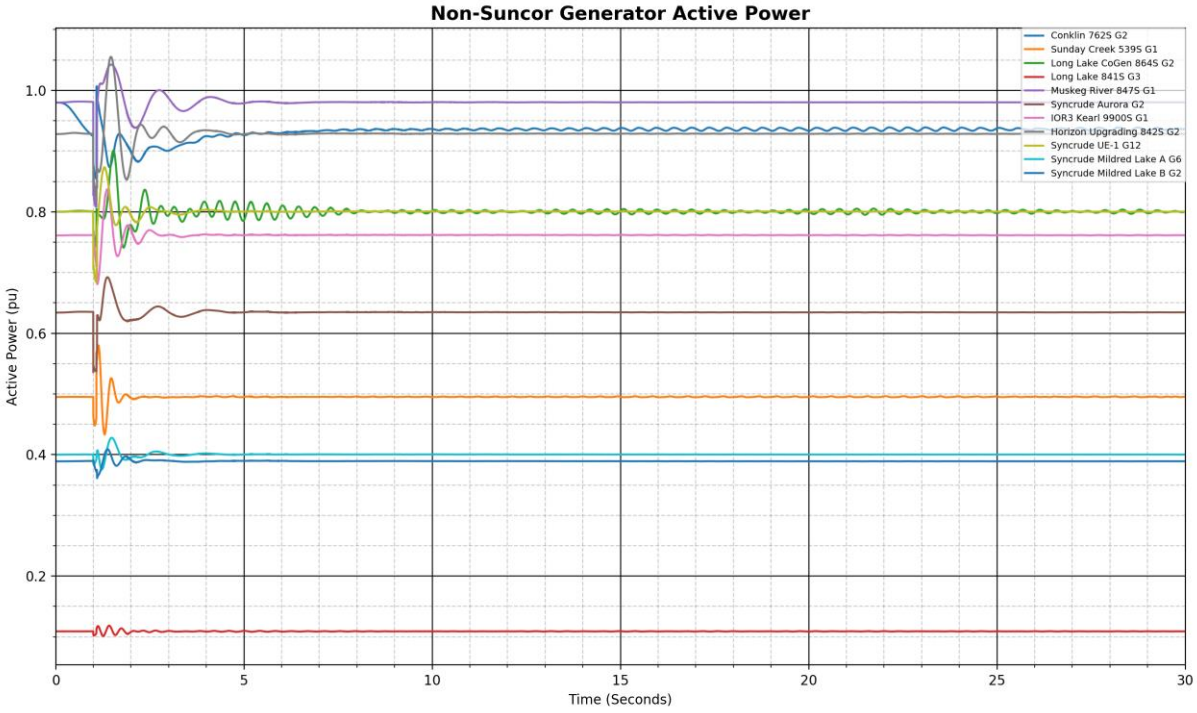
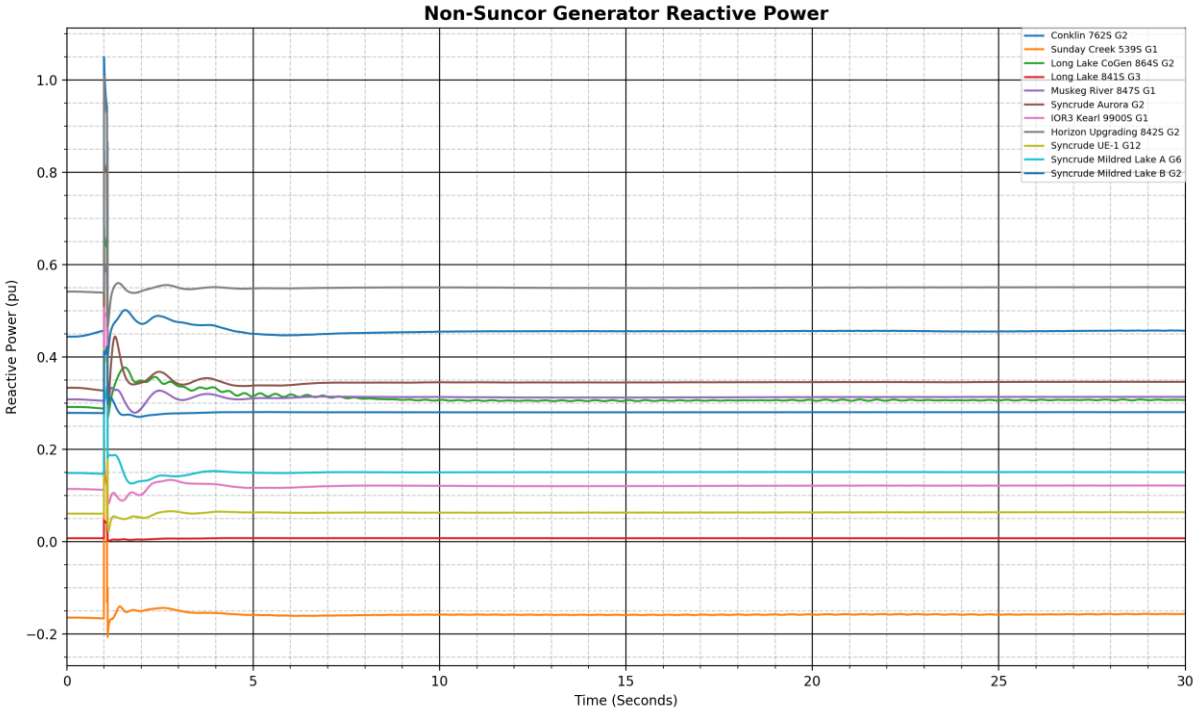

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
0
5
10
15
20
25
30
Time (Seconds)

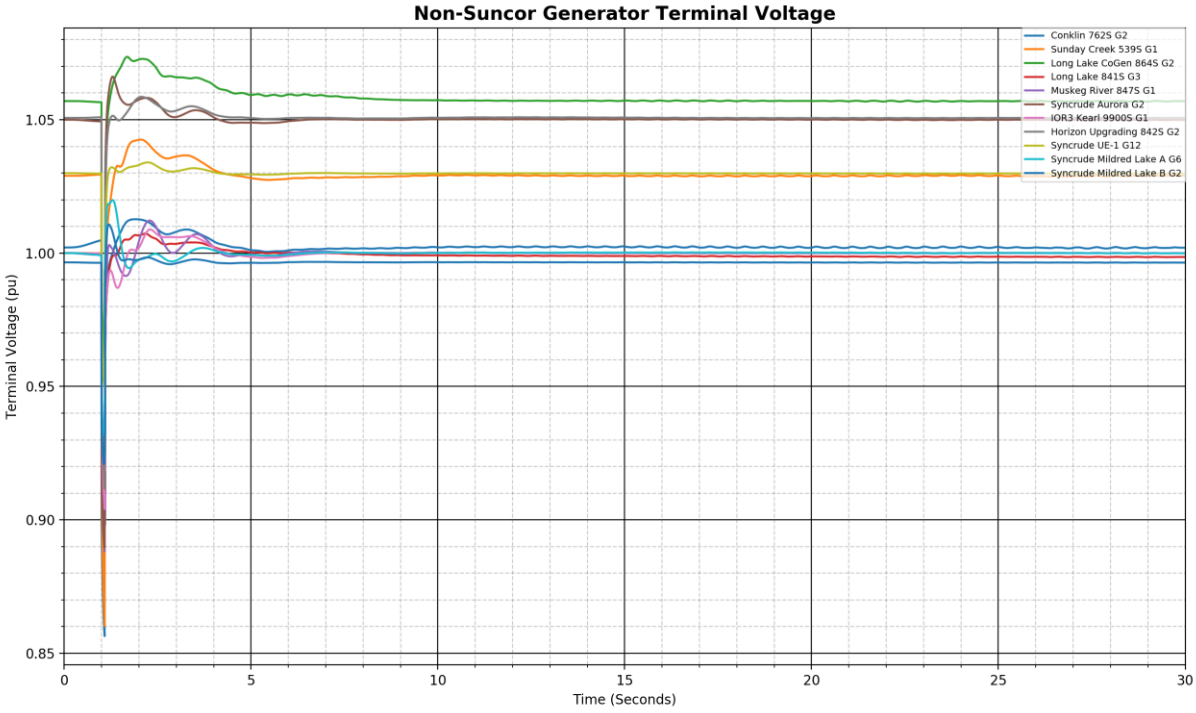
Figure A4-60: 9L07 (Thickwood Hills 951S to Dawes 2011S): Fault at Dawes 2011S

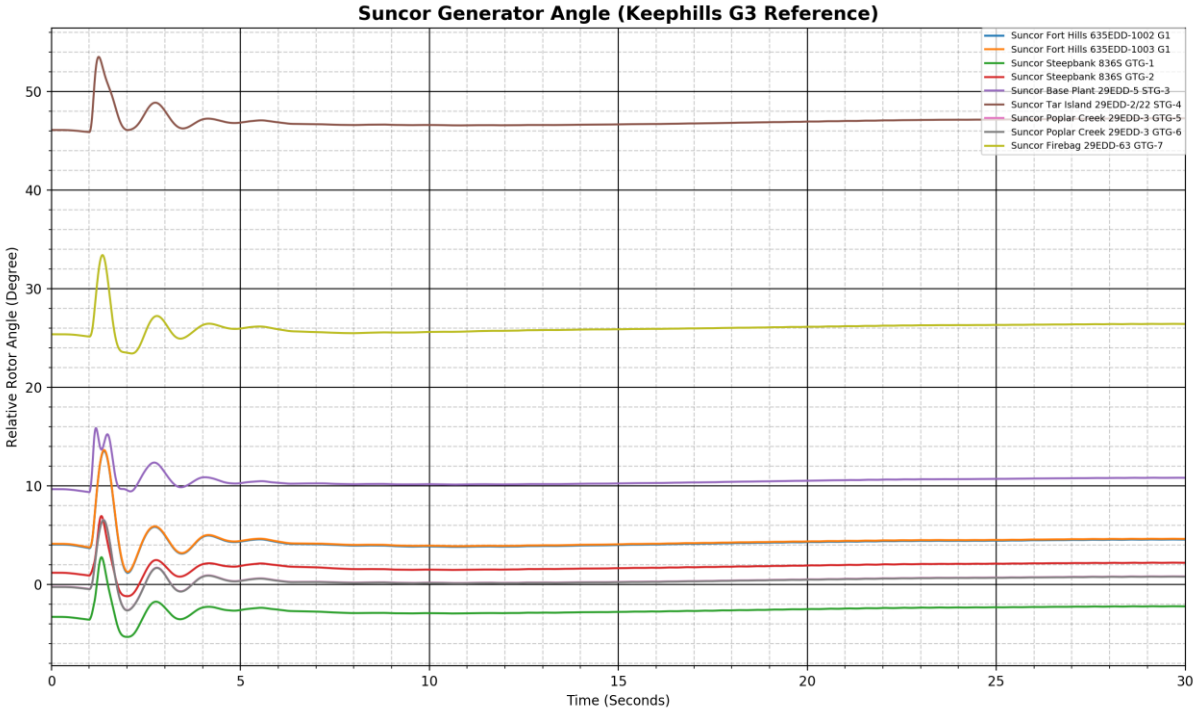


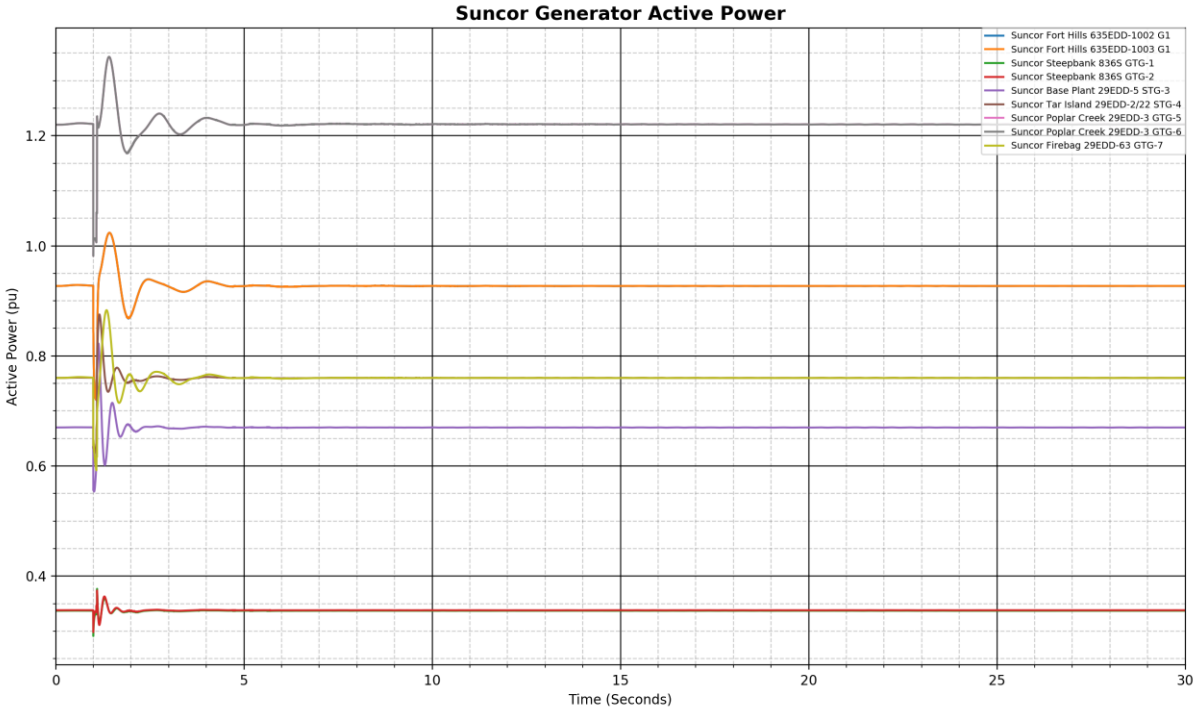

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

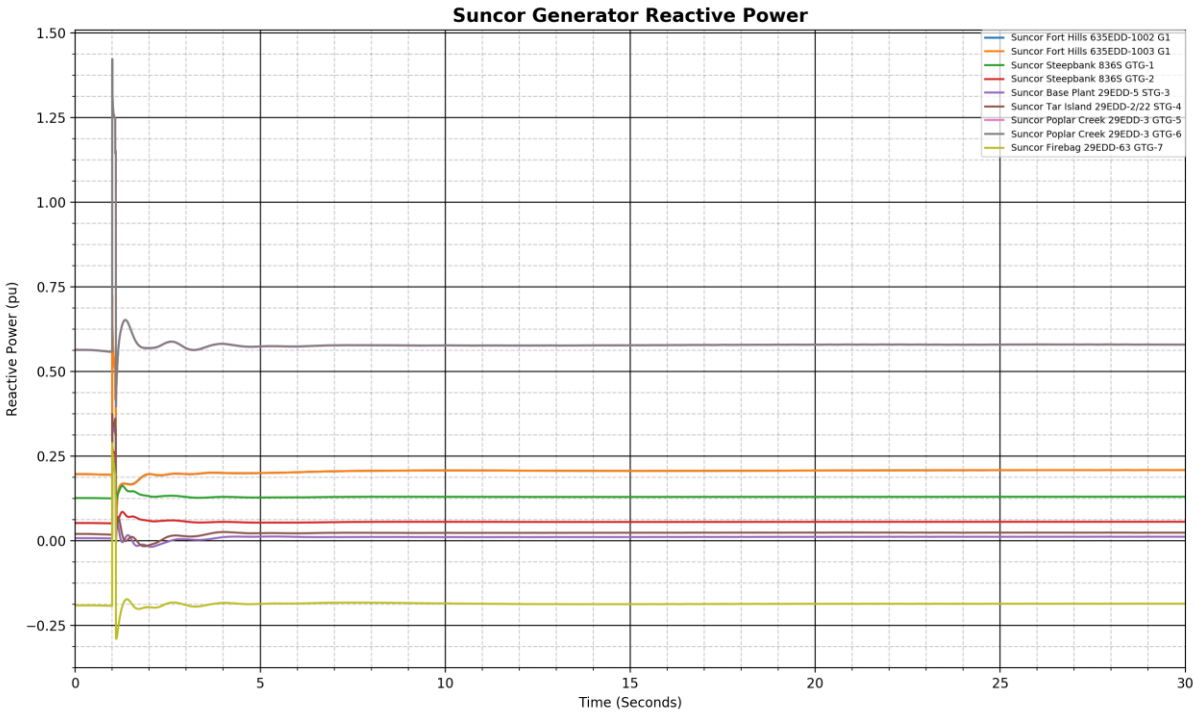

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

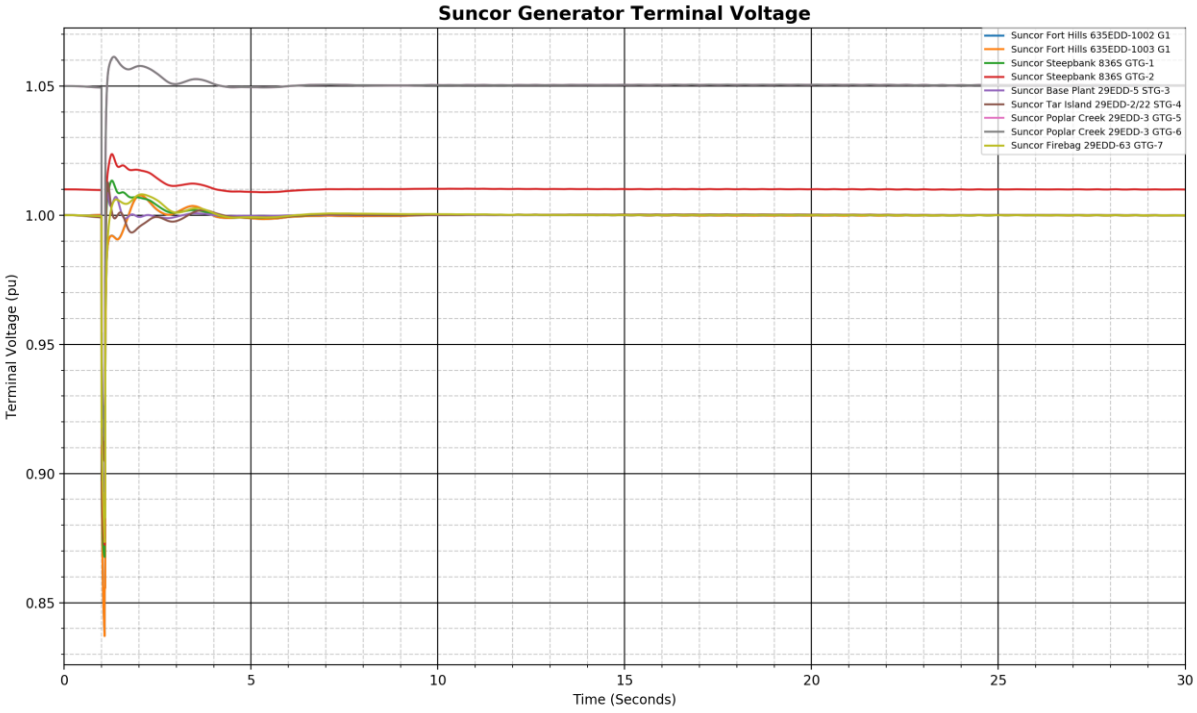

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

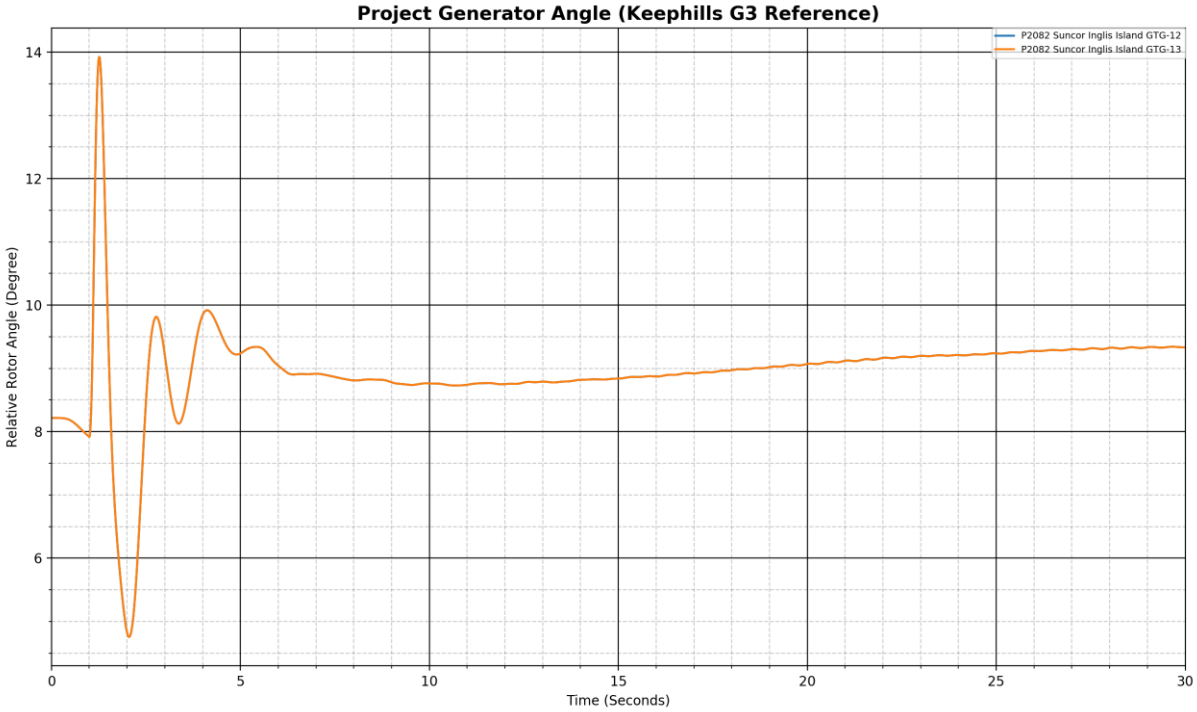

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

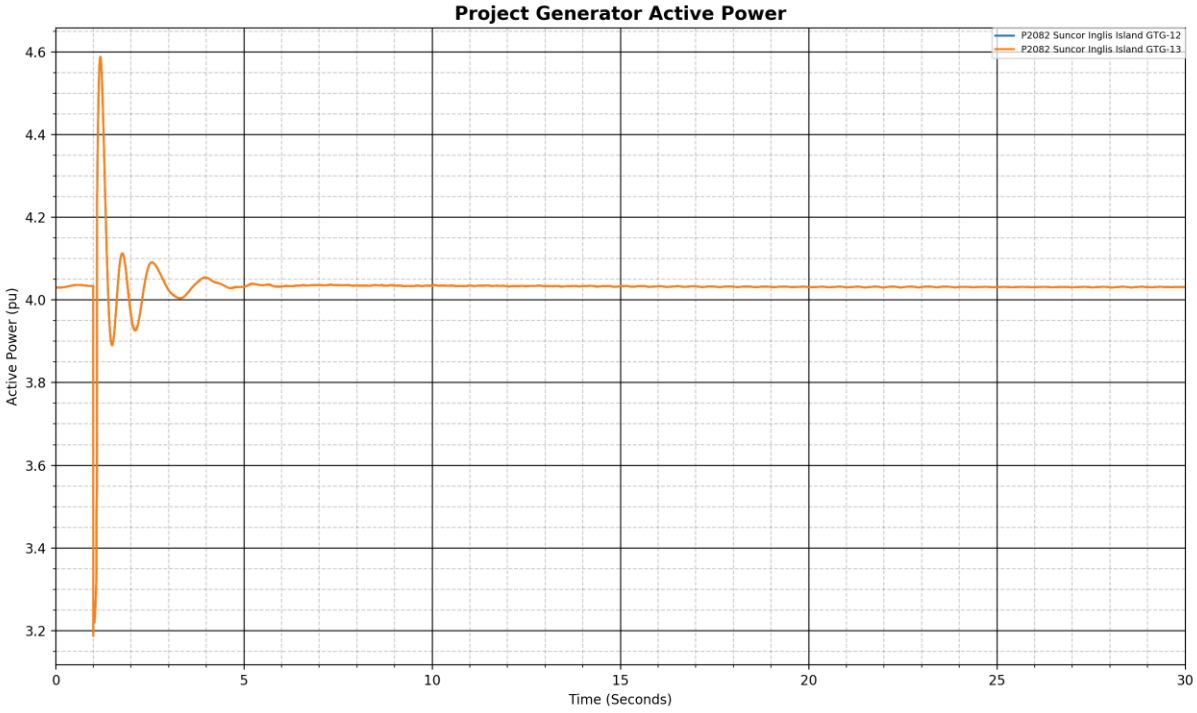

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

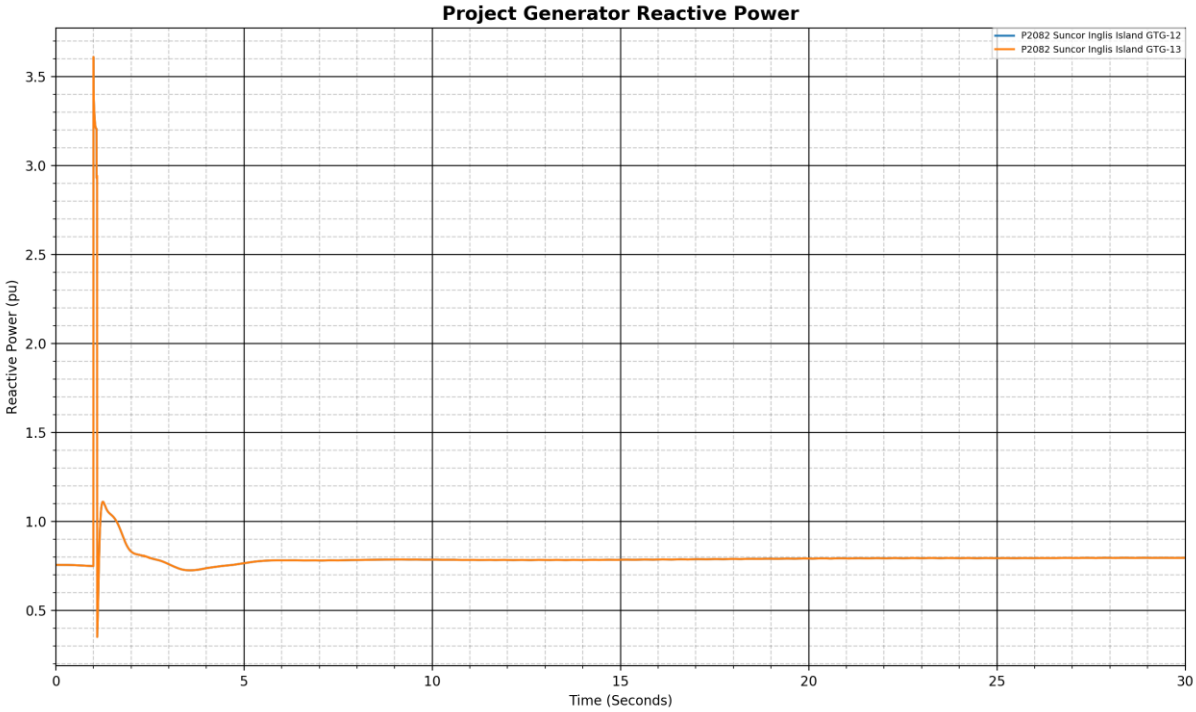

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

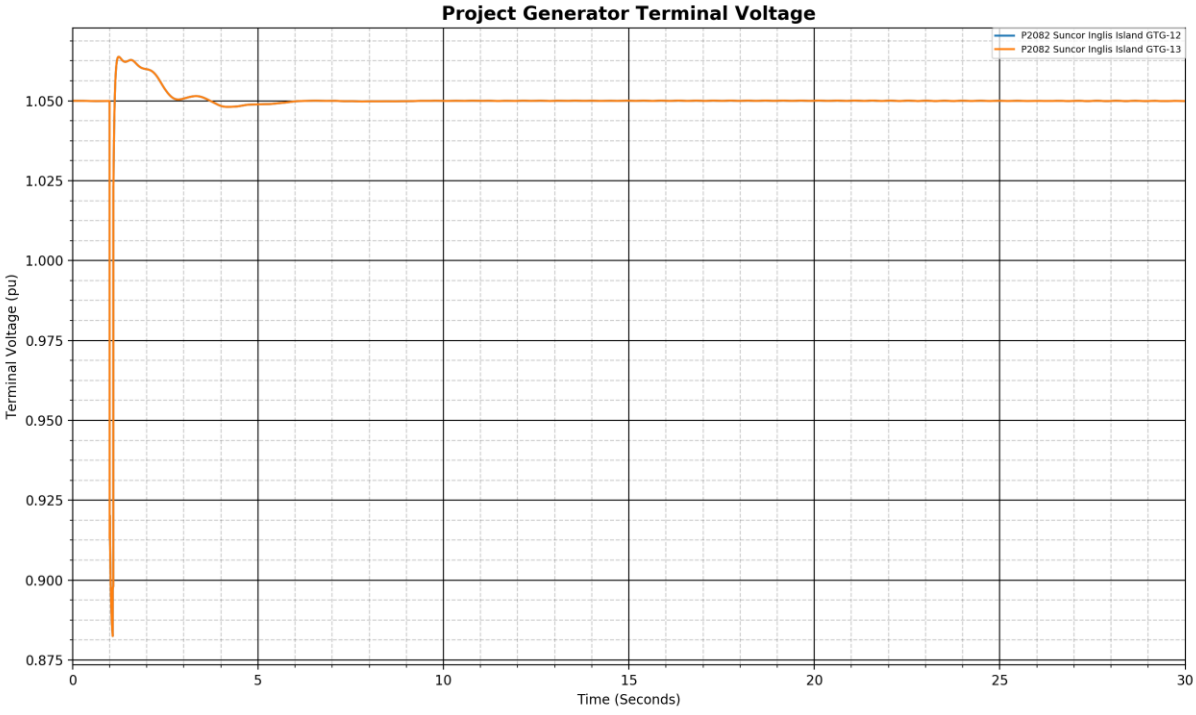

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

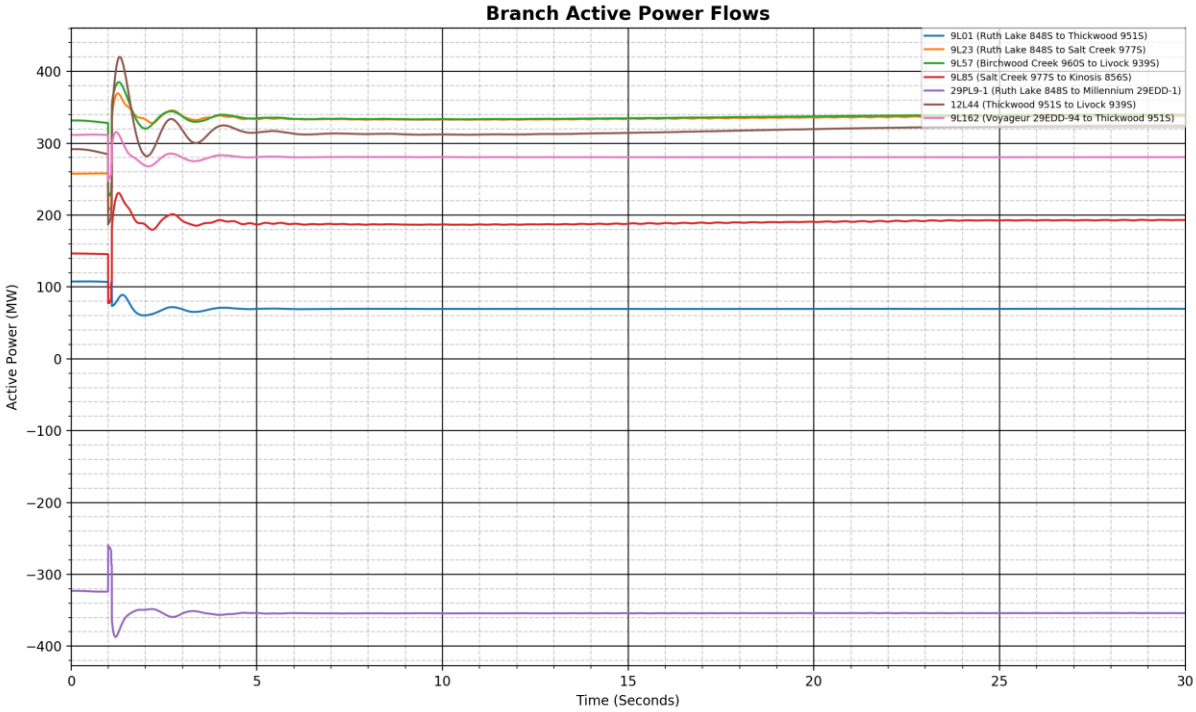

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
14
12
10
8
6
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.050
1.025
1.000
0.975
0.950
0.925
0.900
0.875
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

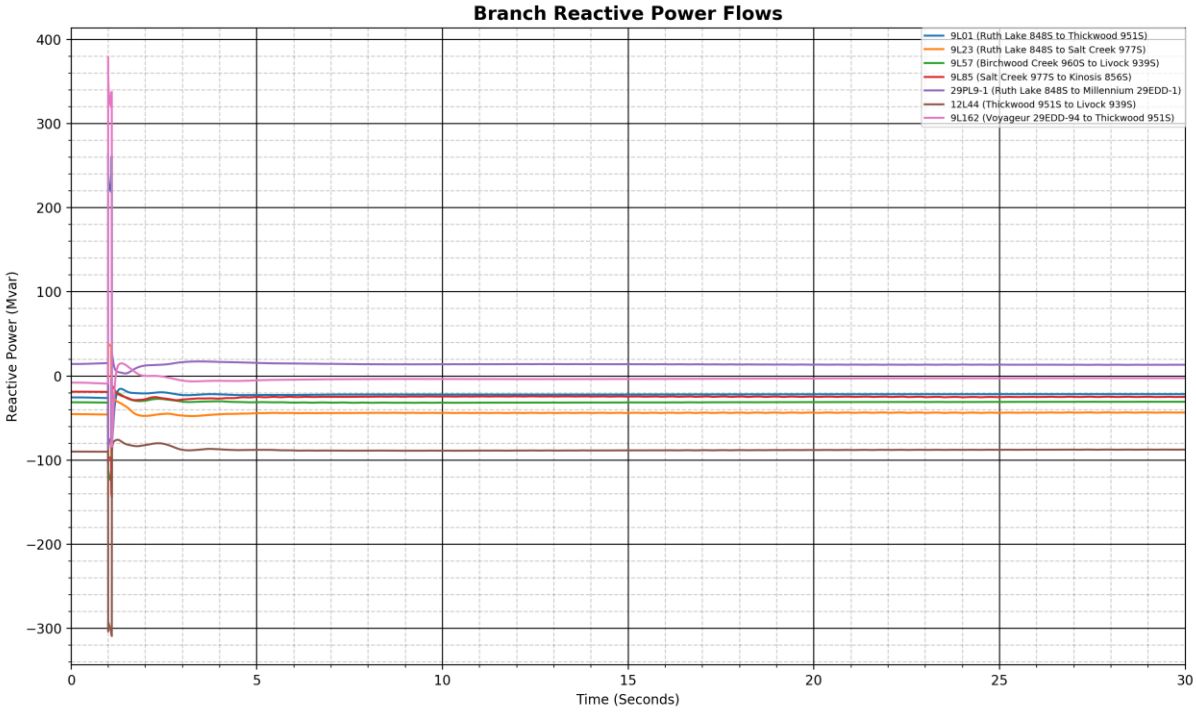
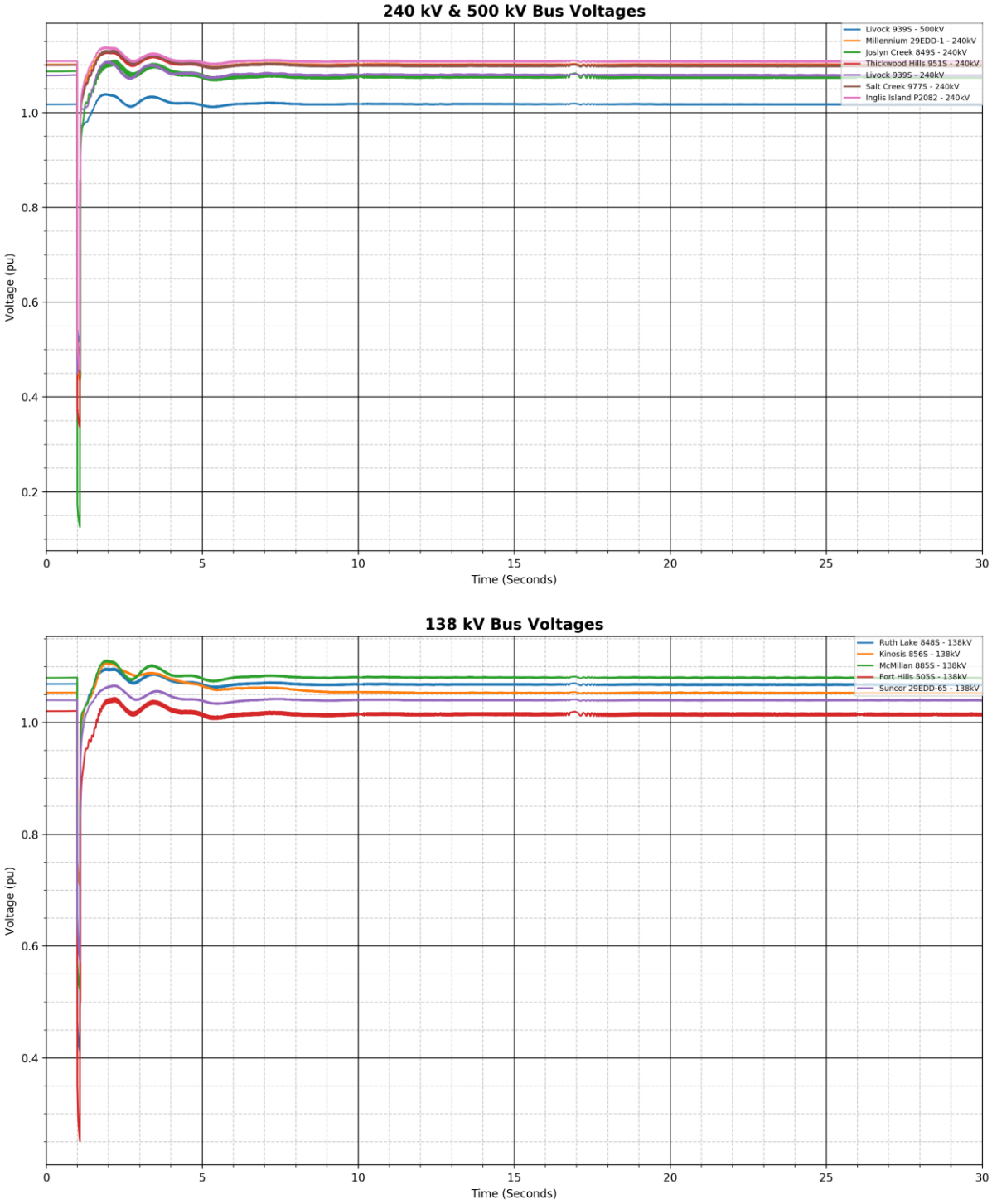
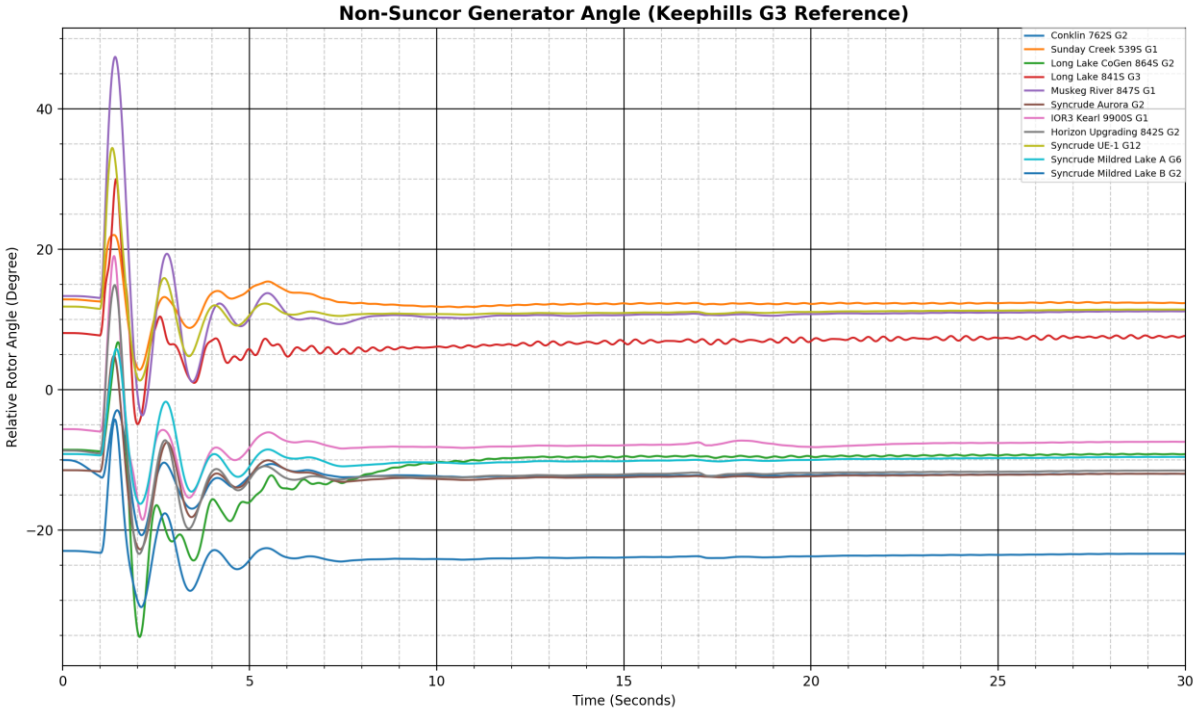
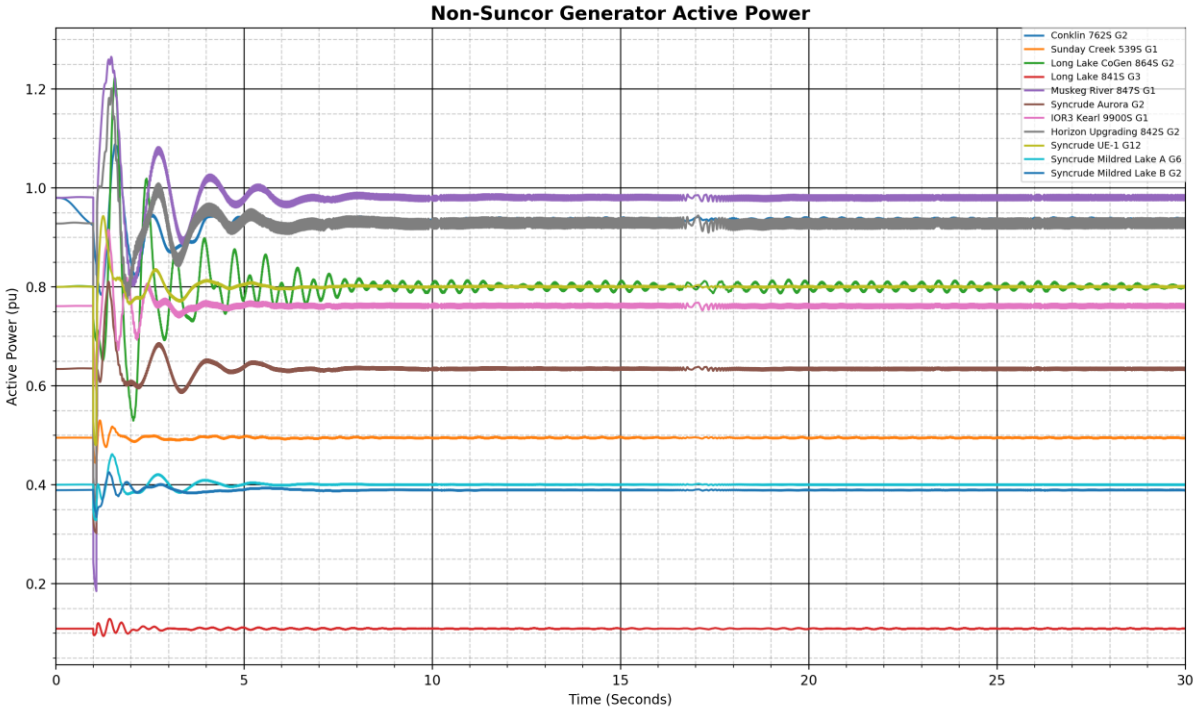
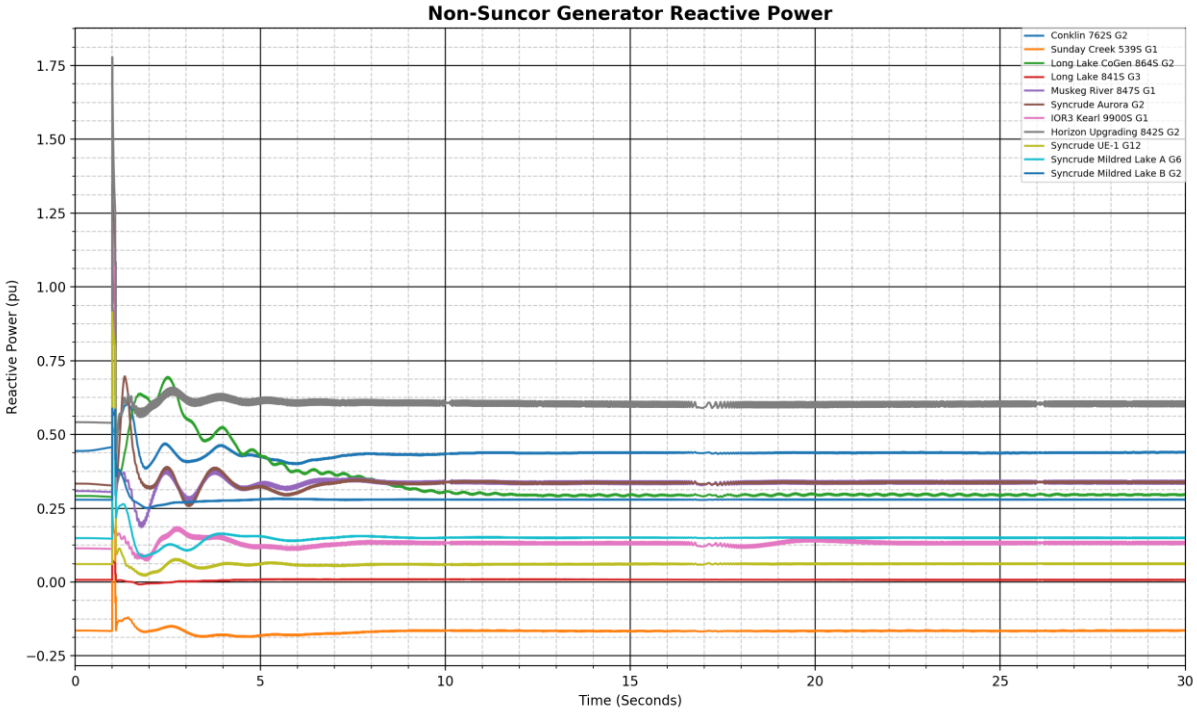

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

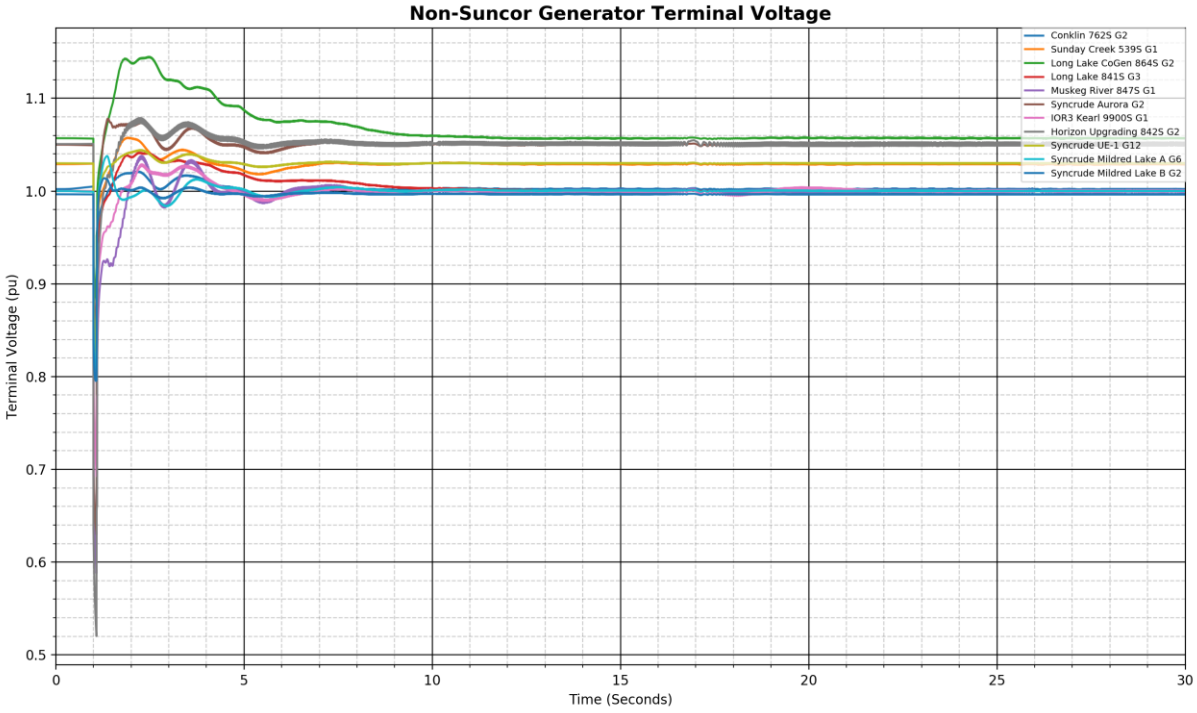
Figure A4-61: 9L08 (Dover 888S to Joslyn Creek 849S): Fault at Dover 888S

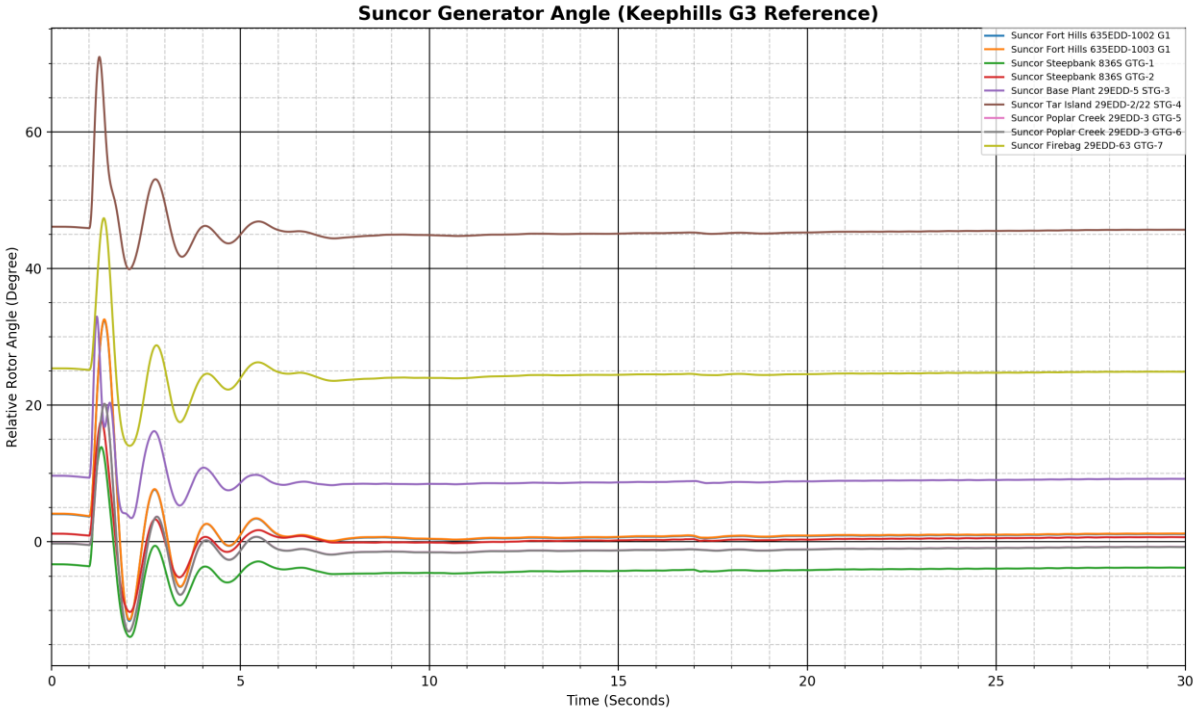


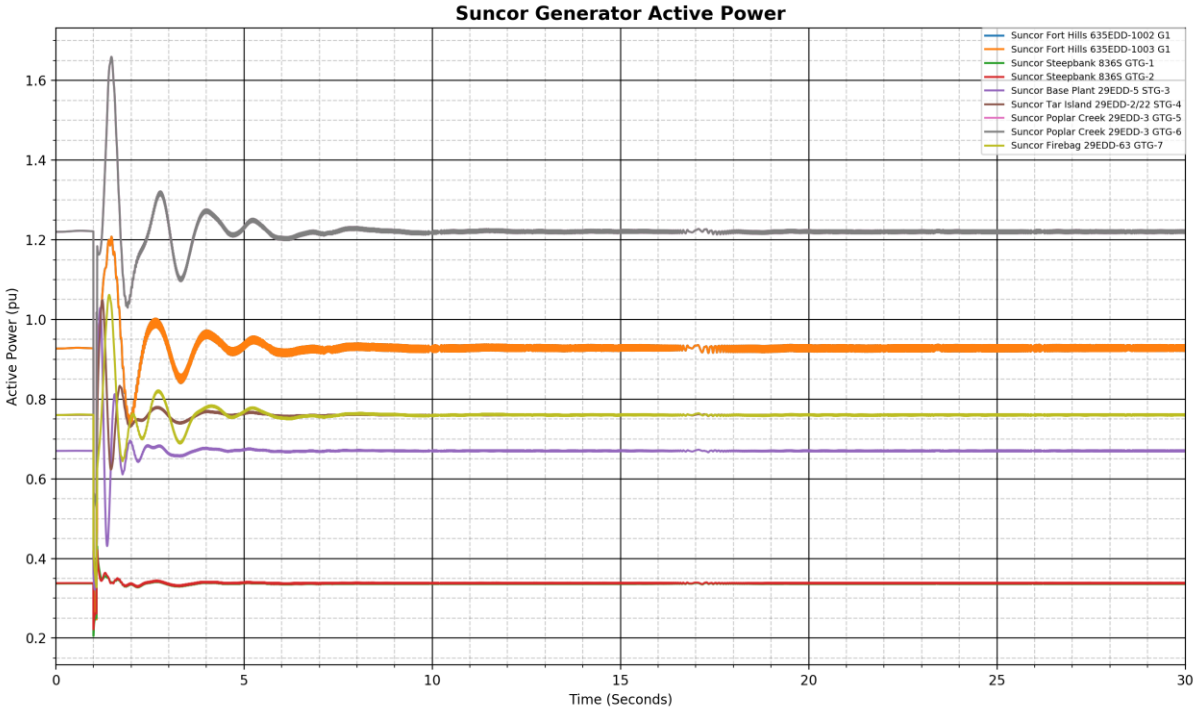

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

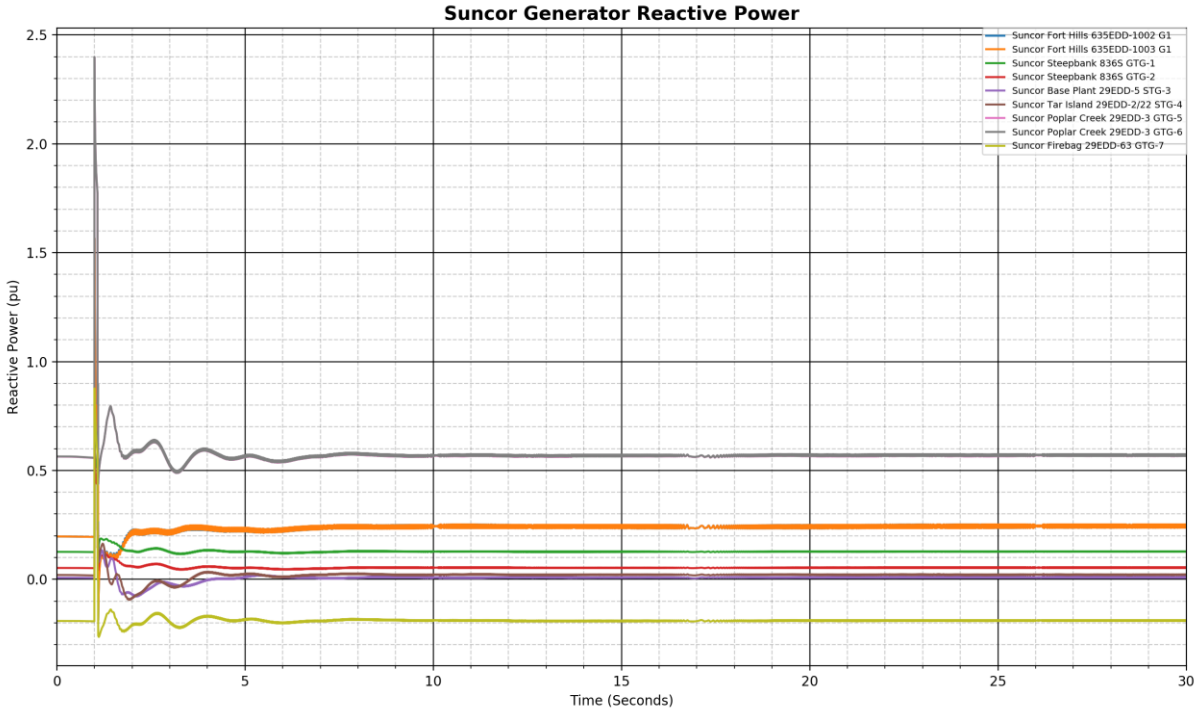

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

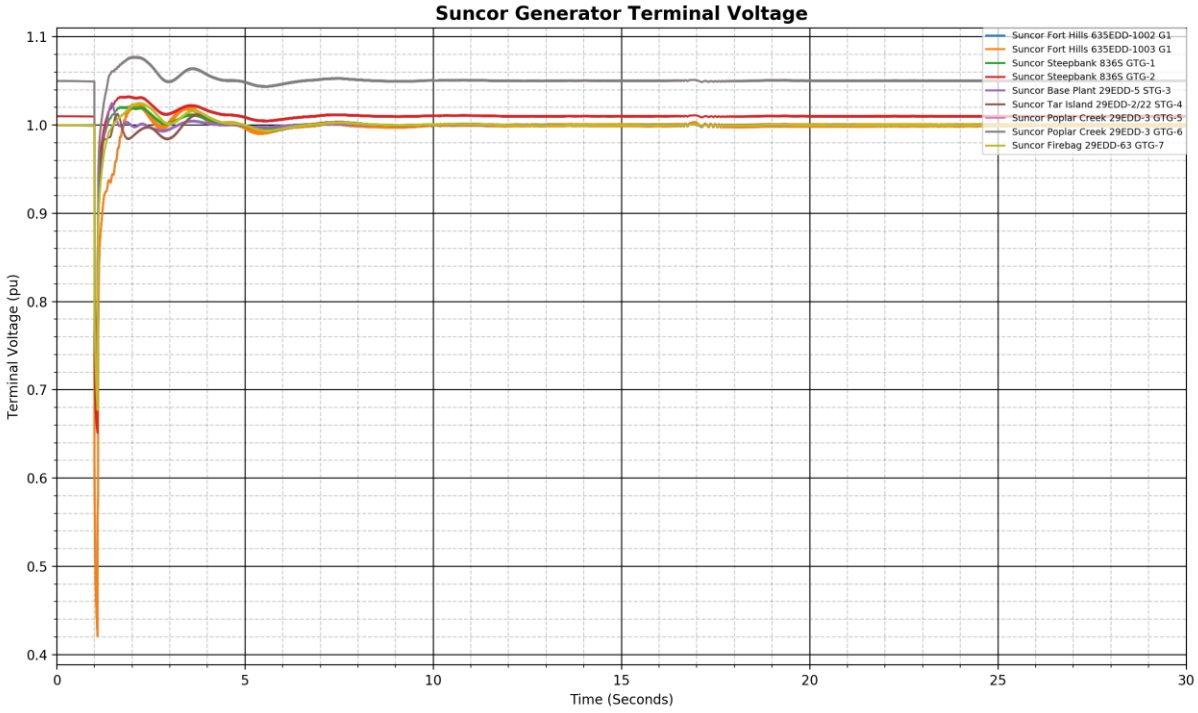

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

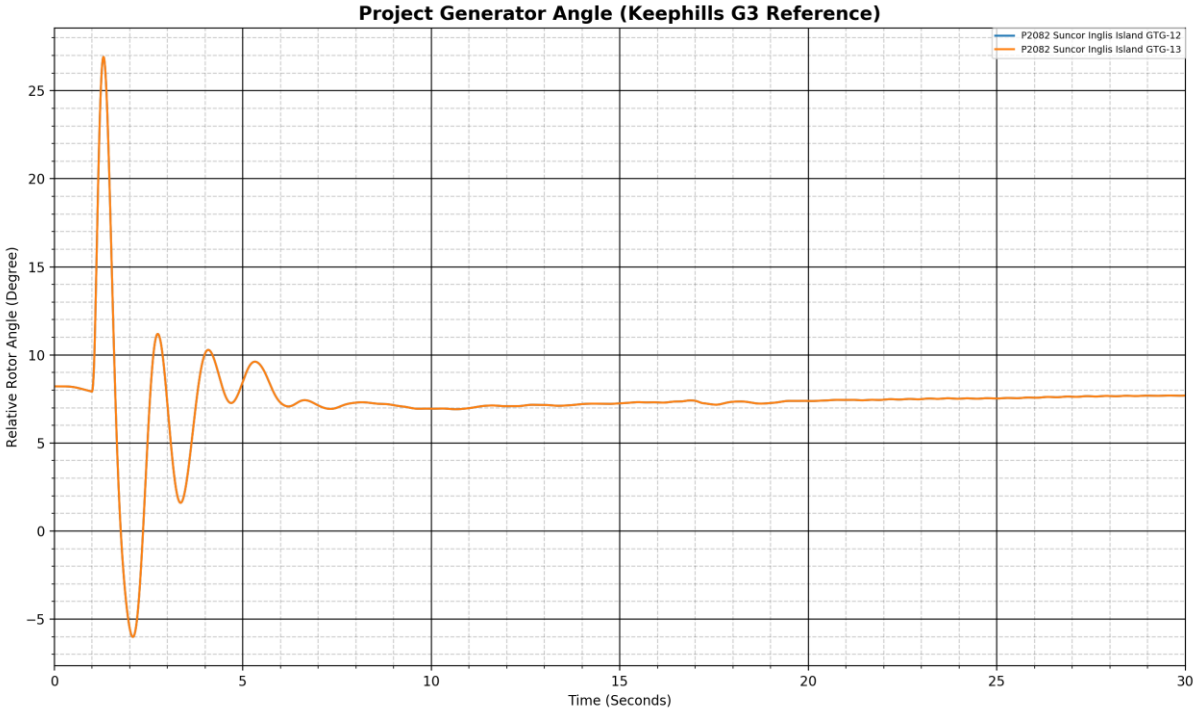

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

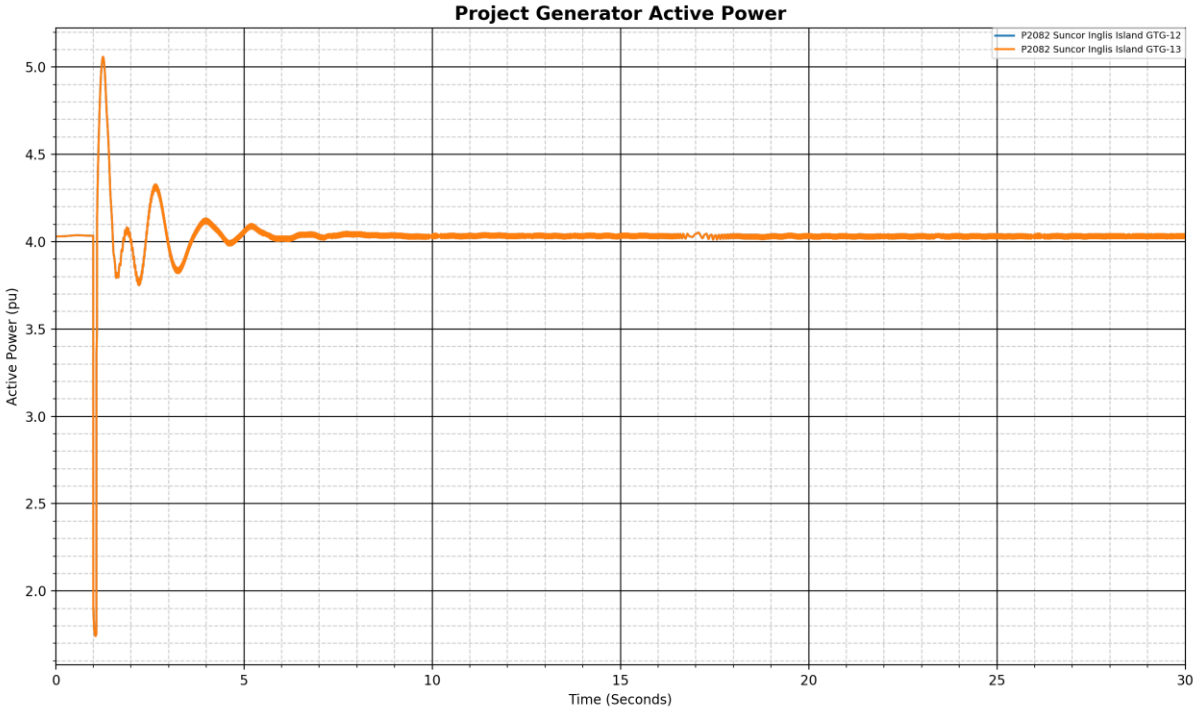

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

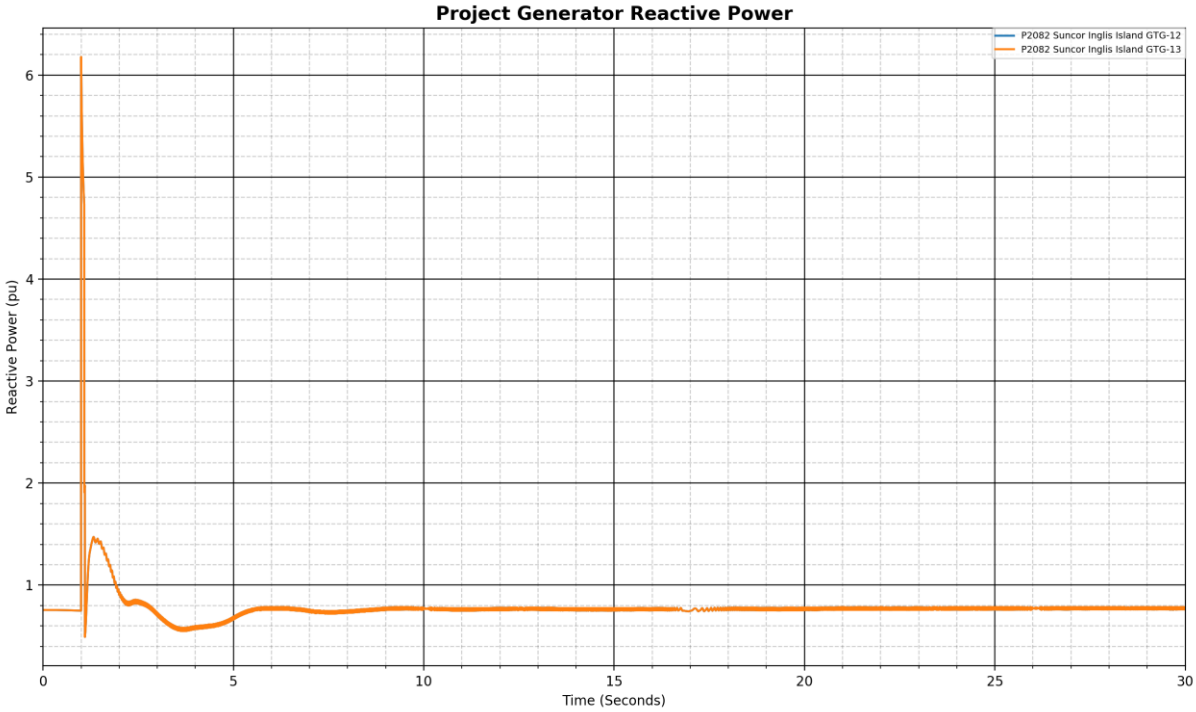

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

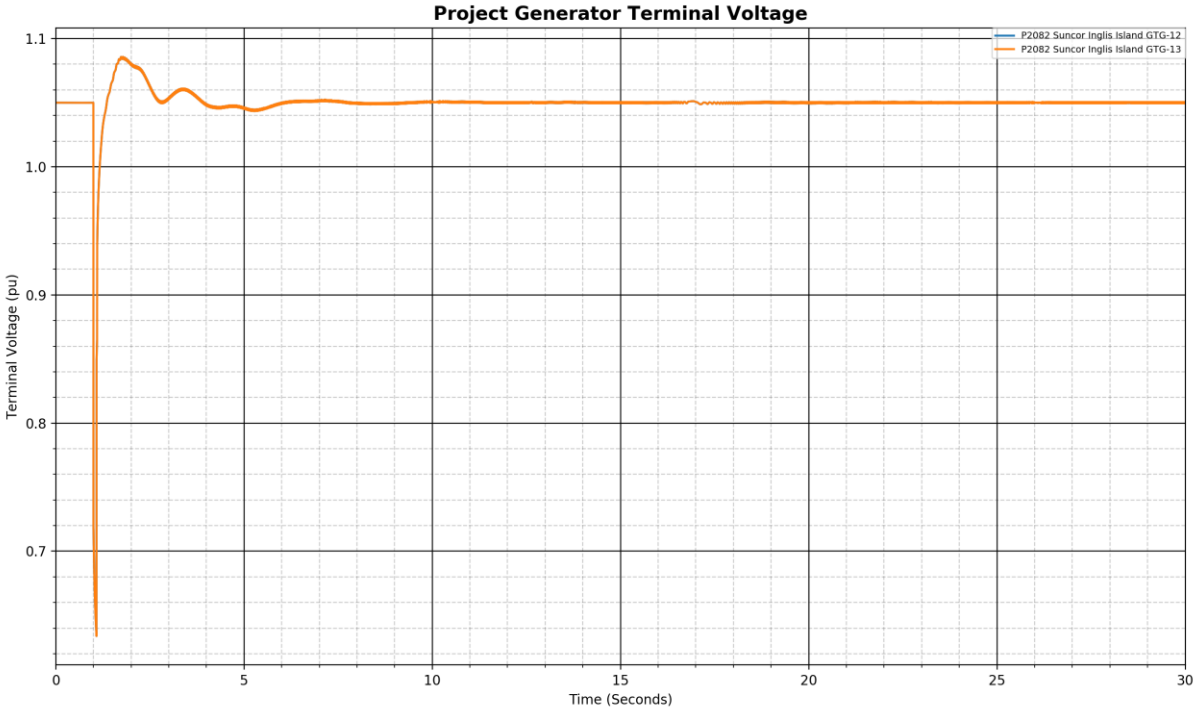

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

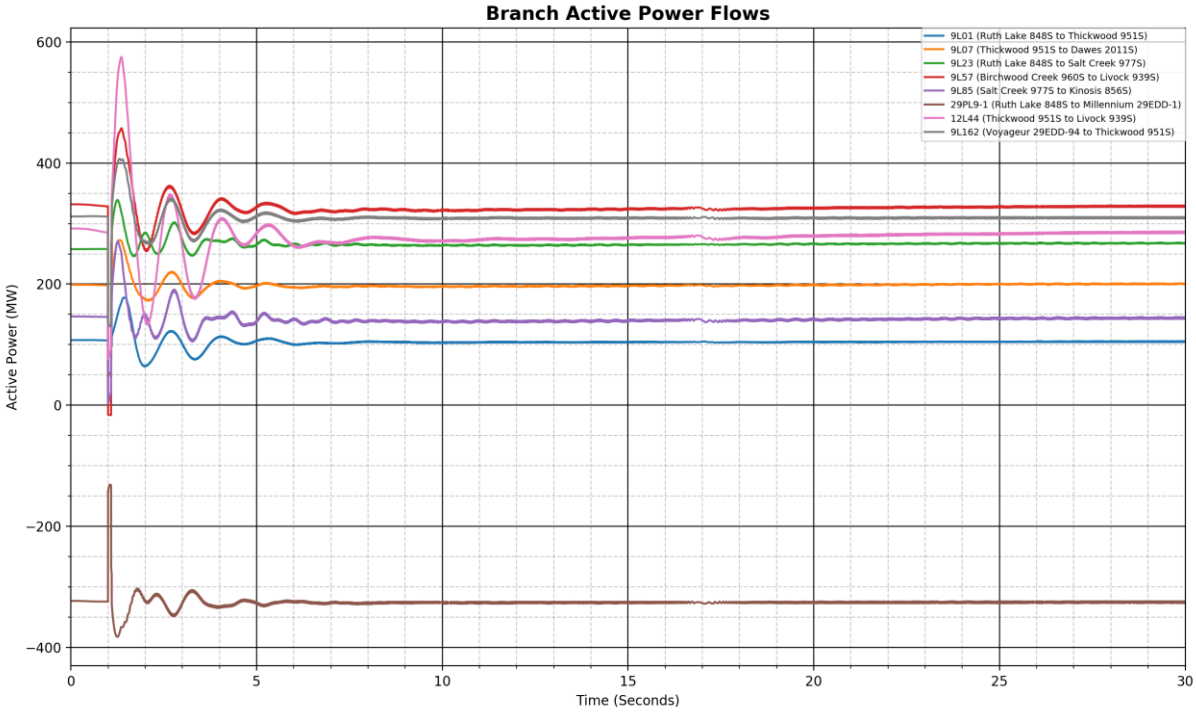

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
25
20
15
10
5
0
−5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
5
10
15
20
25
30
1
2
3
4
5
6


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0
5
10
15
20
25
30
0.7
0.8
0.9
1.0
1.1


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

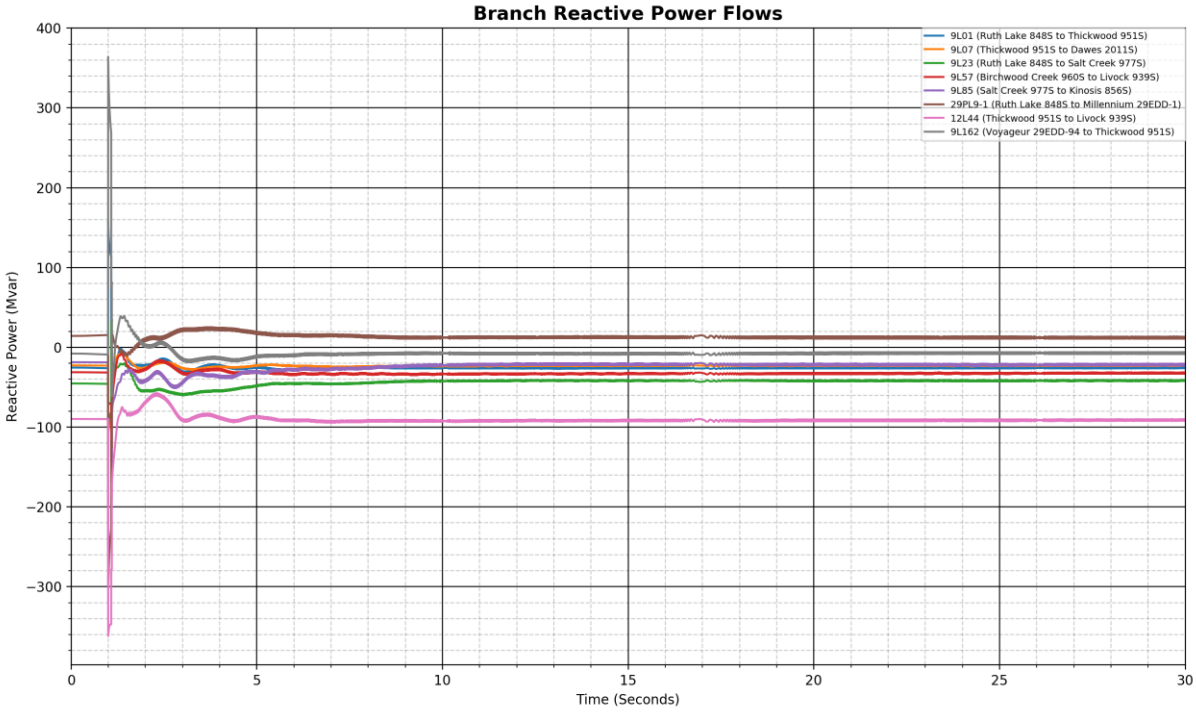
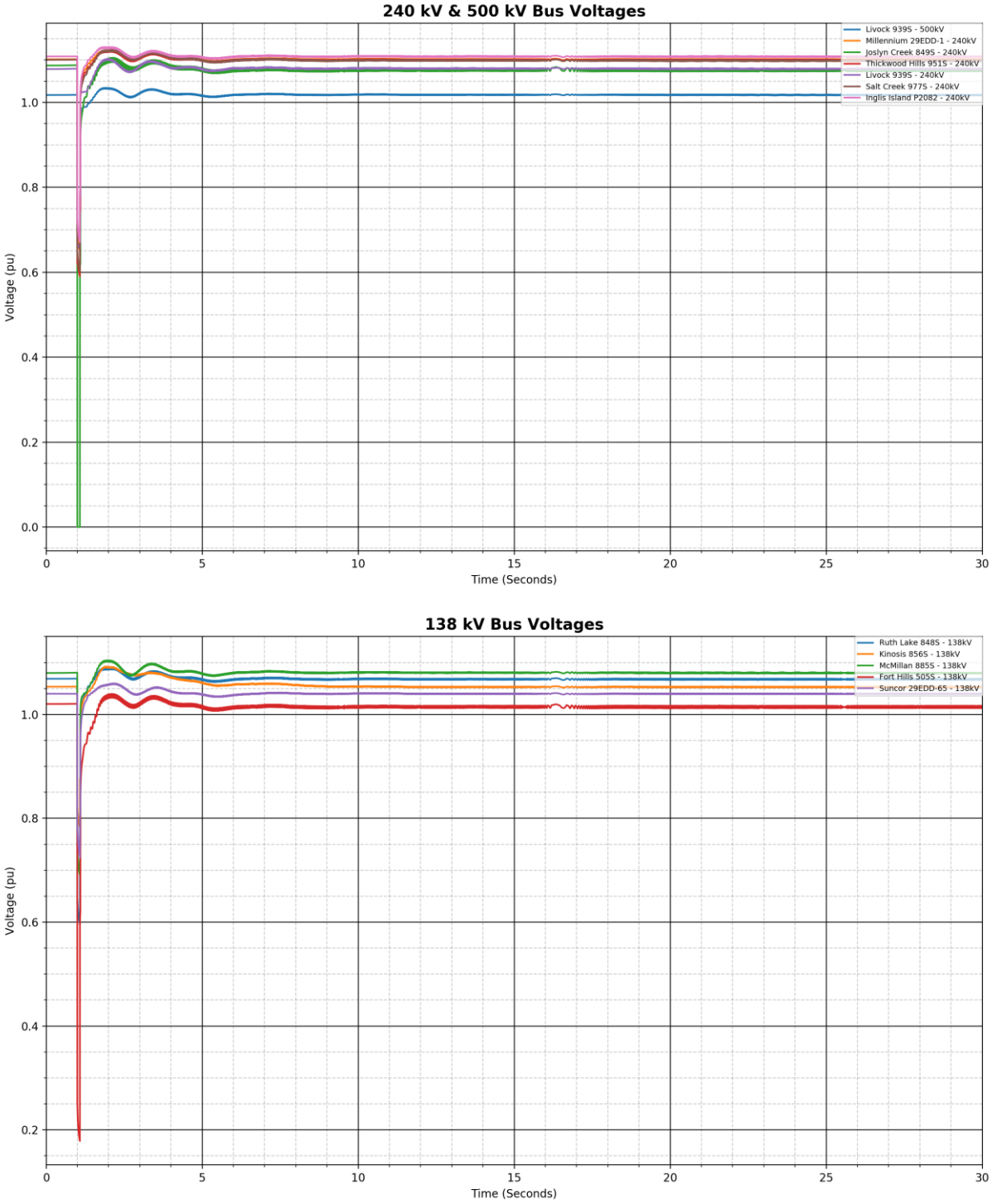
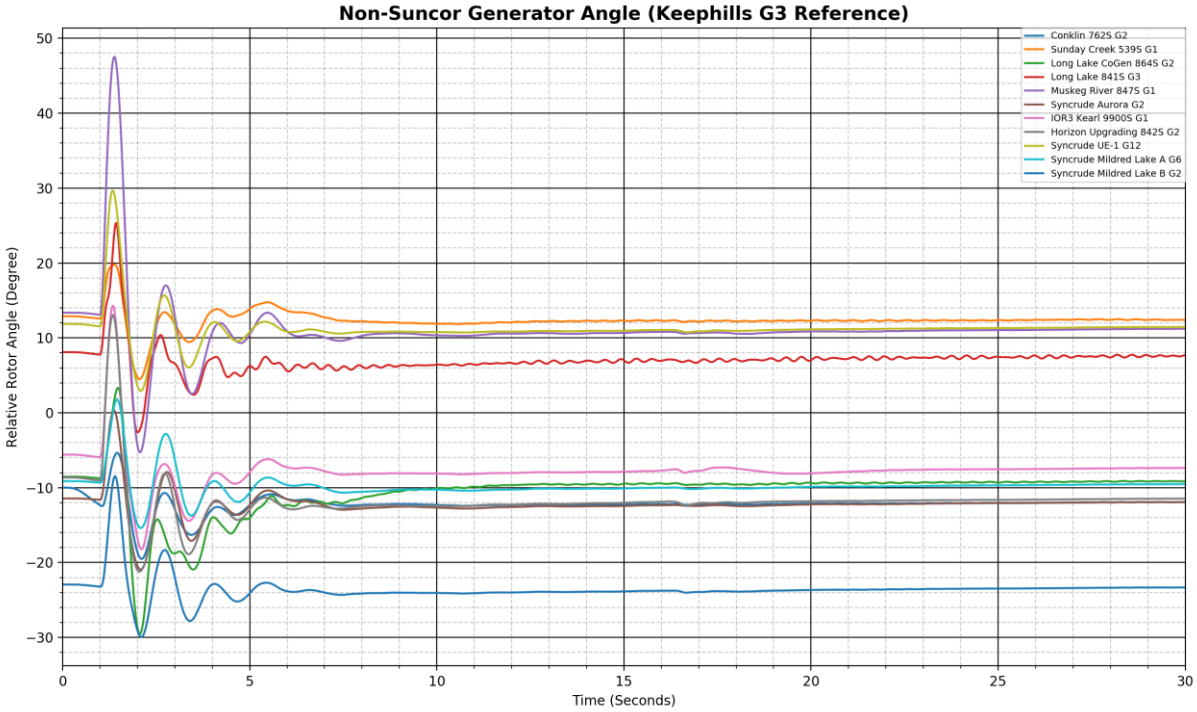
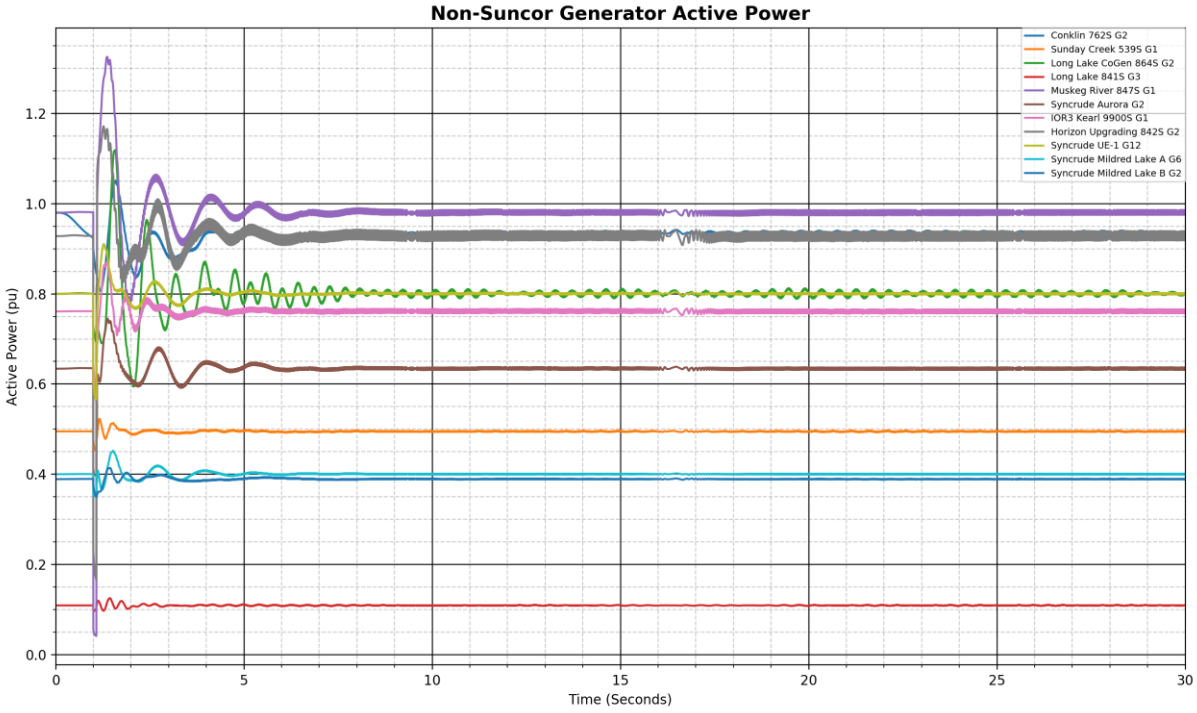
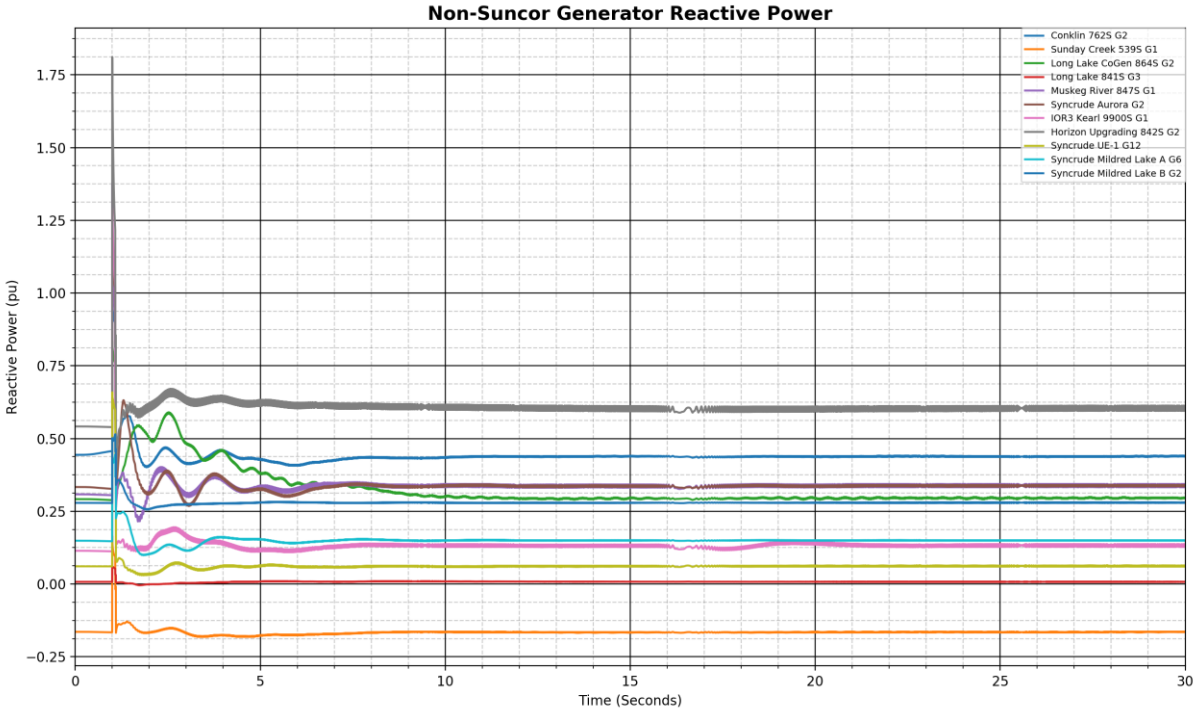

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

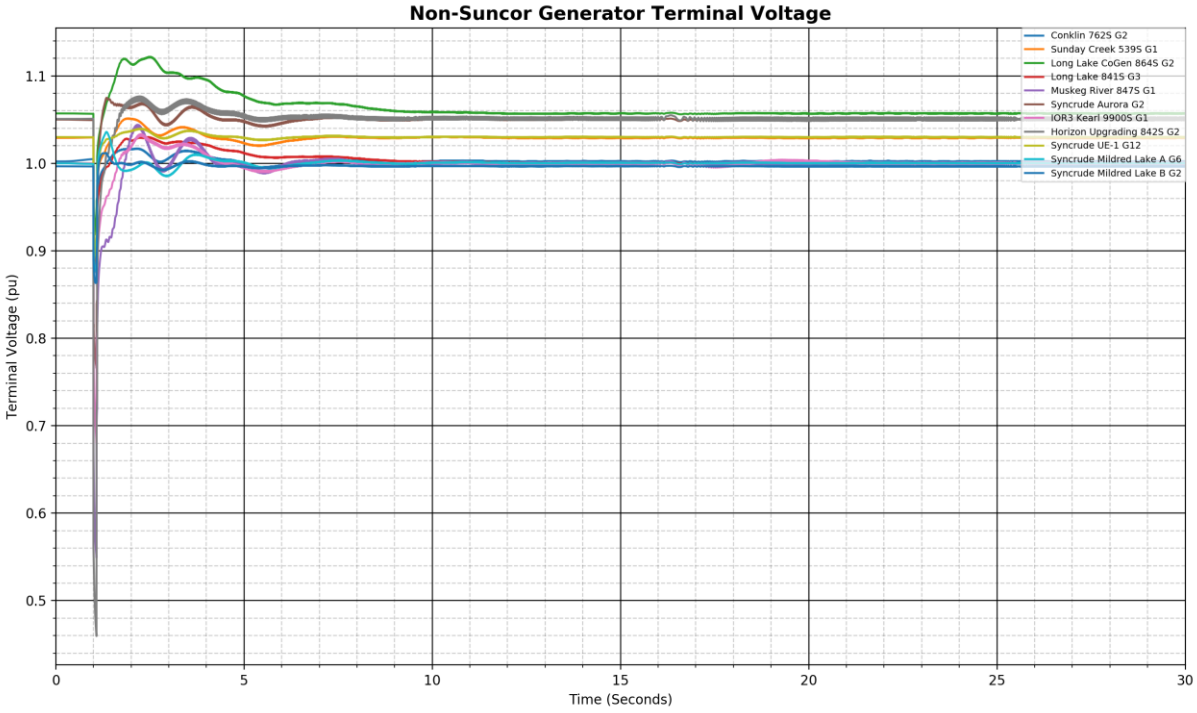
Figure A4-62: 9L08 (Dover 888S to Joslyn Creek 849S): Fault at Joslyn Creek 849S

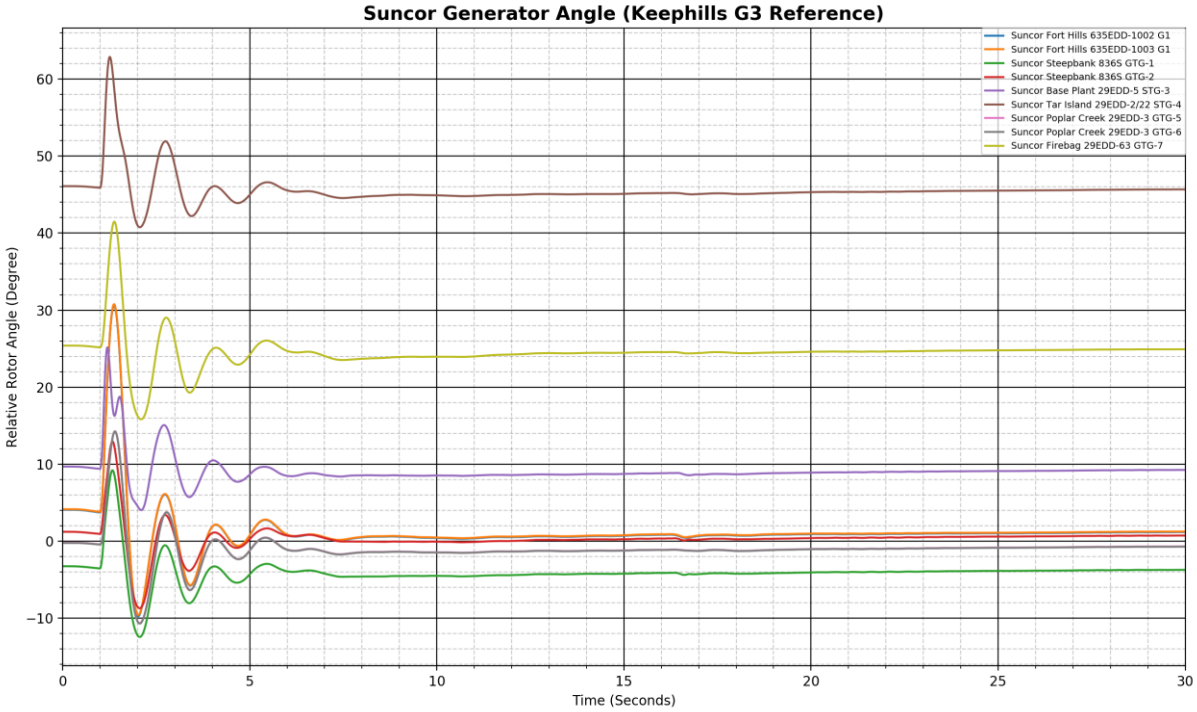


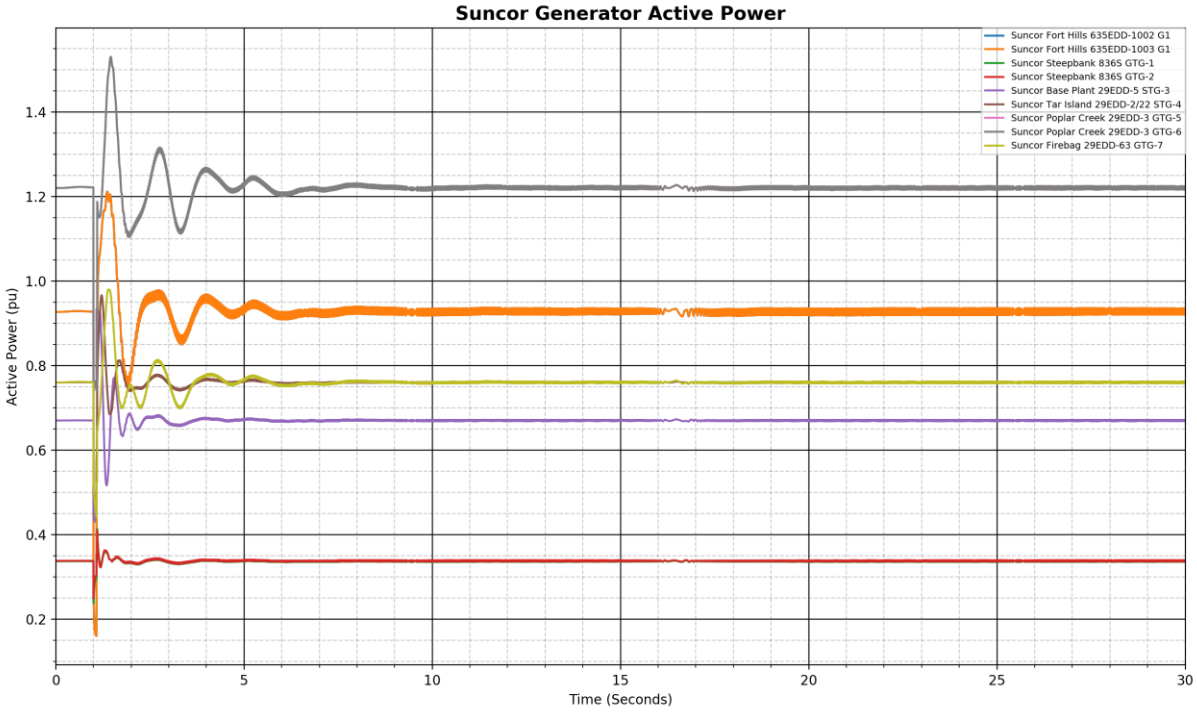

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

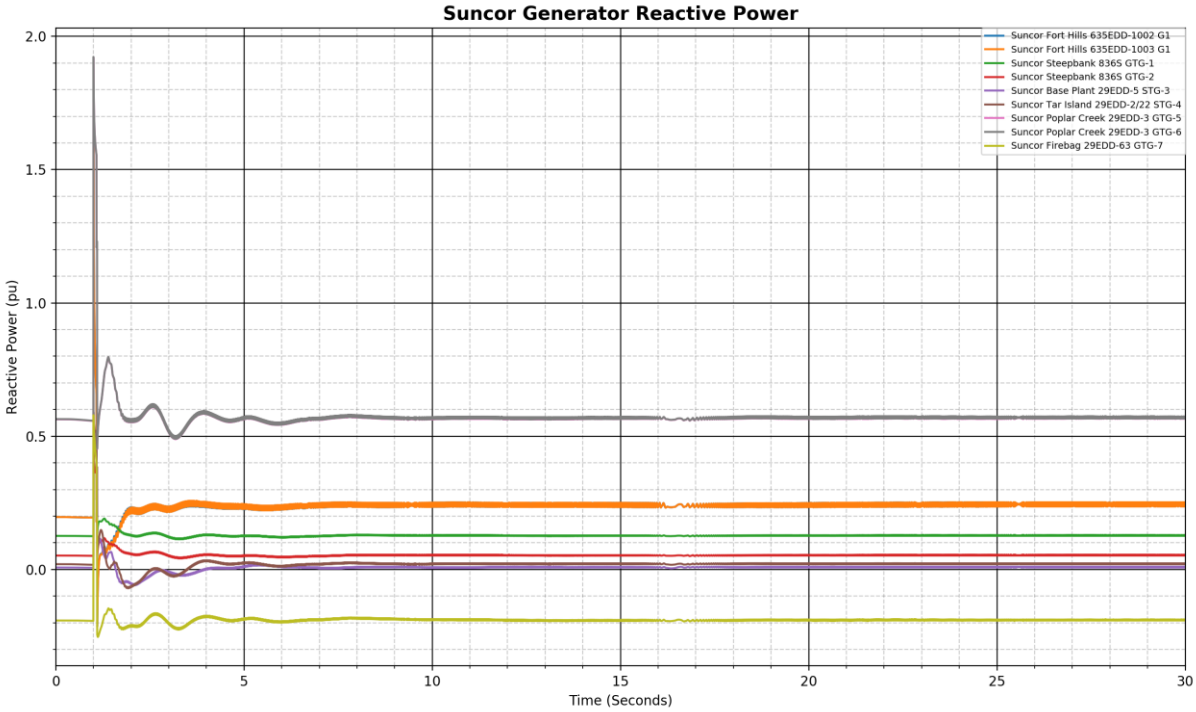

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

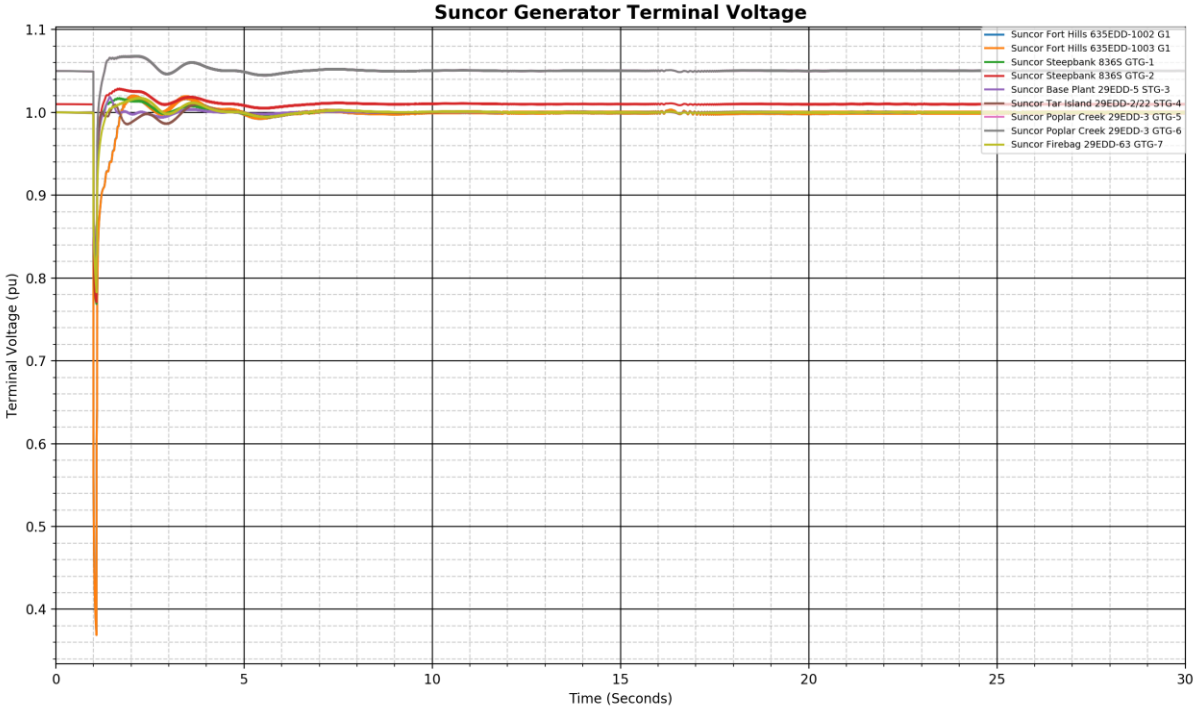

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

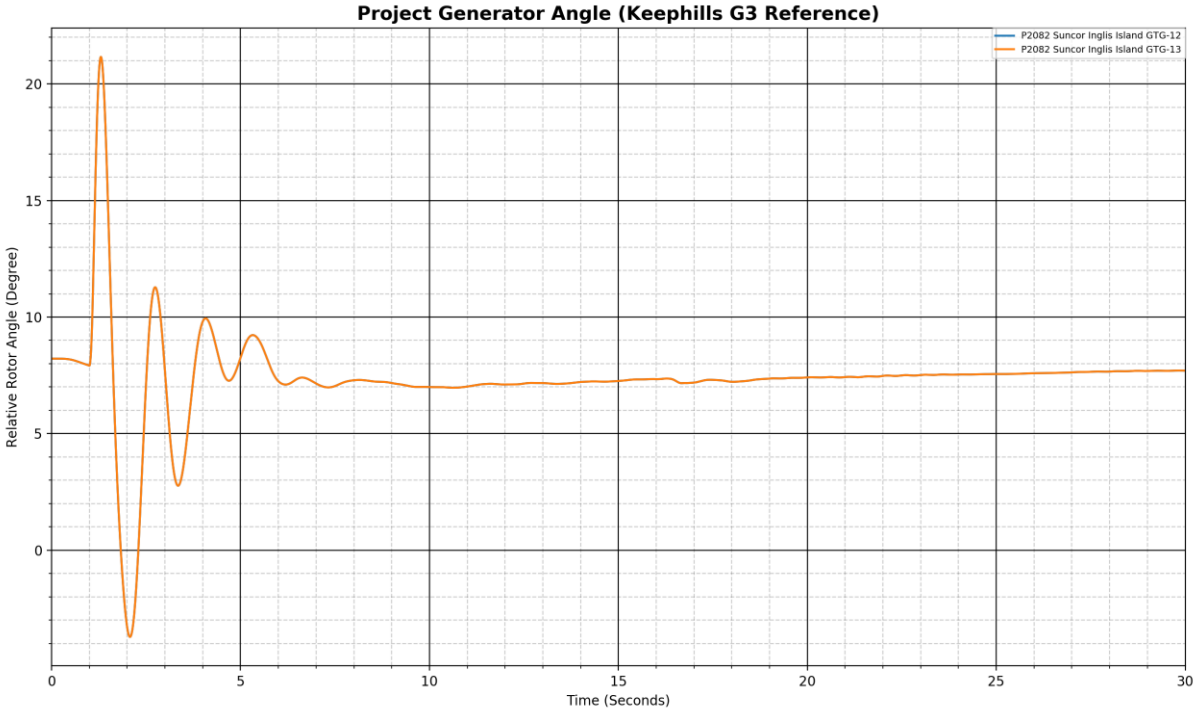

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

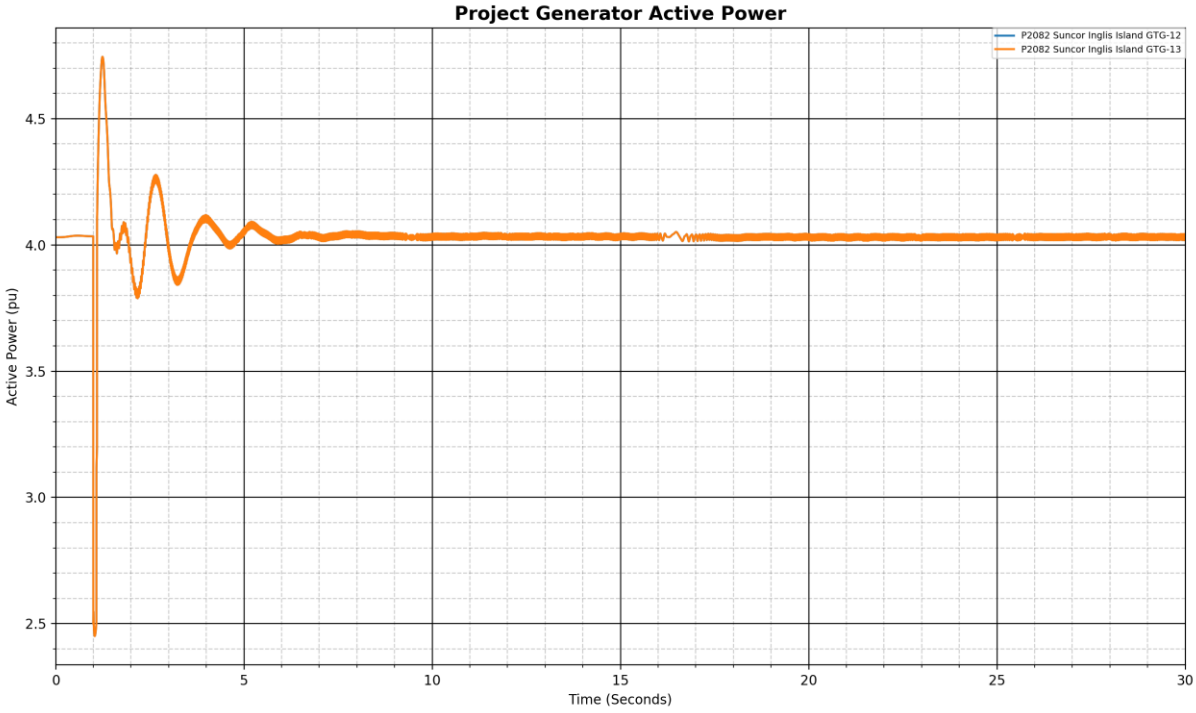

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

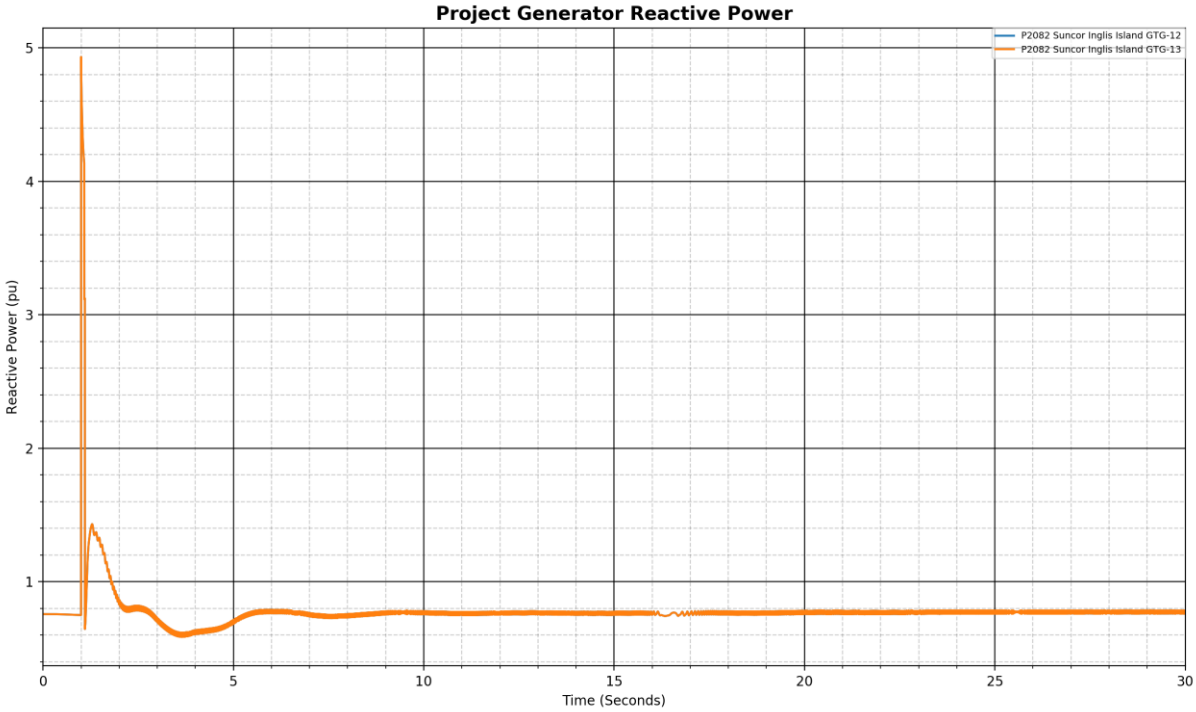

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

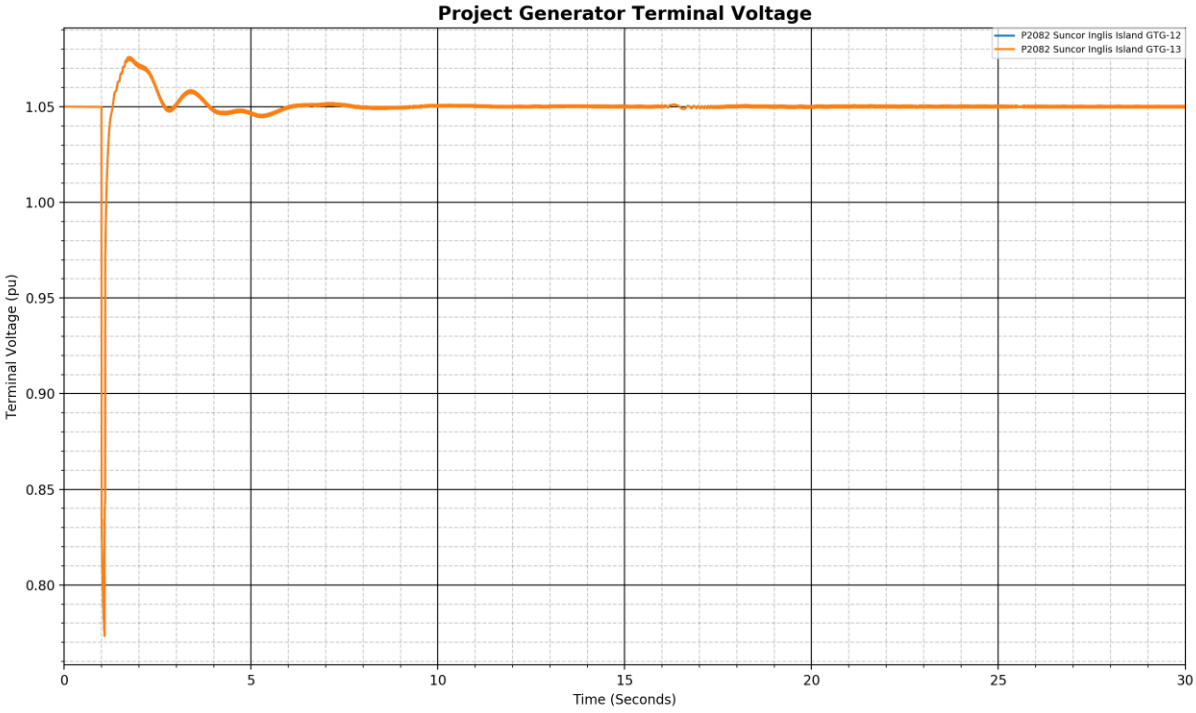

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

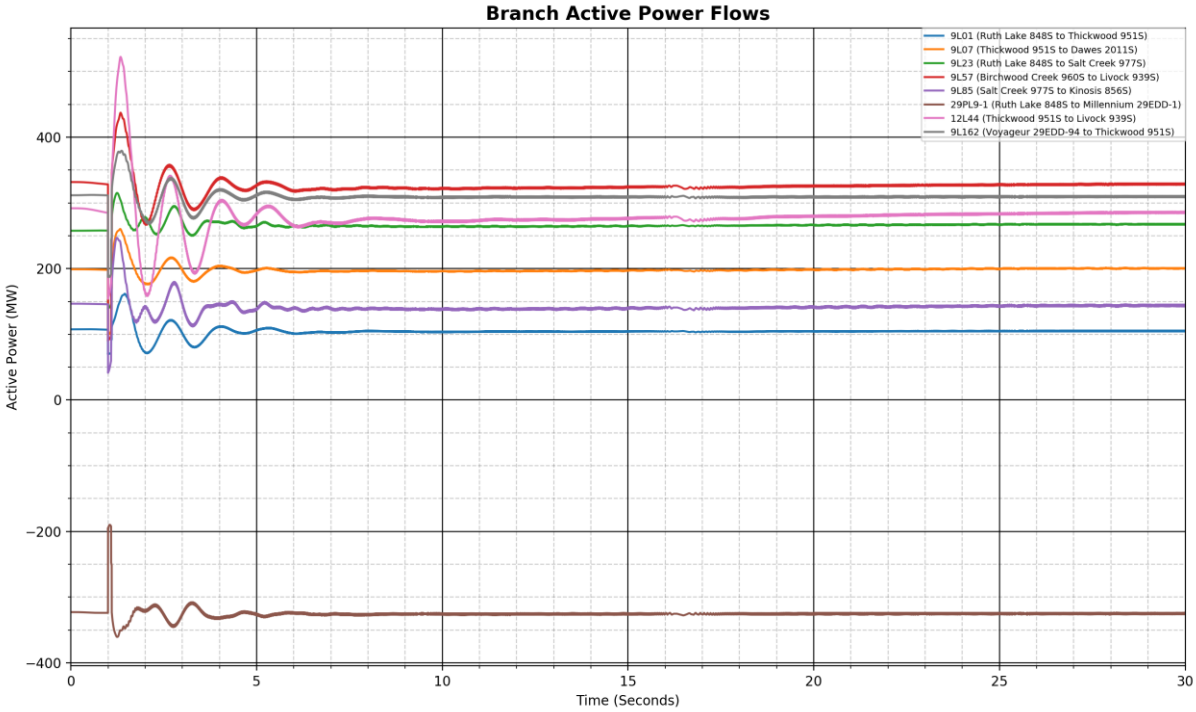

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
20
15
10
5
0
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
4.5
4.0
3.5
3.0
2.5
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
5
10
15
20
25
30
1
2
3
4
5


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0
5
10
15
20
25
30
0.80
0.85
0.90
0.95
1.00
1.05


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

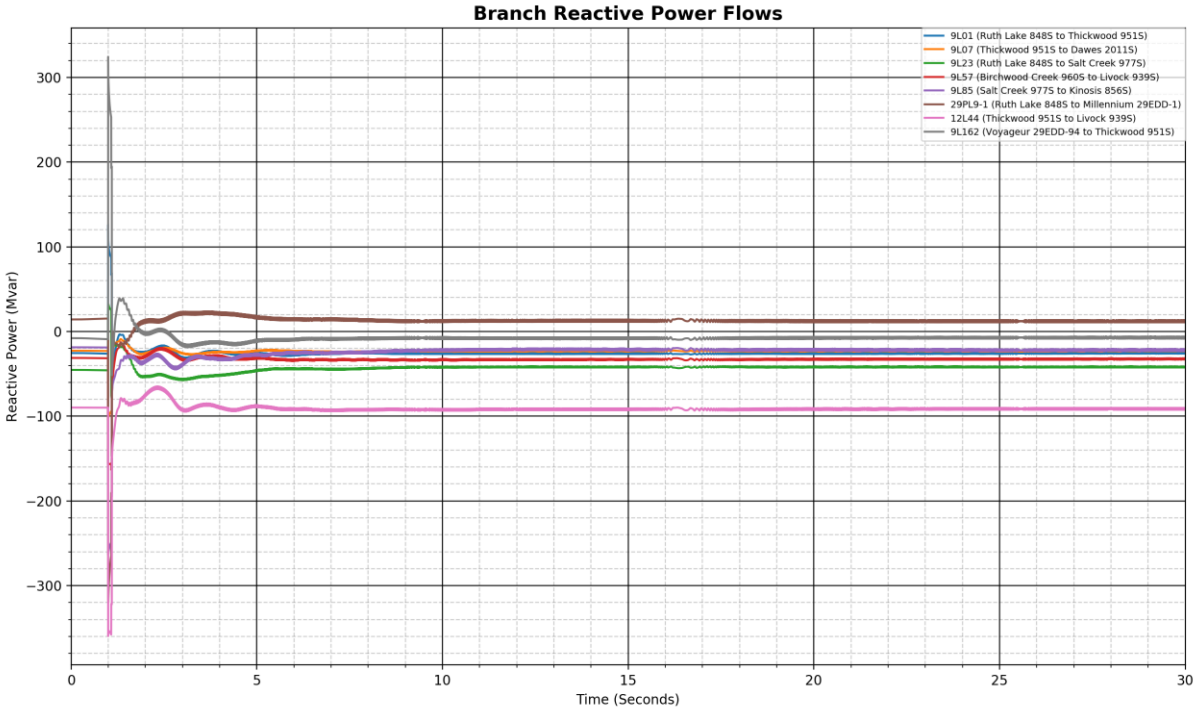
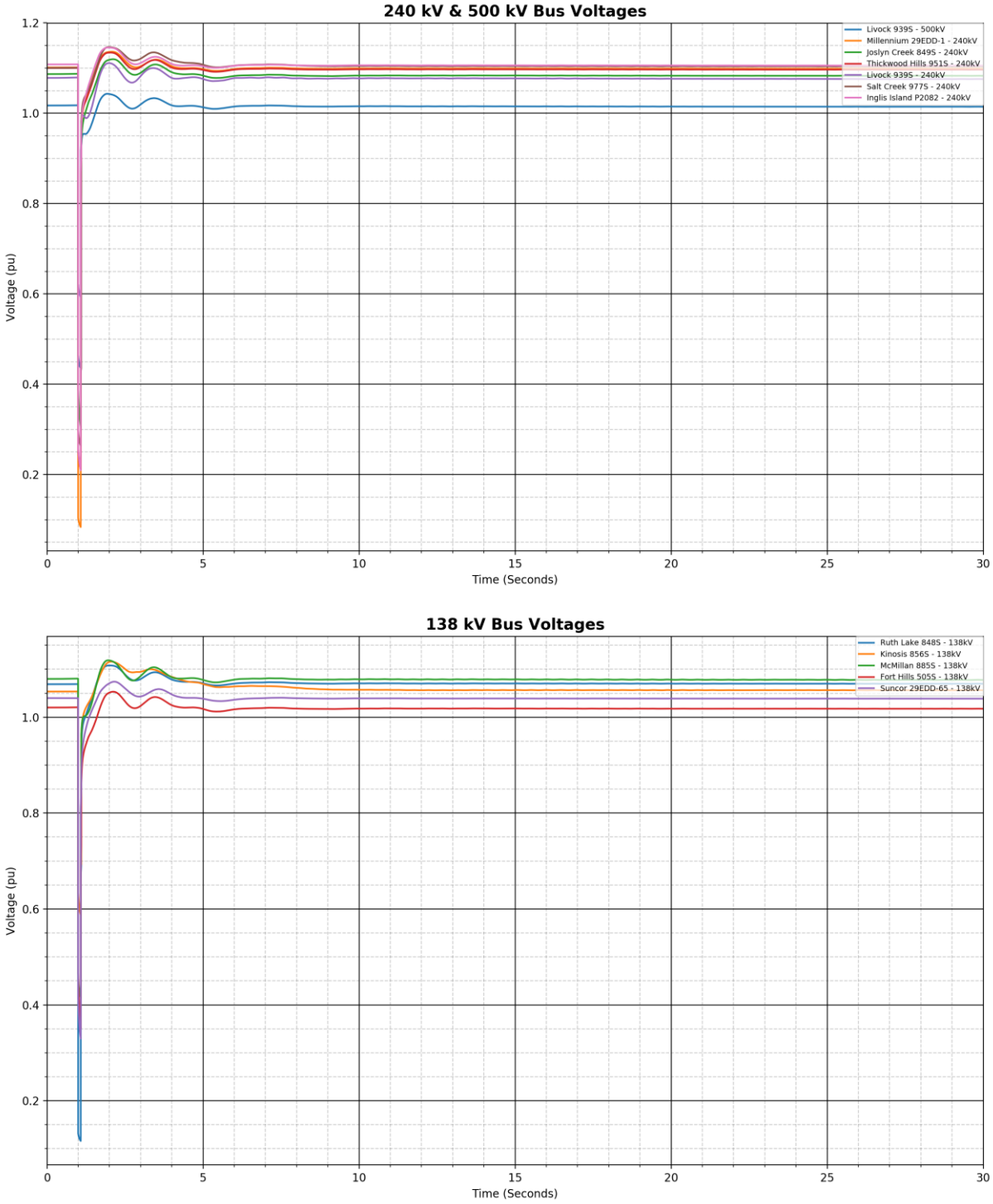
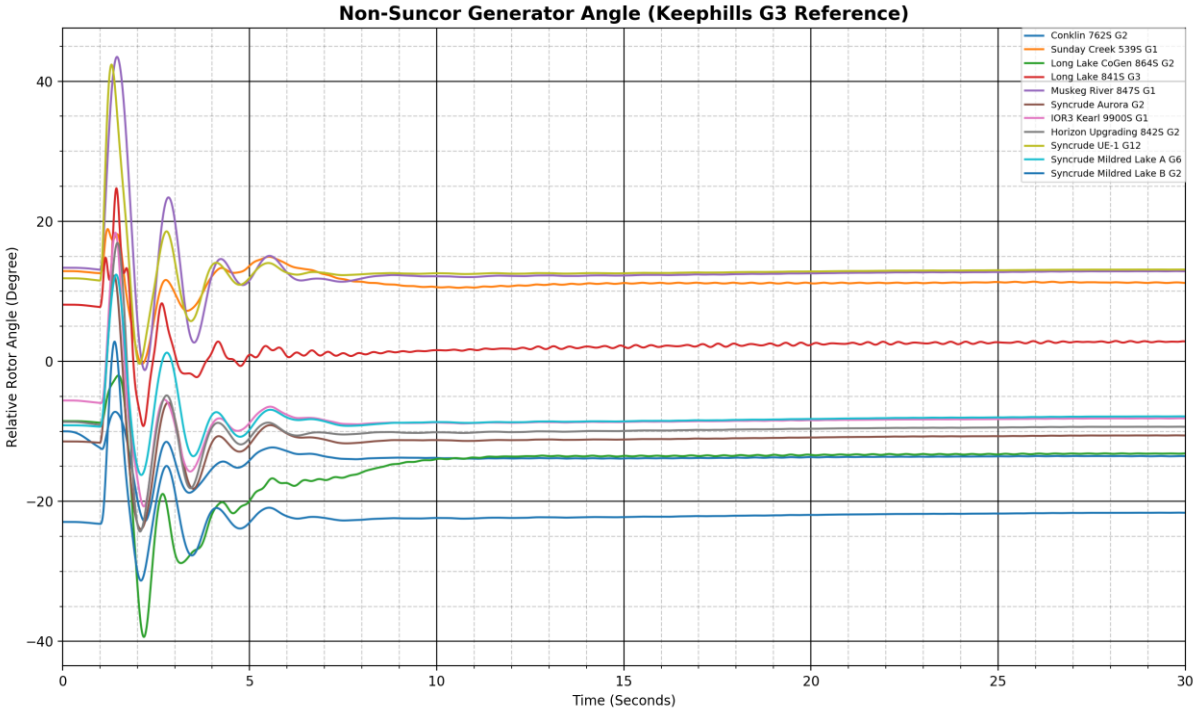
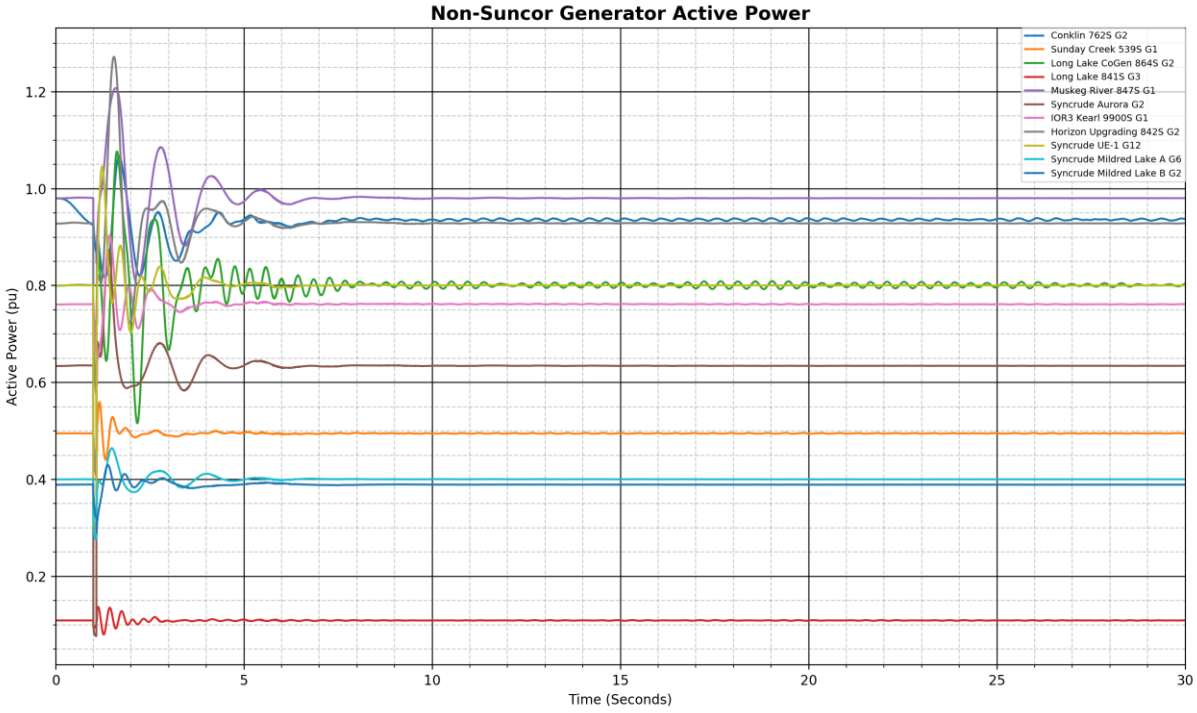
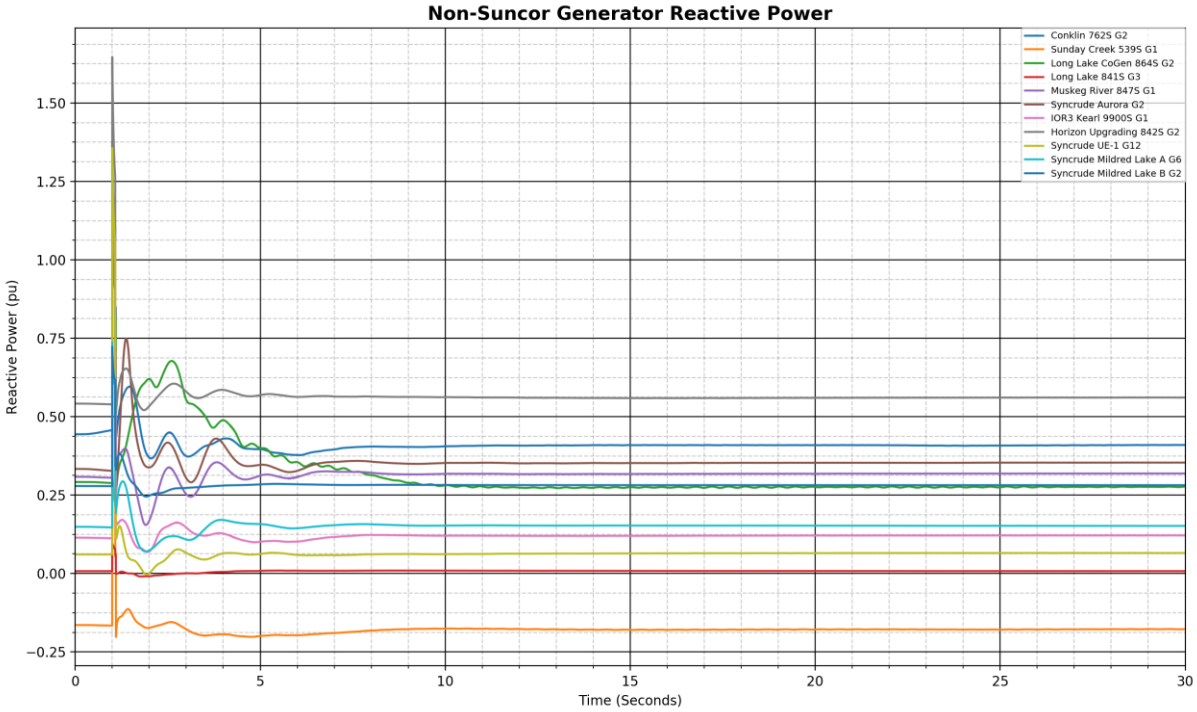

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

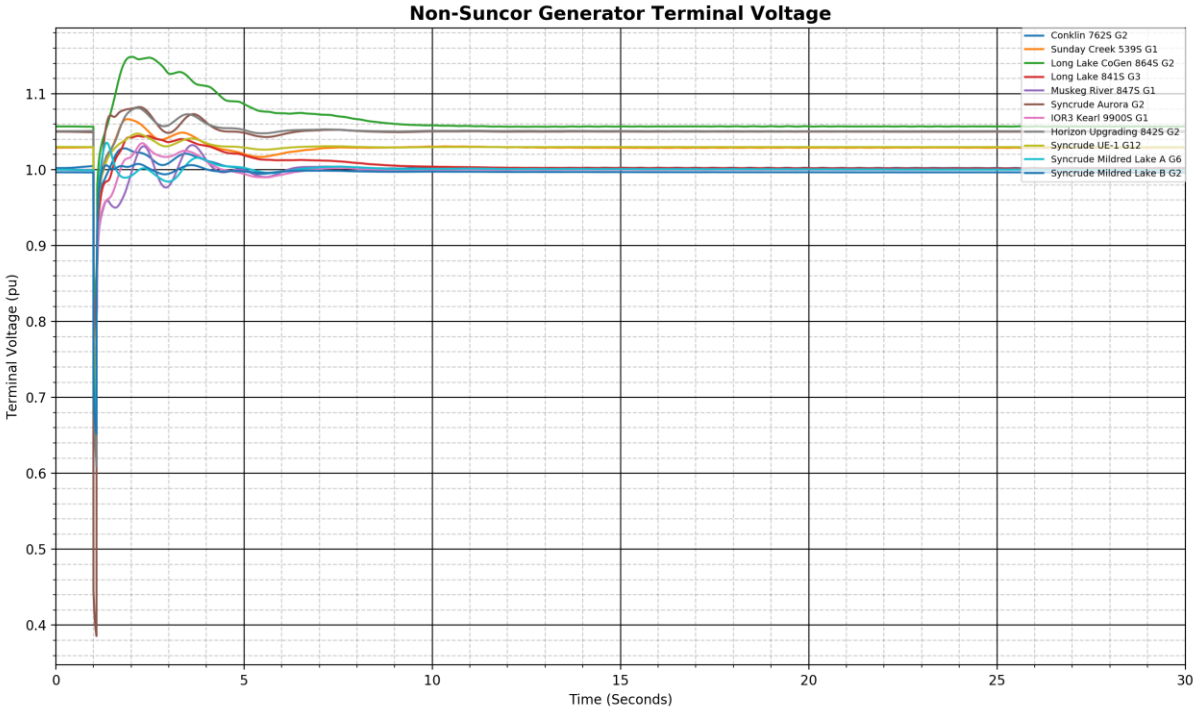
Figure A4-63: 9L23 (Ruth Lake 848S to Salt Creek 977S): Fault at Ruth Lake 848S

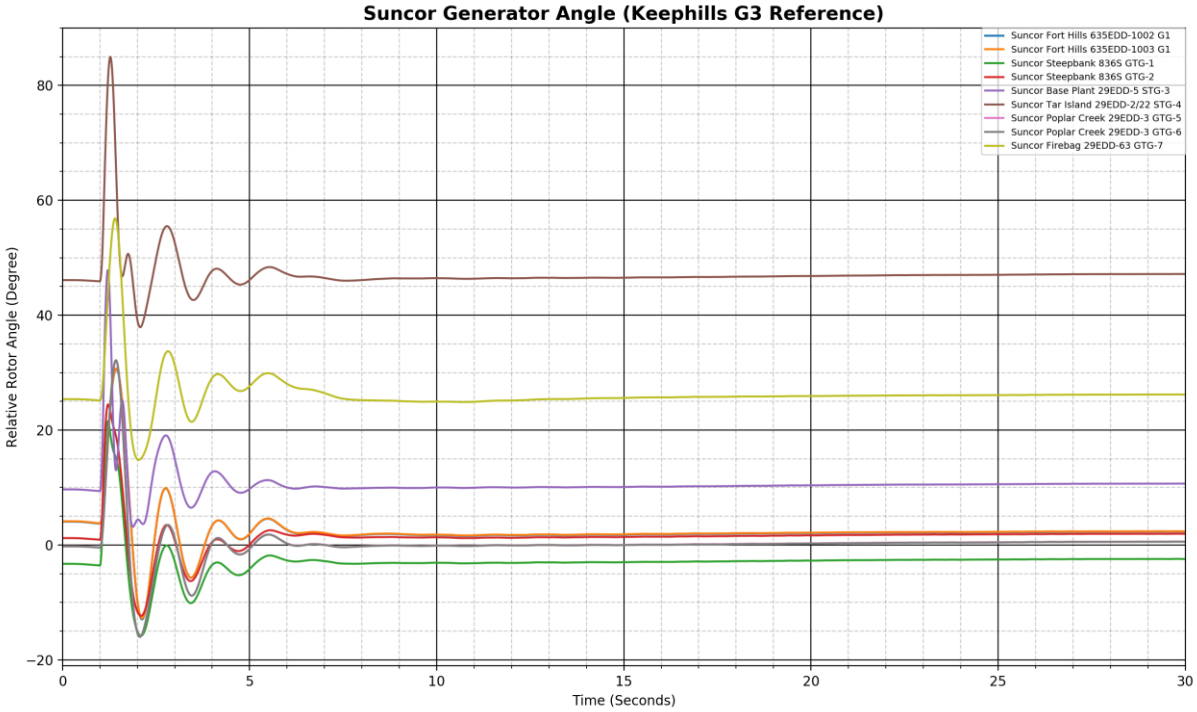


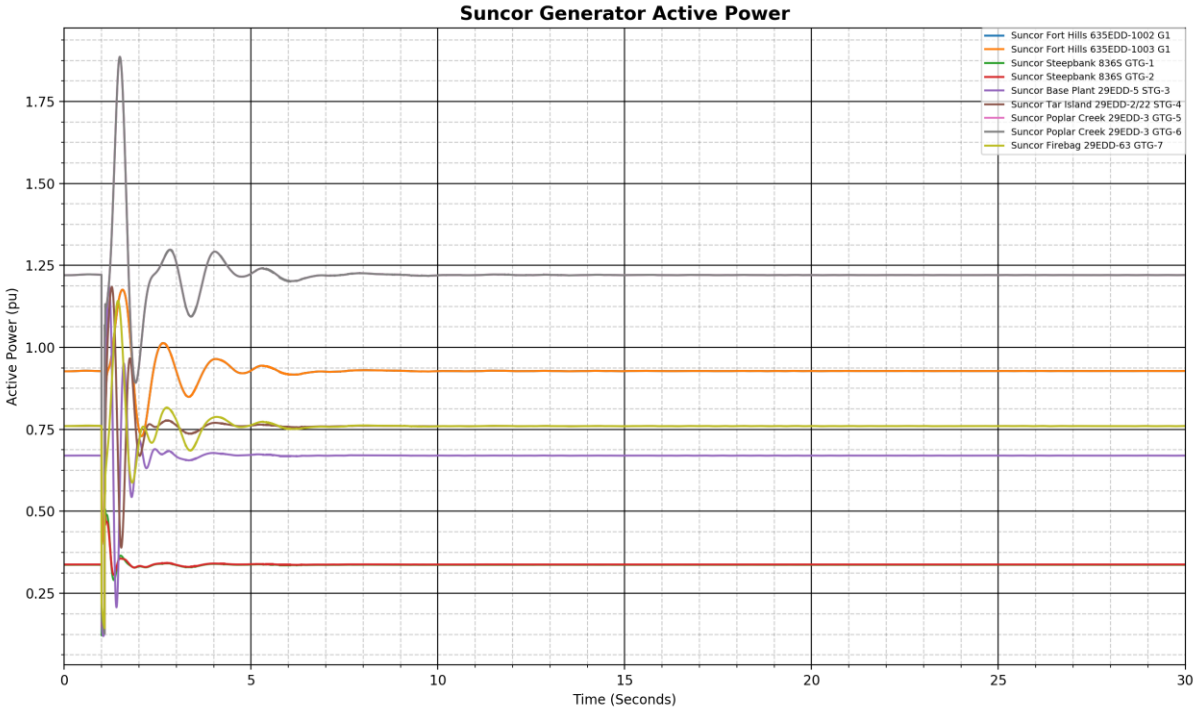

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

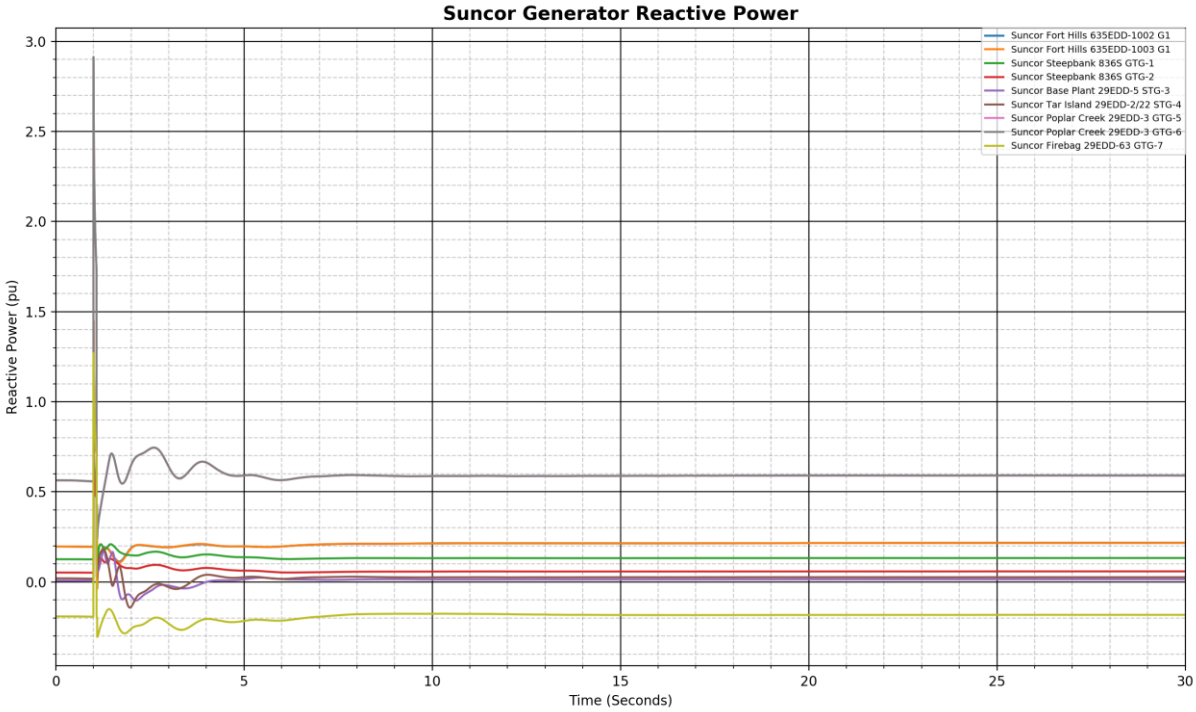

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

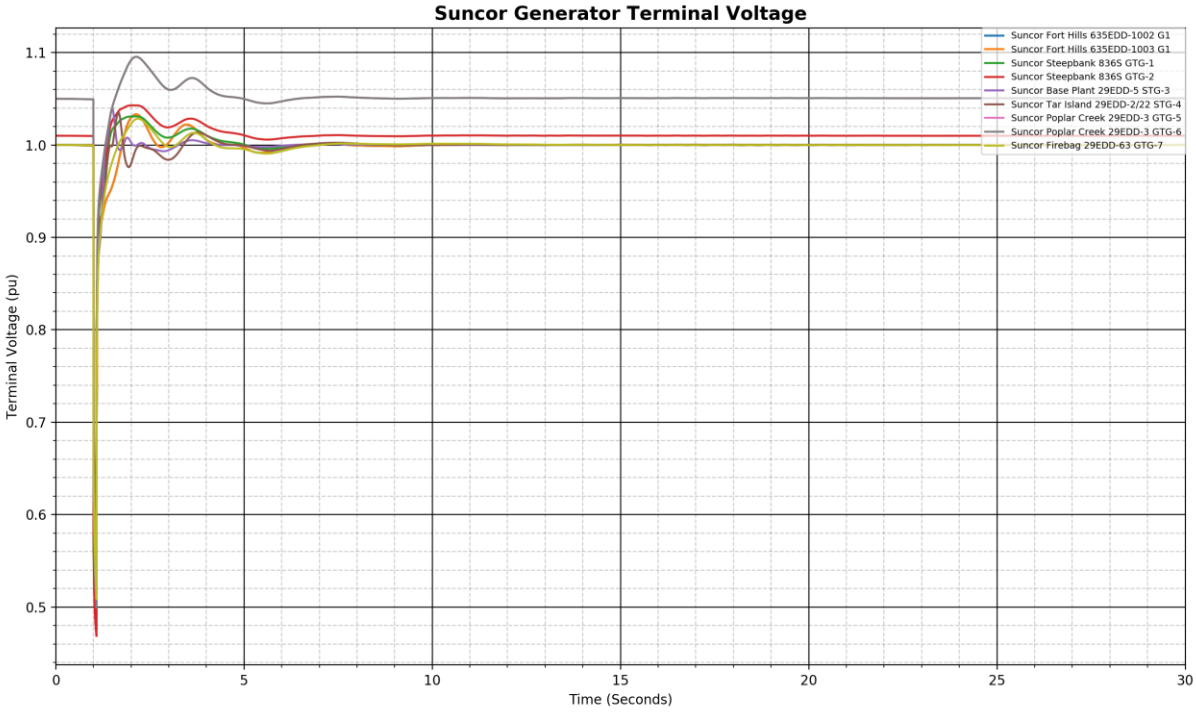

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

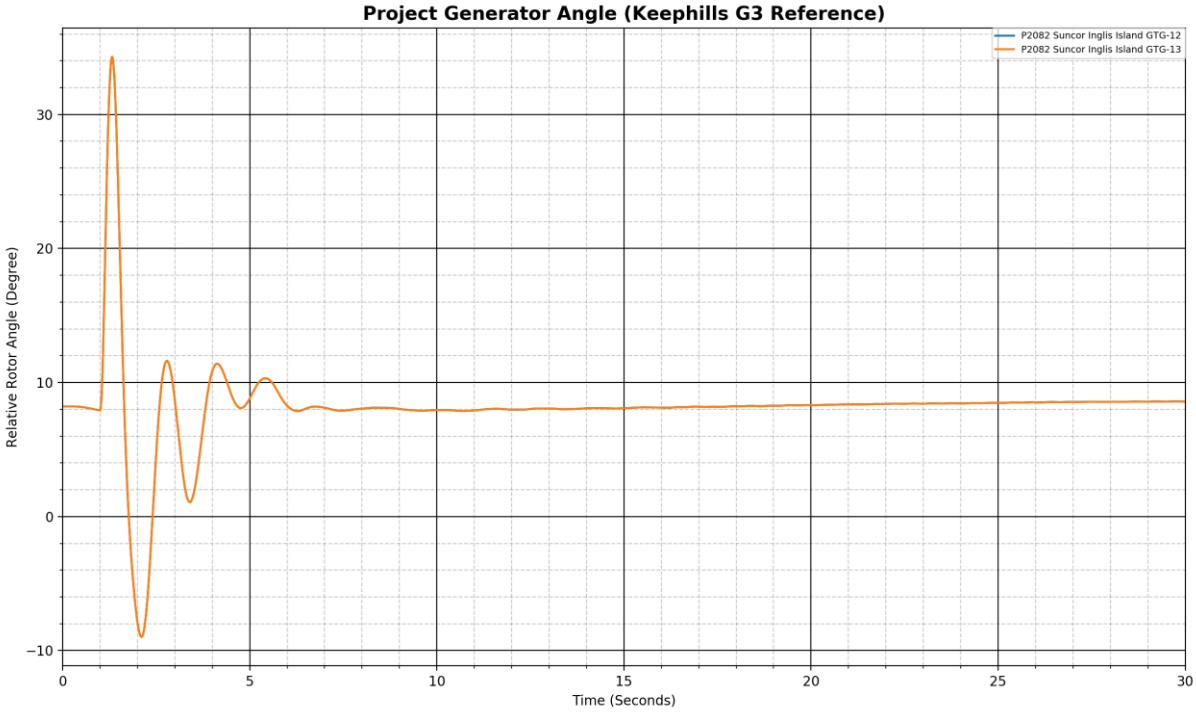

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

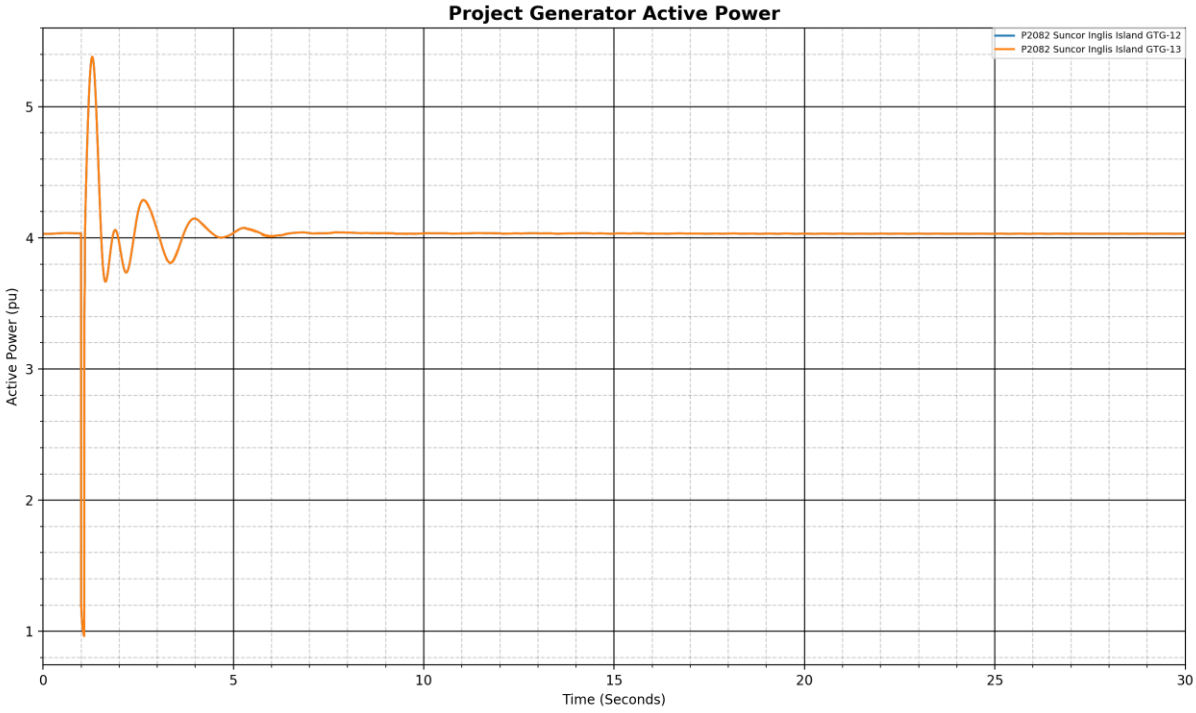

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

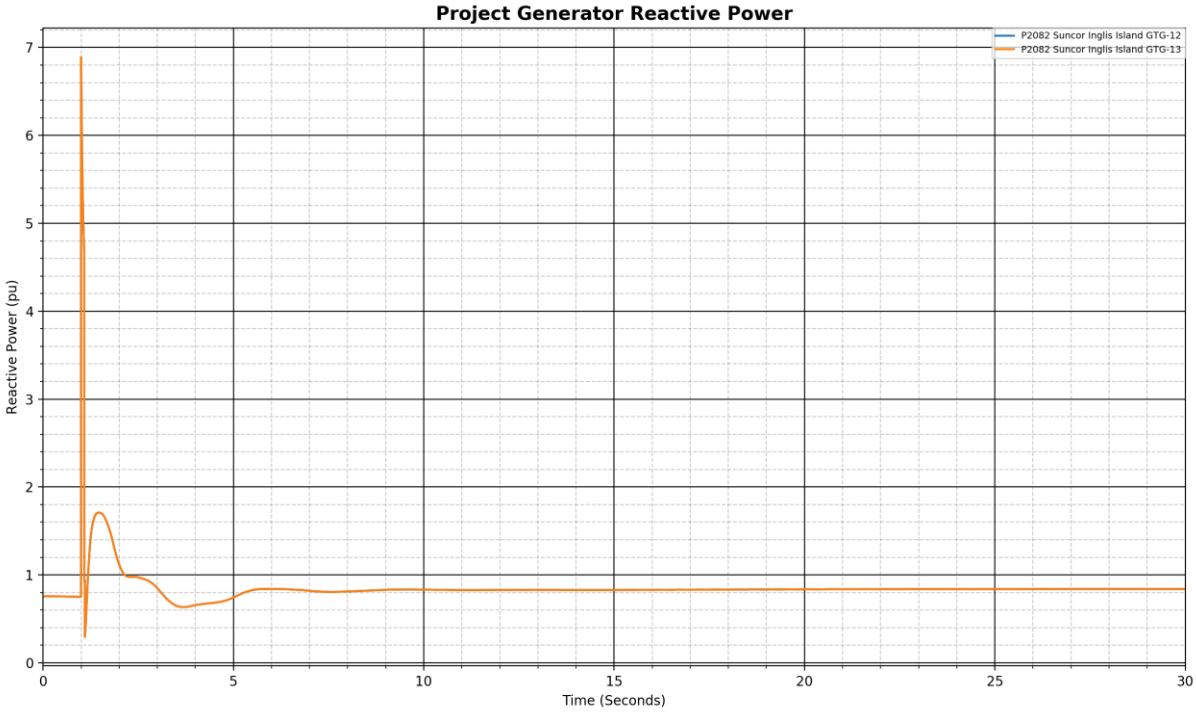

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

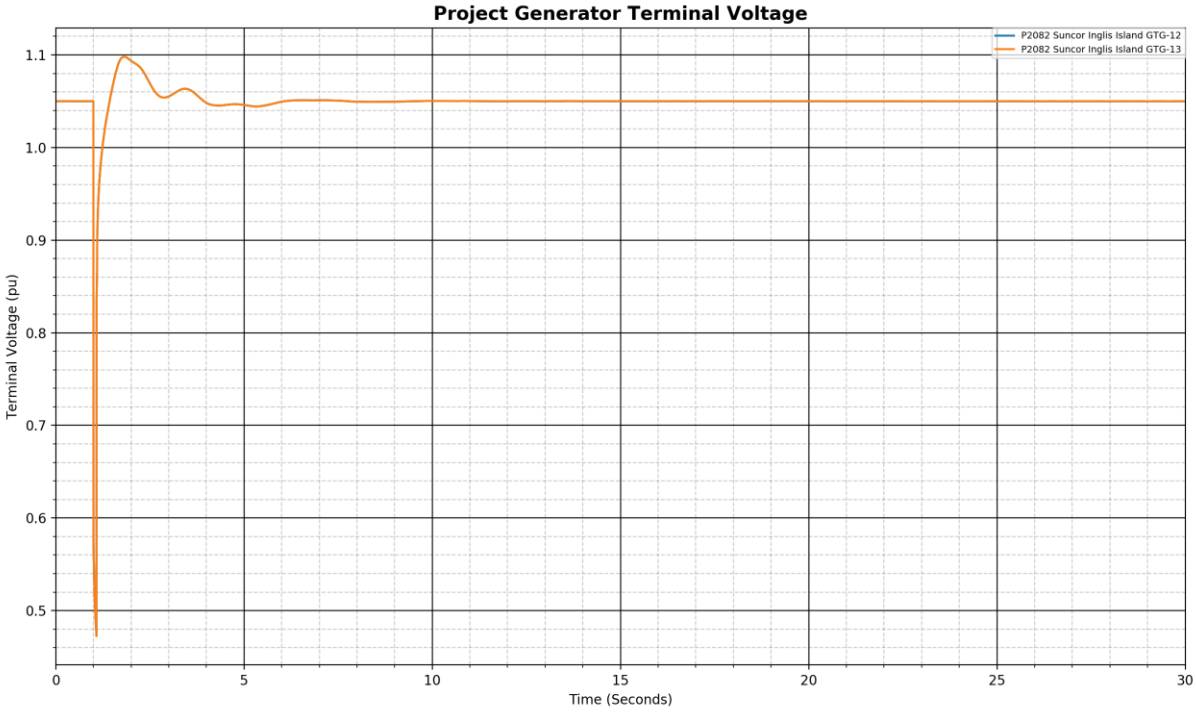

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

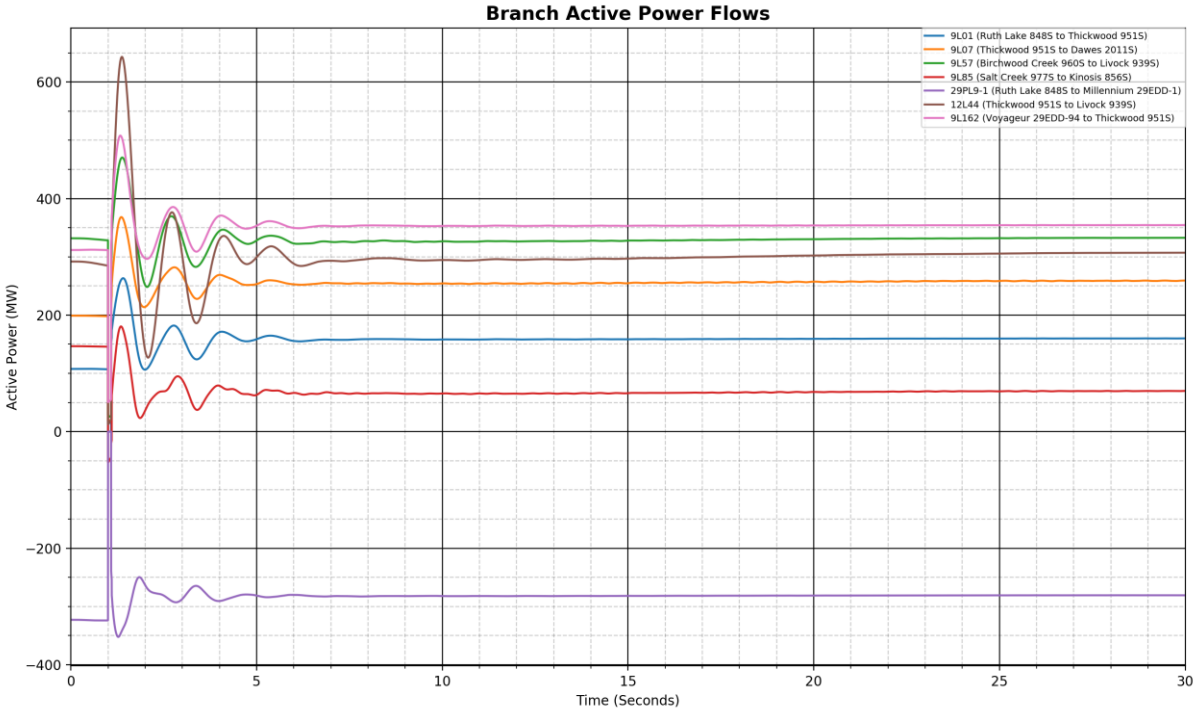

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
20
10
0
−10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5
4
3
2
1
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

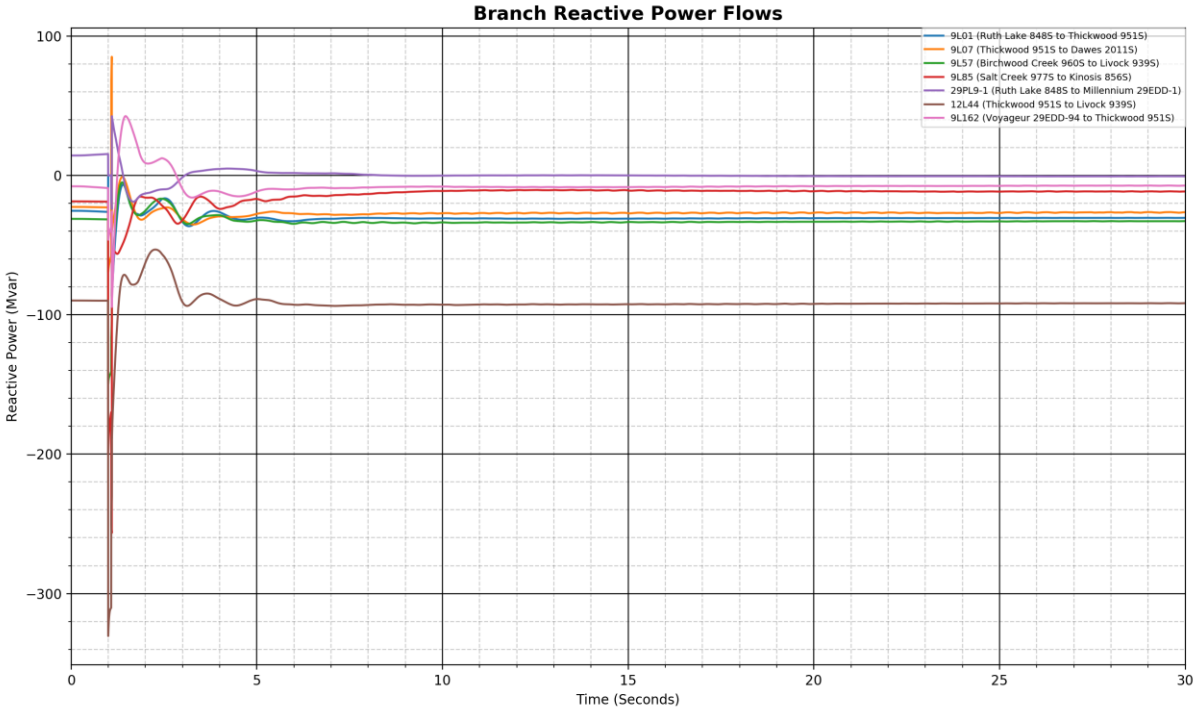
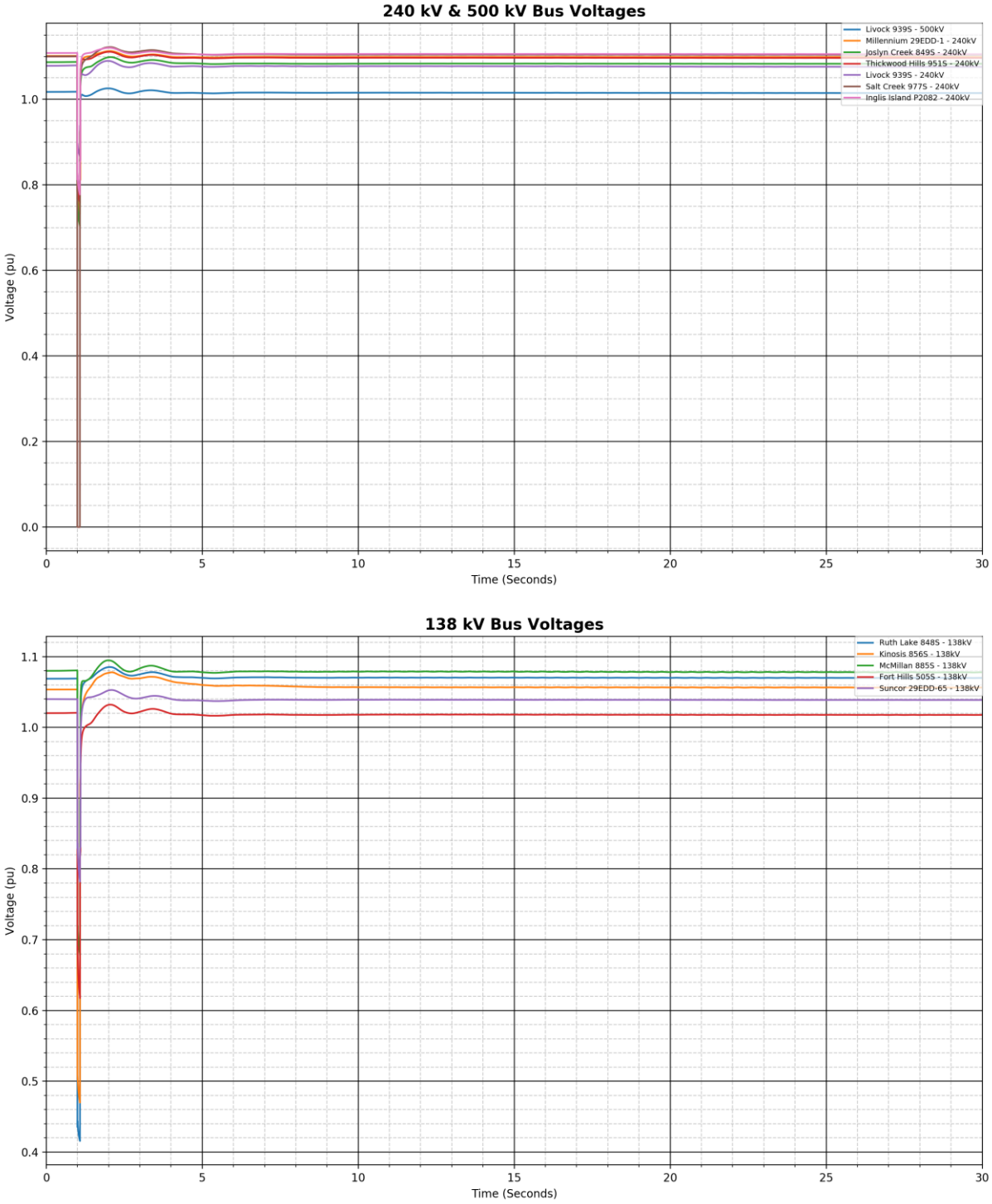
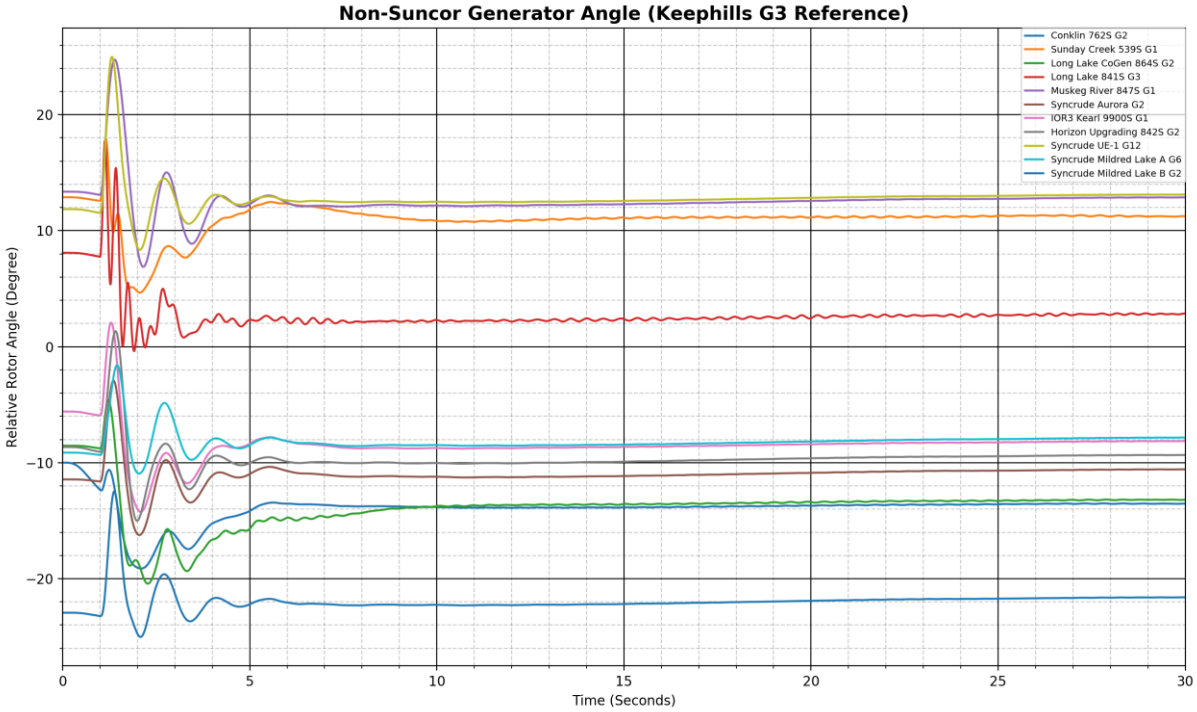
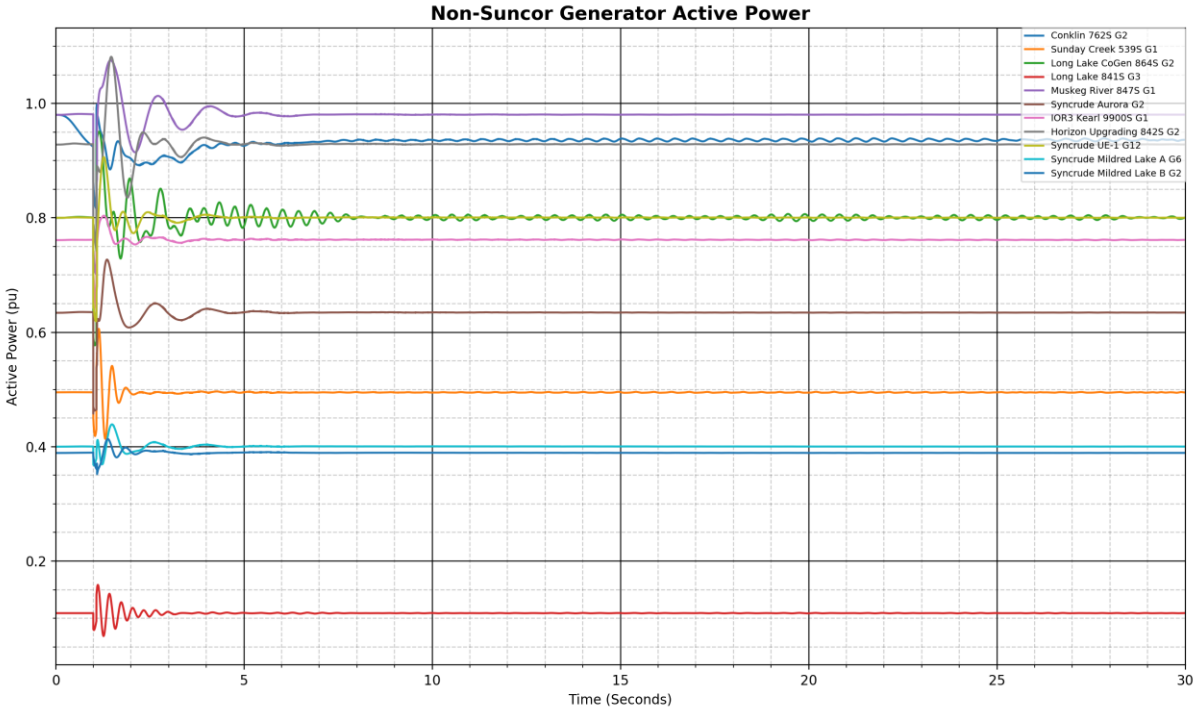
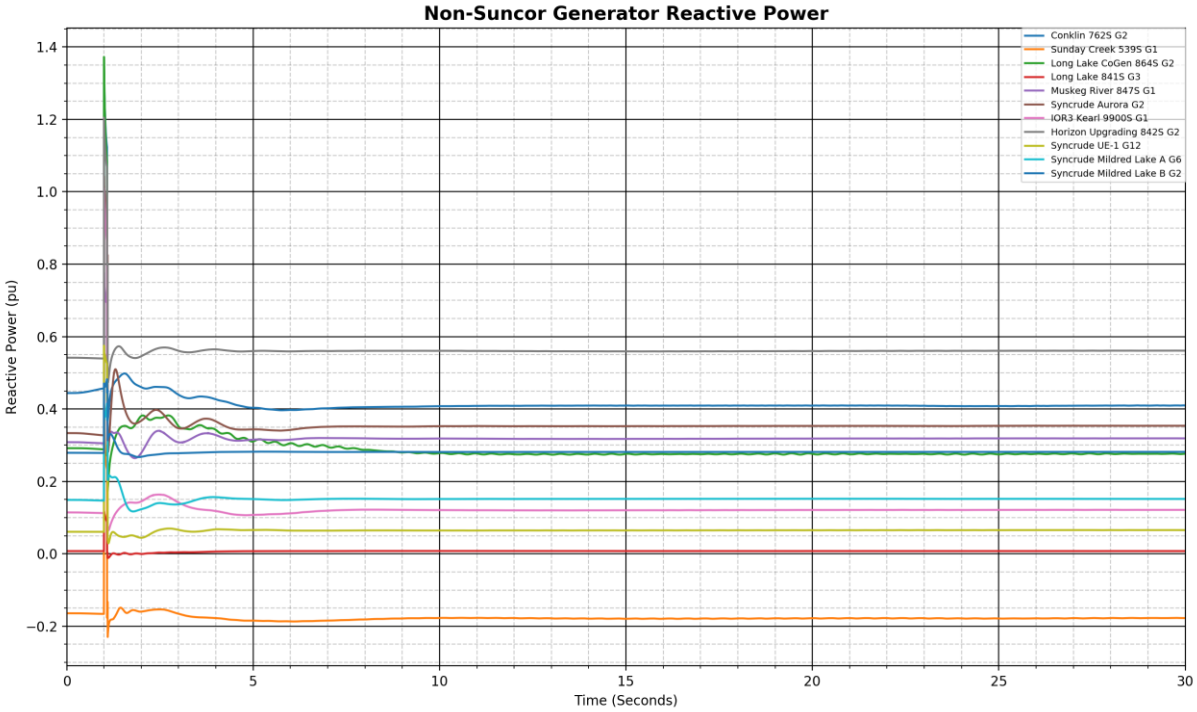

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

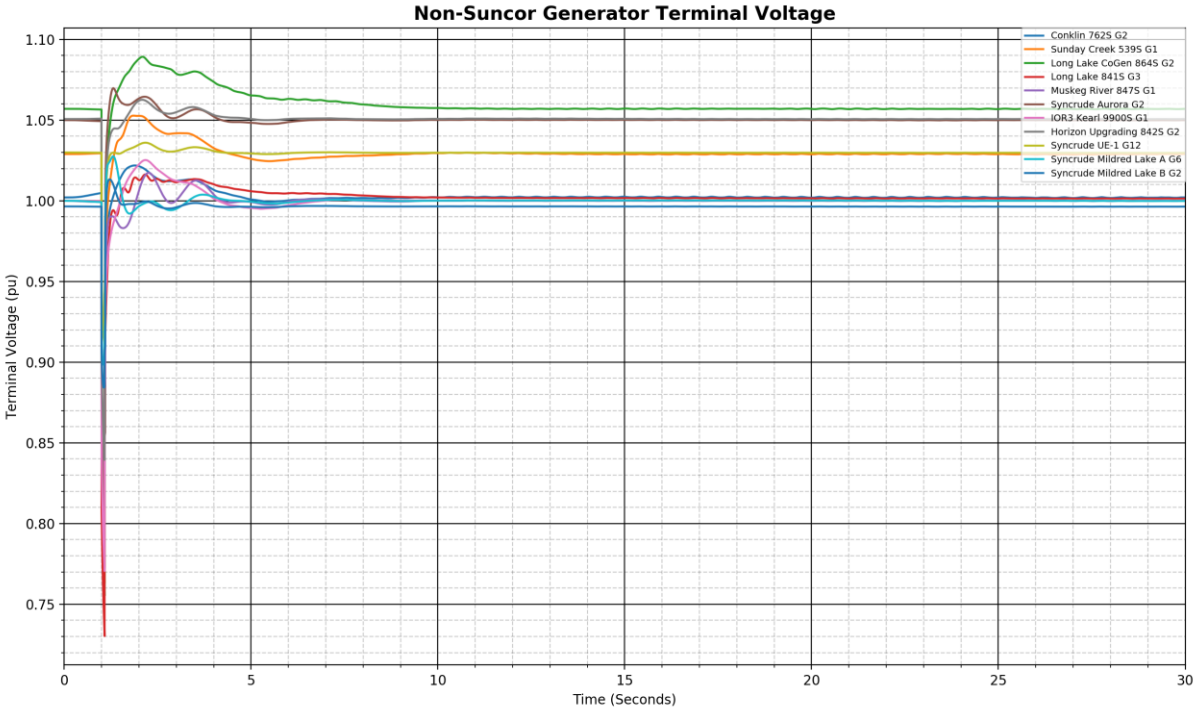
Figure A4-64: 9L23 (Ruth Lake 848S to Salt Creek 977S): Fault at Salt Creek 977S

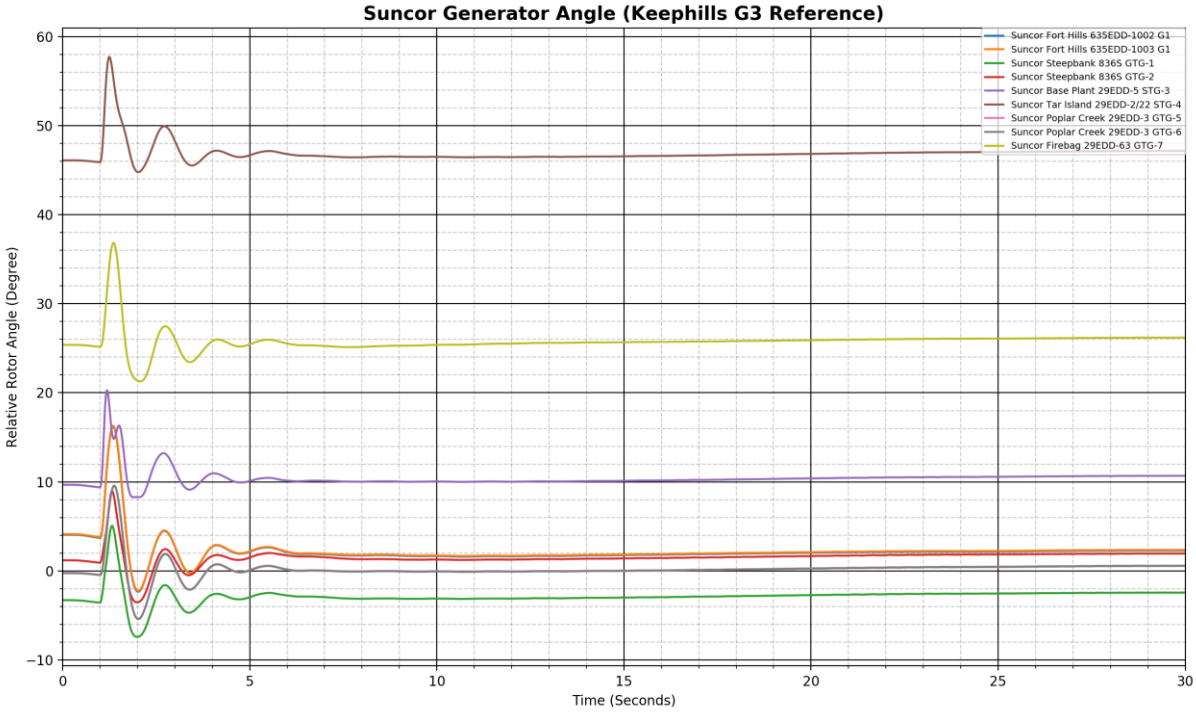


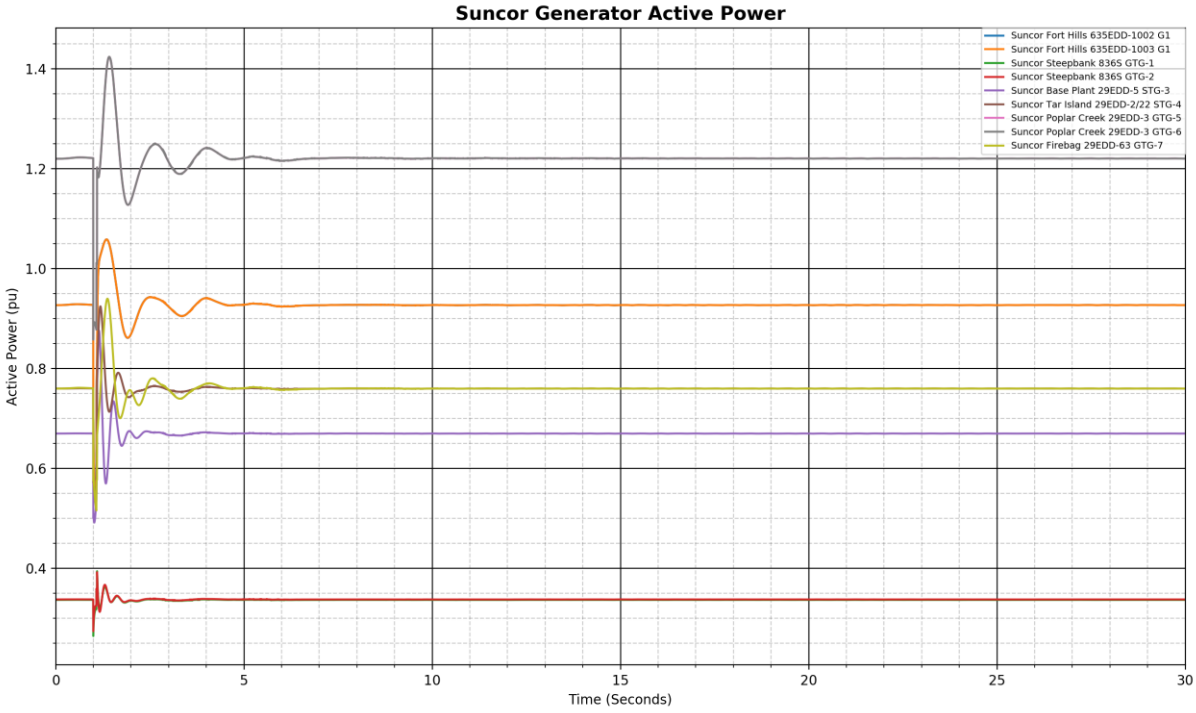

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

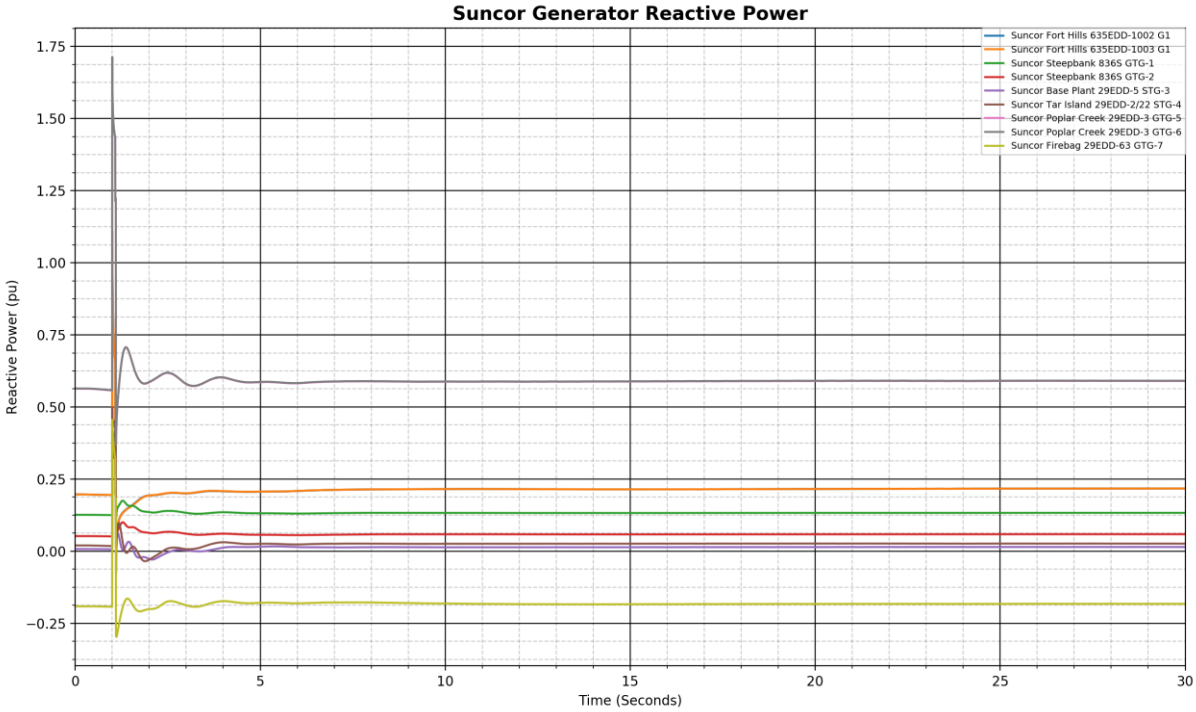

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

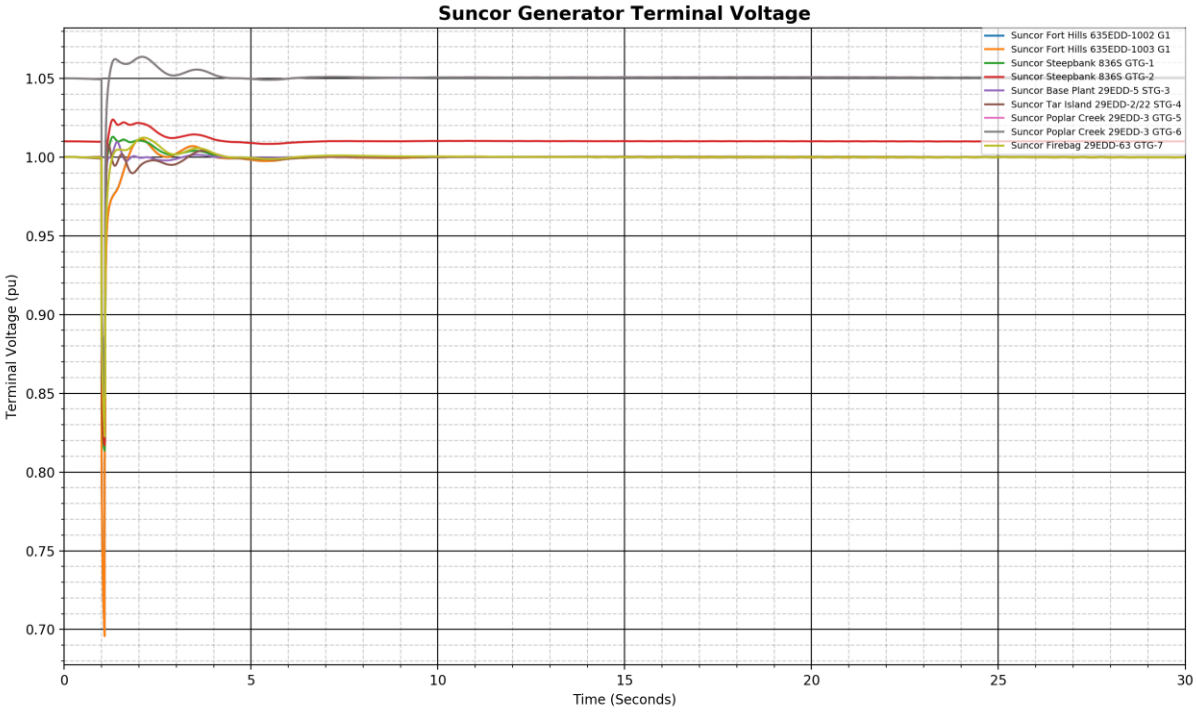

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

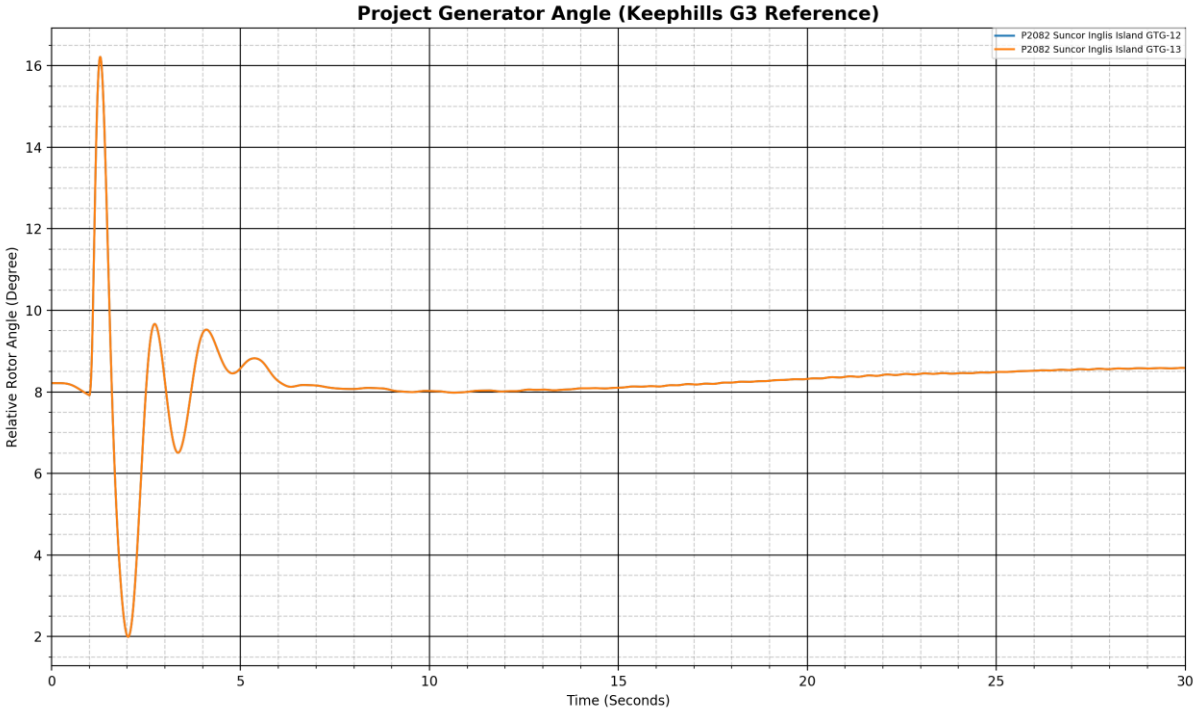

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

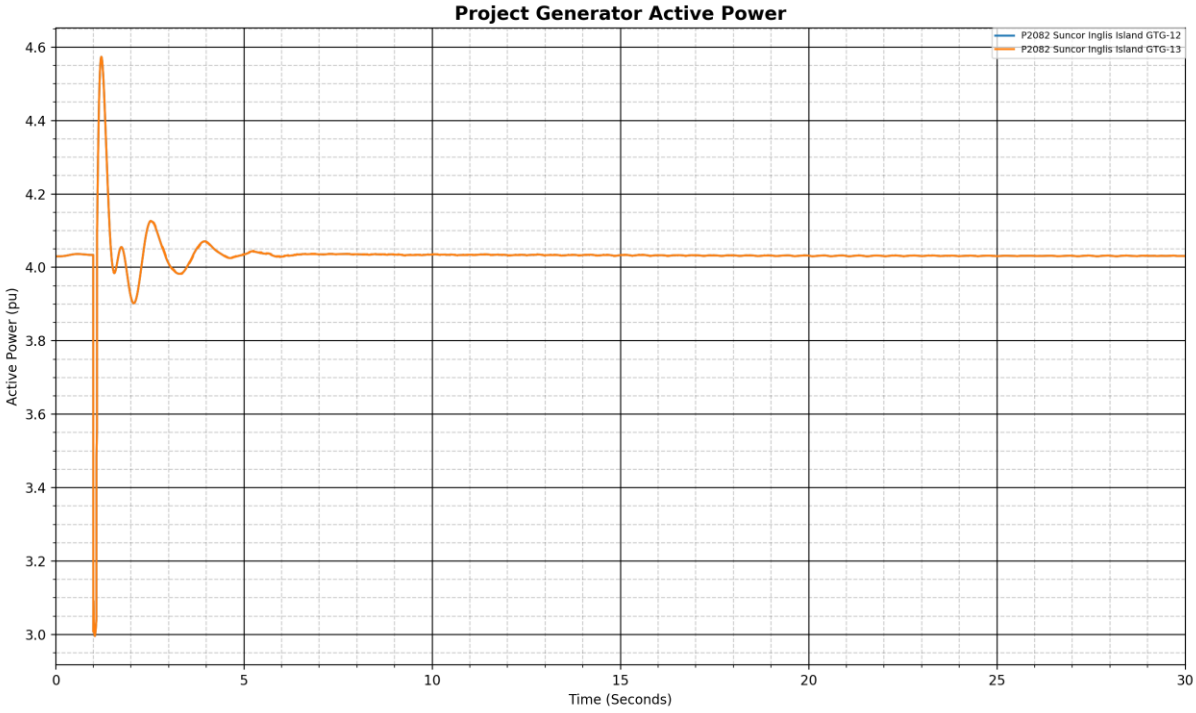

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

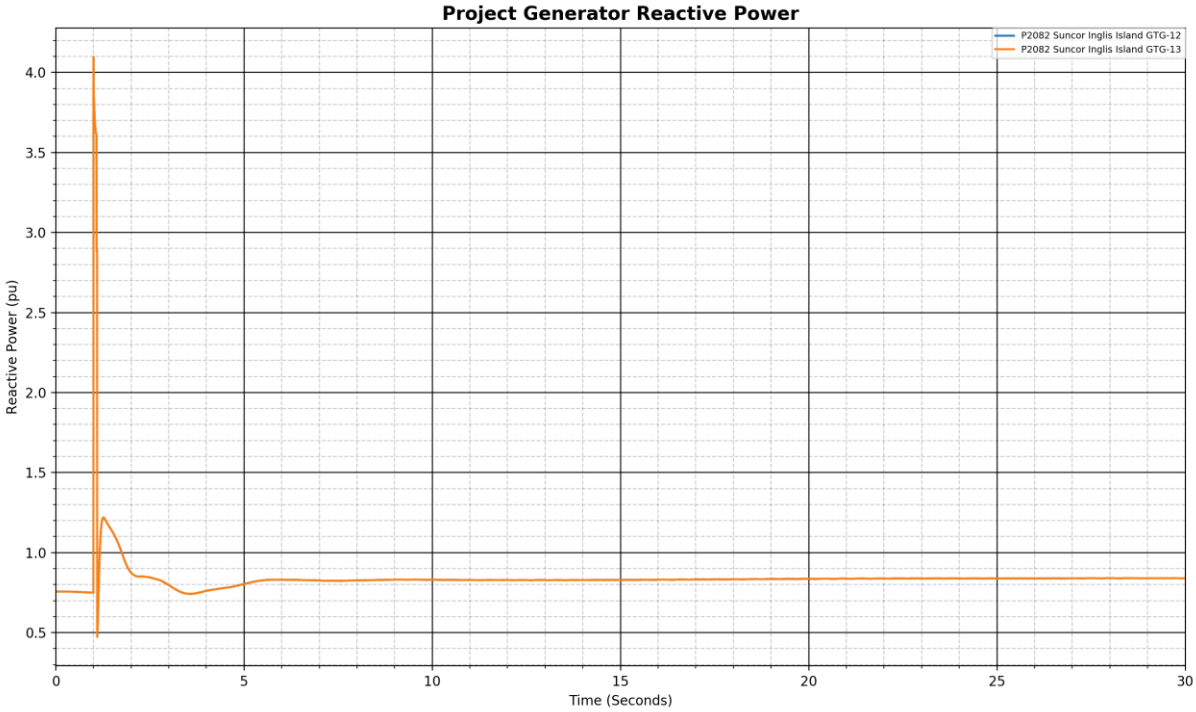

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

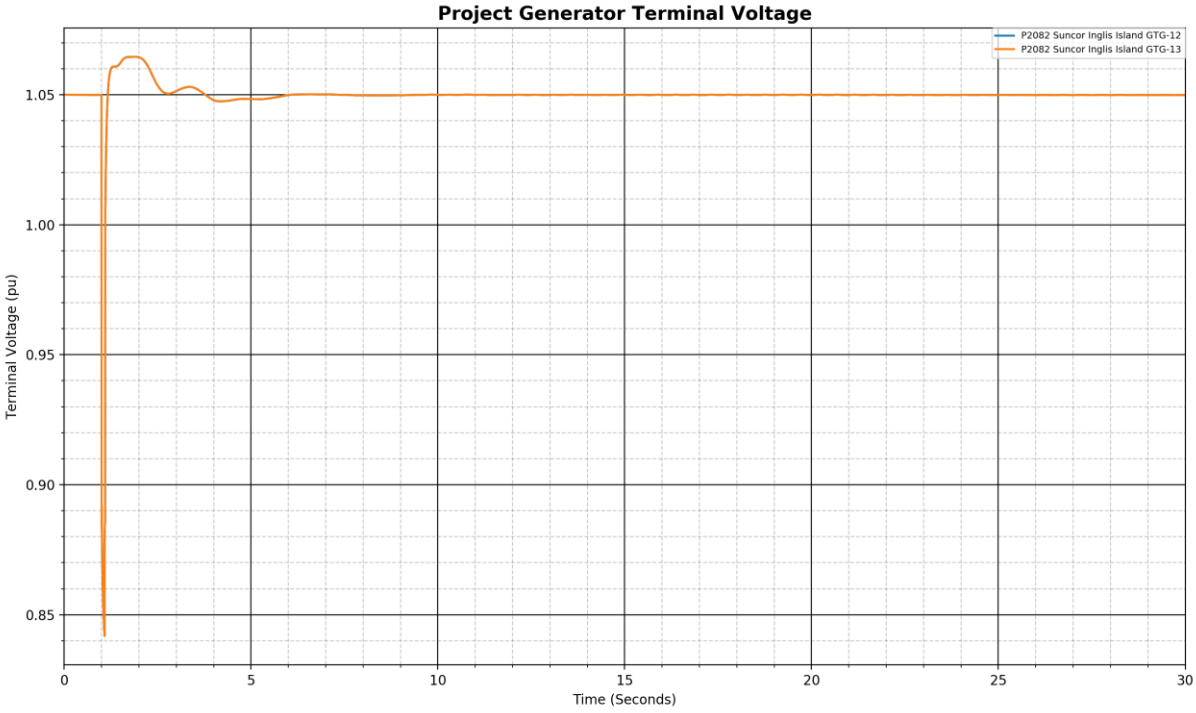

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

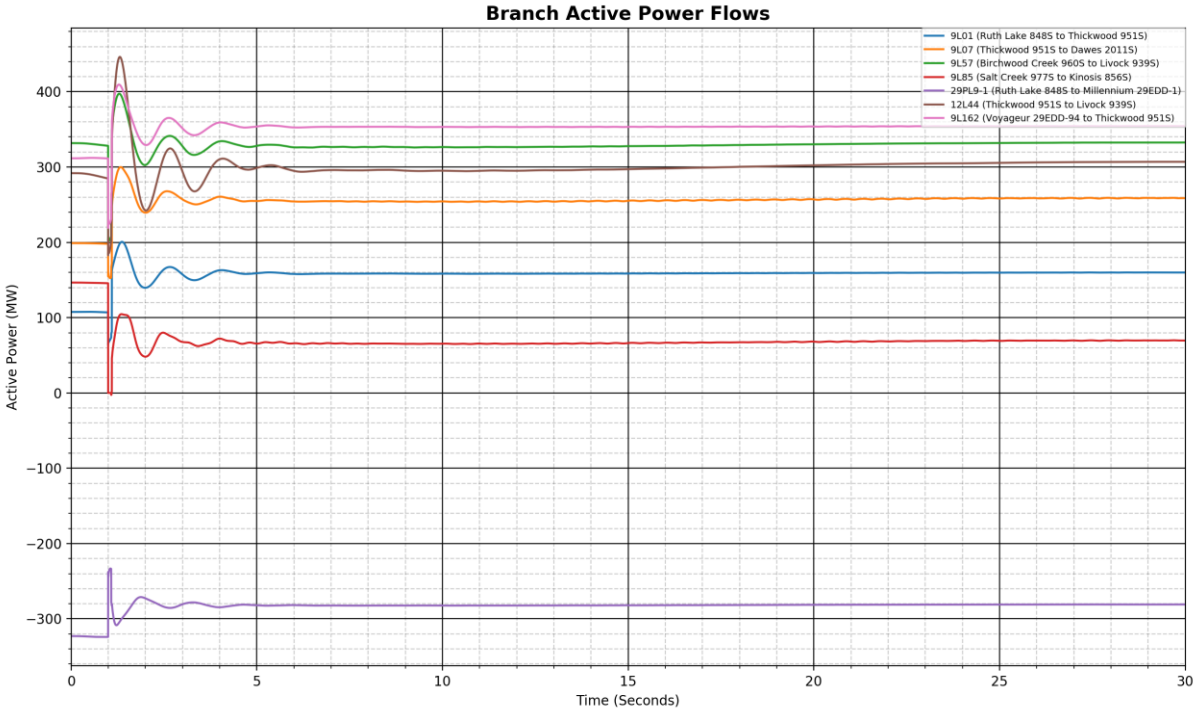

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
2
4
6
8
10
12
14
16
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

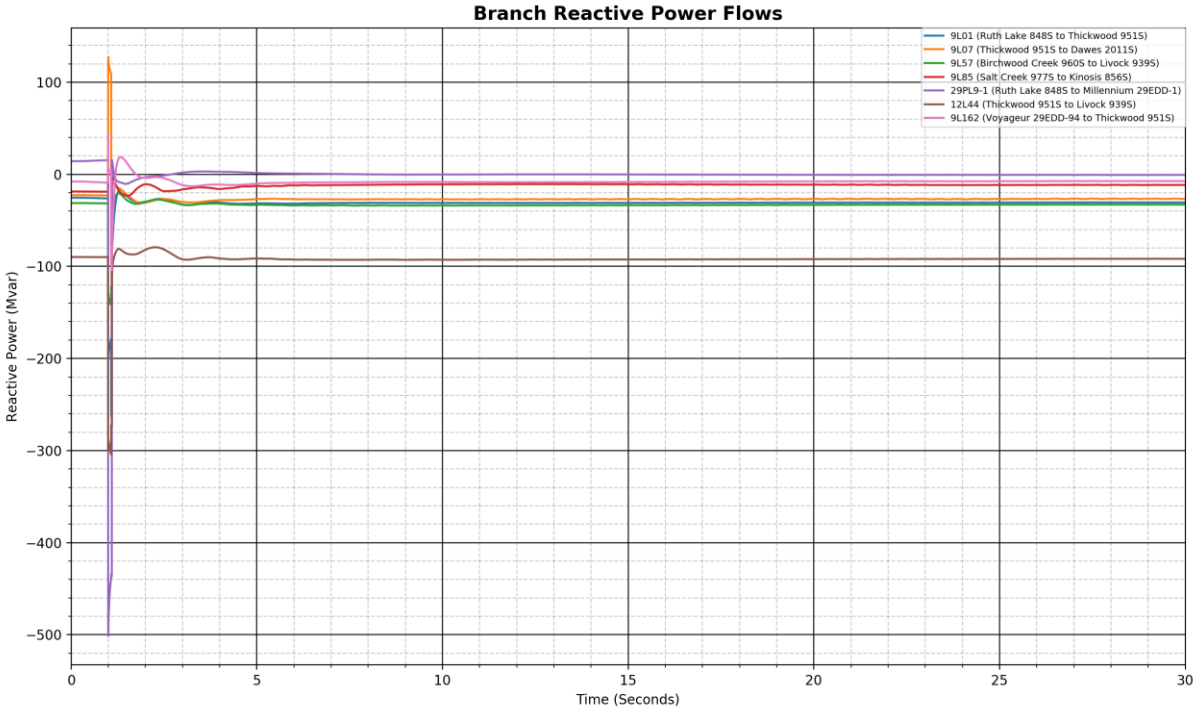
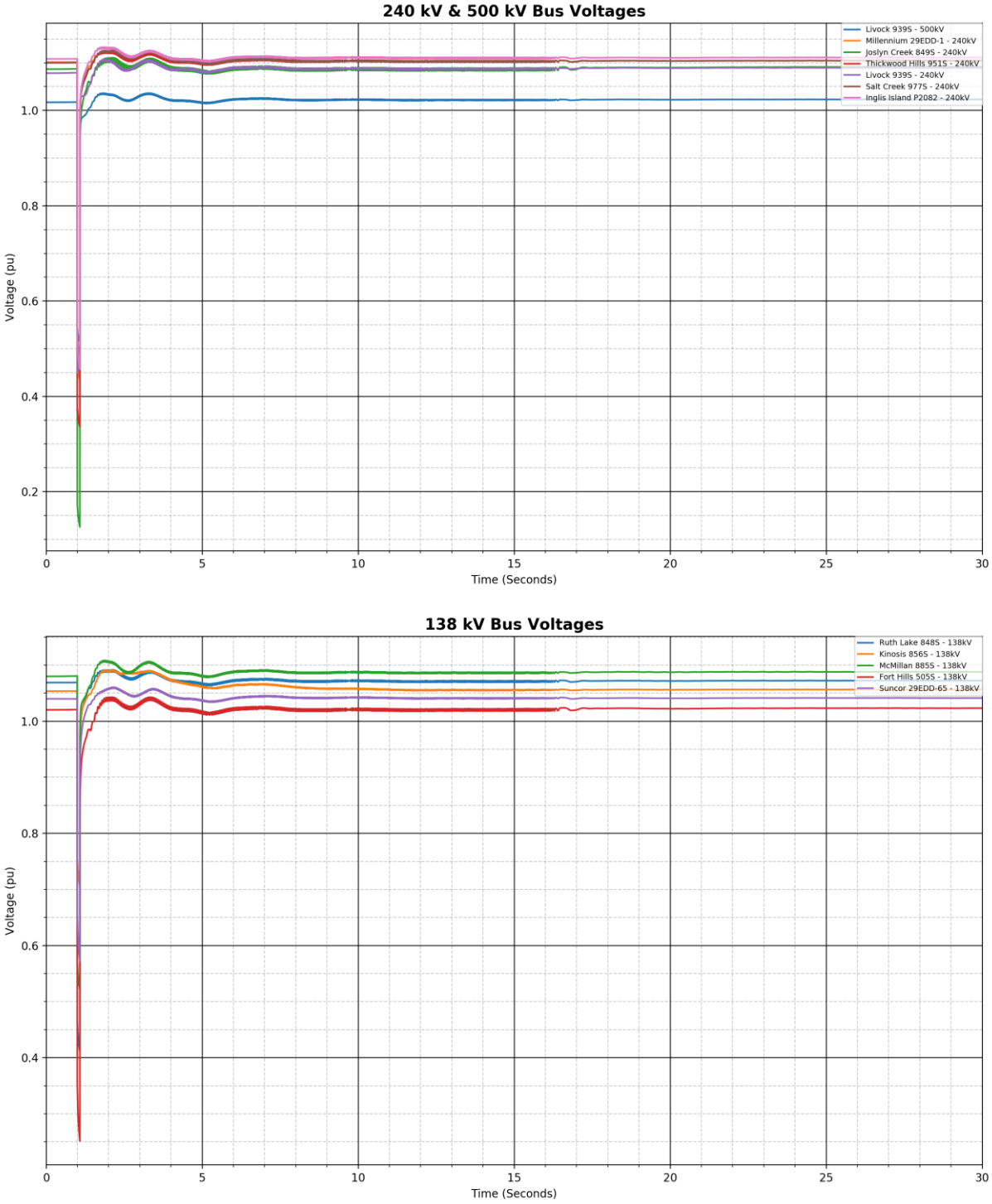
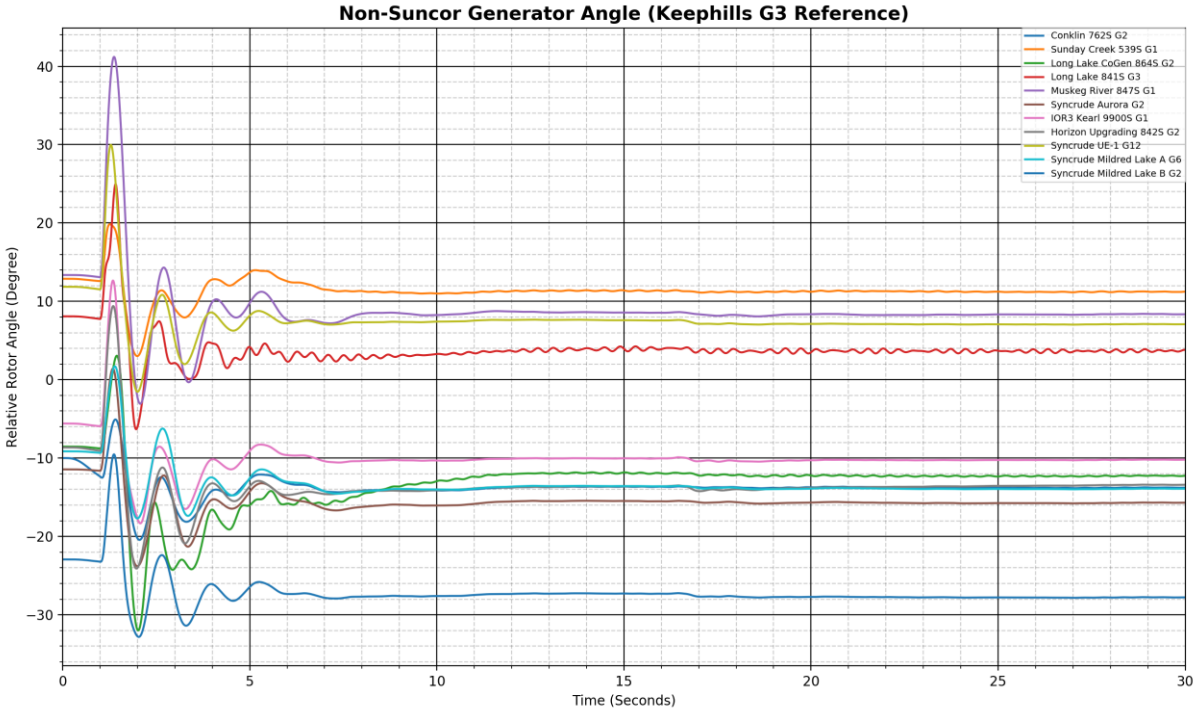
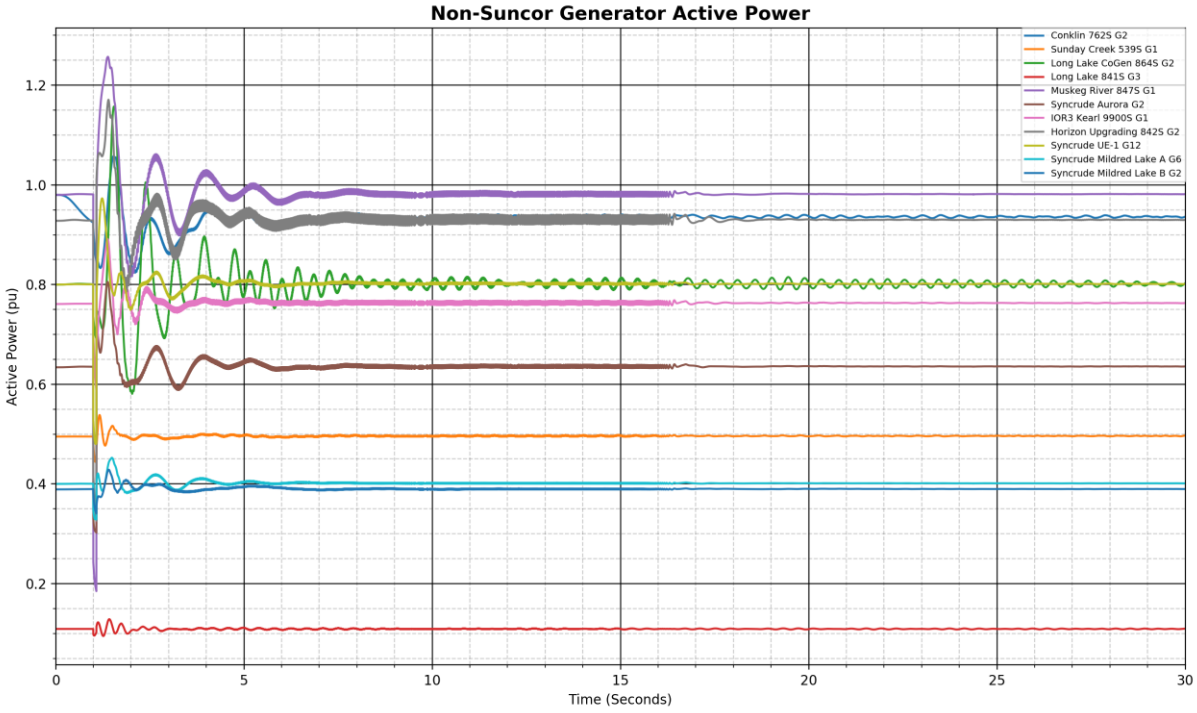
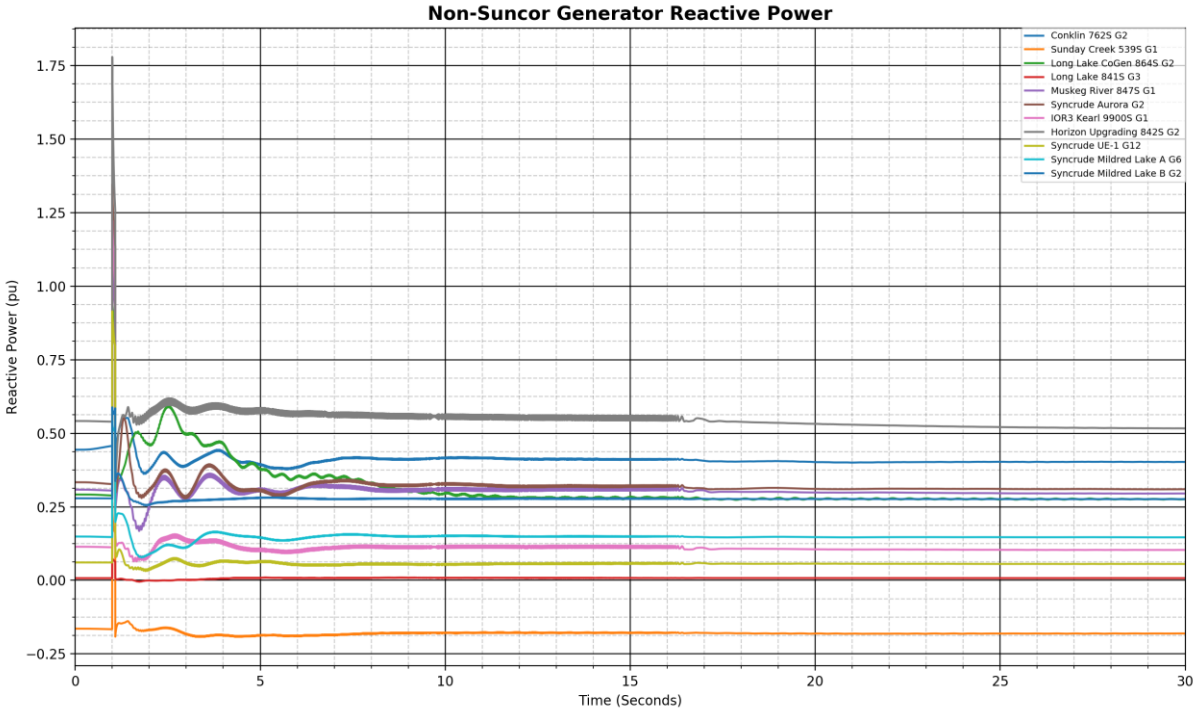

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

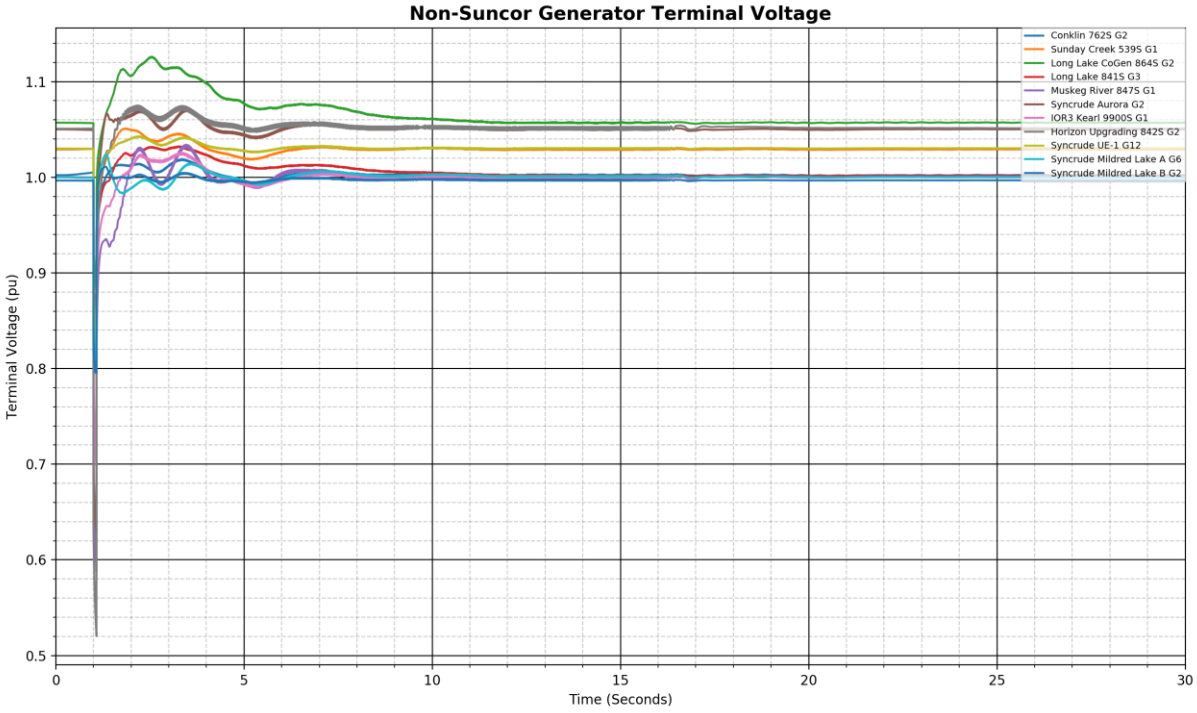
Figure A4-65: 9L43 (Dover 888S to Mackay River 874S): Fault at Dover 888S

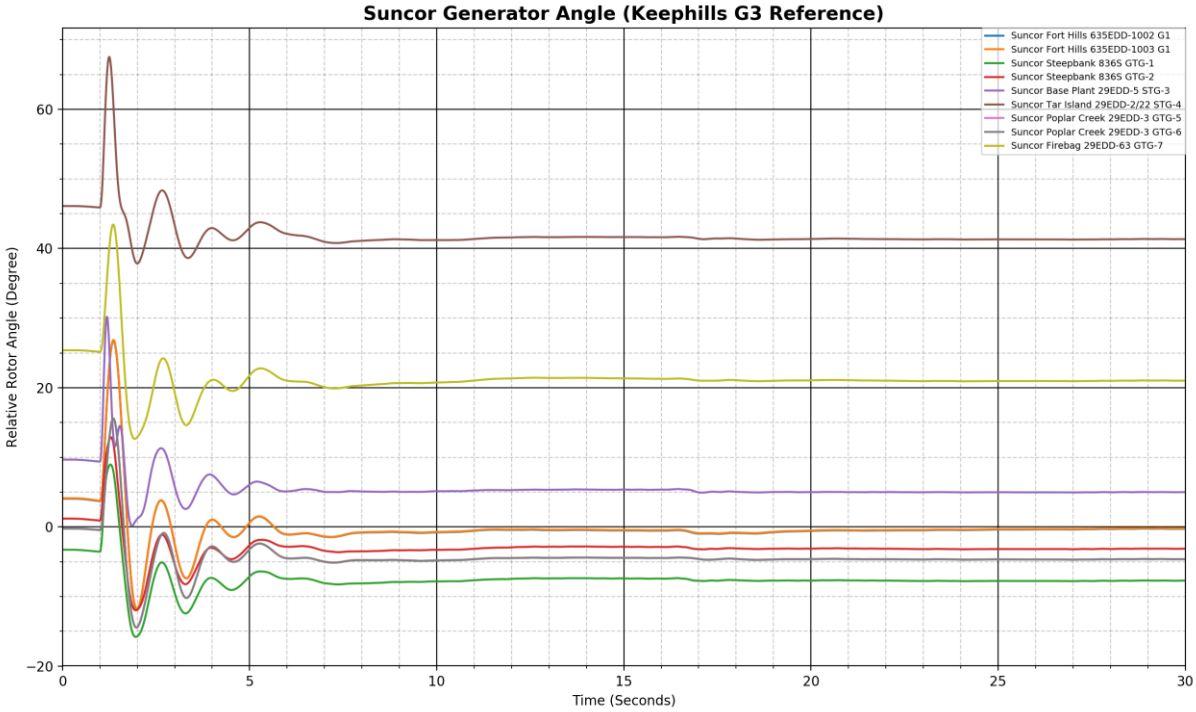


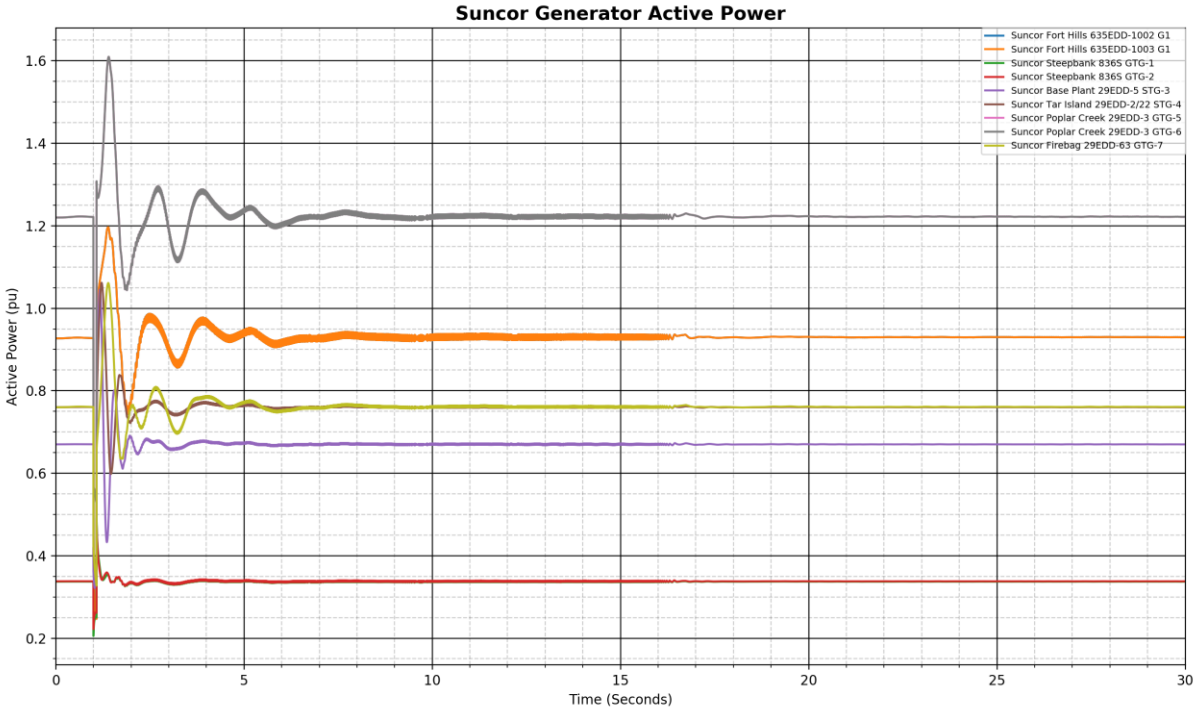

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

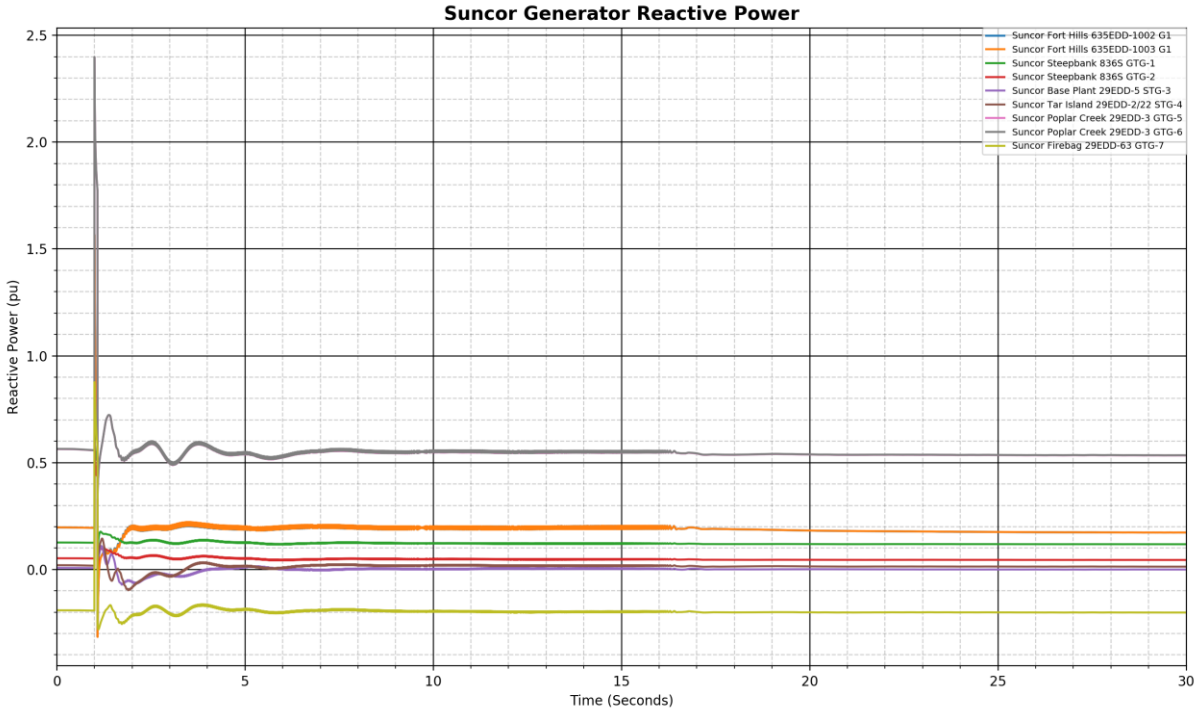

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

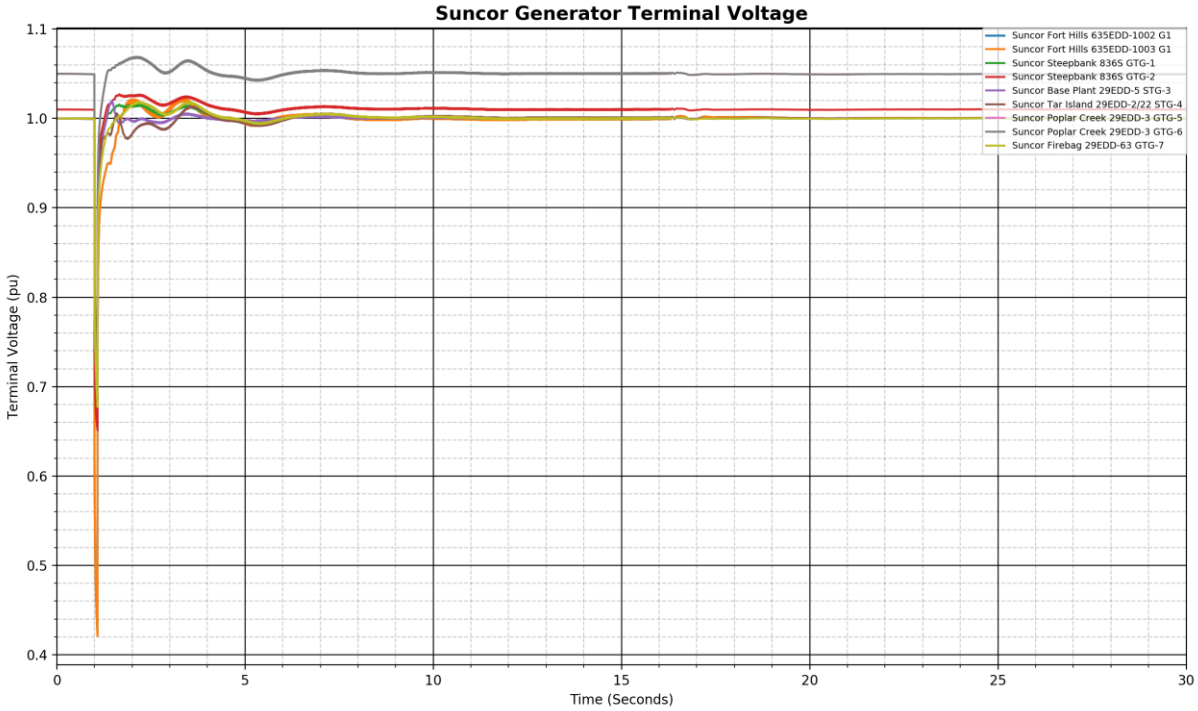

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

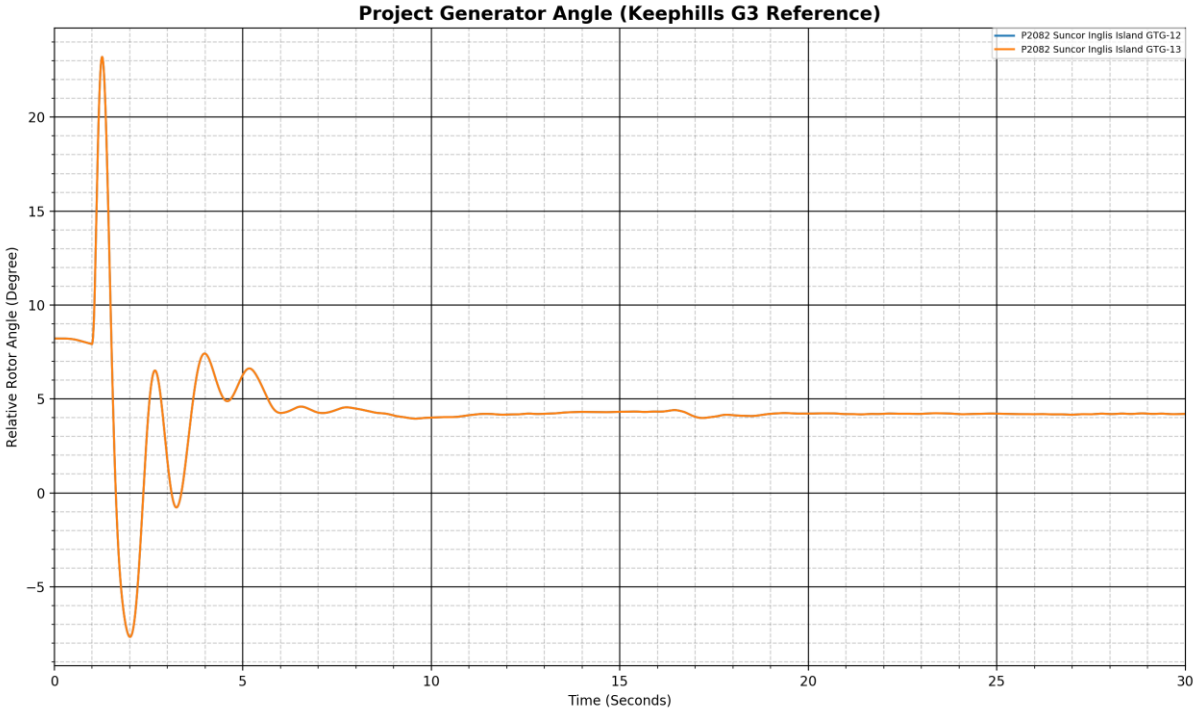

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

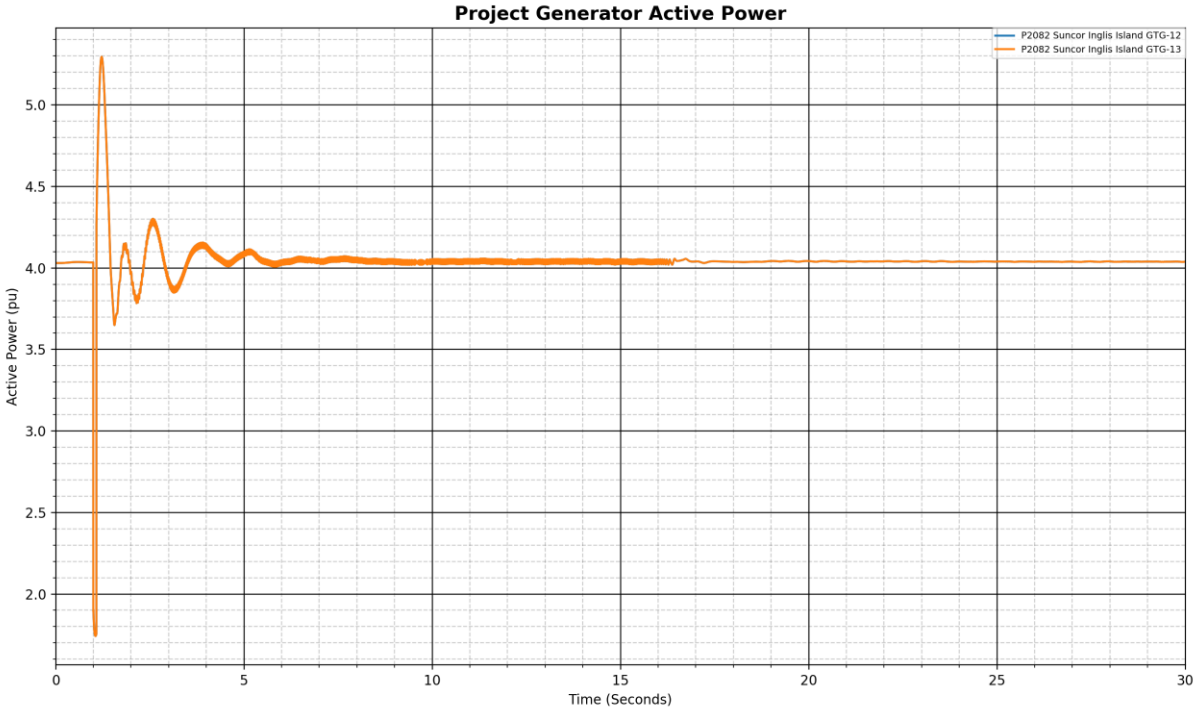

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

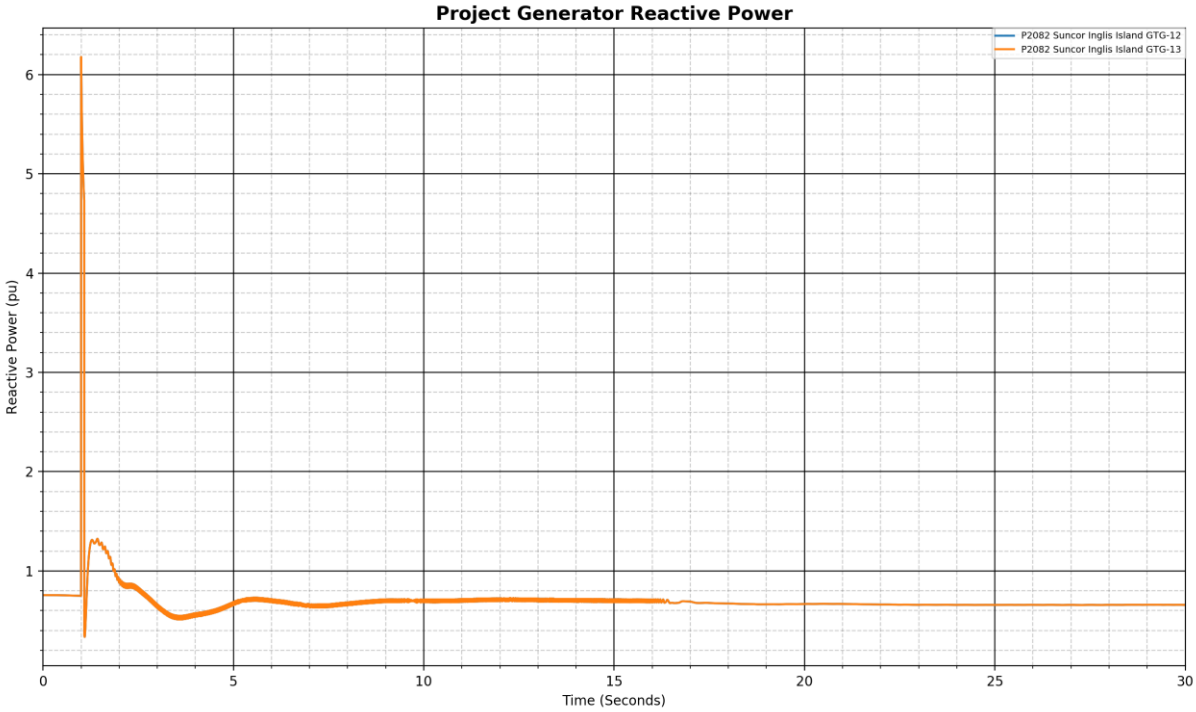

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

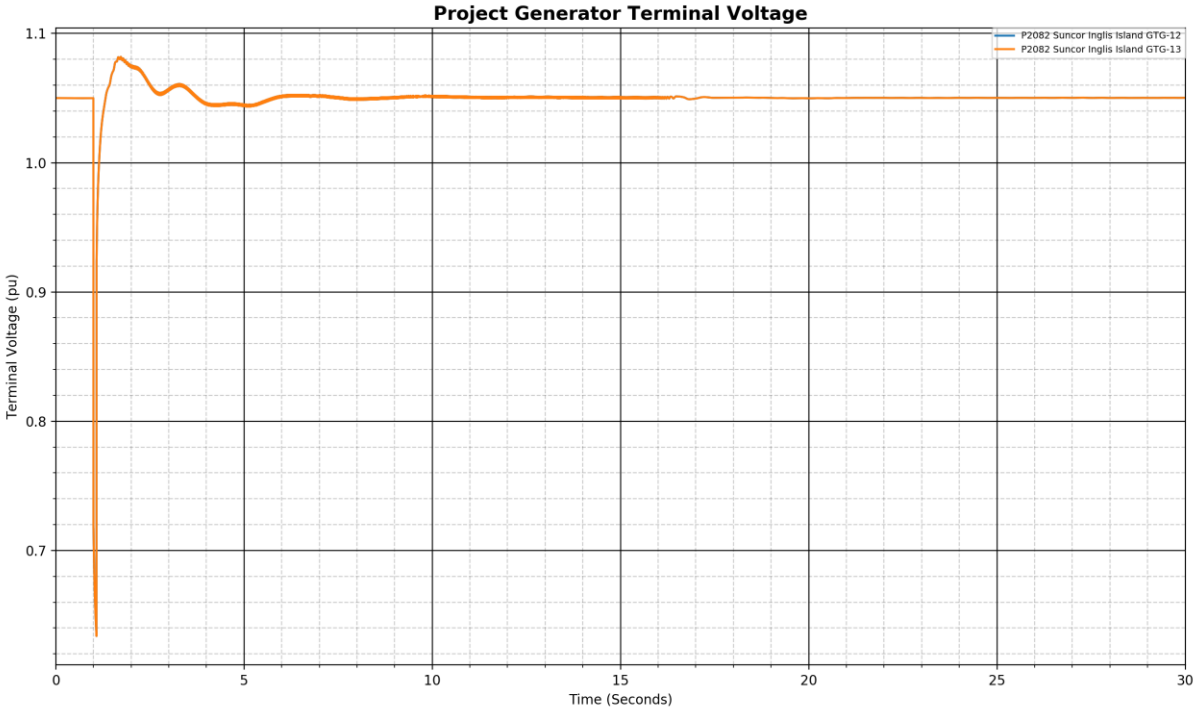

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

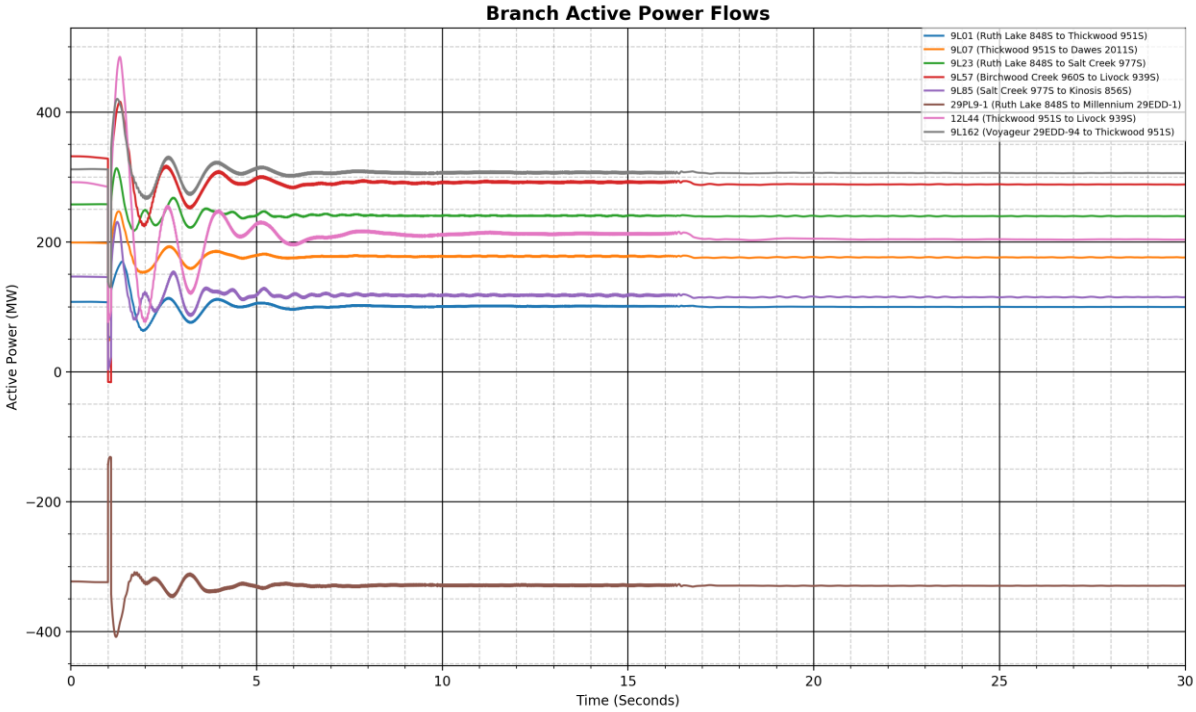

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
20
15
10
5
0
−5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
5
10
15
20
25
30
1
2
3
4
5
6


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0
5
10
15
20
25
30
0.7
0.8
0.9
1.0
1.1


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

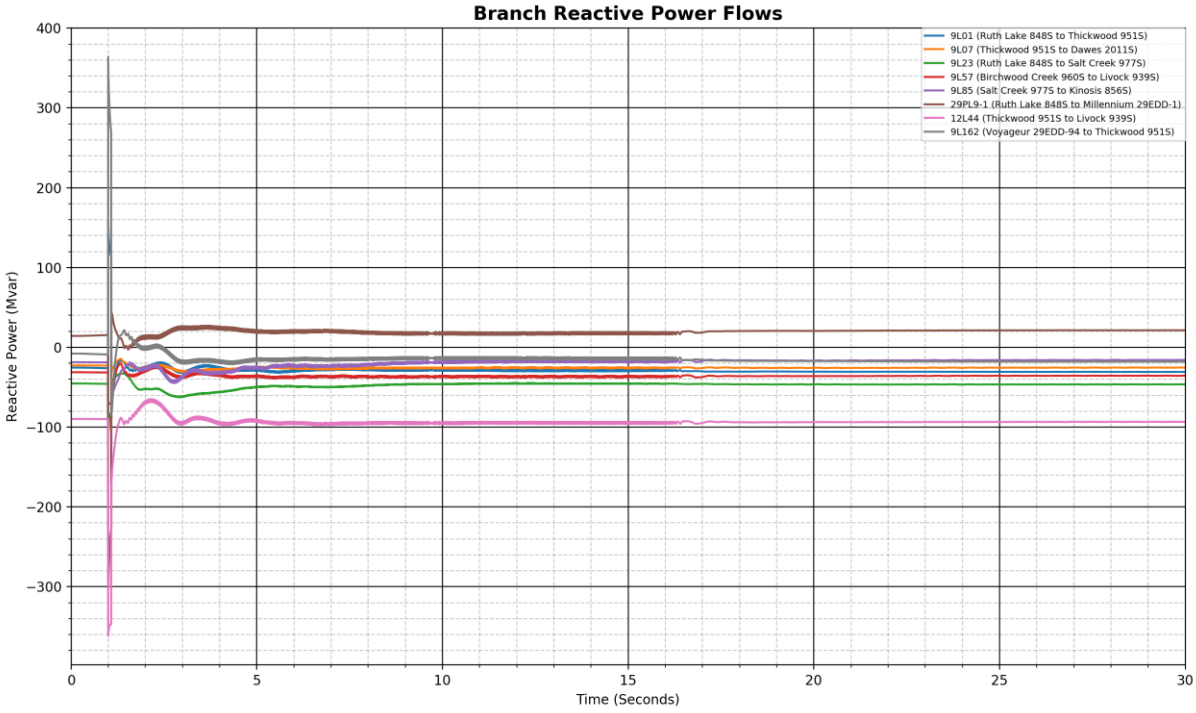
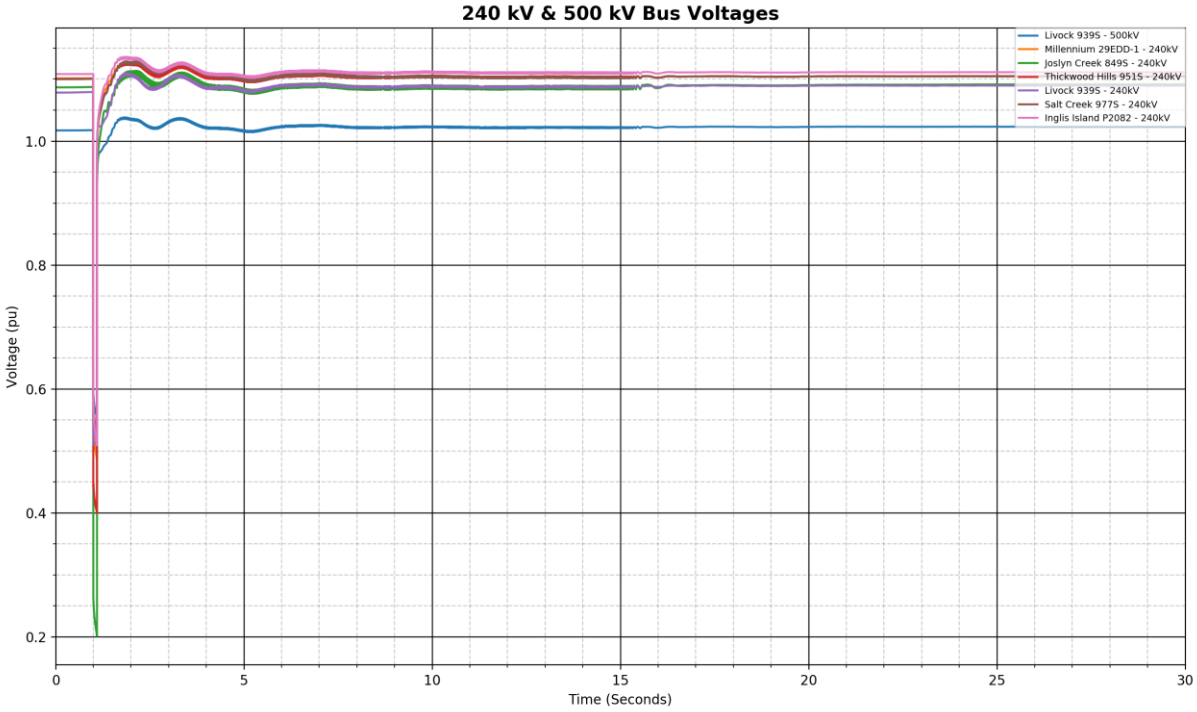
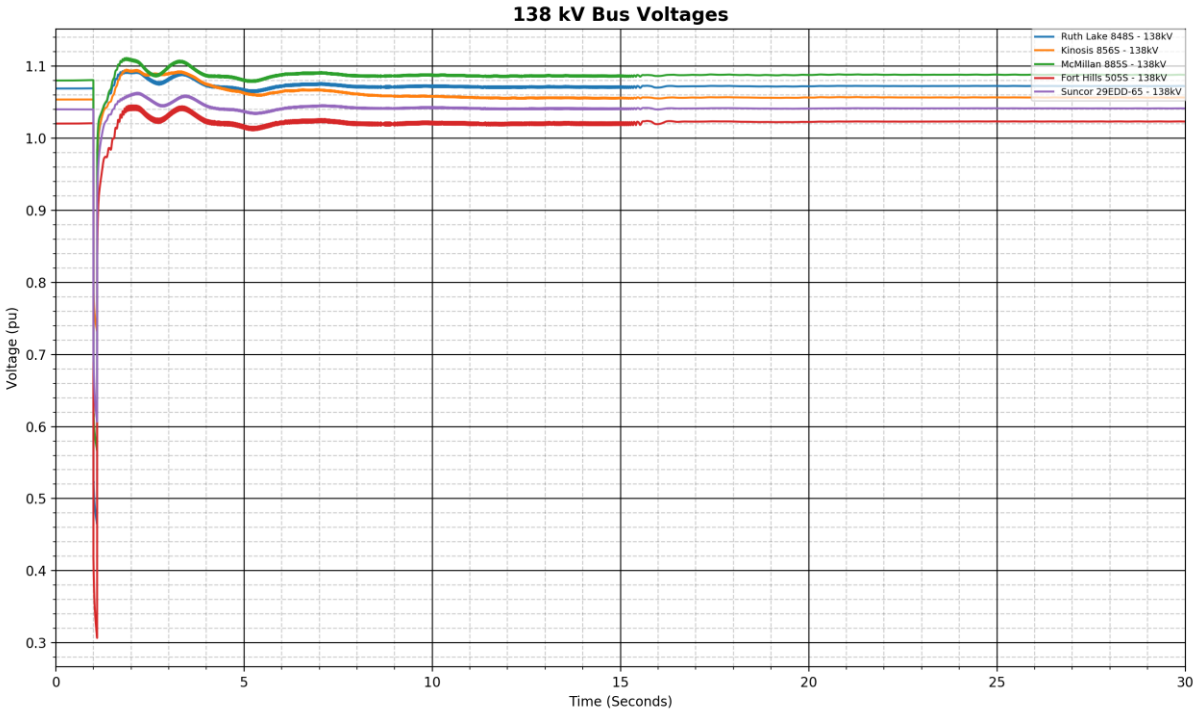
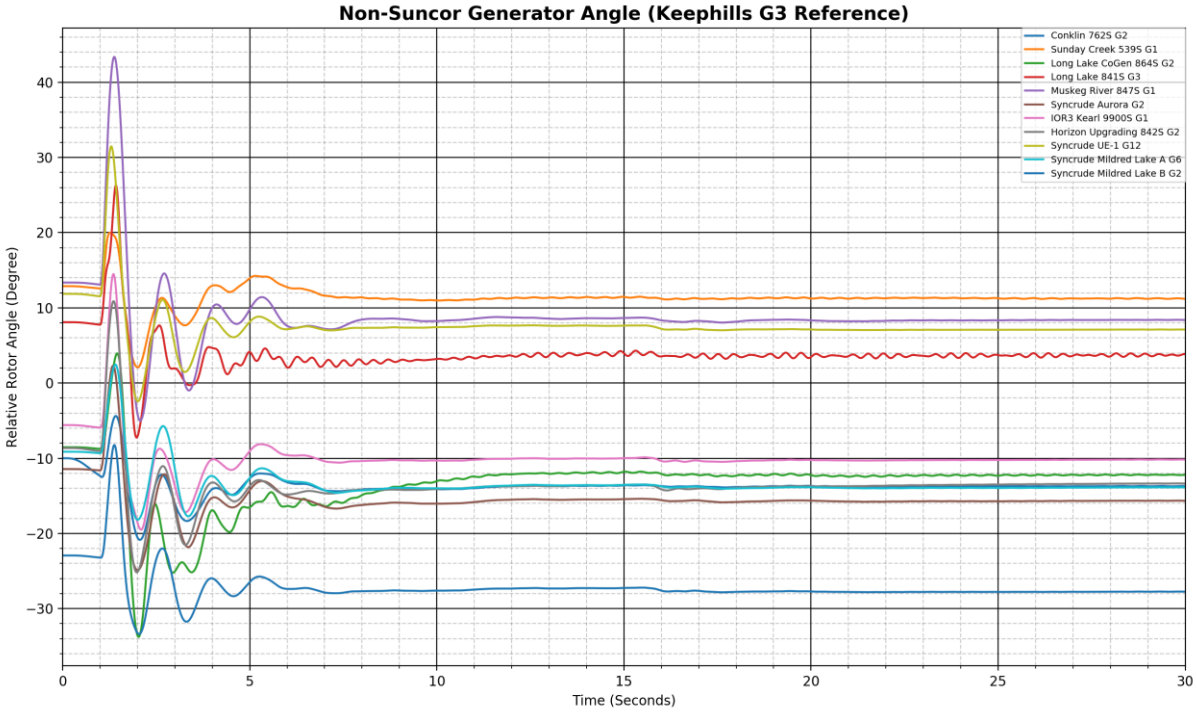
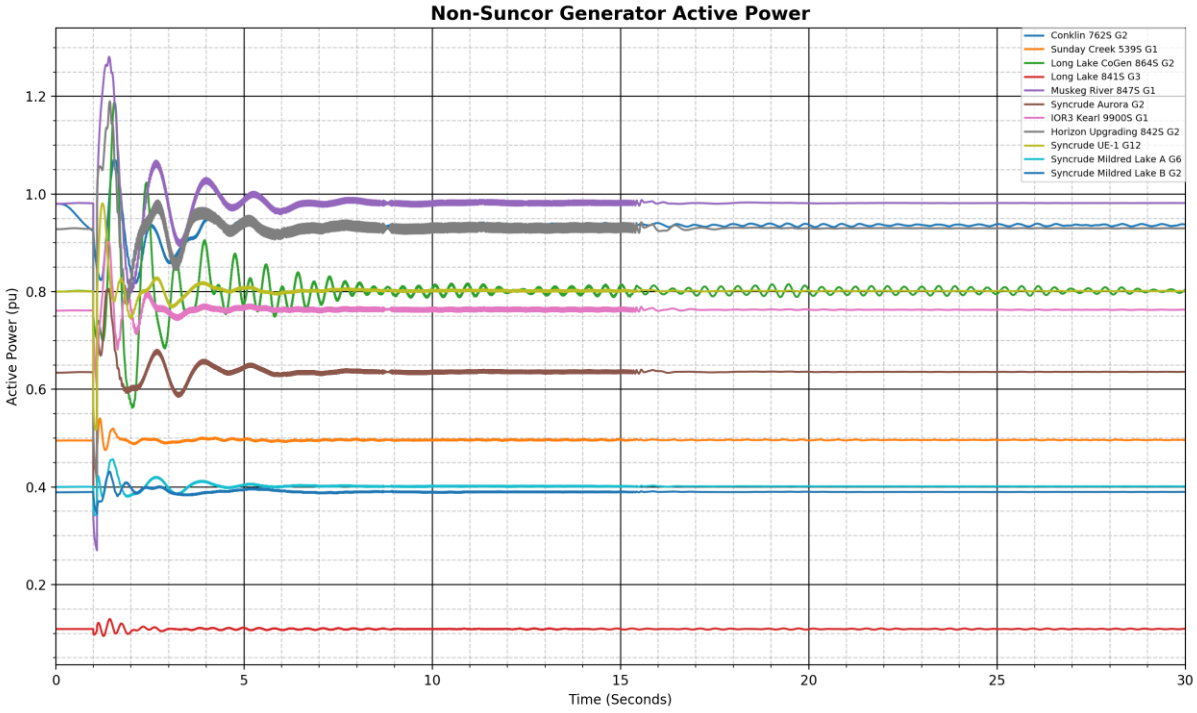

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

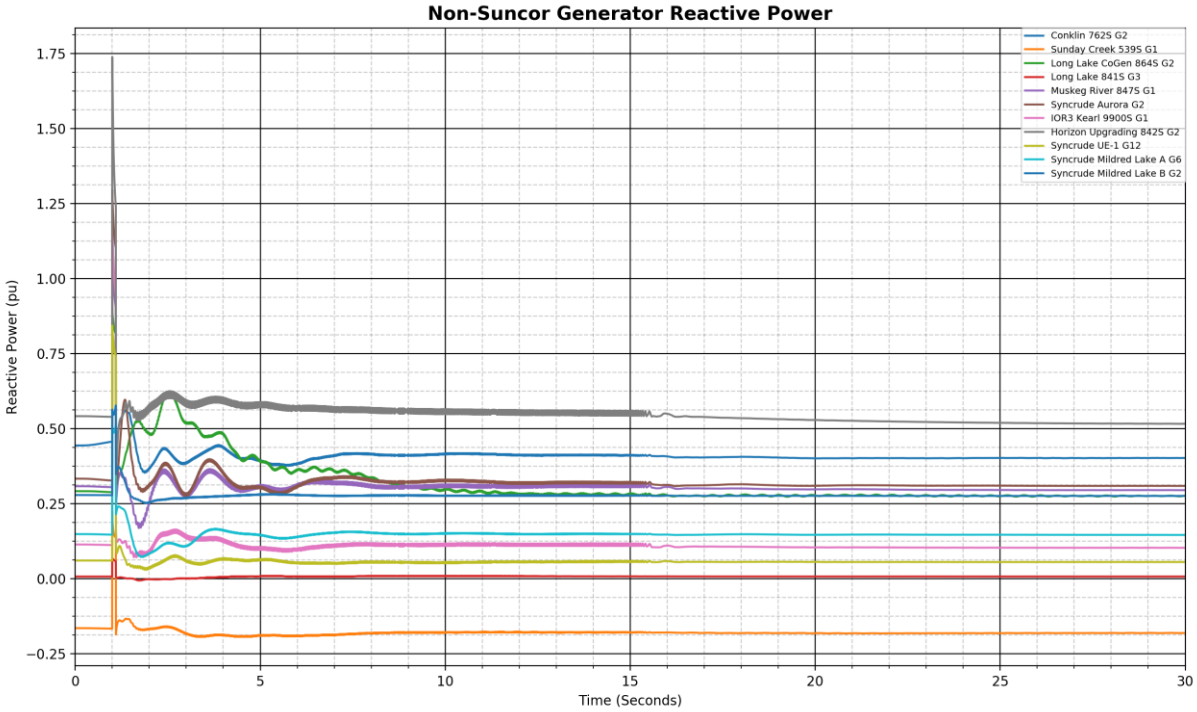
Figure A4-66: 9L43 (Dover 888S to Mackay River 874S): Fault at Mackay River 874S

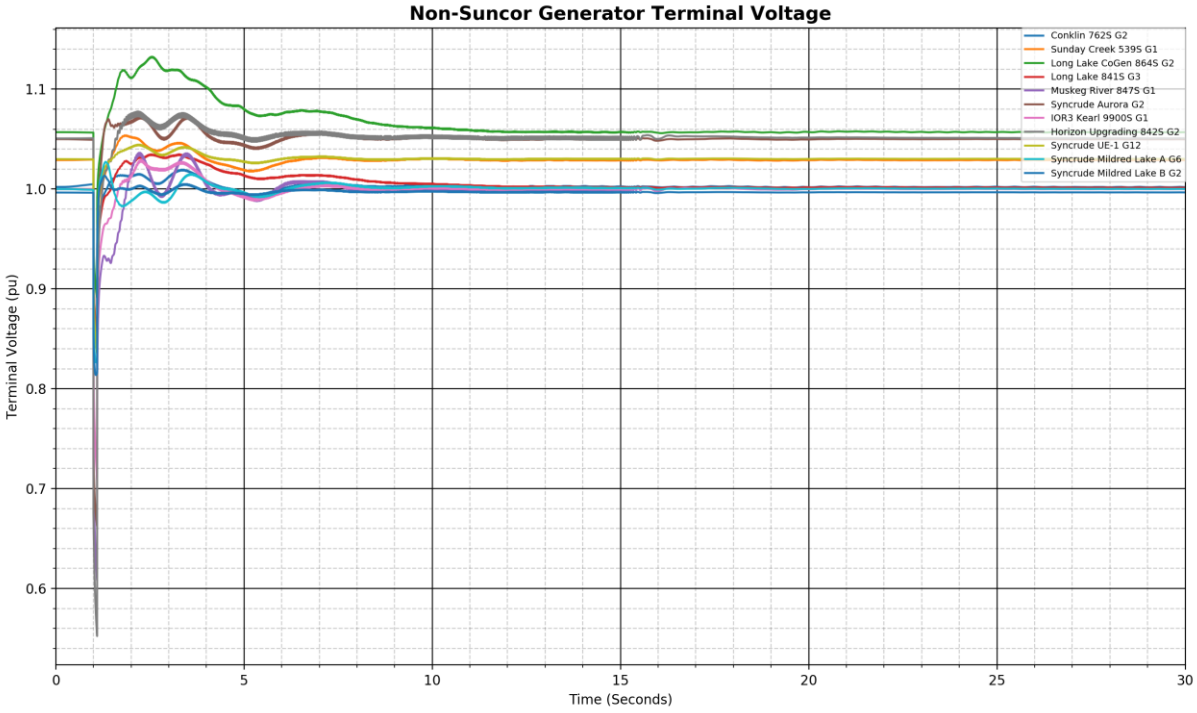


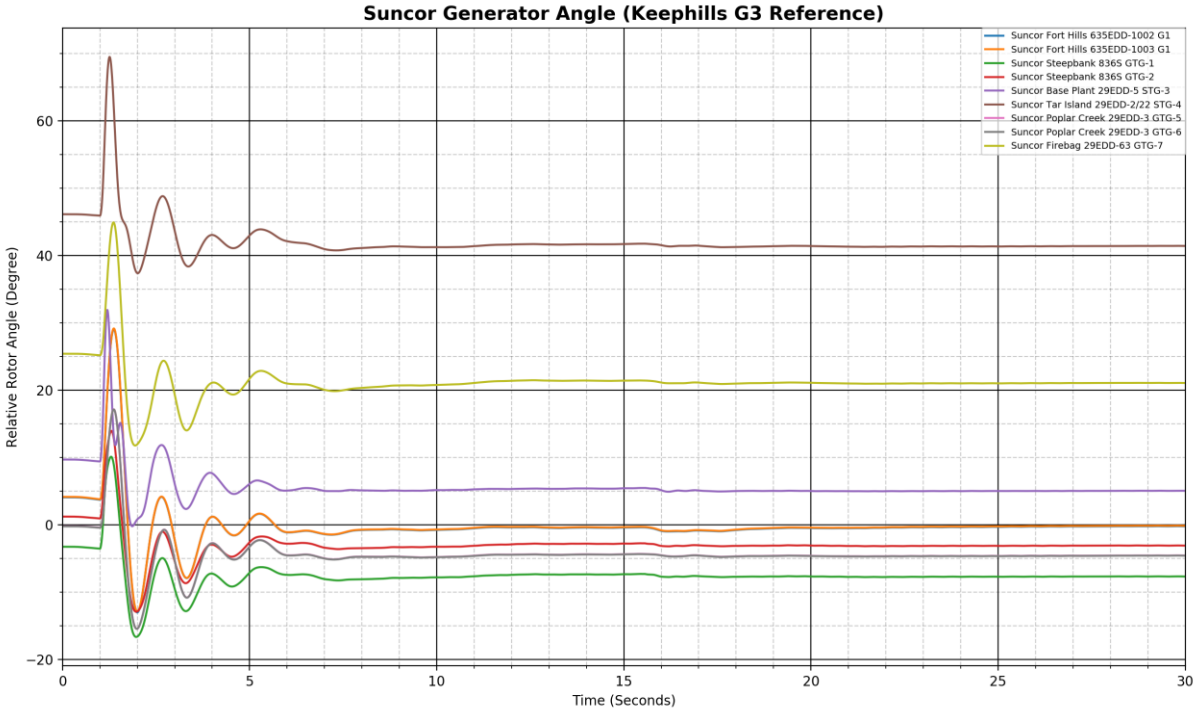


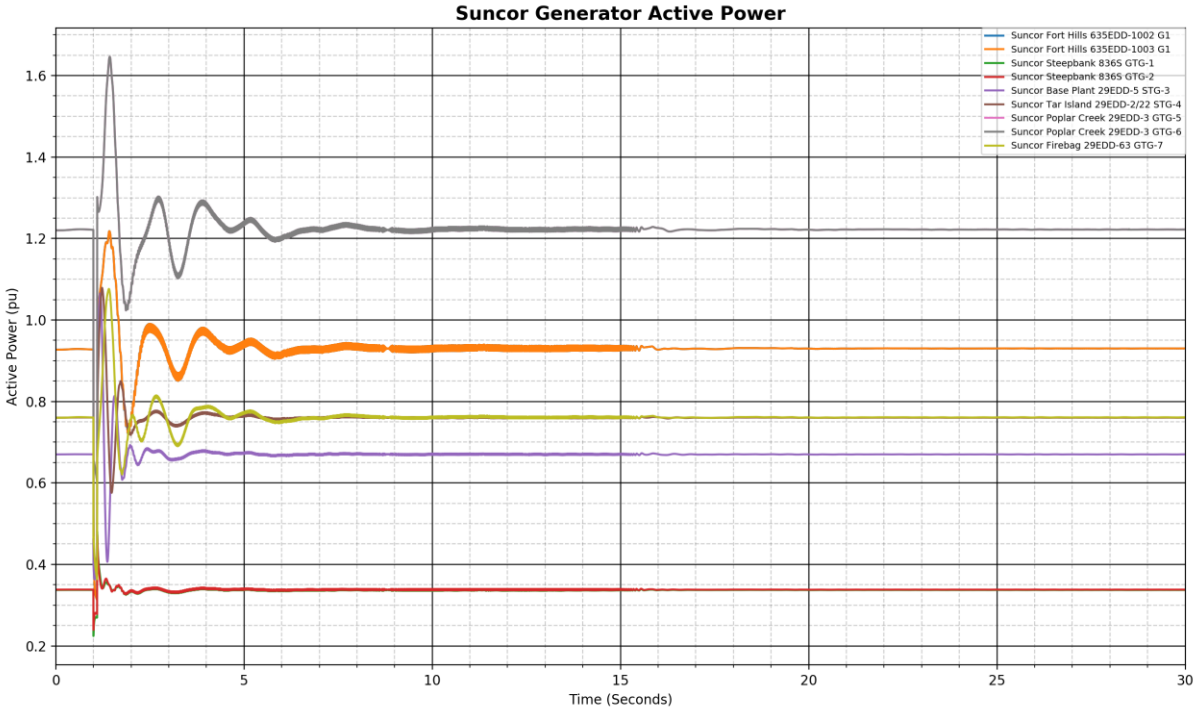

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

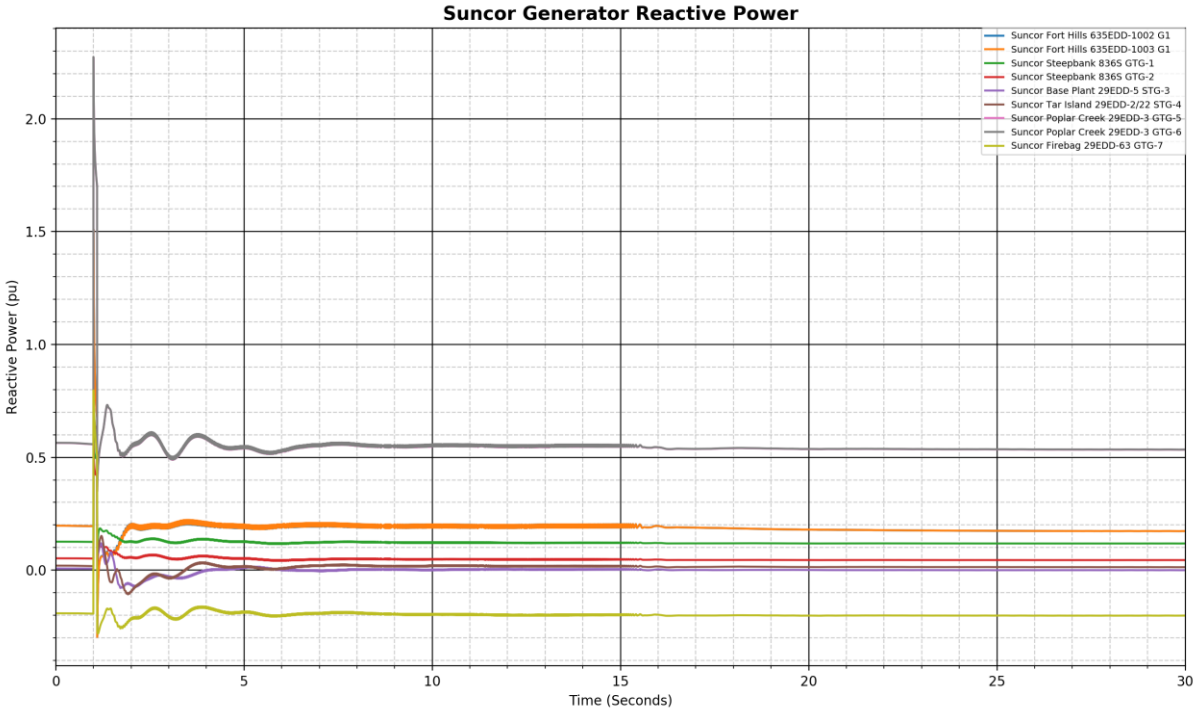

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

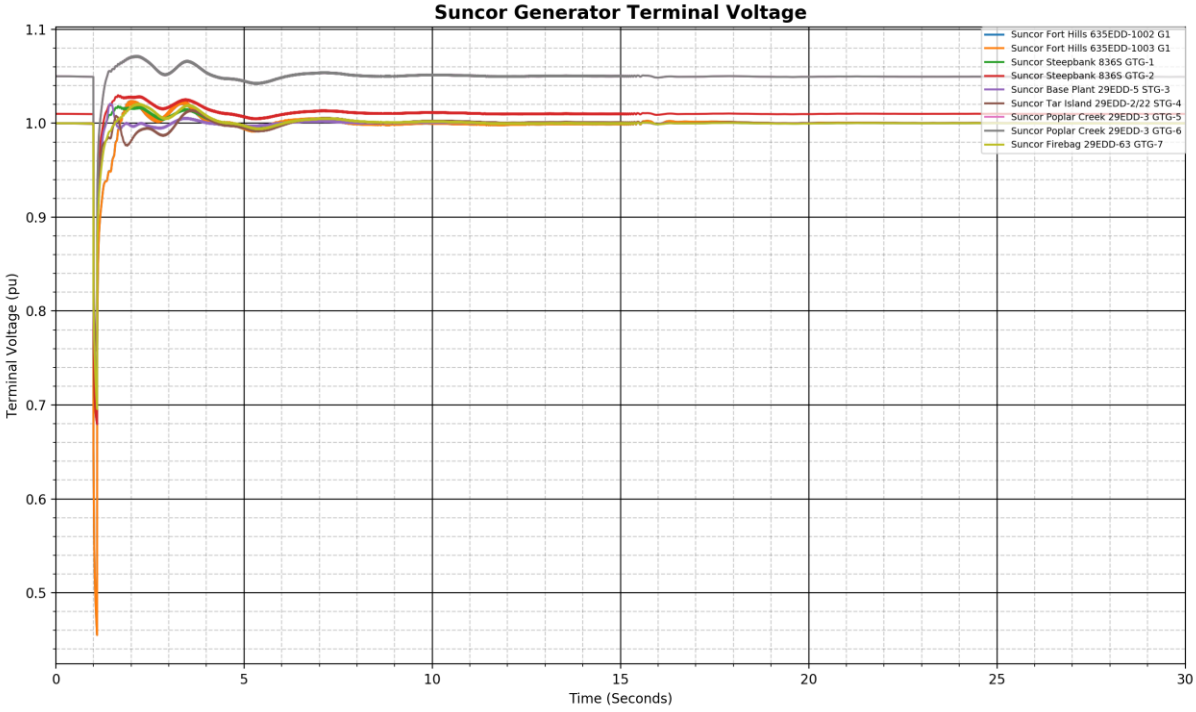

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

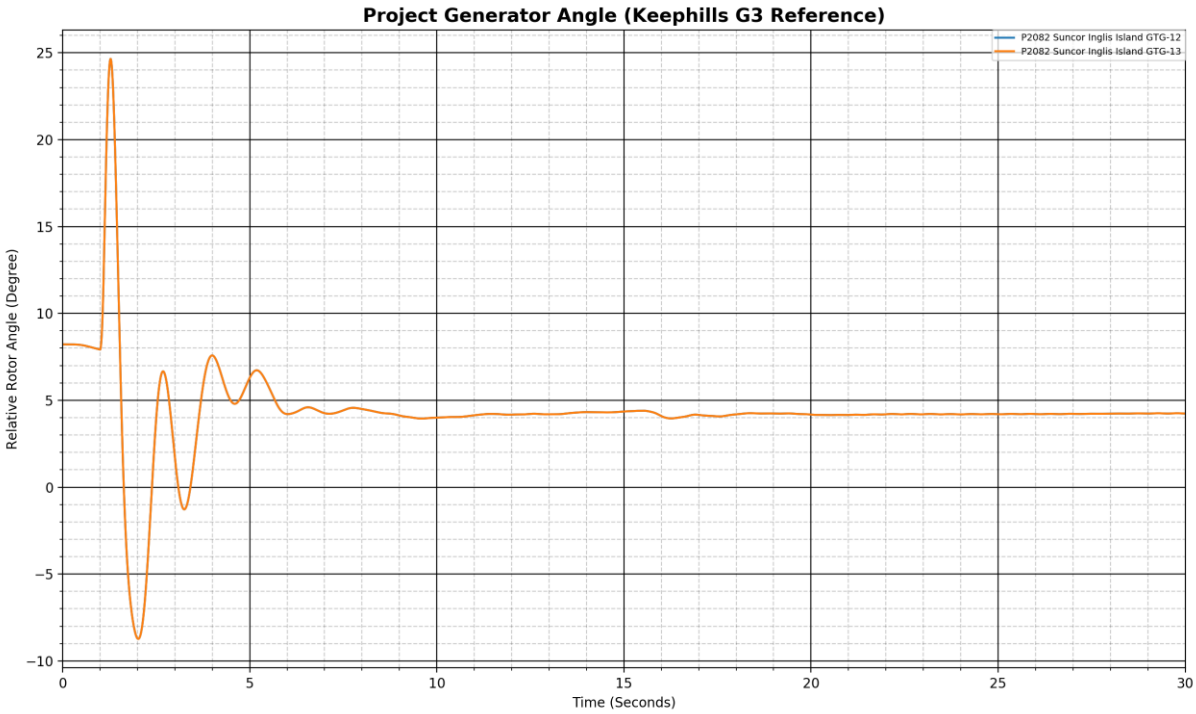

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

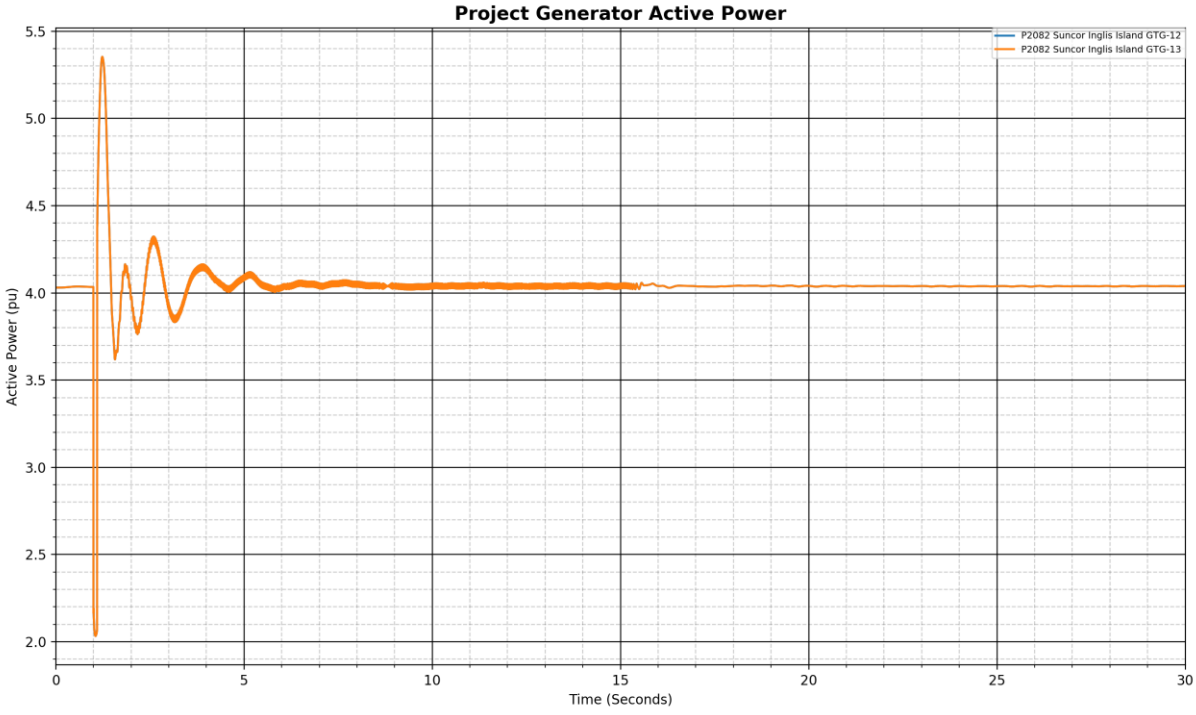

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

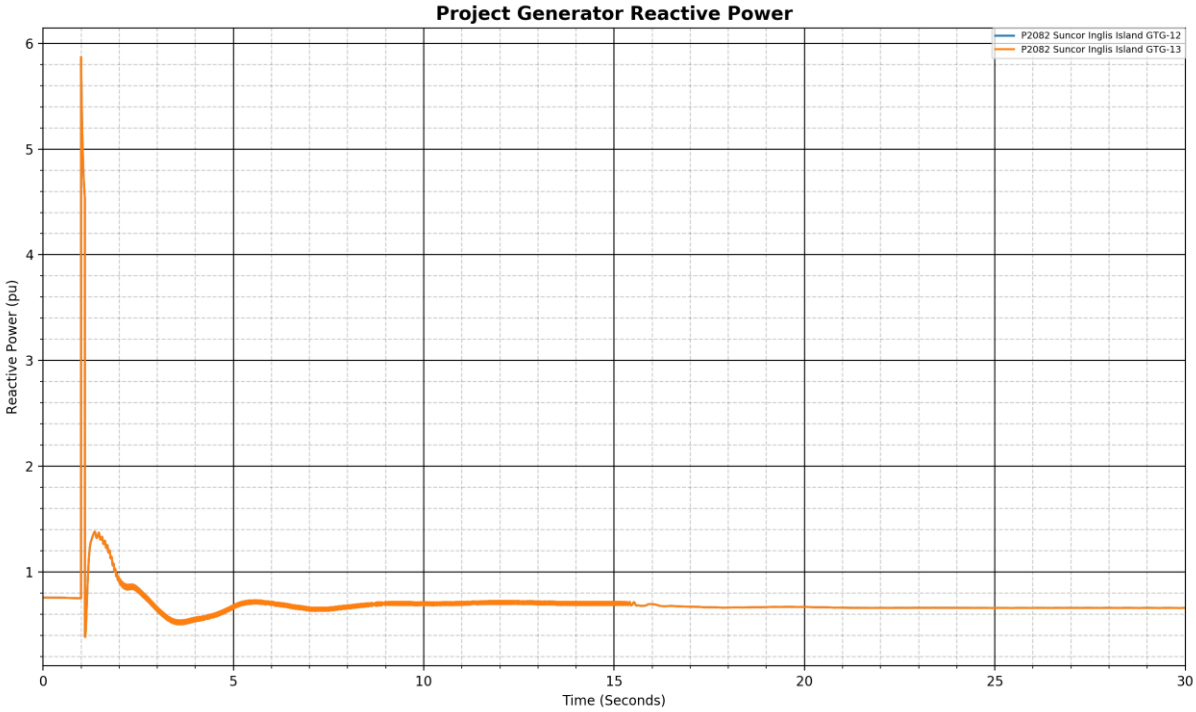

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

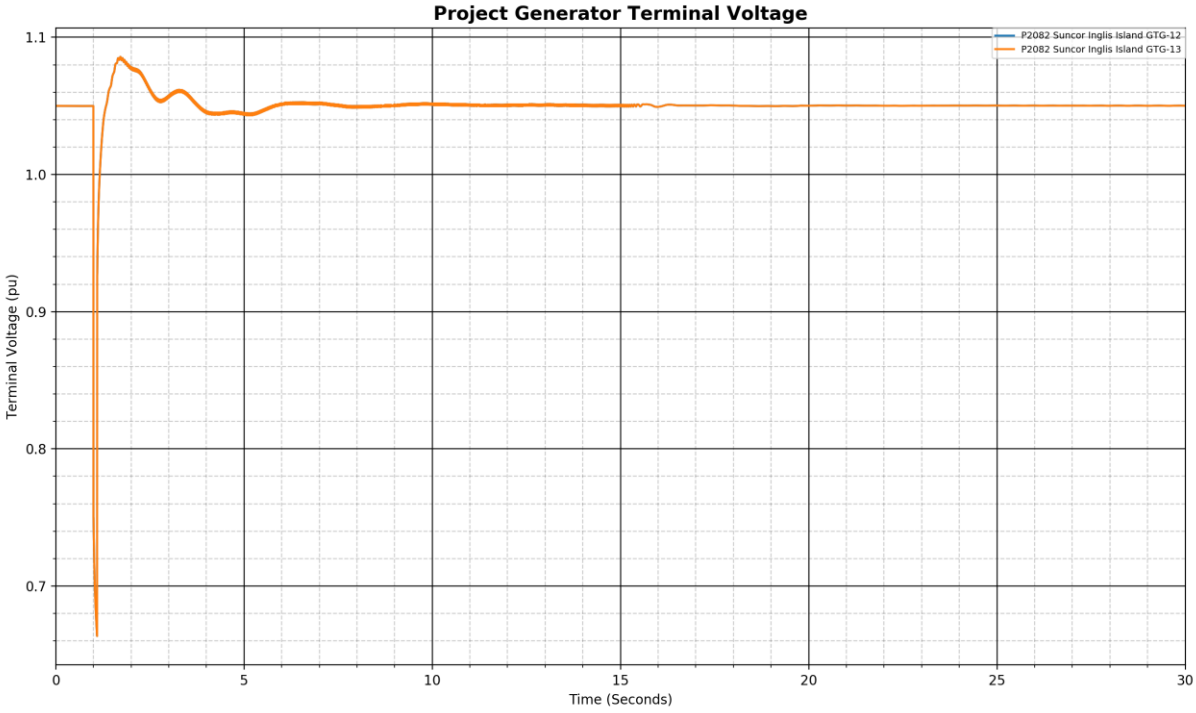

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

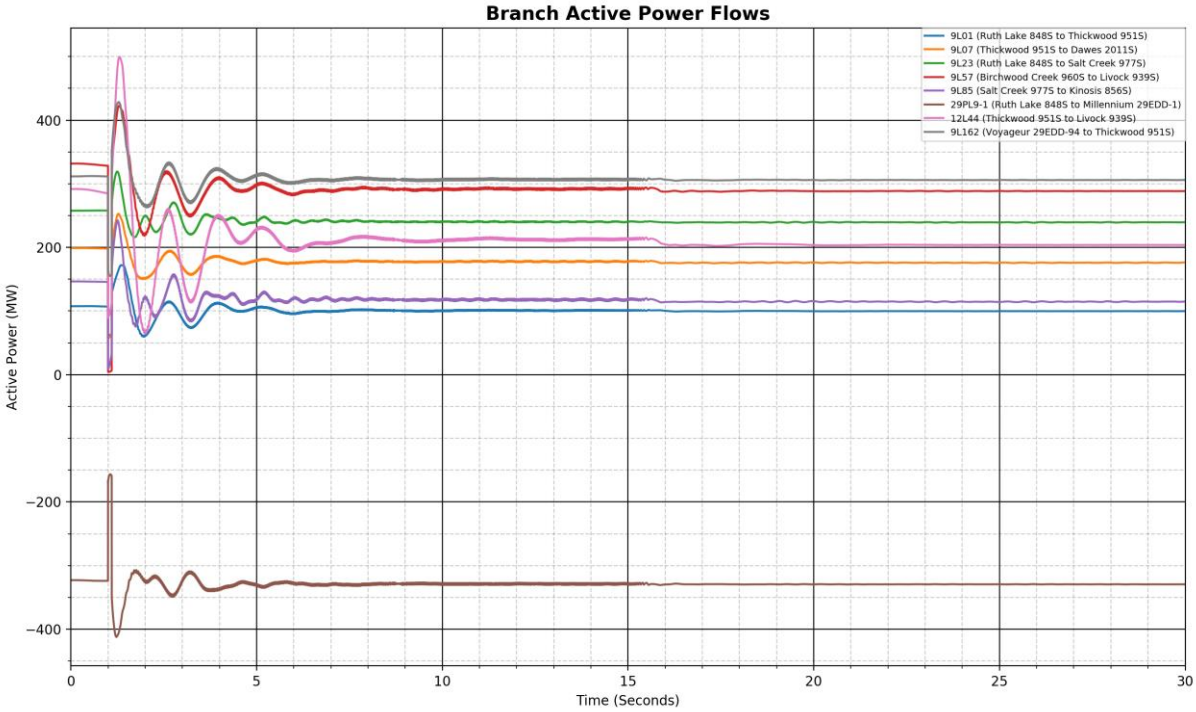

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
5
10
15
20
25
30
1
2
3
4
5
6


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0
5
10
15
20
25
30
0.7
0.8
0.9
1.0
1.1


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

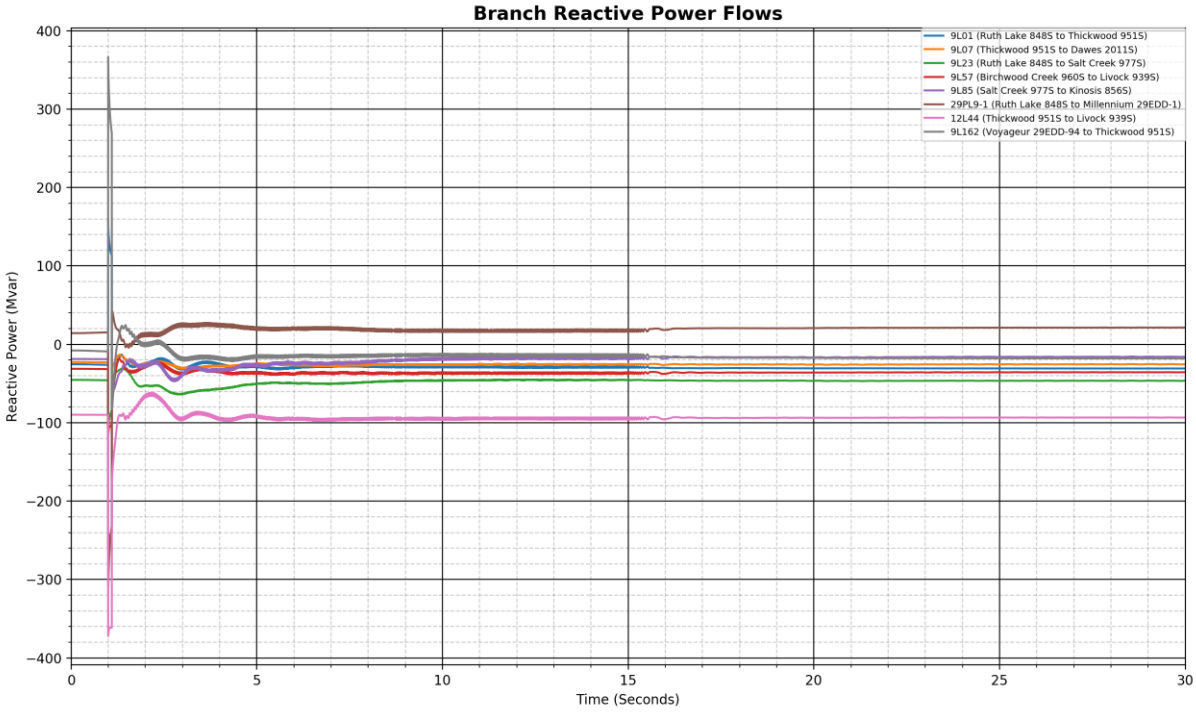
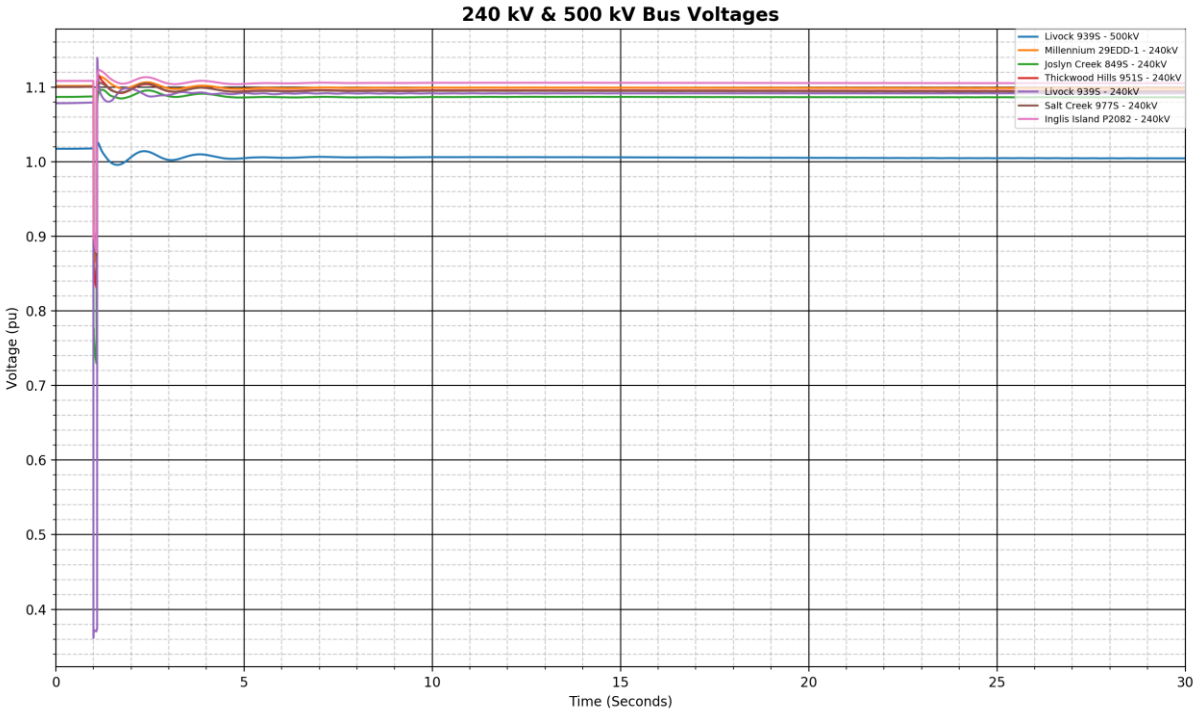
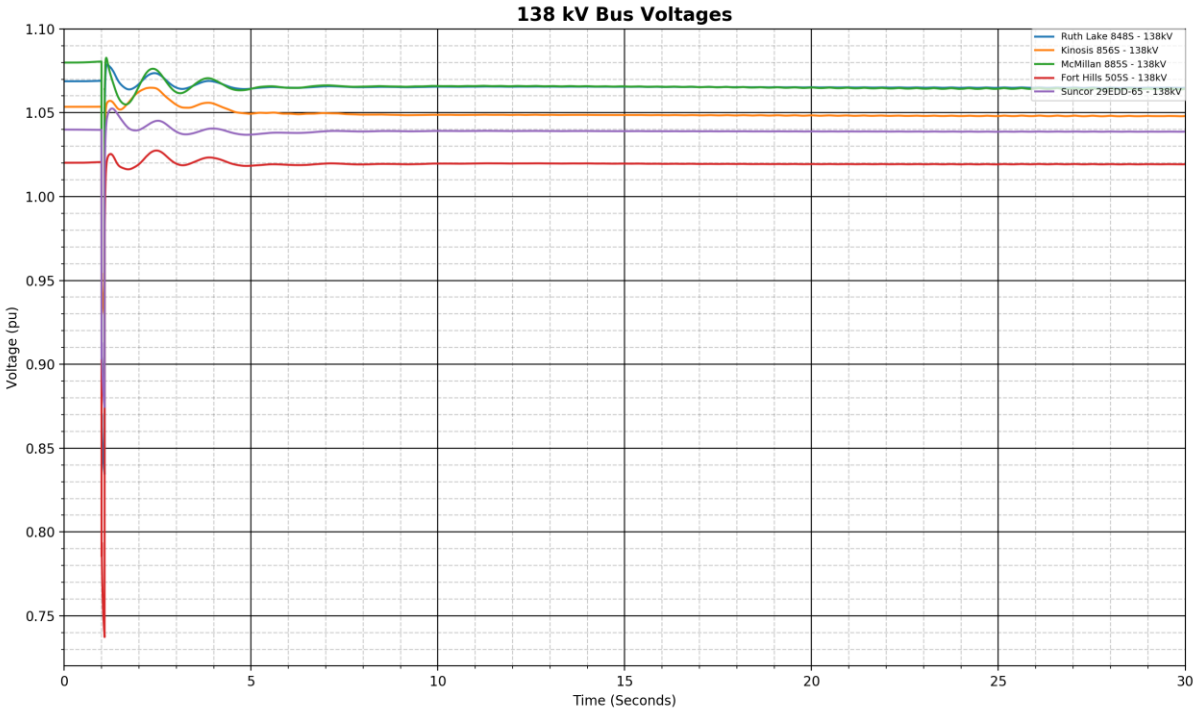
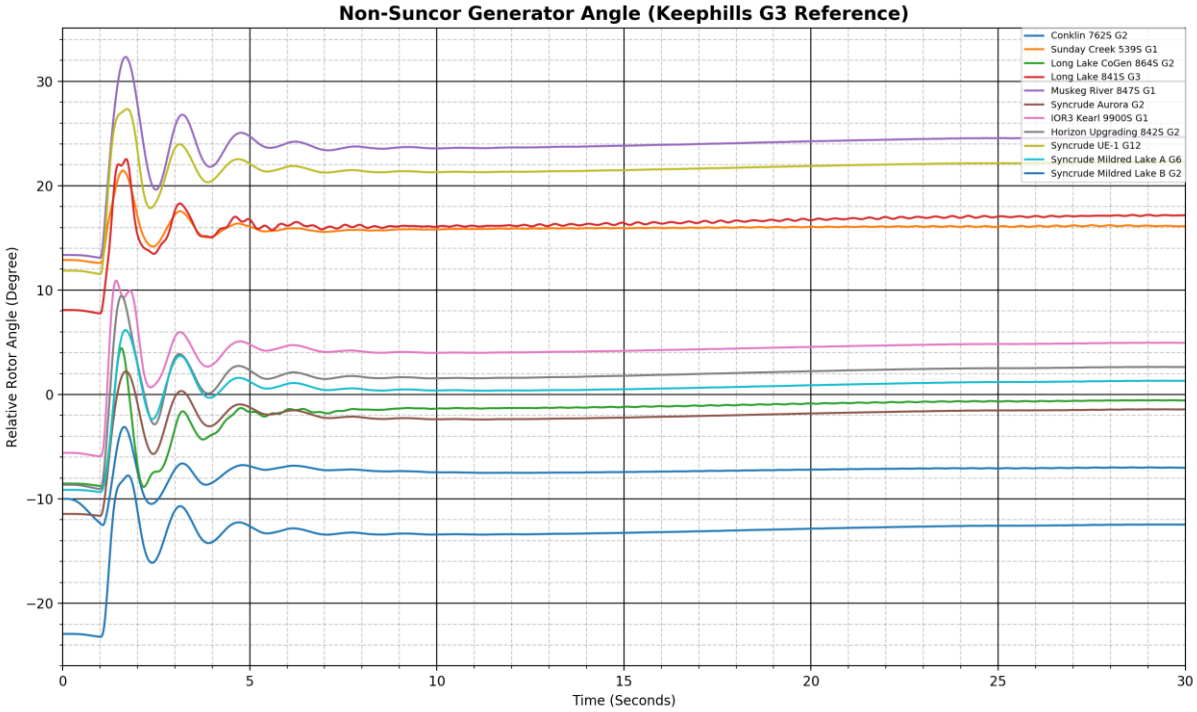
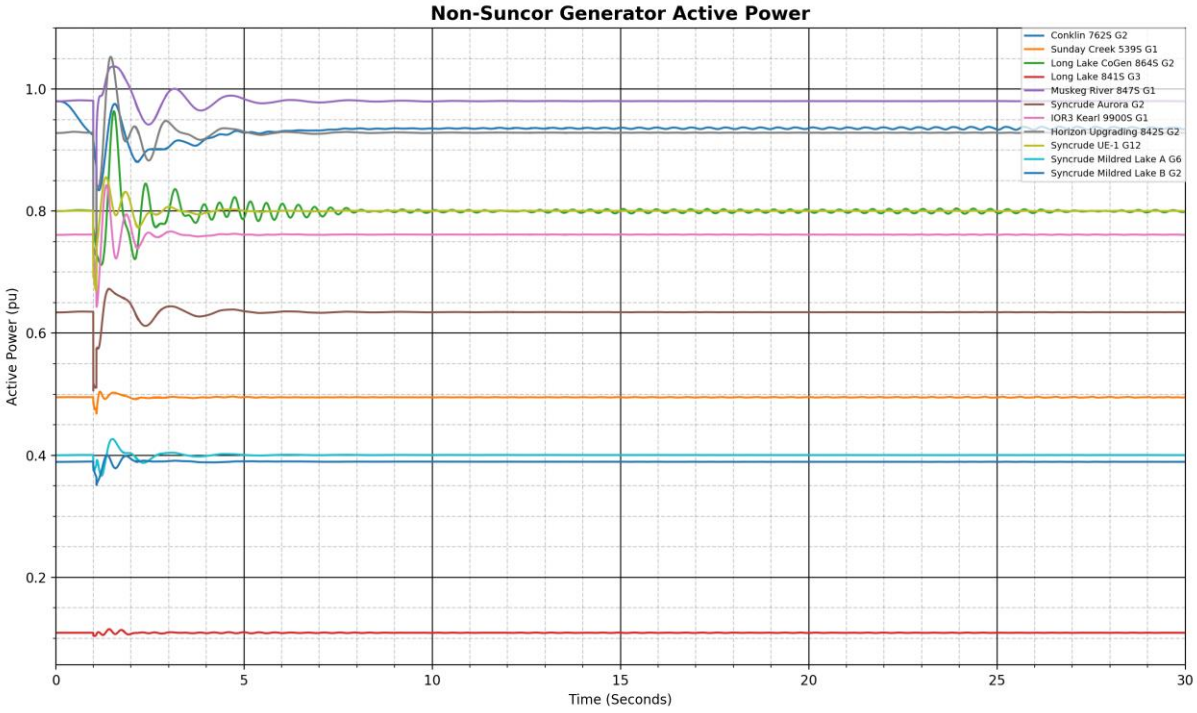

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

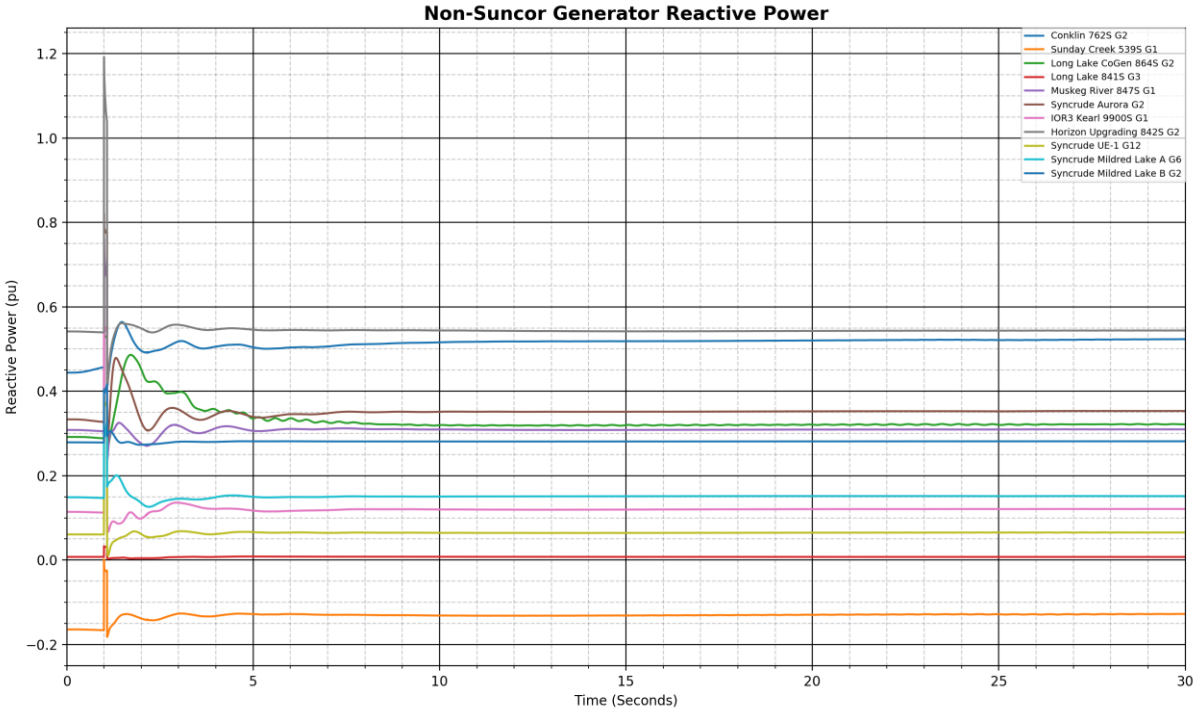
Figure A4-67: 9L57 (9L57 Birchwood Creek 960S to Livock 939S): Fault at Birchwood Creek 960S

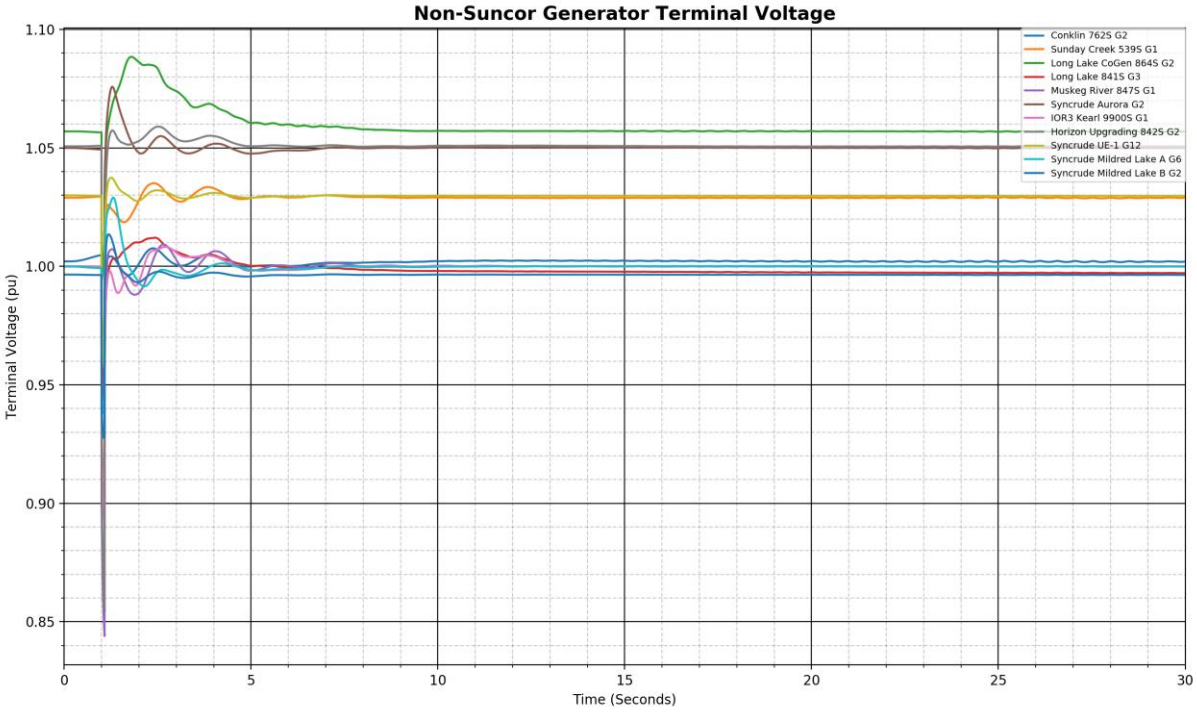


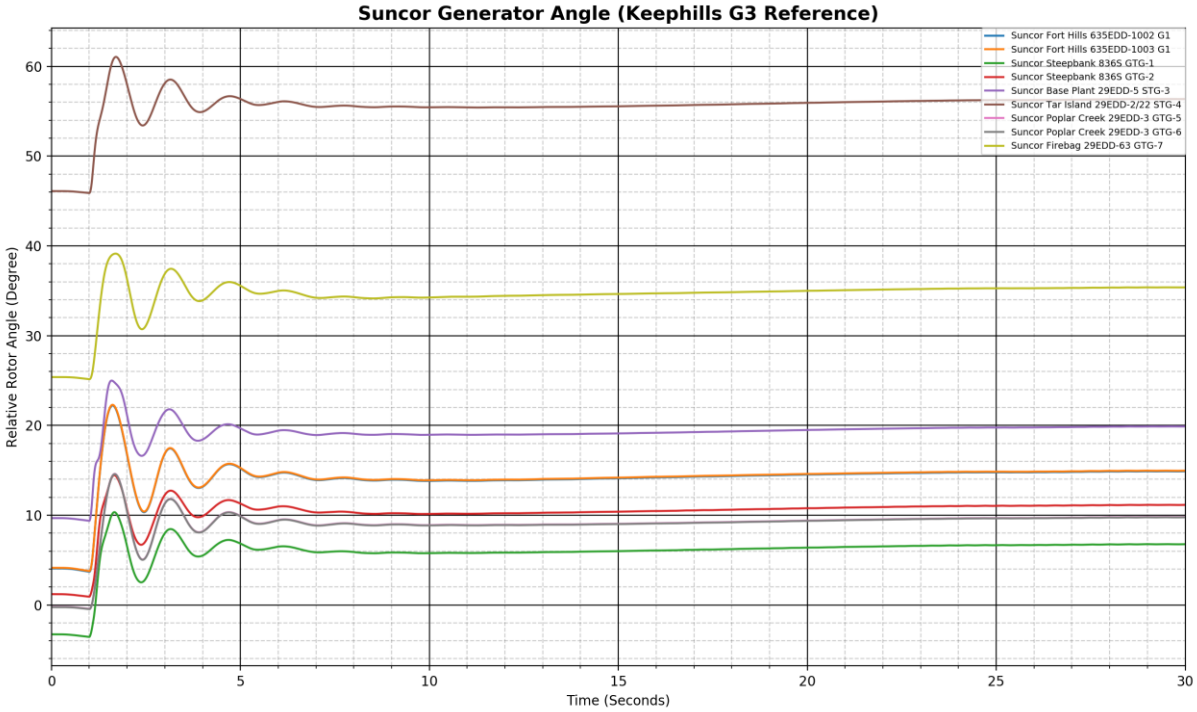


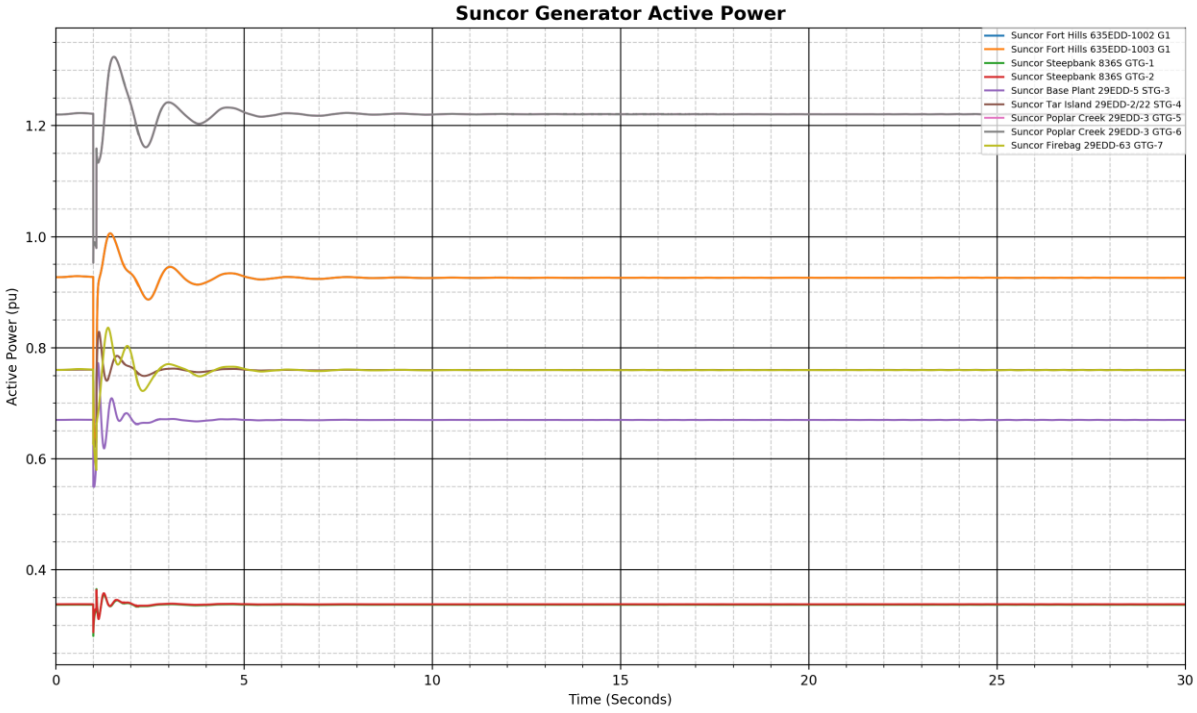

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

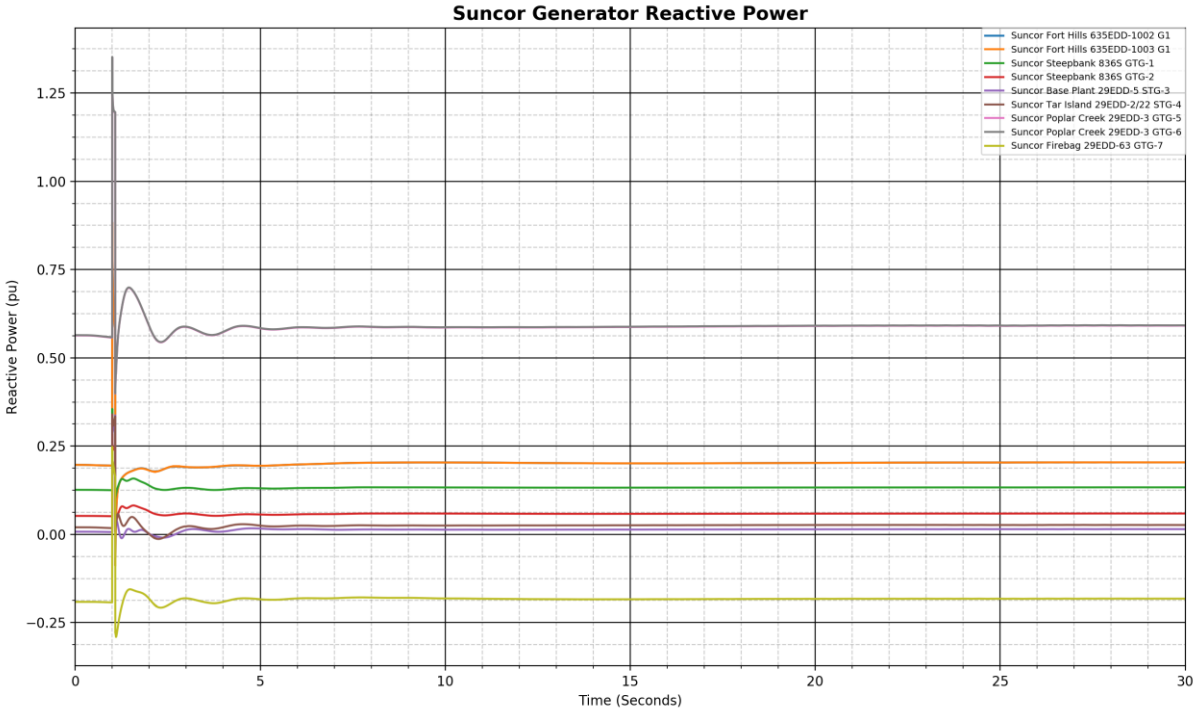

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

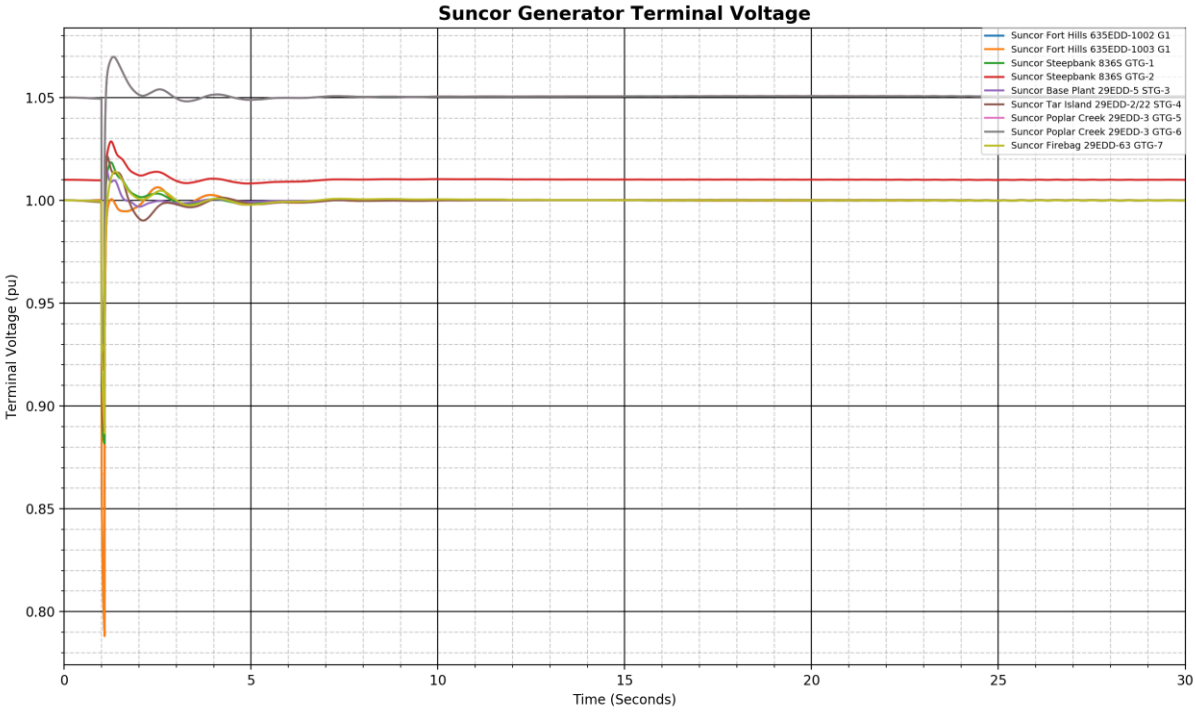

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

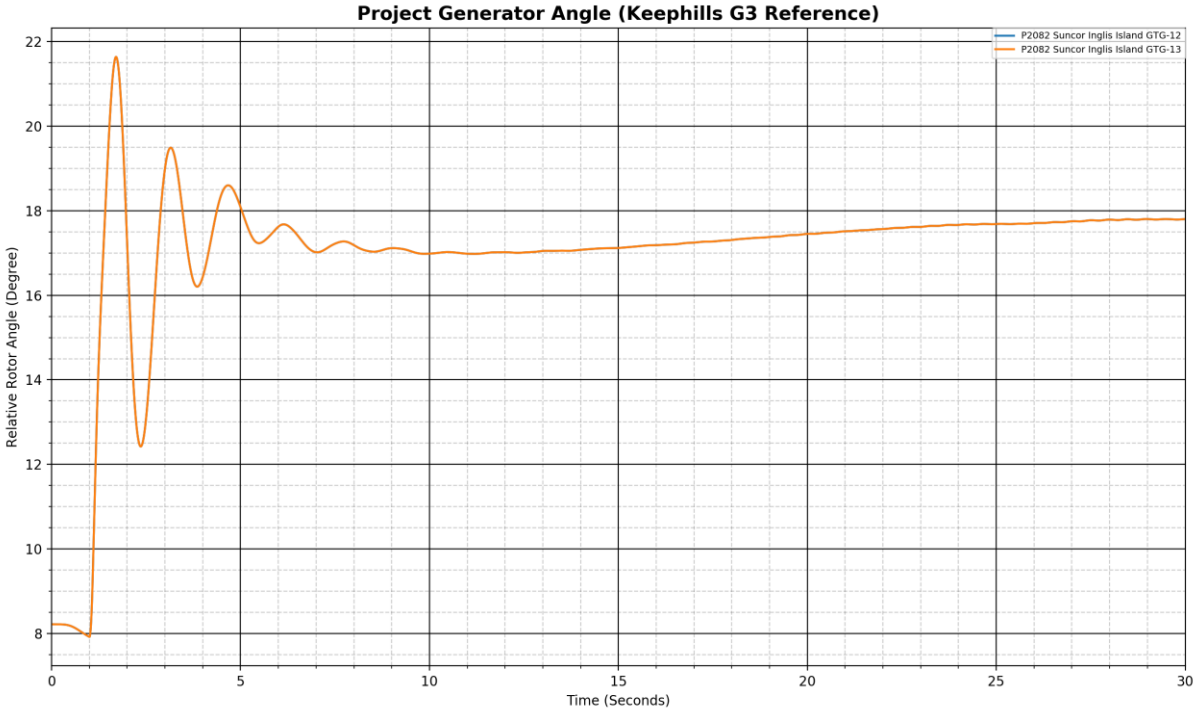

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

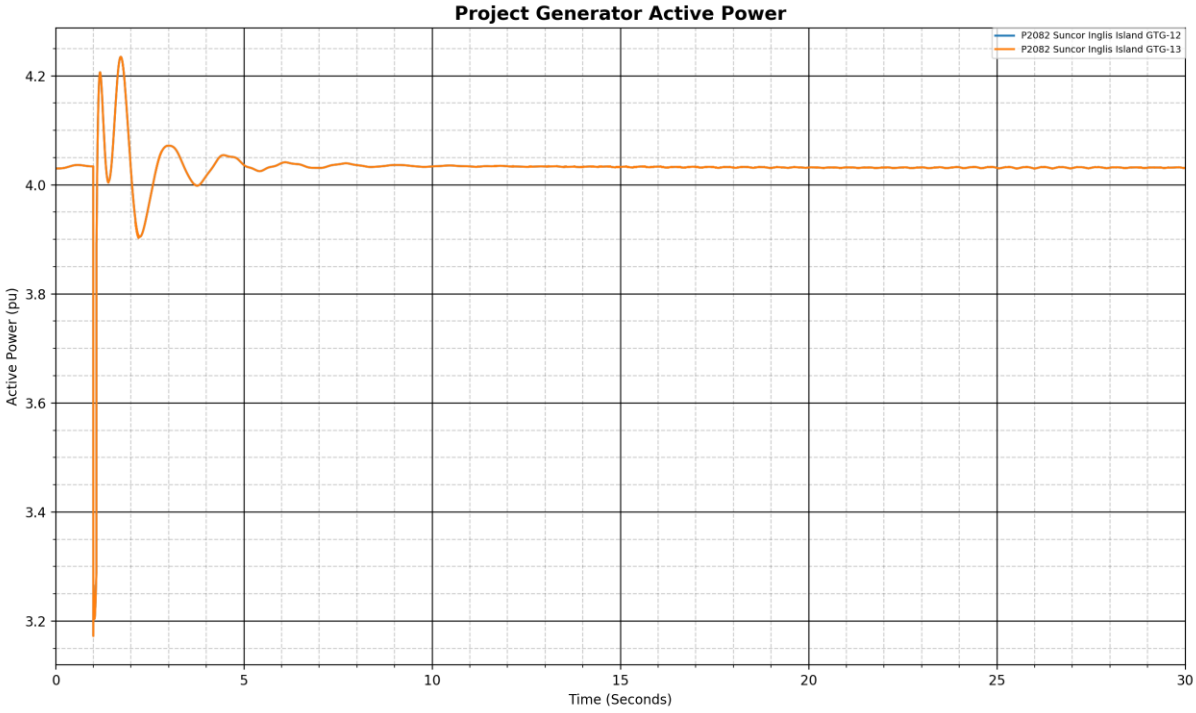

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

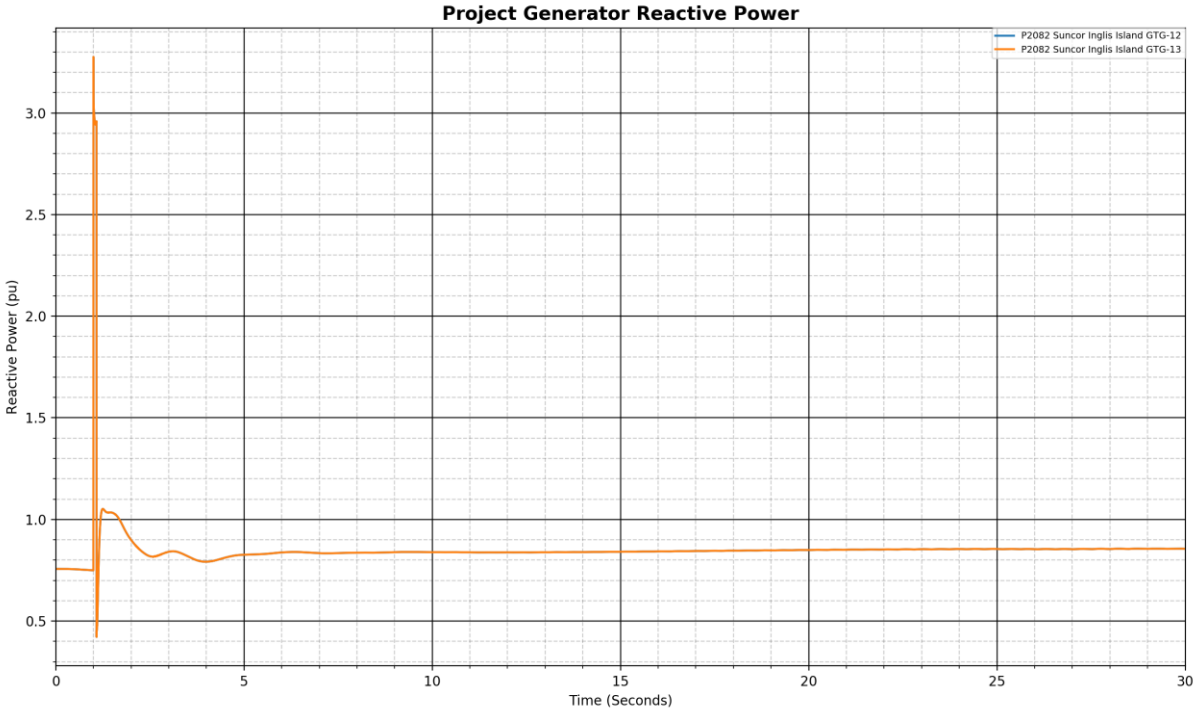

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

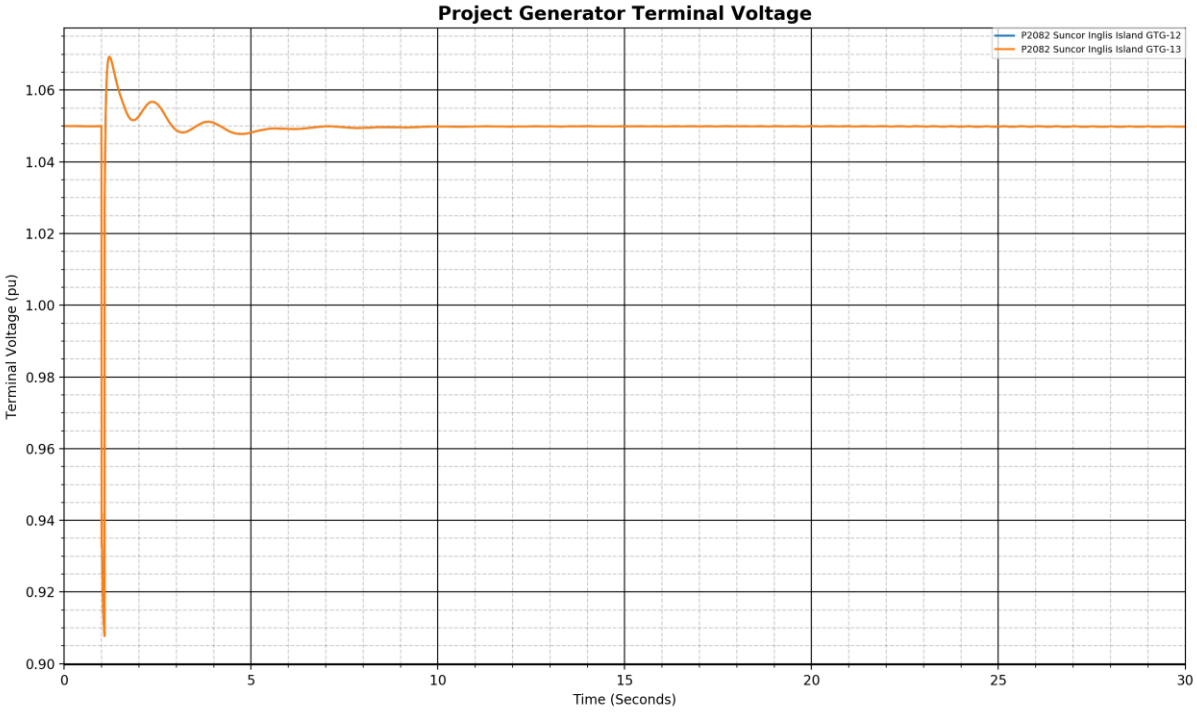

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

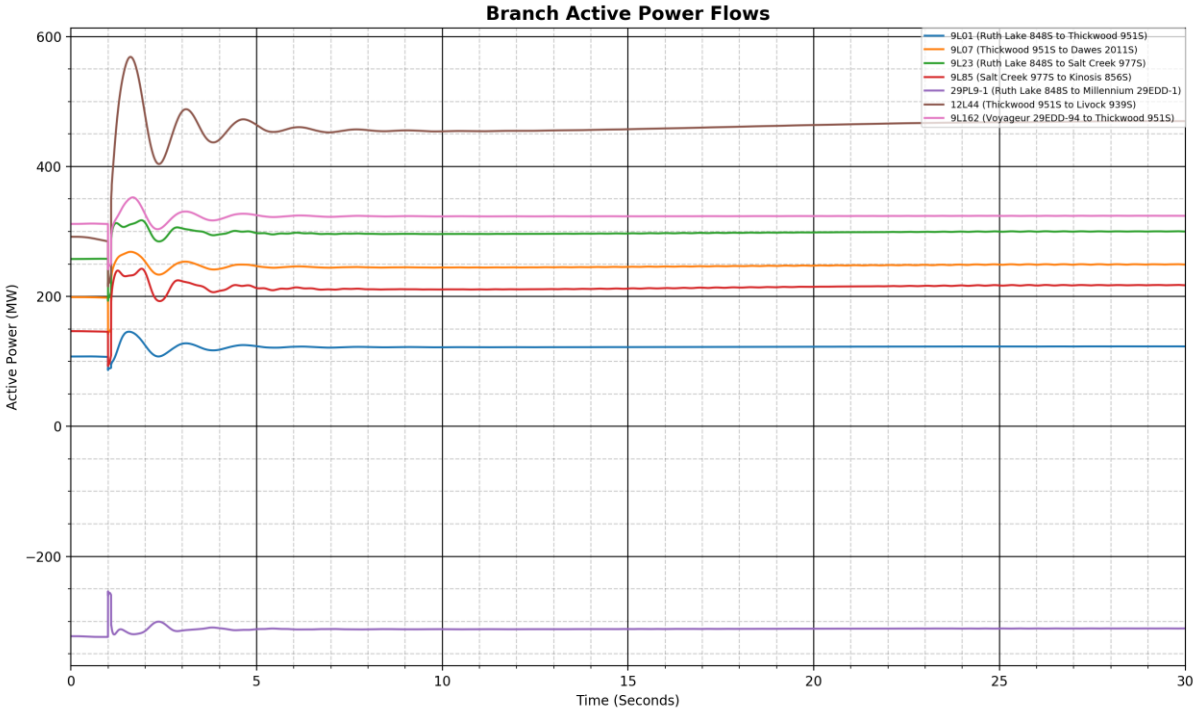

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
22
20
18
16
14
12
10
8
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
4.2
4.0
3.8
3.6
3.4
3.2
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

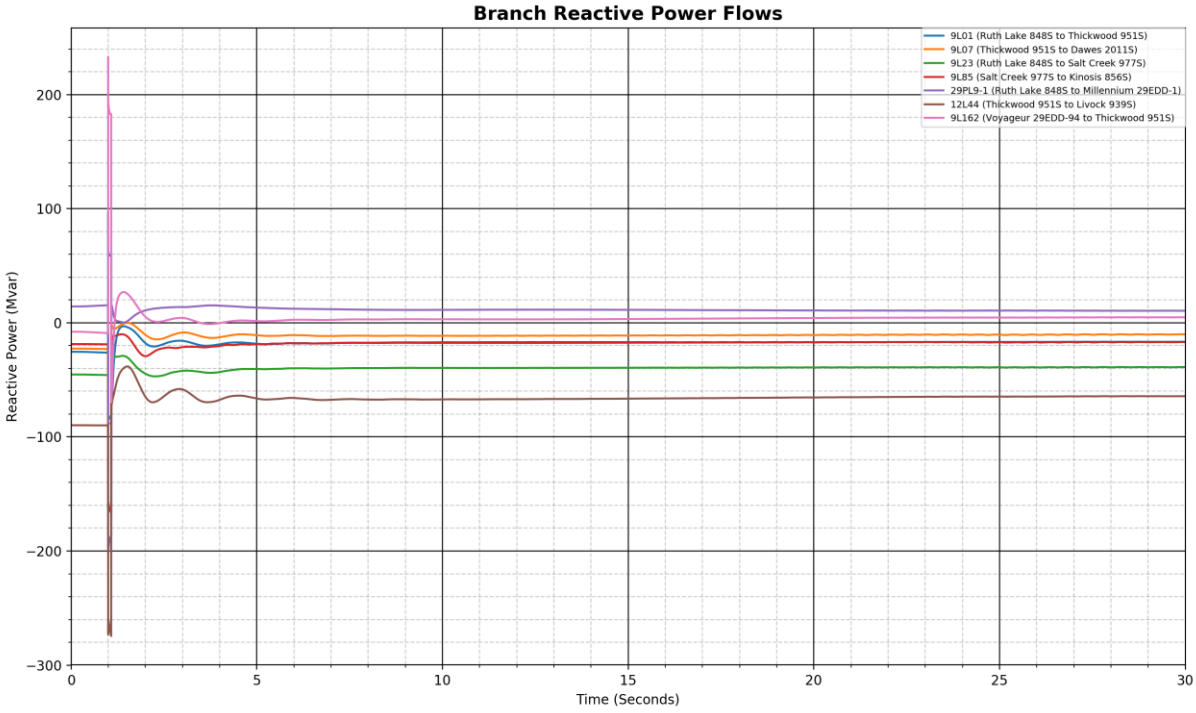
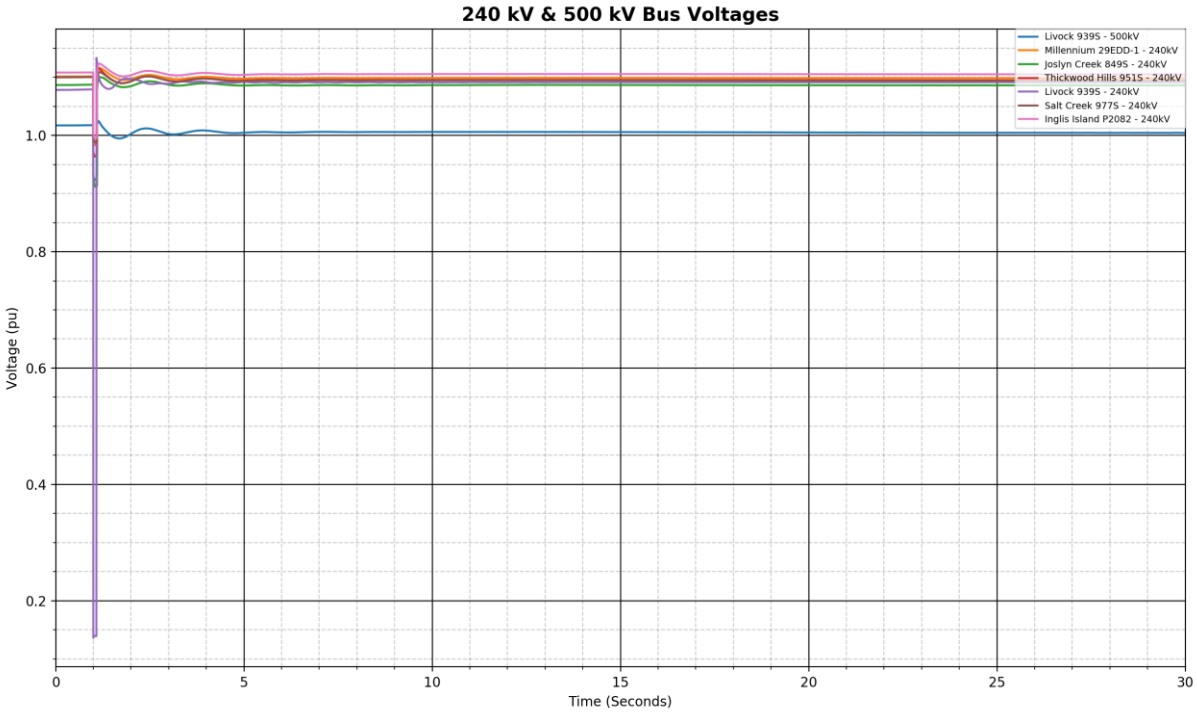
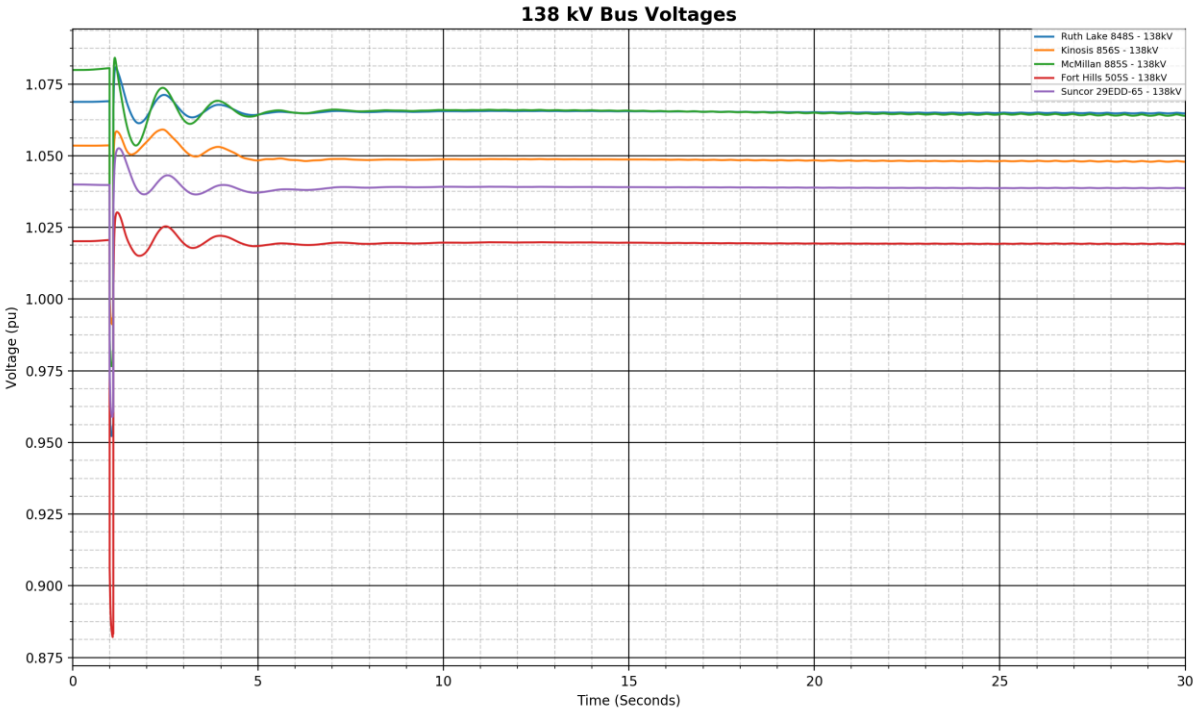
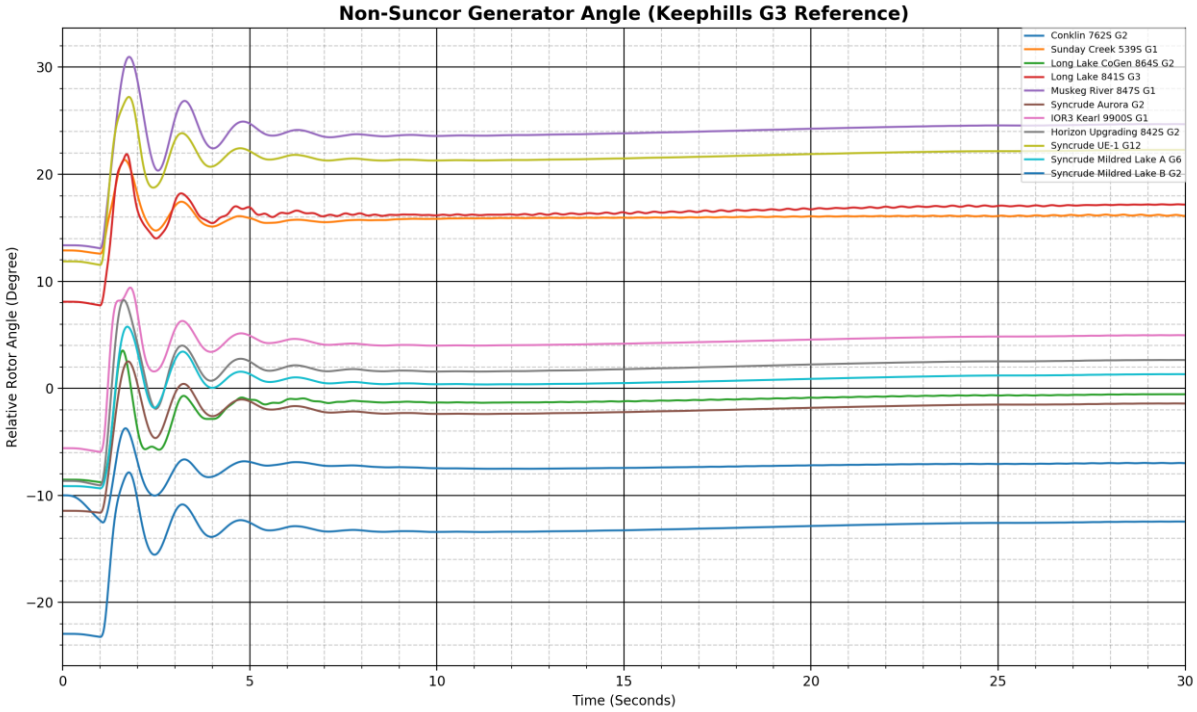
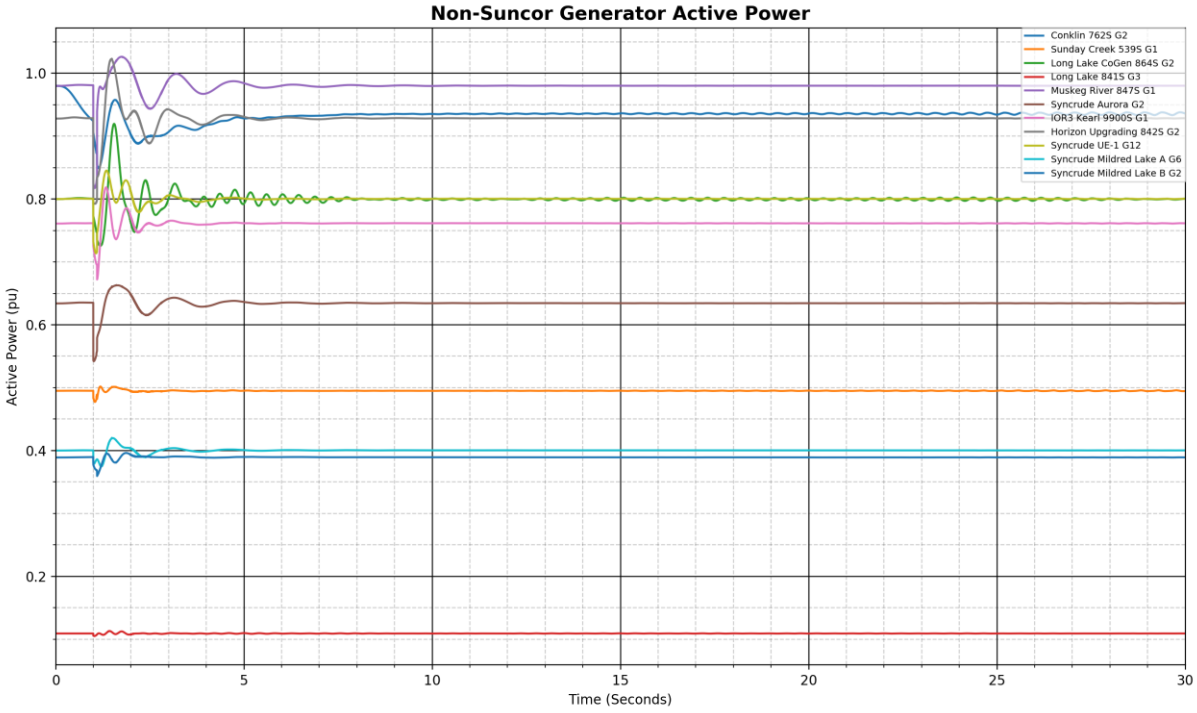

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

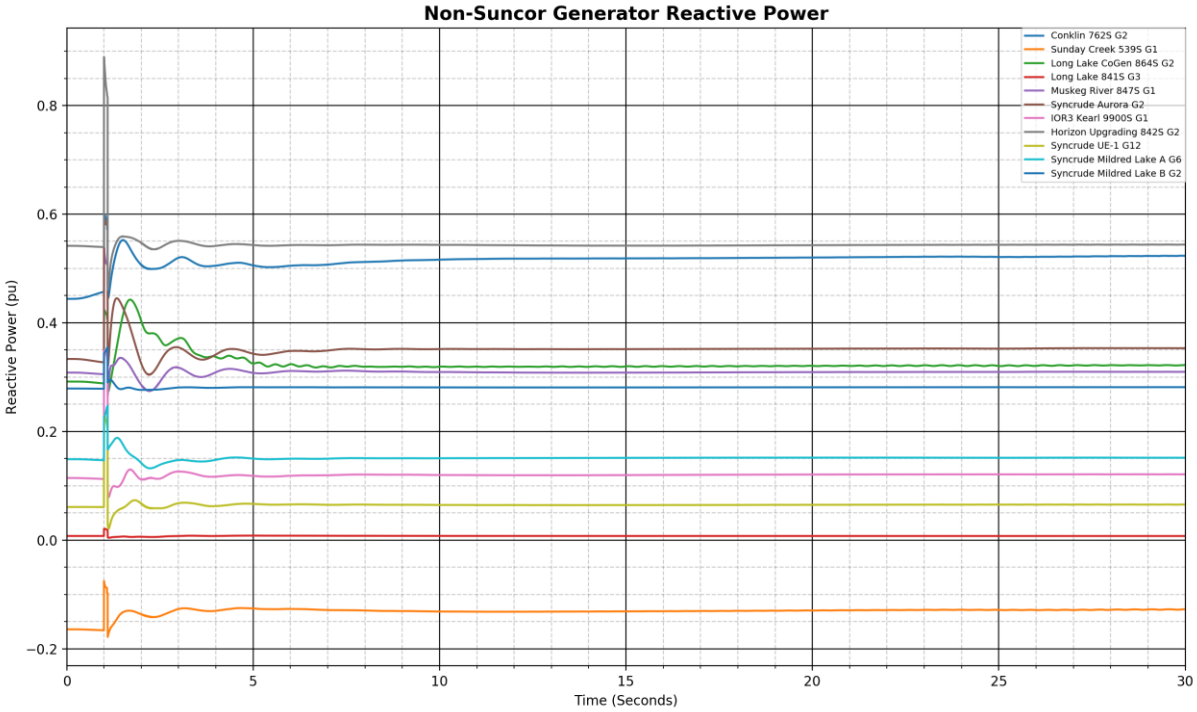
Figure A4-68: 9L57 (9L57 Birchwood Creek 960S to Livock 939S): Fault at Livock 939S

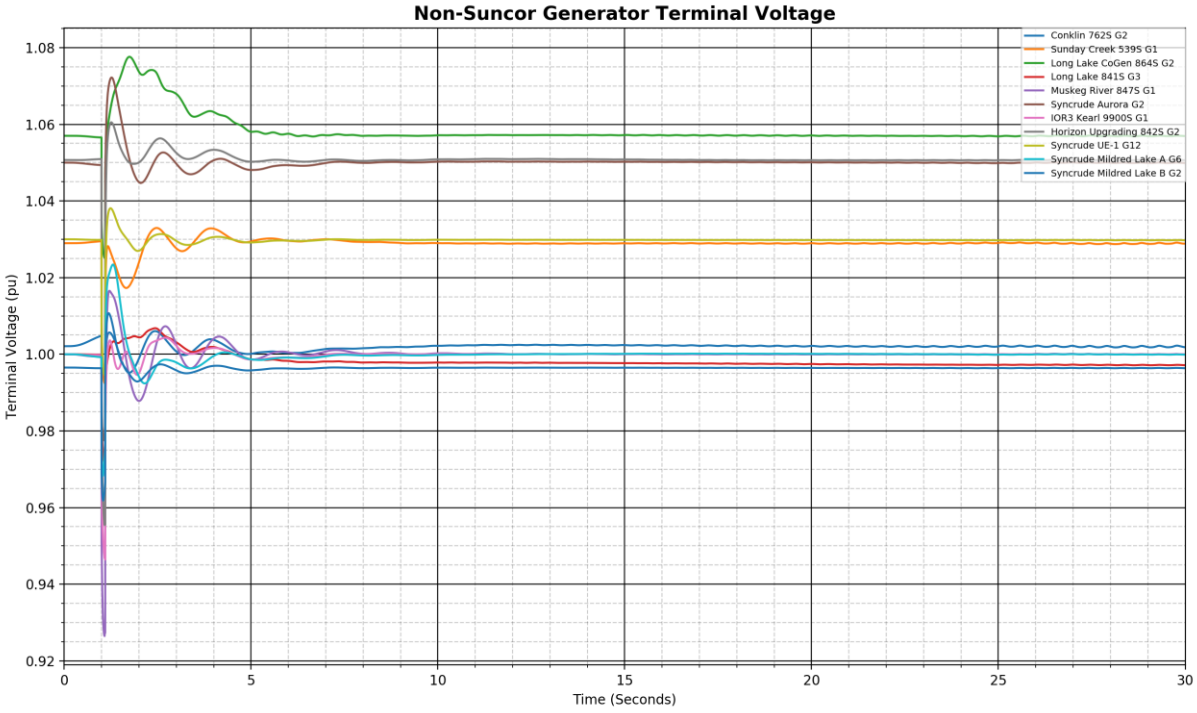


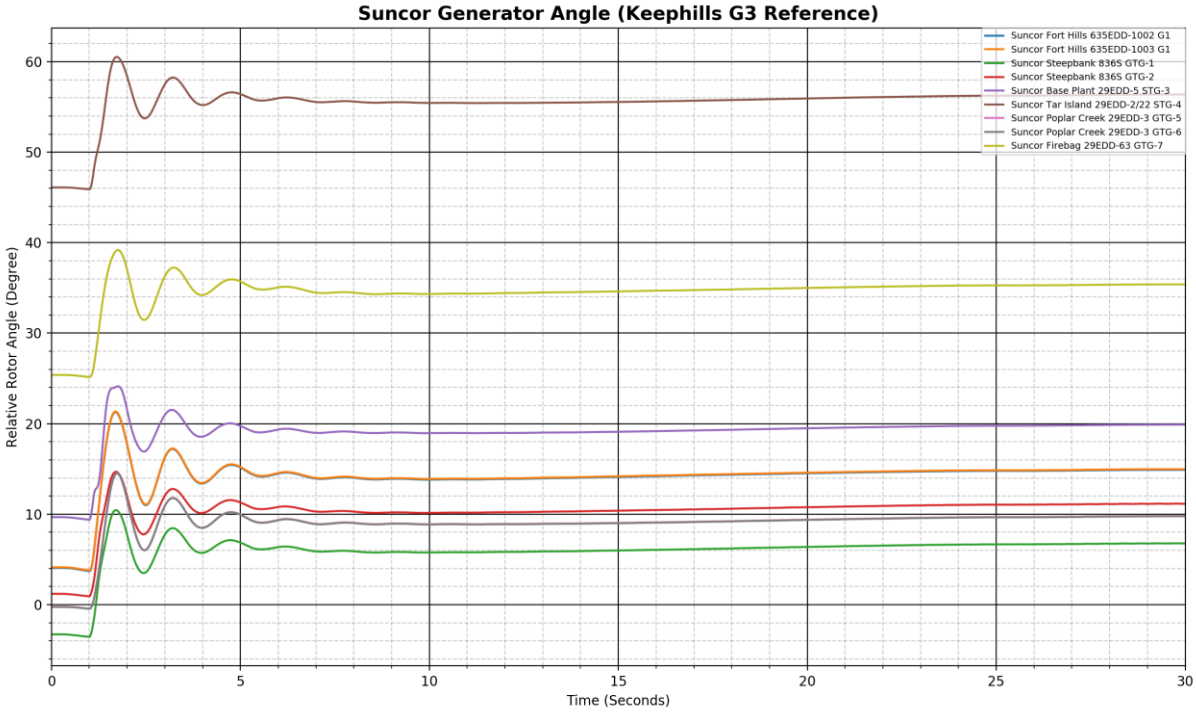


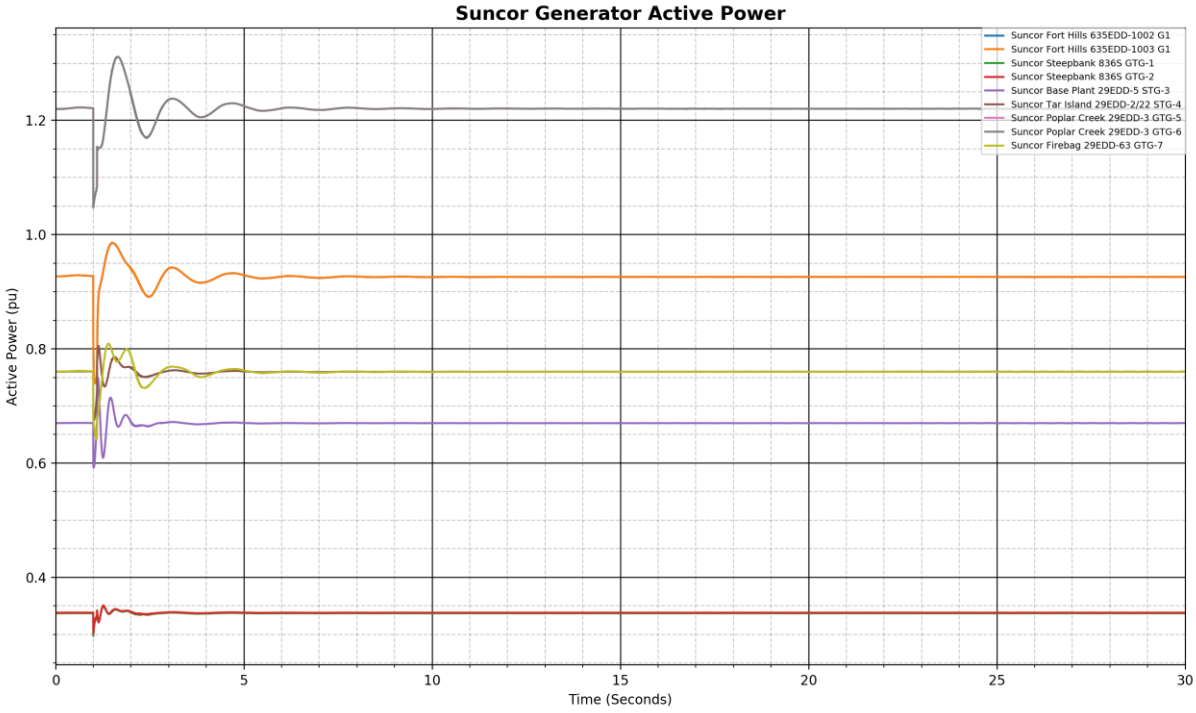

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

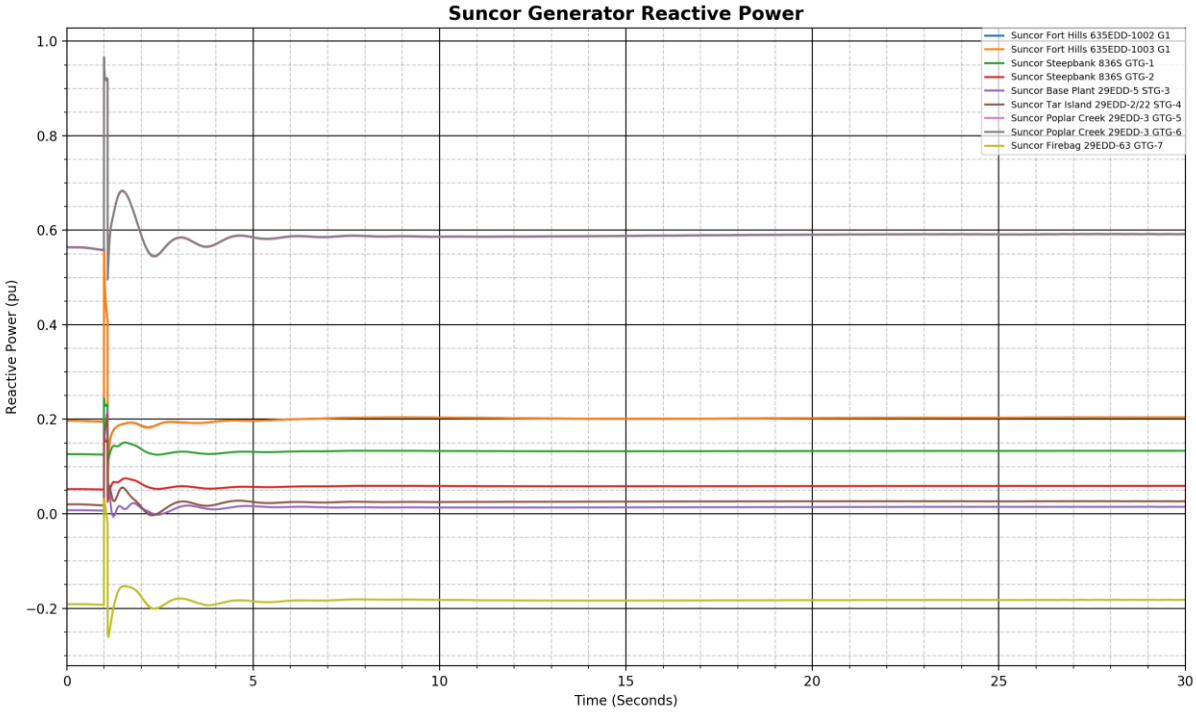

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

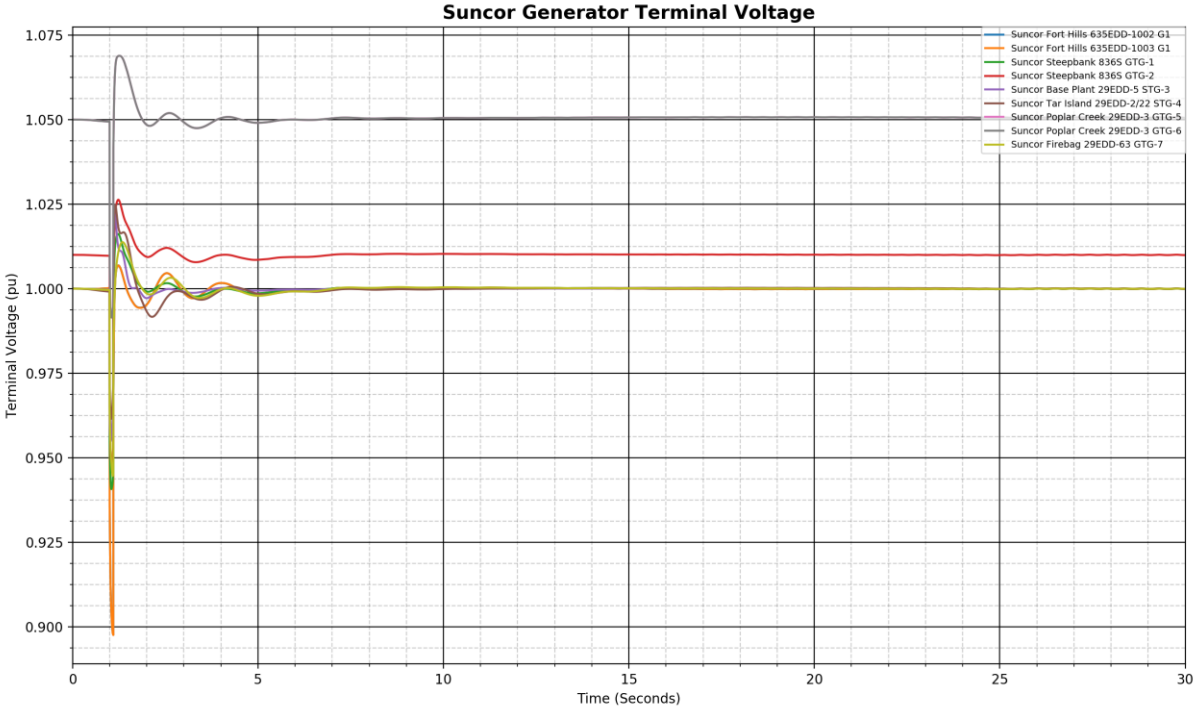

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

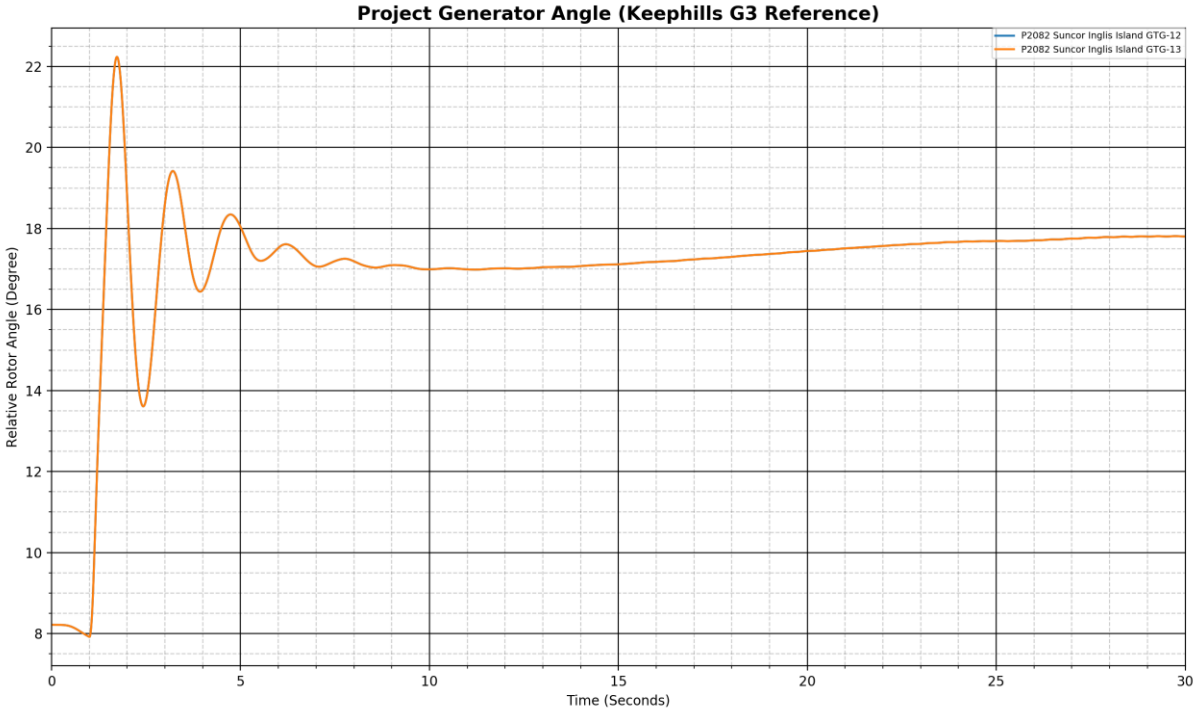

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

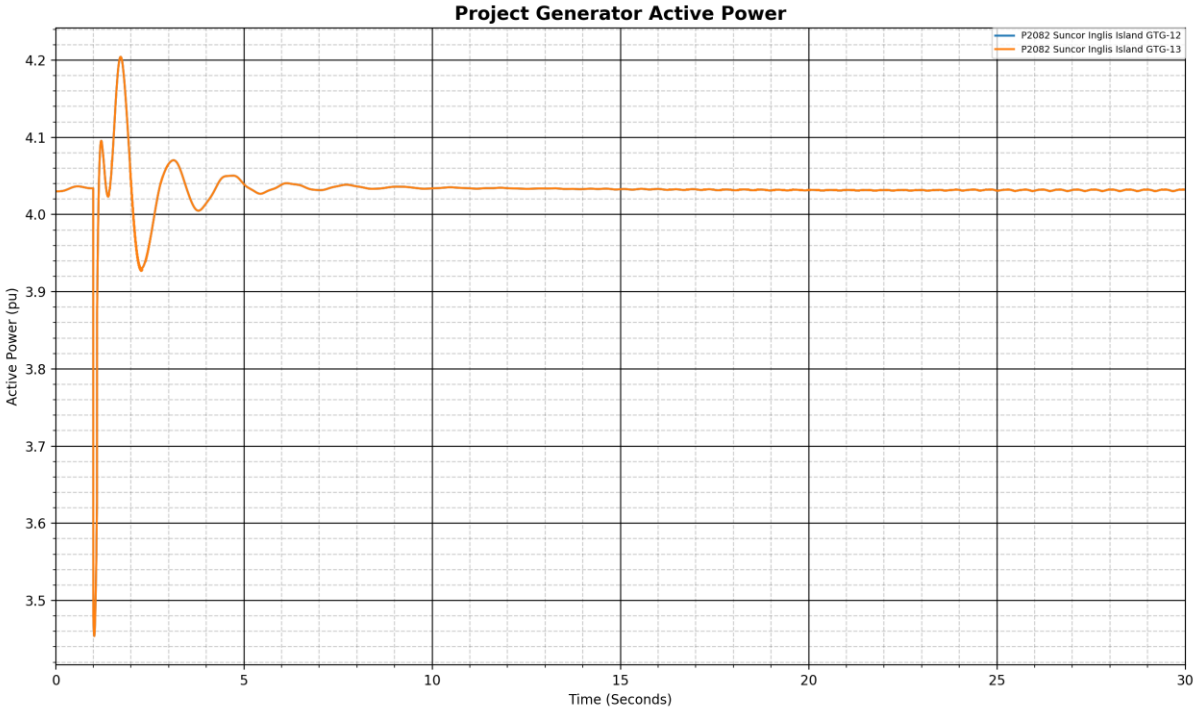

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

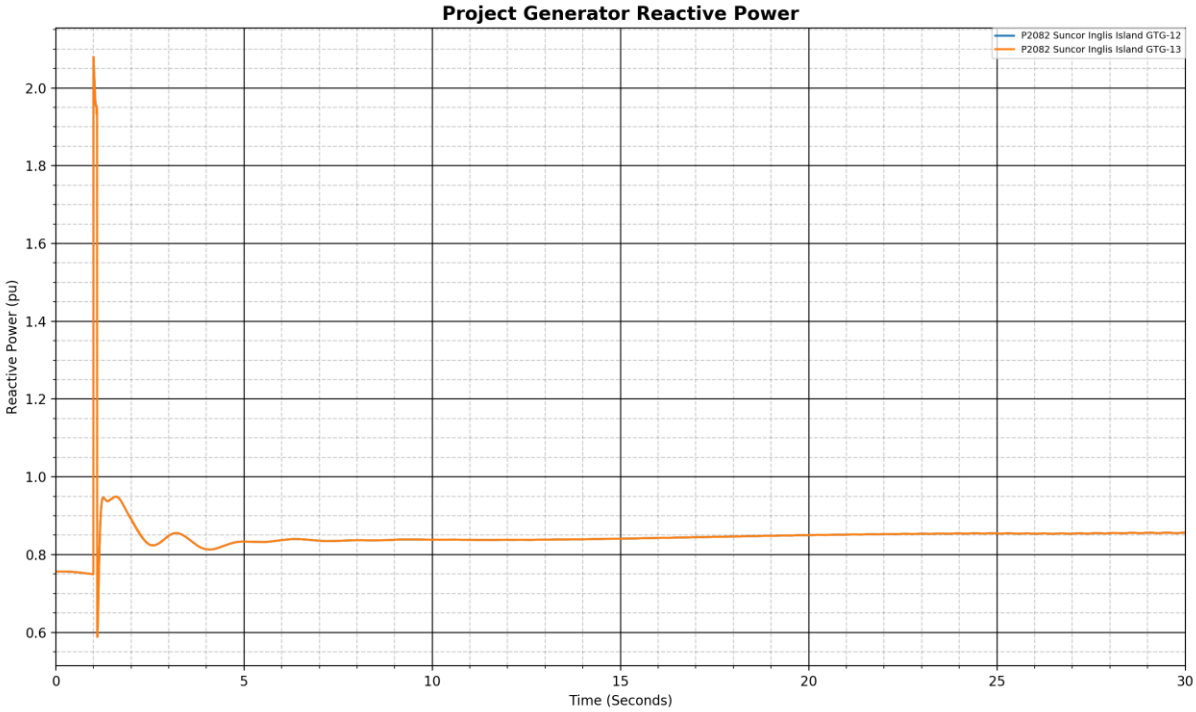

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

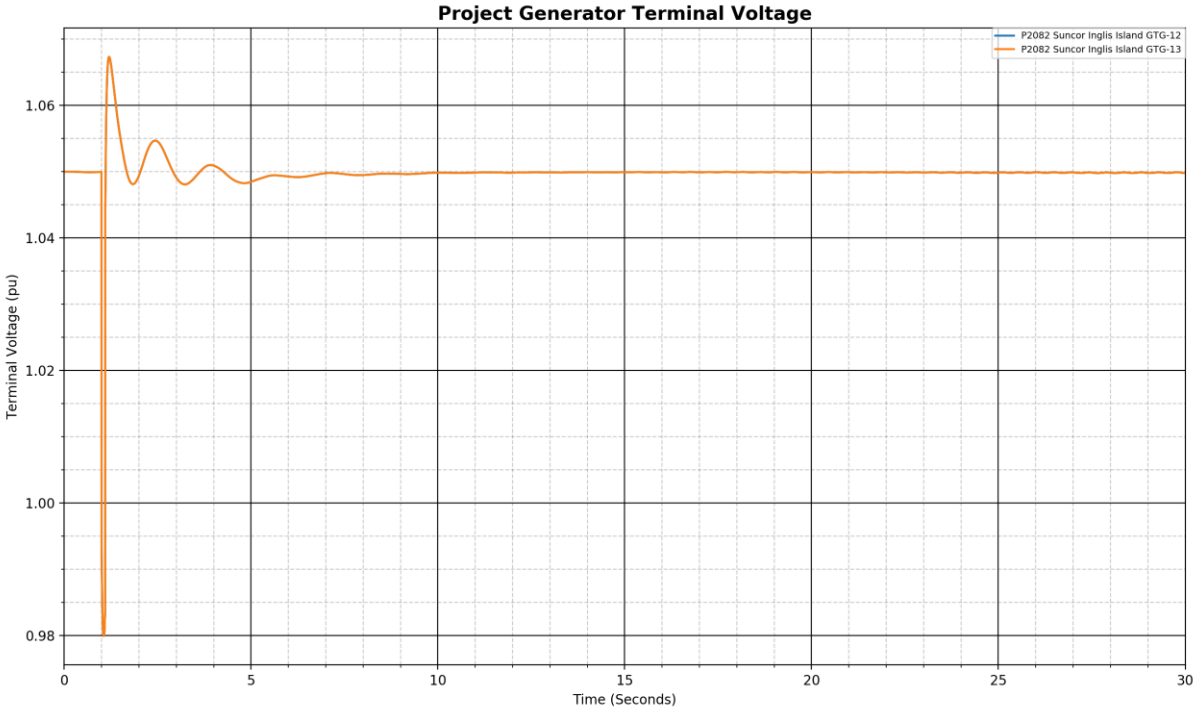

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

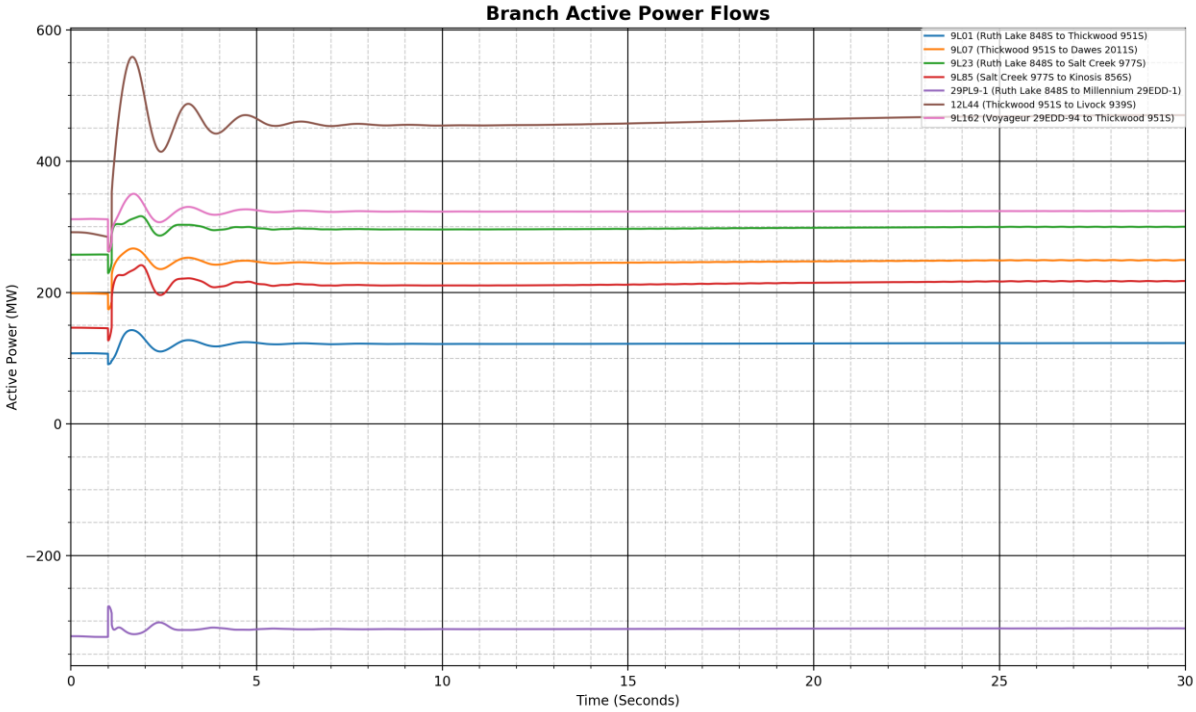

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

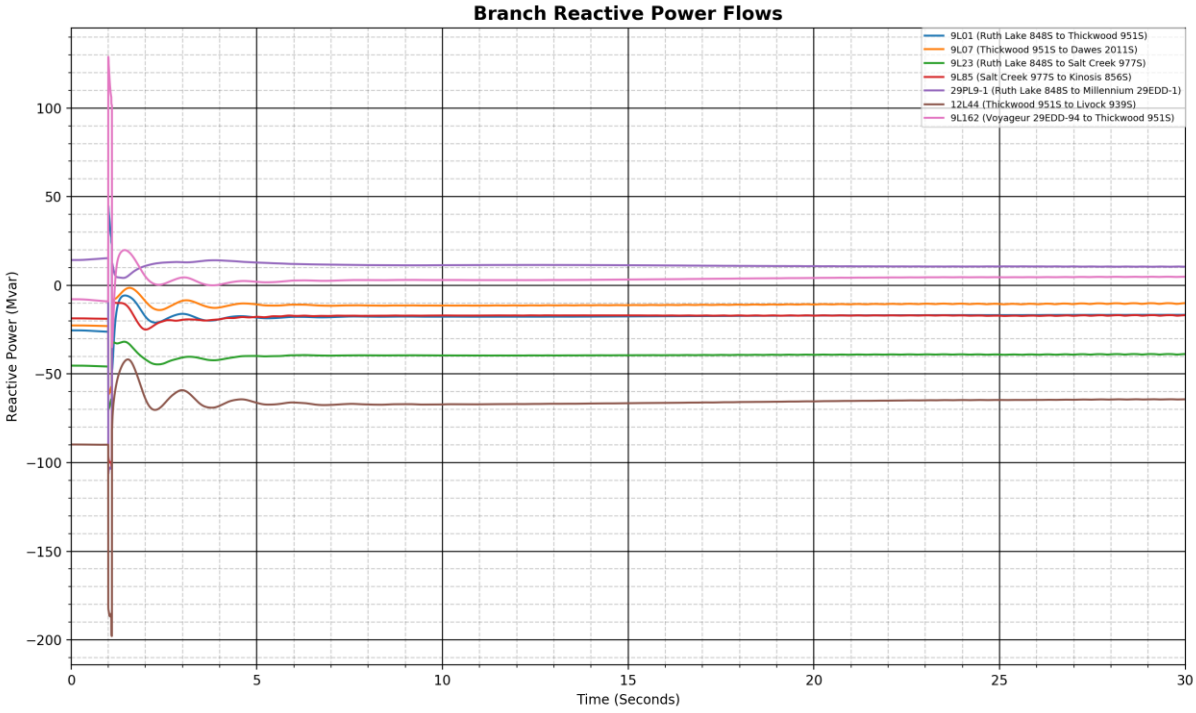
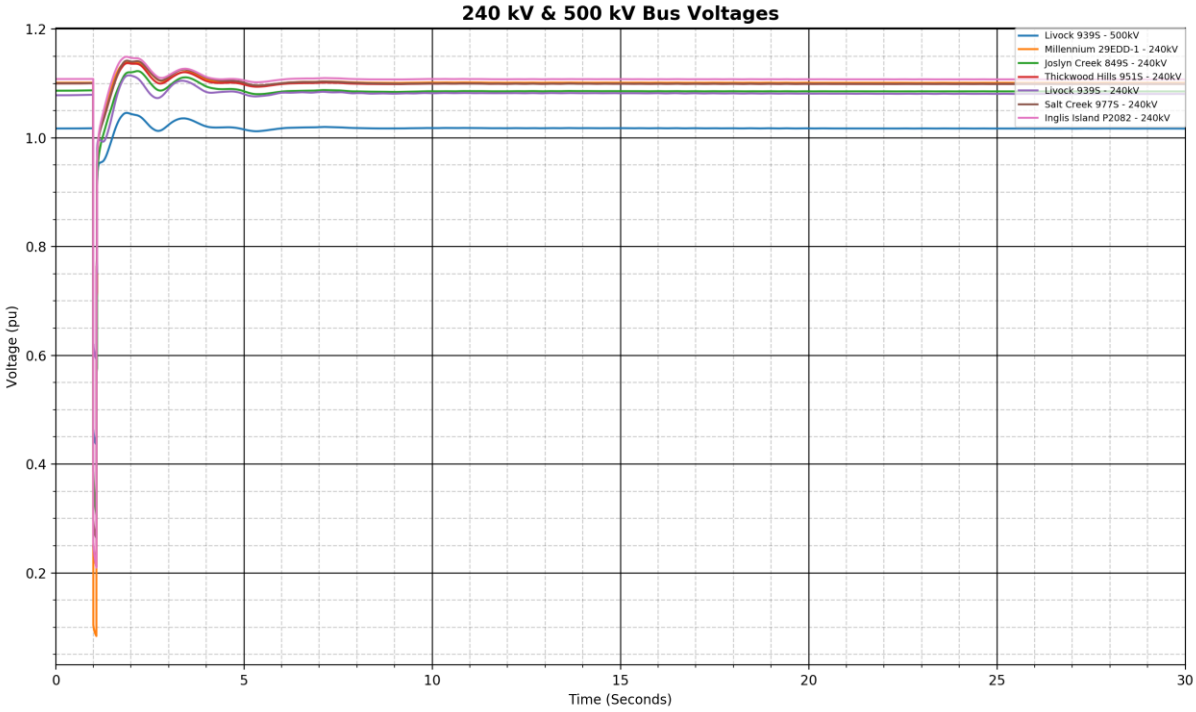
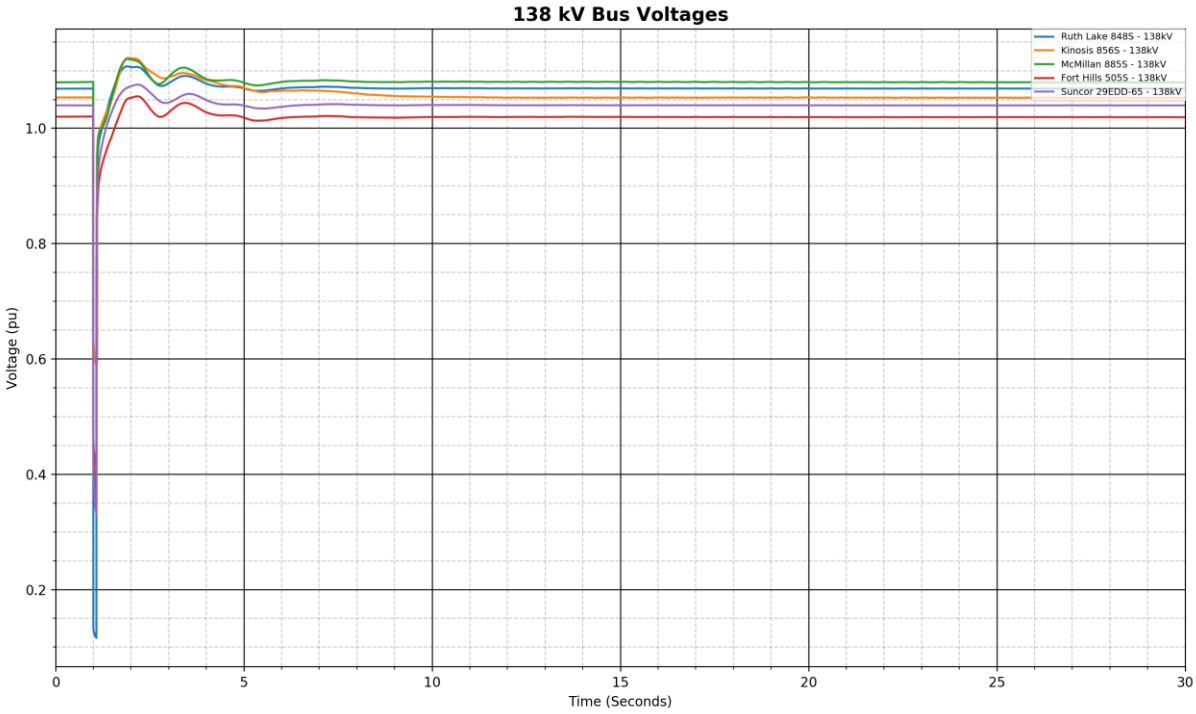
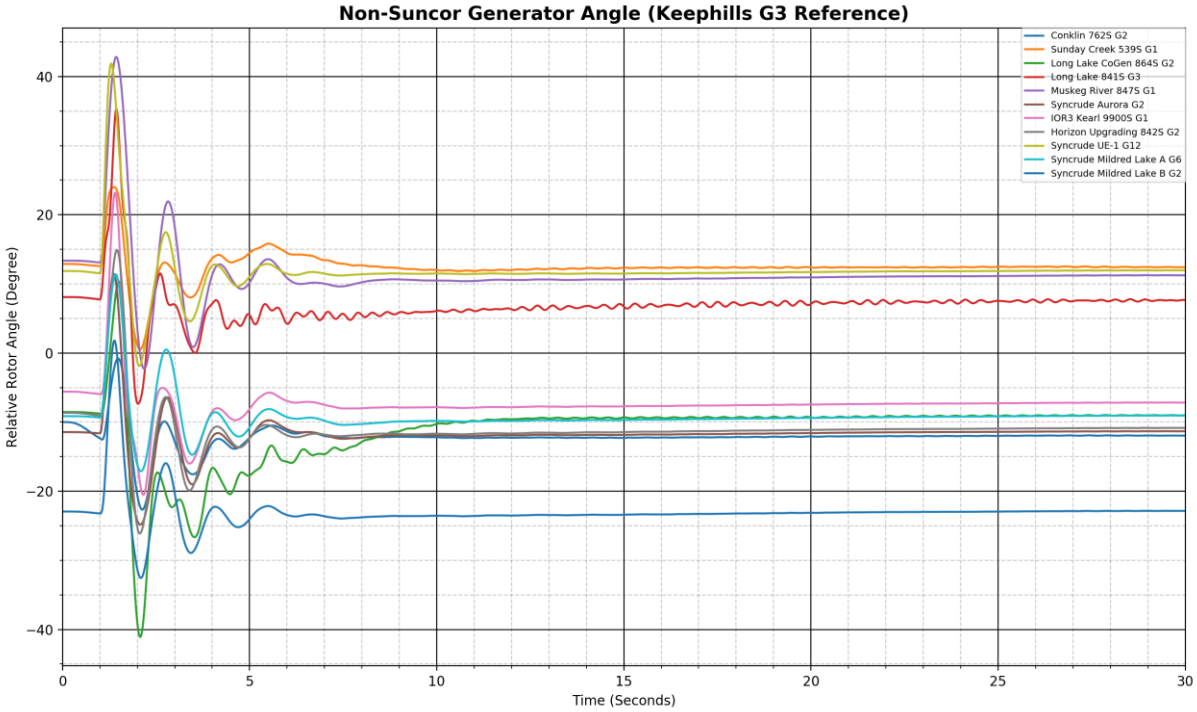
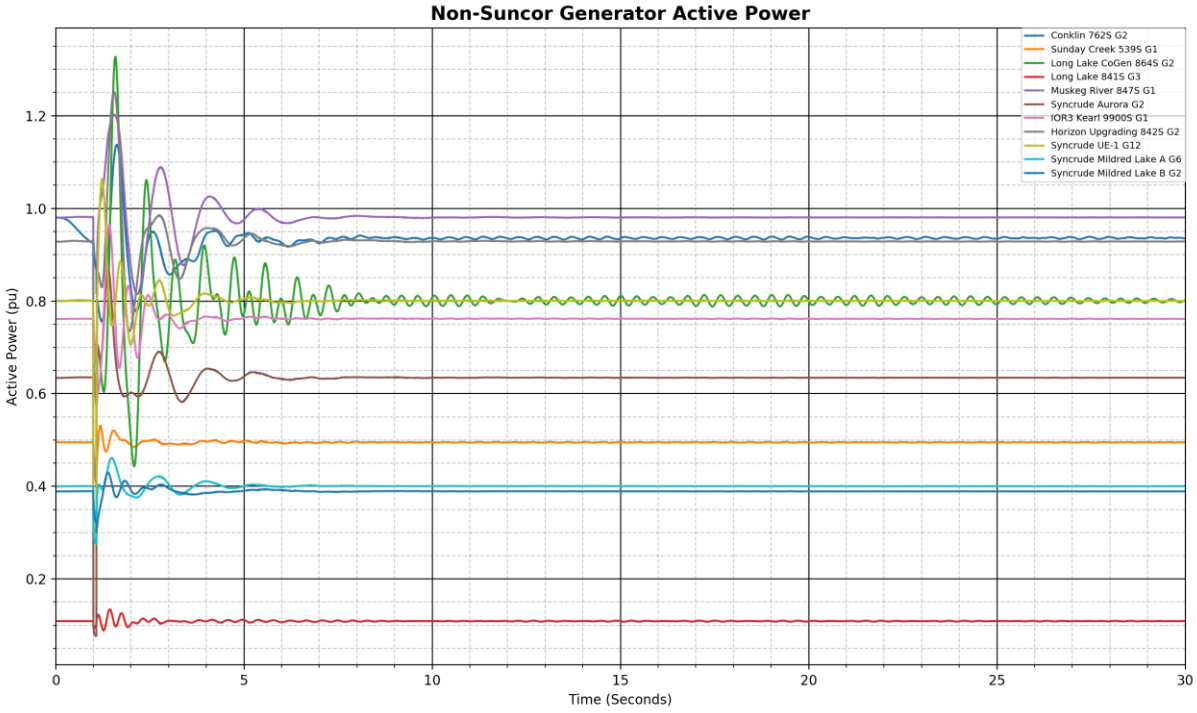

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

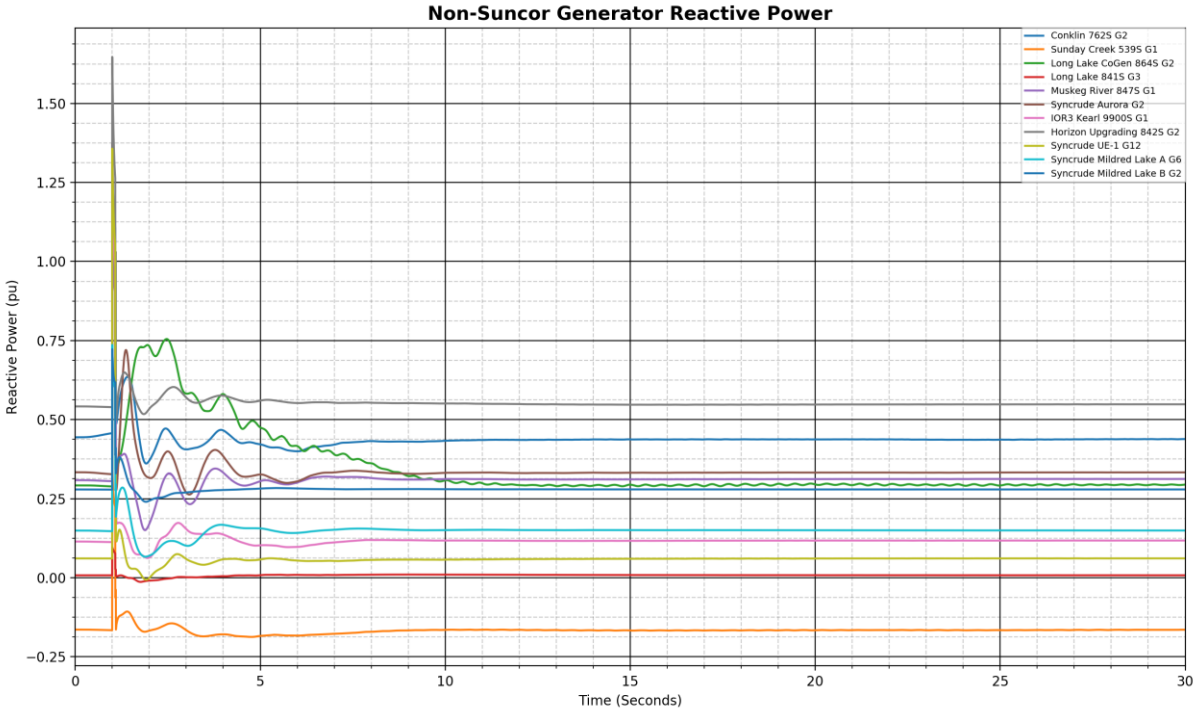
Figure A4-69: 9L58 (Ruth Lake 848S to Dover 888S): Fault at Ruth Lake 848S

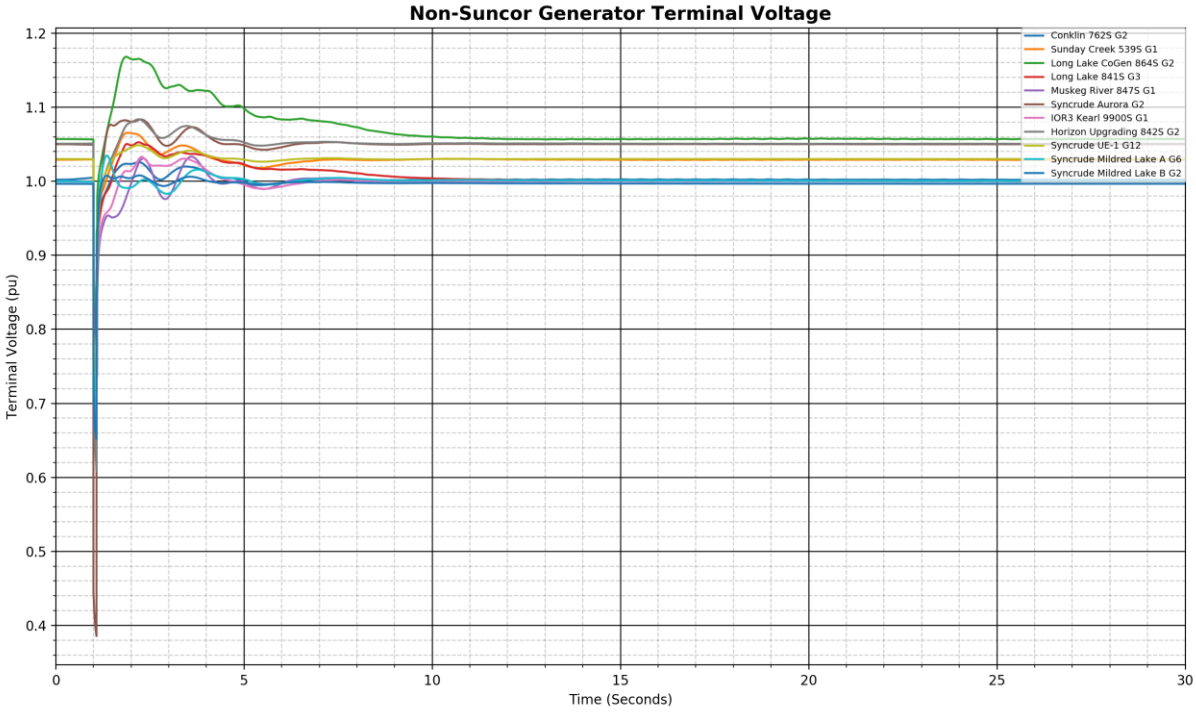


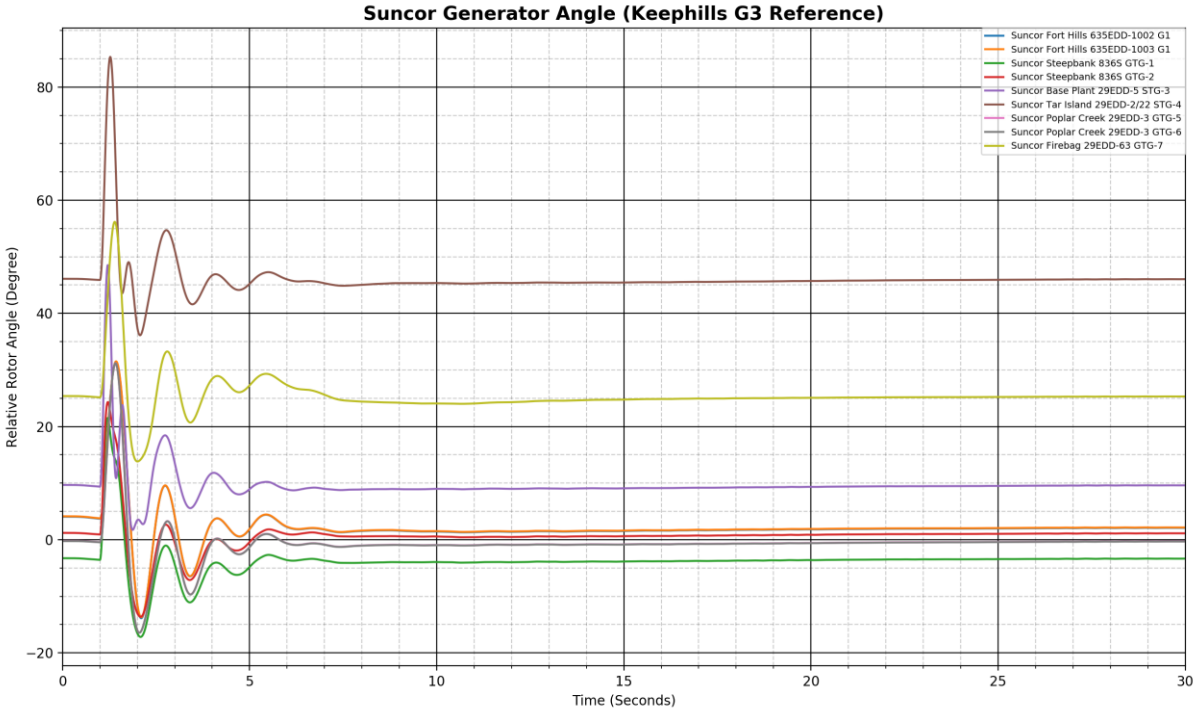


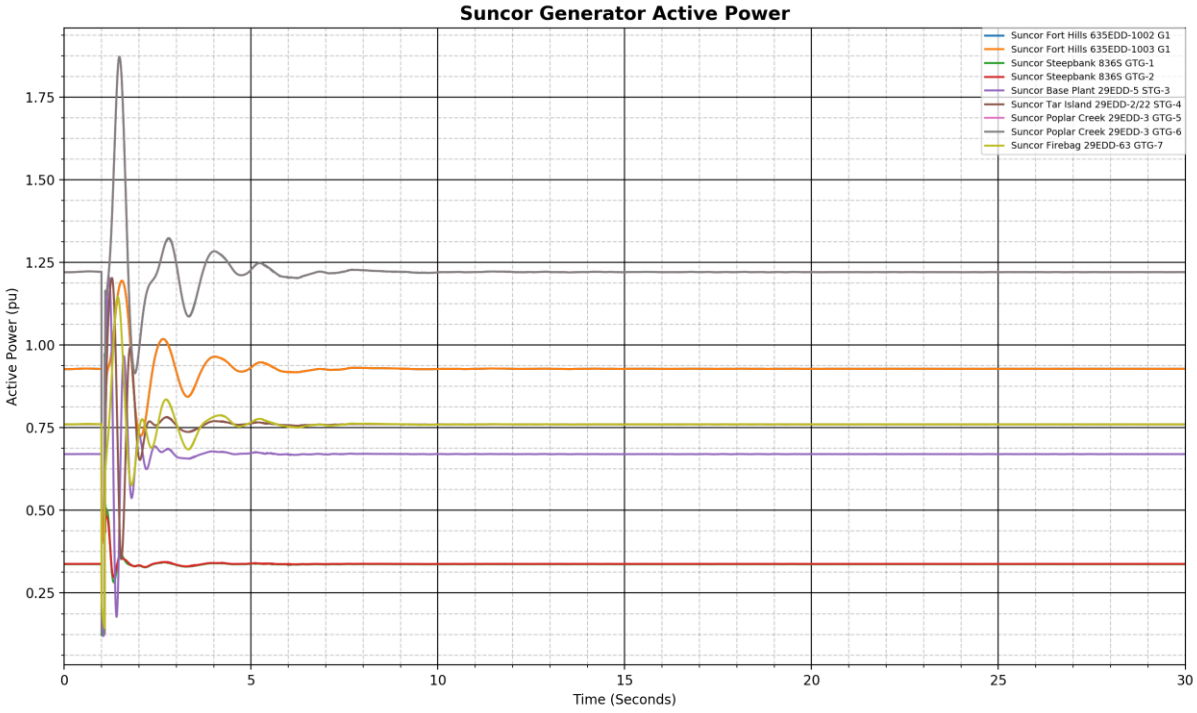

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

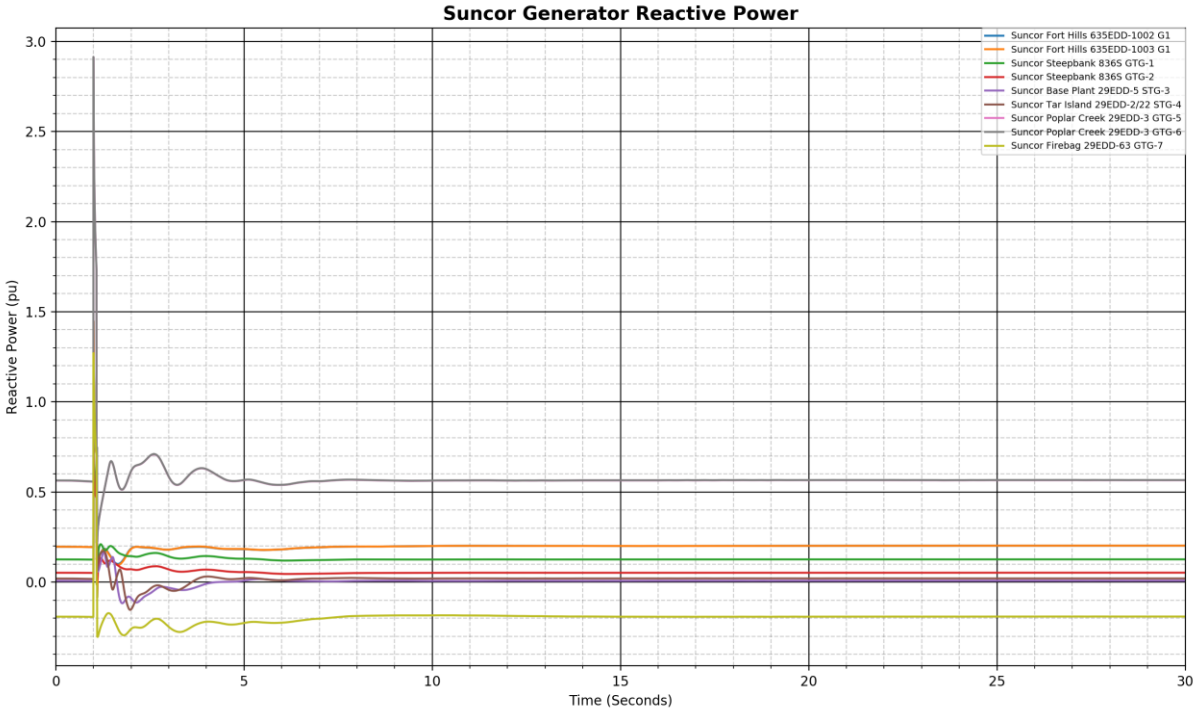

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

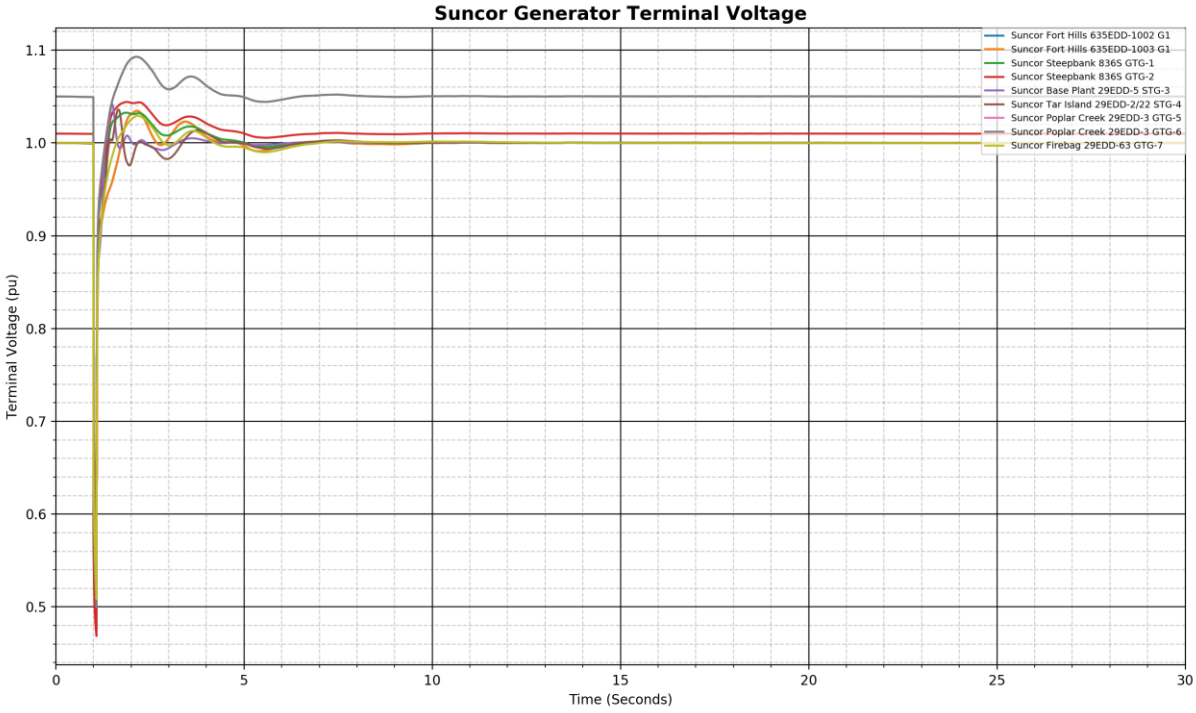

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

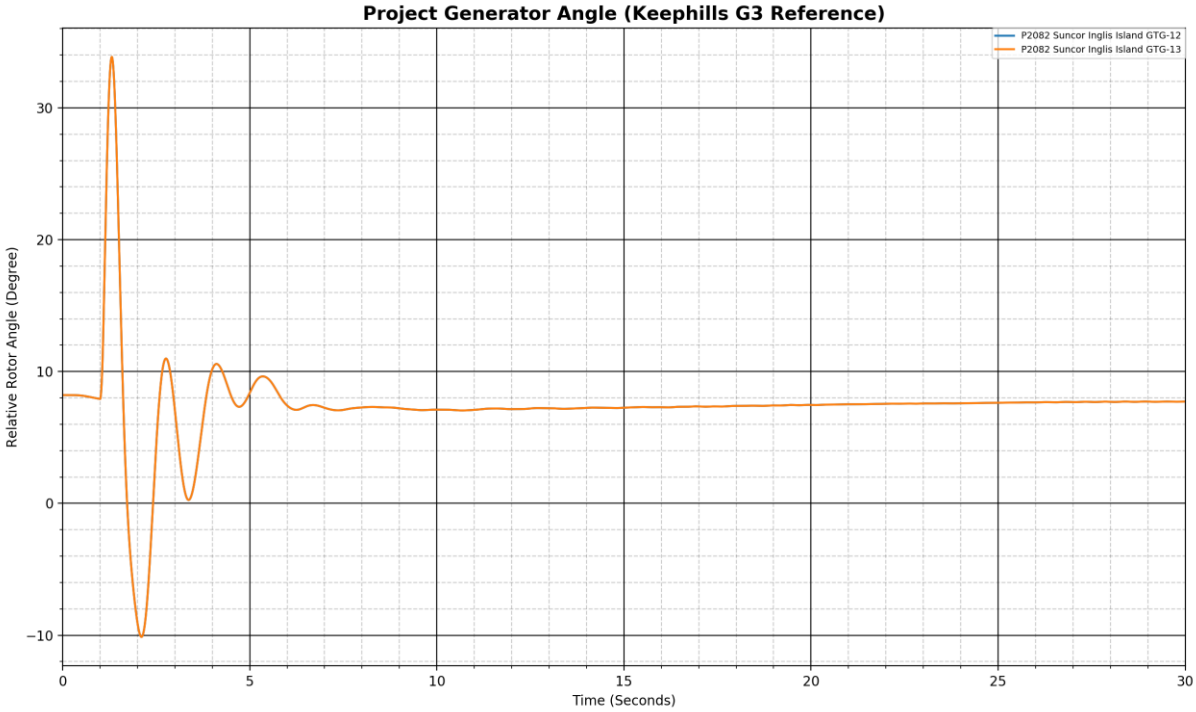

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

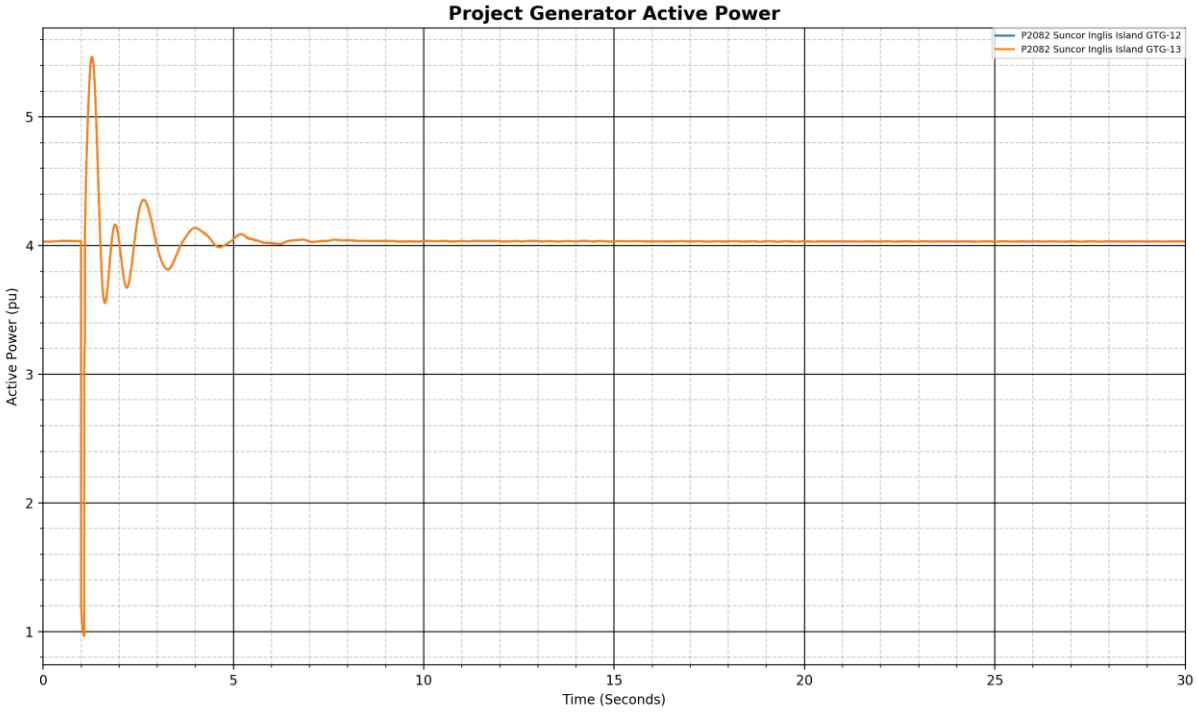

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

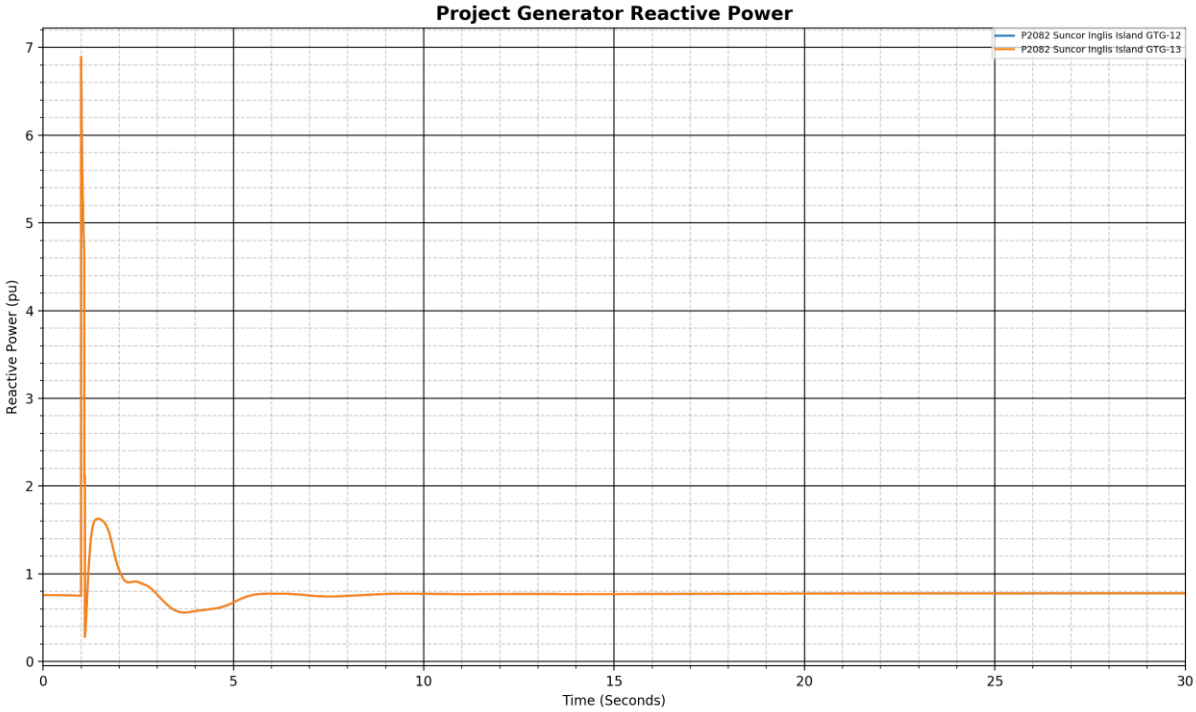

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

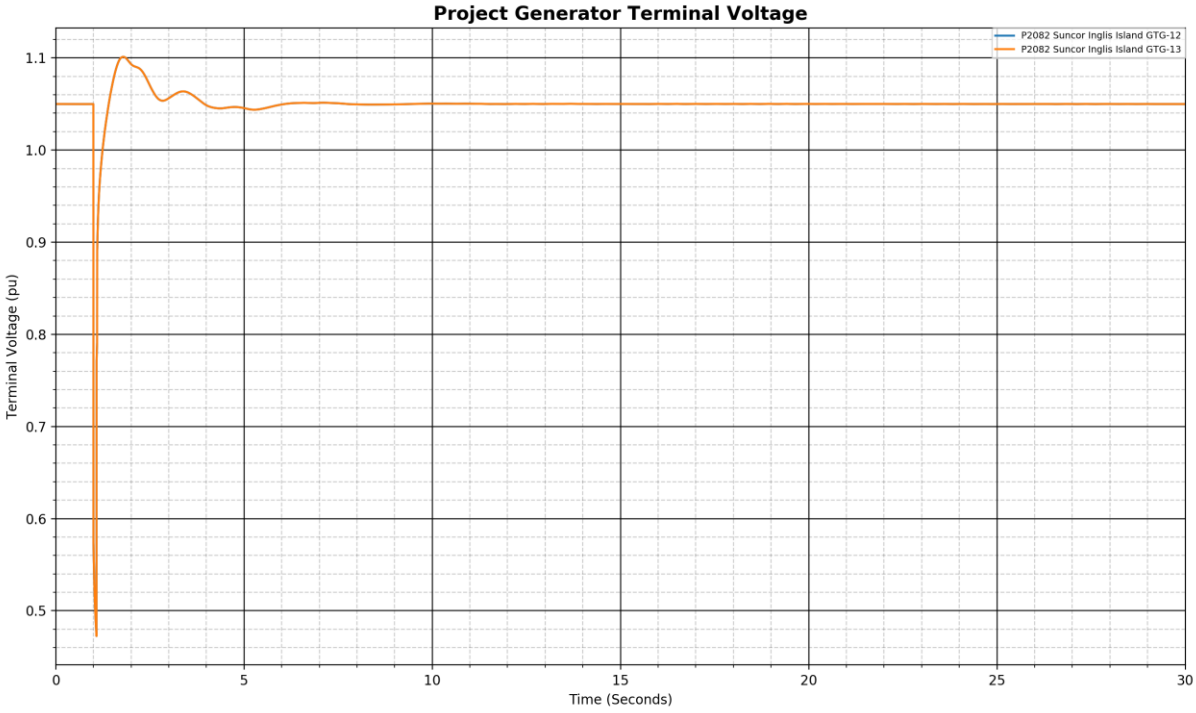

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

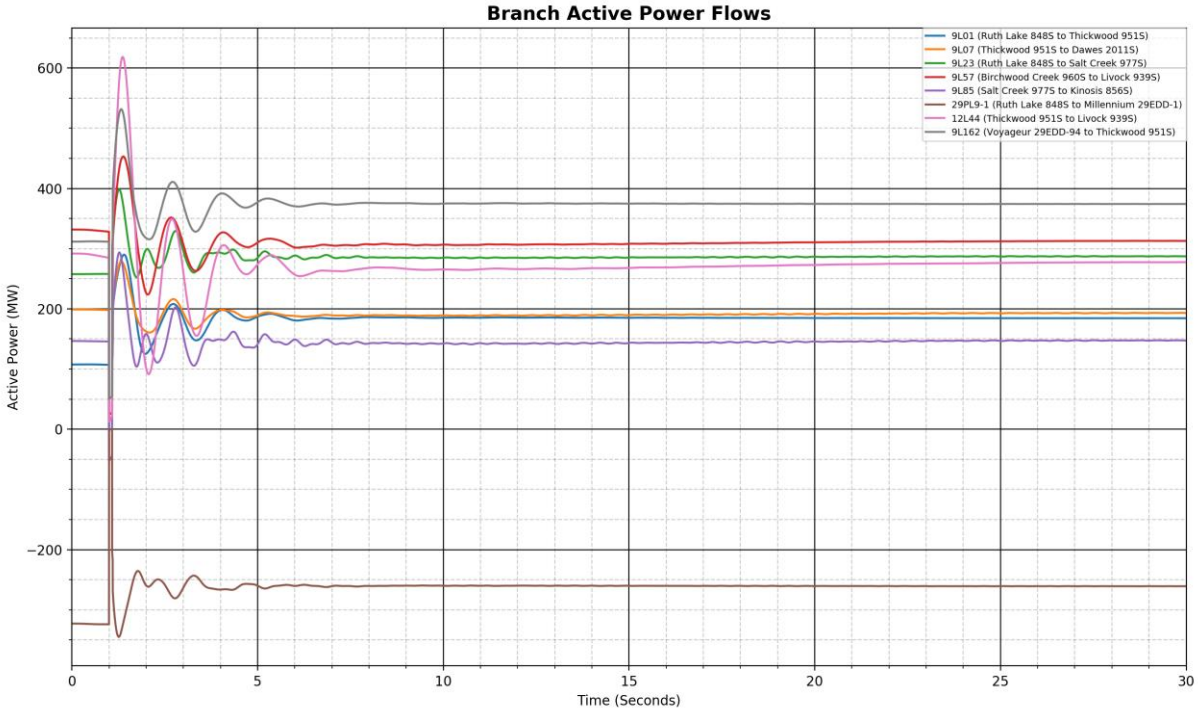

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
20
10
0
−10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5
4
3
2
1
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
600
400
200
0
−200
0
5
10
15
20
25
30
Time (Seconds)

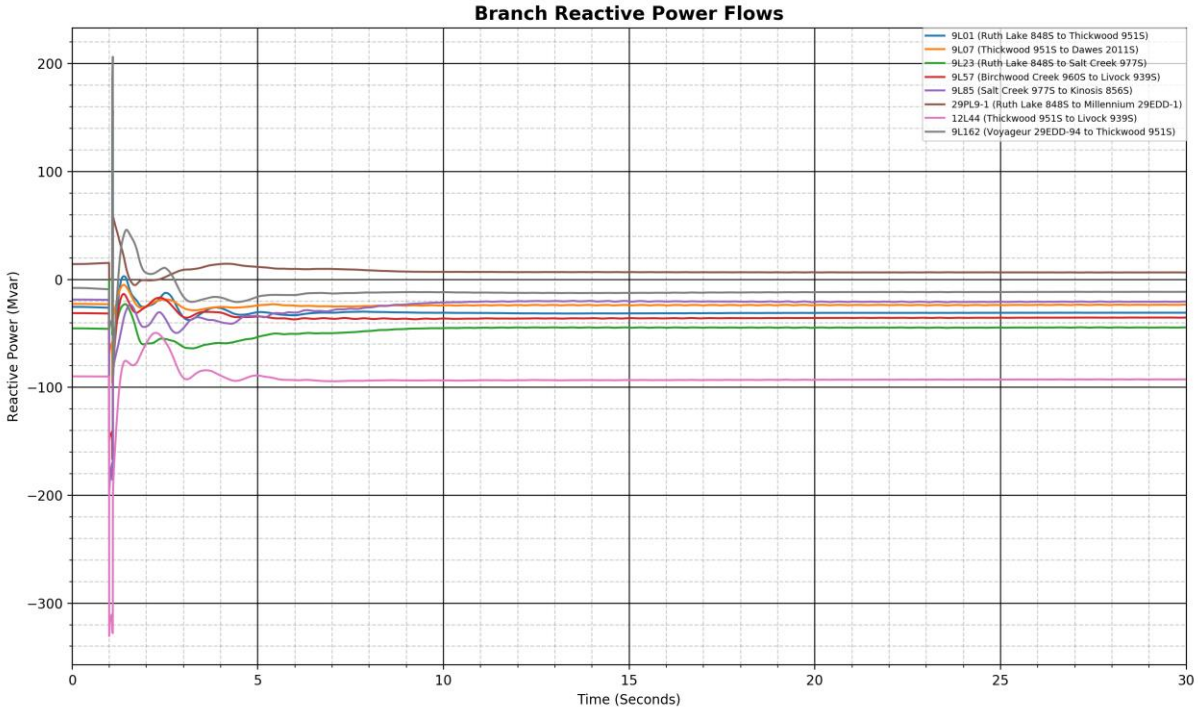
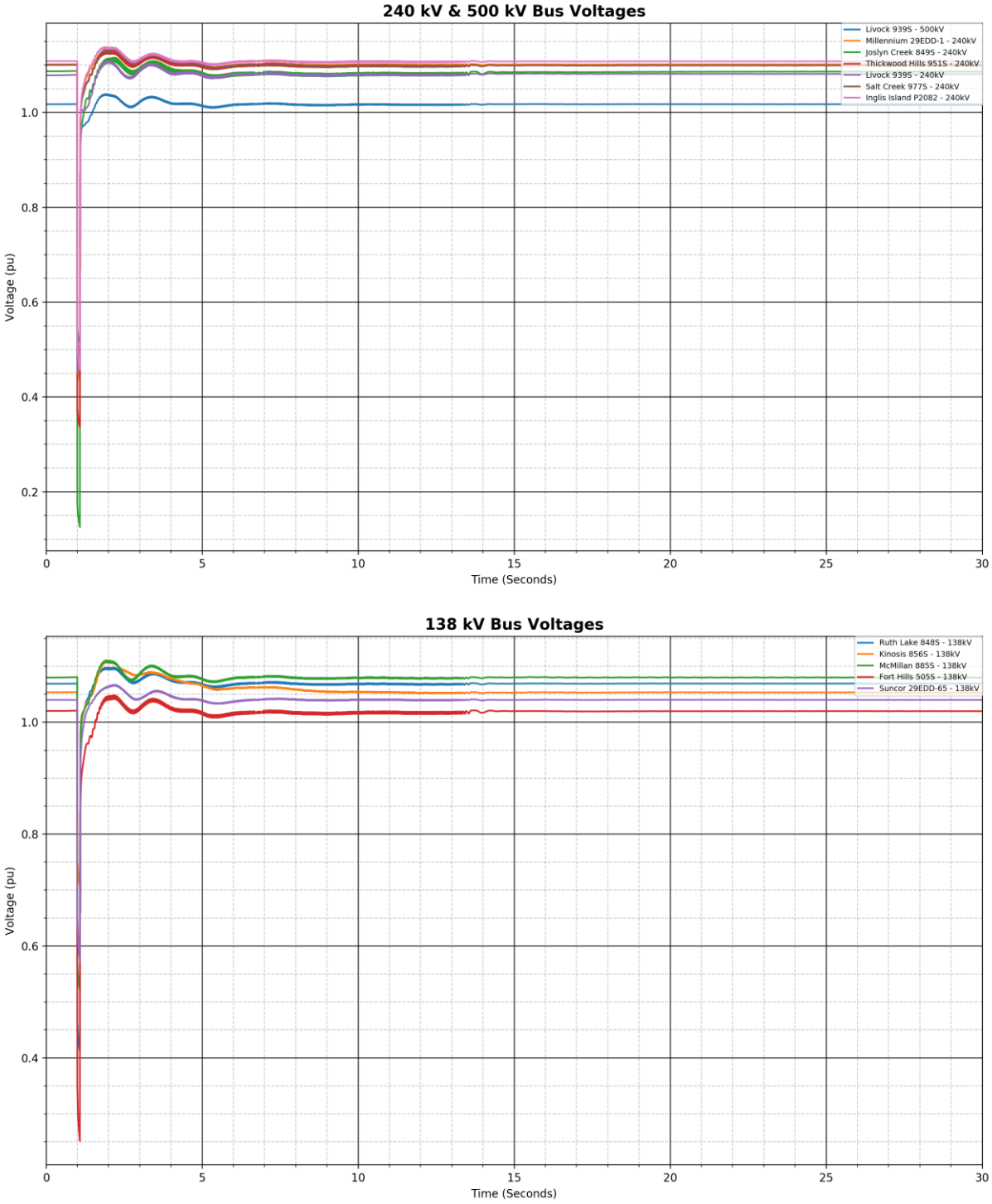
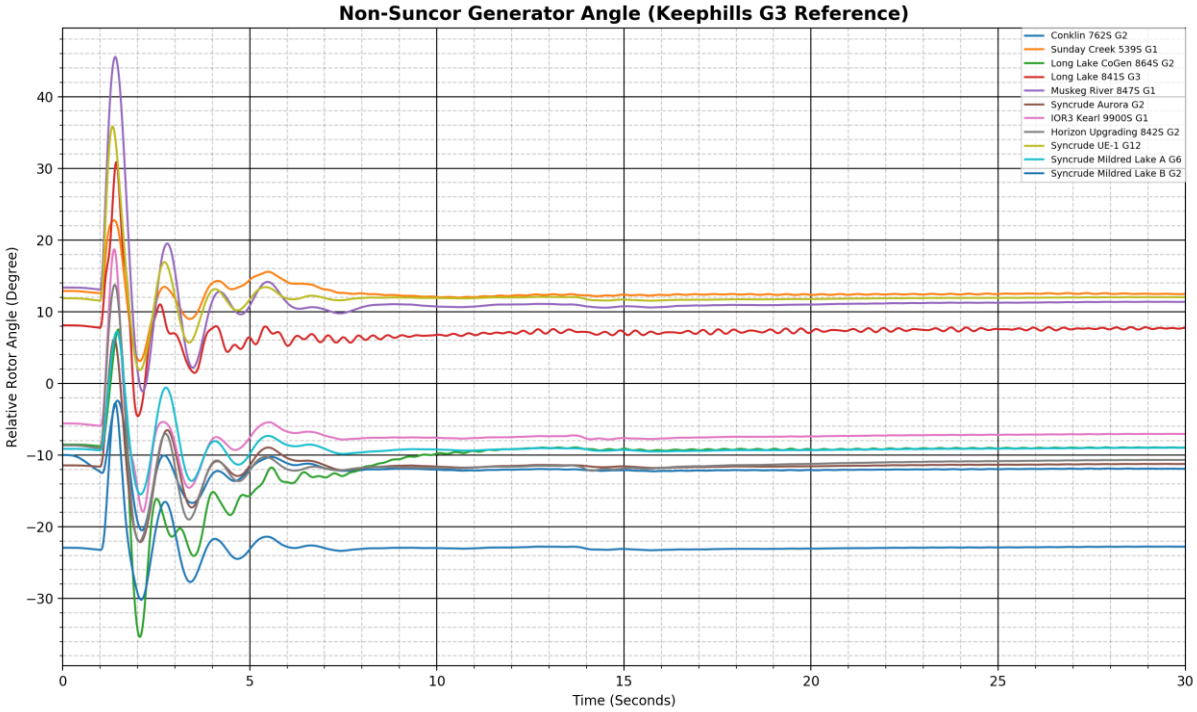
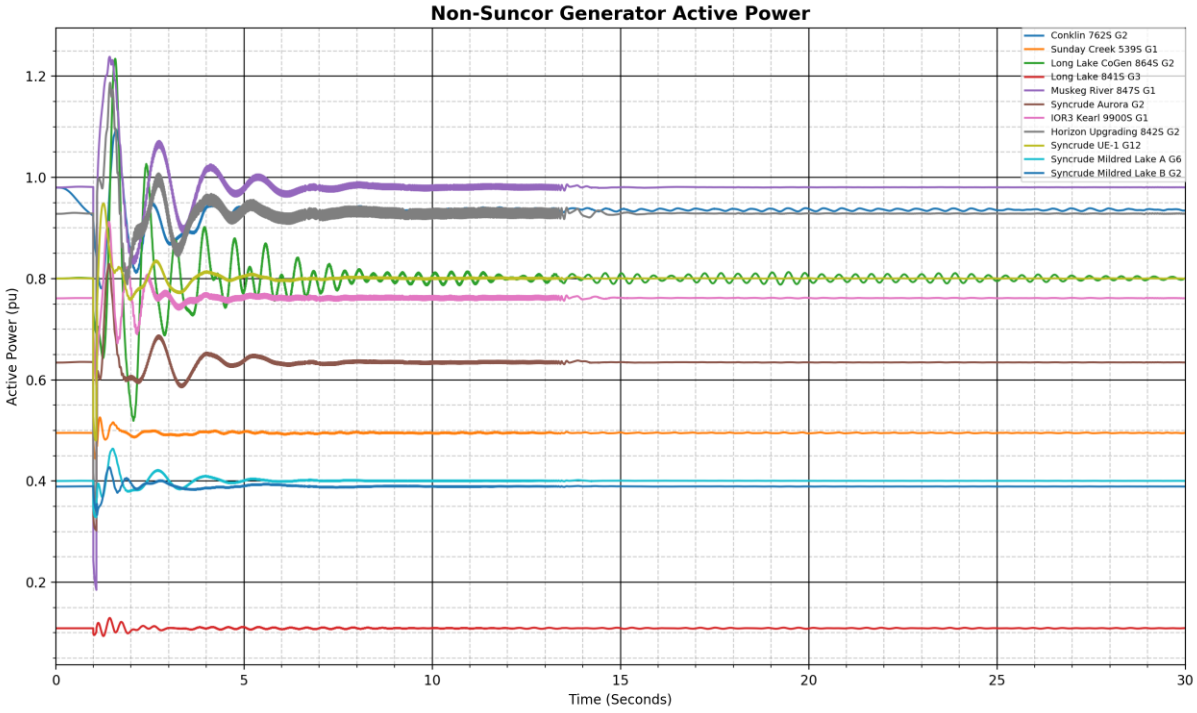
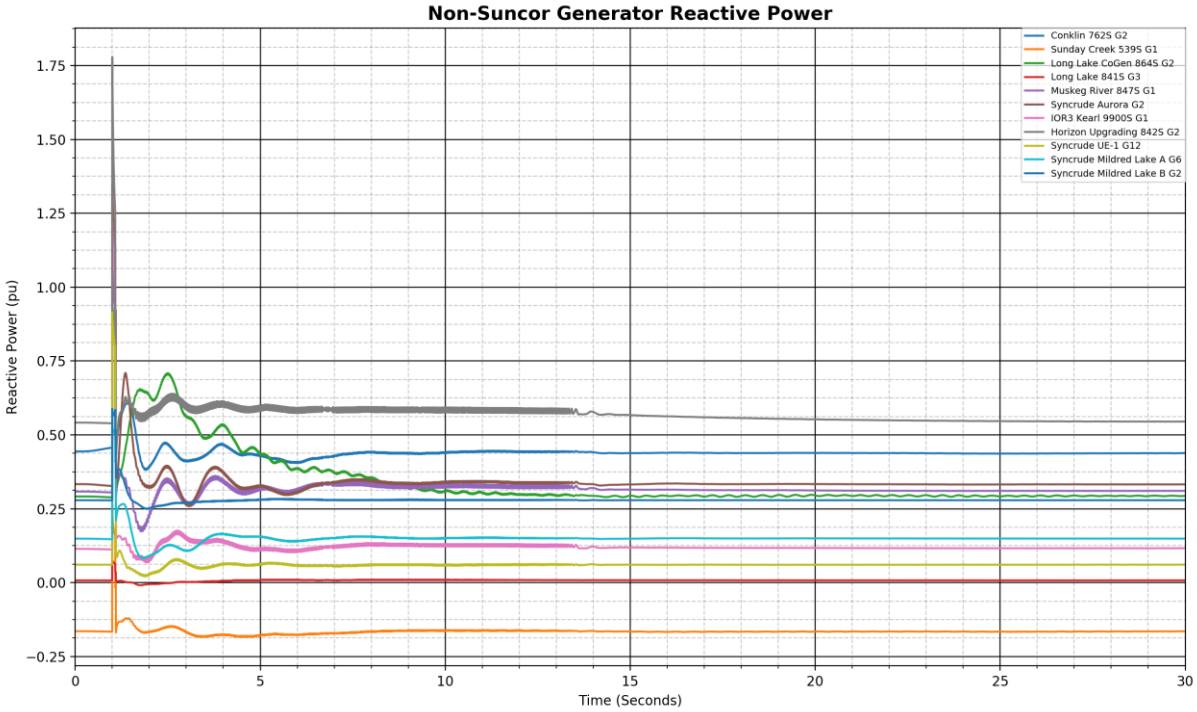

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
200
100
0
−100
−200
−300
0
5
10
15
20
25
30
Time (Seconds)

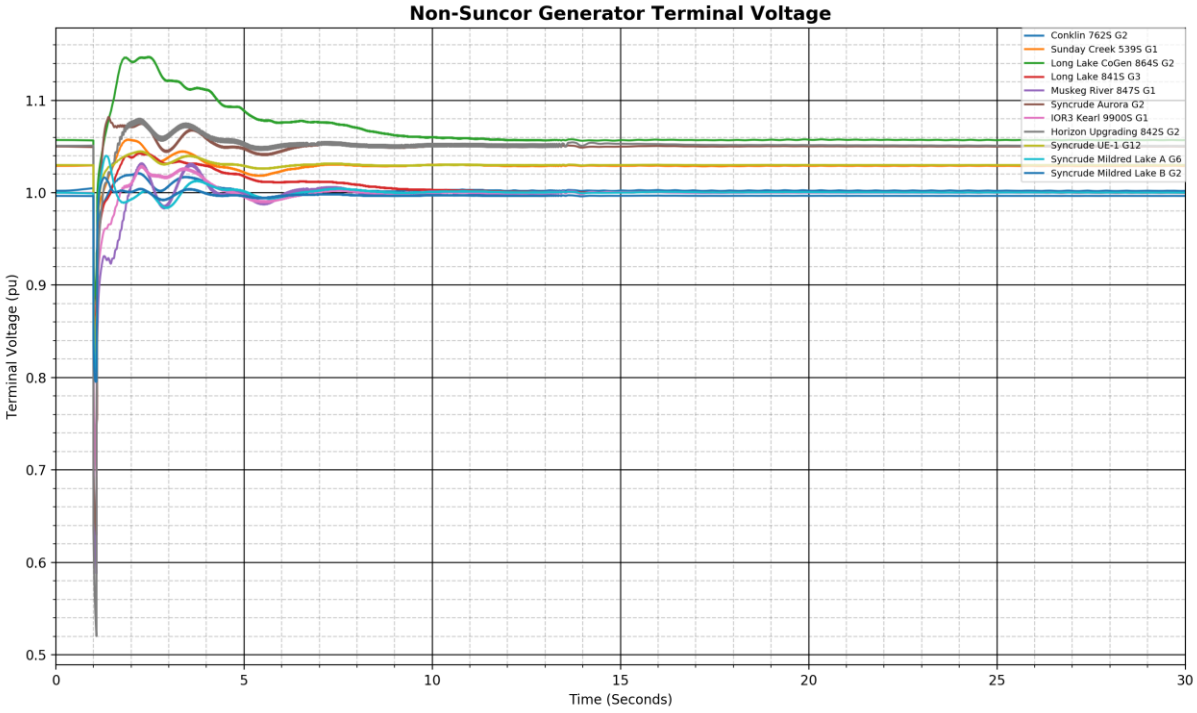
Figure A4-70: 9L58 (Ruth Lake 848S to Dover 888S): Fault at Dover 888S

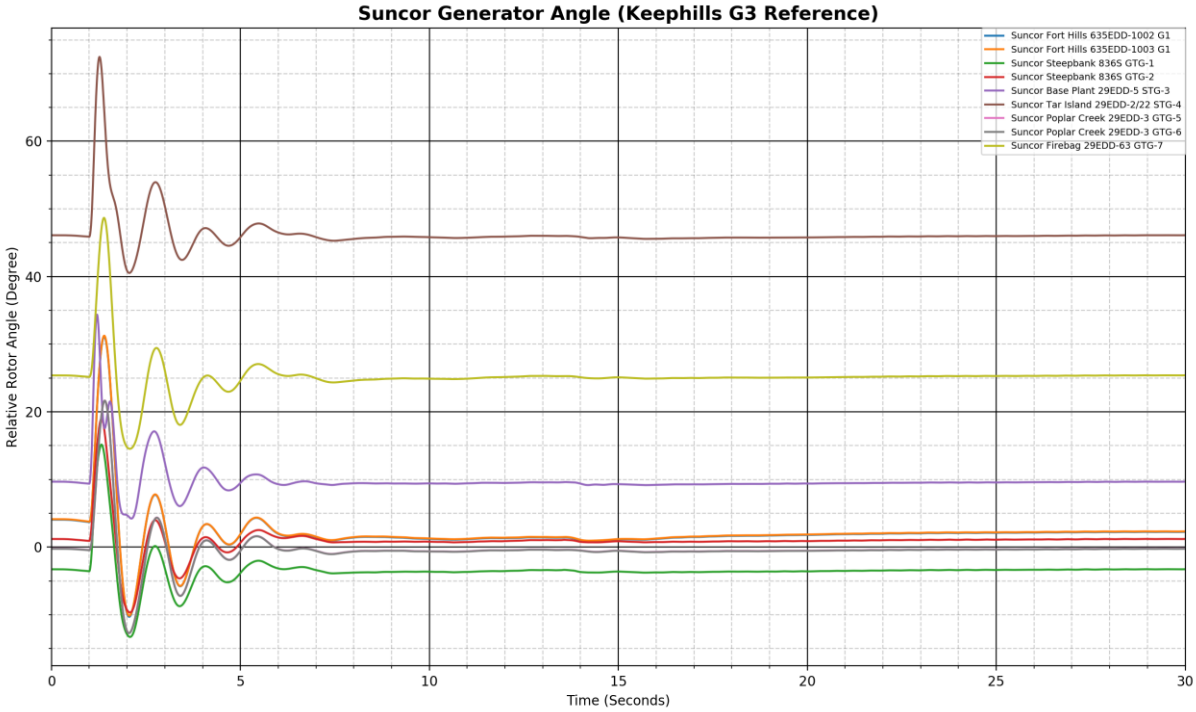


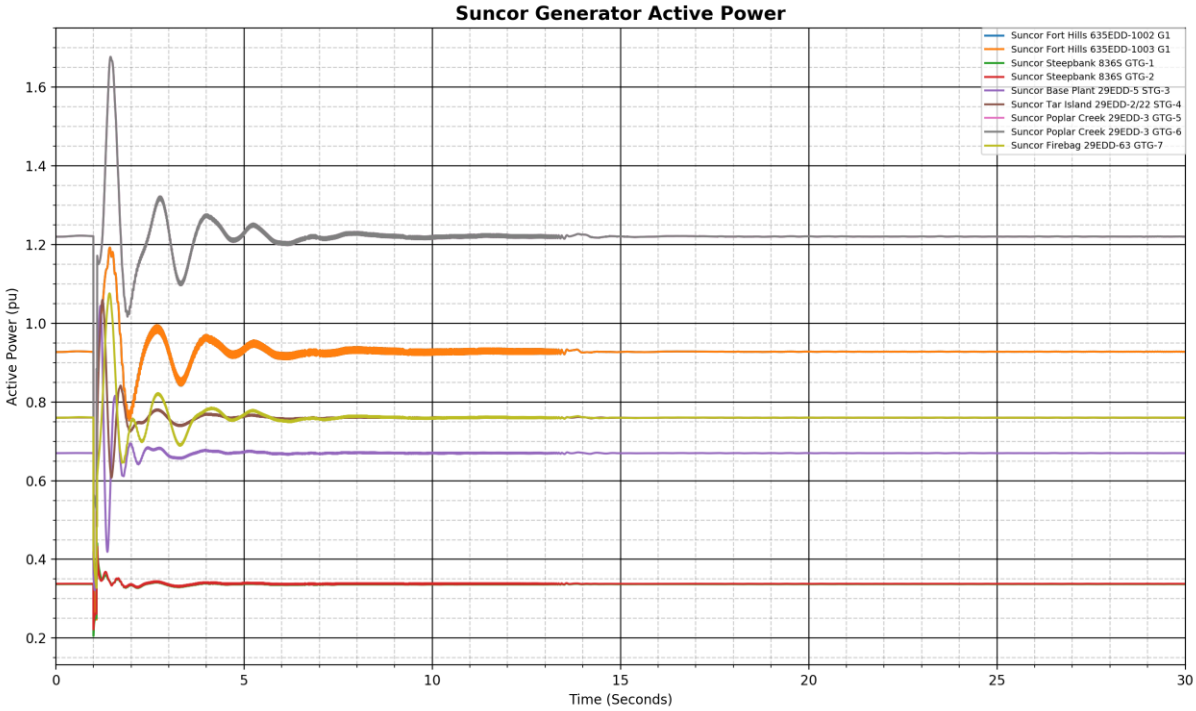

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

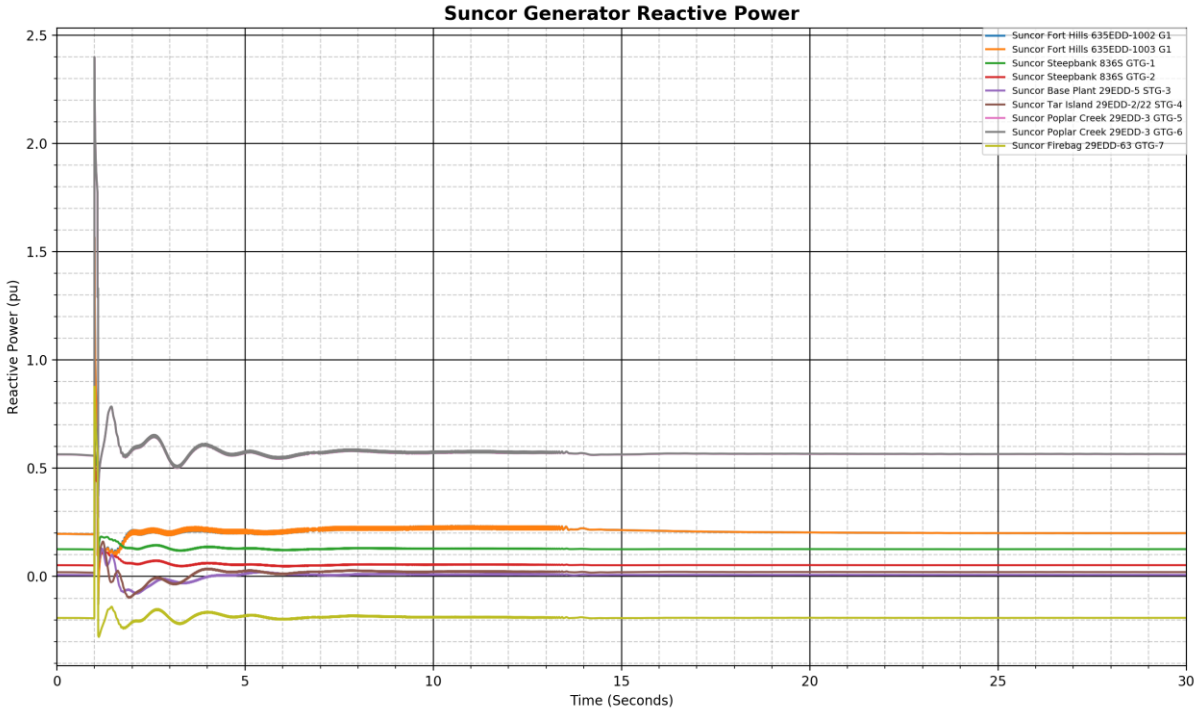

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

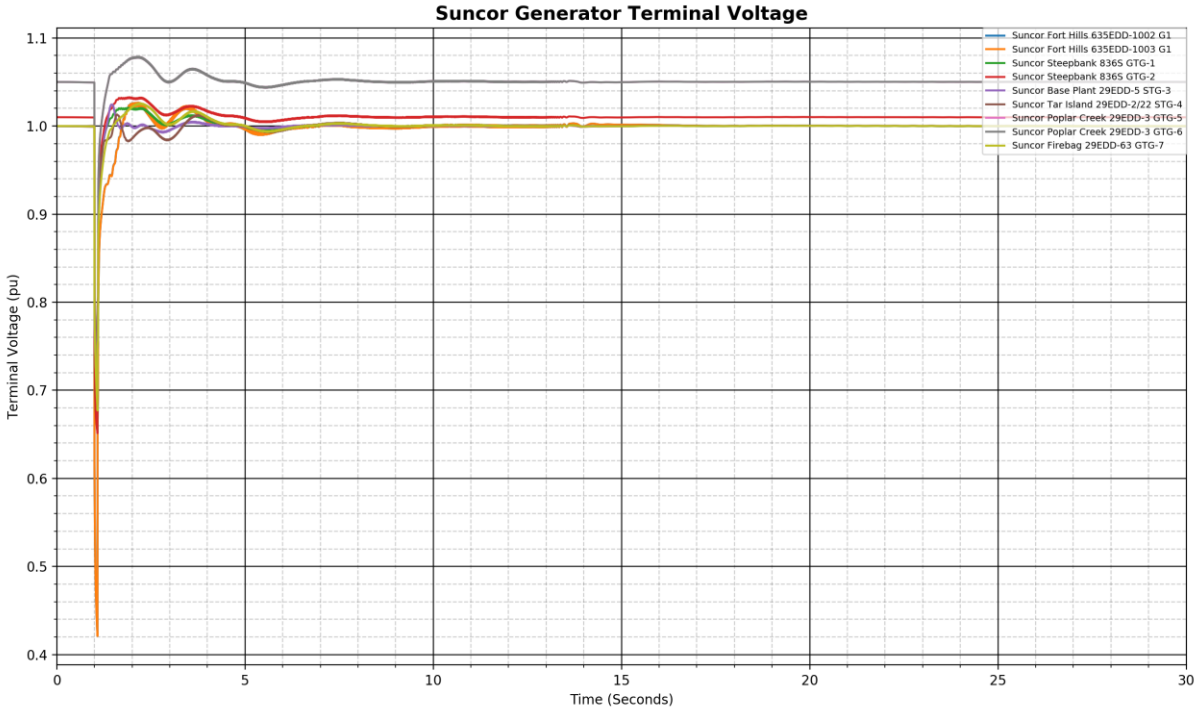

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

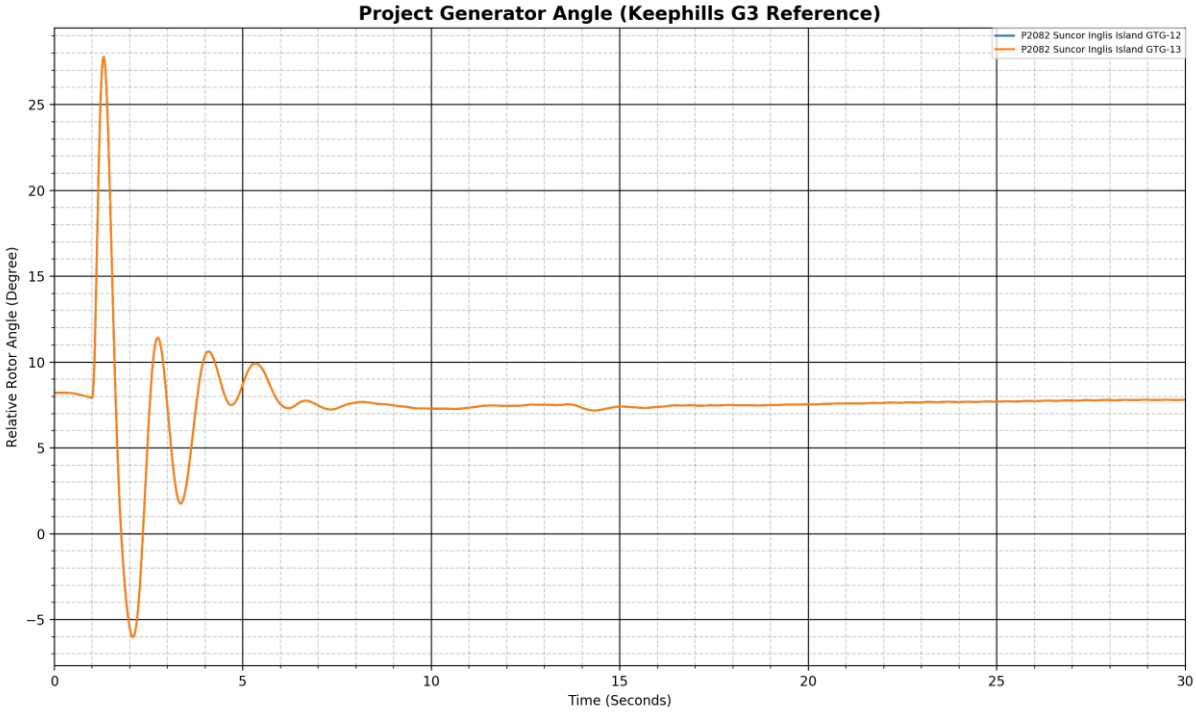

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

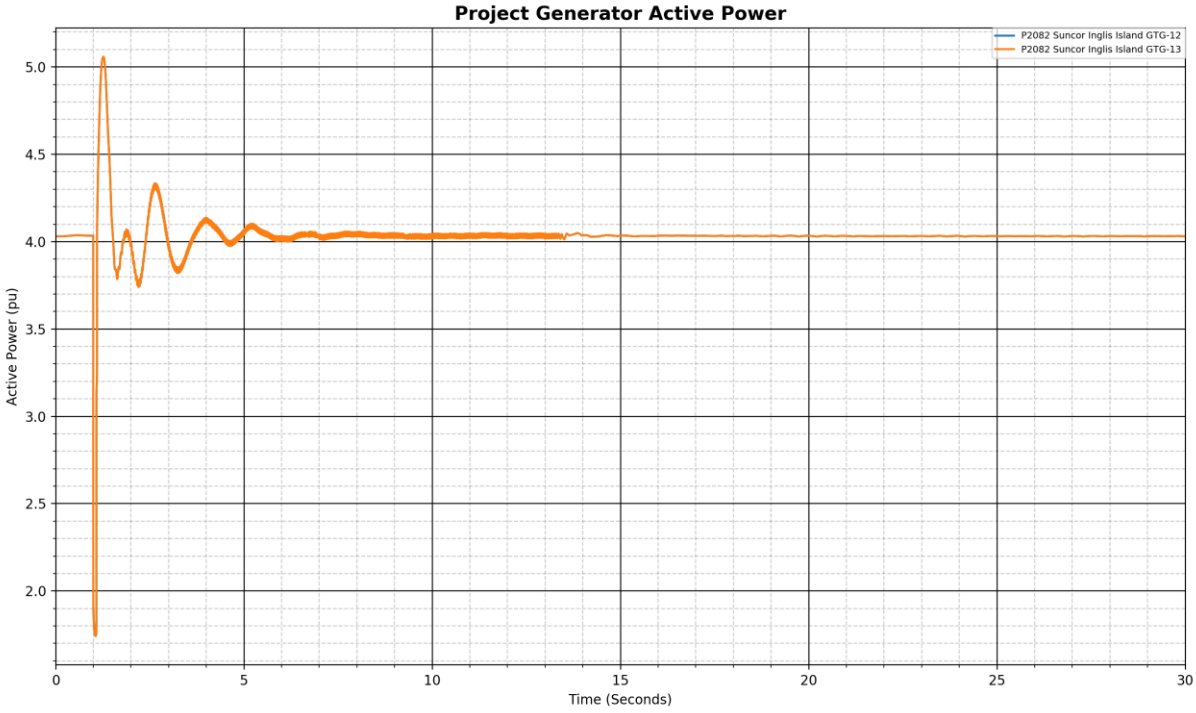

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

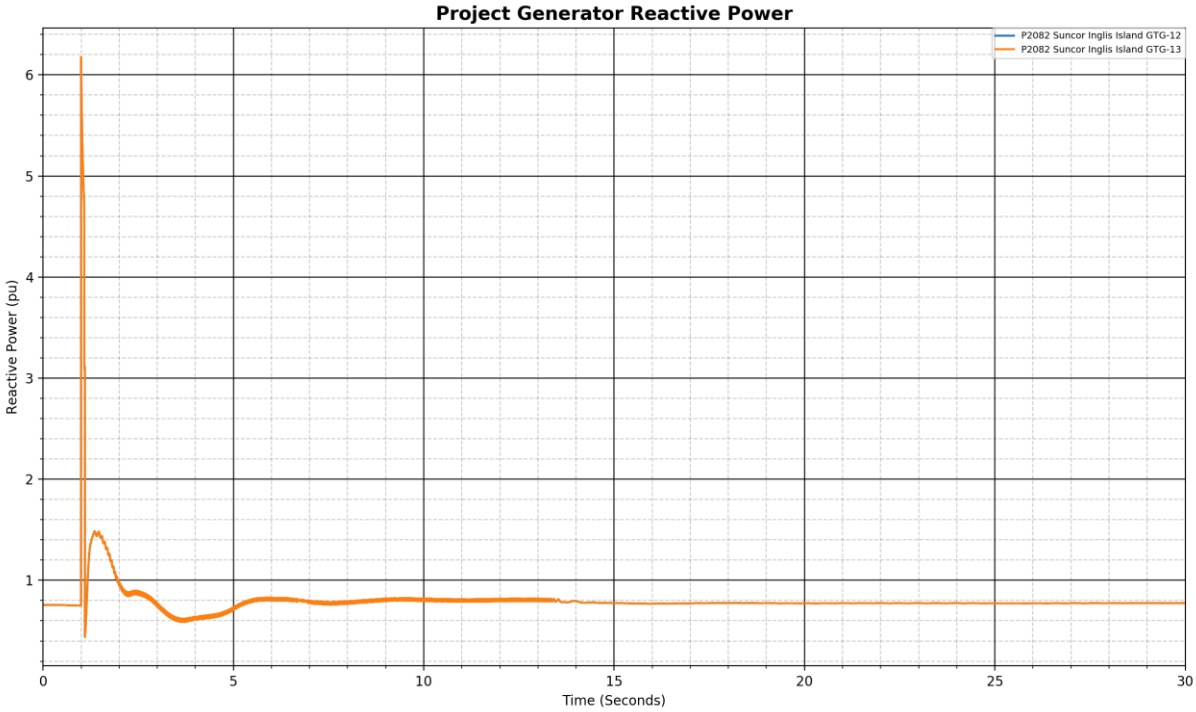

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

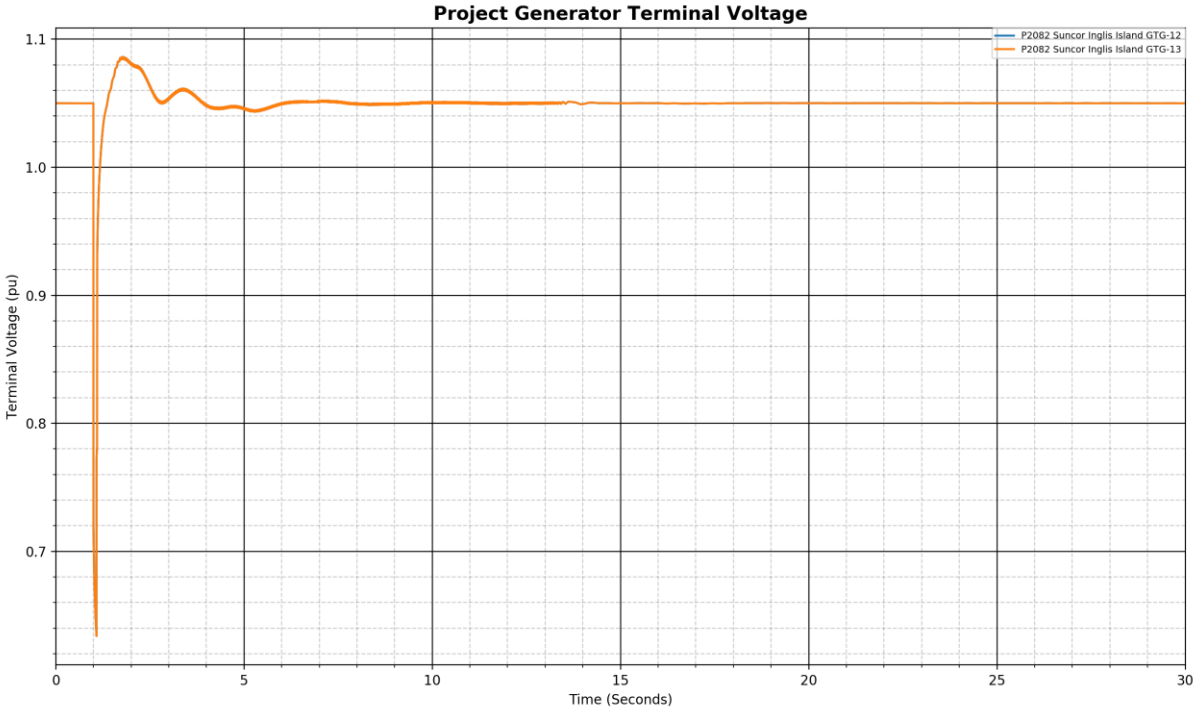

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

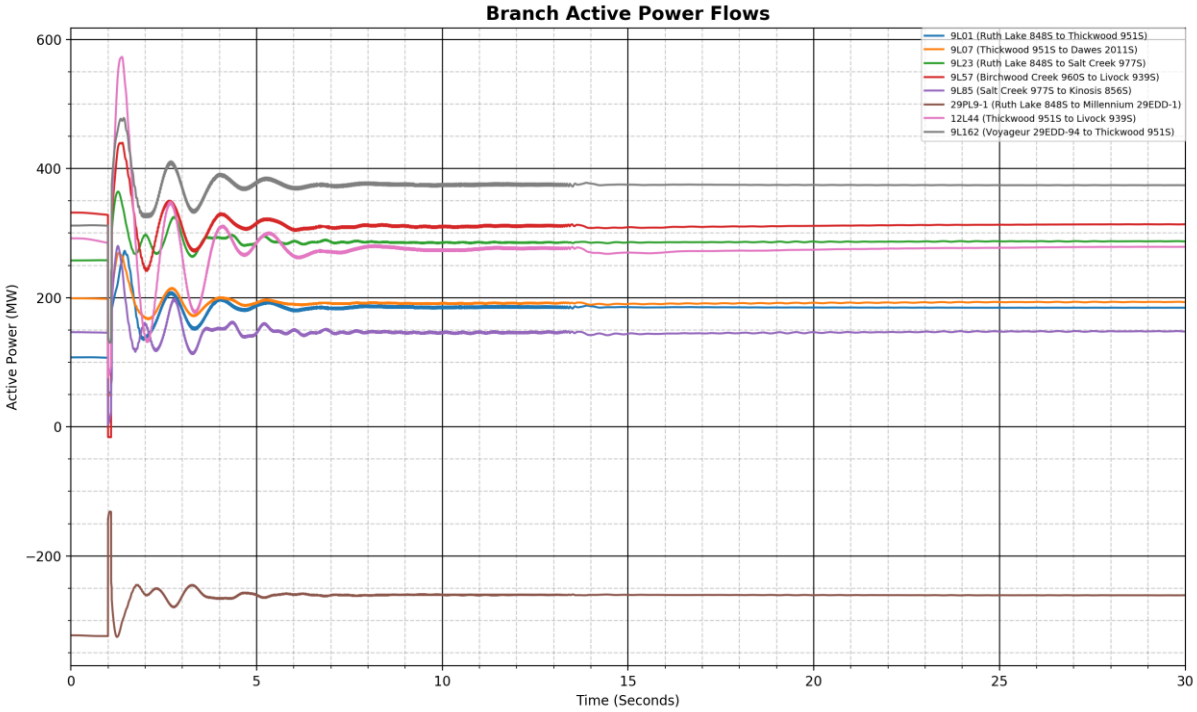

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
25
20
15
10
5
0
−5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
5
10
15
20
25
30
1
2
3
4
5
6


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0
5
10
15
20
25
30
0.7
0.8
0.9
1.0
1.1


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

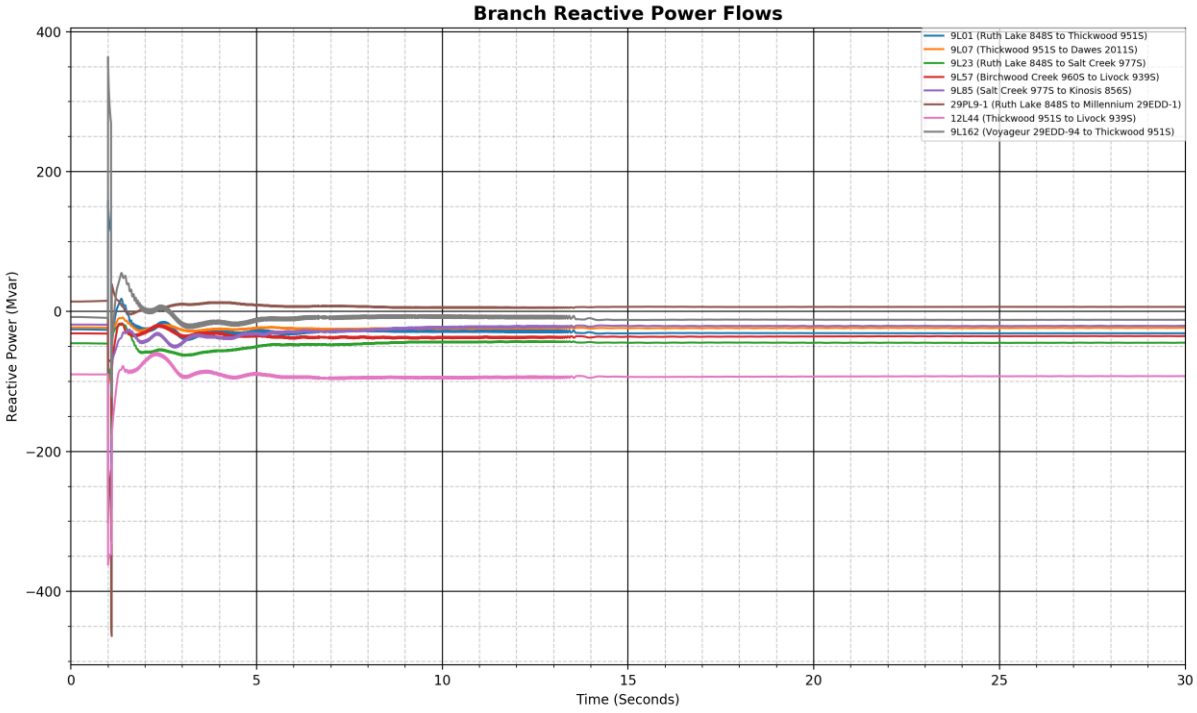
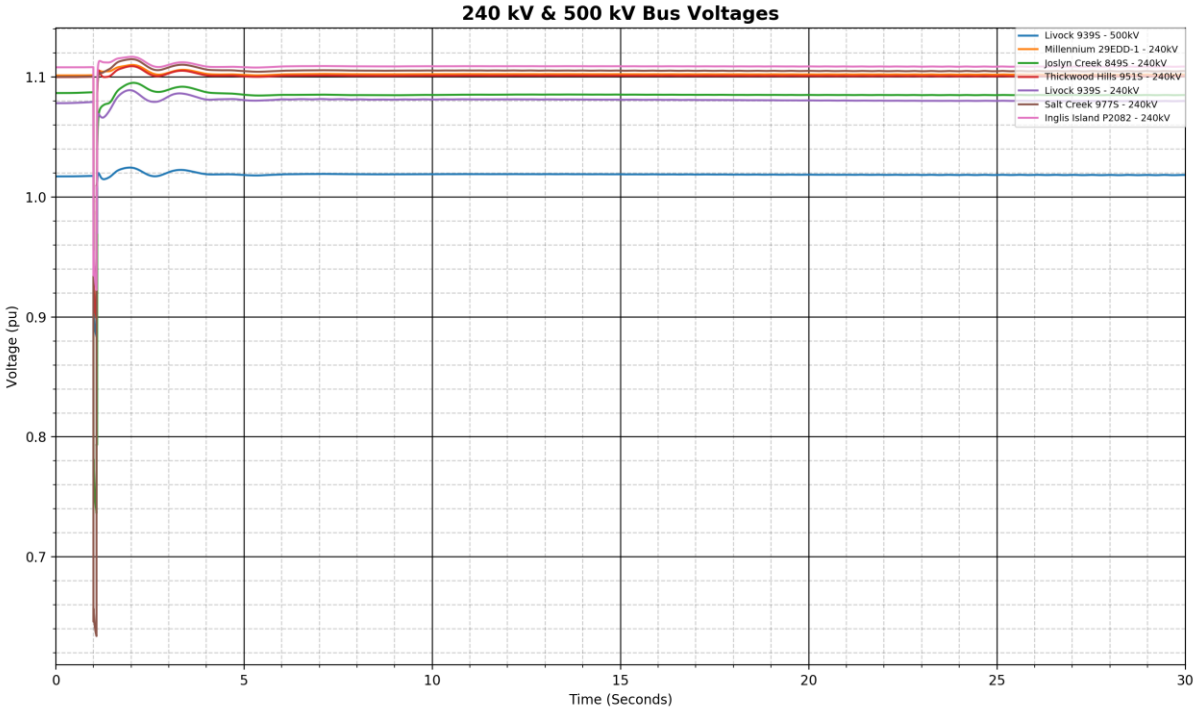
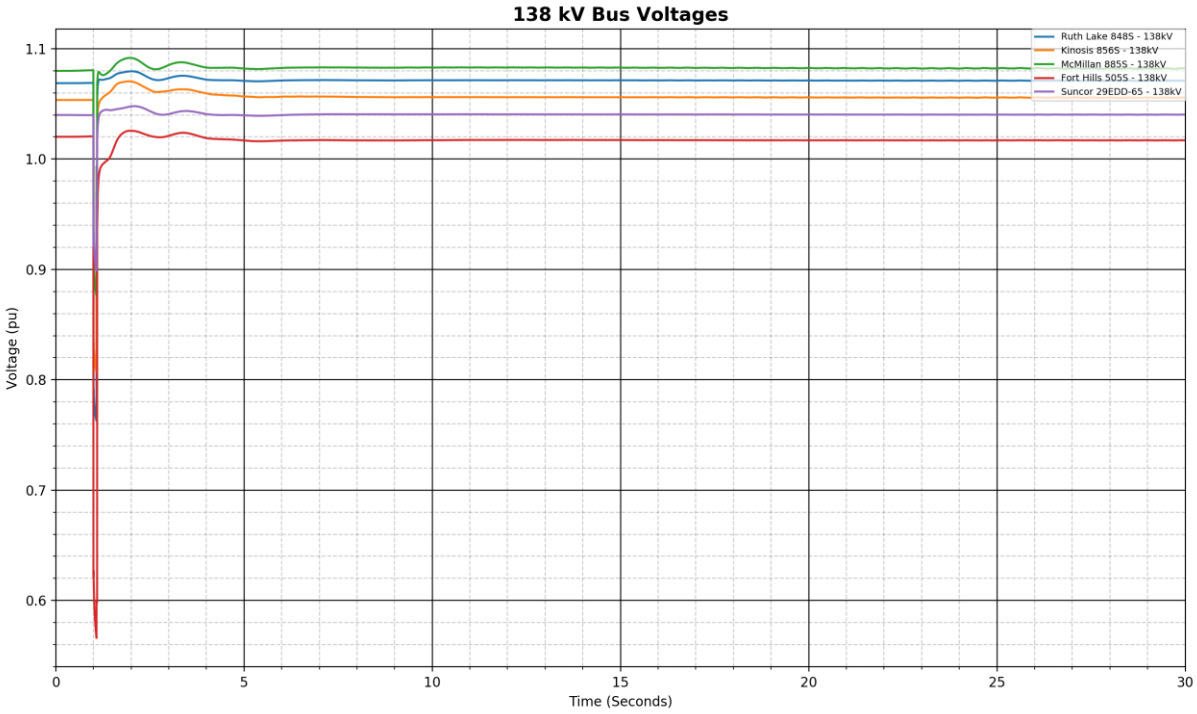
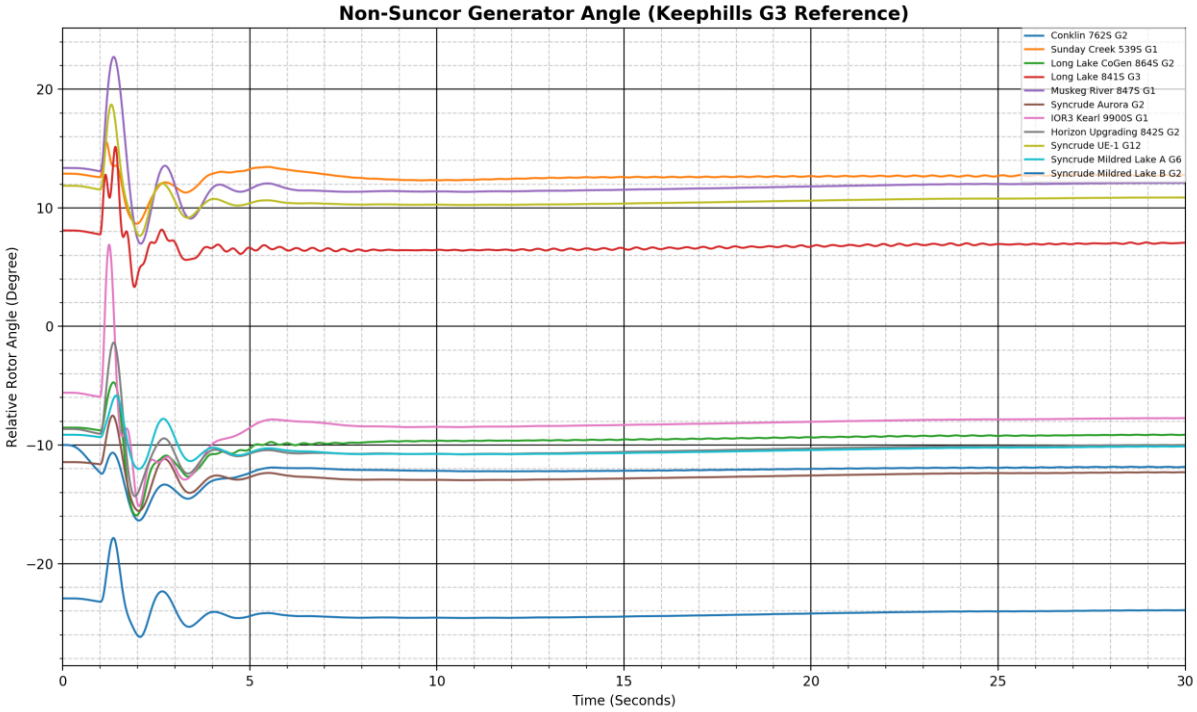
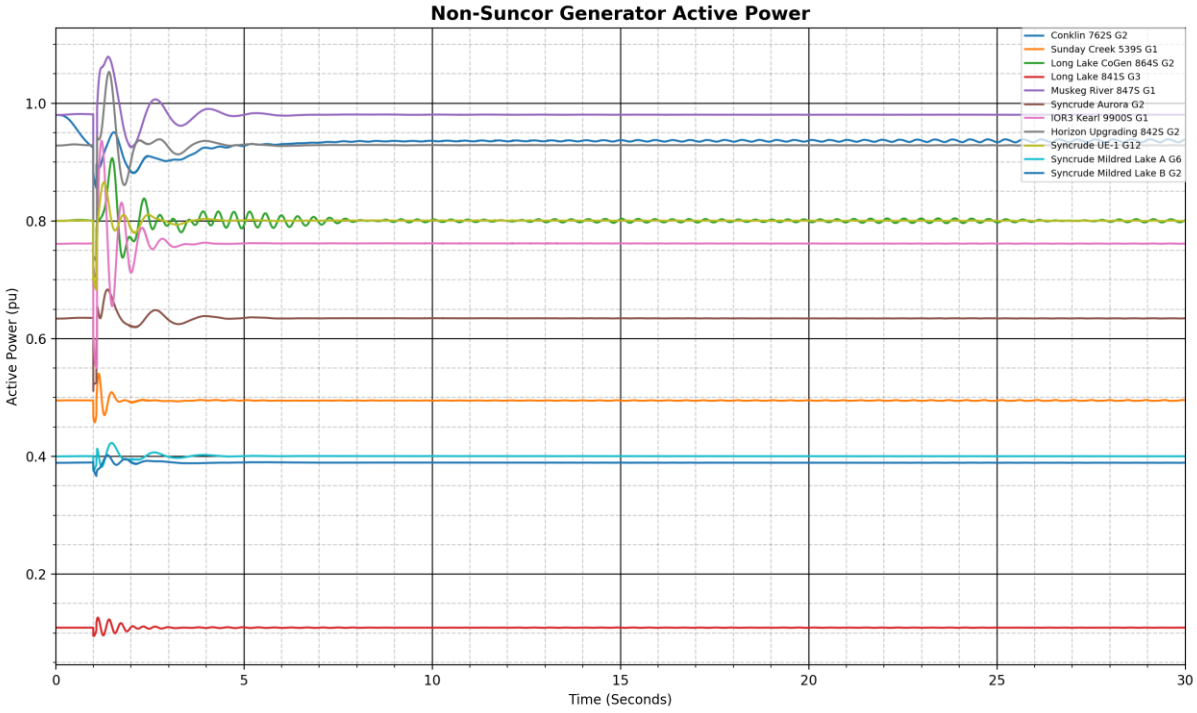

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

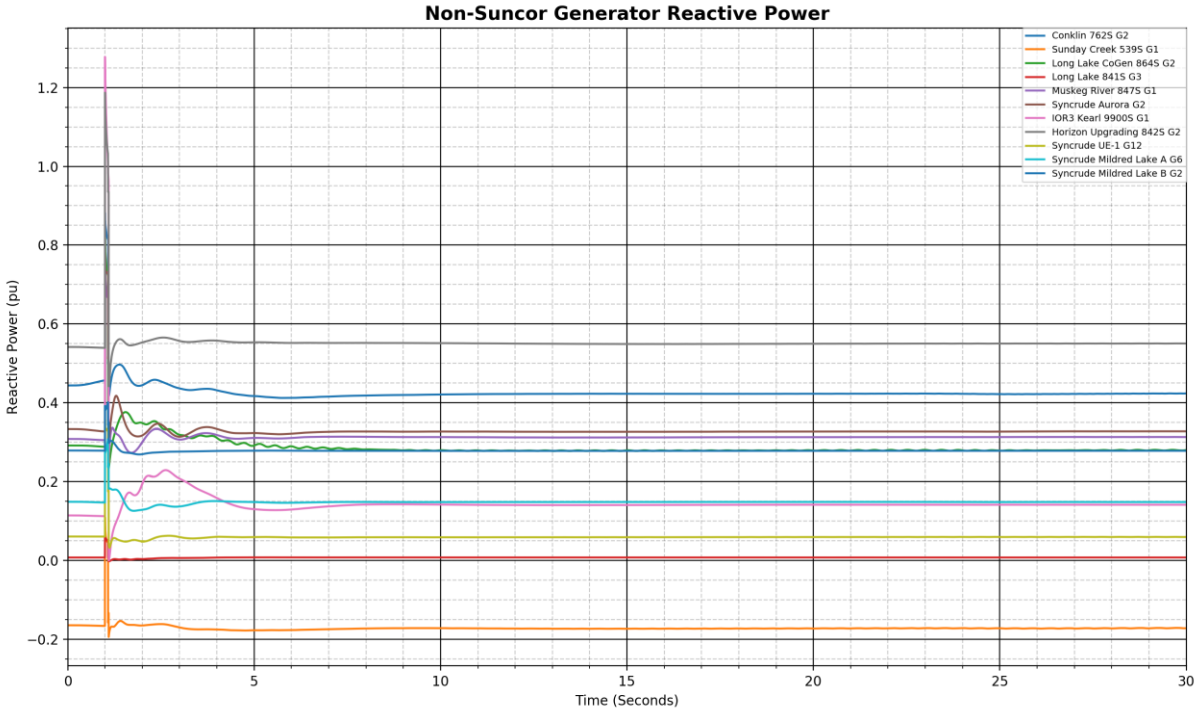
Figure A4-71: 9L69 (Black Fly 934S to McClelland 957S): Fault at Black Fly 934S

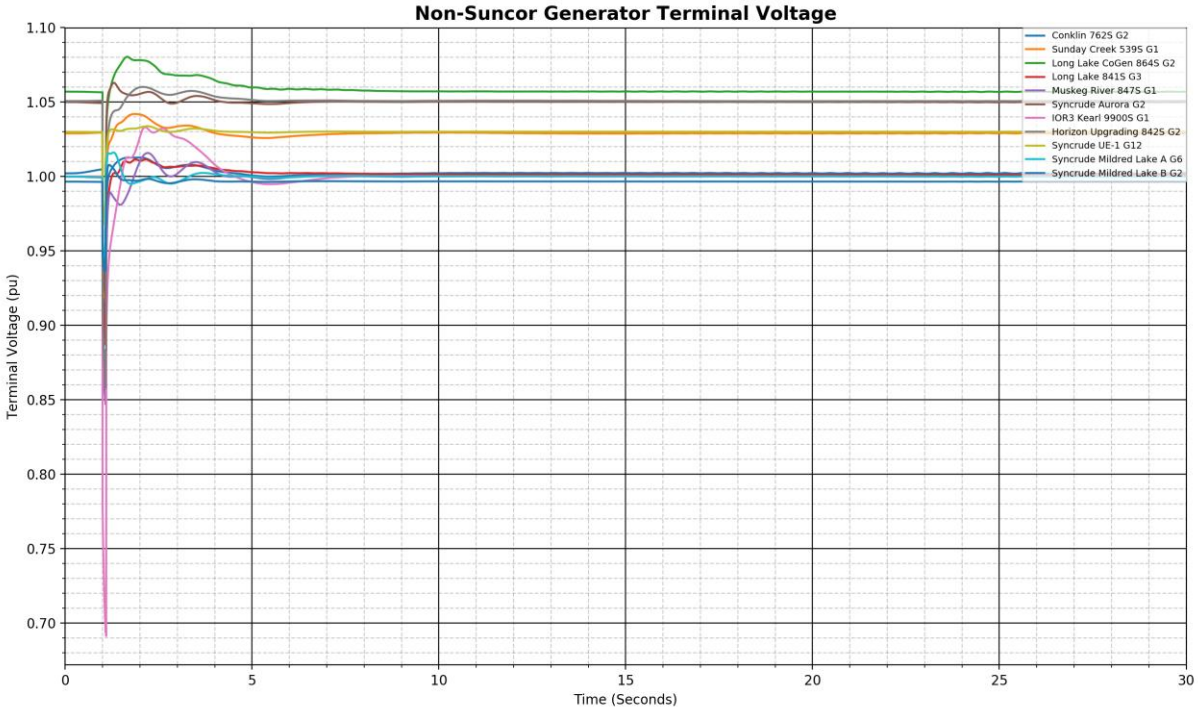


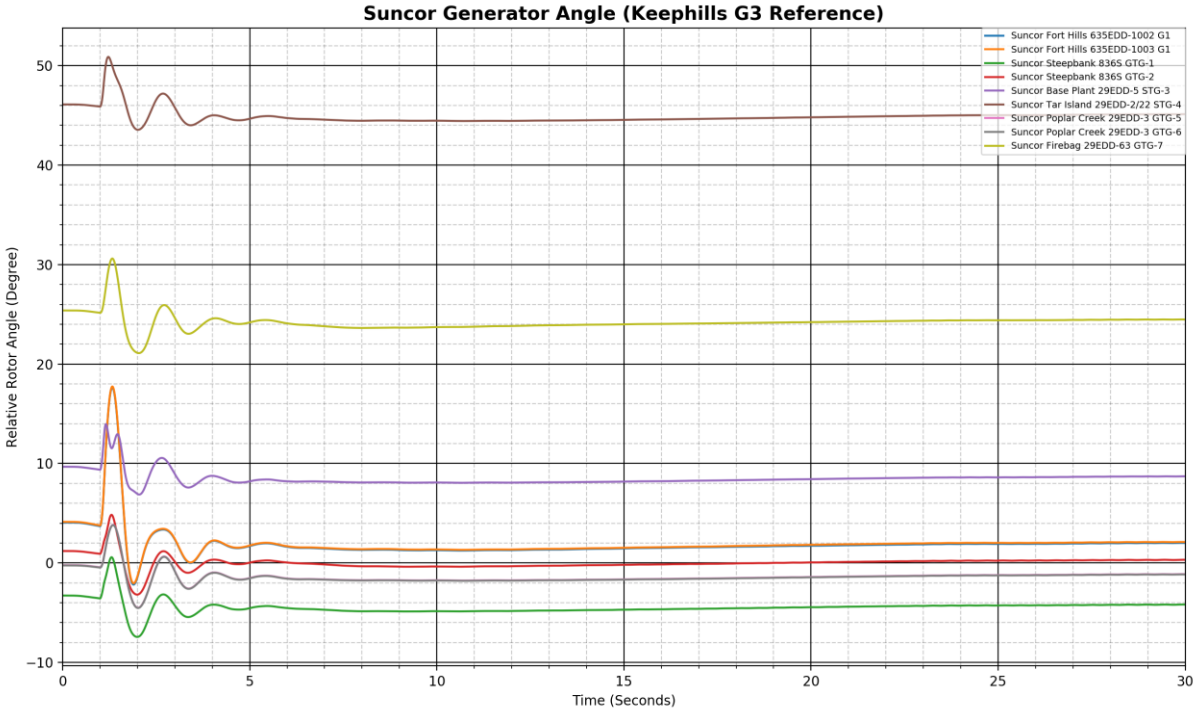


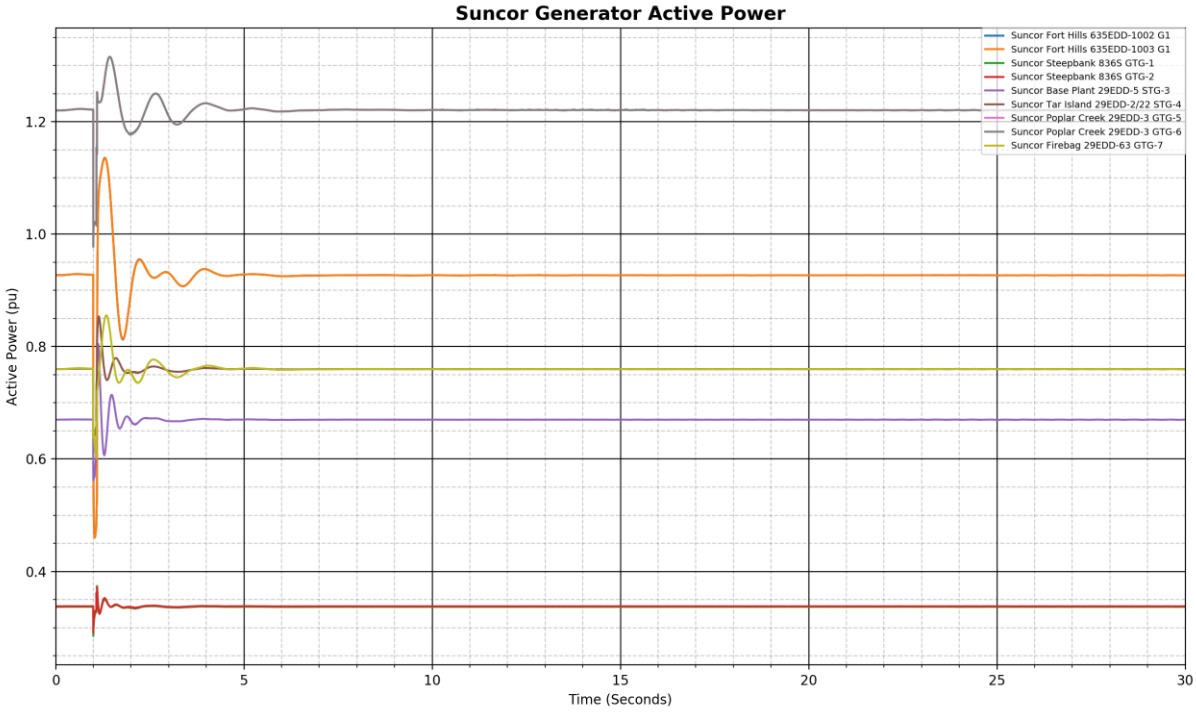

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

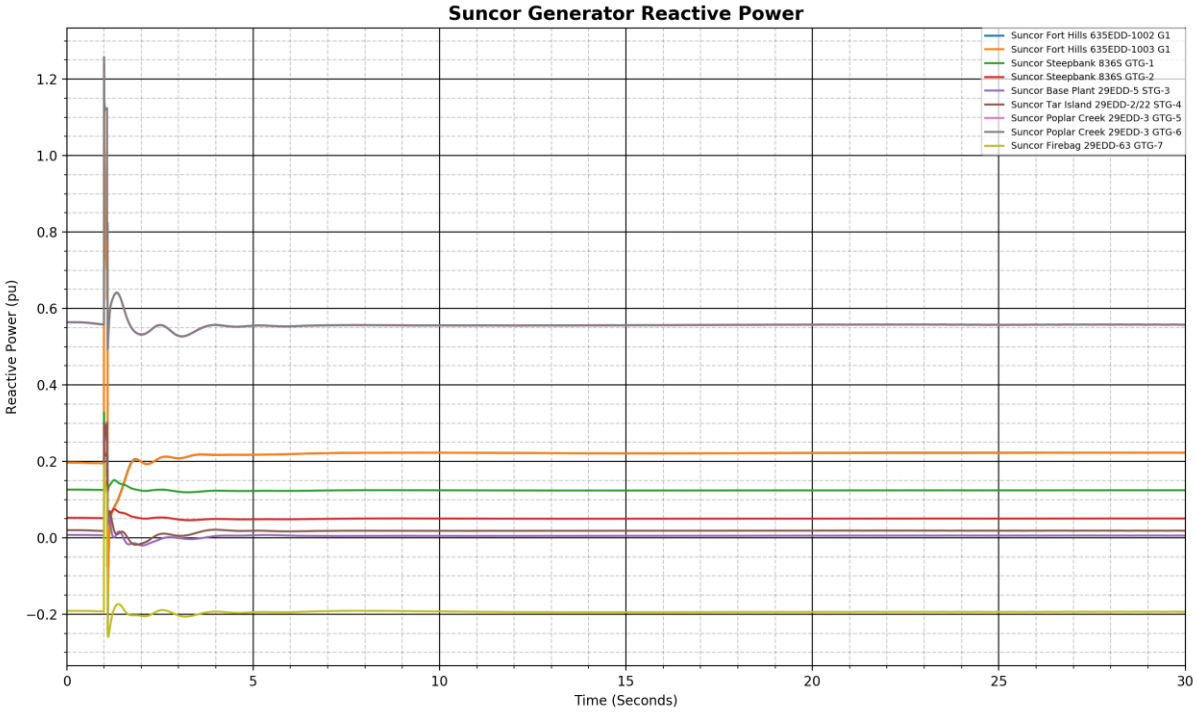

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

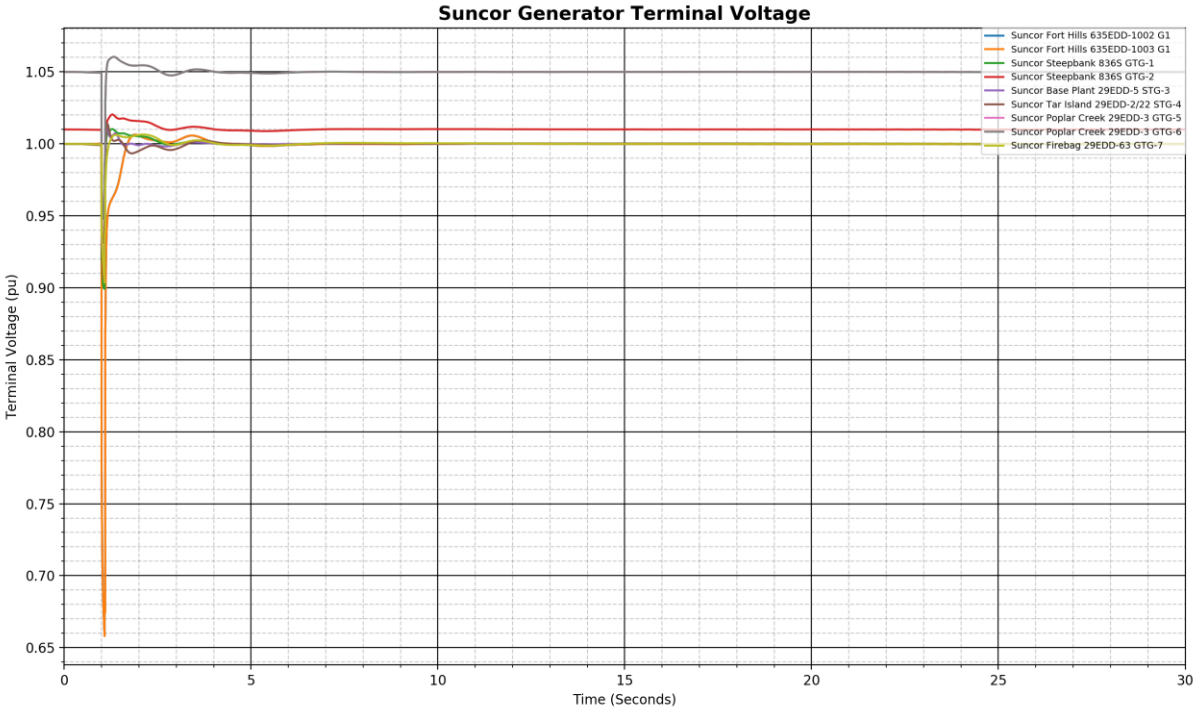

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

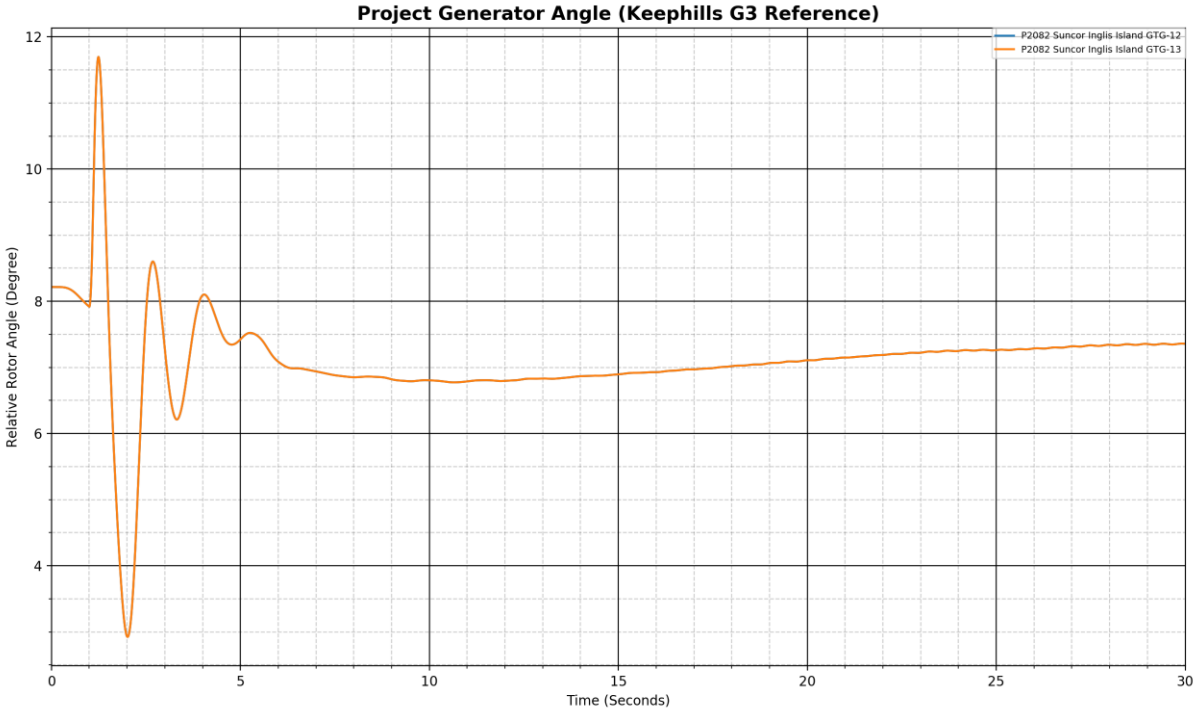

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

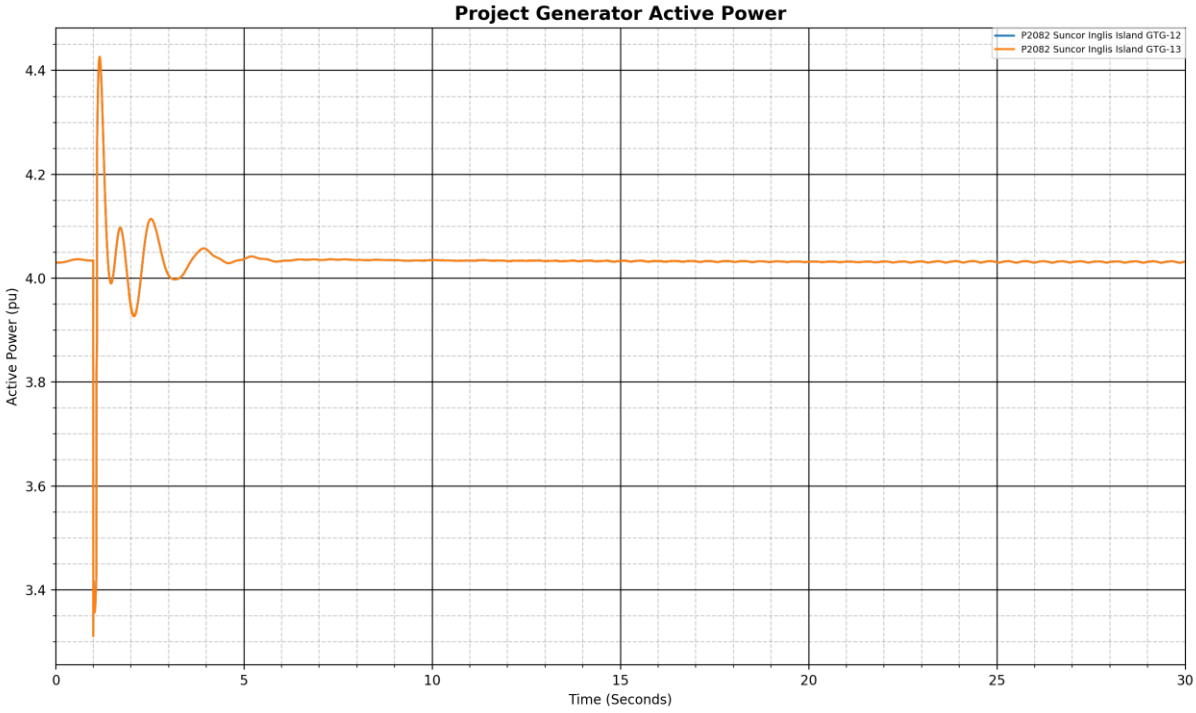

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

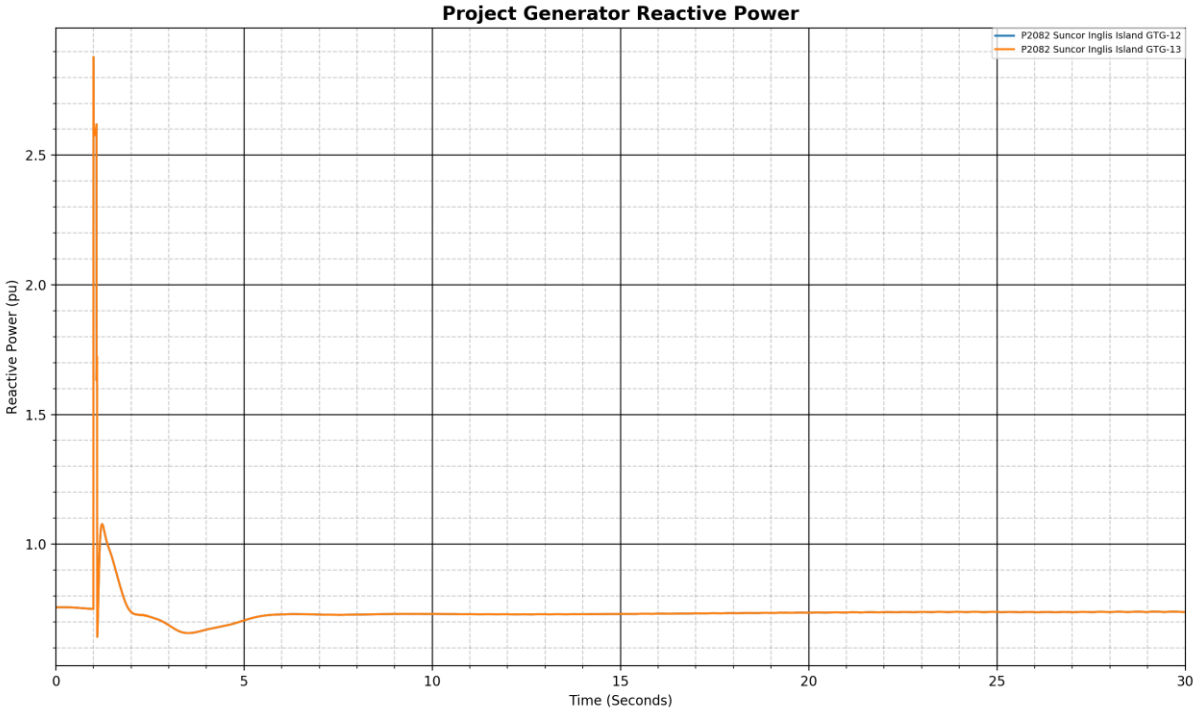

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

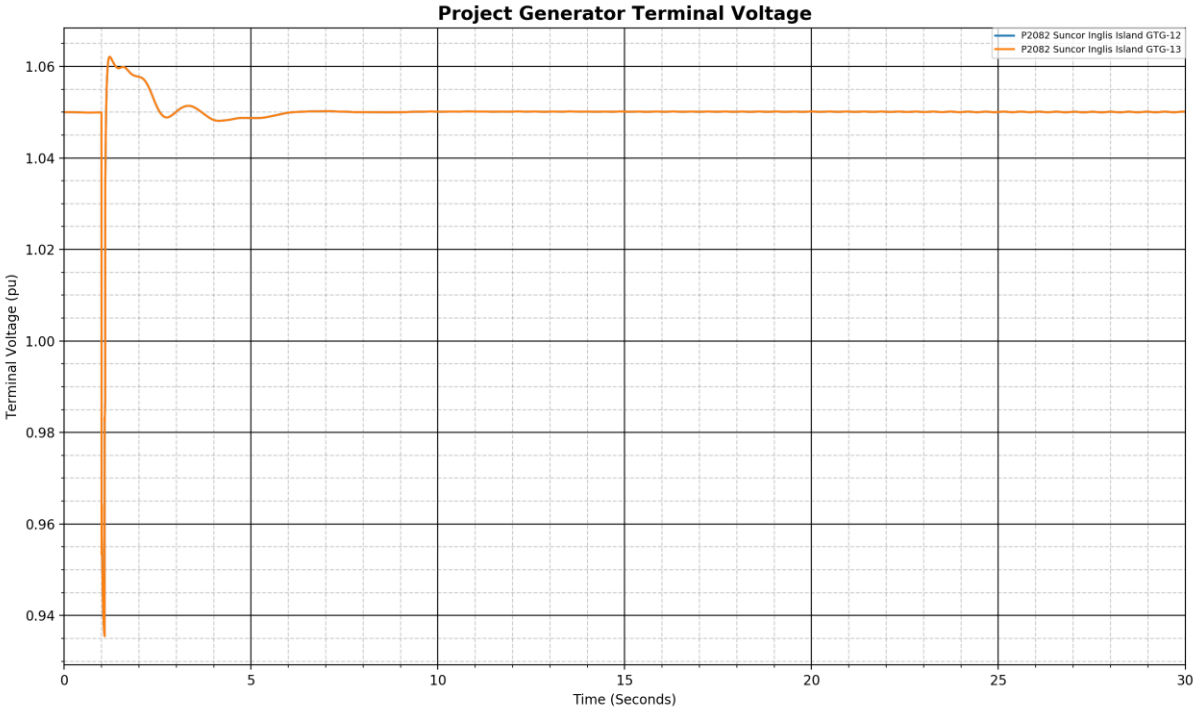

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

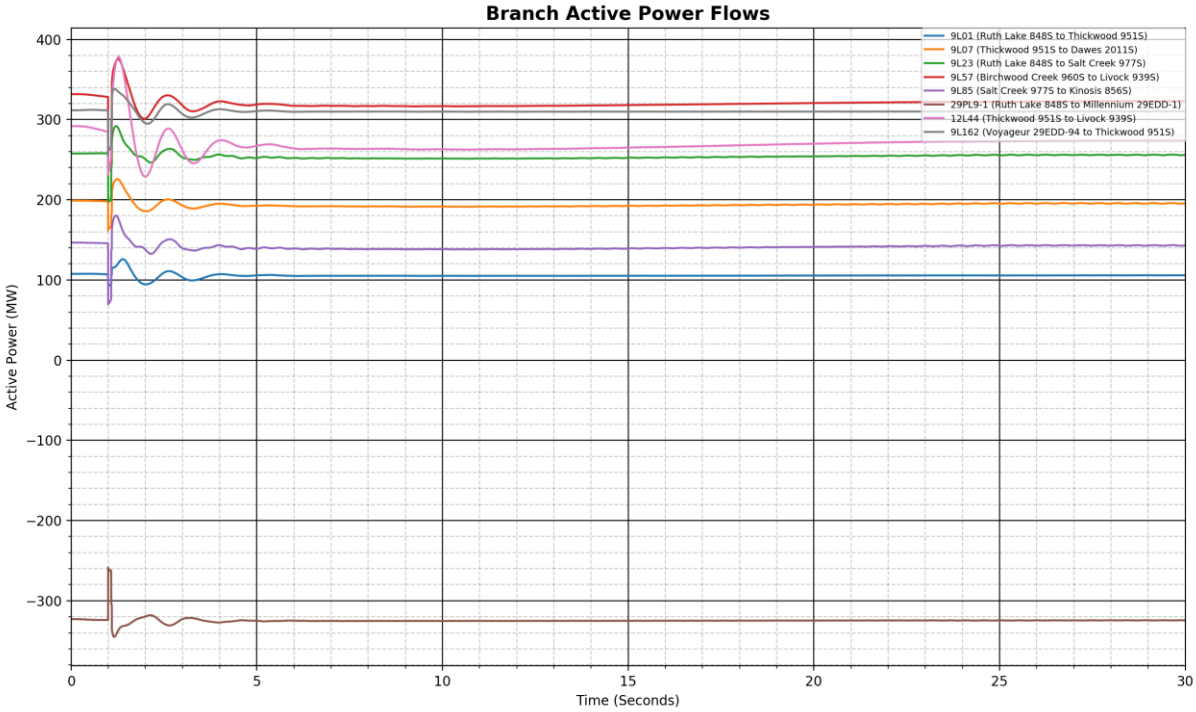

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
12
10
8
6
4
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
4.4
4.2
4.0
3.8
3.6
3.4
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
2.5
2.0
1.5
1.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

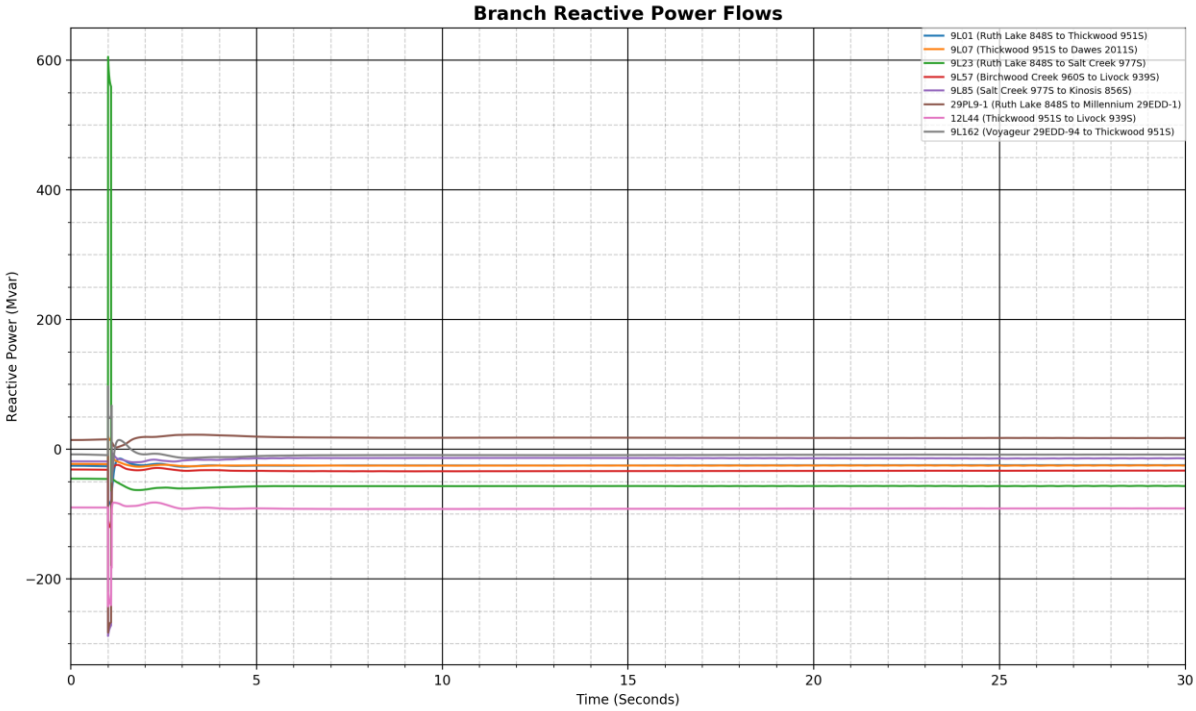
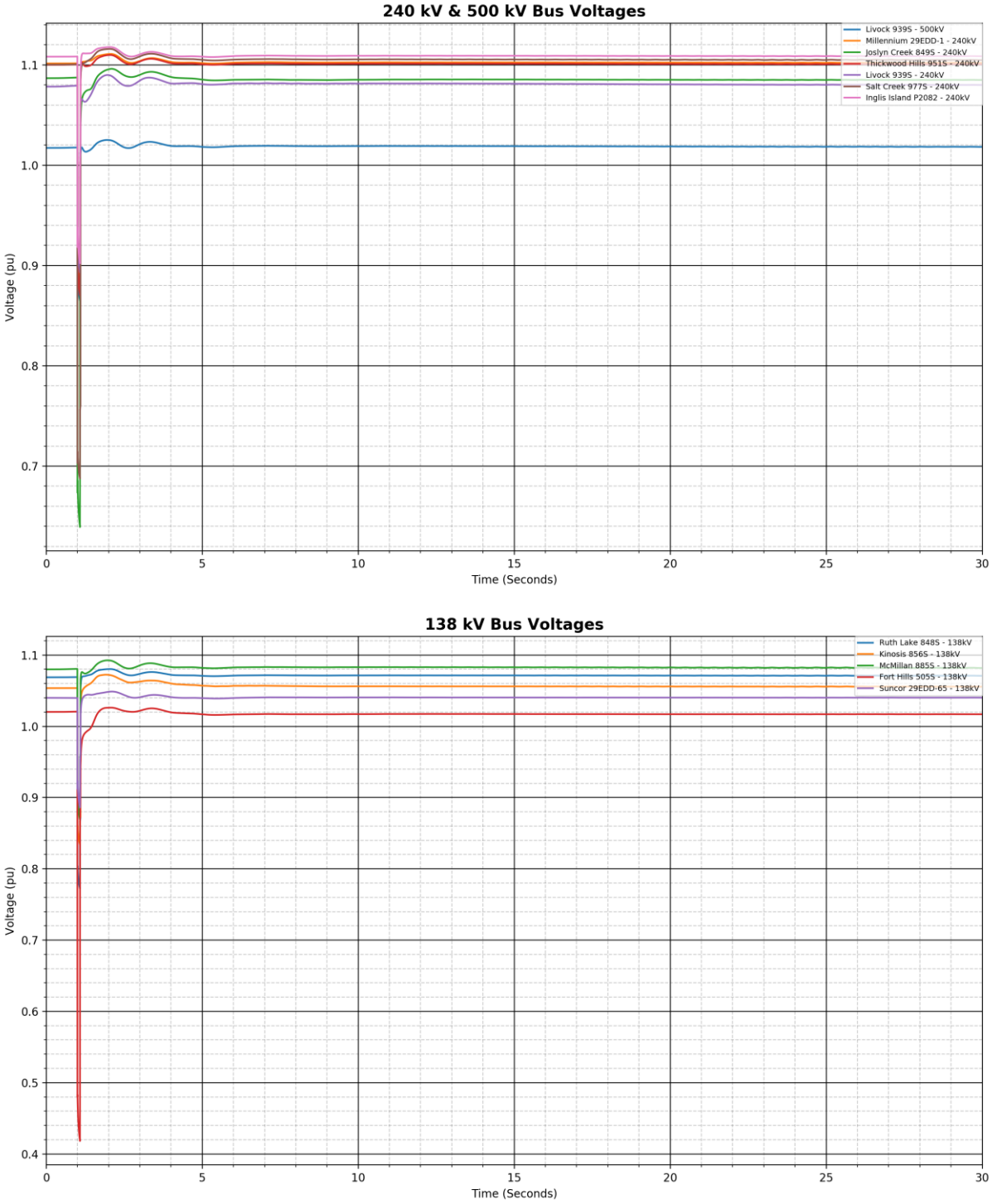
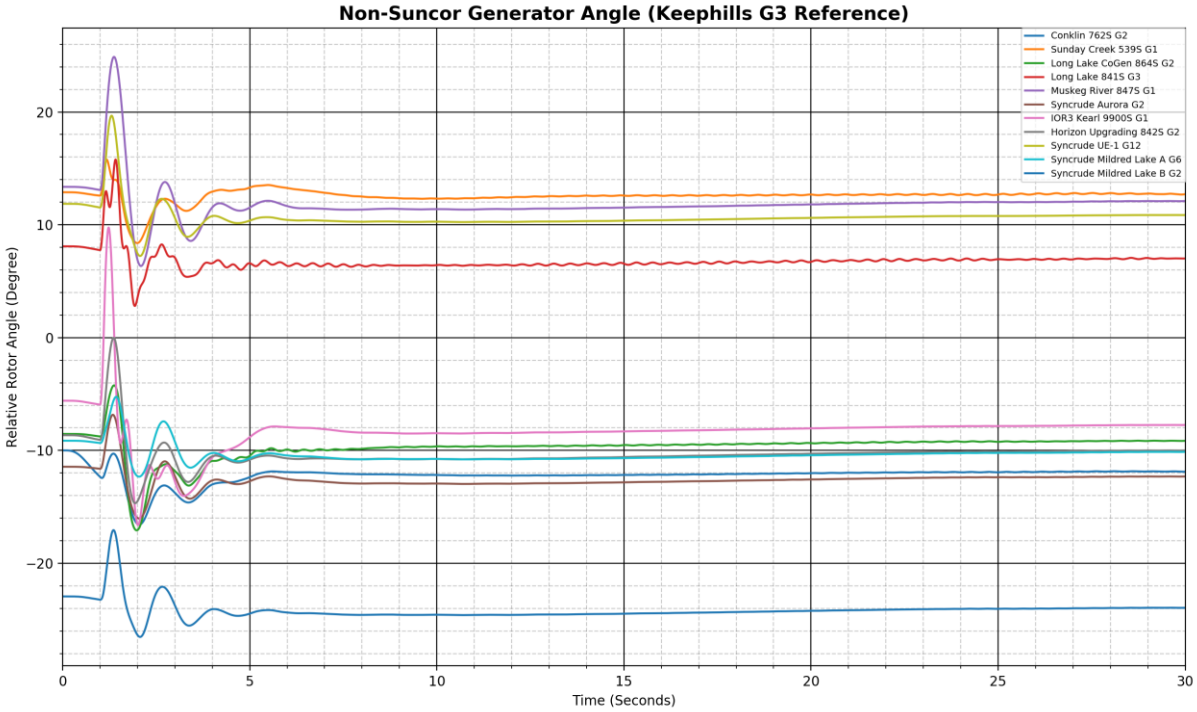
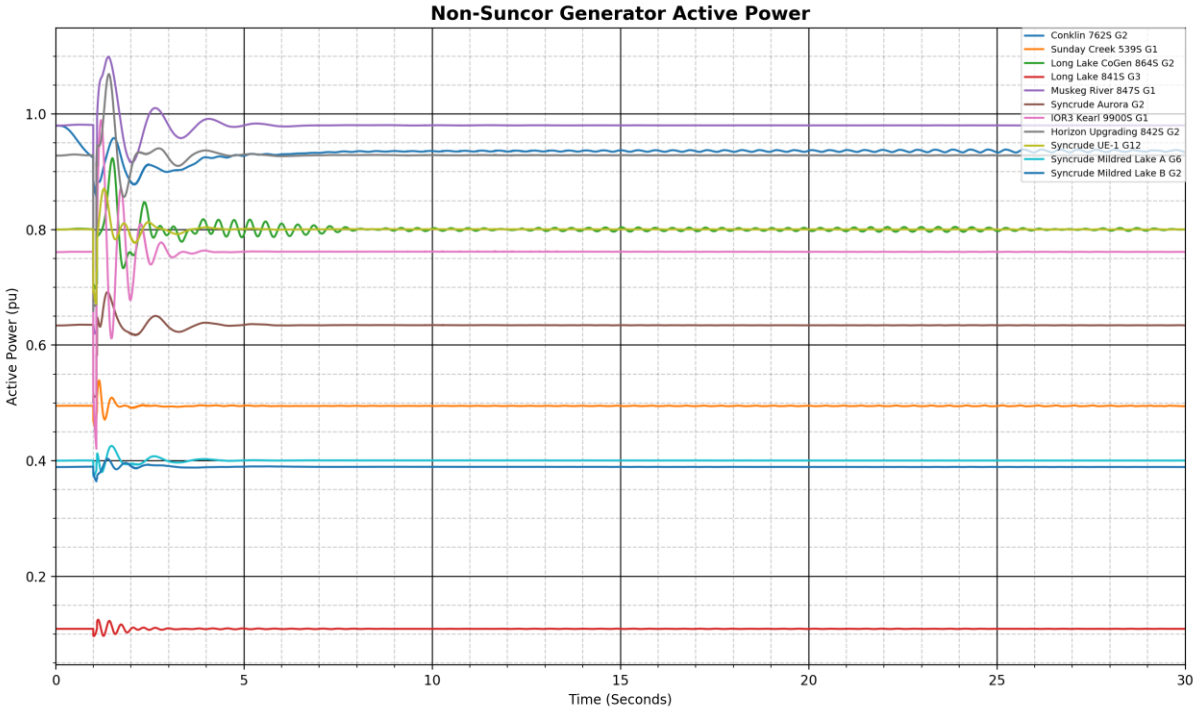
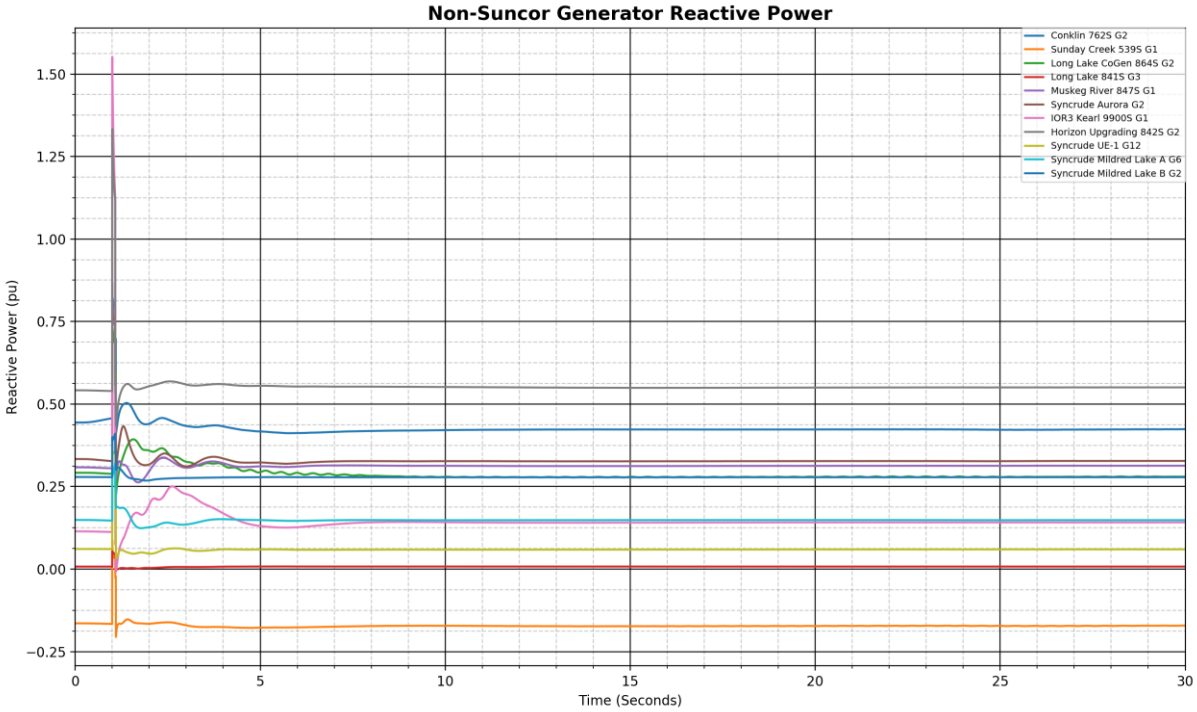

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

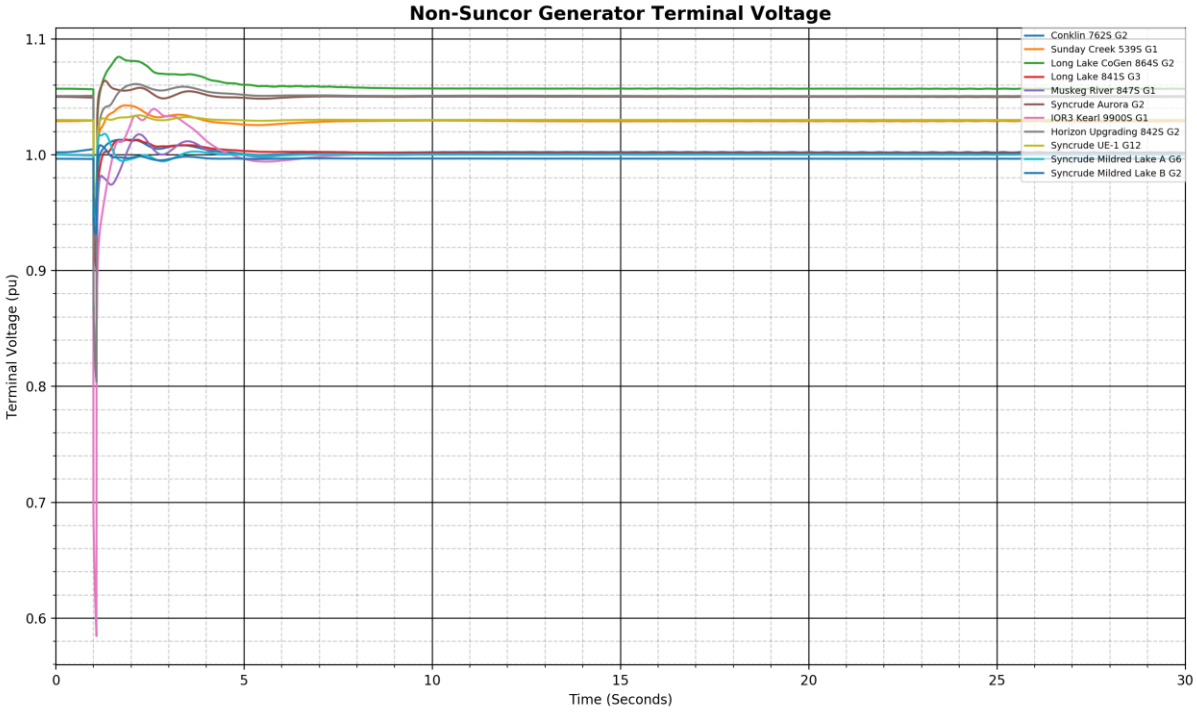
Figure A4-72: 9L69 (Black Fly 934S to McClelland 957S): Fault at McClelland 957S

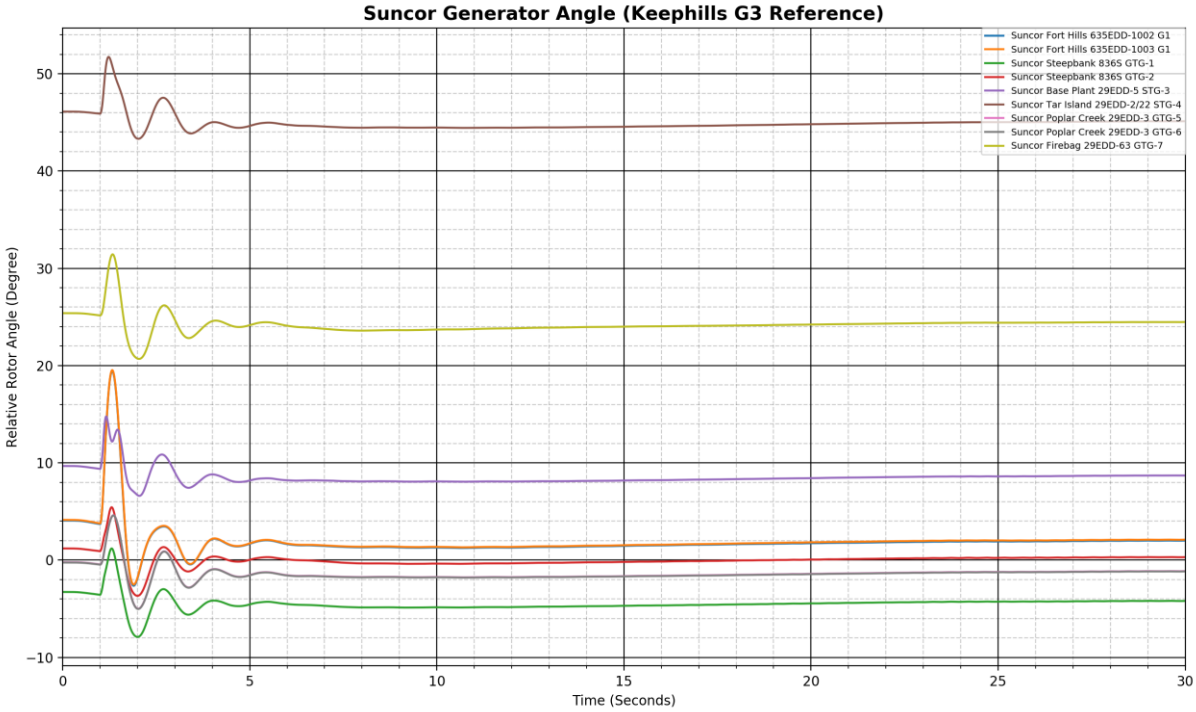


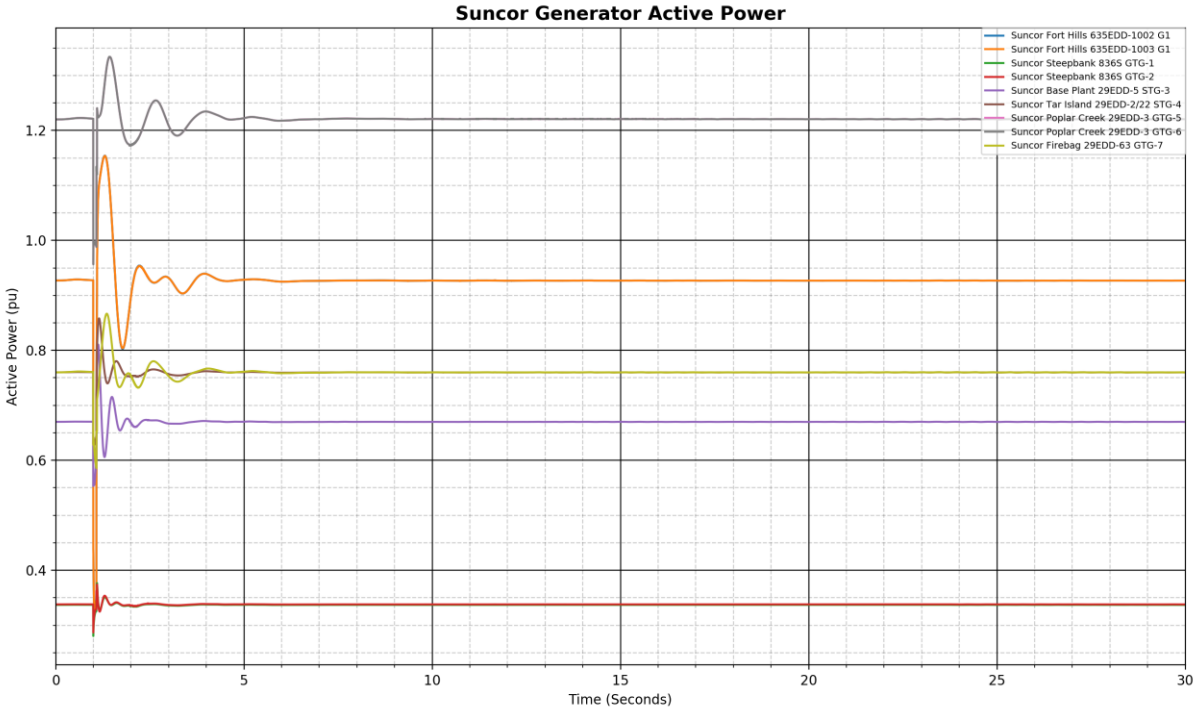

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

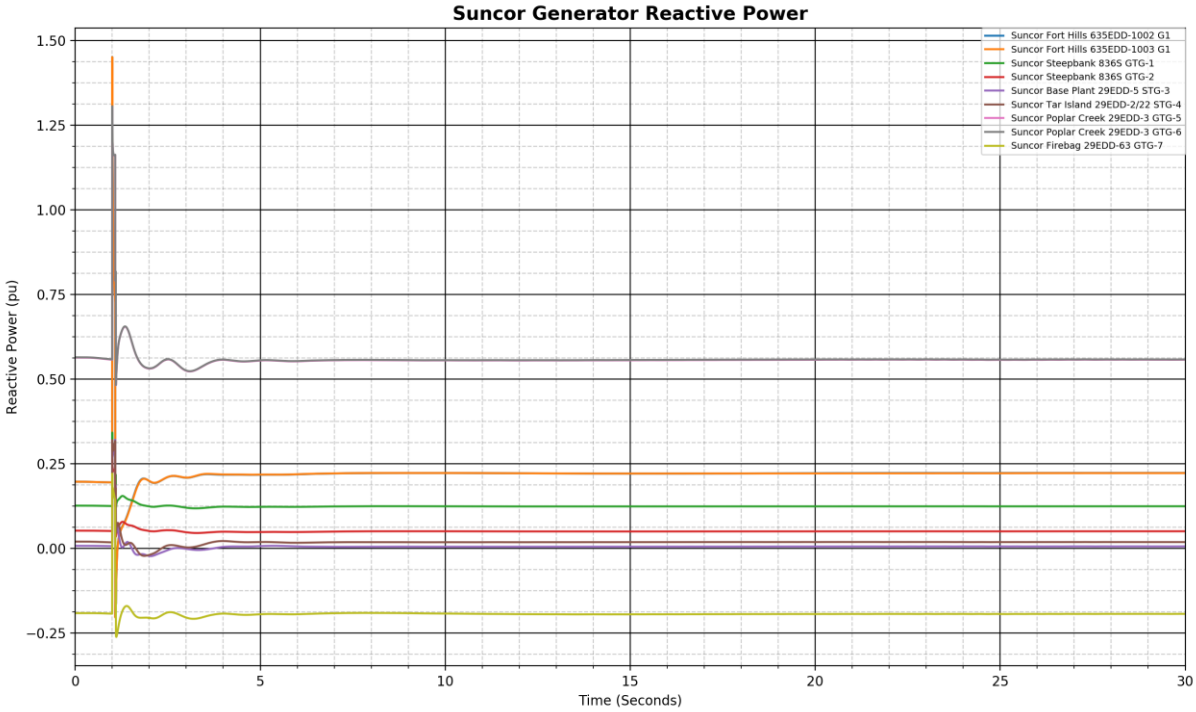

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

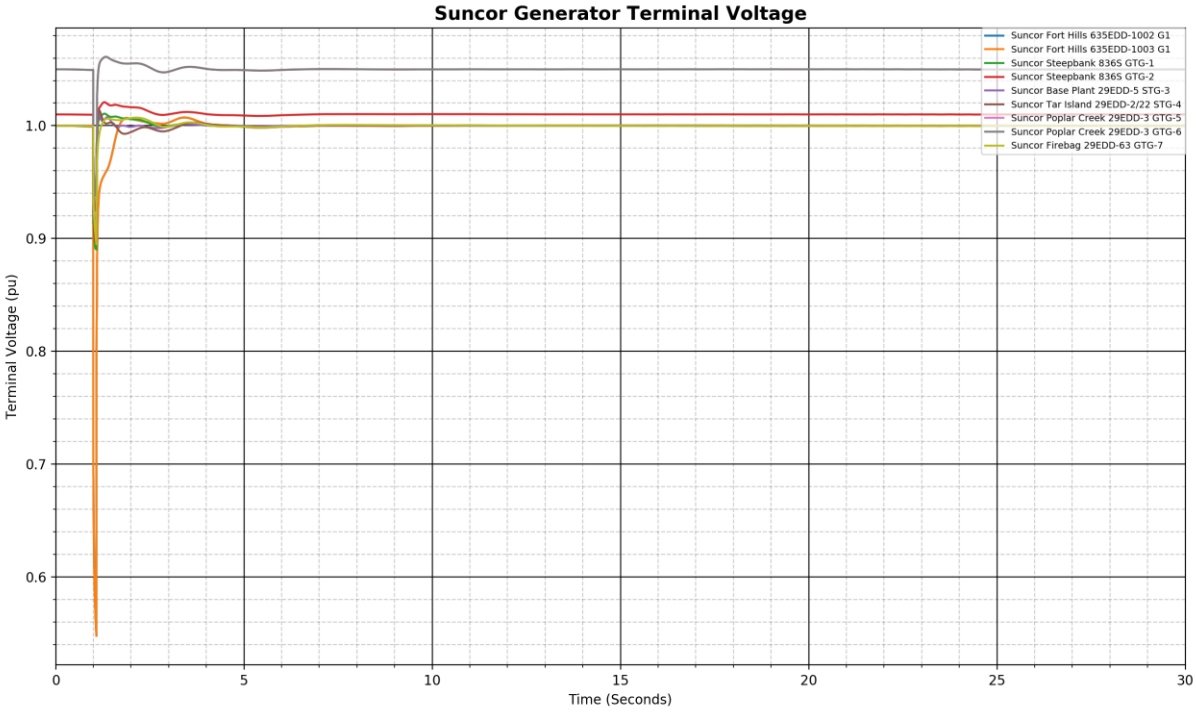

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

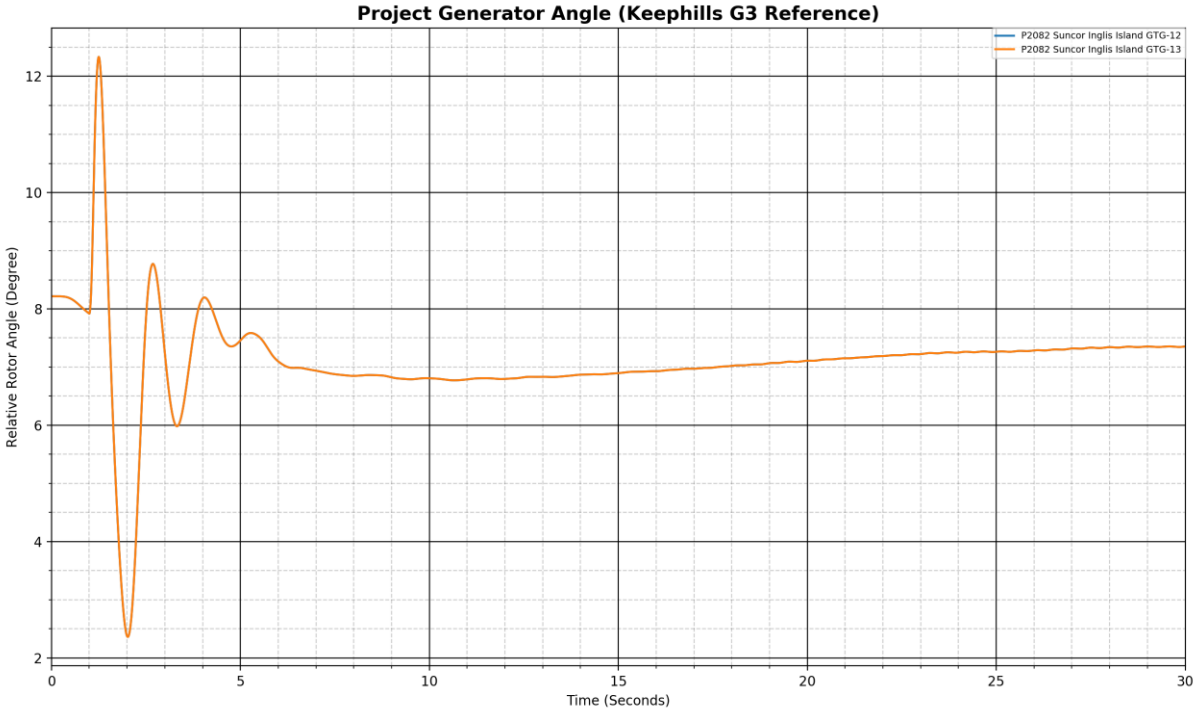

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

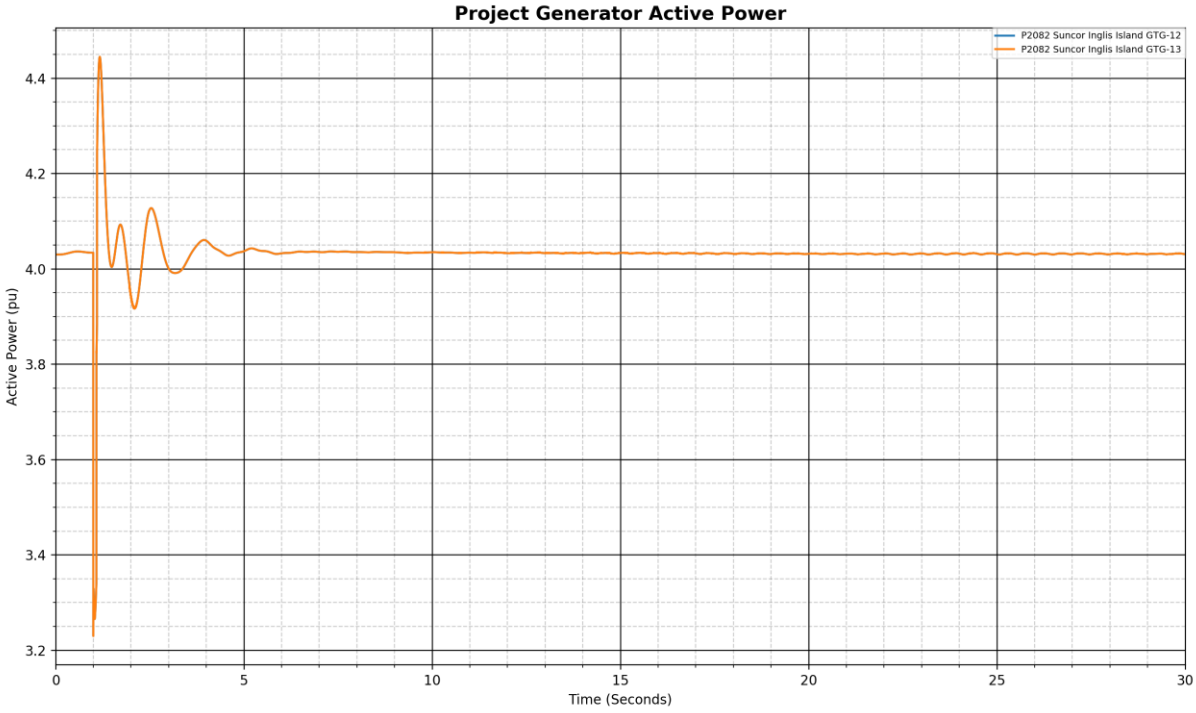

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

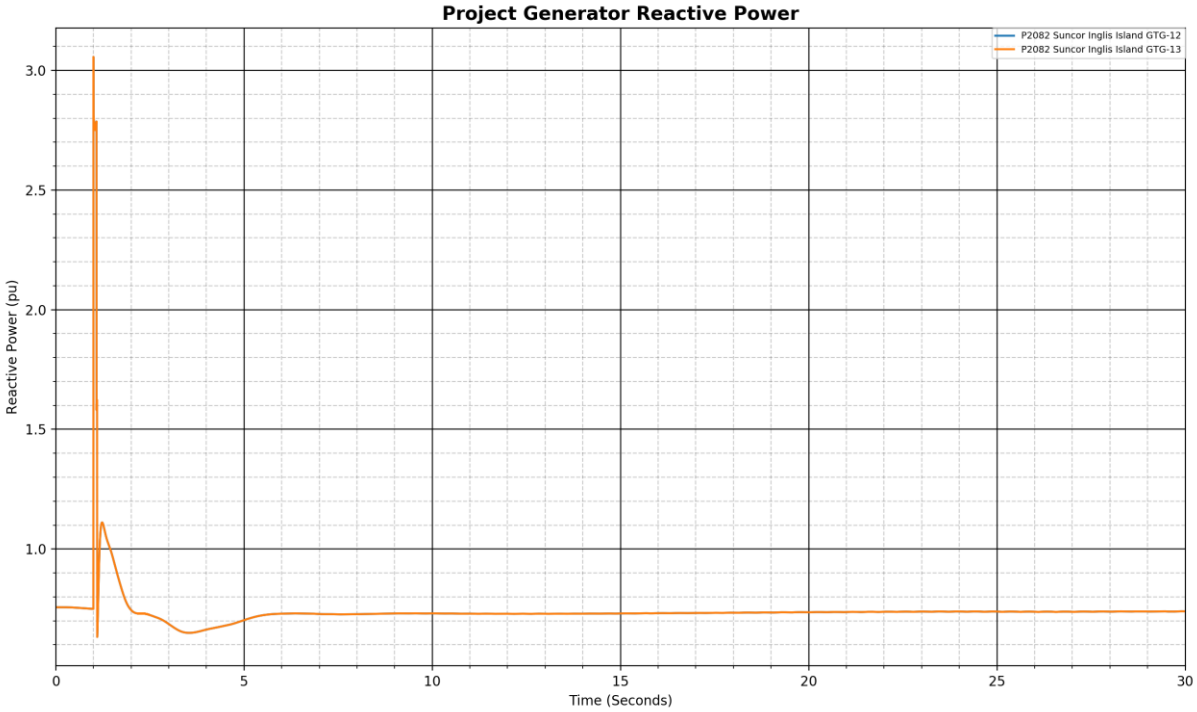

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

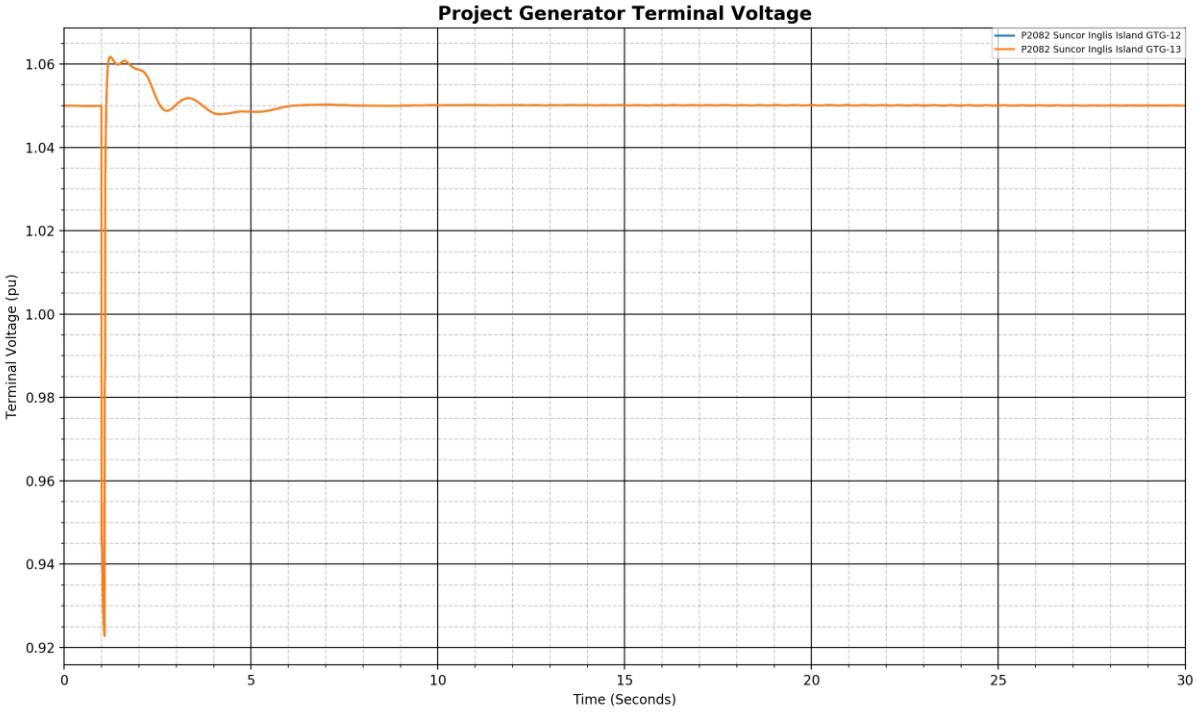

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

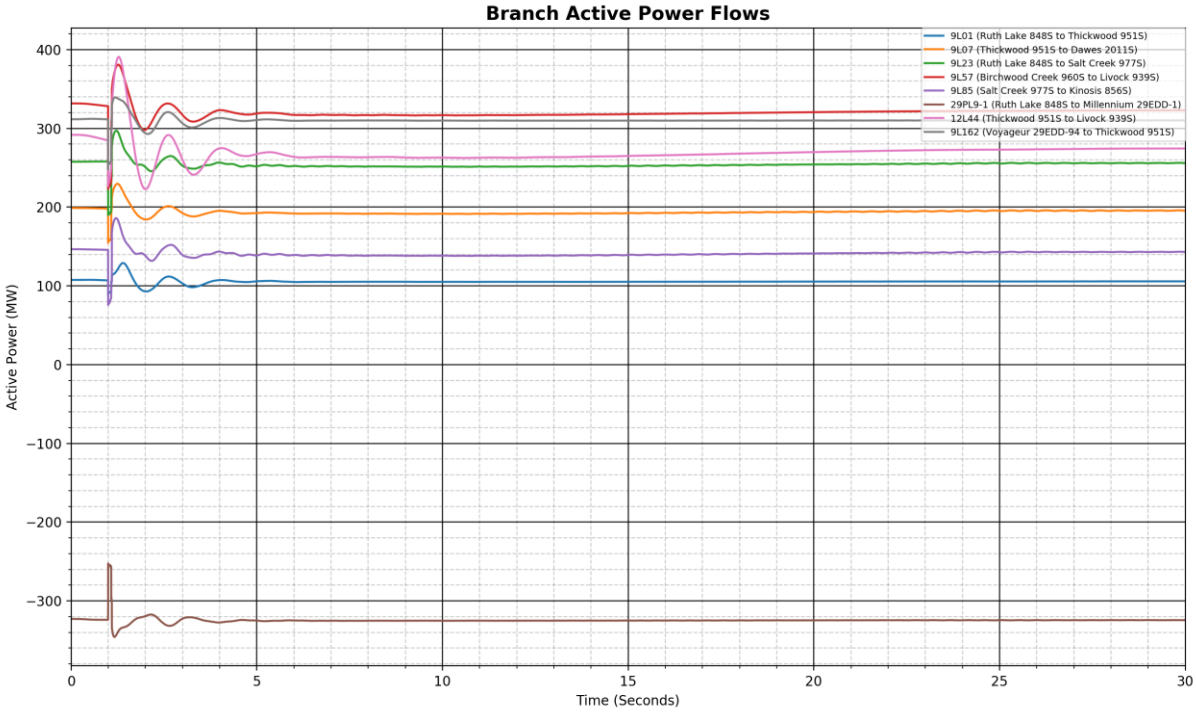

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
2
4
6
8
10
12
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
3.2
3.4
3.6
3.8
4.0
4.2
4.4
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

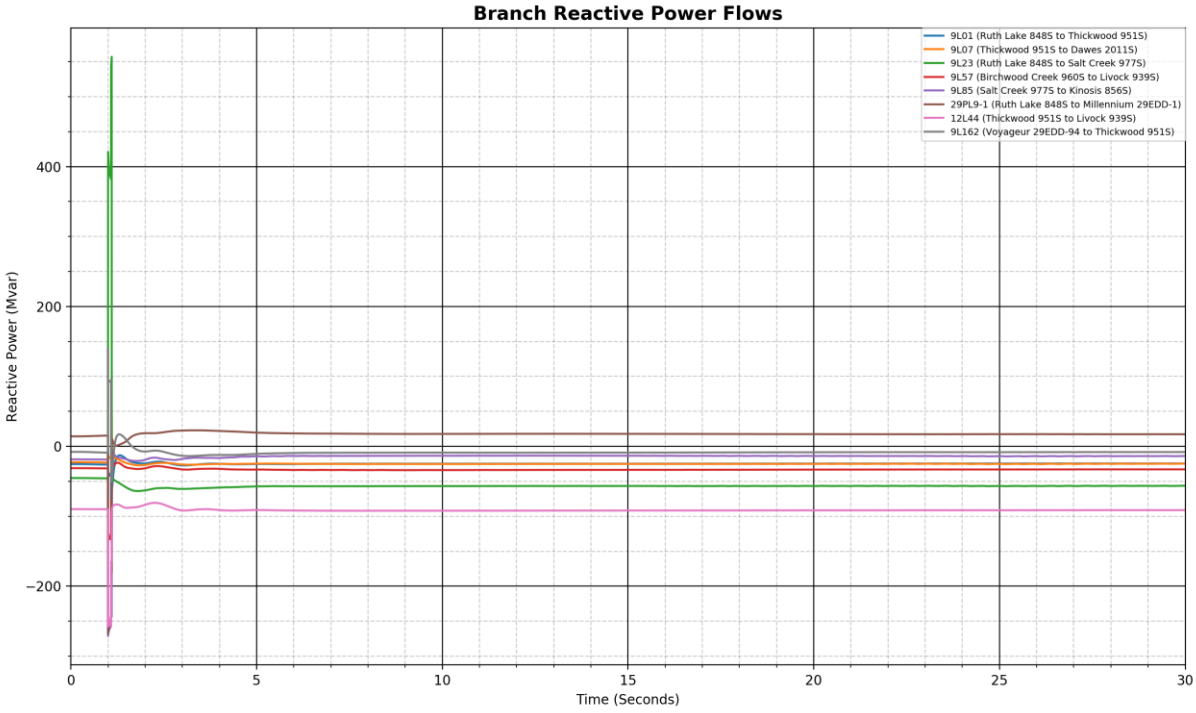
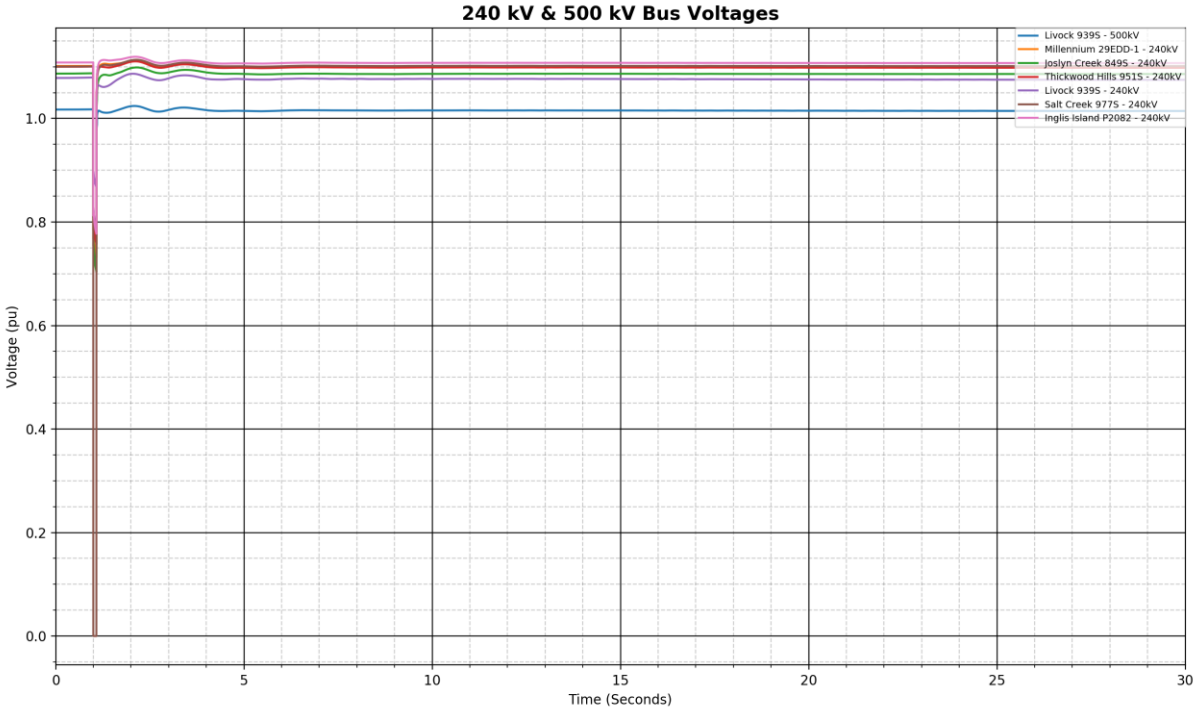
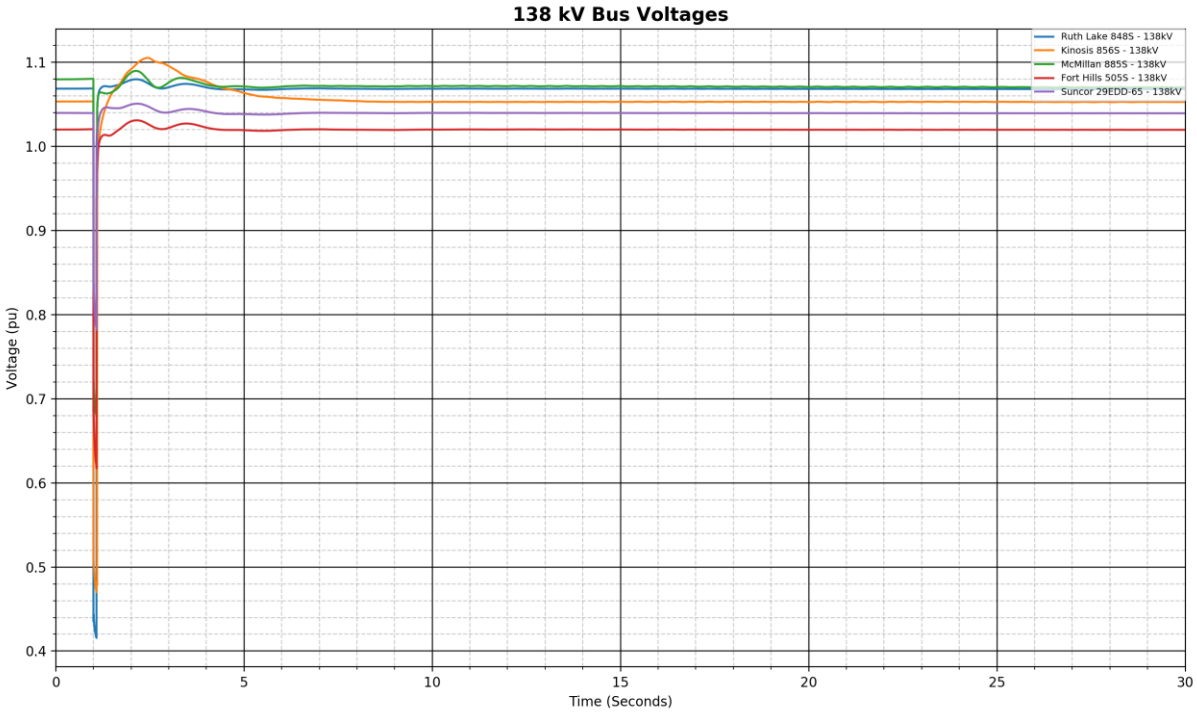
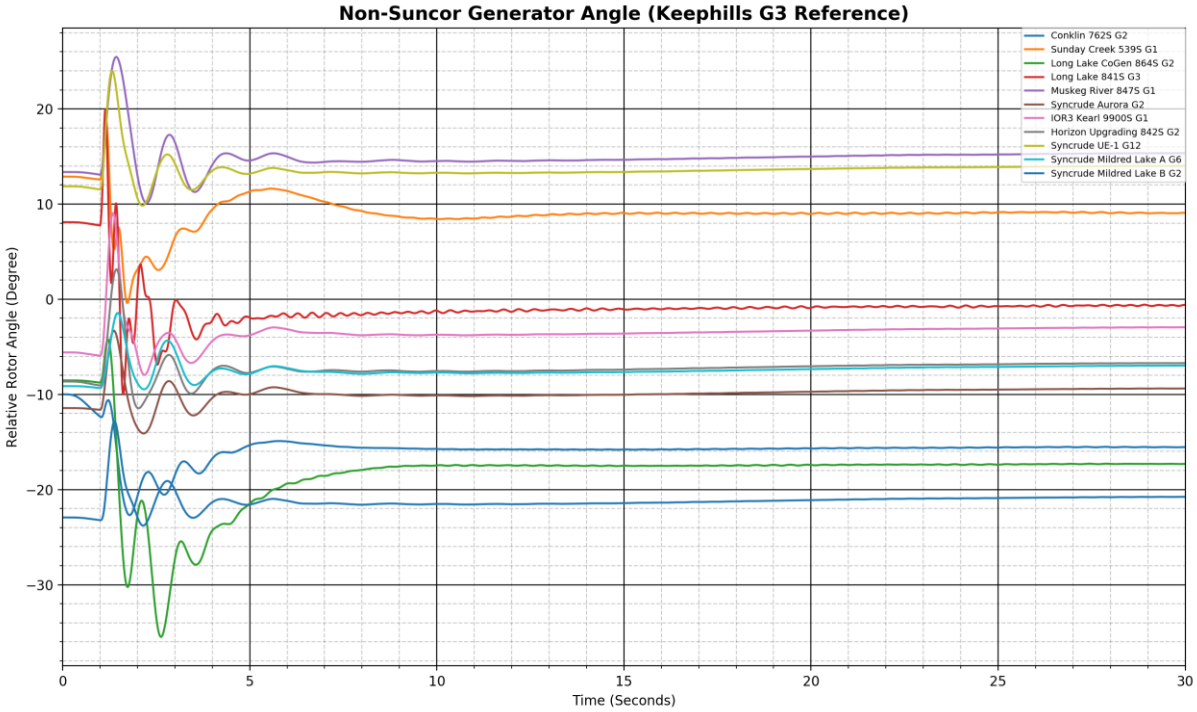
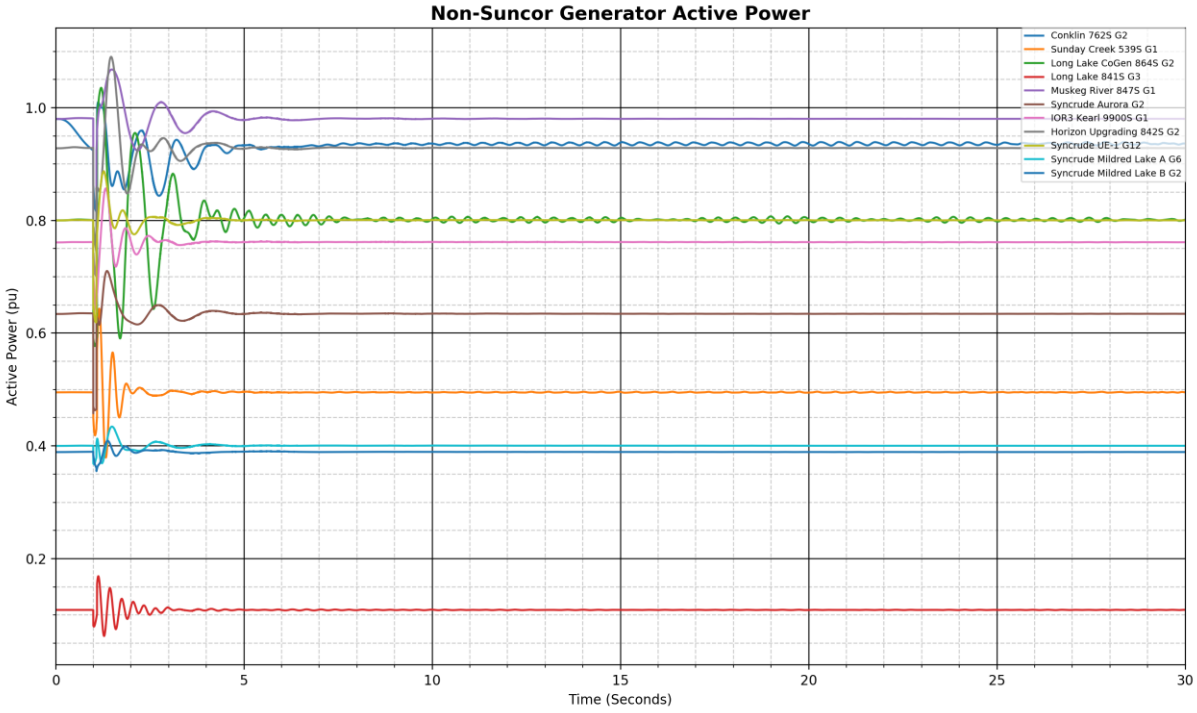

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)

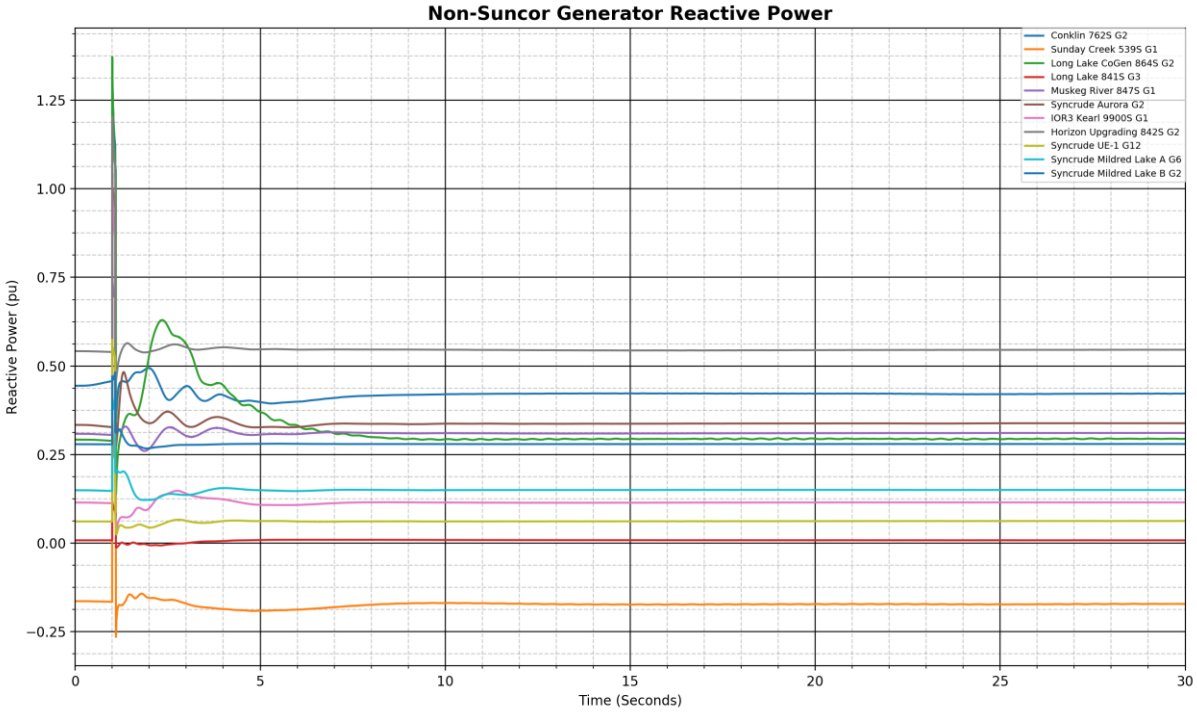
Figure A4-73: 9L85 (Salt Creek 977S to Kinosis 856S): Fault at Salt Creek 977S

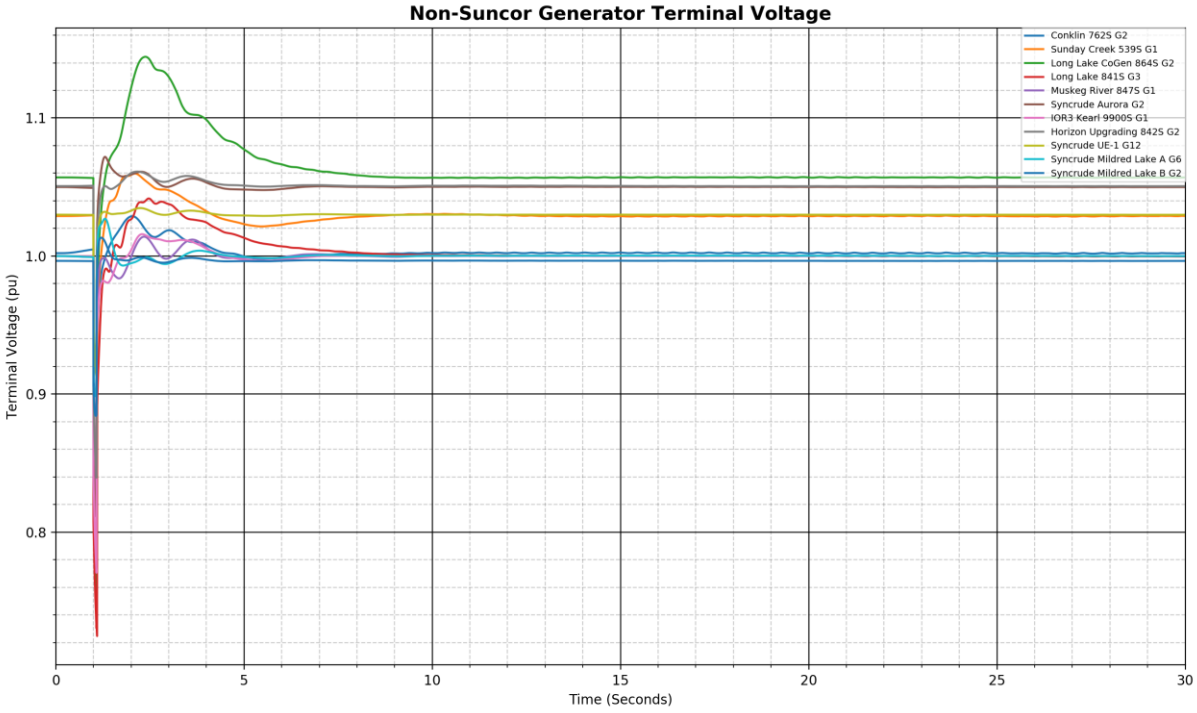


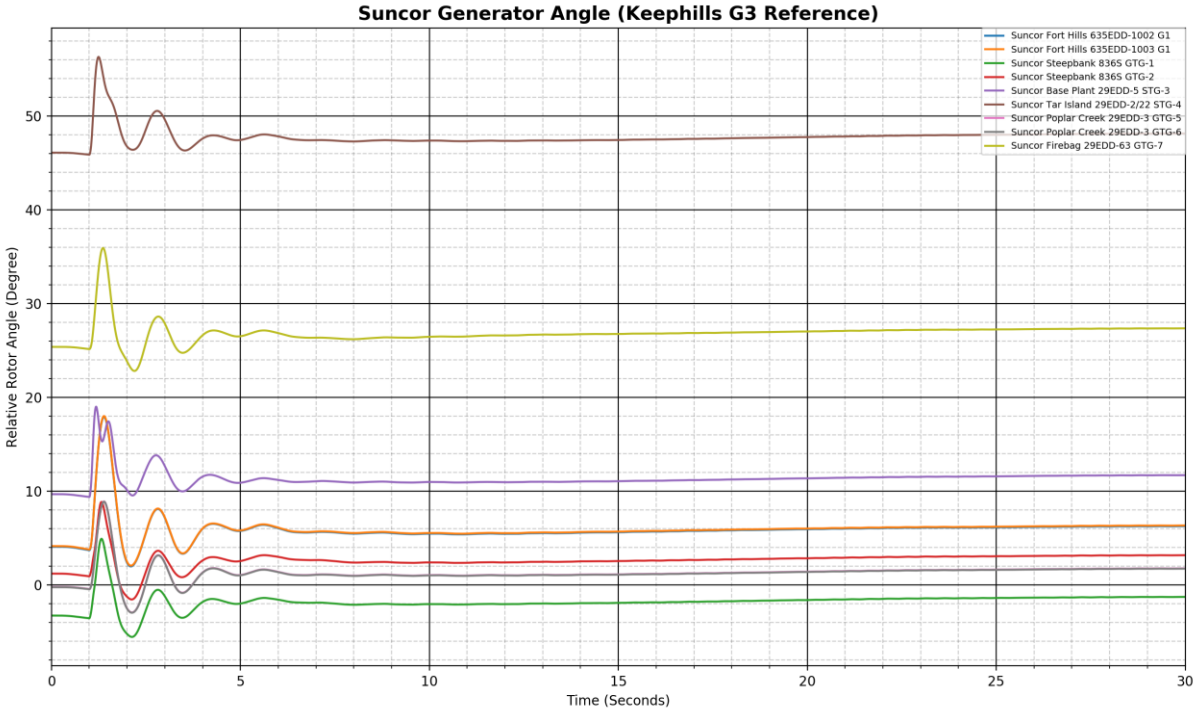


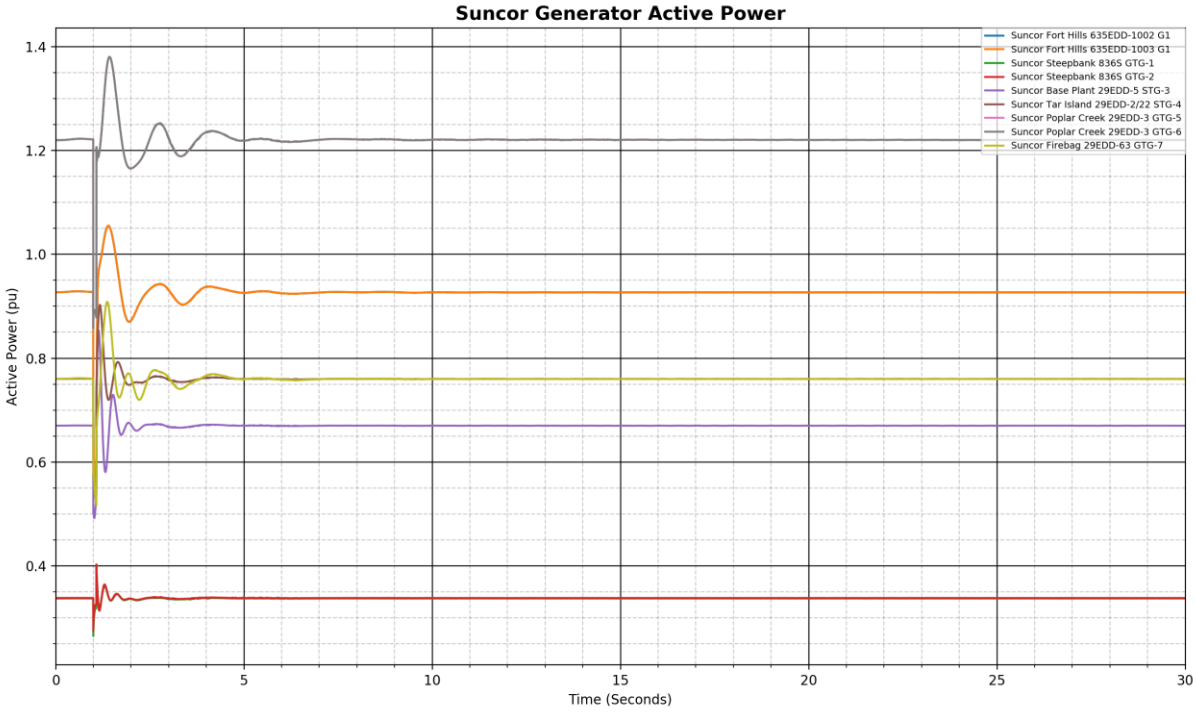

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

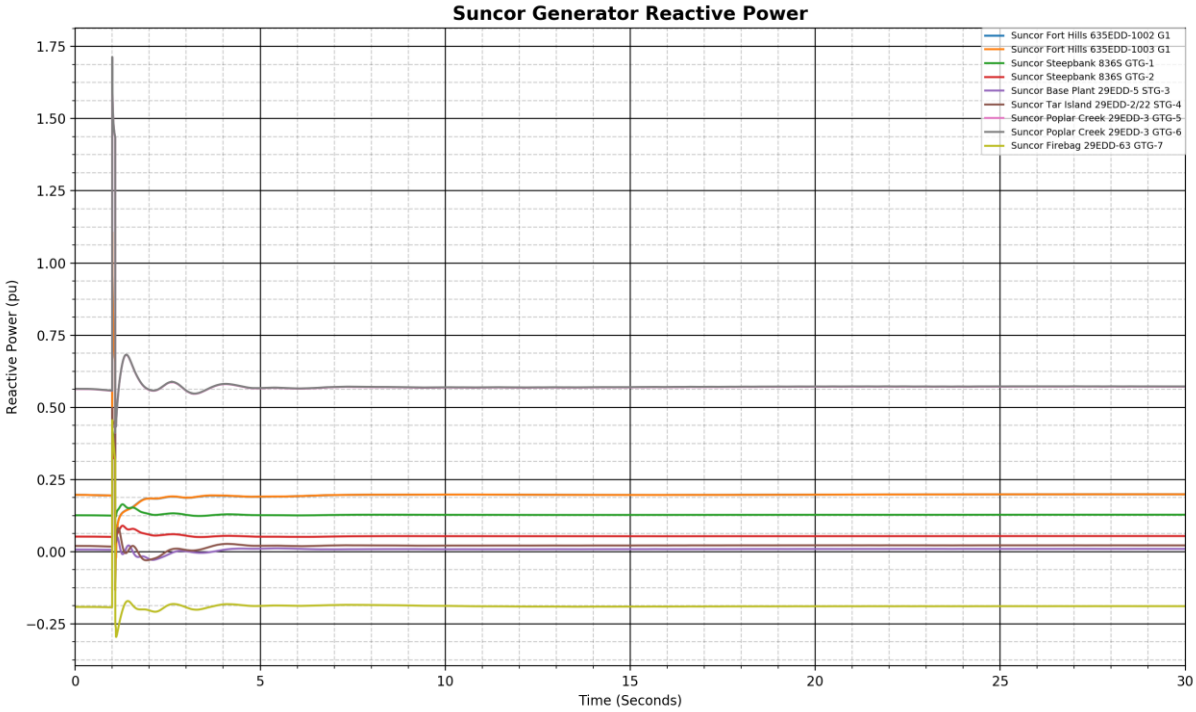

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

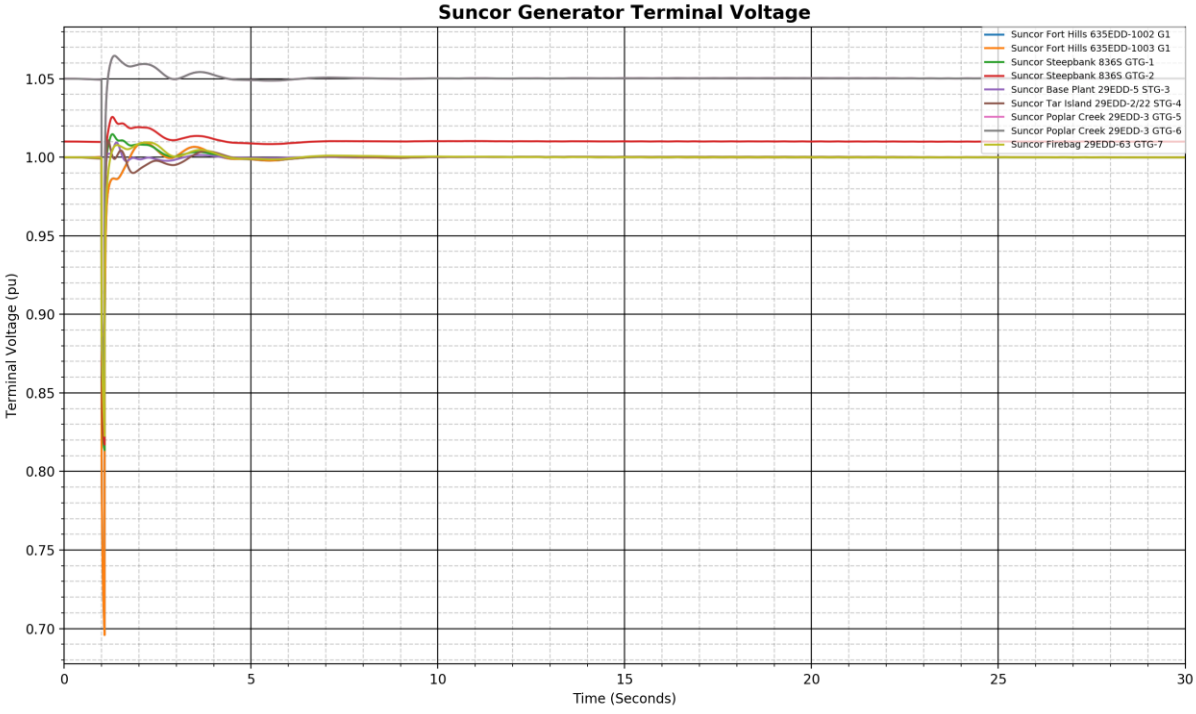

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

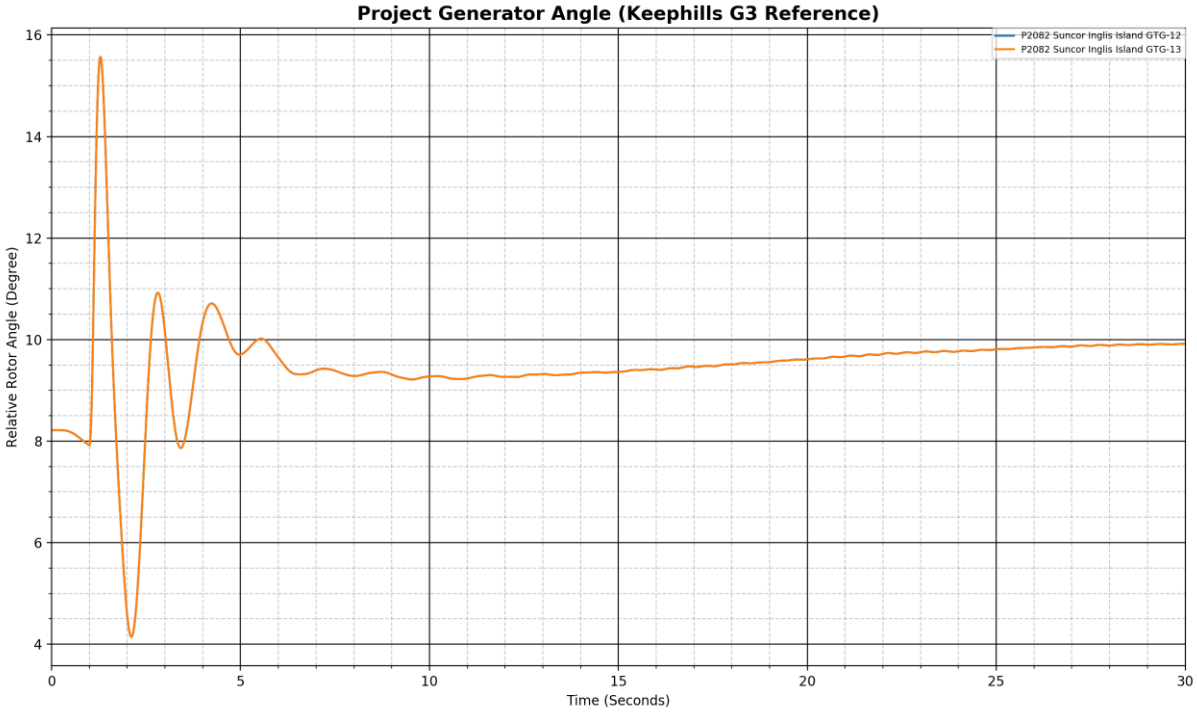

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

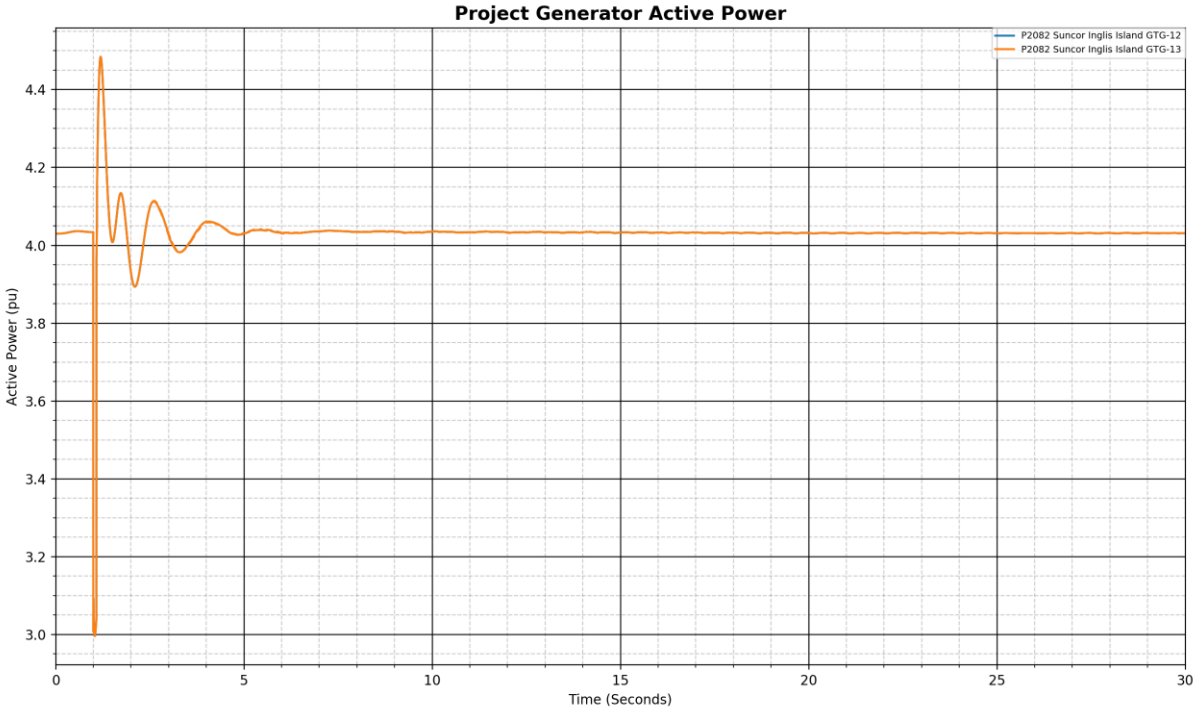

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

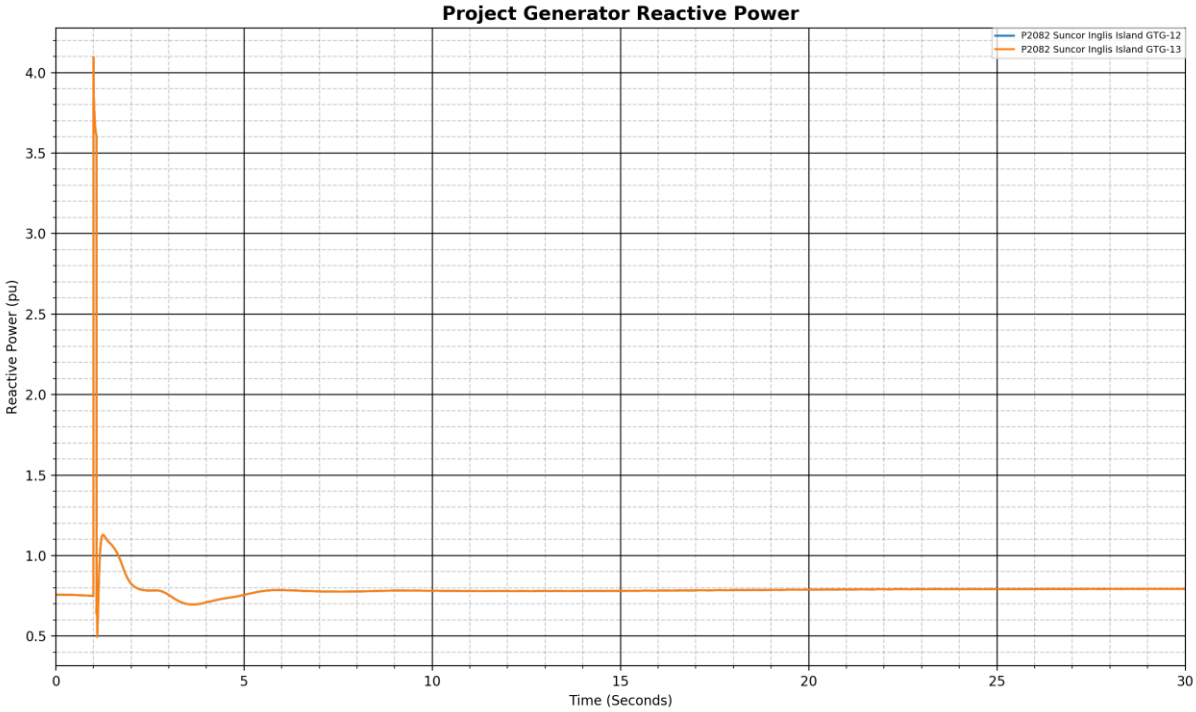

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

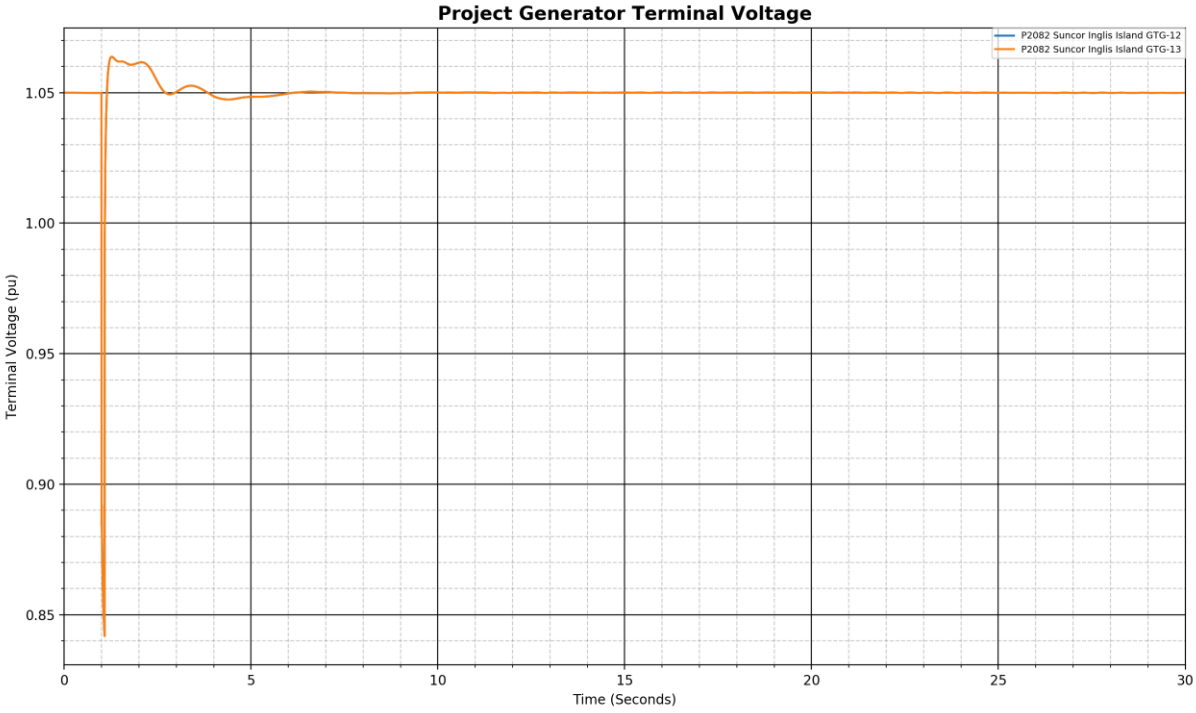

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

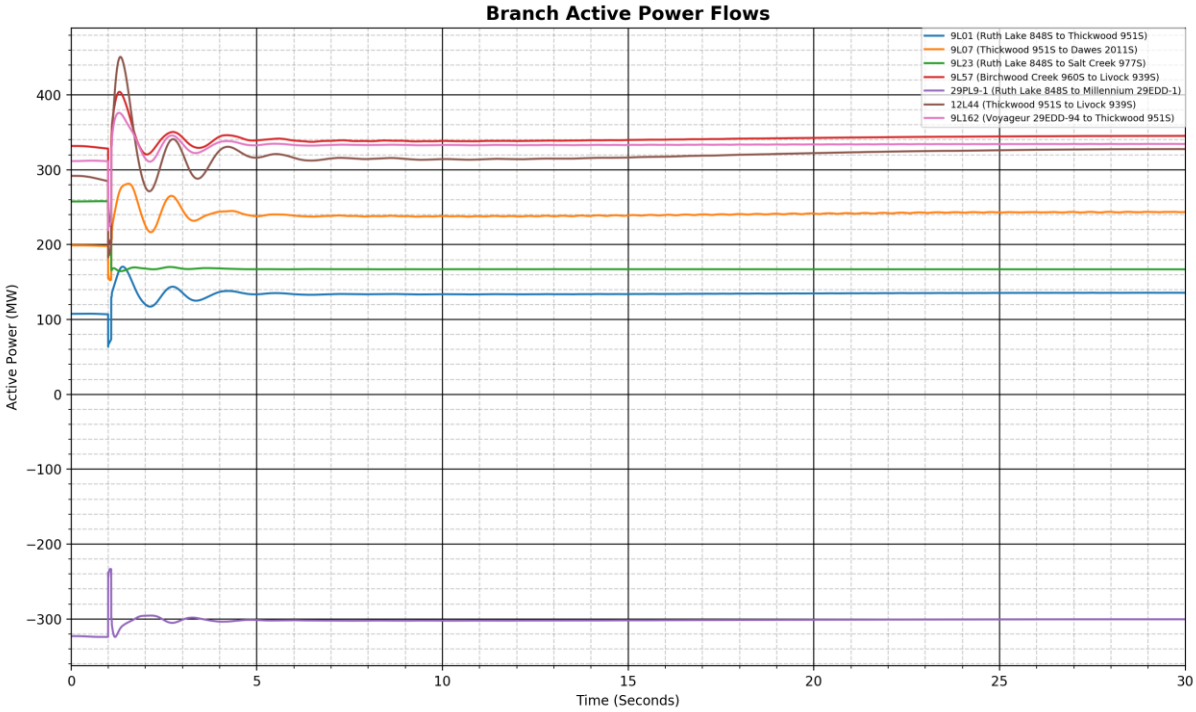

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
16
14
12
10
8
6
4
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

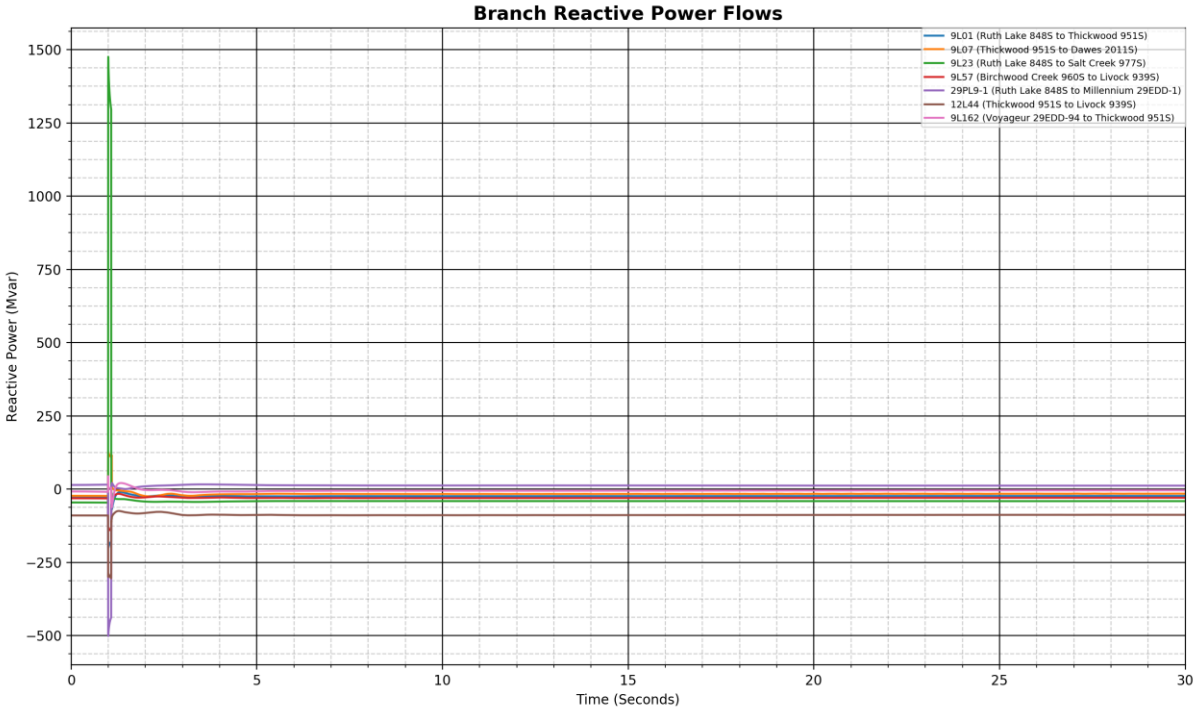
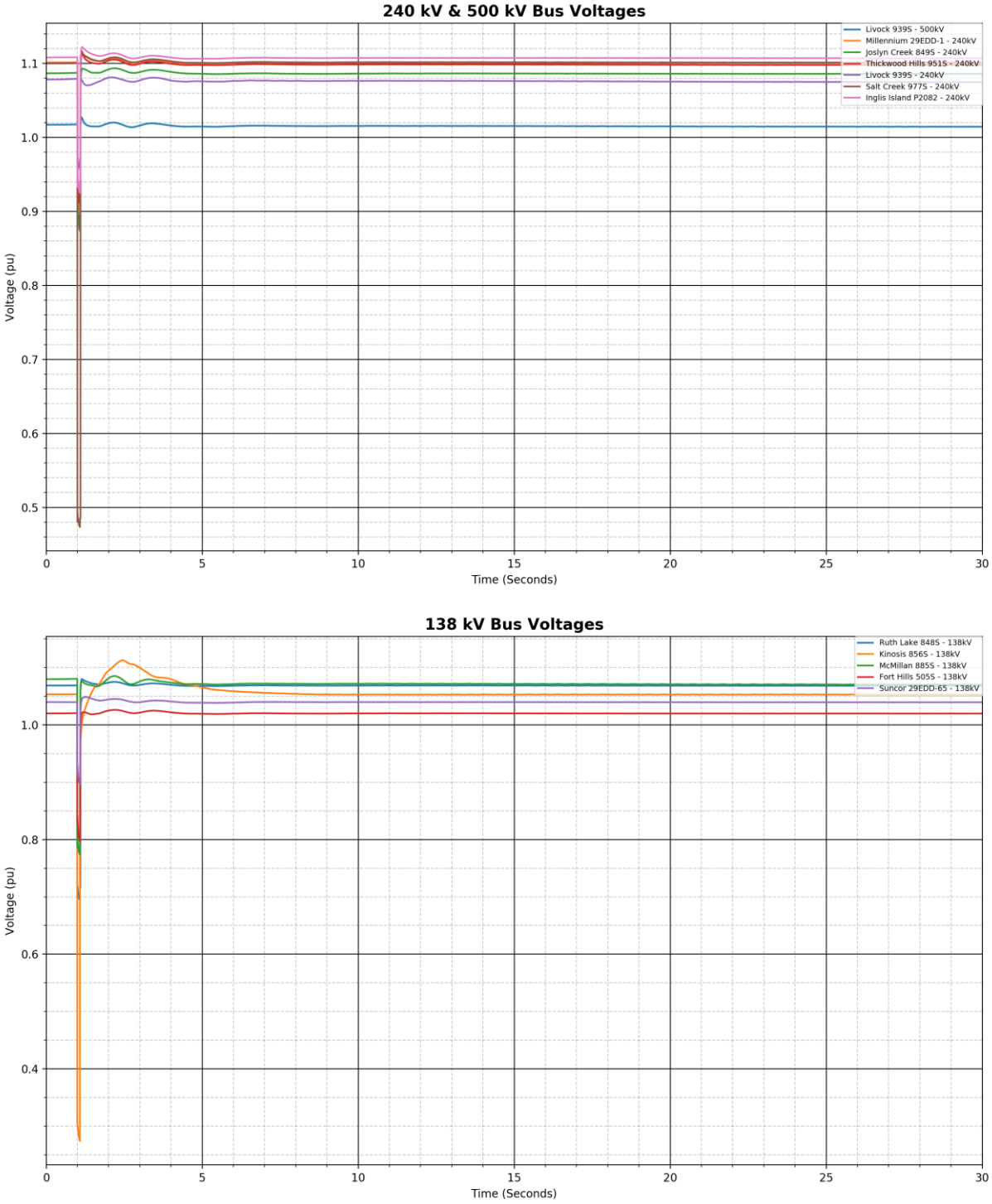
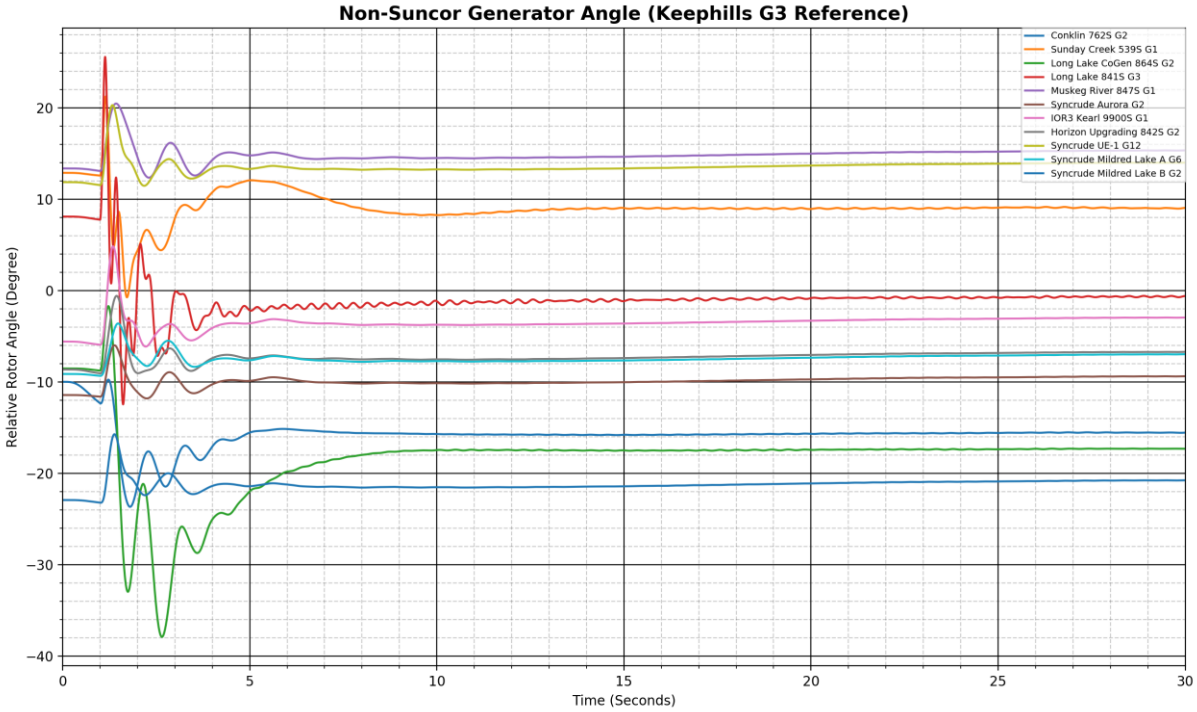
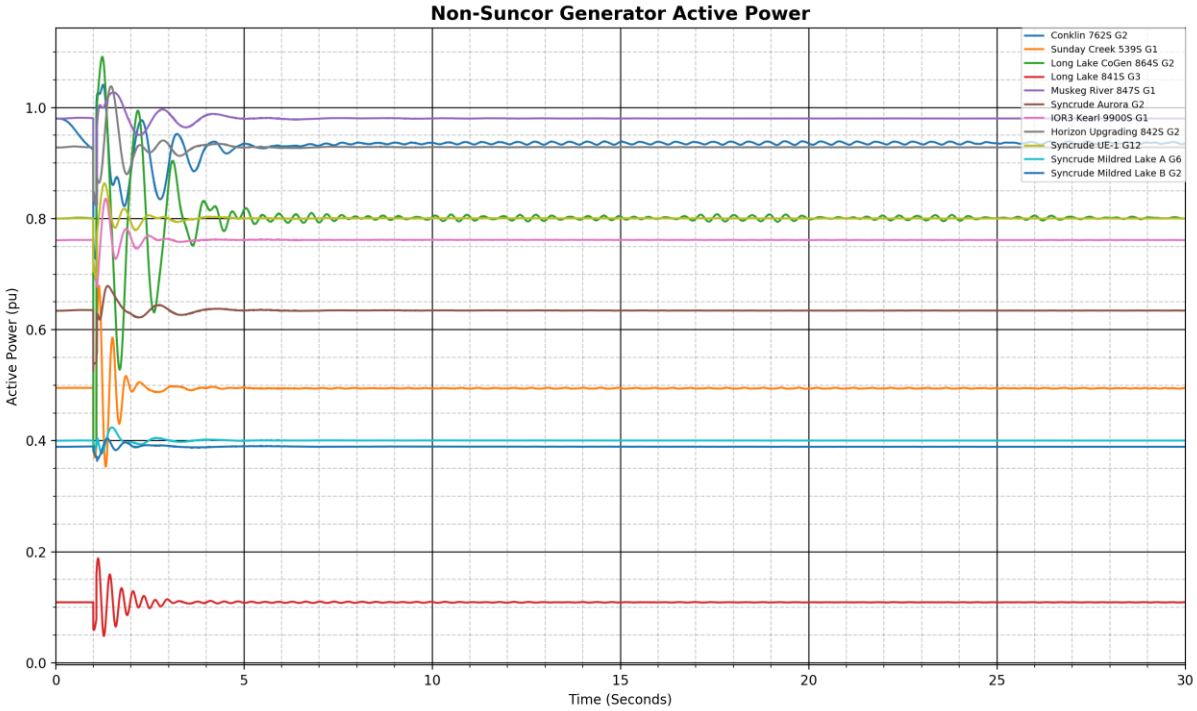
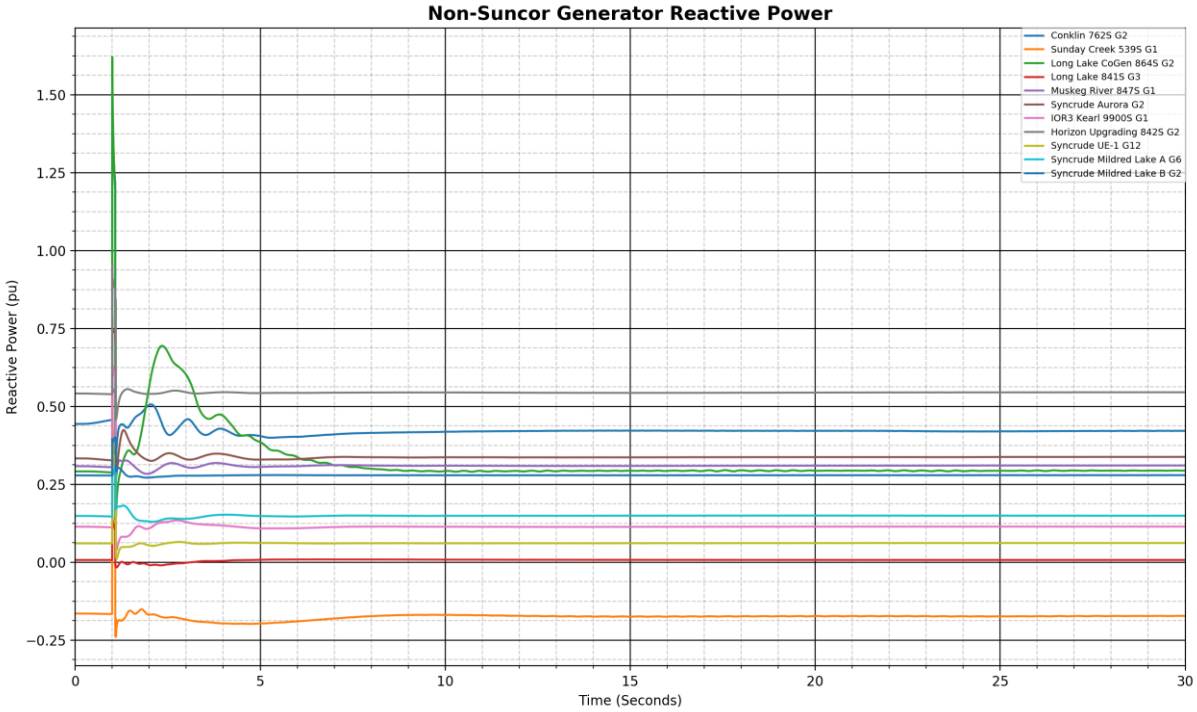

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

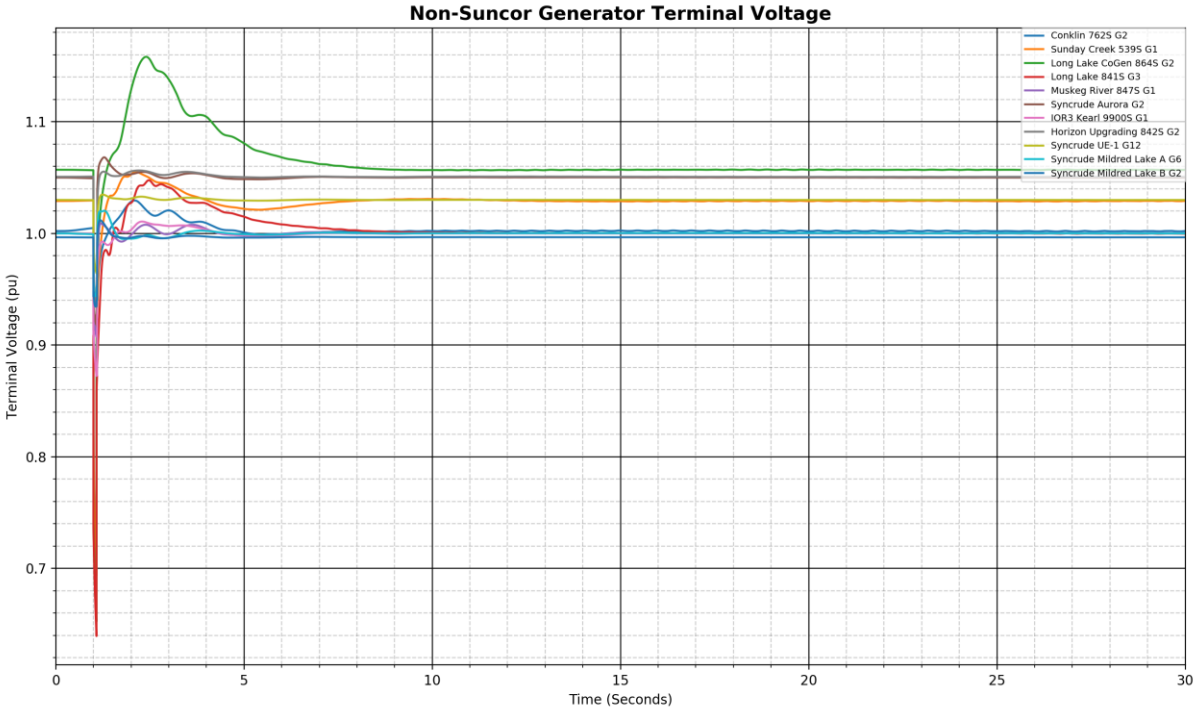
Figure A4-74: 9L85 (Salt Creek 977S to Kinosis 856S): Fault at Kinosis 856S

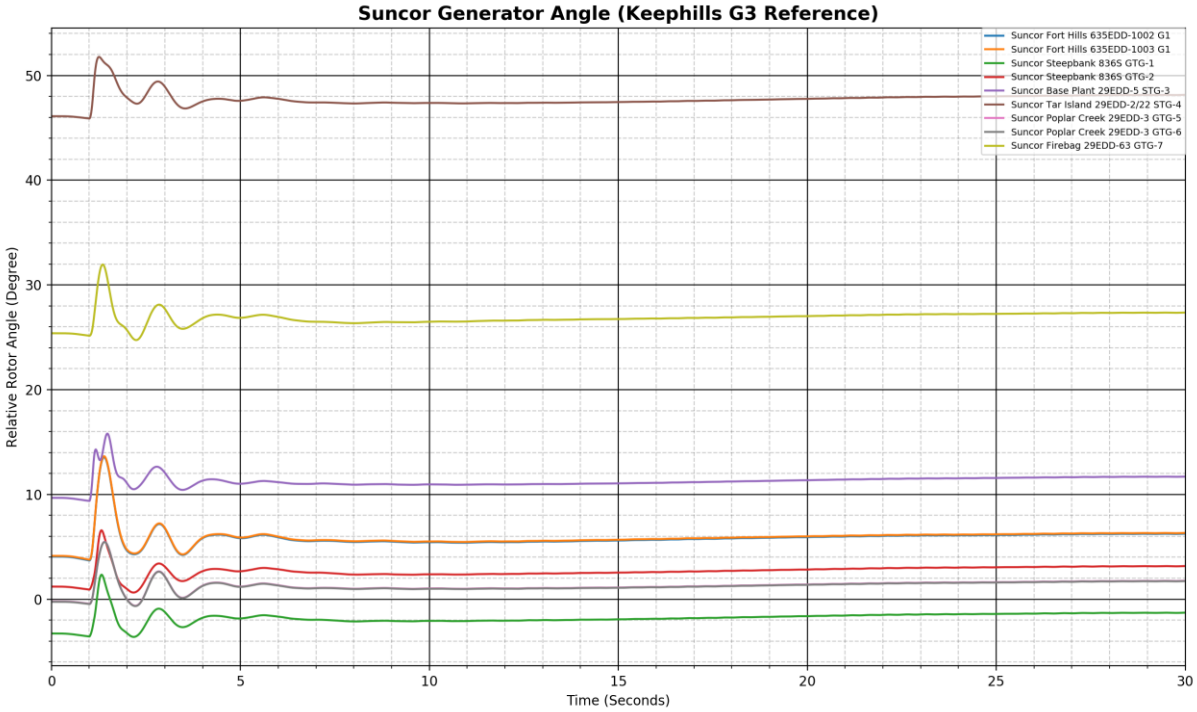


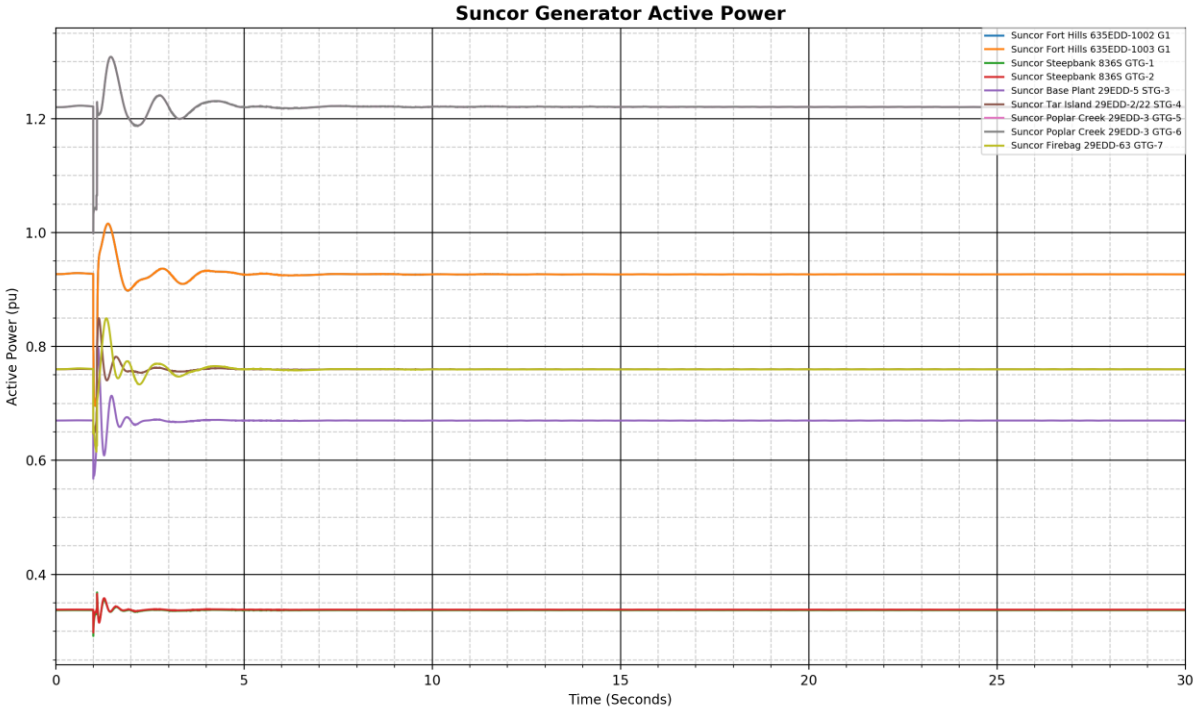

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

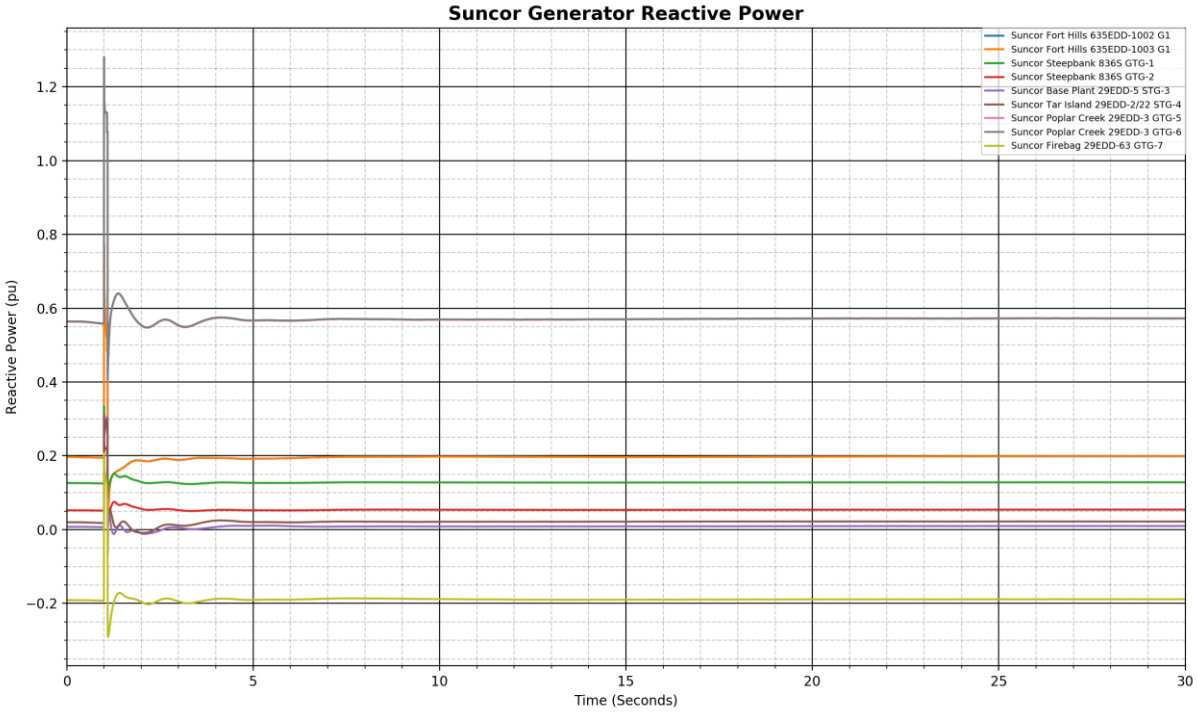

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

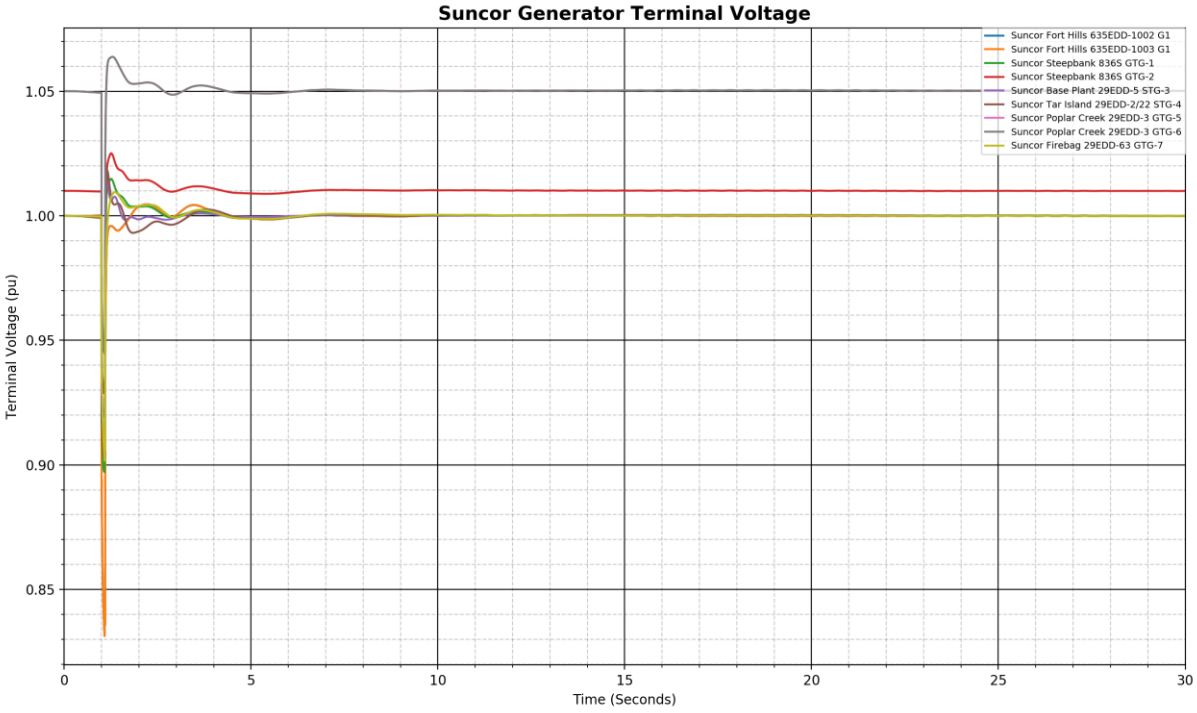

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

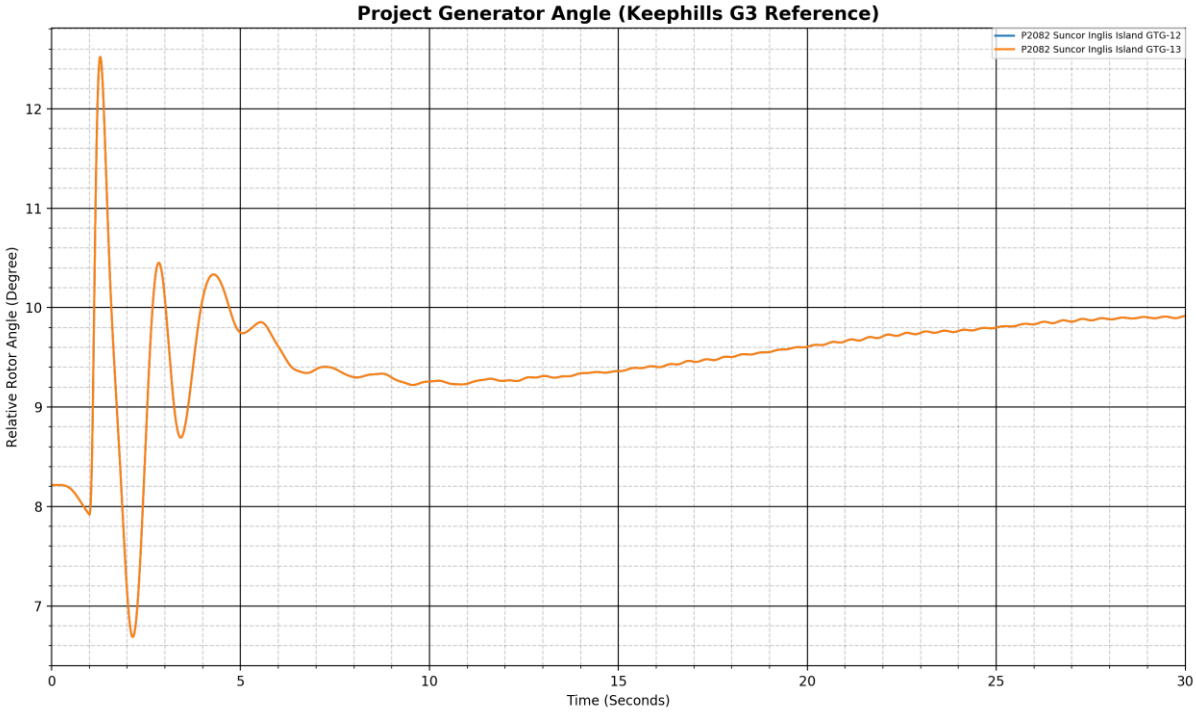

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

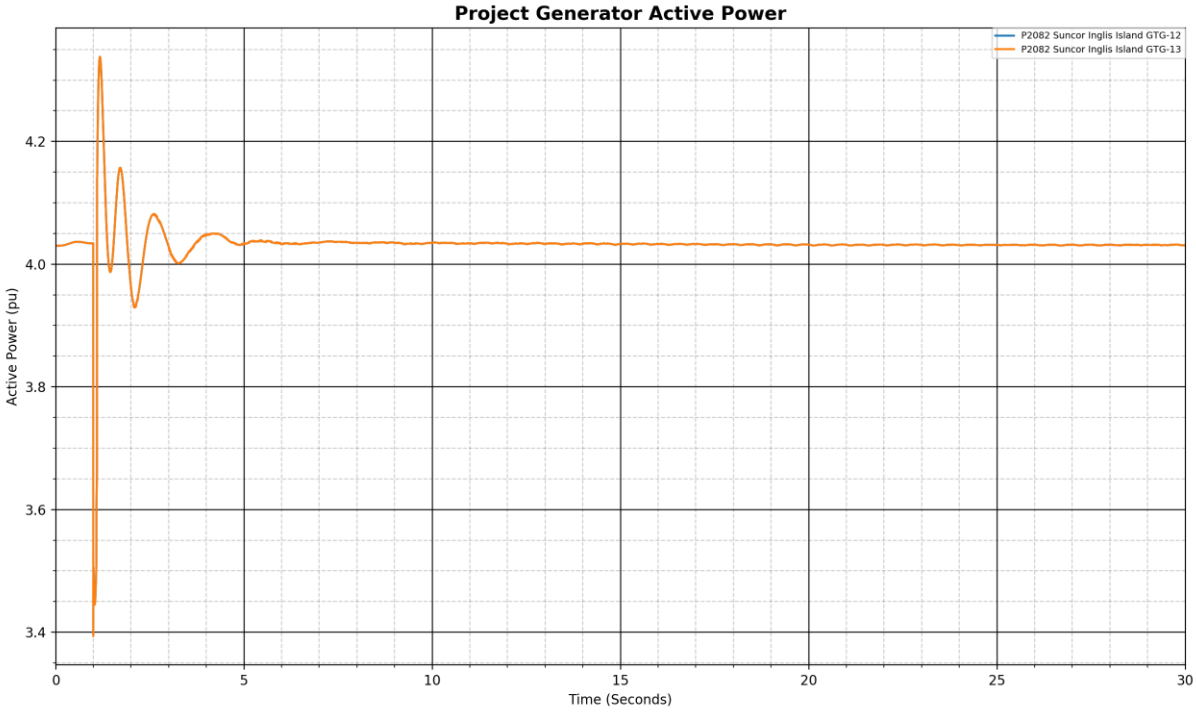

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

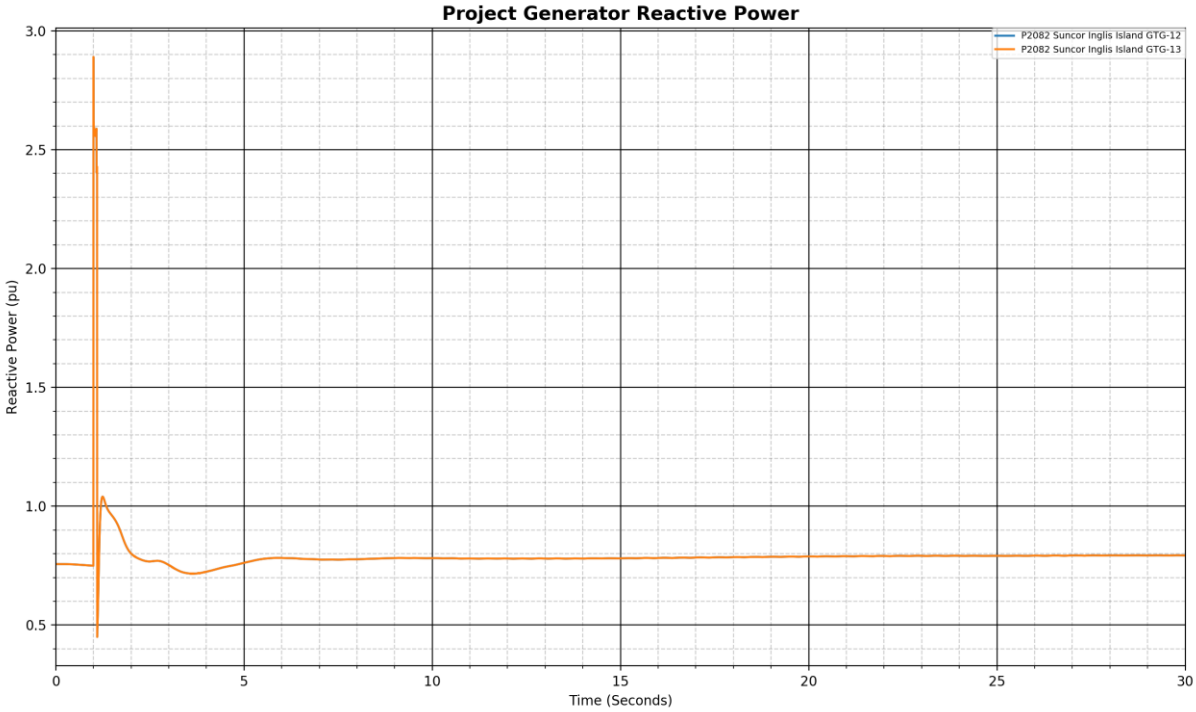

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

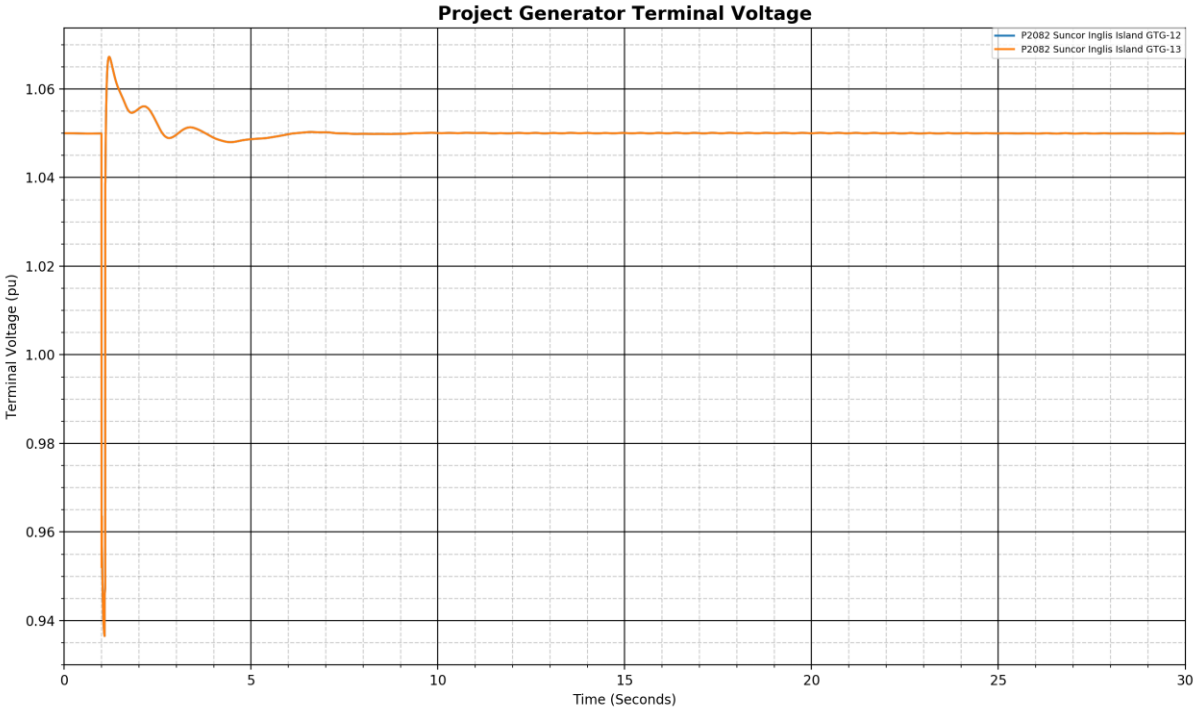

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

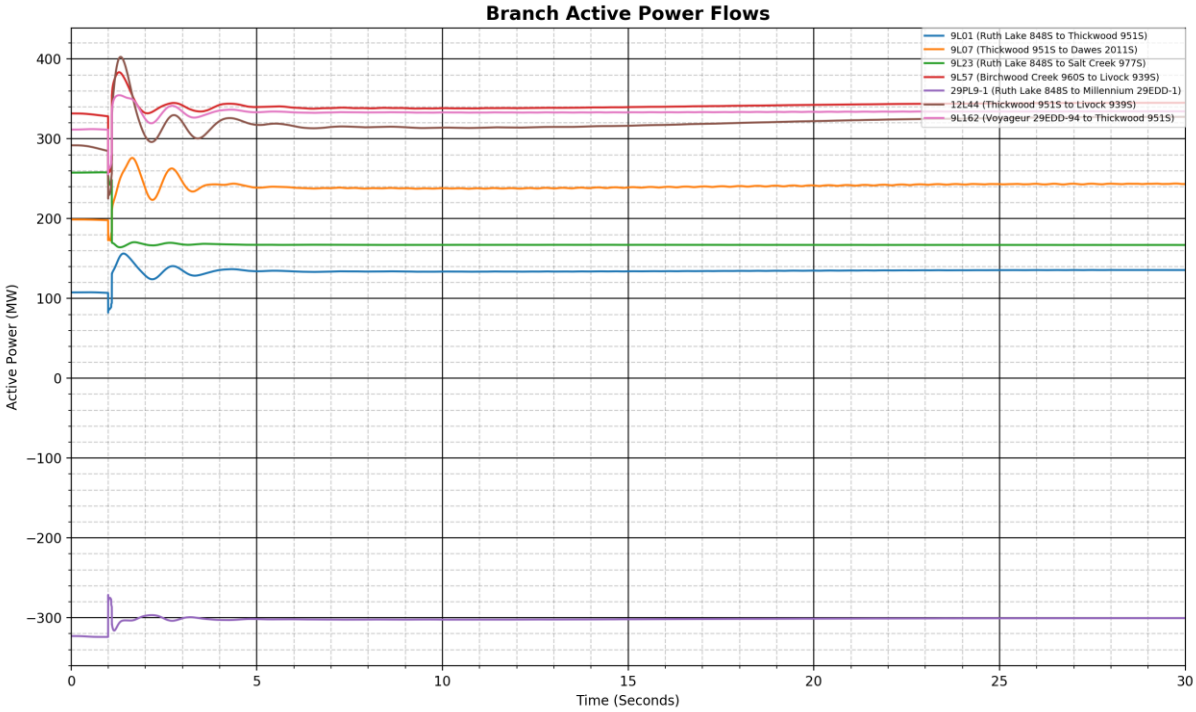

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
12
11
10
9
8
7
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
4.2
4.0
3.8
3.6
3.4
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0
5
10
15
20
25
30
Time (Seconds)


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

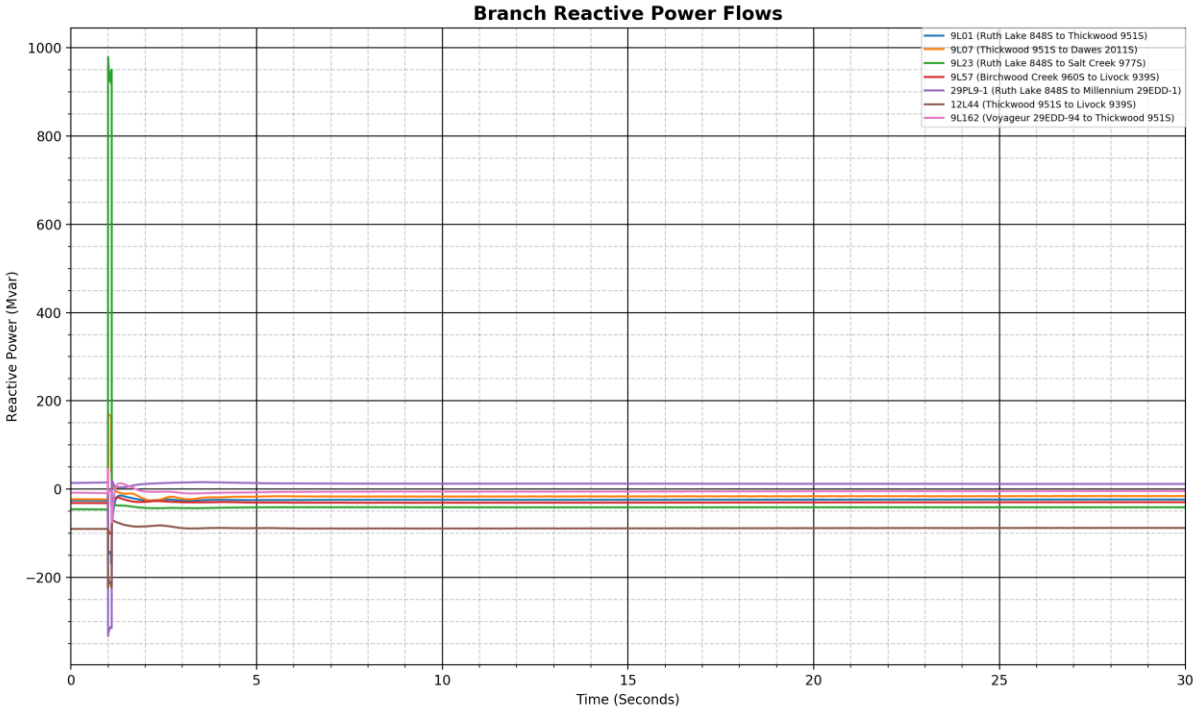
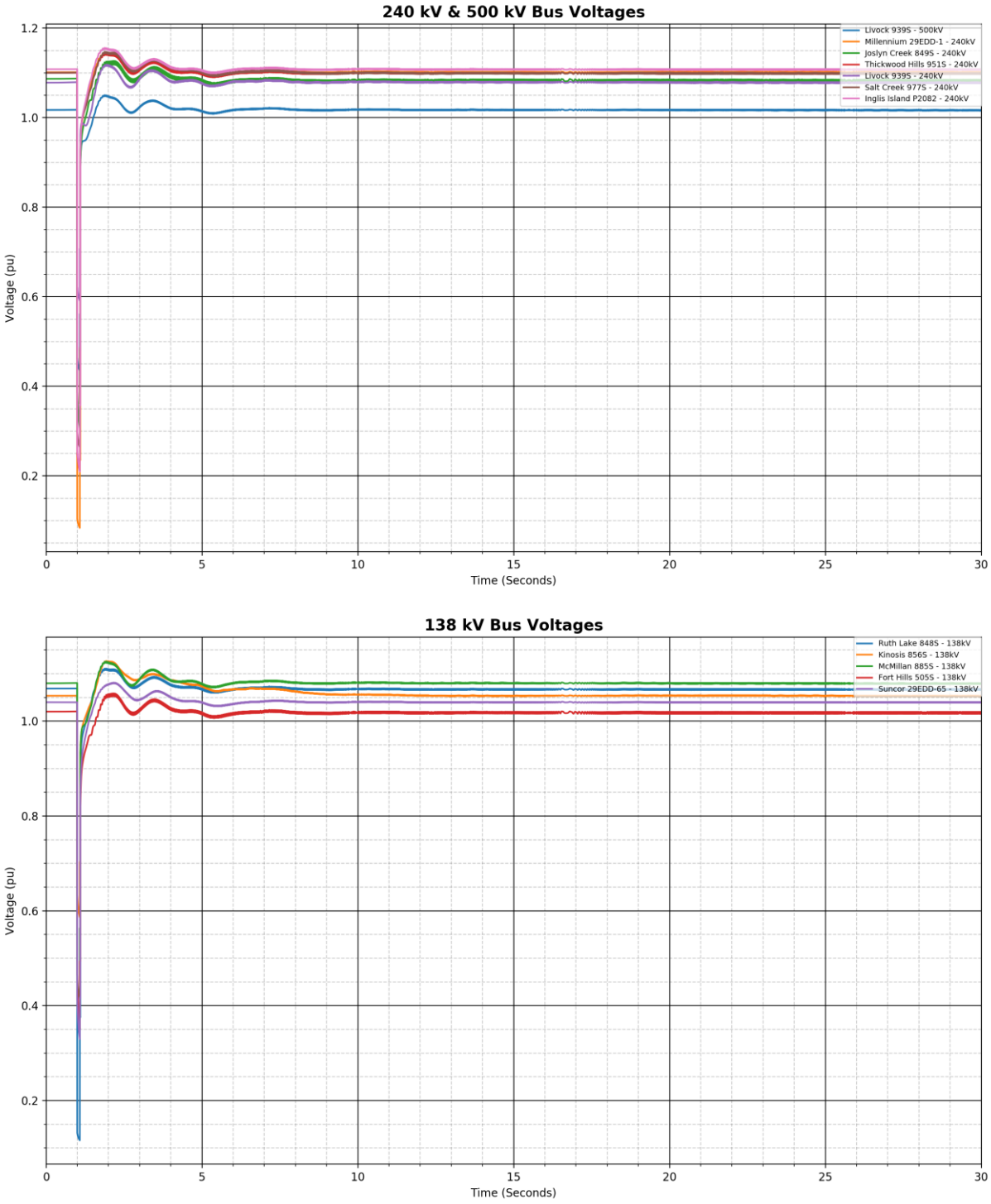
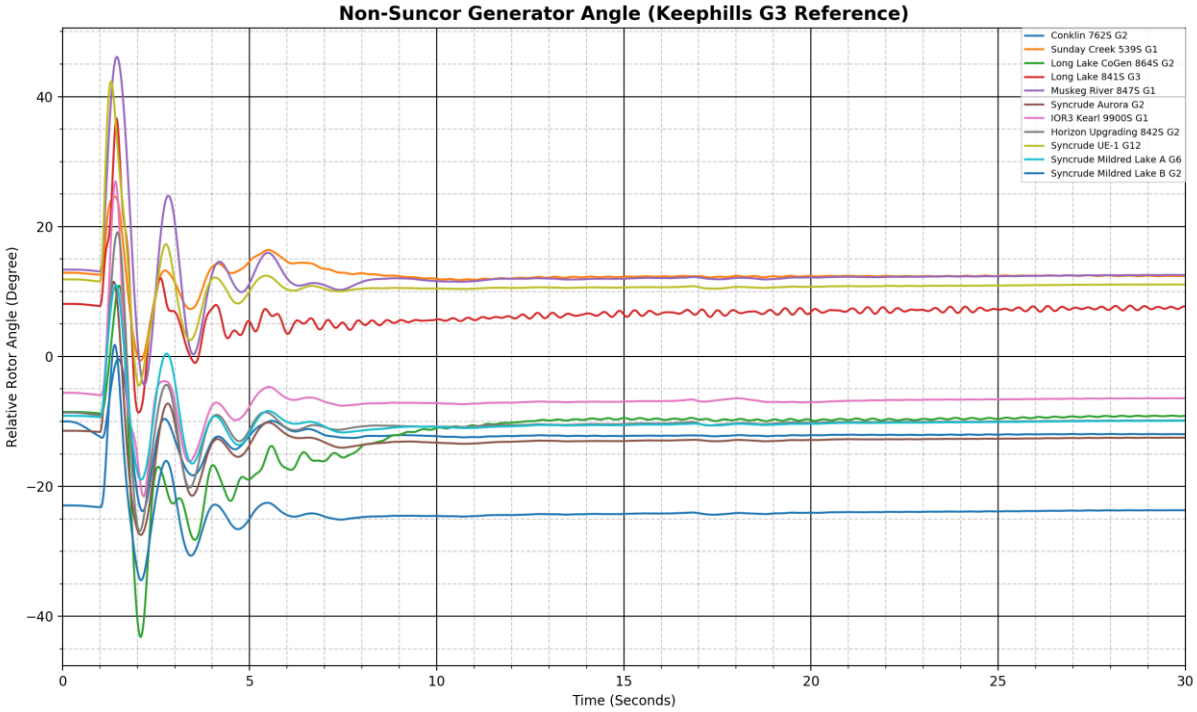
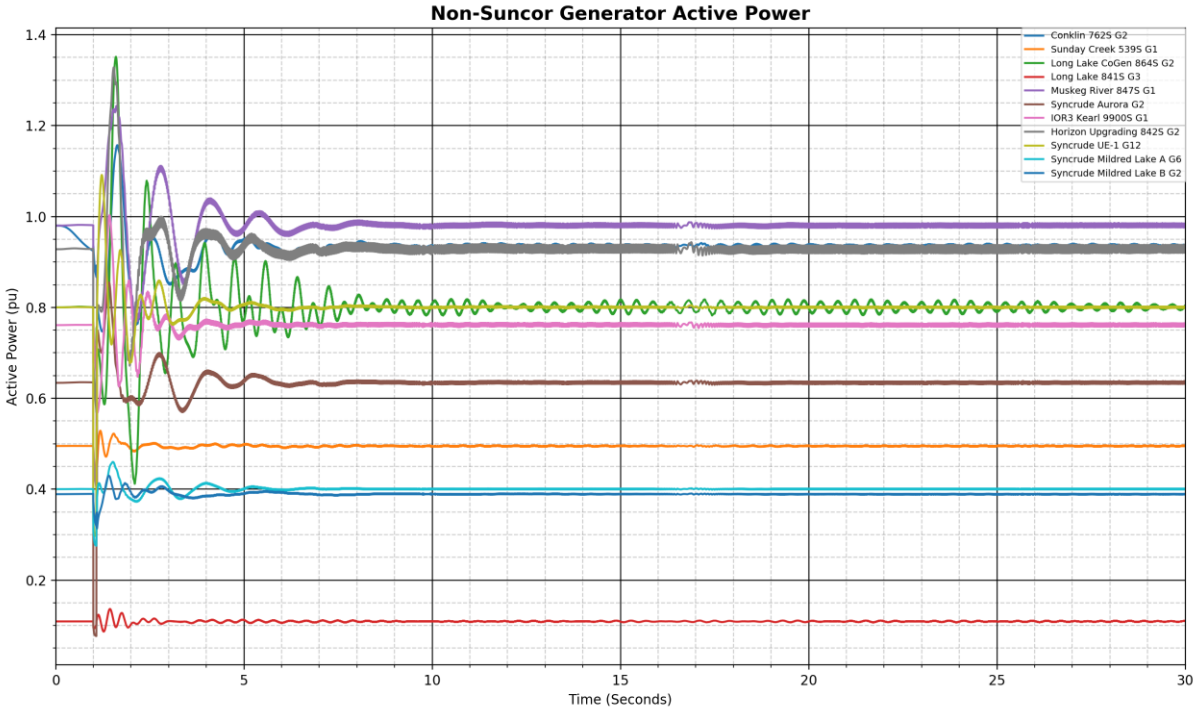
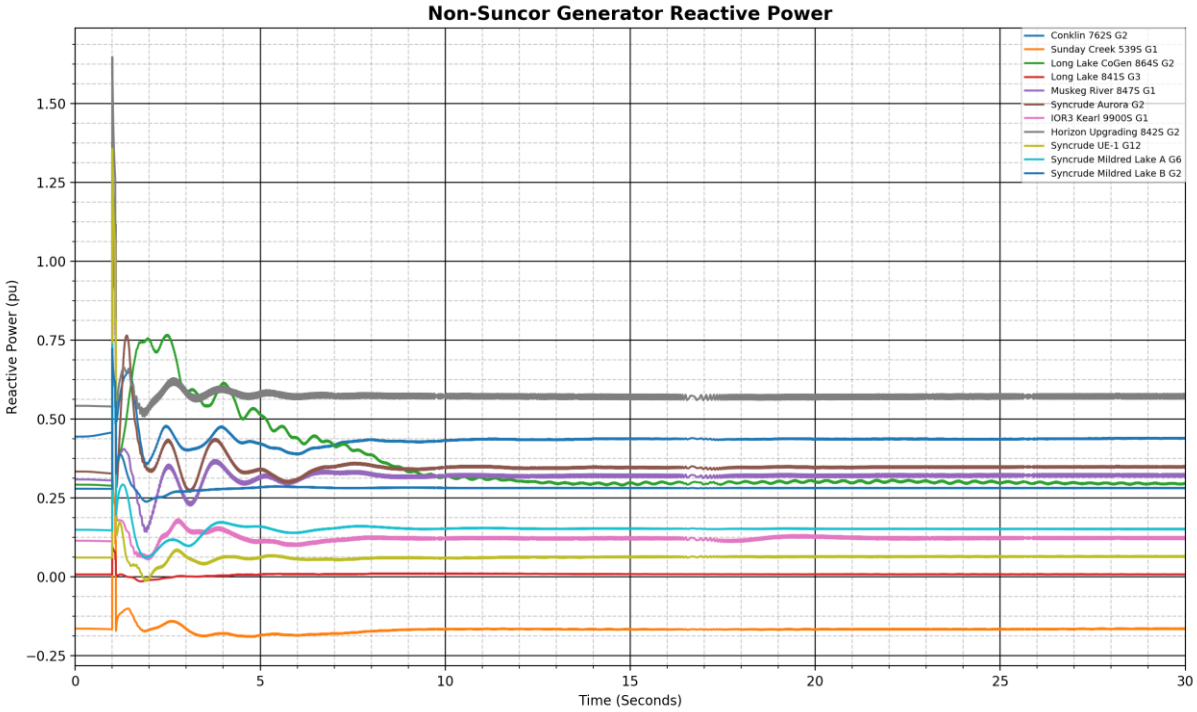

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

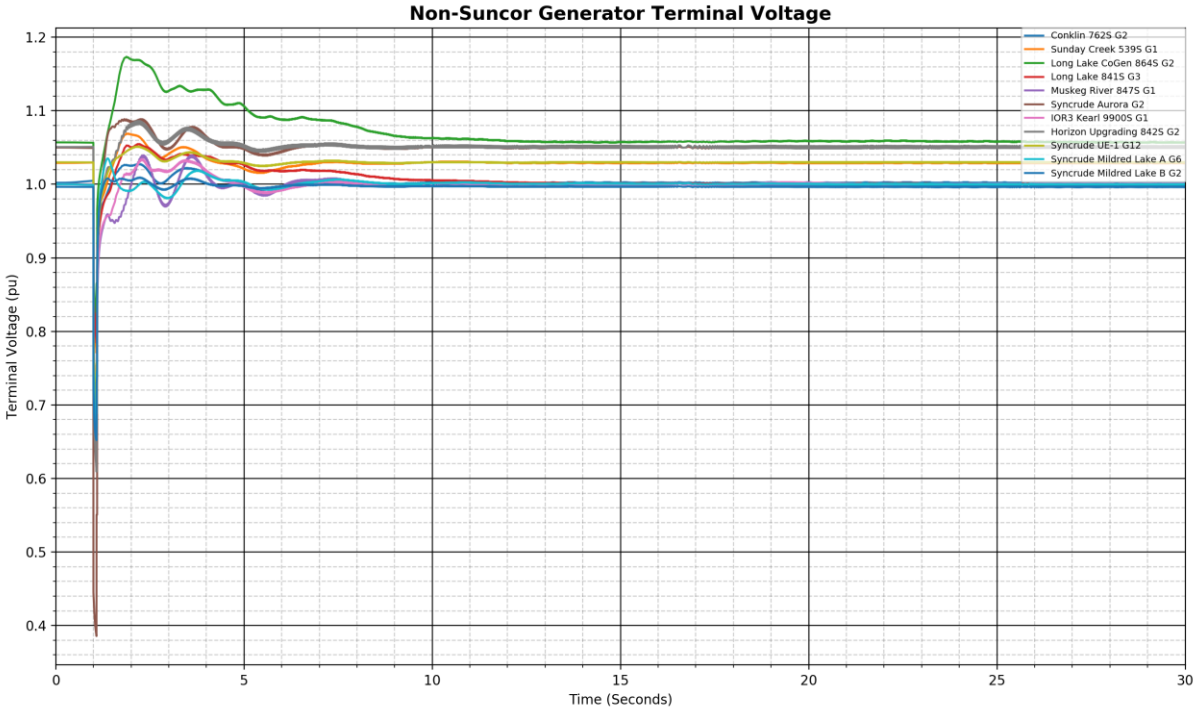
Figure A4-75: 29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1): Fault at Ruth Lake 848S

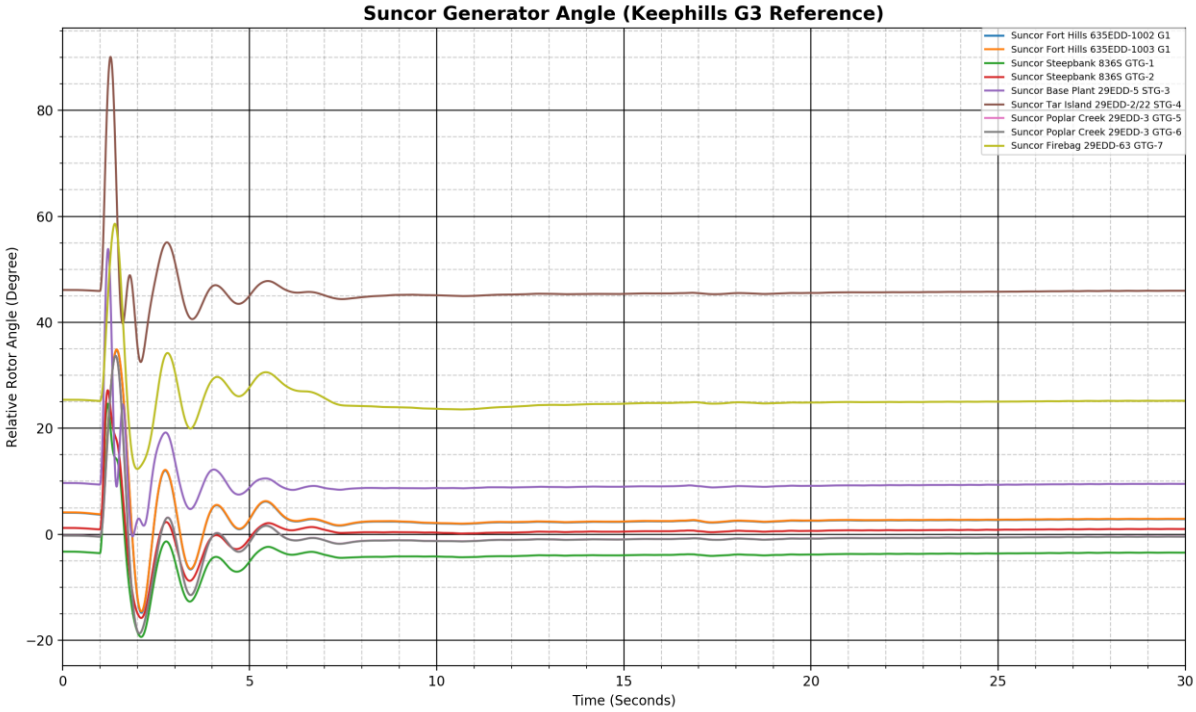


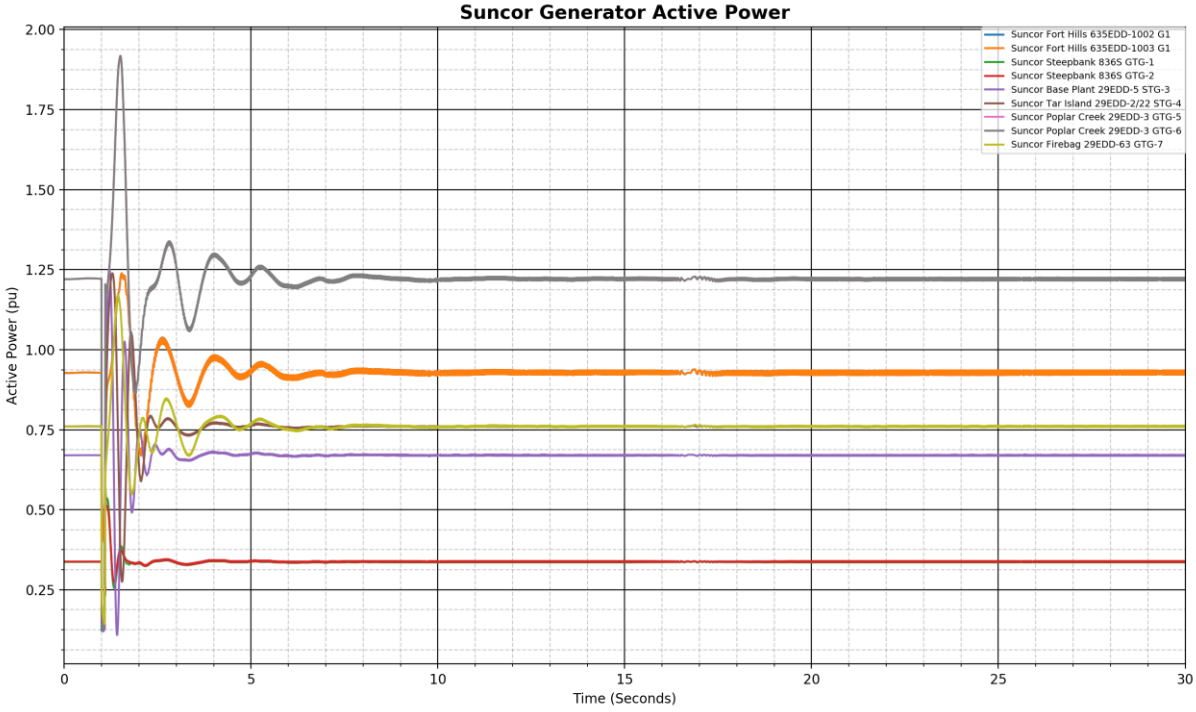

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

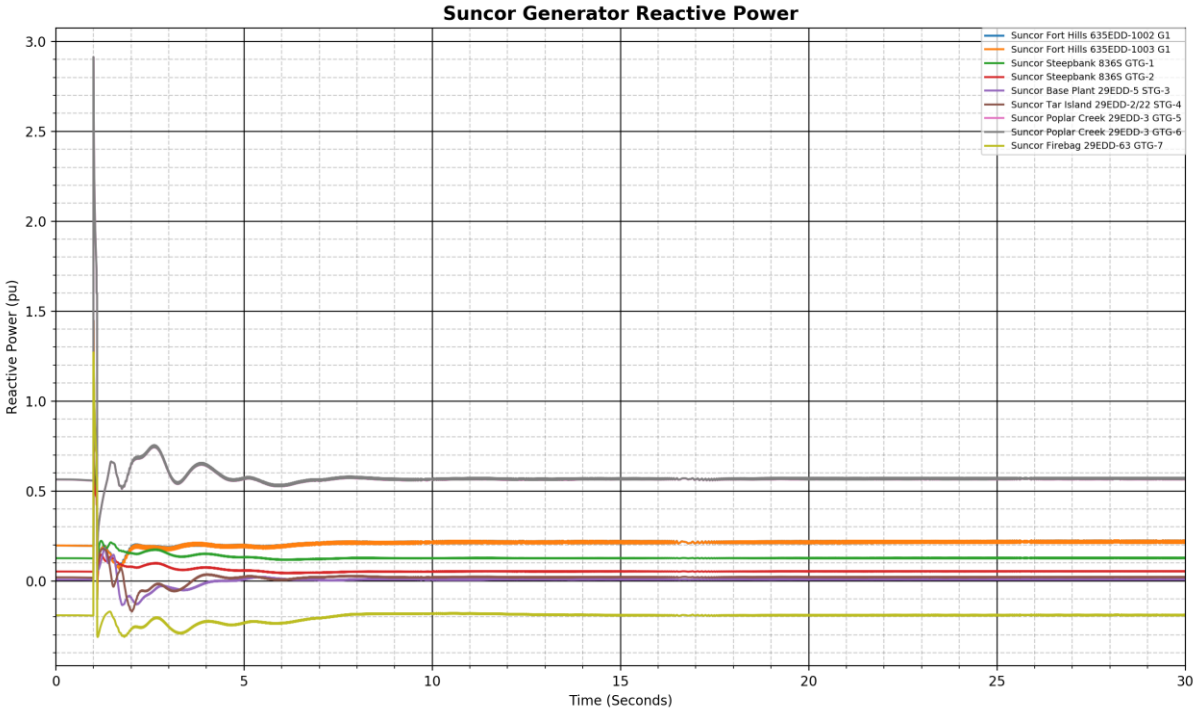

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

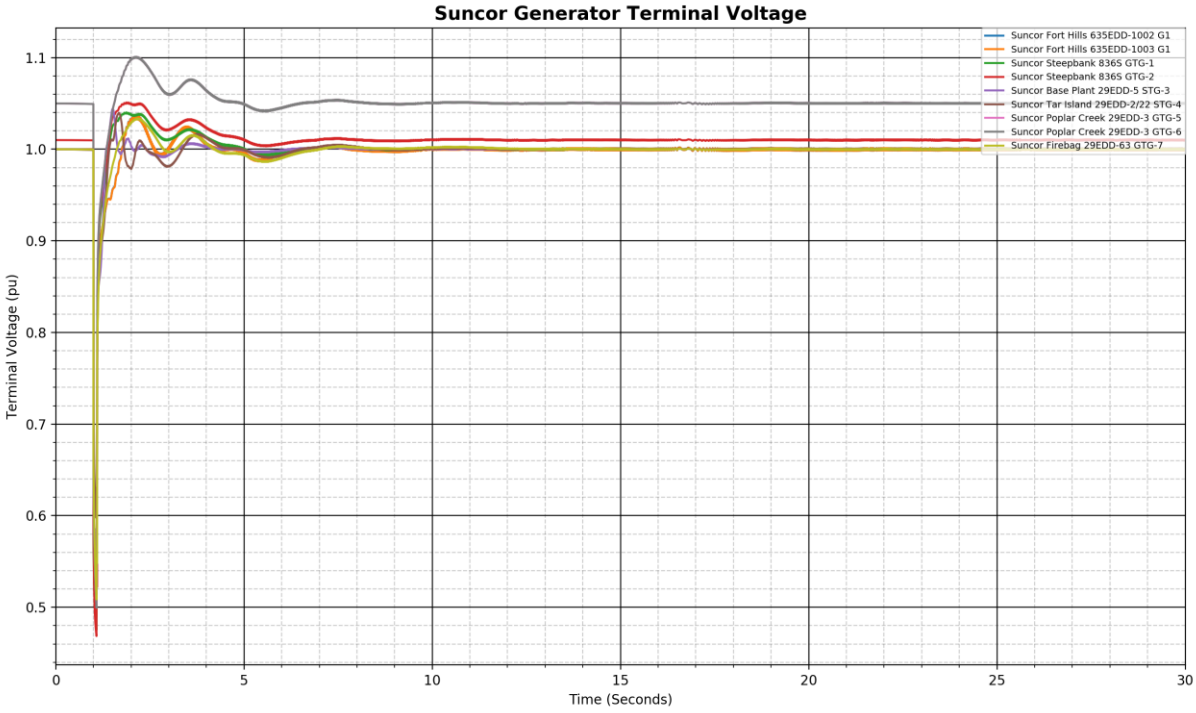

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

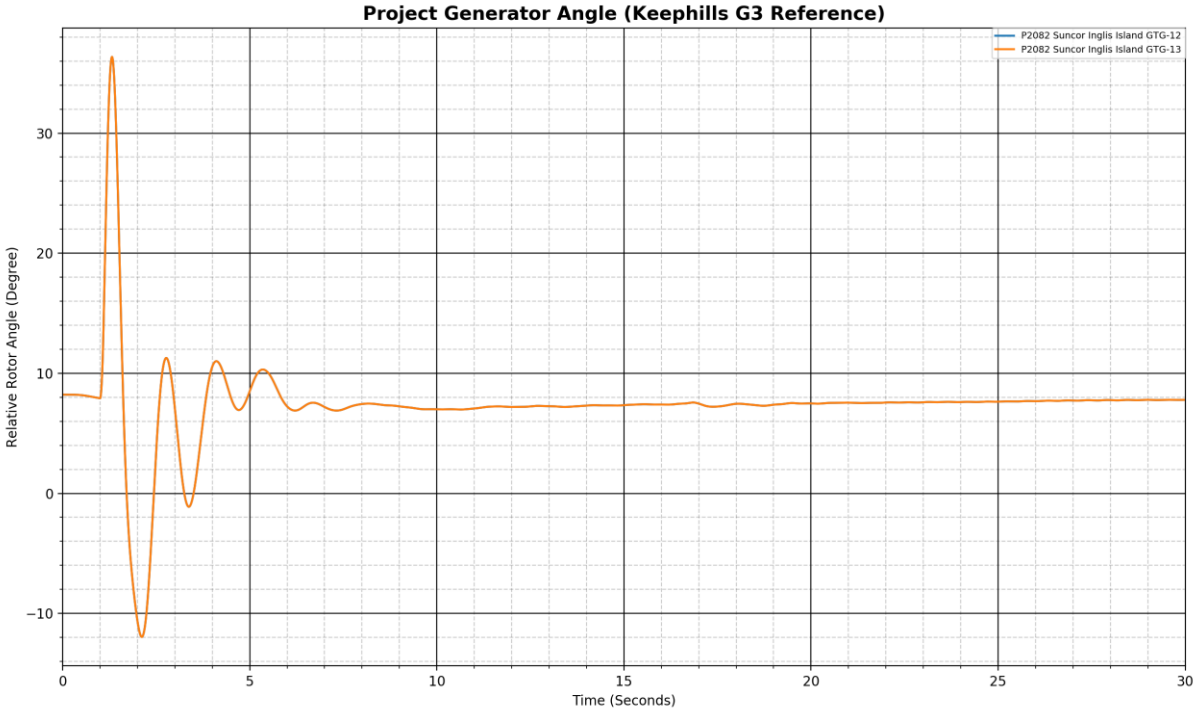

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

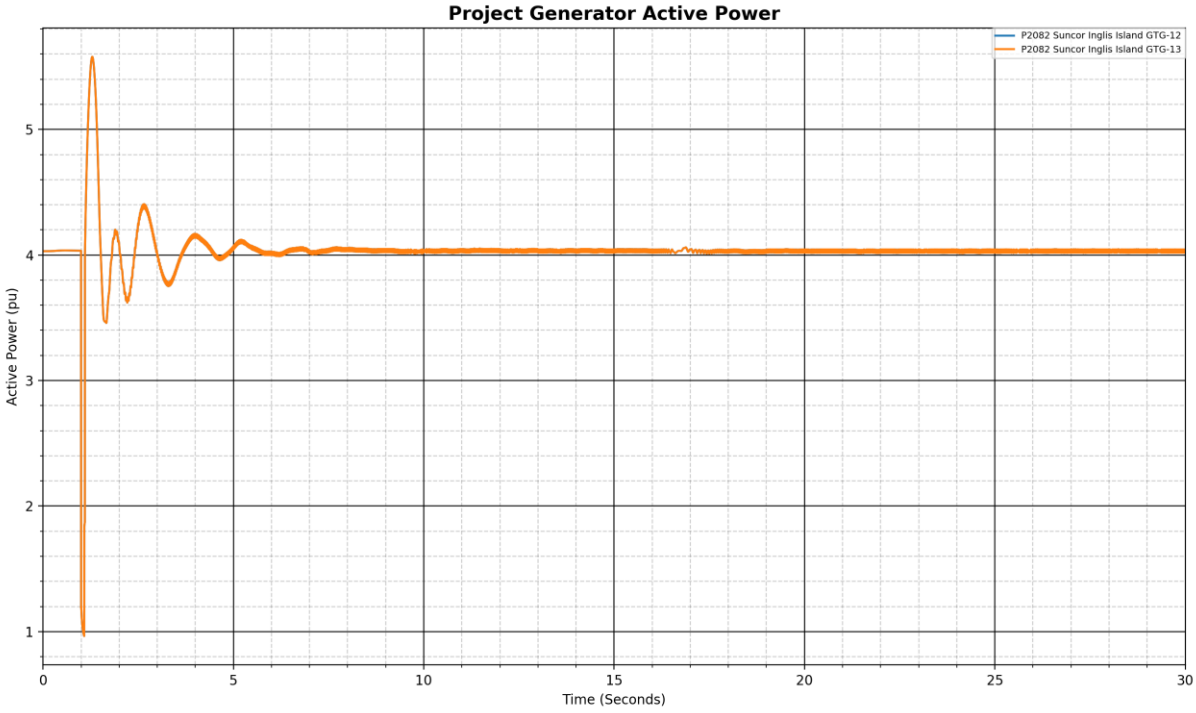

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

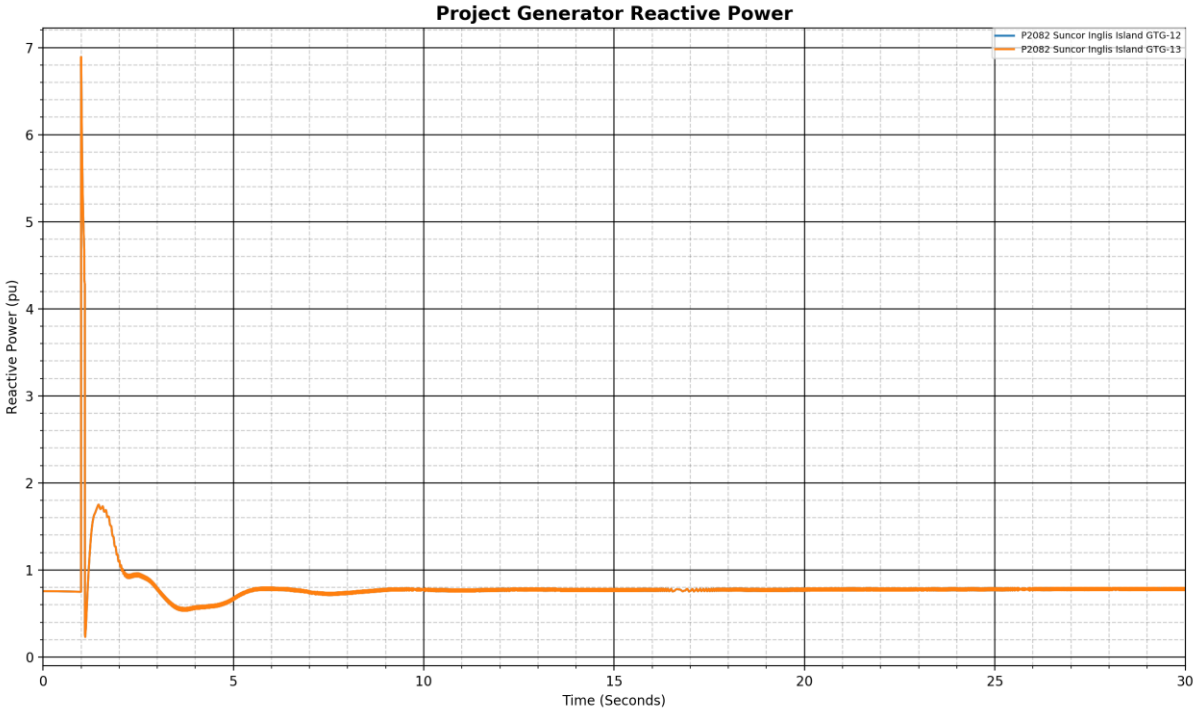

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

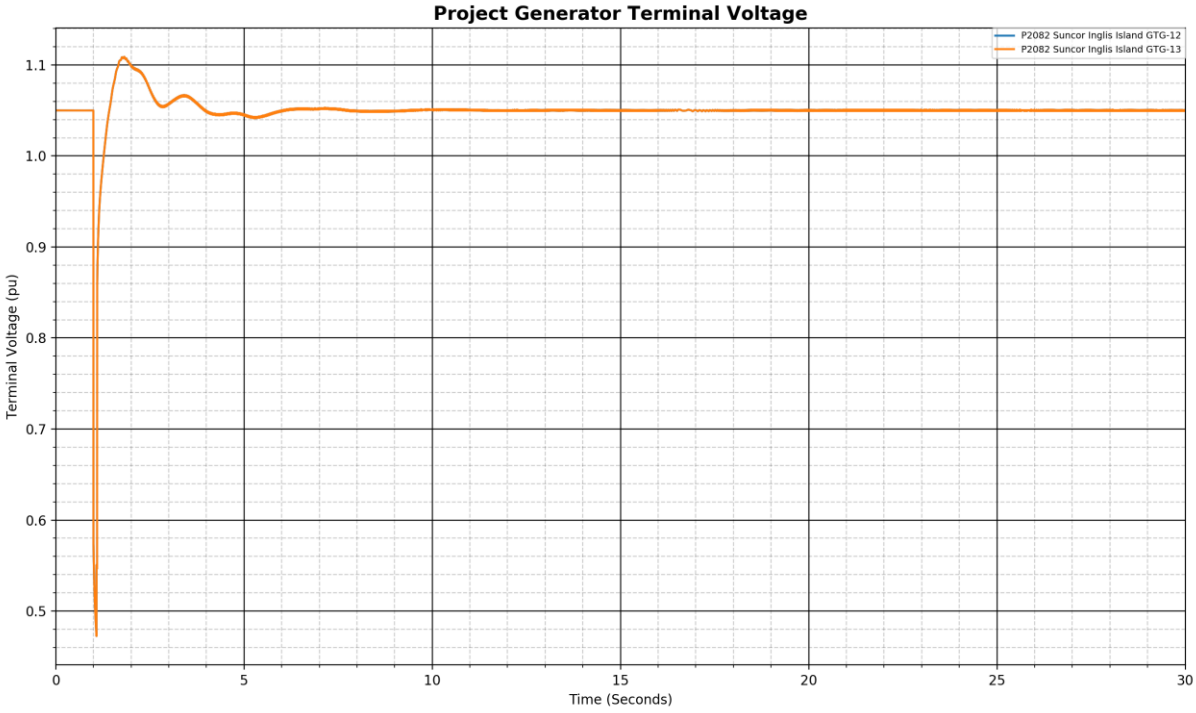

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

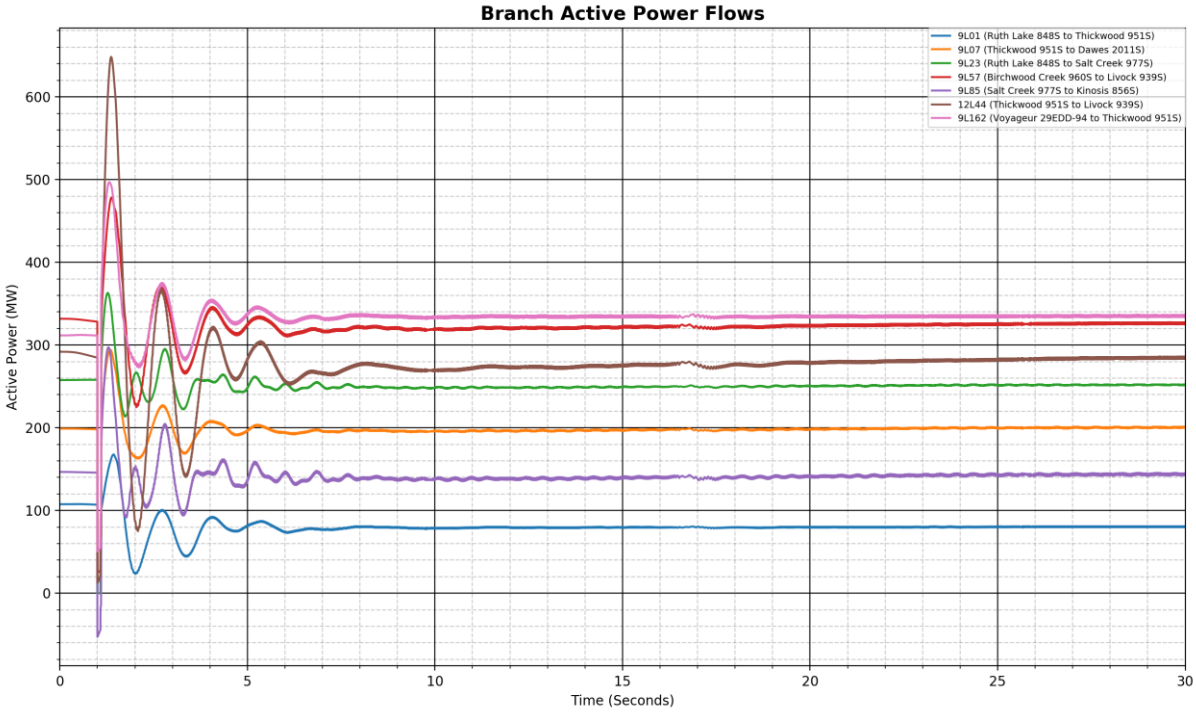

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
20
10
0
−10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5
4
3
2
1
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

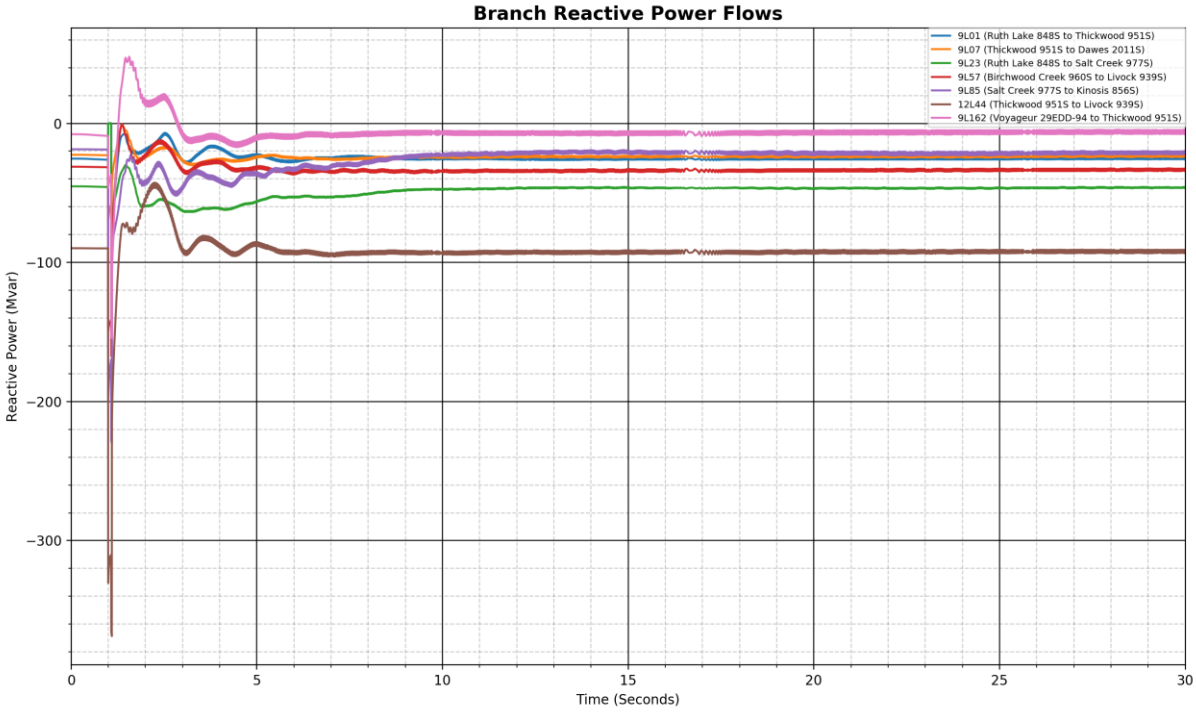
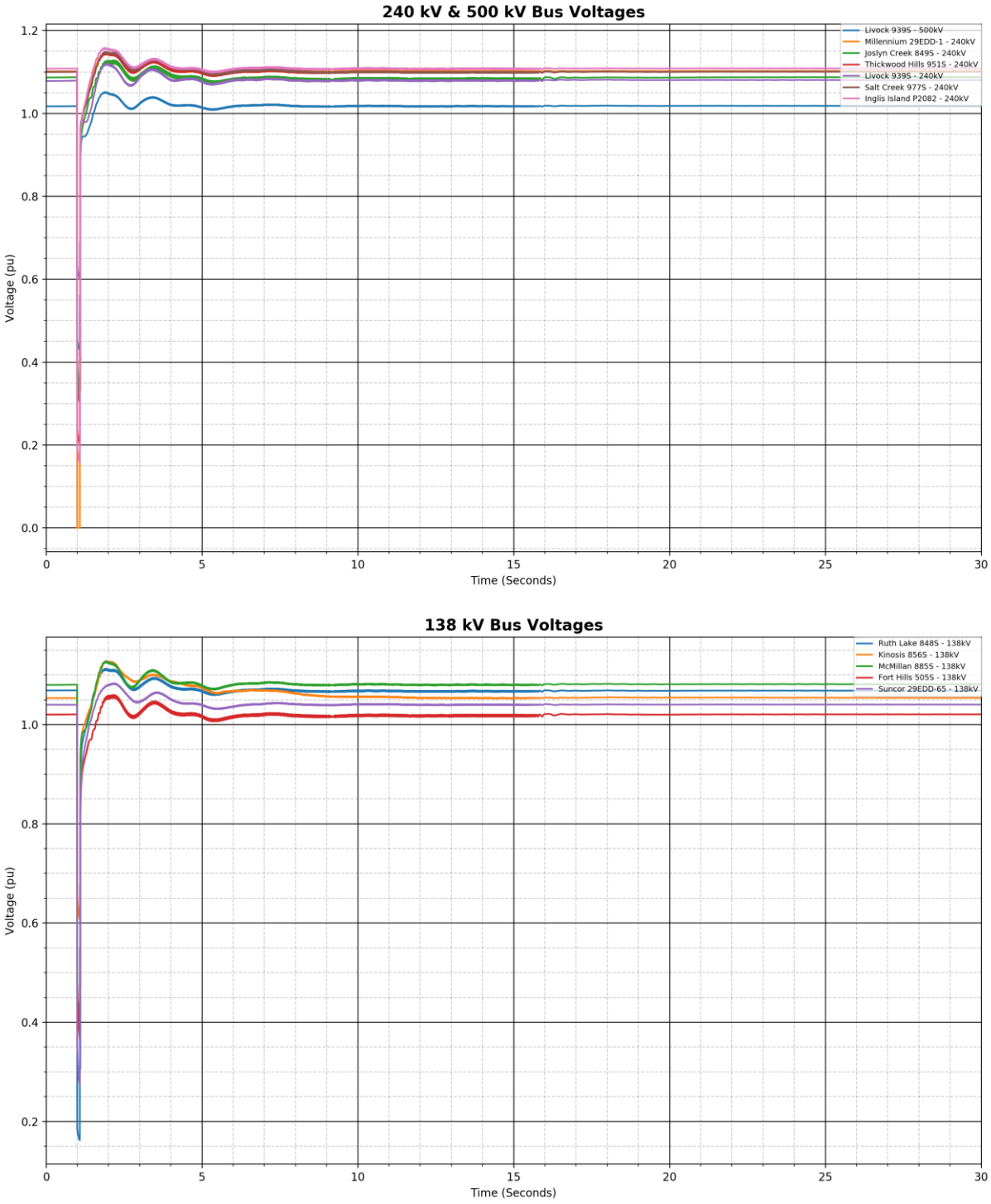
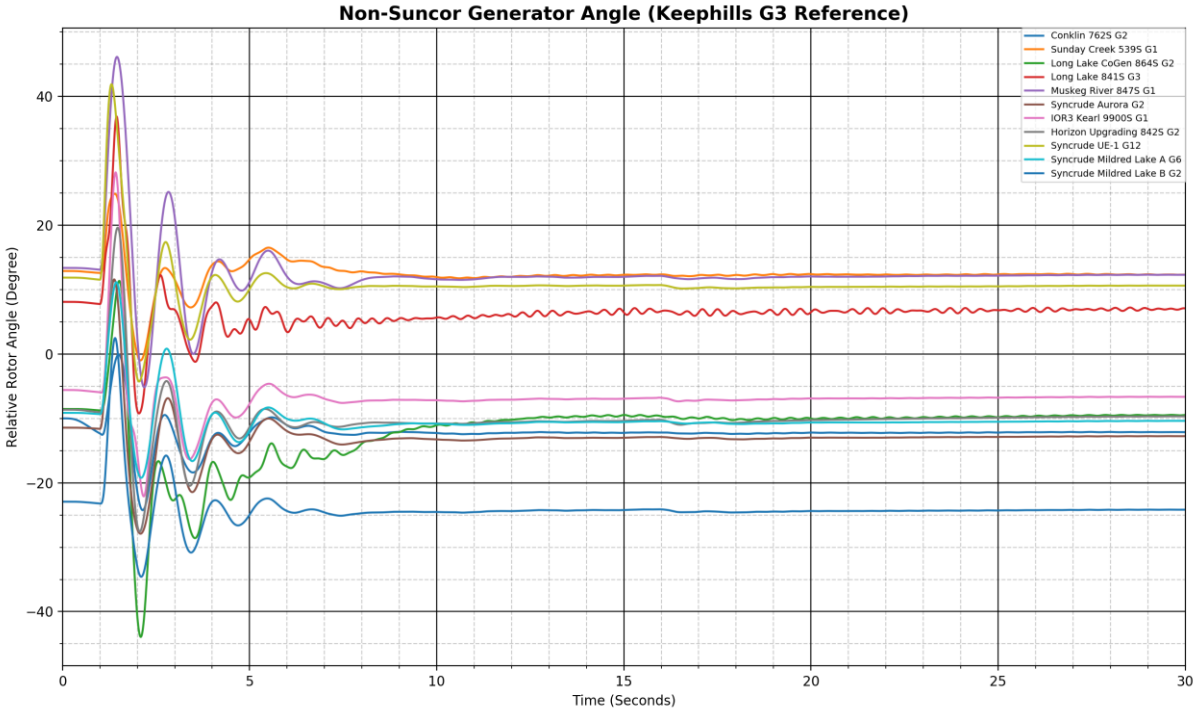
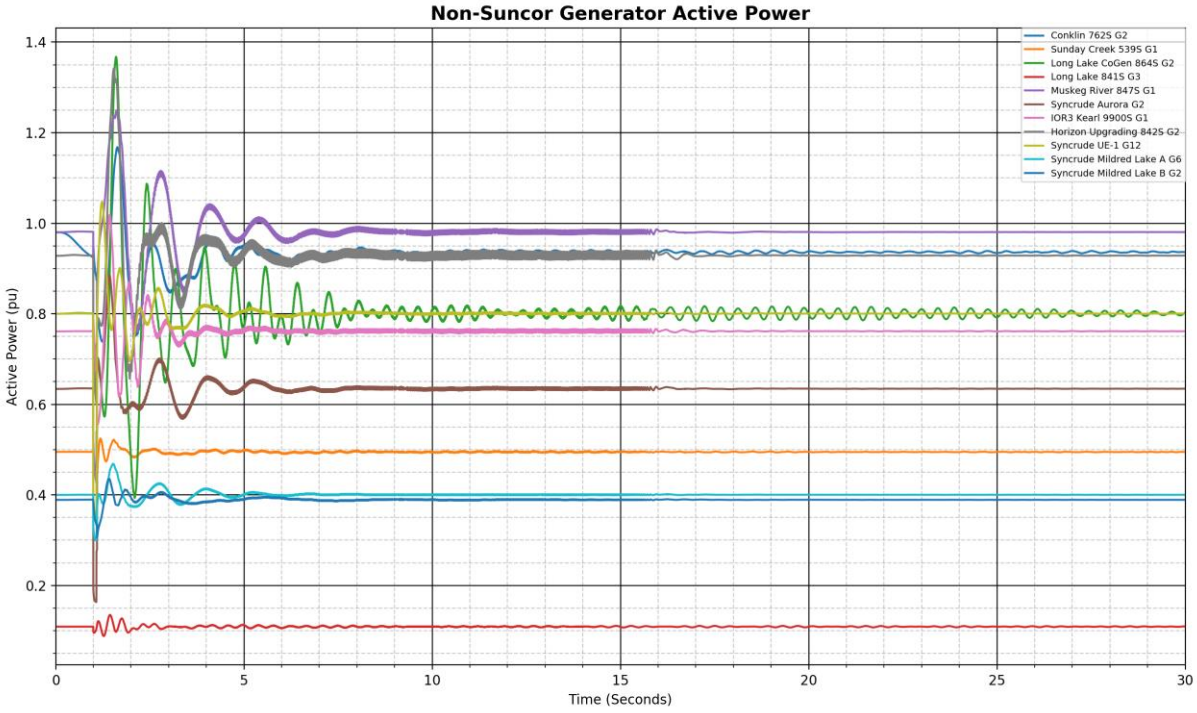
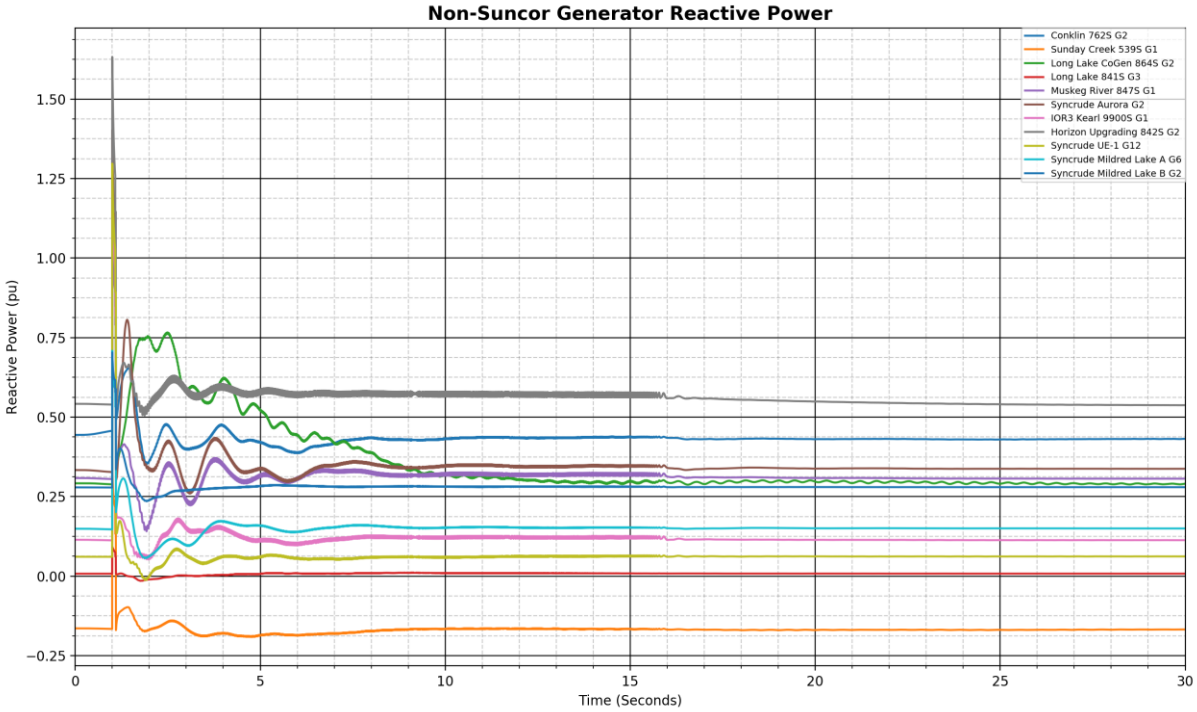

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

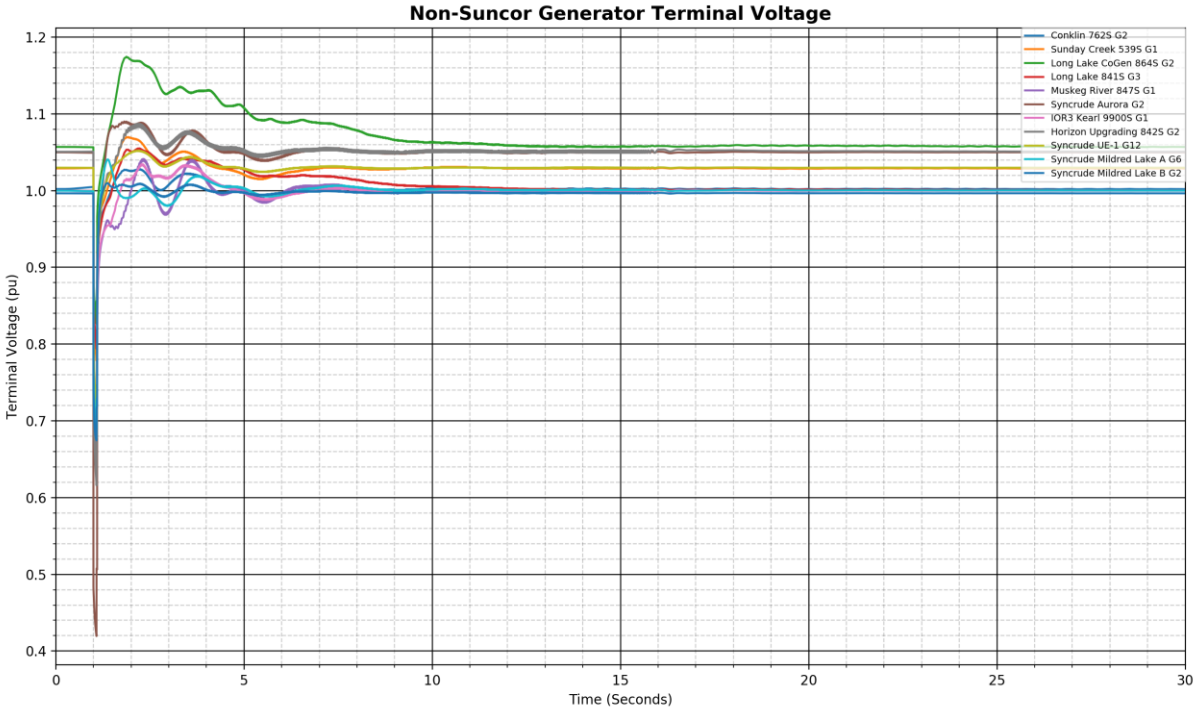
Figure A4-76: 29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1): Fault at Millennium 29EDD-1

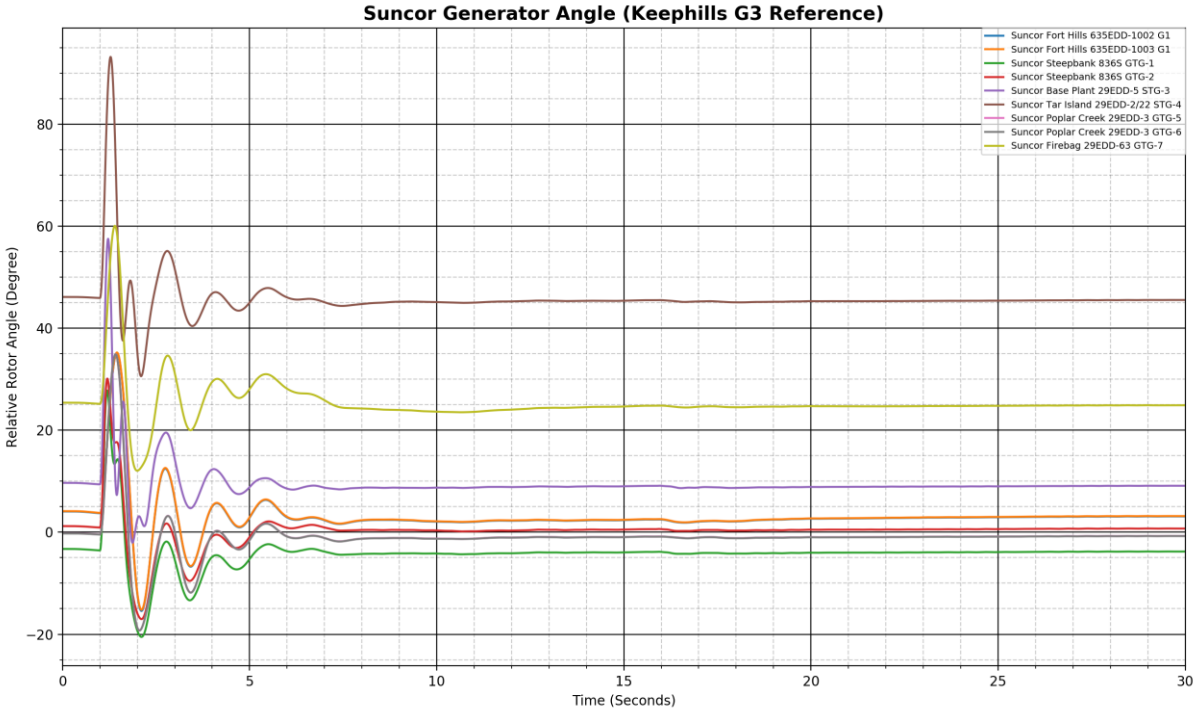


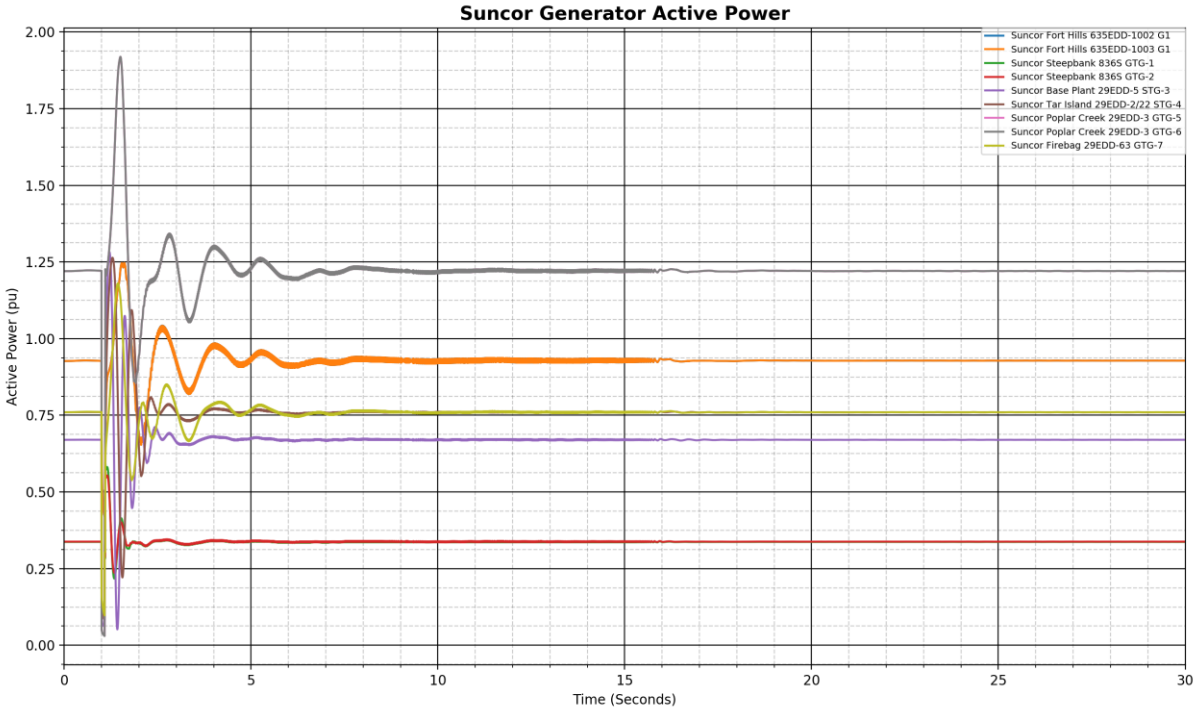

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

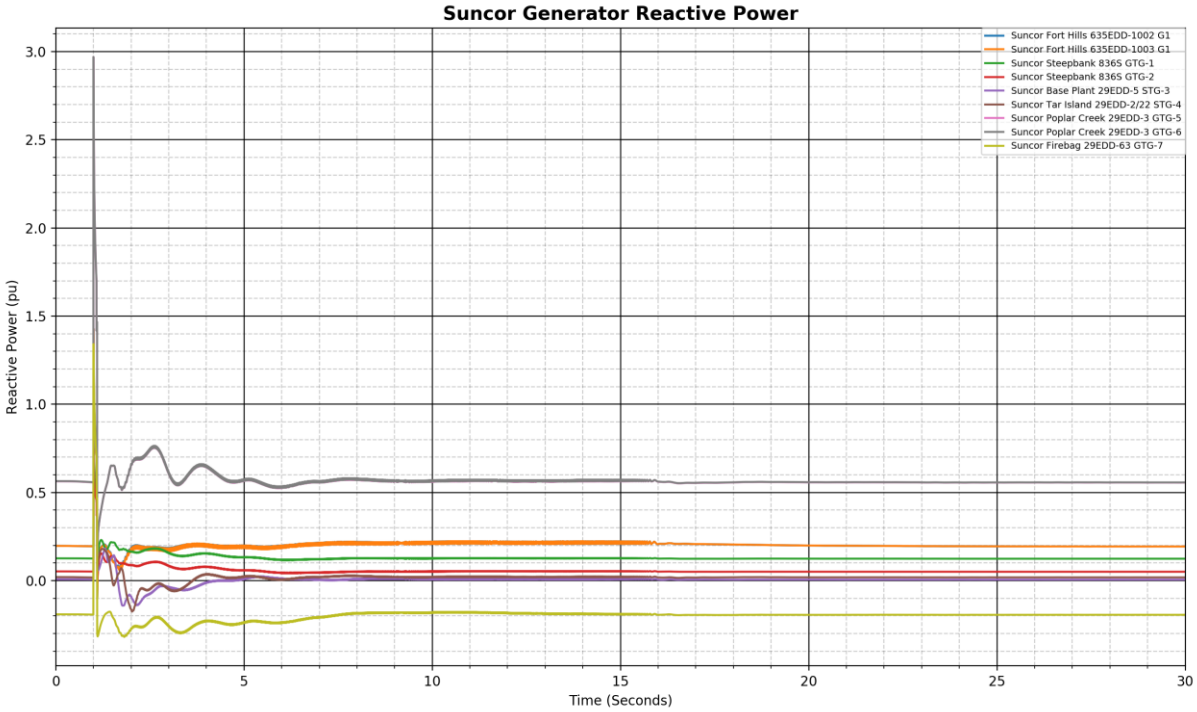

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

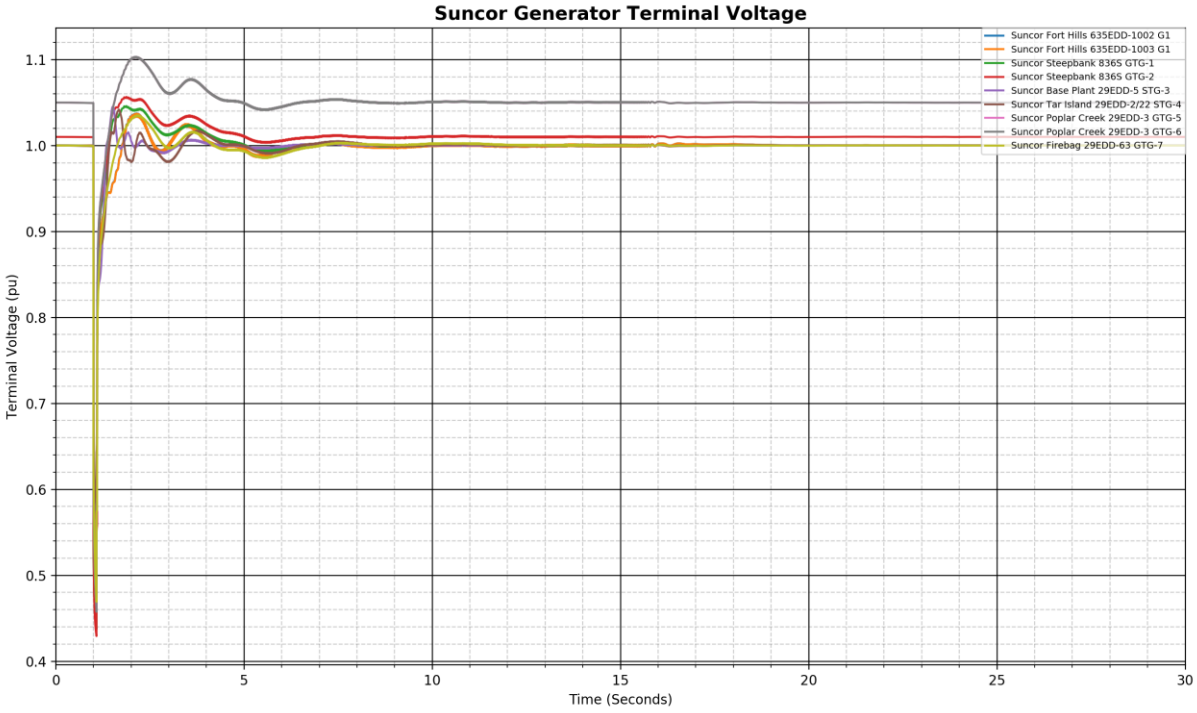

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

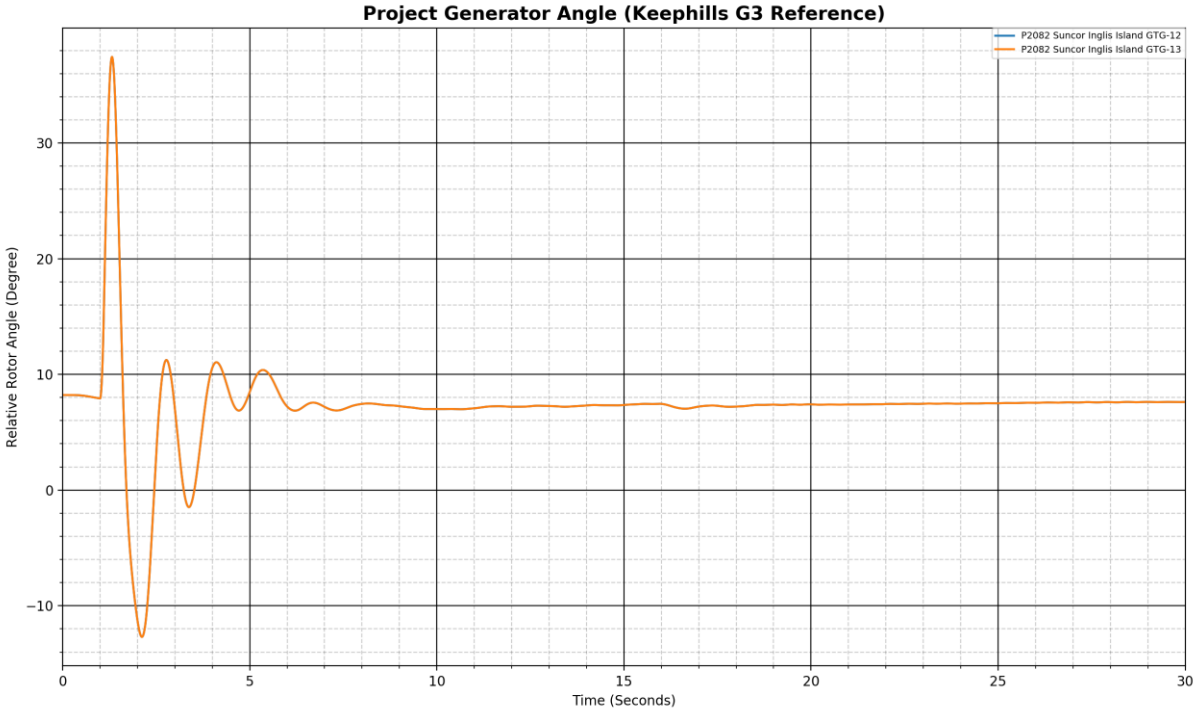

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

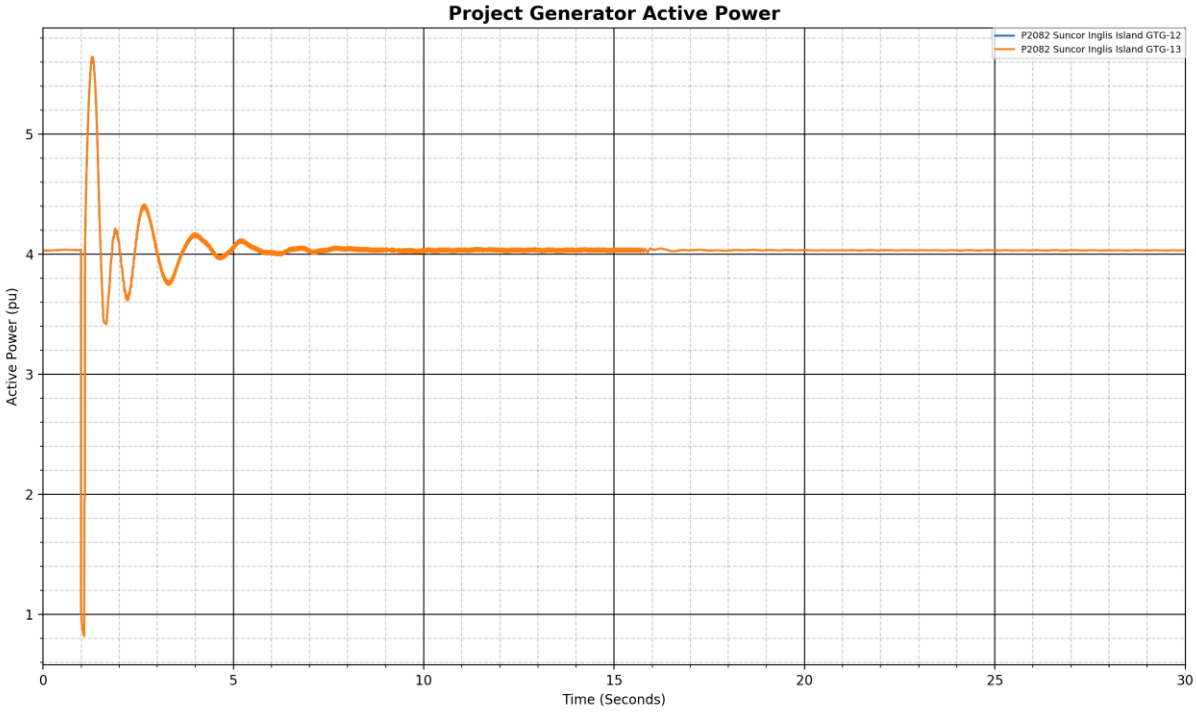

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

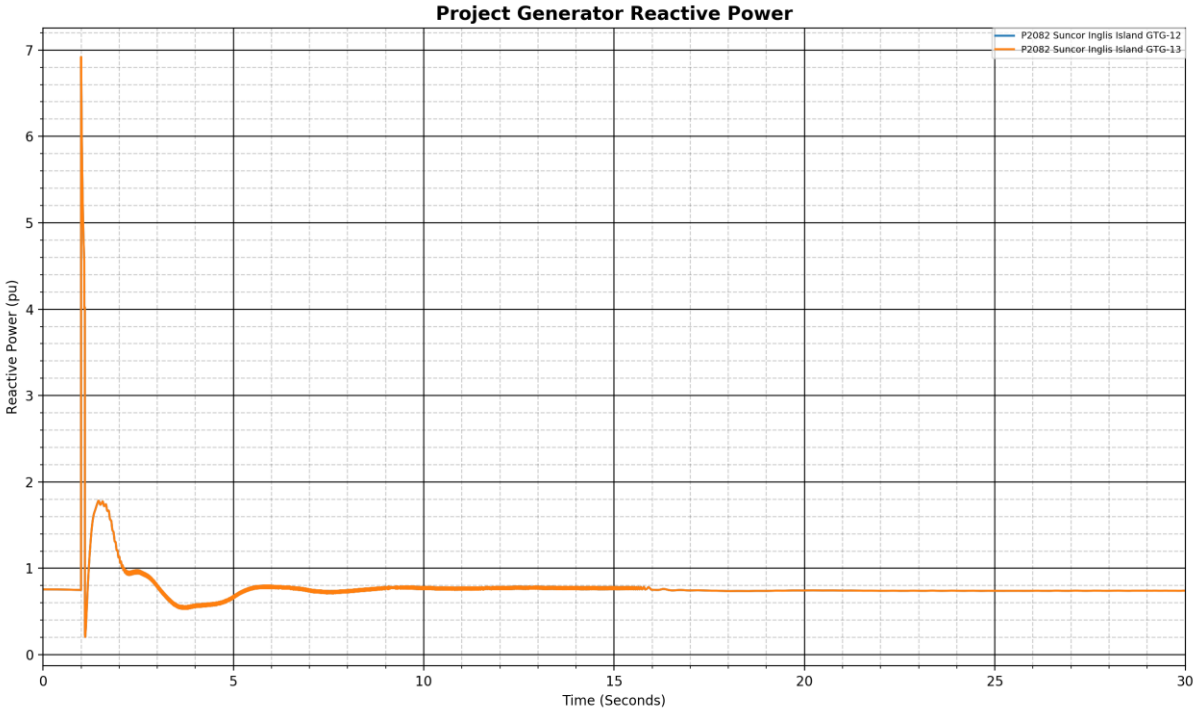

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

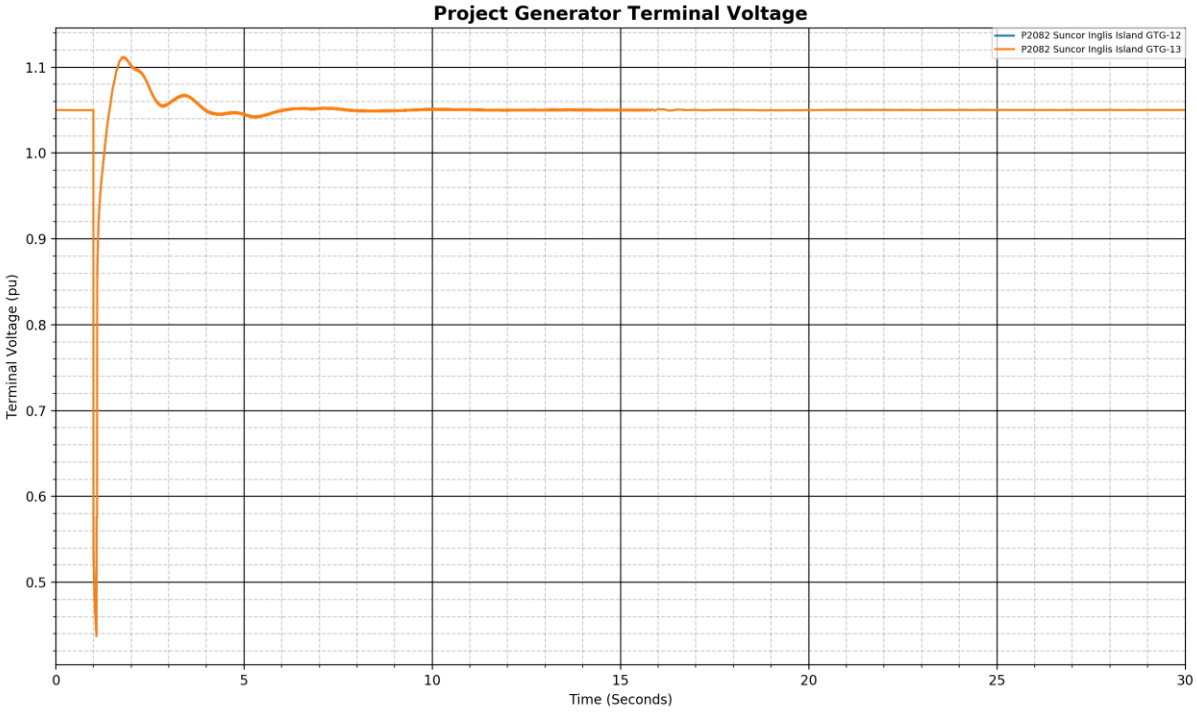

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

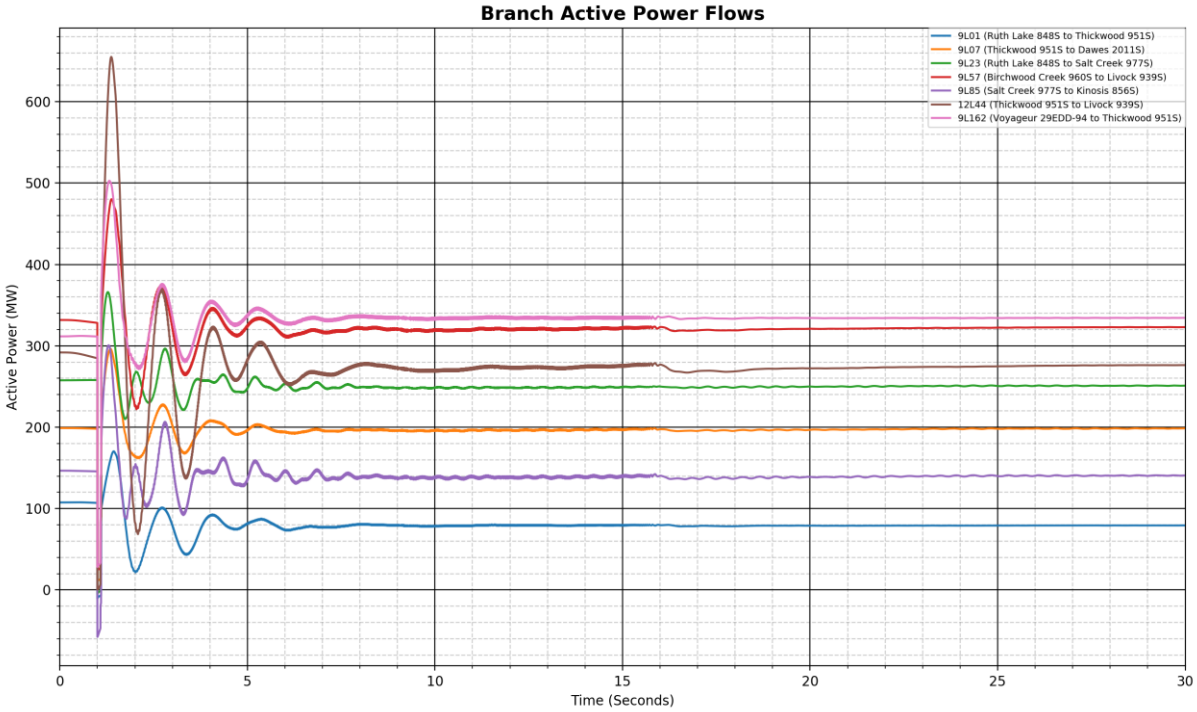

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
20
10
0
−10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5
4
3
2
1
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Active Power (MW)
Time (Seconds)

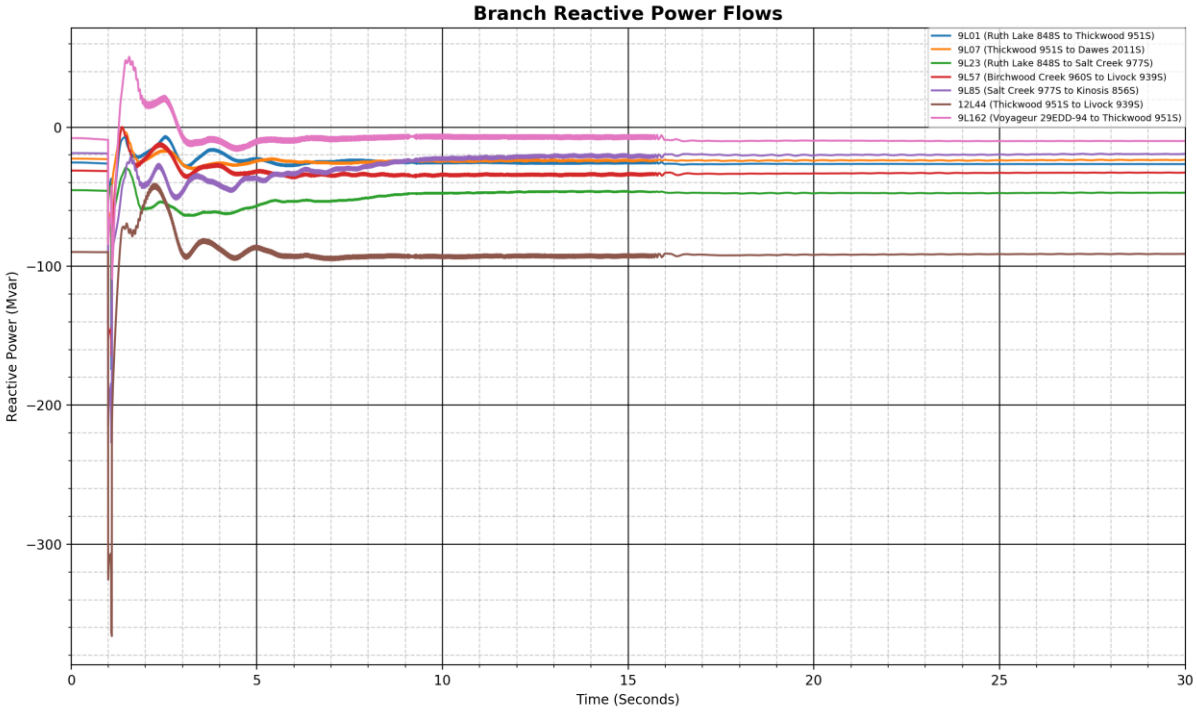
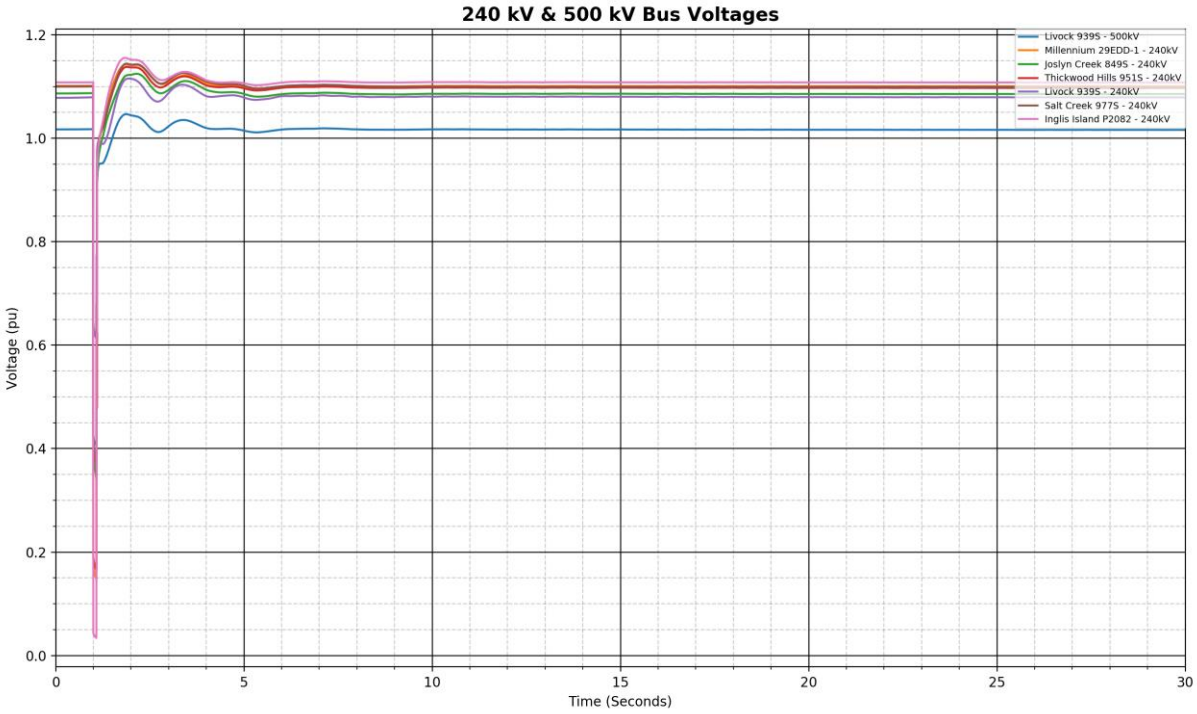
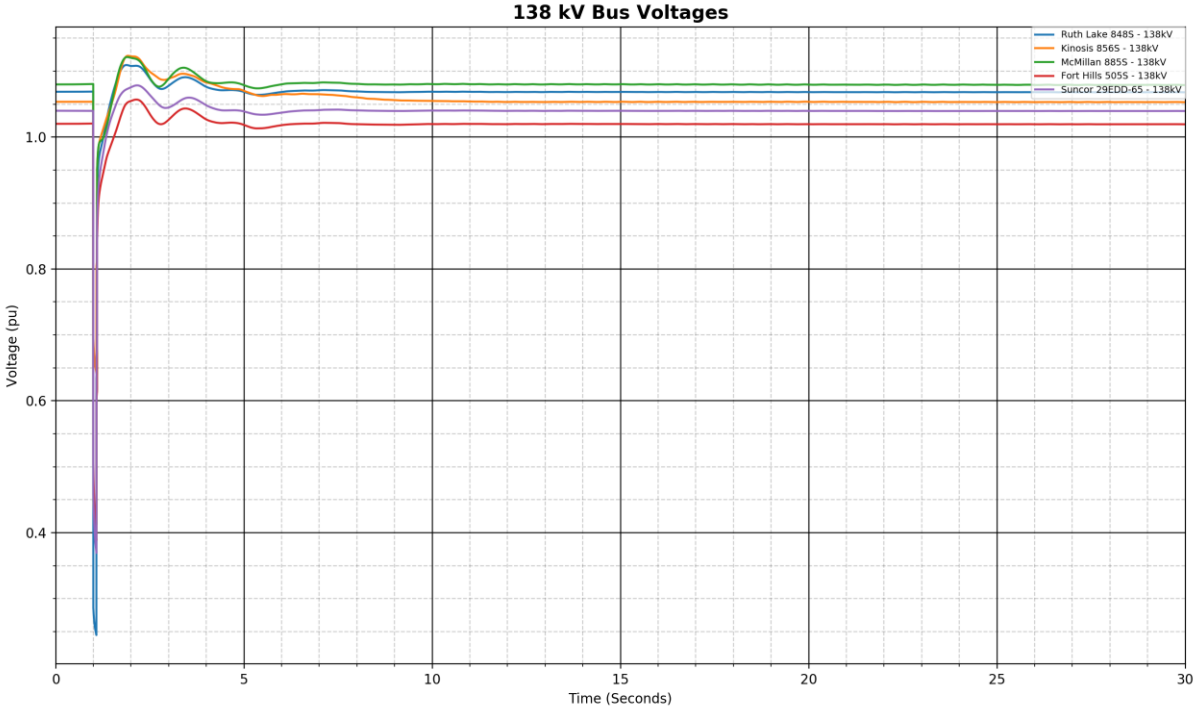
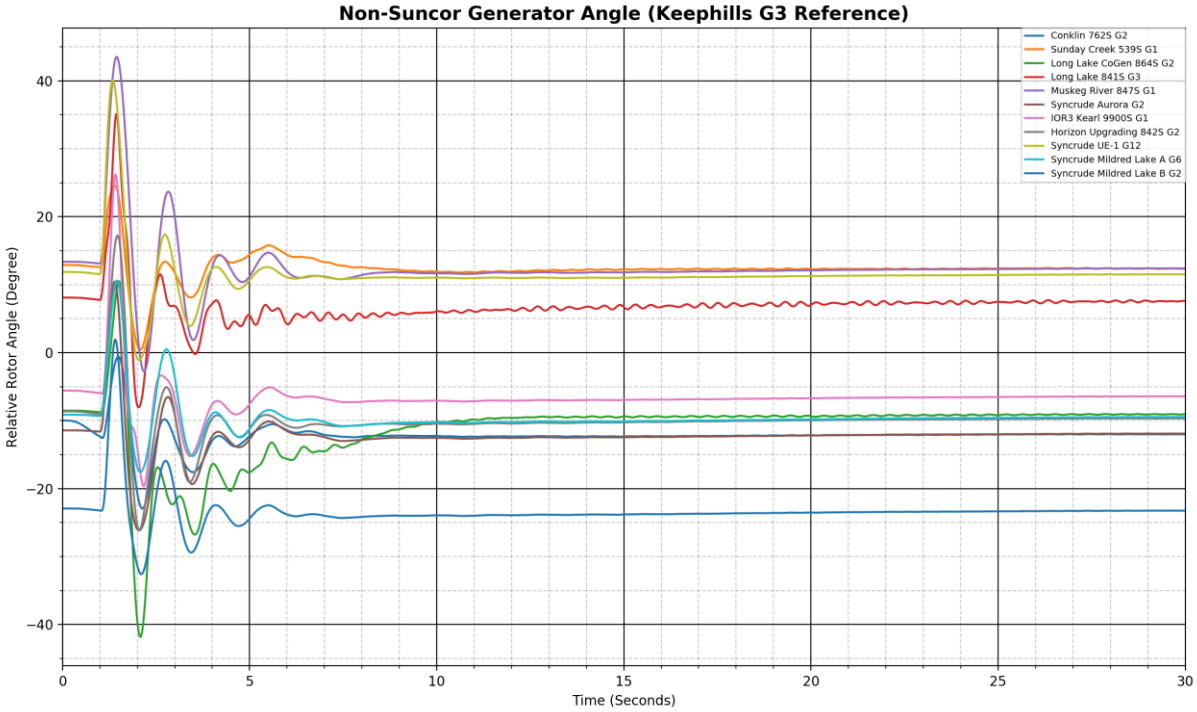
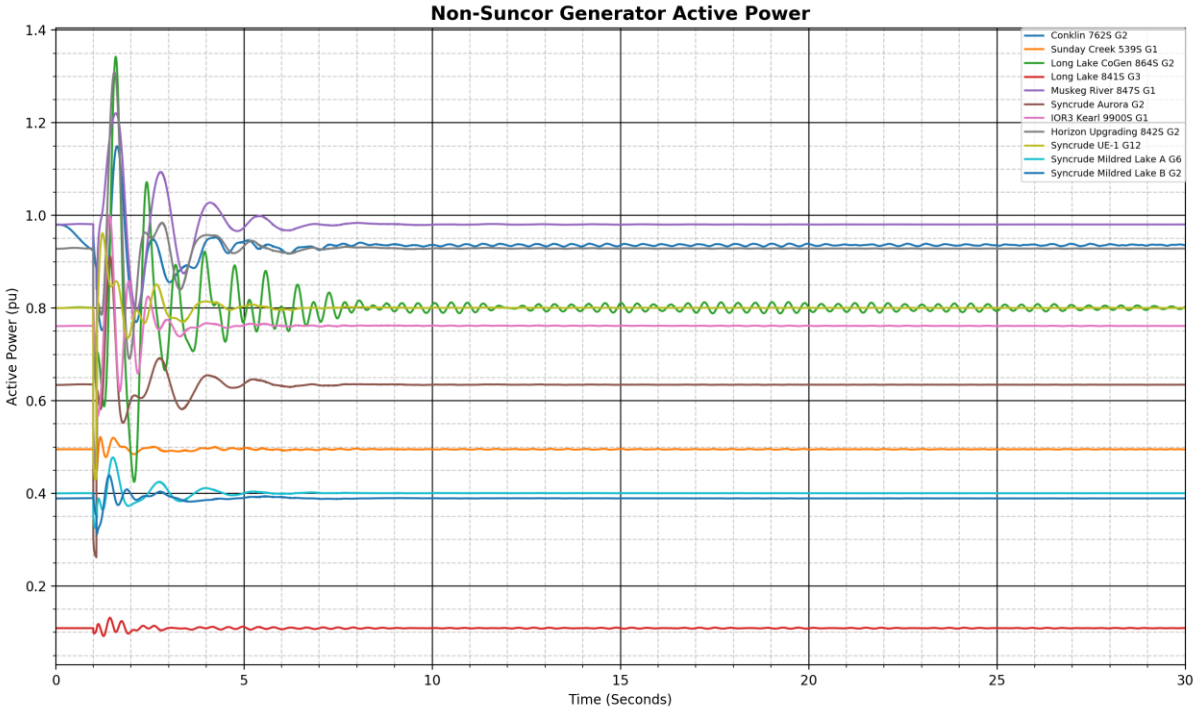

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
12L44 (Thickwood 951S to Livock 939S)
9L162 (Voyageur 29EDD-94 to Thickwood 951S)
Reactive Power (Mvar)
Time (Seconds)

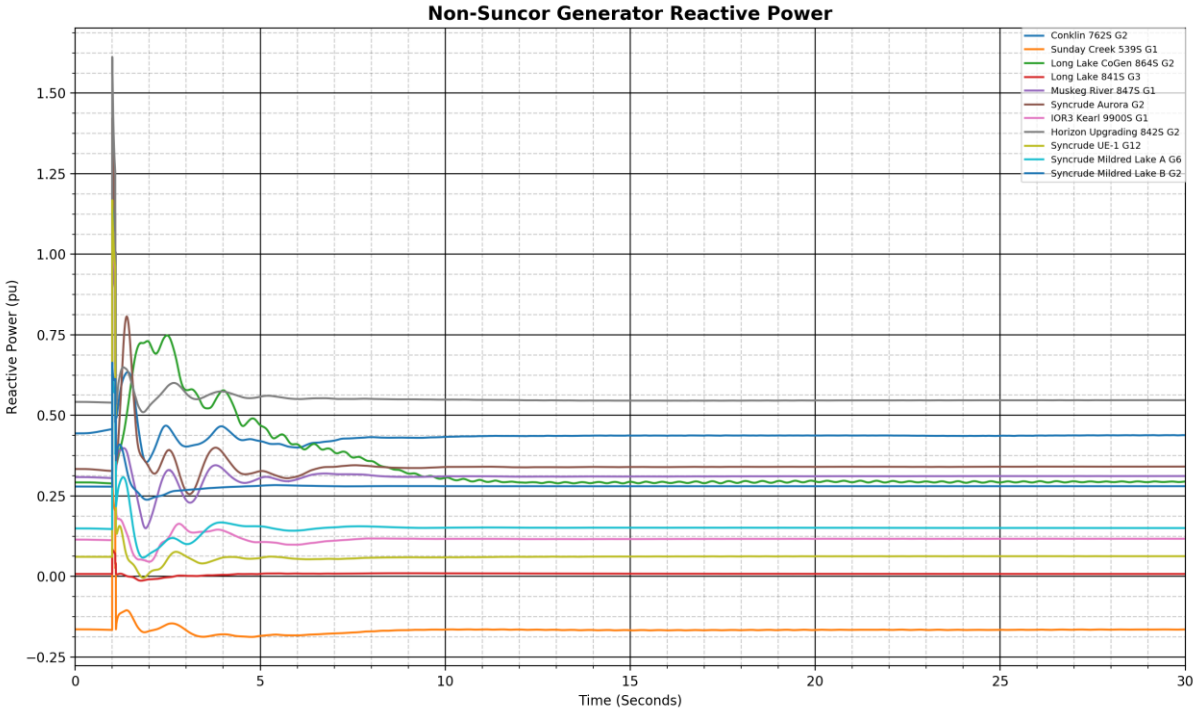
Figure A4-77: 9L162 (Voyageur 29EDD-94 to Thickwood Hills 951S): Fault at Voyageur 29EDD-94

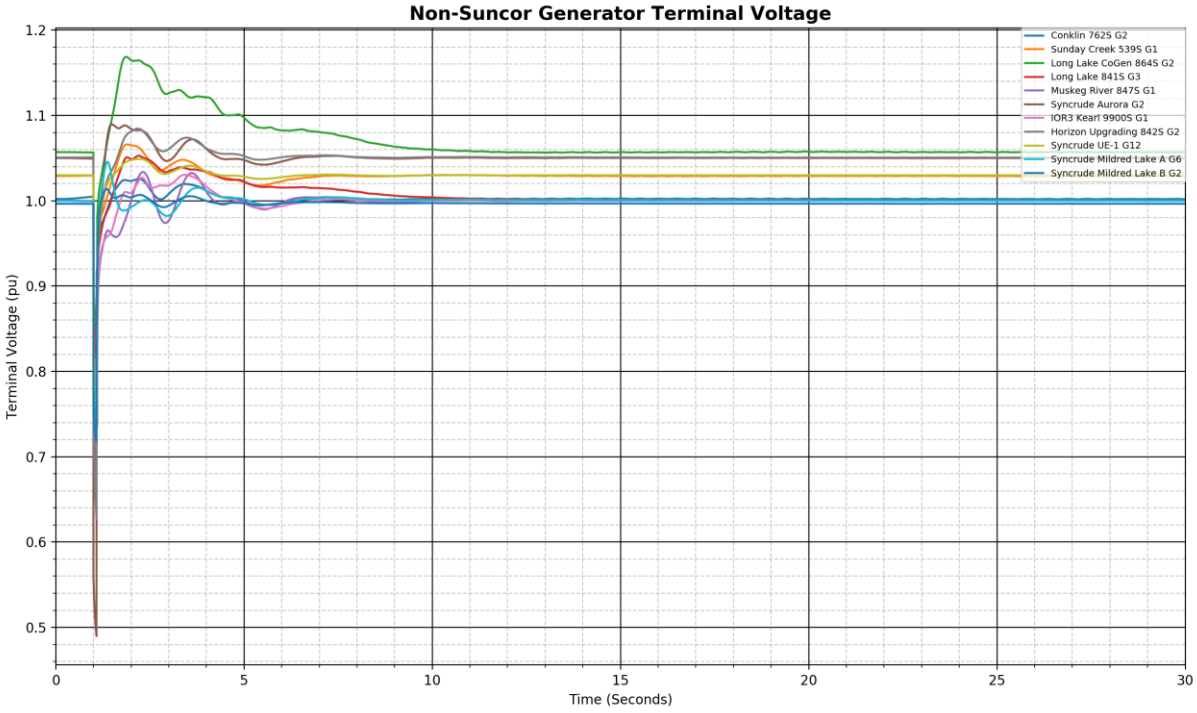


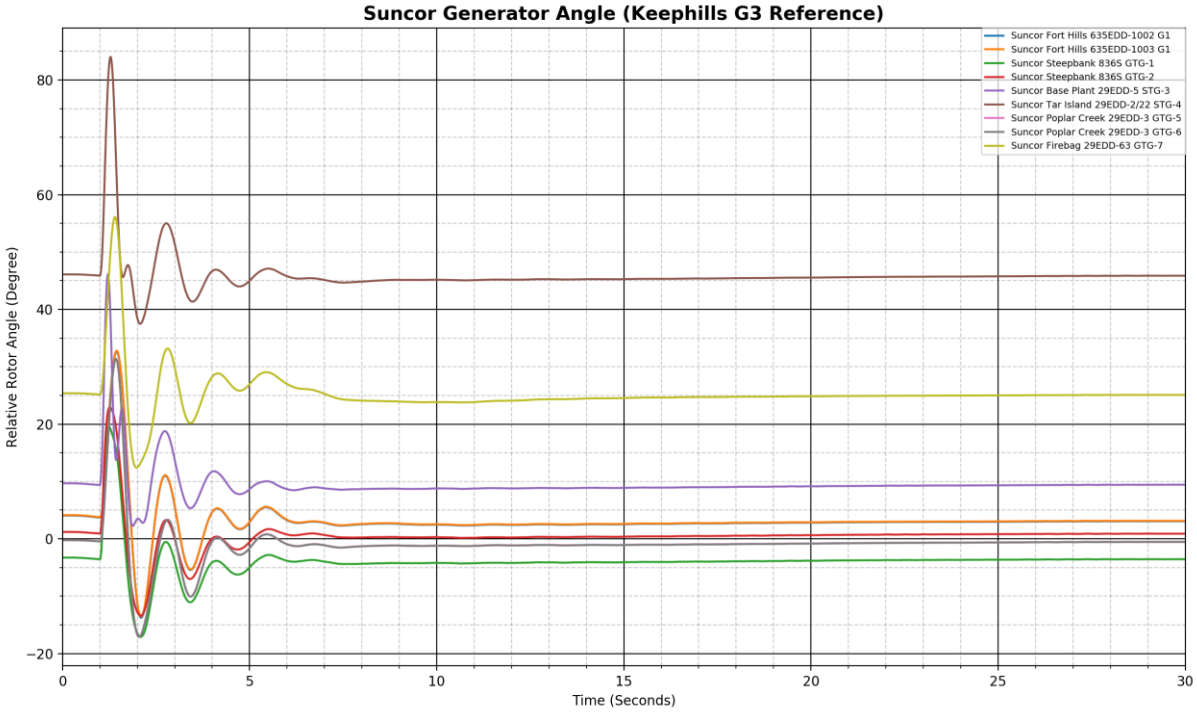


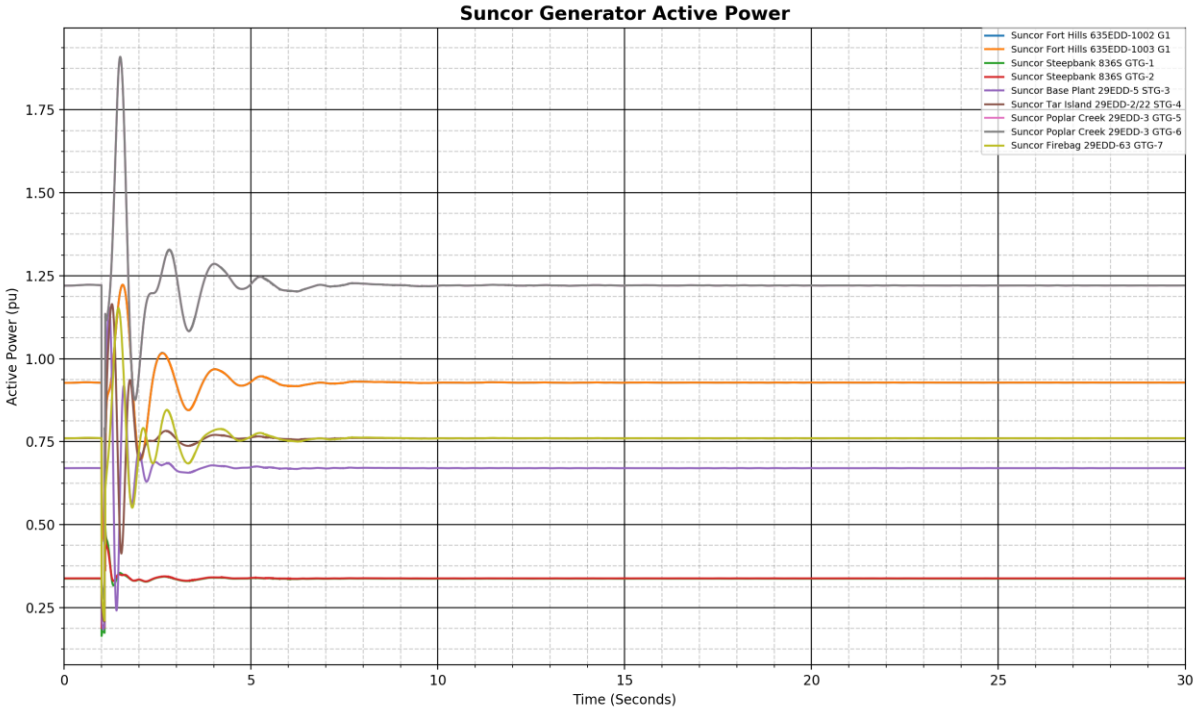

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

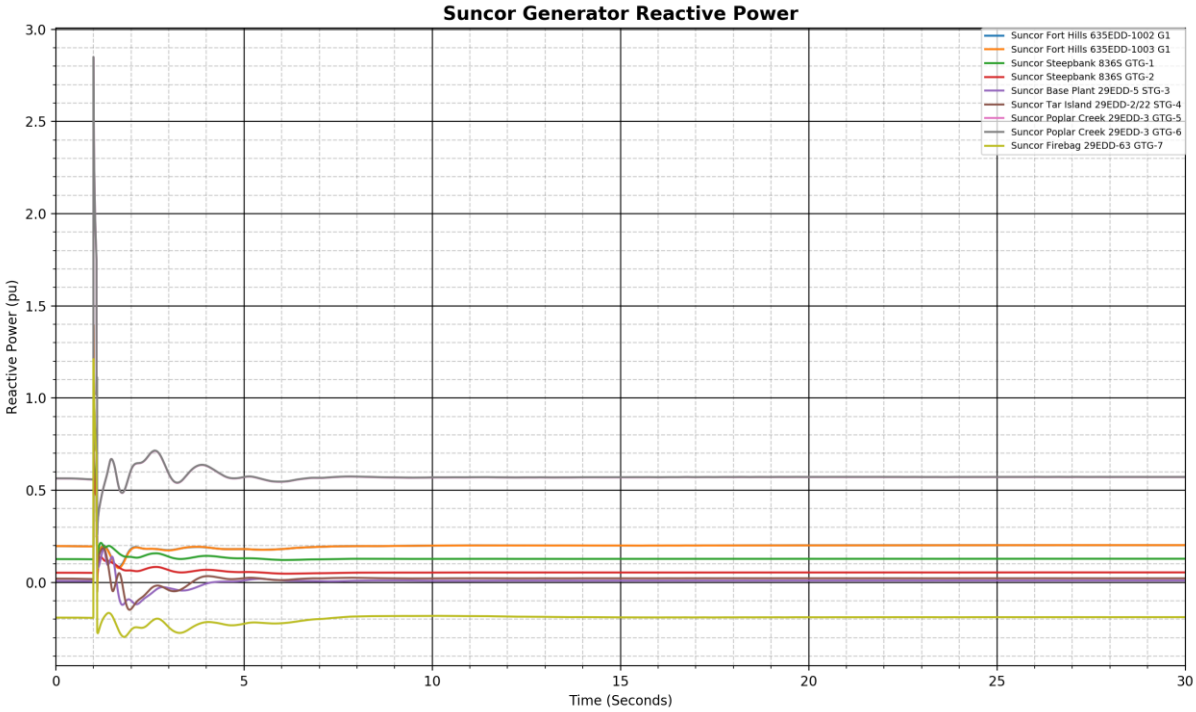

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

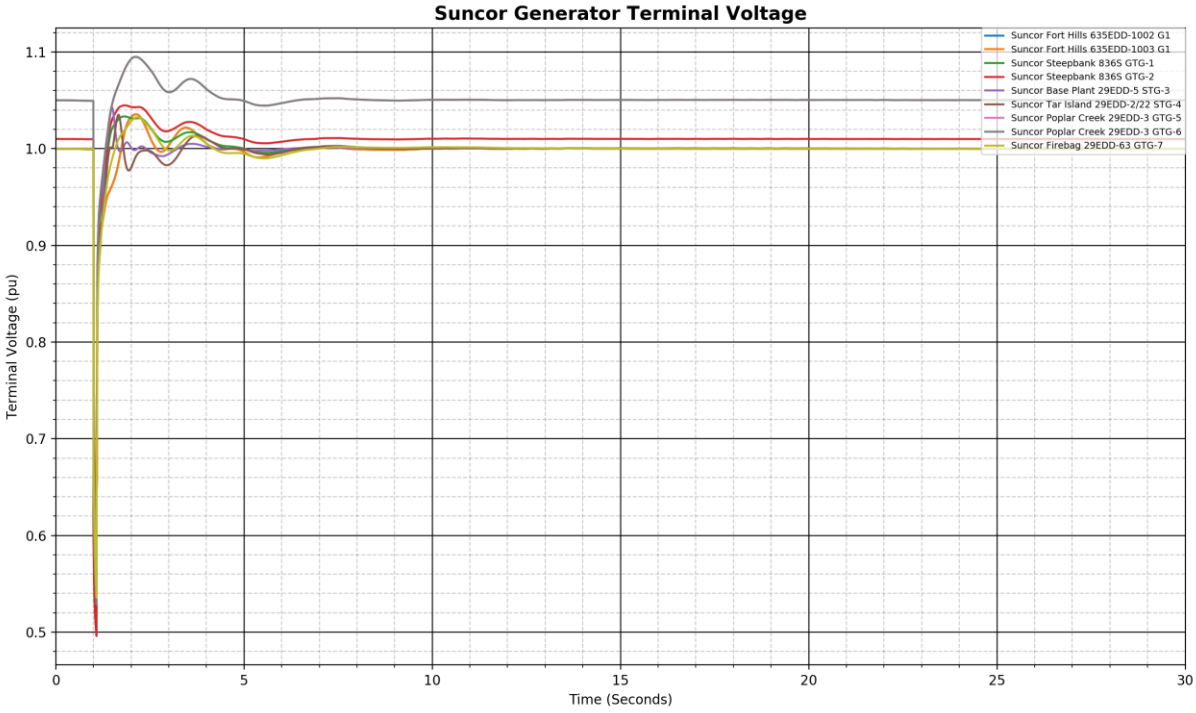

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

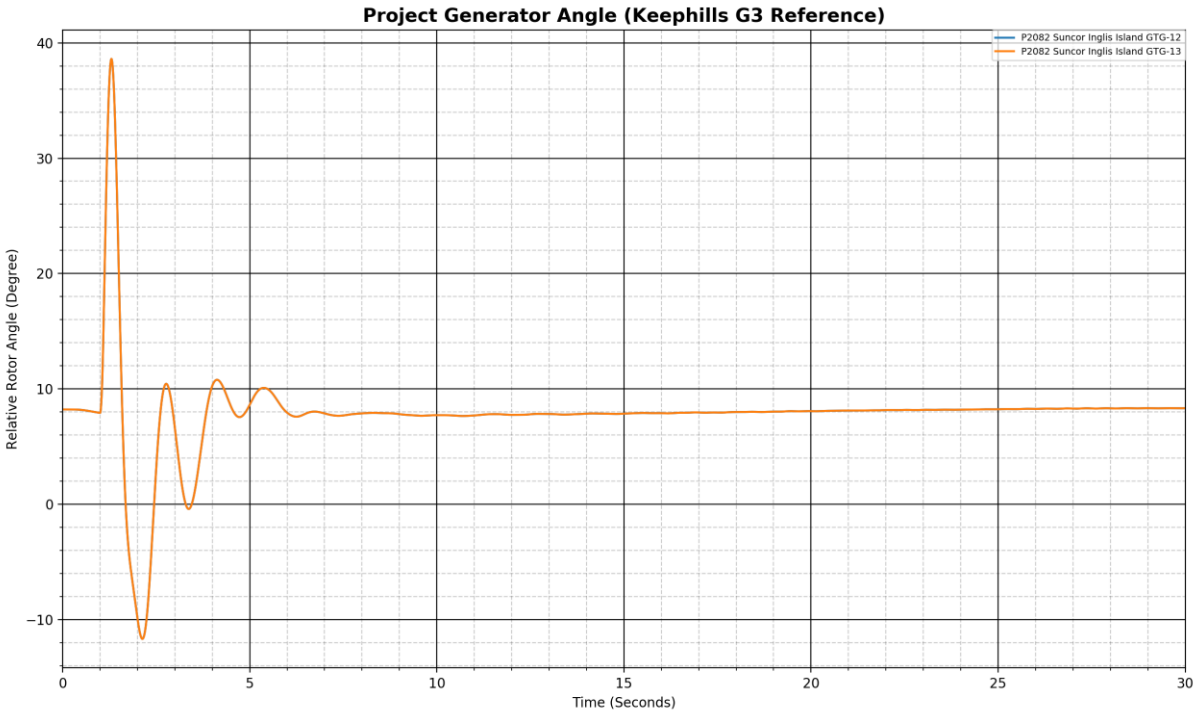

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

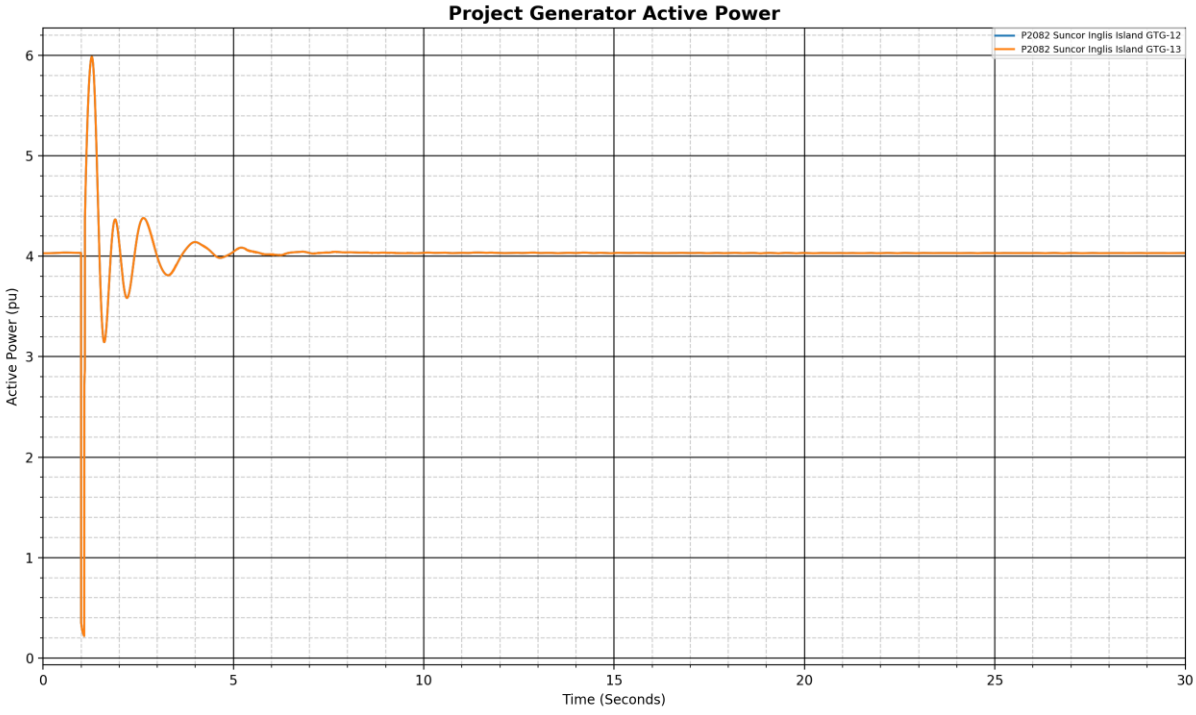

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

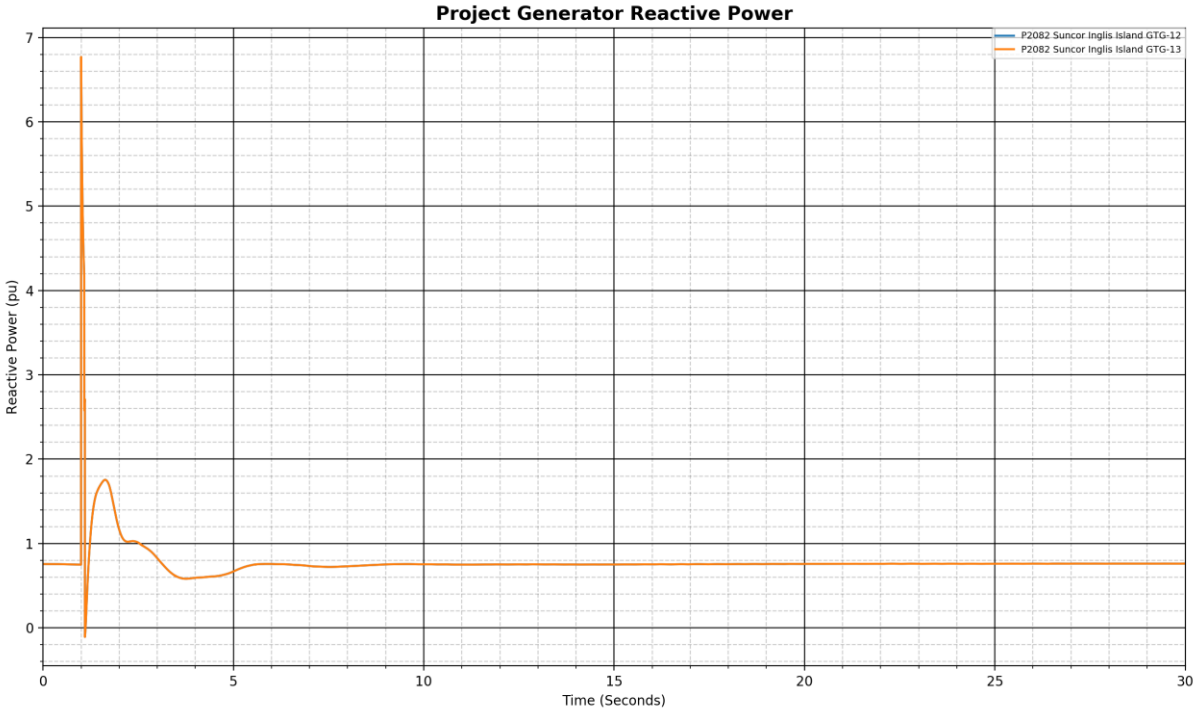

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

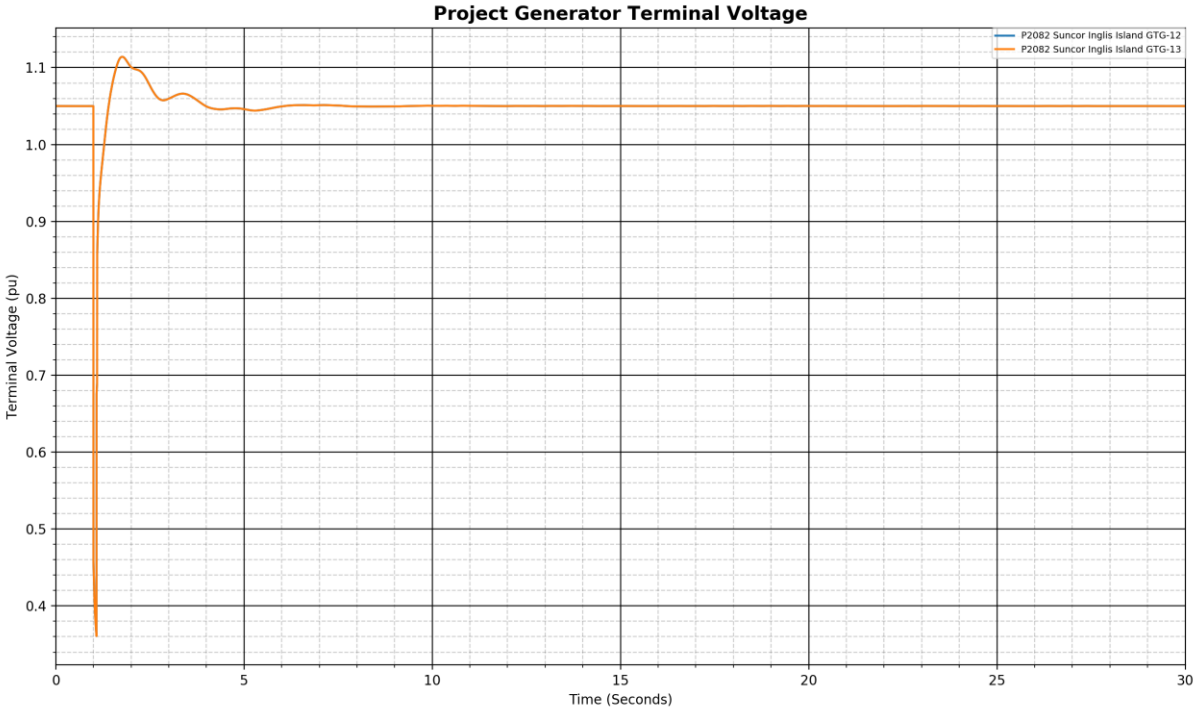

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

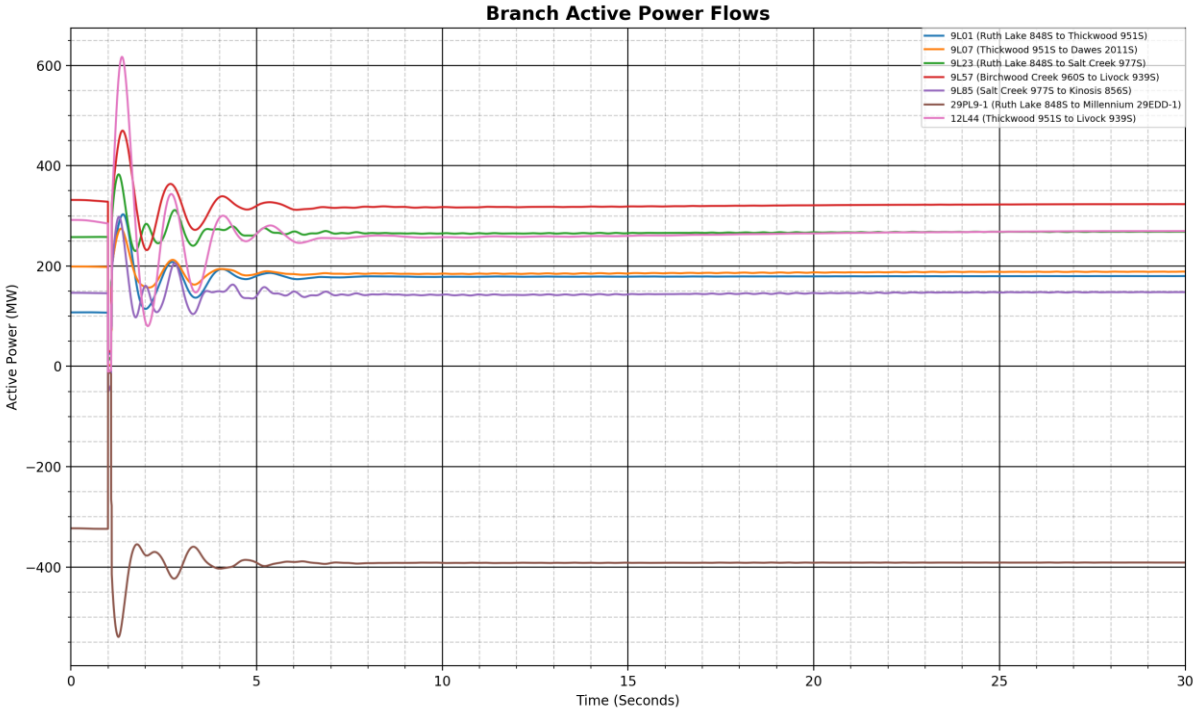

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7


Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
Time (Seconds)
40
30
20
10
0
−10
0
5
10
15
20
25
30


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
Time (Seconds)
6
5
4
3
2
1
0
0
5
10
15
20
25
30


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)

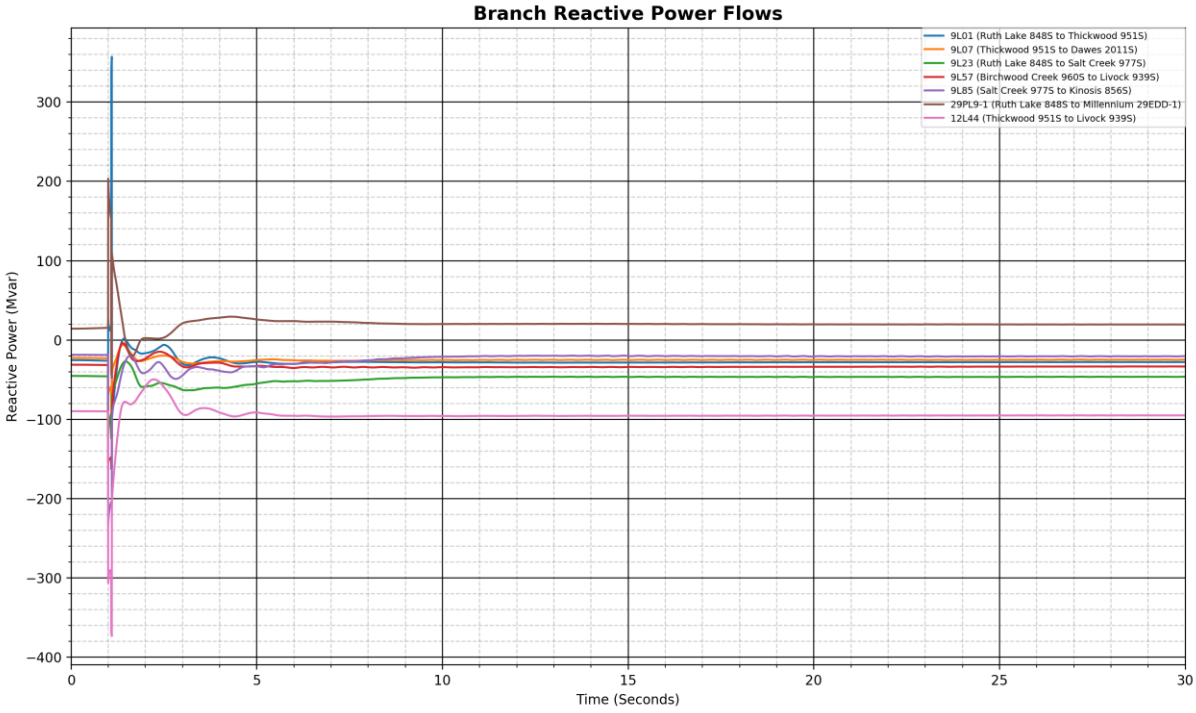
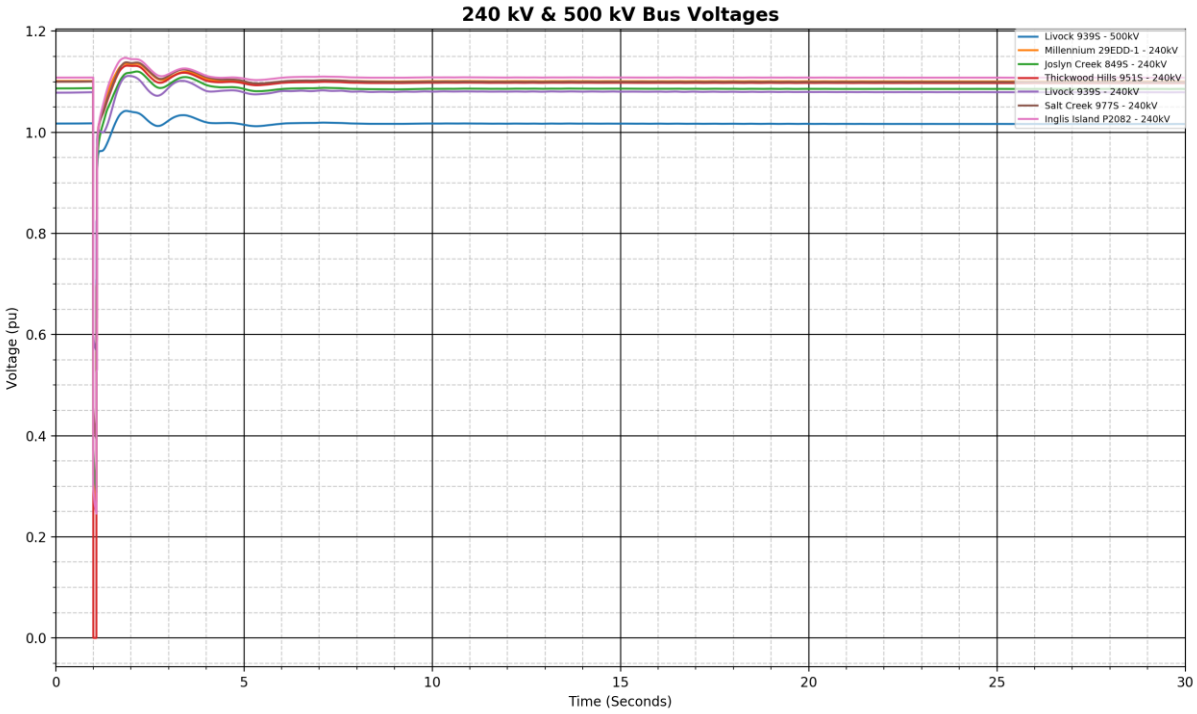
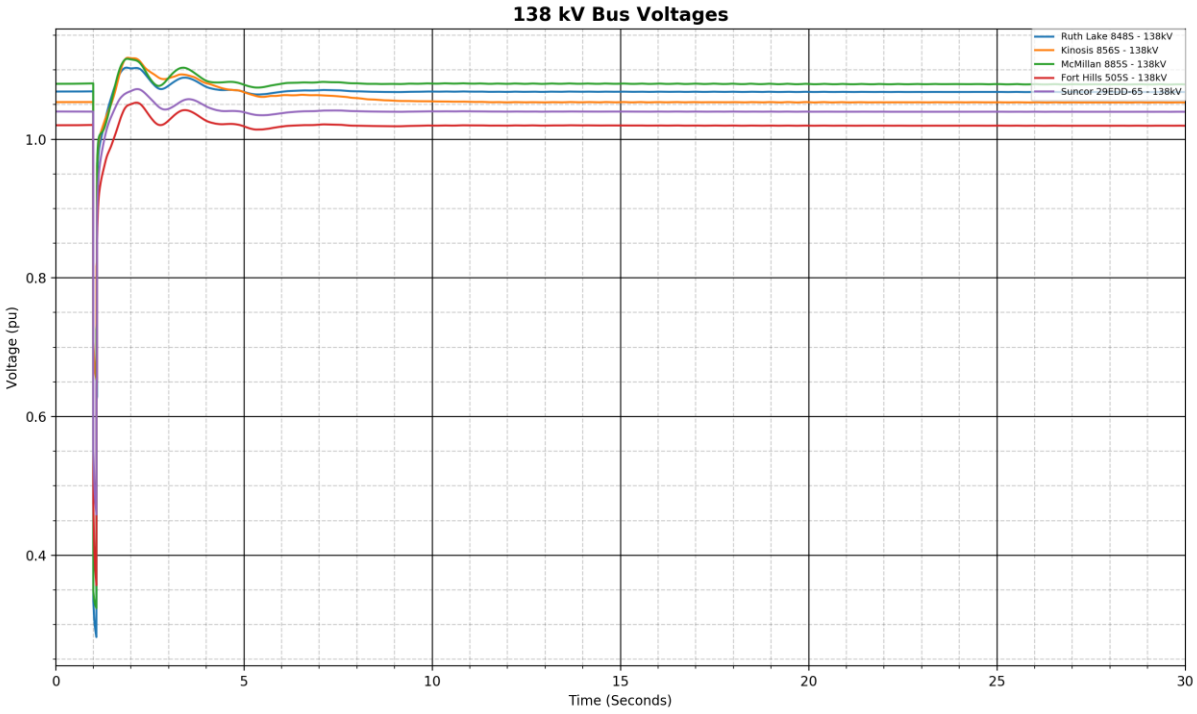
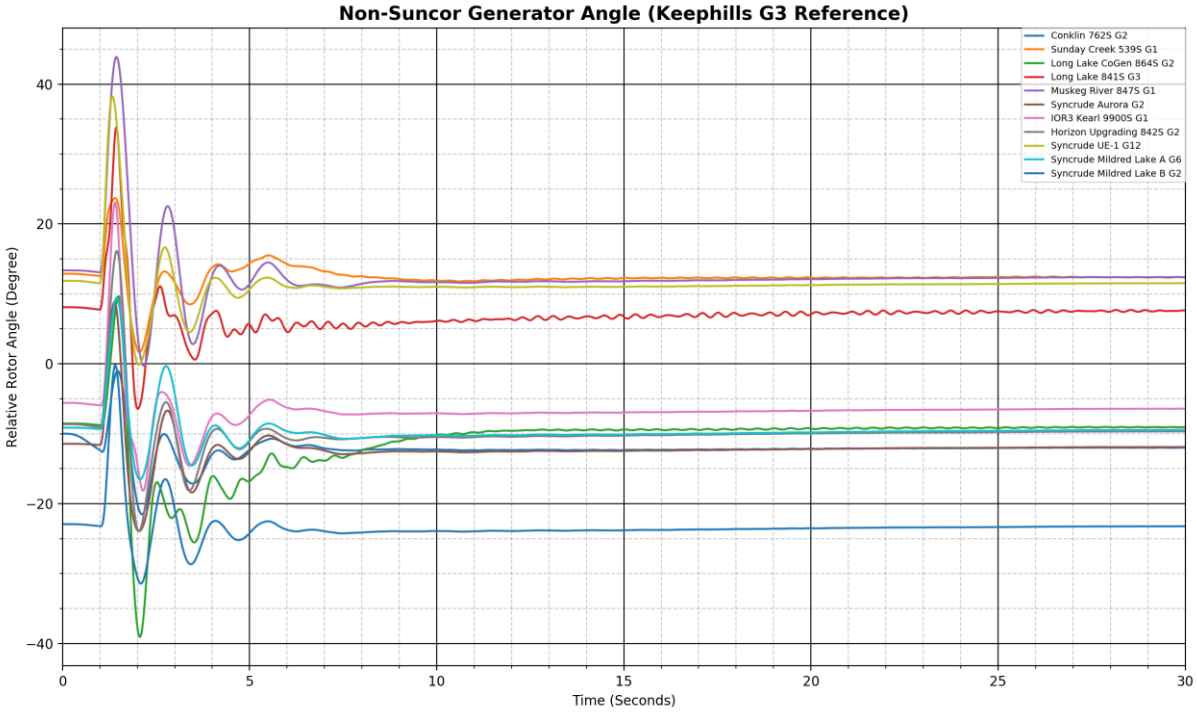
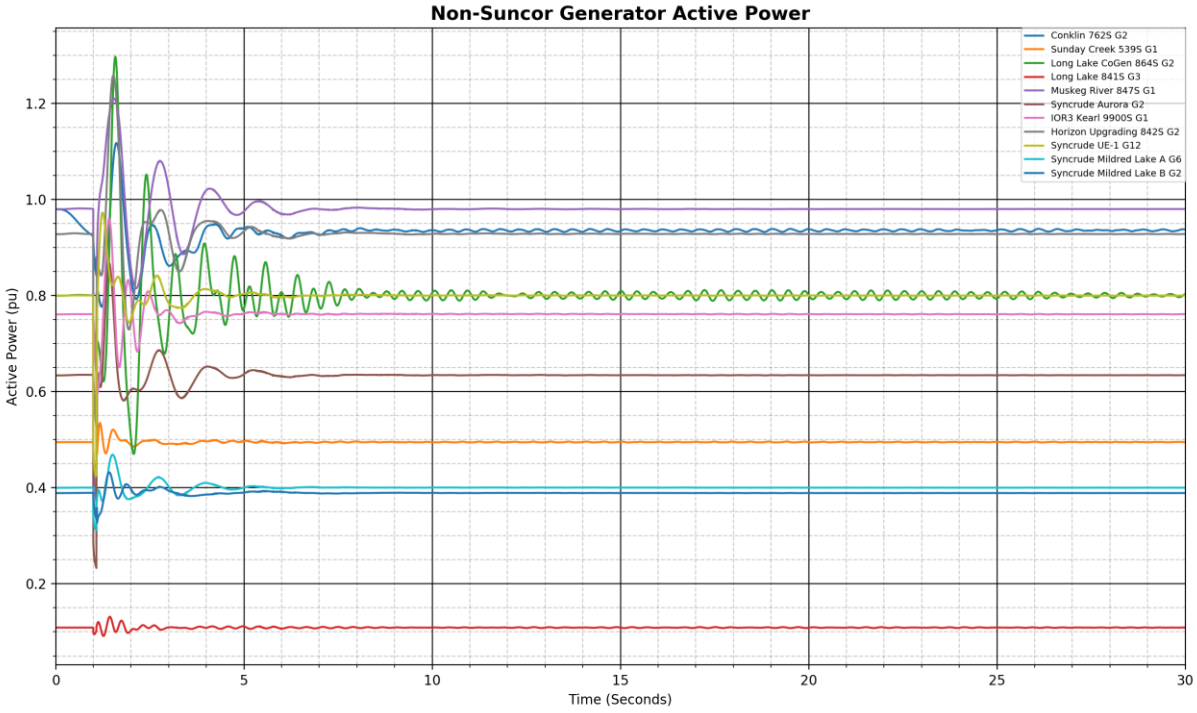

Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Reactive Power (Mvar)
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

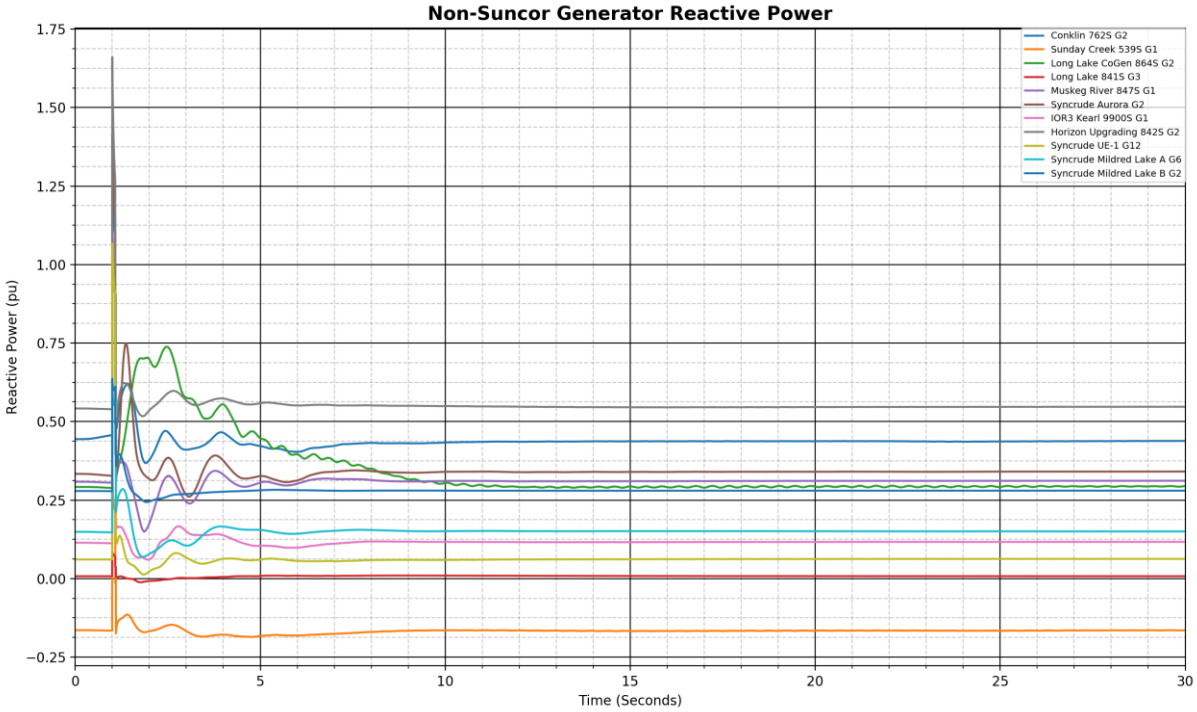
Figure A4-78: 9L162 (Voyageur 29EDD-94 to Thickwood Hills 951S): Fault at Thickwood Hills 951S

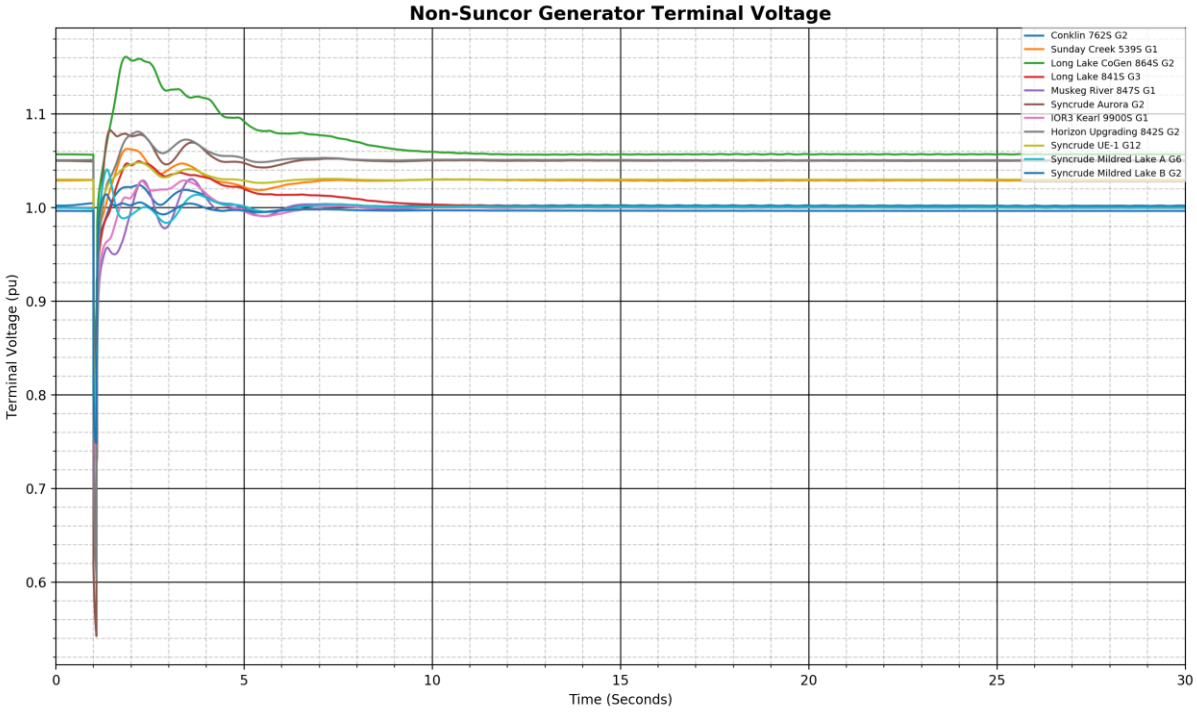


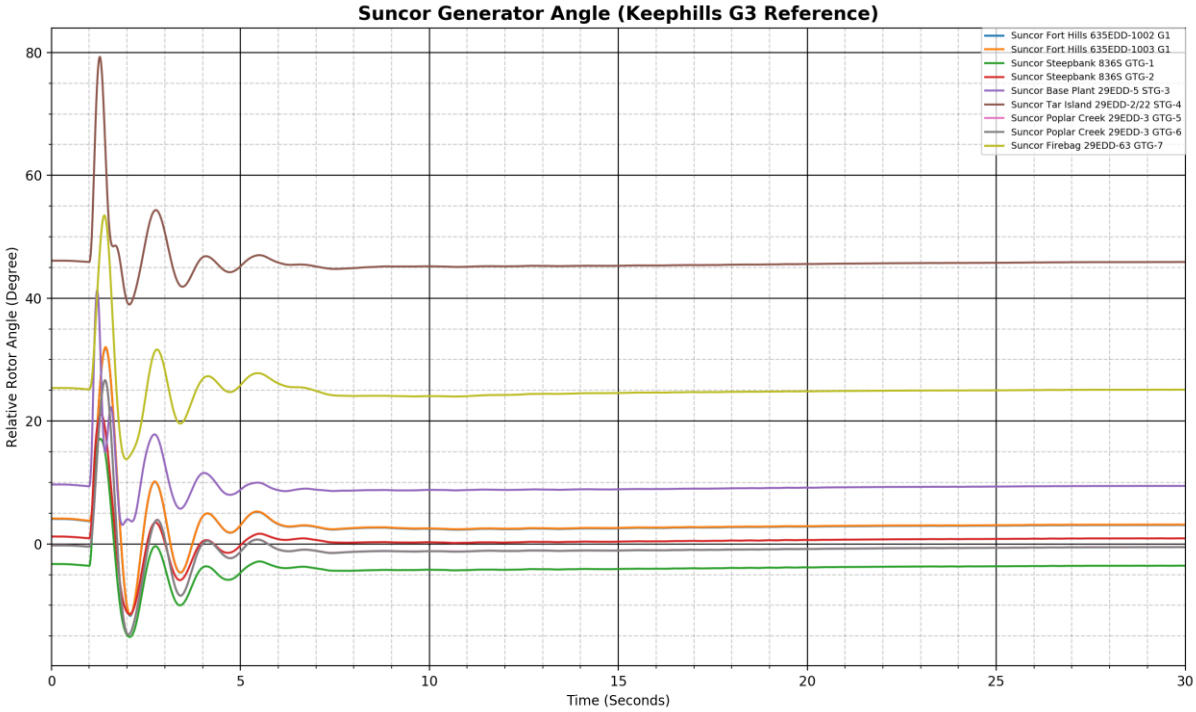


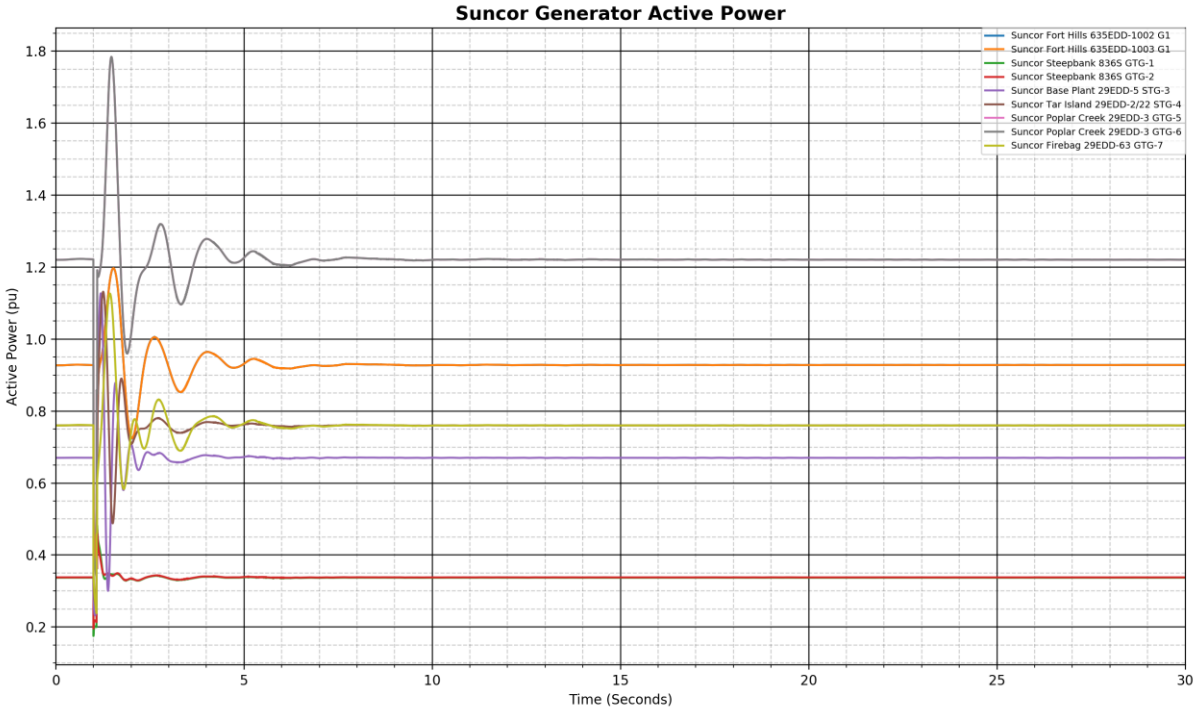

Non-Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

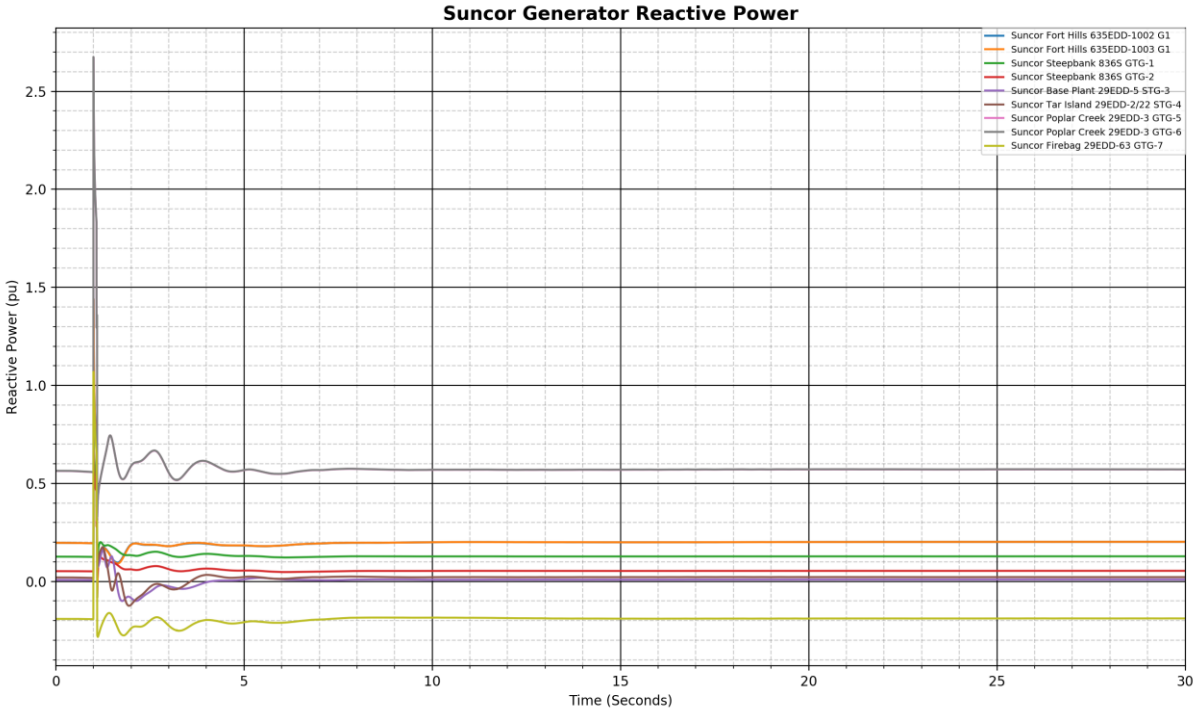

Non-Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

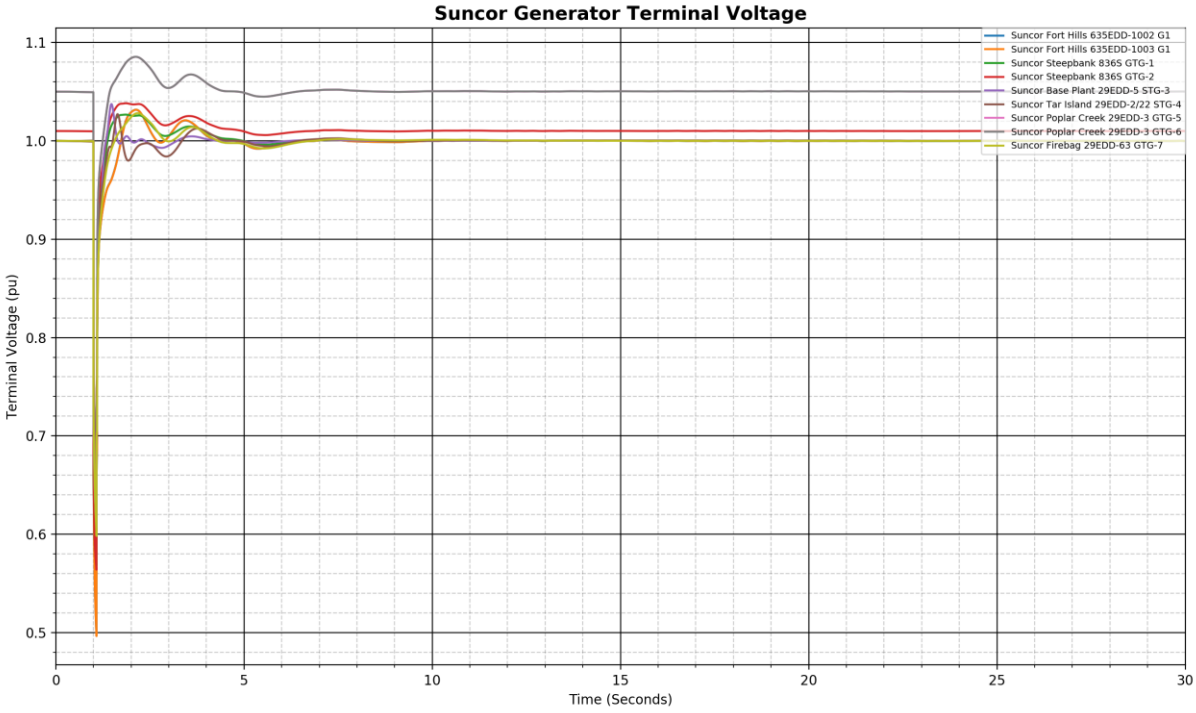

Non-Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

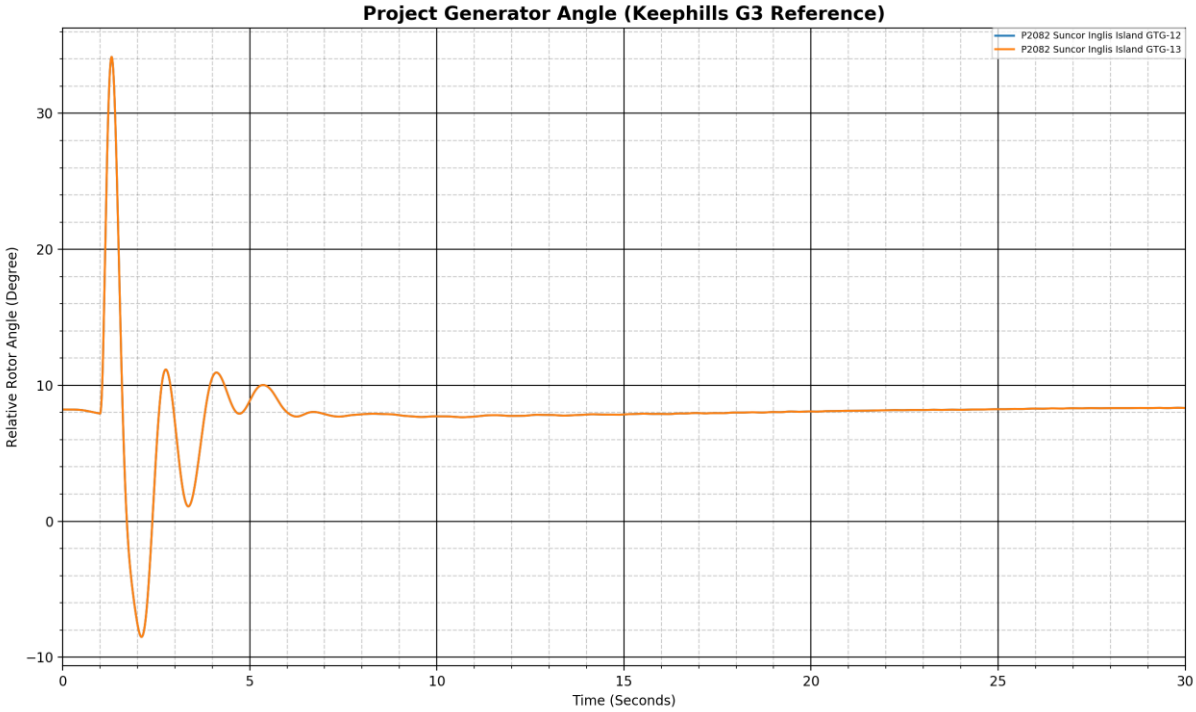

Non-Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Conklin 762S G2
Sunday Creek 539S G1
Long Lake CoGen 864S G2
Long Lake 841S G3
Muskeg River 847S G1
Syncrude Aurora G2
IOR3 Kearl 9900S G1
Horizon Upgrading 842S G2
Syncrude UE-1 G12
Syncrude Mildred Lake A G6
Syncrude Mildred Lake B G2

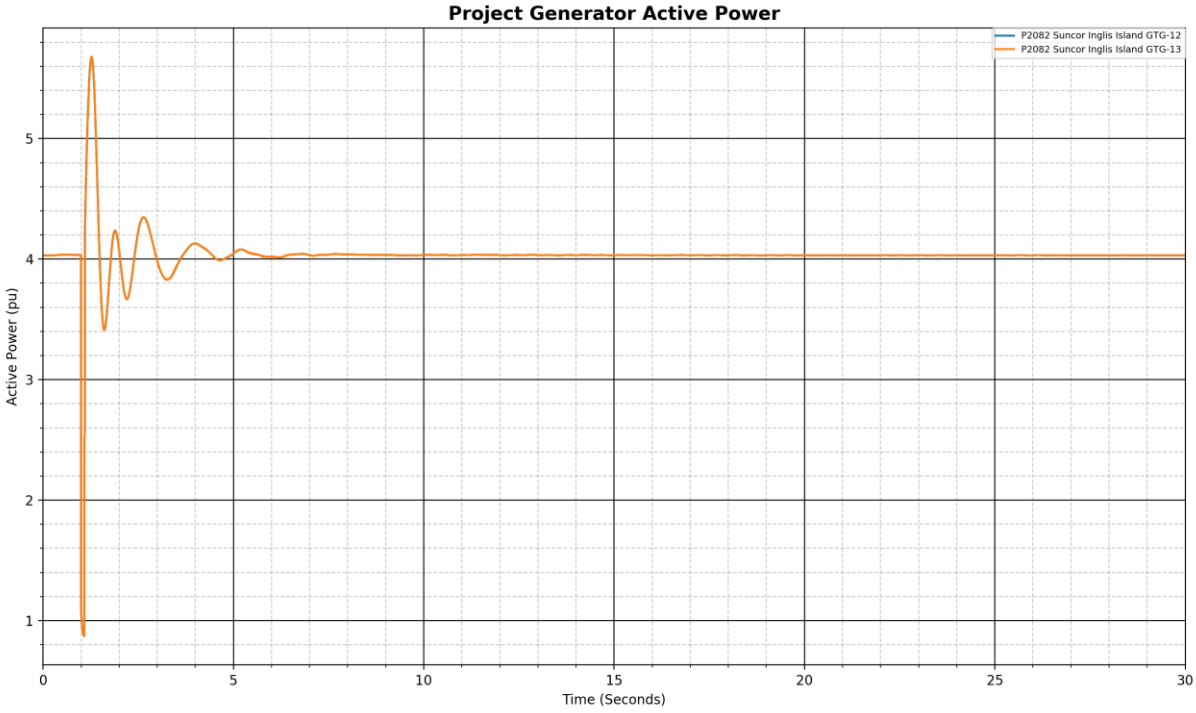

Suncor Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

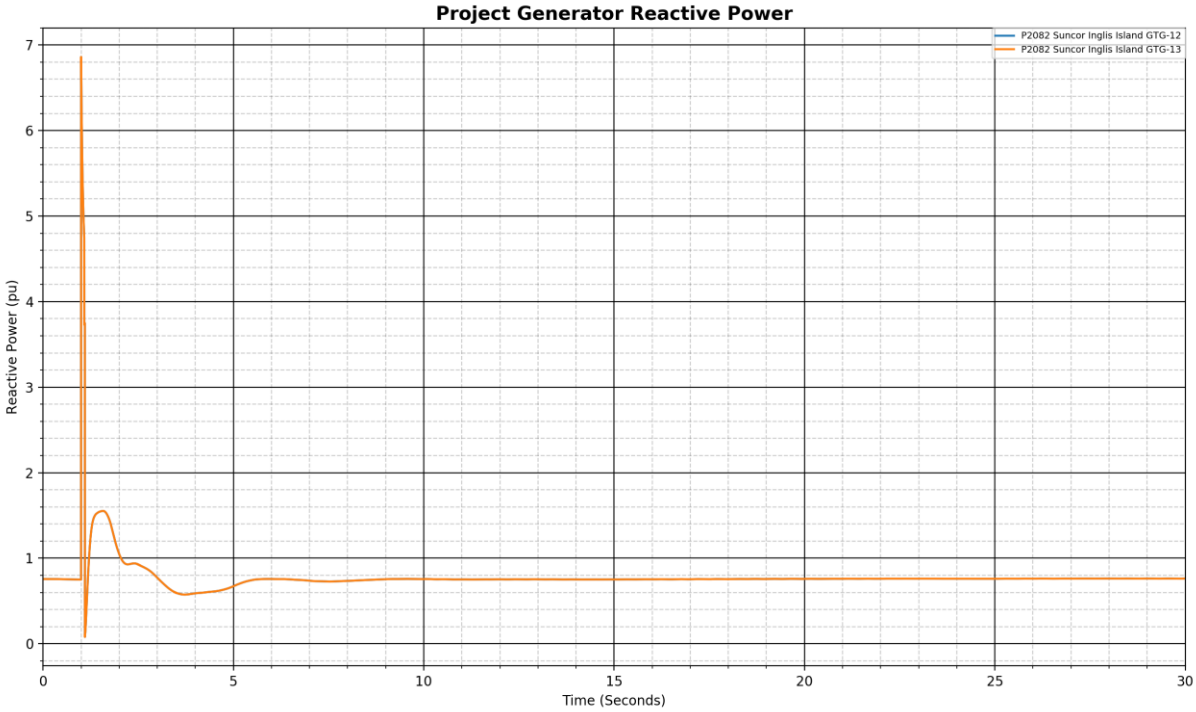

Suncor Generator Active Power
Active Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

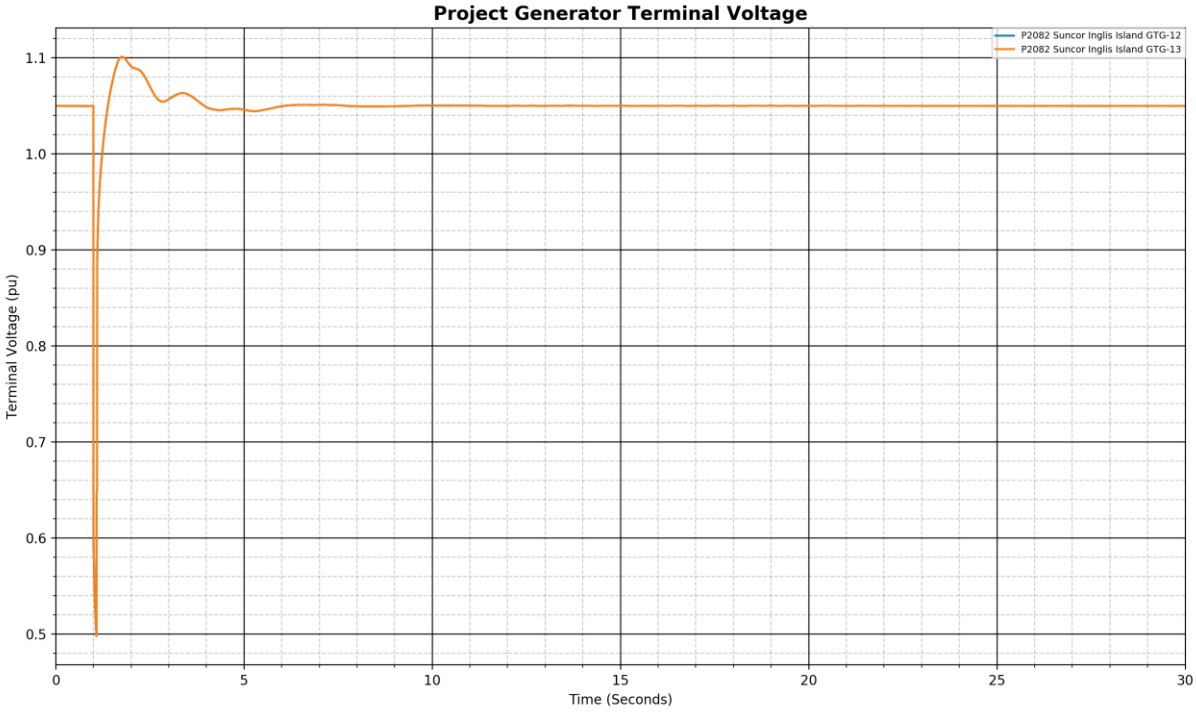

Suncor Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

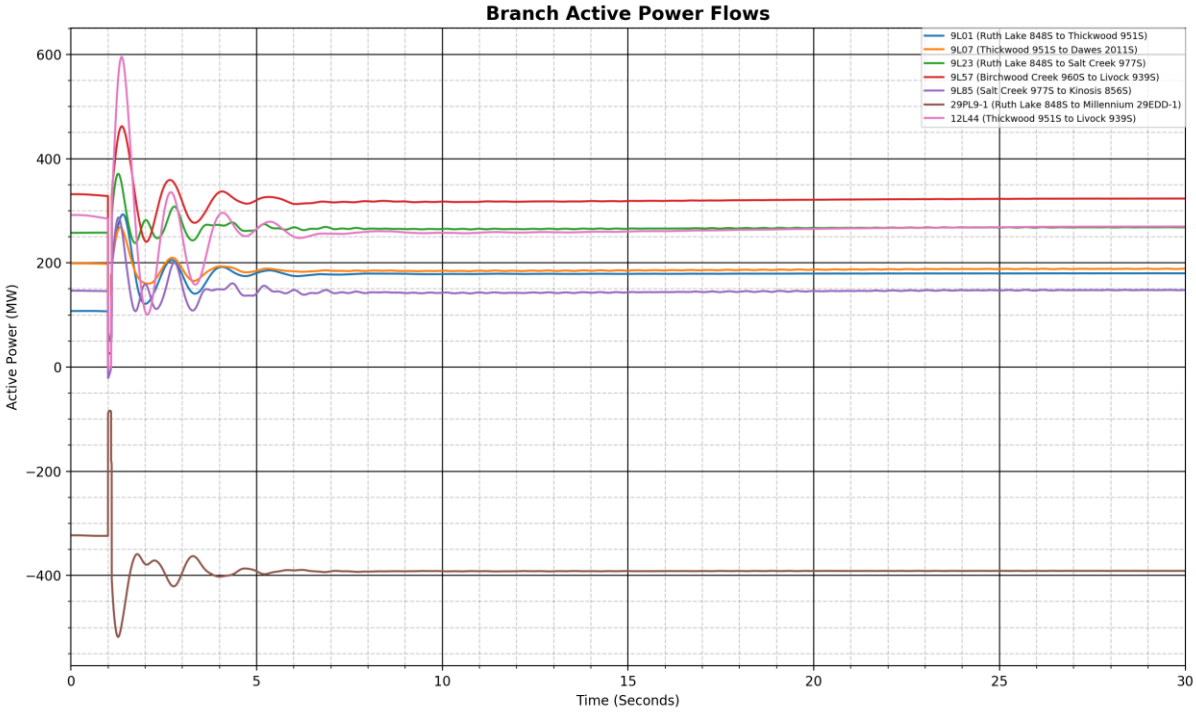

Suncor Generator Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
Suncor Fort Hills 635EDD-1002 G1
Suncor Fort Hills 635EDD-1003 G1
Suncor Steepbank 836S GTG-1
Suncor Steepbank 836S GTG-2
Suncor Base Plant 29EDD-5 STG-3
Suncor Tar Island 29EDD-2/22 STG-4
Suncor Poplar Creek 29EDD-3 GTG-5
Suncor Poplar Creek 29EDD-3 GTG-6
Suncor Firebag 29EDD-63 GTG-7

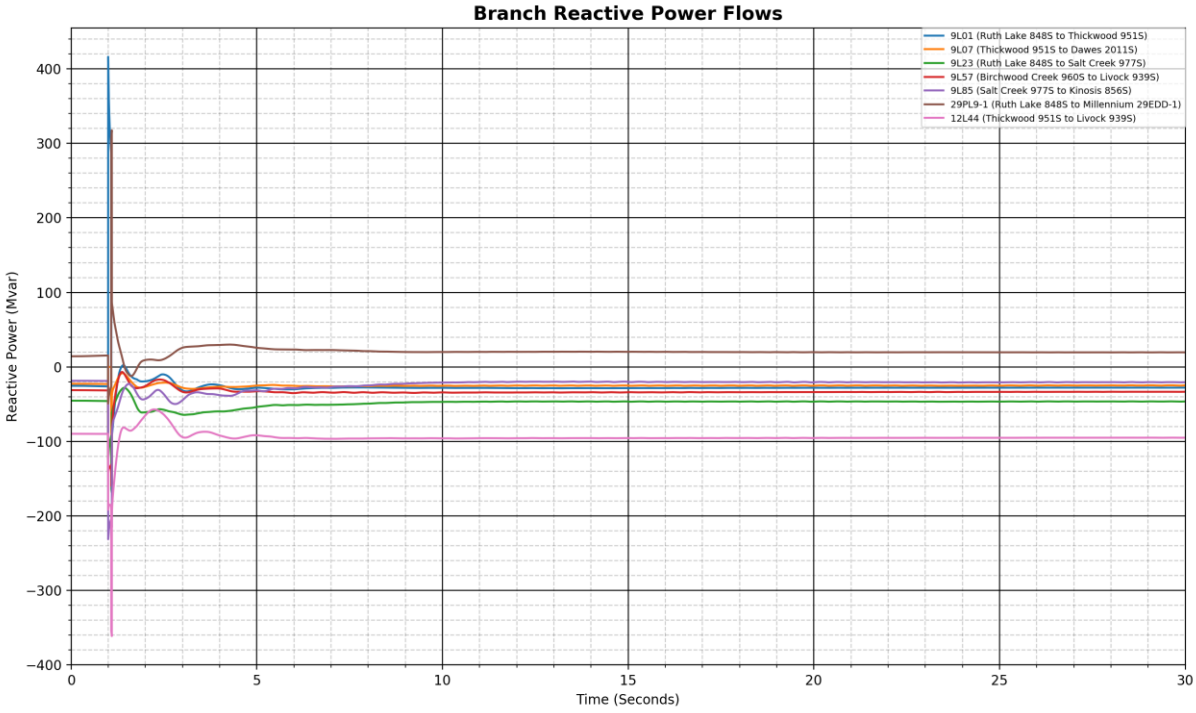

Project Generator Angle (Keephills G3 Reference)
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Relative Rotor Angle (Degree)
30
20
10
0
−10
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Active Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Active Power (pu)
5
4
3
2
1
0
5
10
15
20
25
30
Time (Seconds)


Project Generator Reactive Power
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Reactive Power (pu)
Time (Seconds)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30


Project Generator Terminal Voltage
P2082 Suncor Inglis Island GTG-12
P2082 Suncor Inglis Island GTG-13
Terminal Voltage (pu)
Time (Seconds)
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
5
10
15
20
25
30


Branch Active Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Active Power (MW)
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Time (Seconds)


Branch Reactive Power Flows
9L01 (Ruth Lake 848S to Thickwood 951S)
9L07 (Thickwood 951S to Dawes 2011S)
9L23 (Ruth Lake 848S to Salt Creek 977S)
9L57 (Birchwood Creek 960S to Livock 939S)
9L85 (Salt Creek 977S to Kinosis 856S)
29PL9-1 (Ruth Lake 848S to Millennium 29EDD-1)
12L44 (Thickwood 951S to Livock 939S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
Time (Seconds)

Attachment A5

Dynamic Data and Assumptions

Table A5-1: GENROU - Round Rotor Generator Model (Quadratic Saturation)

Round Rotor Generator Model (Quadratic Saturation)													
T´do	T″do	T´qo	T″qo	H	D	Xd	Xq	X´d	X´q	X″d = X″q	Xl	S(1.0)	S(1.2)
9.81	0.045	1.09	0.073	4.66	0.0	2.76	2.66	0.275	0.431	0.214	0.173	0.19	0.84

Table A5-2: IEEEST - IEEE Stabilizing Model

IEEE Stabilizing Model											
A1	A2	A3	A4	A5	A6	T1 (sec)	T2 (sec)	T3 (sec)	T4 (sec)	T5 (sec)	T6 (>0) (sec)
0.008	0.000016	2.5	0.0	0.18	0.0	0.18	0.08	0.18	0.08	1.5	1.5
KS	LSMAX	LSMIN	VCU	VCL							
-1.0	0.05	-0.05	0.0	0.0							

Table A5-3: EXST1 - IEEE Type ST1 Excitation System

IEEE Type ST1 Excitation System					
TR	VIMAX	VIMIN	TC	TB (sec)	KA
0.008	999	-999	0.8	4.1	303.8
TA (sec)	VRMAX	VRMIN	KC	KF	TF (> 0) (sec)
0.04	10.88	-4.26	0.25	0.0	1.0

Table A5-4: GAST - Gas Turbine-Governor

Gas Turbine-Governor								
R	T1	T2	T3	AT	KT	VMAX	VMIN	Dturb
0.05	0.1	1.0	5.0	1.0	3.125	1.0	0.05	0.1

Attachment A6

Post-Mitigation Power Flow Diagrams

List of Figures

Scenario and Case Name	Contingency (System Element Lost)	Figure Number
2023SL_Post-Project	12L44 (Sunnybrook 510S - Livock 939S)	Figure A6-1
	Thickwood Hills 951S Transformer 1201T	Figure A6-2
	12L45 (Thickwood Hills 951S - Livock 939S)	Figure A6-3

Figure A6-1: 2023 Summer Light Post-Project Contingency of 12L44 (Sunnybrook 510S - Livock 939S)

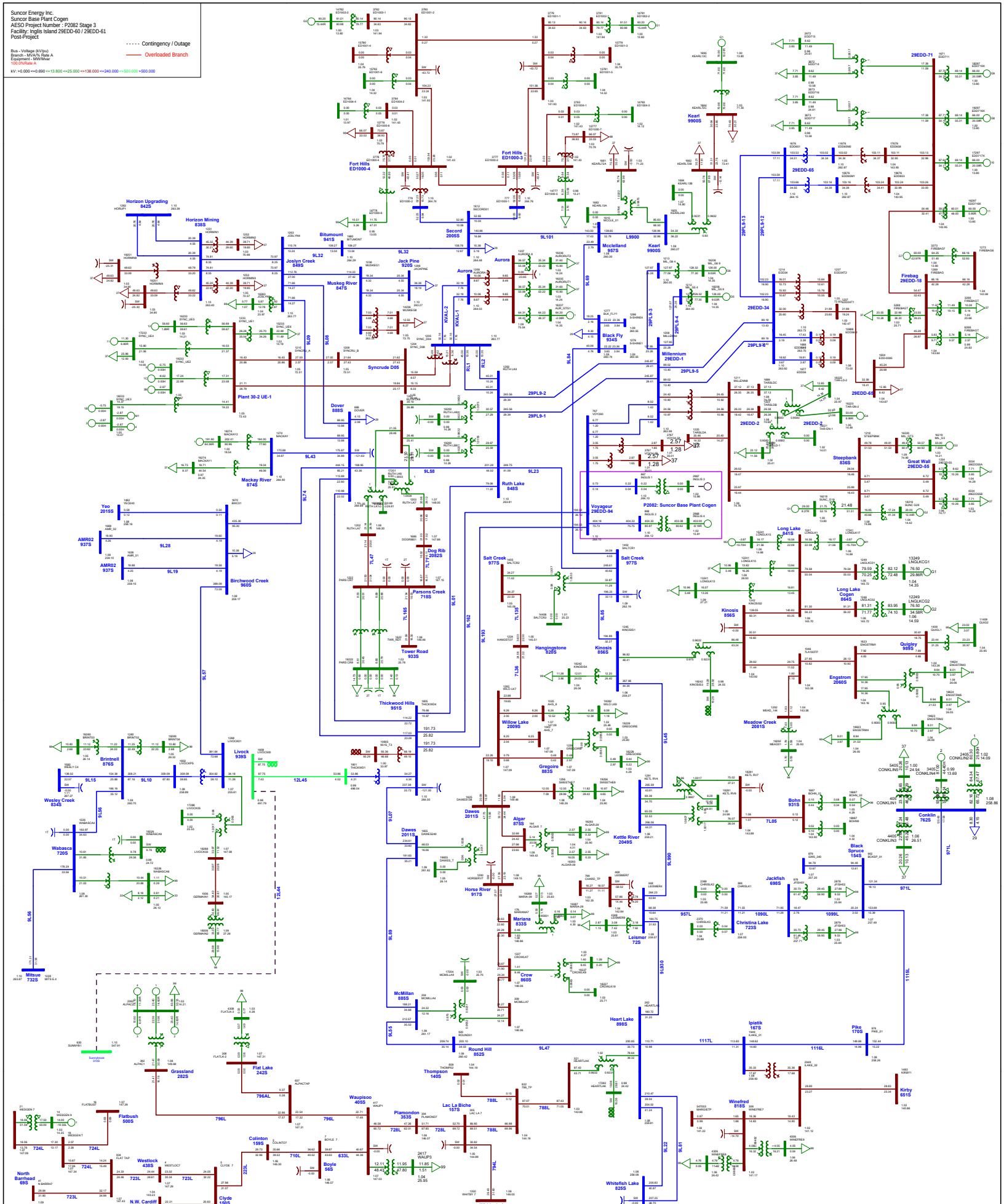


Figure A6-2: 2023 Summer Light Post-Project Contingency of Thickwood Hills 951S Transformer 1201T

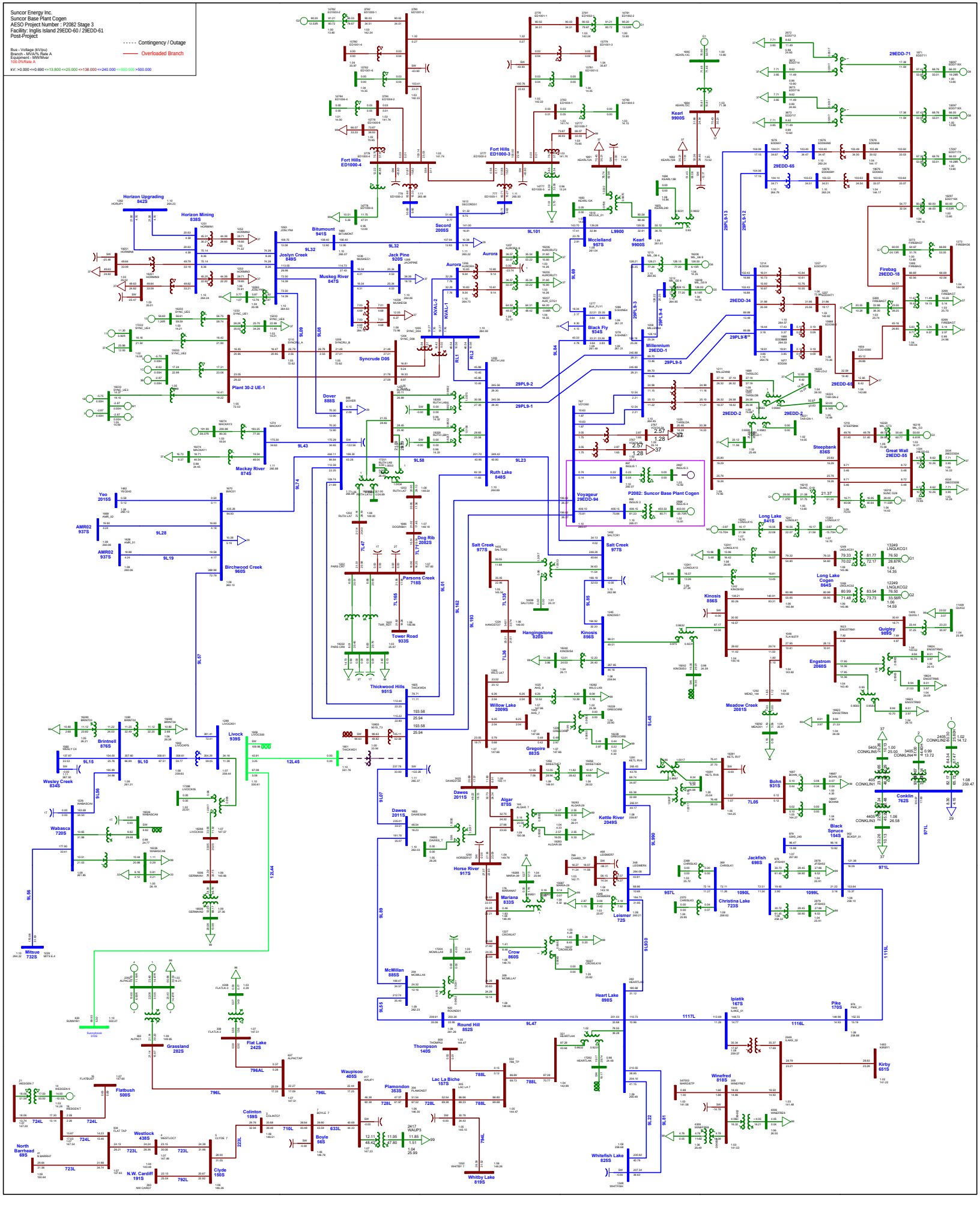
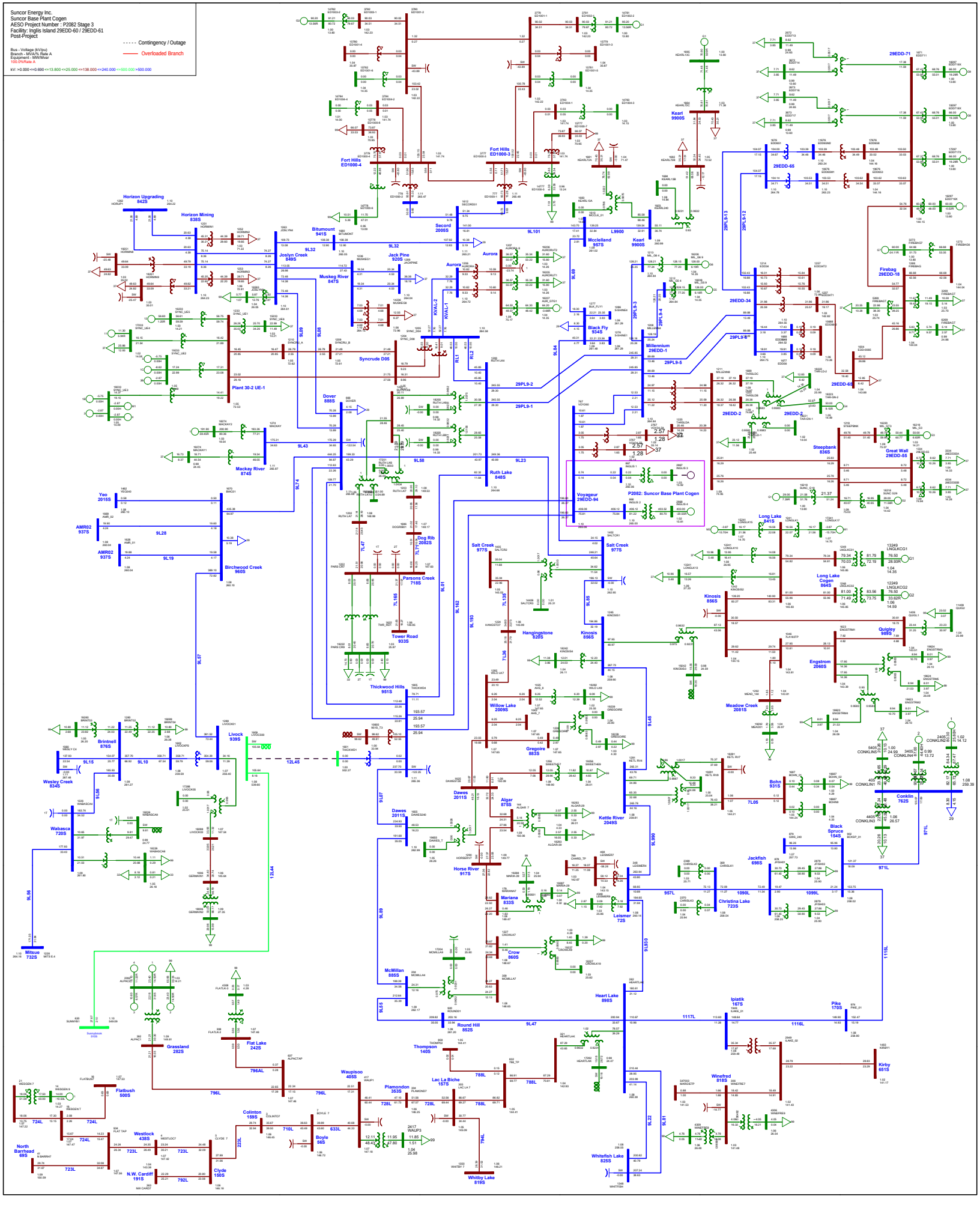

Suncor Energy Inc.
Suncor Base Plant Cogen
AESO Project Number : P2082 Stage 3
Facility: Inglis Island 29EDD-60 / 29EDD-61
Post-Project
Contingency / Outage
Overloaded Branch
Bus - Voltage (kV/pu)
Branch - MVA/% Rate A
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=0.690 <=13.800 <=25.000 <=138.000 <=240.000 <=500.000 >500.000
Horizon Upgrading 942S
Horizon Mining 838S
Bitumount 941S
Joslyn Creek 849S
Muskeg River 847S
Jack Pine 920S
Second 2005S
Fort Hills ED1000-4
Fort Hills ED1000-3
Aurora
Kearl 9900S
Mccleland 987S
Black Fly 934S
Millennium 29EDD-1
Syncrude D05
Plant 30-2 UE-1
Dover 888S
Mackay River 874S
Ruth Lake 848S
Yoo 2015S
AMR02 937S
Birchwood Creek 960S
Dog Rib 2082S
Parsons Creek 718S
Tower Road 933S
Thickwood Hills 951S
Salt Creek 977S
Hangingstone 920S
Kinosis 856S
Kinosis 856S
Long Lake 841S
Long Lake Cogen 864S
Steepbank 836S
Great Wall 29EDD-55
Firebag 29EDD-18
29EDD-71
29EDD-65
29EDD-34
29EDD-66
29EDD-2
29PL9-1
29PL9-2
29PL9-3
29PL9-4
29PL9-5
29PL9-6
29PL9-12
29PL9-13
P2082: Suncor Base Plant Cogen
Voyageur 29EDD-94
Livock 939S
Wesley Creek 834S
Brintnell 876S
Wabasca 720S
Mitsue 732S
Grassland 2025
Flat Lake 2425
Flatbush 500S
Westlock 438S
North Barrhead 69S
N.W. Cardiff 191S
Clyde 160S
Colinton 159S
Boyle 66S
Whitefish Lake 925S
Whitby Lake 819S
Waupisoo 408S
Plamondon 383S
Lac La Biche 157S
Thompson 140S
Heart Lake 899S
Round Hill 852S
McMillan 888S
Crow 860S
Mariana 833S
Horse River 917S
Gregoire 883S
Algar 879S
Dawes 2011S
Willow Lake 2009S
Kettle River 2049S
Leismer 72S
Christina Lake 723S
Jackfish 698S
Bohn 931S
Meadow Creek 2081S
Quigley 989S
Engstrom 2060S
Black Spruce 154S
Conklin 762S
Pike 1702S
Ipiatik 167S
Winefred 818S
Kirby 651S
Sunnybrook 910S
Fort Hills ED1000-3
Second ED1000-2
Second ED1000-1
Fort Hills ED1000-1
Fort Hills ED1000-2
Kearl 9900S
Kearl 9900S
Kearl 9900S

Figure A6-3: 2023 Summer Light Post-Project Contingency of 12L45 (Thickwood Hills 951S - Livock 939S)


Suncor Energy Inc.
Suncor Base Plant Cogen
AESO Project Number : P2082 Stage 3
Facility: Inglis Island 29EDD-60 / 29EDD-61
Post-Project
Contingency / Outage
Overloaded Branch
Bus - Voltage (kV/pu)
Branch - MVA/% Rate A
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=0.690 <=13.800 <=25.000 <=138.000 <=240.000 <=500.000 >500.000
Horizon Upgrading 942S
Horizon Mining 838S
Bitumount 941S
Joslyn Creek 849S
Muskeg River 847S
Jack Pine 920S
Aurora
Second 2005S
Fort Hills ED1000-4
Fort Hills ED1000-3
Kearl 9900S
Mccleland 987S
Millennium 29EDD-1
Black Fly 934S
Syncrude D05
Plant 30-2 UE-1
Dover 888S
Mackay River 874S
Dog Rib 2082S
Parsons Creek 718S
Tower Road 933S
Thickwood Hills 951S
Hangingstone 920S
Kinosis 856S
Kinosis 866S
Salt Creek 977S
Voyageur 29EDD-94
P2082: Suncor Base Plant Cogen
Ruth Lake 848S
Yoo 2015S
AMR02 937S
Birchwood Creek 960S
Livock 939S
Wesley Creek 834S
Wabasca 720S
Mitsue 732S
Brintnell 876S
Grassland 2825
Flatbush 500S
Flat Lake 2425
Thompson 140S
Round Hill 852S
Heart Lake 899S
Mcmillan 888S
Plamondon 383S
Waupisoo 408S
Lac La Biche 157S
Colinton 159S
Westlock 439S
North Barrhead 69S
Clyde 160S
N.W. Cardiff 191S
Whitefish Lake 925S
Whitby Lake 819S
Winefred 818S
Ipiatik 167S
Pike 1720S
Kirby 651S
Jackfish 698S
Christina Lake 723S
Leismer 72S
Kettle River 2049S
Horse River 917S
Mariana 833S
Crow 860S
Algar 879S
Gregoire 883S
Dawes 2011S
Willow Lake 2009S
Meadow Creek 2081S
Bohn 931S
Conklin 762S
Black Spruce 154S
Quigley 989S
Engstrom 2060S
Steepbank 836S
Great Wall 29EDD-55
Long Lake Cogen 864S
Long Lake 841S
Firebag 29EDD-18
29EDD-71
29EDD-65
29EDD-34
29EDD-66
29EDD-2
29PL9-1
29PL9-2
29PL9-3
29PL9-4
29PL9-5
29PL9-6
29PL9-12
29PL9-13
9L01
9L09
9L32
9L84
9L58
9L74
9L43
9L89
9L08
9L91
9L162
9L193
9L85
9L45
9L99
9L39
9L07
9L56
9L37
9L15
9L10
9L26
12L45
12L44
971L
1116L
1117L
957L
1090L
1099L
7L05
7L136
7L155
7L165
7L74
7L47
796L
724L
723L
792L
710L
633L
223L
794L
9L22
9L81
9L47
9L5
9L6
9L3359
Sunnybrook 910S
Syncrude 1
Syncrude 2
Syncrude 3
Syncrude 4
Syncrude 5
Syncrude 6
Syncrude 7
Syncrude 8
Syncrude 9
Syncrude 10
Syncrude 11
Syncrude 12
Syncrude 13
Syncrude 14
Syncrude 15
Syncrude 16
Syncrude 17
Syncrude 18
Syncrude 19
Syncrude 20
Syncrude

Attachment A7

Constraint Effective Factors Table

Table A7-1: Generator Type

Generating Facility Name and Unit Number	Suncor CBR G1	Suncor CBR G2	Suncor Steepbank	Suncor Firebag	Suncor 29EDD-71	Suncor Tar Island	Suncor Millenium G5	Suncor Millenium G6	Suncor Fort Hills G1	Suncor Fort Hills G2	MEG Christina Lake	Sunday Creek	IOL Kearl	Mckay River	Muskeg	Syncrude	CNRL Horizon	Long Lake
Type	Cogen	Cogen	Steam Turbine	Gas Turbine	Gas Turbine	Steam Turbine	Gas Turbine	Gas Turbine	Cogen	Cogen	Cogen	Thermal	Cogen	Cogen	Cogen	Cogen	Cogen	Cogen

Table A7-2: Constraint Effective Factors under N-1 Contingencies for Post-Project Scenarios

Case Names	Contingency	Limiting Branch	Plants																
			Suncor CBR G1	Suncor CBR G2	Suncor Steepbank	Suncor Firebag	Suncor 29EDD-71	Suncor Tar Island	Suncor Millenium G5	Suncor Millenium G6	Suncor Fort Hills G1	Suncor Fort Hills G2	MEG Christina Lake	Sunday Creek	IOL Kearl	Mckay River	Muskeg	Syncrude	CNRL Horizon	Long Lake
2023SL_Post-Project.sav	12L41 (Sunnybrook 510S - Livock 939S)	9L74 (Dover 888S - Birchwood Creek 960S)	34.6%	34.6%	34.9%	34.5%	34.5%	34.9%	34.9%	34.9%	36.7%	36.7%	23.0%	22.6%	36.3%	37.0%	36.7%	35.0%	37.0%	29.9%
2023SL_Post-Project.sav	12L41 (Sunnybrook 510S - Livock 939S)	9L57 (Livock 939S - Birchwood Creek 960S)	32.2%	32.2%	32.6%	32.2%	32.2%	32.5%	32.5%	32.5%	34.3%	34.3%	21.5%	21.1%	34.0%	34.5%	34.2%	32.7%	34.5%	27.9%
2023SL_Post-Project.sav	951S1201T (Thickwood Hills 951S Transformer 1201T)	9L74 (Dover 888S - Birchwood Creek 960S)	34.5%	34.5%	34.9%	34.5%	34.5%	34.9%	34.8%	34.8%	36.7%	36.7%	22.9%	22.6%	36.3%	37.0%	36.6%	35.0%	37.0%	29.8%
2023SL_Post-Project.sav	951S1201T (Thickwood Hills 951S Transformer 1201T)	9L57 (Livock 939S - Birchwood Creek 960S)	32.2%	32.2%	32.5%	32.2%	32.1%	32.5%	32.5%	32.5%	34.3%	34.3%	21.4%	21.1%	34.0%	34.5%	34.2%	32.6%	34.5%	27.8%
2023SL_Post-Project.sav	12L44 (Thickwood Hills 951S - Livock 939S)	9L74 (Dover 888S - Birchwood Creek 960S)	34.6%	34.6%	34.9%	34.5%	34.5%	34.9%	34.9%	34.9%	36.7%	36.7%	22.9%	22.6%	36.3%	37.0%	36.7%	35.0%	37.0%	29.8%
2023SL_Post-Project.sav	12L44 (Thickwood Hills 951S - Livock 939S)	9L57 (Livock 939S - Birchwood Creek 960S)	32.2%	32.2%	32.5%	32.2%	32.2%	32.5%	32.5%	32.5%	34.3%	34.3%	21.4%	21.1%	34.0%	34.5%	34.2%	32.7%	34.5%	27.8%
2023WP_Post-Project.sav	718S701T (Parsons Creek 718S Transformer 718S701T)	718S702T (Parsons Creek 718S Transformer 718S702T)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2023WP_Post-Project.sav	718S702T (Parsons Creek 718S Transformer 718S702T)	718S701T (Parsons Creek 718S Transformer 718S701T)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%